New Mexico Geological Society

Downloaded from: https://nmgs.nmt.edu/publications/guidebooks/18



Principal aquifers and uses of water between Laguna Pueblo and Gallup, Valencia and McKinley Counties, New Mexico

James B. Cooper and S. W. West
1967, pp. 145-149. https://doi.org/10.56577/FFC-18.145

in:

Defiance, Zuni, Mt. Taylor Region (Arizona and New Mexico), Trauger, F. D.; [ed.], New Mexico Geological Society 18th Annual Fall Field Conference Guidebook, 228 p. https://doi.org/10.56577/FFC-18

This is one of many related papers that were included in the 1967 NMGS Fall Field Conference Guidebook.

Annual NMGS Fall Field Conference Guidebooks

Every fall since 1950, the New Mexico Geological Society (NMGS) has held an annual Fall Field Conference that explores some region of New Mexico (or surrounding states). Always well attended, these conferences provide a guidebook to participants. Besides detailed road logs, the guidebooks contain many well written, edited, and peer-reviewed geoscience papers. These books have set the national standard for geologic guidebooks and are an essential geologic reference for anyone working in or around New Mexico.

Free Downloads

NMGS has decided to make peer-reviewed papers from our Fall Field Conference guidebooks available for free download. This is in keeping with our mission of promoting interest, research, and cooperation regarding geology in New Mexico. However, guidebook sales represent a significant proportion of our operating budget. Therefore, only *research papers* are available for download. *Road logs*, *mini-papers*, and other selected content are available only in print for recent guidebooks.

Copyright Information

Publications of the New Mexico Geological Society, printed and electronic, are protected by the copyright laws of the United States. No material from the NMGS website, or printed and electronic publications, may be reprinted or redistributed without NMGS permission. Contact us for permission to reprint portions of any of our publications.

One printed copy of any materials from the NMGS website or our print and electronic publications may be made for individual use without our permission. Teachers and students may make unlimited copies for educational use. Any other use of these materials requires explicit permission.

This page is intentionally left blank to maintain order of facing pages.

PRINCIPAL AQUIFERS AND USES OF WATER BETWEEN LAGUNA PUEBLO AND GALLUP, VALENCIA AND McKINLEY COUNTIES, NEW MEXICO[1]

By

JAMES B. COOPER AND S. W. WEST
Albuquerque, New Mexico and Denver, Colorado

INTRODUCTION

From Laguna Pueblo in Valencia County westward to Gallup in McKinley County, U.S. Highway 66 (Interstate 40) traverses areas that are topographically and geologically diverse (fig. 1), but which have a common feature, or failure—sparse supplies of ground water. Ground water is available in quantities of more than a few gpm (gallons per minute) at only a few localities in any of the areas.

The principal aquifer between Laguna Pueblo and Grants is the unconsolidated alluvium of Quaternary age along the Rio San Jose. In the Grants-Bluewater region the principal aquifer is formed by the Glorieta Sandstone and the overlying San Andres Limestone of Permian age; a secondary aquifer is the interbedded alluvium and basalt of Quaternary age.

North of Grants in the Ambrosia Lake region the Westwater Canyon Member of the Morrison Formation of Jurassic age is the principal aquifer. Westward from the Grants-Bluewater region to near Gallup, the principal aquifer is the middle sandstone of the Chinle Formation of Triassic age.

On the slopes of the Zuni Mountains ground water is obtained from the Glorieta Sandstone and the San Andres Limestone.

At and near Gallup five stratigraphic units, the Glorieta Sandstone and San Andres Limestone, the Westwater

1. Publication authorized by the Director, U.S. Geological Survey.

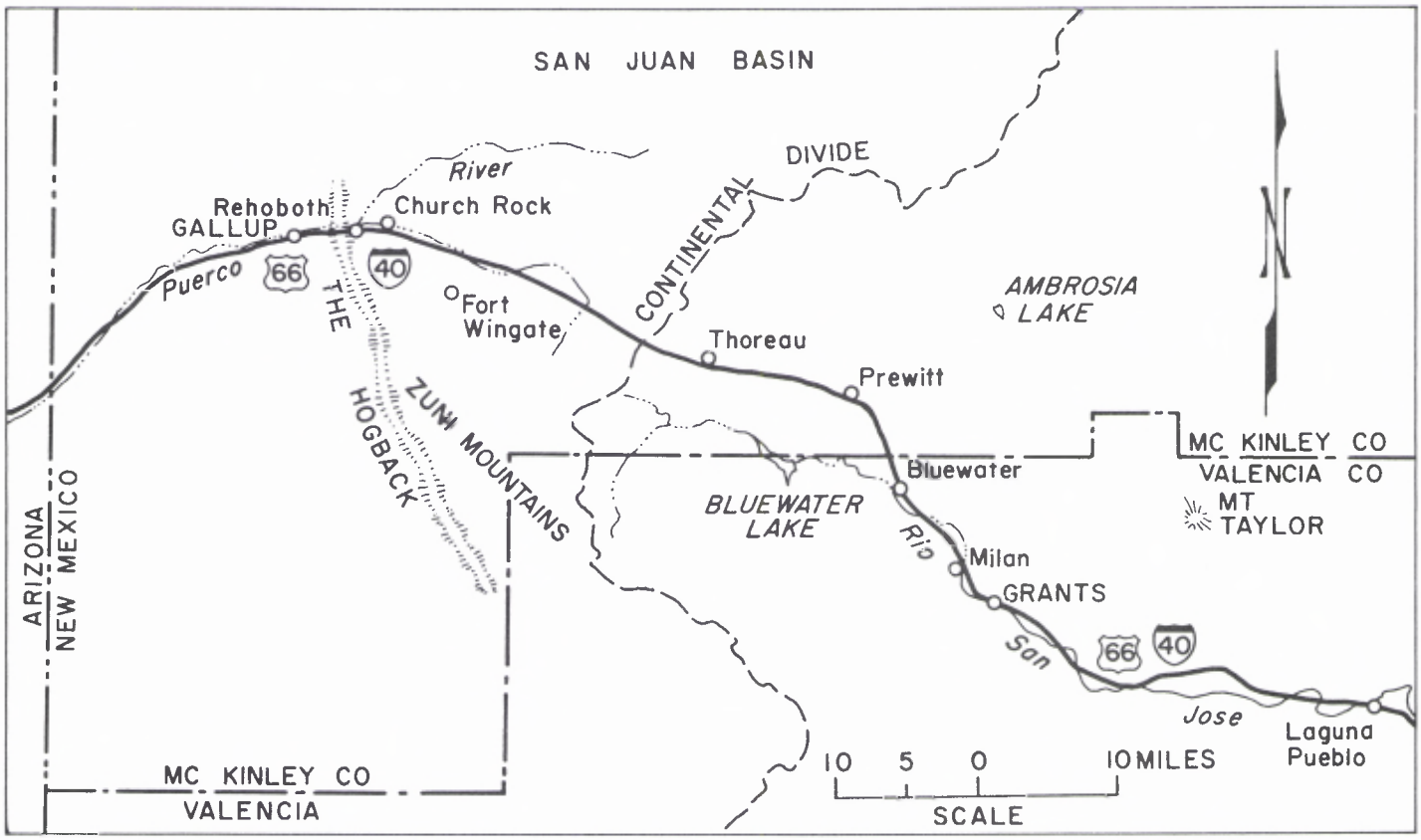


FIGURE 1
Map showing localities mentioned in text.

Canyon Member and the Dakota Sandstone, and the Gallup Sandstone of the Mesaverde Group, form three aquifers that are the most productive of ground water.

Structural features are important factors affecting the ability of the rocks to contain water and to yield water to wells, and structure largely controls the availability, depth, and quality of water in the aquifers. In most of the area the regional dip of the rocks is northward, with northeastward and northwestward components, at angles generally of from 2° to 5°. Much steeper dips are present near major fault zones and near anticlinal and synclinal structural axes. The steep dips affect profoundly the depth to usable ground water supplies. For example, rocks of the Morrison Formation, the Dakota Sandstone, and the Mesaverde Group crop out as steeply tilted beds having a westerly dip in The Hogback east of Gallup. The top of the Dakota Sandstone in the eastern part of Gallup is about 750 feet below the land surface and in the western part, about 1,940 feet.

At Thoreau, where Triassic and older rocks dip steeply northward from the flanks of the Zuni Mountains, the top of the Glorieta Sandstone is about 600 feet below the land surface on the south side of the highway, and it is about 1,100 feet below the land surface about half a mile to the north near the center of Thoreau.

GLORIETA SANDSTONE AND SAN ANDRES LIMESTONE

The Glorieta Sandstone and the overlying San Andres Limestone, both of Permian age, commonly form a single hydrologic unit but one of marked variation in both vertical and horizontal permeability.

The Glorieta generally is a well-sorted, very fine to medium-grained, orange-pink to whitish, quartz sandstone. The upper part of the formation is well cemented and resistant to erosion; the lower part commonly is soft and friable. On the north slope of the Zuni Mountains the formation has been cemented with silica, which makes it nearly impermeable: Locally, it is intensely fractured due to crustal deformation in the Zuni Mountains and has relatively high permeability. Its thickness within the area ranges from 100 to 300 feet.

The San Andres Limestone is a bluish-gray limestone near its base; the upper one-third is a grayish-pink, cherty, fossiliferous limestone, or, at places, a light-gray to yellowish-buff sandstone or sandy limestone. The San Andres within the area ranges from 0 to 150 feet thick. The variations in thickness are due to a long period of erosion during which solution channels formed a karst topography on its surface. The limestone locally has been entirely removed by erosion and the Chinle Formation of Late Triassic age lies directly on the Glorieta Sandstone.

From The Hogback east of Gallup eastward for several miles, the San Andres occurs as small remnants between the Glorieta and Chinle. A few wells in that area have been drilled into the San Andres, but most go directly from the Chinle Formation into the Glorieta Sandstone.

Both the Glorieta and the San Andres crop out on the flanks of the Zuni Mountains, largely on broad dip slopes, and, in places, they form the walls of deep, narrow canyons.

The Glorieta Sandstone often yields only small amounts of water to wells because in most places it is so fine-grained and so tightly cemented that storage and movement of water are confined largely to fractures. However, the Glorieta Sandstone contributes large amounts of water to the overlying San Andres Limestone by slow upward leakage, as water is withdrawn from the San Andres. This recharge of the San Andres is especially significant east of Gallup, where a few high yield wells penetrate remnants of the San Andres Limestone. The system of solution channels in the San Andres forms a natural collection gallery for water contributed slowly across a broad contact between the two formations.

The San Andres Limestone yields much more water to wells than does the Glorieta because of fractures and solution channels in the San Andres which serve as conduits for water. In the Zuni Mountains, near its outcrop, the San Andres yields several hundreds of gallons per minute. In the Grants-Bluewater region, between Bluewater and Milan, wells that tap the San Andres yield from 500 to more than 2,000 gpm. Farther from the outcrops the formation yields much less water, probably because ground-water circulation has been less and fewer channels have been dissolved.

Many wells that tap the San Andres near Gallup and on the flanks of the Zuni Mountains near Thoreau yield water by natural flow.

The Glorieta Sandstone and San Andres Limestone are recharged at their outcrops on the flanks of the Zuni Mountains where runoff from spring snowmelt and summer thunderstorms infiltrates the formations.

Natural discharge from these formations is by vertical leakage into overlying units and by flow from springs on the flanks of the Zuni Mountains. Water in the aquifer moves northeastward into the San Juan basin and southeastward towards the Grants-Bluewater region.

The chemical quality of the water in the Glorieta Sandstone and the San Andres Limestone near Gallup, Thoreau, and Prewitt is fair, although it is commonly hard, and in places it is high in sulfate. It is generally usable for domestic, stock, and industrial supplies. At greater distances from the outcrop, such as in the Ambrosia Lake area, the water is extremely high in sulfate and dissolved solids and is unsuitable for most purposes.

MIDDLE SANDSTONE OF THE CHINLE FORMATION

The middle part of the Chinle Formation of Triassic age is a yellow to gray sandstone with partings of purple to gray siltstone and mudstone. At places, a pebble to cobble conglomerate containing fragments of petrified wood is present within, or at the base of, the sandstone. Because of intertonguing with the upper and lower parts

of the Chinle the thickness of the middle sandstone varies from about 60 to 225 feet within the area.

The Chinle Formation underlies the floor of the valley between Grants and Gallup, and crops out in places along the valley edge. The middle sandstone crops out and forms a dip slope on the north flank of the Zuni Mountains south of Thoreau and Prewitt. A few outcrops can be seen in highway road cuts in this region.

The middle sandstone is a persistent aquifer, and near Thoreau and Prewitt it supplies nearly all of the ground water used for stock, domestic, and industrial use. Pumping rates of as much as 30 gpm are reported in these areas, but rates of 5 to 20 gpm are much more common and probably represent the maximum yield of most wells. Water in the aquifer is under artesian pressure owing to the dip of the beds northeastward from the slopes of the Zuni Mountains into the San Juan Basin. The water does not flow above the land surface from wells drilled into the aquifer but does rise some distance above the depth at which it is tapped in a well.

The middle sandstone is recharged at its outcrops in the mountains. No points of natural discharge are known. The general direction of movement of water in the aquifer is assumed to be northeastward from the recharge areas and down-dips into the San Juan Basin; however, in the valley near Thoreau and Prewitt the water moves southeastward, apparently in response to heavy withdrawals by pumpage in this region.

The chemical quality of water in the middle sandstone is variable; most of the water is of good to fair quality, but some is of poor quality. Principal dissolved solids in water from the aquifer are sodium, bicarbonate, and sulfate. The total differences in water quality are caused largely by differences in the clay content of the formation, by the ion-exchange capabilities within the formation, and by the movement and flushing action in the aquifer resulting from recharge by fresher water near the outcrop.

WESTWATER CANYON MEMBER

The Westwater Canyon Member of the Morrison Formation of Jurassic age consists of white to red very fine to coarse-grained partly conglomeratic sandstone. The member is massive and crossbedded and commonly is tightly cemented. Within the area the thickness of the Westwater Canyon ranges from 30 to 270 feet.

The Westwater Canyon crops out and forms steep cliffs in the escarpments north of the highway between Laguna Pueblo and Gallup; east of Gallup it crops out in the hogback. Near Laguna Pueblo and at a few other scattered localities within the area the outcrops are mined for uranium ore. In the Ambrosia Lake region many miles of underground workings have tapped the sandstone for its rich uranium content.

Where the Westwater Canyon Member is below the water table yields to wells of 5 to 20 gpm are common. In the Ambrosia Lake region several hundred gpm were pumped from individual mine shafts when the shafts were first bottomed in the sandstone. In the Gallup region the water-bearing properties of the Westwater Canyon are ill defined because few wells tap it exclusively. At Gallup the Dakota Sandstone lies directly on the Westwater Canyon Member and the two lithologic units form a single hydrologic unit.

The Westwater Canyon Member is recharged by infiltration of precipitation and runoff on the outcrops which generally are on higher ground. The water in the aquifer is under artesian pressure and water levels rise several tens of feet above the top of the aquifer at most places where it is tapped by wells.

The general direction of movement of water in the aquifer is northeastward, except near Gallup where it is northward or westward. Water in the aquifer is discharged naturally through small springs and seeps in the outcrop areas. At Gallup the Westwater Canyon probably transmits large volumes of water locally by slow vertical leakage to the overlying more permeable Dakota Sandstone.

The chemical quality of the water in the Westwater Canyon Member is suitable for domestic, stock, and industrial use. The water generally contains less than 1,000 ppm (parts per million) dissolved solids; the main constituents are calcium, sodium, bicarbonate, and sulfate.

DAKOTA SANDSTONE

The Dakota Sandstone of Cretaceous age consists of yellowish-buff to gray, massive, quartz sandstone with local beds and lenses of conglomerate and coal. Generally the sandstone is firmly cemented with silica. Fractures are abundant locally. The Dakota ranges in thickness from 50 to 250 feet within the area.

The Dakota forms the caprock on the escarpments and mesas along the highway between Laguna Pueblo and Gallup and crops out over large areas on the back slopes of the escarpments. East of Gallup the Dakota crops out as a sharp ridge in The Hogback.

The Dakota Sandstone contains water where it lies below the water table. In the eastern part of the Ambrosia Lake region, several mine shafts encountered water in the Dakota in quantities large enough to create dewatering problems. Near Gallup its fine texture and tight cementation preclude large yields of water, except possibly where fracture systems are well developed. Within most of the area where the Dakota is an aquifer, yields of 1 to 10 gpm can be obtained from wells.

The Dakota Sandstone is recharged by precipitation on its outcrops and probably, in places, by downward percolation of water through fault zones. At Gallup it receives recharge from slow upward leakage from the Westwater Canyon Member.

Water in the Dakota is generally under artesian pressure; however, pressures are not sufficient to cause flow above the land surface from wells that tap the aquifer, except at a few places near Gallup. Before the artesian head was lowered by continuous withdrawal of water for many years at Gallup, all the wells that tapped the Dakota would flow several gallons per minute.

Natural discharge is the area is limited to small seeps and springs in outcrop areas.

The direction of movement of water in the aquifer is ill defined, but probably is to the northeast, east of the Continental Divide, and north or west, west of the Continental Divide.

The chemical quality of the water in the Dakota Sandstone is variable. Commonly the water is high in dissolved solids and may be unsuitable for domestic use, but is generally is suitable for stock. The inferior quality of water in the Dakota is probably due to oxidation of sulfide minerals within the sandstone and in the overlying Mancos Shale.

GALLUP SANDSTONE

The Gallup Sandstone of the Mesaverde Group of Cretaceous age consists of light-gray, buff, and pale-red very fine to very coarse grained sandstone and thin to thick beds of shale. The thickness ranges from 60 to 350 feet within the area.

The Gallup Sandstone crops out as a caprock in escarpments east of Gallup, as sharp ridges along the west side of The Hogback, and in small patches in the center of Gallup. In the western part of the town the top of the Gallup Sandstone is about 950 feet below the land surface.

The Gallup Sandstone is an aquifer where it lies below the water table. At Gallup it yields as much as 260 gpm of water to wells.

The Gallup Sandstone is recharged in its outcrop areas by infiltration of precipitation and runoff. Locally, it is recharged by downward percolation of water from the overlying unconsolidated sediments. Annual recharge probably is small in the Gallup region as indicated by declining water levels in the vicinity of well fields. Water from the sandstone is discharged naturally through small springs and seeps in the outcrop areas and by vertical or lateral leakage into adjacent unconsolidated deposits.

The chemical quality of the water in the Gallup Sandstone varies widely, probably because of variations in the quality of recharge water and because of the presence locally of coal beds and carbonaceous shale within the formation.

ALLUVIUM AND BASALT

Alluvium and basalt of Quaternary age form a single hydrologic unit in parts of the Grants-Bluewater region. They were deposited in stream courses cut into the late Tertiary basalt flows that covered much of the region. The main stream courses had been eroded to depths of 150 to 200 feet or more below the altitude of the present land surface when deposition began in Quaternary time.

First to be deposited was alluvium composed of silt, sand, and gravel, which accumulated to depths of 30 feet or more along the stream courses. The first of four basaltic lava flows then filled parts of the valleys and covered the alluvium. The four cycles of basalt flows and deposition of alluvial material have resulted in an accumulation of alluvium and interbedded basalt having a thickness which generally ranges from 100 to 140 feet in the region between Bluewater and Grants.

The lowermost bed of alluvium is the most permeable, and most wells are drilled through the basalt and interbeds of alluvium into the basal sand and gravel. The basalt is sufficiently fractured to act as an aquifer, but interconnections between fractures are poor. Water in the aquifer is under water-table conditions. The alluvium and basalt yield adequate supplies of water for stock and domestic use at many places and at a few places supplies adequate water for irrigation use.

The chemical quality of the water in the alluvium and basalt ranges widely within short distances and varies within short periods of time because the sources of recharge are numerous and because these sources may contribute water of different quality at different times. In the vicinity of Grants, Milan, and Bluewater the alluvium contains water of good quality.

ALLUVIUM

Alluvium of Quaternary age along the Rio San Jose, near Laguna Pueblo consists mainly of silt, clay, very fine to medium sand, and interbedded very coarse sand and gravel, and volcanic debris. The alluvium is as much as 150 feet thick. The alluvium north of the Rio San Jose contains coarser and better sorted sediments than does the alluvium south of the river.

Much of the alluvium on the north side was derived from the hard, dense, volcanic rocks of Mount Taylor and consists of sand and gravel generally well rounded and sorted.

The alluvium on the south side of the river was derived largely from soft sandstone and shale, which tend to disintegrate into small particles during erosion and transportation. Such alluvium has low permeability and yields water slowly to wells.

The yield of wells that tap the alluvium range from 2 to more than 150 gpm. Most of the large-capacity wells obtain water from discontinuous beds of channel gravel which are interbedded with flood-plain silt.

The chemical quality of water in the alluvium varies from good to very poor. Water in the fine alluvium south of the Rio San Jose is more highly mineralized than water in the coarse alluvium north of the river because the fine alluvium contains a greater proportion of readily soluble minerals.

Precipitation, streamflow, and discharge from the underlying rocks are all sources of recharge to the alluvium.

The alluvium discharges water to the Rio San Jose in the western part of the area, where its channel intercepts the water table, and elsewhere by evapotranspiration where the water table is within a few feet of the land surface.

UTILIZATION OF WATER

The prinicpal utilization of ground water in the reach between Laguna Pueblo and Gallup is for public supply,

industrial use, and irrigation. Some of the communities have public supply systems, others depend upon individual private wells. All motels, cafes, and service stations along the reach and the Indian Schools and Mission schools—notably the Baca Day School near Prewitt, the Thoreau Boarding School at Thoreau, and the Rehoboth Mission School at Rehoboth—are supplied by their own wells. Many private wells supplying water for industrial uses are located in Grants and Gallup, and at several other locations.

Irrigation is practiced principally in the region near Grants and Bluewater. The following discussion of the utilization of water is confined to brief descriptions of a few major points of withdrawal of ground water within the area.

PUBLIC SUPPLY

Two wells that tap water in the alluvium along the Rio San Jose in the Laguna Pueblo supply the communities of Seama and Paraje, the Laguna-Acoma School, and the Bureau of Indian Affairs School at Old Laguna. One well, 100 feet deep, is pumped at 60 gpm; the second well, 150 feet deep, was tested at 450 gpm.

The Town of Grants has five drilled wells that supply peak demands of 50 million gallons per month to the public-supply system. Three of the wells tap the alluvium and basalt aquifer. They range in depth from 95 to 110 feet and yield about 500 gpm each. Two wells tap the San Andres Limestone at depths of 245 and 300 feet. The 245 foot well is pumped at 2,100 gpm. The 300 foot well was tested at 1,380 gpm. After the San Andres wells were drilled, the three wells that tap the alluvium and basalt aquifer were "retired" because of frequent bacterial pollution of the shallow, unconfined water.

The village of Milan has two drilled wells that tap the alluvium and basalt aquifer. One well is 126 feet deep and is pumped at 160 gpm; the second well is 150 feet deep and is pumped at 1,110 gpm. Peak public-supply demand at Milan reaches 11 million gallons per month.

The public supply for the community of Bluewater is obtained from one drilled well 350 feet deep that taps the San Andres Limestone and is pumped at 60 gpm. Peak demand at Bluewater reaches about 1.5 million gallons per month.

At the community of Fort Wingate one drilled well that is privately owned supplies a peak demand of about 350,000 gallons per month to the community. This well is 350 feet deep and taps the Glorieta Sandstone. The Bureau of Indian Affairs Boarding School at Fort Wingate uses nearly one million gallons per month at peak demand. The school is supplied by four wells that tap the Glorieta Sandstone, and by a spring that rises from the Glorieta Sandstone or San Andres Limestone and flows 46 gpm. The wells range in depth from 312 to 430 feet.

The community of Indian Village (Church Rock) is supplied by two wells owned by the Navajo Indian tribe. Estimated usage in the community is about two million gallons per month. Part of the water is supplied by a well 215 feet deep that taps alluvium, and part is supplied by a well 1,966 feet deep that taps the Glorieta Sandstone.

The city of Gallup has a peak demand of about 60 million gallons per month of water to its public-supply system. The water is obtained from about 14 wells that range in depth from 320 to 2,400 feet. Five of the wells tap only the Gallup Sandstone; the remainder are drilled into the Westwater Canyon Member-Dakota Sandstone aquifer. Individual yields of the wells range from less than 100 gpm to 260 gpm.

INDUSTRIAL

The amount of water pumped in the area for industrial use has not been estimated. The largest users are the Homestake Mining Co. uranium mills north of Grants, the Anaconda Co. uranium mill west of Bluewater, the El Paso Natural Gas Co. compressor station south of Thoreau, the Transwestern Pipeline Co. compressor station north of Thoreau, and the El Paso Natural Gas Co. plant east of Gallup.

IRRIGATION

Approximately 1,900 acre-feet (620 million gallons) of water were estimated to have been pumped from wells for irrigation use in the Grants-Bluewater region in 1966. Nearly all of the irrigation wells tap the San Andres Limestone. A few wells tap both the alluvium and basalt aquifer and the San Andres Limestone. Yields of some of the wells exceed 2,000 gpm.

The first irrigation well in this region was drilled in 1944. By 1954 the use of ground water for irrigation reached a peak of 12,600 acre-feet. Since 1954 the use of ground water for irrigation use has steadily declined. Several wells formerly used for irrigation have been converted to municipal and industrial use.

REFERENCES

Cooper, J. B., and John, E. C., 1965, Ground-water occurrence and geology of southeastern McKinley County, New Mexico: U.S. Geol. Survey open-file report, 263 p., 7 figs.

Dinwiddie, G. A., and Motts, W. S., 1964, Availability of ground water in parts of the Acoma and Laguna Indian Reservations, New Mexico: U.S. Geol. Survey Water-Supply Paper 1576-E, 65 p., 12 figs.

Dinwiddie, G. A., Mourant, W. A., and Basler, J. A., 1966, Municipal water supplies and uses, northwestern New Mexico: N. Mex. State Engineer Tech. Rept. 29C, 197 p., 24 figs.

Gordon, E. D., 1961, Geology and ground-water resources of the Grants-Bluewater area, Valencia County, New Mexico: N. Mex. State Engineer Tech. Rept. 20, 109 p., 14 figs.

West, S. W., 1961, Availability of ground water in the Gallup area, New Mexico: U.S. Geol. Survey Circ. 443, 21 p., 2 figs.



Centennial arch overlooking Fort Wingate from the south.