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Summary of Test Drilling, Gran Quivira National Monument, New Mexico

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Introduction

The National Park Service contracted in September 1953 for one or more test holes to be drilled at Gran Quivira National Monument to determine the availability of a ground-water supply for the Monument. At the request of the Park Service, the Ground Water Branch of the U. S. Geological Survey participated in the test-drilling and well-construction program. This report describes samples collected during drilling, gives the results of the aquifer tests, and lists the chemical analysis of the water obtained from the test hole which was finished as a production well. Geologic and hydrologic data on the area are summarized in the report "Availability of ground water at Gran Quivira National Monument, New Mexico", by Alfred Clebsch, Jr.

Location of Site

A site in the NE¼NW¼SW¼ sec. 4, T. 1 S., R. 6 E., Socorro County, N. Mex., was selected for the Gran Quivira test hole. The quality of water in the main zone of saturation at this site was expected to be as good as any in the area. Also, the alluvium could be tested for shallow perched water at this site. The location was thought to be south of a possible westward extension under the alluvium of two dikes, thought to be barriers to ground-water movement. The two dikes crop out prominently at the monument headquarters and extend more than a mile east northeast from the headquarters (Clebsch, 1957, pl. 1).

A thin zone containing perched ground water was penetrated at about 320 feet. The driller estimated that the zone yields about a quart of water per minute, which cascades down the hole. The main water table is about 612 feet below land surface, which is more than 60 feet deeper than was expected. (See Clebsch, 1957, pl. 1.) The northward-trending trough in the water table, therefore, is deeper than is shown on plate 1 of the report by Clebsch.

The sandstone cuttings from the main water-yielding zone have very low permeability, so most of the water probably flows to the well from fractures in the sandstone rather than from interstices between the sand grains. After pumping for 24 hours at a rate of 50 gpm (gallons per minute) the drawdown was less than 1 foot. The small drawdown indicates that the sandstone is much more permeable than would be expected from examination of the cuttings.

That the sandstone aquifer is fractured is inferred also from the fact that several times during drilling of the water-yielding zone, only a small amount of cuttings was recovered by the bailer after a few feet of drilling. After drilling a few more feet and bailing again, an unusually large amount of cuttings was recovered. The cuttings broken by the bit during drilling possibly were washed into fractures in the rock by the surging action of the bit. On drilling deeper, and with further surging, the cuttings were washed back into the hole to be recovered by a later run of the bailer.

Table 1.--Summary sample description, Gran Quivira Test Hole 1 (15.8.4.)12), Gran Quivira National Monument, N. Mex.

Material	Thickness (feet)	Depth (feet)
Quaternary alluvium:		
Sand, silty and clayey, brown, very fine to fine, little medium; contains a few pebbles of limestone and siltstone	65	65
Clay, very sandy and silty, brown; contains small amounts of white limestone	5	70
Permian:		
San Andres limestone:		
Limestone, slightly sandy, very slightly cherty, mostly white to pink, contains a little gray	20	90
Limestone, dark- to medium-gray, partly mottled; contains small amounts of siltstone, greenish-gray to pale-orangish-green	20	110
Tertiary:		
Intrusive igneous rock:		
Diorite, medium-gray to pale-greenish-gray, black specks, fine-grained, contains small amounts of mica, garnet, and magnetite(?), very slightly calcareous	7	117
Permian:		
San Andres limestone:		
Limestone, light-brown to medium-gray, minor amounts of pink, contains calcite veinlets; small amounts of reddish-brown siltstone	13	130
Tertiary:		
Intrusive igneous rock:		
Diorite, light-gray to orangish-gray with black specks, medium- to very fine-grained, contains mica, garnet, and magnetite(?)	10	140
Permian:		
San Andres limestone:		
Limestone, medium-gray and light-brown, very fine-grained; contains small amounts of white very calcareous clay	5	145

Table 1.--Summary sample description - Continued

Material	Thickness (feet)	Depth (feet)
Tertiary:		
Igneous intrusive rock:		
Diorite, as at 130 to 140; contains a small amount of pale-brown to brown dolomite and very little white limestone	35	180
Permian:		
San Andres limestone:		
Limestone, mostly buff, white to pale-orange at top, gray at base; contains some interbedded dolomite, orangish-brown to brown; upper 10 feet of unit contains minor amounts of calcareous, argillaceous, very pale-green siltstone	23	203
Tertiary:		
Igneous intrusive rock:		
Diorite, as at 130 to 140	47	250
Permian:		
San Andres limestone:		
Limestone, white to very pale-orange, medium-gray near base; contains minor amounts of maroon to reddish-orange siltstone in upper 10 feet; also contains pink shale and limestone near base	20	270
Tertiary:		
Igneous intrusive rock:		
Diorite, as at 130 to 140	10	280
Permian:		
San Andres limestone:		
Limestone, very light-gray to bluish-gray, partly mottled; contains calcite veinlets	7	287
Shale, very calcareous, brownish-orange and pale-olive-green; contains inclusions of an unidentified black mineral	8	295

Table 1.--Summary sample description - Continued

Material	Thickness (feet)	Depth (feet)
Permian:		
San Andres limestone:		
Limestone, brownish-gray to gray, with a little white to buff; minor amounts of pale-green siltstone and pale-green to medium-gray gypsum in upper 20 feet of unit	60	373
Sandstone, very calcareous, slightly silty, pale-orangish-buff, coarse- to very fine-grained, well-rounded, tightly cemented	22	395
Limestone, dark-gray to brownish-gray, dark-brown and lithographic in lower 25 feet of unit, slightly fossiliferous	70	465
Glorieta sandstone:		
Sandstone, silty and calcareous, buff, medium- to very fine-grained, subrounded, friable	52	517
Limestone, very pale-brownish-gray to buff with minor medium-gray, very slightly fossiliferous	11	528
Sandstone, silty and calcareous, buff, medium- to very fine-grained, subrounded, friable	22	550
Shale, gray	1	551
Yeso formation:		
Sandstone, white, very fine- to medium-grained, medium grains rounded, fine grains angular, hard tightly cemented	86	637
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A commercially manufactured well screen was installed in the lower 20 feet of the hole opposite the main aquifer. The screen is 6-inch ID pipe with machine-cut circular perforations which has been wrapped with stainless steel, keystone-shaped wire. The slot size is 0.060 inch. The bottom of the screen was plugged. About 4 feet of 6-inch blank pipe was attached to the top of the screen. The screen was installed through 8-inch casing by lowering it to the bottom of the hole. The bottom of the 8-inch casing is 20 feet above the bottom of the hole, and the 4 feet of blank pipe attached to the top of the screen telescopes up into the casing but is not attached to it. This arrangement will allow removal of the screen for cleaning or replacing if it becomes necessary.

The size of the screen opening was chosen so as to present as much open area as possible to allow free movement of water to the pump and to prevent rock fragments from being picked up by the pump. The slot size is not fine enough to screen out individual sand grains of the formation. Because the sandstone is tightly cemented, it is not likely to cave and pass through the screen.

Aquifer tests

The well was tested four times by bailing before casing was installed: twice while it was 6½ inches in diameter and twice after it had been reamed to 10 inches. The tests ranged from 18 minutes at 12 gpm in the small hole to 4 hours at an average rate of 15 gpm for the final bailing test in the 10-inch hole. During 70 minutes of the final test, the bailing rate was 18½ gpm. An attempt was made to measure recovery of the water level in the well as soon as possible after the end of each period of bailing. The only test in which residual drawdown was observed was the final test, when less than 0.2 foot was measured 6 minutes after bailing ceased. In a few minutes more the water level had recovered completely.

After the casing and screen were installed, the well was tested by pumping. In order to establish the maximum potential yield of the well, a step test was performed. Pumping was begun at 10 gpm and then increased through several increments to 50 gpm. Fifty gallons per minute was the maximum rate attainable with the test pump. The pump was operated continuously at 50 gpm for 6 hours. During this time no drawdown was indicated by the airline gage. At the end of 6 hours the pump was shut off and the water level in the well was allowed to recover. After the water level had recovered, the pump was operated continuously for 24 hours at 50 gpm. Again, no drawdown was indicated by the airline gage. The pressure gage on the airline was checked for accuracy by substituting a second gage. Readings from the two gages corresponded very closely. Both the gages could be read to within 1 foot so presumably the drawdown was less than 1 foot. It was not possible to use an electric line to measure drawdown during the test, because the collars on the pump column obstructed passage of the electric line.

Chemical quality of water

The following lists the chemical constituents dissolved in a sample of water that was collected after the well had been pumped continuously for 1½ hours at 50 gpm. This sample is thought to be representative of water in the main aquifer (table 2). The analysis indicates that the water is very hard and of the calcium sulfate type.

Table 2.--Chemical analysis of water from well 18.8.4.312 Gran Quivira National Monument, N. Mex.

Analysis by the U. S. Geological Survey.
(Chemical constituents are in parts per million.)

Silica (SiO_2)	20
Calcium (Ca)	245
Magnesium (Mg)	64
Sodium (Na) + Potassium (K)	26
Bicarbonate (HCO_3)	137
Carbonate (CO_3)	0
Sulfate (SO_4)	727
Chloride (Cl)	36
Fluoride (F)	0.2
Nitrate (NO_3)	12
Dissolved solids	
Calculated	1,200
Residue on evaporation	1,280
Hardness as $CaCO_3$	874
Noncarbonate hardness as $CaCO_3$	762
Specific conductance (micromhos at 25° C)	1,510
pH	7.6

Reference cited

Clebsch, Alfred, Jr., 1957, Availability of Ground Water at Gran Quivira National Monument, New Mexico: U. S. Geological Survey open-file report.