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Department of the Interior
Geological Survey

Water-supply investigation at Torreon,
Sandoval County, New Mexico

By

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INTRODUCTION

The lack of an adequate water supply at the Torreon boarding school has been a matter of concern to the Navajo Service for several years. At the request of the Navajo Service, a brief investigation of the ground-water resources of the Torreon area was made by the Geological Survey in 1948. The investigation was made as a part of the program of study of the ground-water problems of the Navajo Indian Reservation. The Torreon school is one of several that are not on the reservation but are operated by the Navajo Service for the education of Navajo Indians who reside on tracts allotted to them by the Federal Government.

Location

The settlement of Torreon, which consists of a boarding school, a trading post, and a few scattered Navajo hogans, is located in western Sandoval County, New Mexico, in the NW $\frac{1}{4}$ sec. 22, T.18 N., R.4 W. The altitude at Torreon is about 6,500 feet above sea level. The area lies west of the Bernalillo-Farmington highway, with which it is connected by 26 miles of primitive road.

Topography and drainage

The nearly horizontal strata in the vicinity of Torreon have been rather deeply dissected by streams. Cuestas and isolated mesas, separated by broad, sand-filled, usually dry washes, are characteristic of the region. The beginning of a recent cycle of renewed down-cutting in the region is indicated by deep, narrow channels eroded in the alluvial fill by periodic floods.

The Torreon area is drained by Torreon Wash, which flows eastward into the south-flowing Torreones Arroyo. It has been reported that down-cutting in Torreon Wash has lowered the water table in the alluvial fill by several feet in the past few years. A study of the wash channel at the road bridge (pl. 1) revealed that since the bridge was built the total down-cutting probably has not exceeded 2 feet in that vicinity.

Present water supply

The existing water supply at the Torreon school is derived from a drilled well (TN-2, pl. 1), 75 feet deep, located on the south bank of Torreon Wash about 200 yards northeast of the school building. The well penetrates about 40 feet of alluvial fill and 35 feet of underlying, interbedded sandstone, shale, and coal of the Cretaceous Mesaverde formation. The well was drilled to a depth of 60 feet in 1940 and produced about 7 gallons per minute. In 1943, it was deepened to 75 feet and the discharge increased to 10 gallons per minute. The water is dark in color and has an unpleasant taste.

The existing supply of water is inadequate, as about 20 gallons per minute of palatable water is needed for efficient operation of the school.

Field work

The author, accompanied by G. A. Lerua, student engineer, spent July 29 and 30, 1948, in the Torreon area. This period was devoted to examining and sampling the producing wells in the area and to making a rapid reconnaissance of the stratigraphy and geologic structure of the region.

On October 15-17, 1948, a return visit was made to the area in company with L. C. Halpenny, engineer in charge, and R. J. Drake, geologic aide. During this period, two locations for test wells were selected and a plane-table map of the area (pl. 1) was made.

Acknowledgments

C. V. Theis, district geologist in charge of ground-water investigations in New Mexico, was consulted during the course of the work and reviewed the report. C. S. Howard and J. D. Hem, district chemists, Quality of Water Branch, reviewed the section on quality of water. H. V. Peterson, of the Technical Coordination Branch, Water Resources Division, visited the area in 1946 and made a brief report of his findings. The suggestions made by Mr. Peterson were helpful in conducting the investigation described in this report. C. B. Read,

geologist, Fuels Branch, Geologic Division, reviewed the geologic section of the report.

GEOLOGY OF THE TORREON AREA

The formations underlying the Torreon area that are of importance as a possible source of water for the school are the Upper Cretaceous Dakota sandstone and the lower and middle members of the Mesaverde formation.

The section that follows briefly describes the Dakota sandstone and overlying formations. Descriptions of the unexposed rocks were obtained from earlier geologic reports on the region, particularly those on the southern part of the San Juan Basin.^{1/}

Stratigraphy

The stratigraphic relationships of the formations in the Torreon area are as follows:

Age	Formation and member		Approximate thickness (feet)
Quaternary	Alluvium		30 to 40
	Lewis shale	Chacra sandstone member	
Cretaceous (Upper)	Mesaverde formation	Allison member	550+
		Gibson coal member	300+
		Hosta sandstone member	75+
	Mancos shale		2,000 [±]
	Dakota sandstone		200 [±]

The Dakota sandstone, as described by workers in adjacent areas,^{2/} consists of an upper and a lower sandstone member separated by a shale member. The basal sandstone is buff to gray, generally coarse-grained, and locally conglomeratic, with scattered pebbles of quartz, quartzite, and chert. The middle shale member

^{1/} Sears, J. D., Hunt, C. B., and Dane, C. H., Geology and fuel resources of the southern part of the San Juan Basin, N. Mex., parts 1, 2, and 3: U. S. Geol. Survey Bull. 860, 1936.

^{2/} Renick, B. C., Geology and ground-water resources of western Sandoval County, N. Mex.: U. S. Geol. Survey Water-Supply Paper 620, p. 36, 1931.

consists of black carbonaceous shale and shaly sandstone. The upper sandstone member is characteristically finer-grained than the basal member. In this area, the Dakota sandstone is thought to be about 200 feet thick. It is underlain by the Upper Jurassic Morrison formation and overlain by the Mancos shale.

The Mancos shale consists predominantly of light- to dark-gray shales containing occasional thin beds of buff sandstone and limestone. In the upper part of the formation are interbedded sandstone and sandy shale. The thickness of the Mancos shale in the Torreon area is estimated to be approximately 2,000 feet. It is conformably overlain by the massive Hosta sandstone member of the Mesaverde formation.

The Hosta sandstone member, the basal member of the Mesaverde formation, is essentially a buff marine sandstone, soft, thin-bedded to massive, and containing occasional thin beds of shale, coal, and carbonaceous material. It is estimated that the thickness of the Hosta sandstone member of the Torreon area does not greatly exceed 75 feet. It is overlain by the Gibson coal member.

The Gibson coal member is overlain by the Allison member, from which it is distinguished with difficulty. Because of their lithologic similarity, these two members of the Mesaverde formation are discussed here as a unit. These beds consist essentially of light- to dark-gray soft, crumbly, irregularly bedded shale and clay containing occasional thin beds of white to gray cross-bedded sandstone. Thin nonpersistent beds of coal and black carbonaceous material are common throughout the sequence, but are found in greater abundance in the Gibson coal member and the upper part of the Allison member. The estimated total thickness of the two members is about 1,000 feet in the region.^{3/} According to Dane, the upper part of the Allison member is exposed in the Torreon area; consequently, the aggregate thickness of the Allison member and the Gibson coal member is somewhat less than 1,000 feet at Torreon.

^{3/} Dane, C. H., op. cit. p. 96

North and northwest of Torreon, the Allison member is overlain by the Chacra sandstone member. This sandstone, the topmost member of the Mesaverde formation, forms high bluffs above outcrops of the less resistant Allison. The member consists of about 300 feet of gray to brown, medium-grained thin-bedded marine sandstone, interbedded with soft gray shale and an occasional bed of gray massive cross-bedded sandstone. It is overlain by the Lewis shale, which forms the top of the mesa some distance north and east of Torreon.

Quaternary alluvium has filled Torreon Wash to a depth of 30 to 40 feet. This alluvial fill is primarily a very fine grained sand derived from weathering and disintegration of the sandstones and sandy shales of the Allison member and younger beds.

Structure

The sedimentary rocks exposed in the Torreon area dip uniformly to the north, toward the trough of the San Juan Basin, at an angle of 2° to 3°. No evidence of faulting or local folding was observed in the area.

GROUND WATER IN THE TORREON AREA

Cretaceous rocks

No wells are known to produce water from the Dakota sandstone within many miles of Torreon. A well at La Ventana, about 16 miles northeast of Torreon, is believed to produce water from the Dakota sandstone at a depth of from 1,830 to 1,925 feet. At Torreon, the top of the formation is estimated to be at least 3,000 feet below the land surface. As nothing is known about the quantity or quality of water that might be yielded by the formation in the Torreon area, the expense of drilling a test well to the Dakota sandstone is not believed to be warranted.

The Mancos shale is not believed to be water bearing in the region, and cannot be considered as a source of water for the Torreon school.

No wells are known to produce water from the Hosta sandstone member of the Mesaverde formation in the Torreon area. However, about 30 miles west of Torreon, in T.18 N., R 9 W., several wells obtain water from what is thought to be the Hosta sandstone member. The water, although suitable for stock and some domestic uses, is not palatable and is not used for drinking. The top of the Hosta sandstone member is estimated to be about 1,000 feet below the land surface at Torreon. It is doubtful that the member would yield potable water to a well at the Torreon school.

Two wells have been drilled into the lower part of the Allison member of the Mesaverde formation at Torreon school (wells TN-5 and TN-6, table 1). These wells were drilled to depths of 595 and 185 feet, respectively, and were abandoned. A third well (TN-1, table 1), was drilled about $1\frac{1}{2}$ miles west of Torreon to a depth of 785 feet. This well probably reached the Gibson coal member, but did not produce more than 2 gallons per minute and was abandoned. It is apparent that the thin sandstones, shales, and carbonaceous material characteristic of the Allison member and the Gibson coal member do not contain an abundant or a potable supply of water.

Quaternary alluvium

Several shallow wells have been dug in the alluvial fill along the course of Torreon Wash. The wells are dug to a depth only a few feet below the water table and the yield is about 2 to 5 gallons per minute. Records of two of the wells are included in this report (TN-3 and TN-4). The Indians believe that water from the alluvial fill is too hard for washing clothes, and therefore use the softer water from the school well for this purpose. The thickness of alluvial fill is 40 feet along the creek at the Torreon bridge, as shown by the log of well TN-2 (table 2), and the water table lies at a depth of about

16 feet below the land surface.

QUALITY OF WATER

Samples of water collected in the Torreon area were analyzed in the Geological Survey laboratory at Albuquerque. The analyses are shown in table 3.

Well TN-4 was nearly dry at the time the water sample was collected, and therefore the analysis of this sample is not considered truly representative of water from the alluvial fill of Torreon Wash.

The analyses show the difference in quality between water obtained from the alluvial fill (well TN-3) and water obtained partly from the Mesaverde formation and partly from the alluvial fill (well TN-2). The most obvious difference is in the hardness. Well TN-3 produces moderately hard water and well TN-2 produces soft water. According to standards established by the U. S. Public Health Service for water used in common carriers engaged in interstate traffic, drinking water should contain no more than 250 parts per million of sulfate and no more than 1,000 parts per million of dissolved solids. Water from well TN-3 is within the accepted limits, and water from well TN-2 exceeds the limits. With the exception of a high nitrate content, which indicates possible local pollution, the sample from well TN-3 indicates that water from the alluvial fill is suitable for domestic use with respect to its mineral content.

POSSIBILITIES FOR OBTAINING ADDITIONAL WATER

If one, or possibly two, gravel-packed wells were constructed in the alluvial fill of Torreon Wash, it is believed that 20 gallons per minute could be withdrawn from the fill. The water would be of suitable quality, for domestic uses. The proposed locations for test wells are shown on plate 1.

At the time of the investigation, although there had been little rainfall for a rather extensive period previously, ground water was found close to the surface in the bed of Torreon Wash. It is believed that the desired amount of water could be withdrawn indefinitely from the fill, provided that down-cutting

of the stream does not further lower the water table and that other users upstream do not deplete the supply. A low dam, extending some distance down into the fill, could be constructed at the narrows a few hundred feet downstream from well TN-3, to retard further down-cutting of the stream channel.

CONCLUSIONS AND RECOMMENDATIONS

The studies of the ground-water problem at Torreon school indicate that:

1. A supply of about 20 gallons per minute of potable water is needed for efficient operation of the school.
2. The existing water supply is inadequate and unpalatable.
3. Water cannot be obtained from deep beds at reasonable cost, and there is no assurance that the quantity and quality of water in these deep beds would be suitable, as no wells extending below the Allison member of the Mesaverde formation are known to have been drilled in the vicinity of the school.
4. Most likely source of water for the school use is the alluvial fill of Torreon Wash. The water is of suitable quality, though moderately hard, and it is believed that two gravel-packed wells drilled to the bottom of the fill would produce the desired amount of water.
5. It is recommended that a well be drilled on the west side of Torreon Wash, at the site shown on plate 1. The well should be gravel-packed, and well cuttings should be collected each 5 or 10 feet. A pumping test should be made to determine the yield of the well and the transmissibility of the alluvium.
6. If the well does not produce sufficient water a second well should be drilled, on the east side of Torreon Wash, at the site shown on plate 1.
7. Down-cutting of the stream, and the consequent lowering of the water table, could be retarded by constructing a low dam at the narrows a few hundred feet downstream from well TN-3.

Table 1. - Records of wells in Torreon area, Sandoval County, New Mexico.
(All wells are drilled unless otherwise noted in "Remarks" column)

Office number	Location and State file number	Owner	Driller	Date completed	Depth of well (feet)	Dia-meter of well (in.)
TN-1	T. 18 N., R. 4 W. NE $\frac{1}{4}$ sec. 20 (?)	Navajo Service	C. M. Carroll	1936	785	6-5/8
d/ TN-2	NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 22	do.	Burt Cravath	1943	75	6-5/8
d/ TN-3	NW $\frac{1}{4}$ sec. 22	do.	C. C. C.	1939	14	60
d/ TN-4	Sec. 27	do.	do.	1936	17	60
TN-5	NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 22	do.	-	-	595	6-5/8
TN-6	do.	do.	-	-	185	6-5/8

a/ Measuring point was top of casing or top of well curb.

b/ C, cylinder; B, bucket; G, gasoline; H, hand; number indicates horsepower.

c/ D, domestic; S, stock; N, none.

d/ See table 3 for analysis of water from this well.

Records obtained by H. A. Whitcomb and G. A. Lerua

Office number	Water level		Pump and power b/	Use of water c/	Temp. °F.	Remarks
	Depth below measuring point (feet) a/	Date of measurement, 1948				
TN-1	-	-	None	N	-	Not shown on map; about 1½ miles west of Torreon. Navajo Service No. 15B-31. See log.
TN-2	15.27	July 29	C, G, 2	D	70	Supplies water for Torreon School and for Indian families in vicinity. See log.
TN-3	7.53	July 30	B, H	D, S	59	Dug well. Supplies water for indian families and livestock in area.
TN-4	16.72	do.	None	N	55	Dug well. Nearly dry and apparently unused. Not shown on map.
TN-5	-	-	None	N	-	Drilled on school grounds. Plugged and abandoned. See log.
TN-6	-	-	None	N	-	do.

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Table 2. - Logs of wells in Torreon area, Sandoval County, New Mexico.

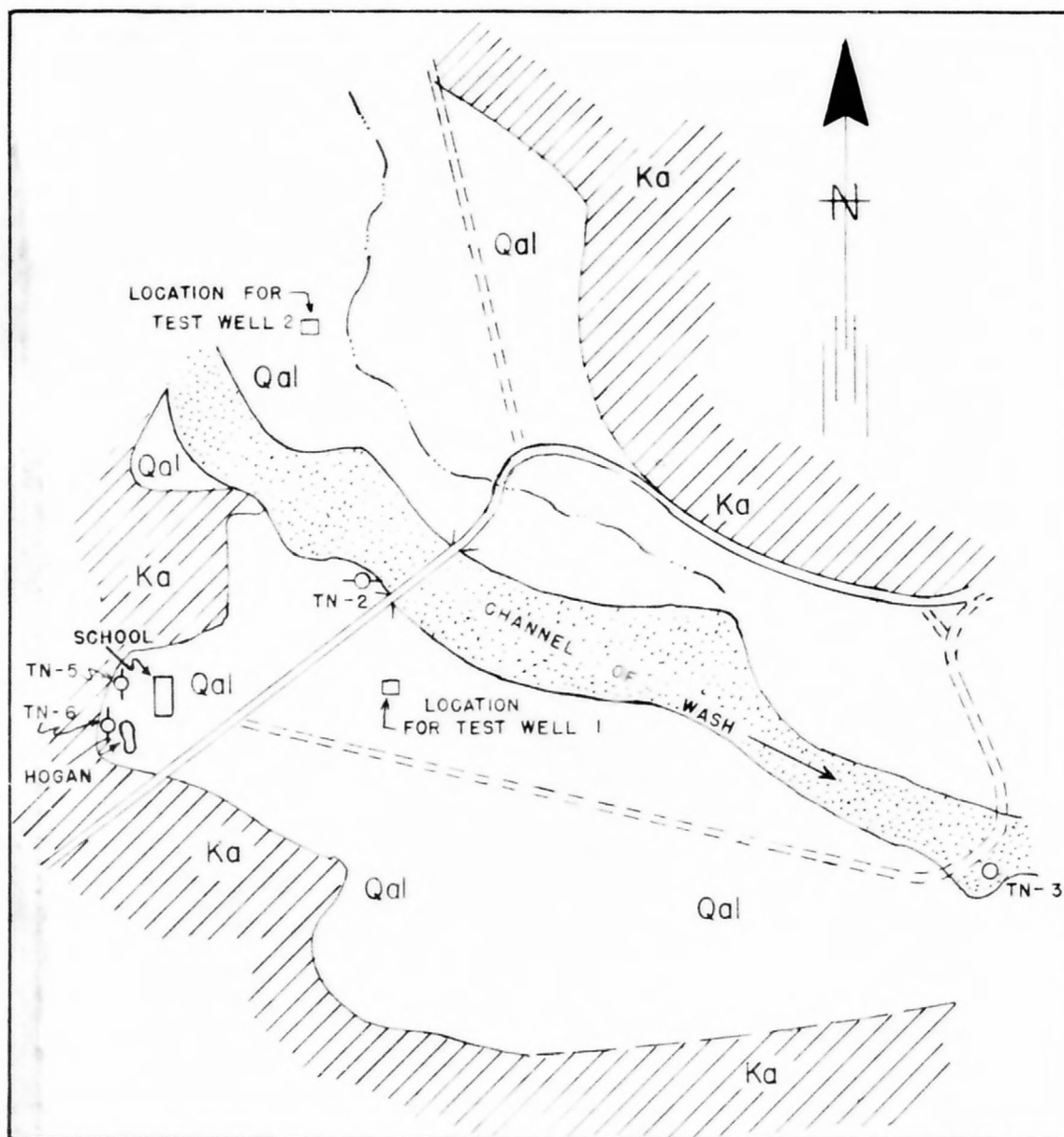
	Thick- ness (feet)	Depth (feet)		Thick- ness (feet)	Depth (feet)
Driller's log of well TN-1. Navajo Service, owner.			Driller's log of well TN-5, -Continued		
Gray shale - - - - -	15	15	Gray shale - - - - -	13	65
Gray sand - - - - -	5	20	Hard shell, water - - -	1	66
Gray shale - - - - -	25	45	Gray sand - - - - -	7	73
Brown sand - - - - -	40	85	Brown shale - - - - -	13	86
Coal - - - - -	12	97	Gray shale - - - - -	11	97
Gray shale - - - - -	18	115	Brown shale - - - - -	5	102
Brown shale - - - - -	55	170	Gray shale - - - - -	13	115
Hard sand - - - - -	5	175	Hard sand - - - - -	5	120
Brown shale - - - - -	135	310	Gray shale - - - - -	17	137
Dry sand, gas - - - - -	12	322	Brown shale - - - - -	12	149
Brown shale, water (1 gpm) -	18	340	Hard sand, water - - -	5	154
Gray shale - - - - -	60	400	Coal - - - - -	3	157
Brown shale - - - - -	50	450	Brown shale - - - - -	13	170
Gray shale - - - - -	15	465	Gray shale - - - - -	45	215
Sand - - - - -	10	475	Hard blue shell - - - -	6	221
Gray shale - - - - -	115	590	Gray shale - - - - -	56	277
Brown shale - - - - -	20	610	Brown shale - - - - -	53	330
Gray sand, water (2 gpm) - -	20	630	Gray shale - - - - -	12	342
Gray sandy shale, gas - - - -	145	775	Brown shale - - - - -	76	418
Dry sand - - - - -	10	785	Dry sand - - - - -	2	420
TOTAL DEPTH - - - - -		785	Gray shale - - - - -	20	440
Driller's log of well TN-2. Navajo Service, owner.			Brown shale - - - - -	13	453
Alluvial fill - - - - -	18	18	Gray shale - - - - -	51	504
Fine sand, water - - - - -	22	40	Fine gray shale, show of gas - - - - -	6	510
Gray shale - - - - -	10	50	Gray shale - - - - -	10	520
Coal, water - - - - -	5	55	Light-brown shale - - -	5	525
Gray shale - - - - -	20	75	Gray shale - - - - -	7	532
TOTAL DEPTH - - - - -		75	White sand - - - - -	3	535
Driller's log of well TN-5 Navajo Service, owner.			Gray shale - - - - -	10	545
Surface soil - - - - -	5	5	Sand, salt water - - -	15	560
Coal - - - - -	1	6	Sandy gray shale - - -	20	580
Brown sand - - - - -	21	27	Sand, gas - - - - -	10	590
Coal - - - - -	3	30	Gray shale - - - - -	5	595
Dark shale - - - - -	22	52	TOTAL DEPTH - - - -		595
- // -					

Table 2. - Logs of wells in Torreon area, Sandoval County, New Mexico - Cont.

	Thick- ness (feet)	Depth (feet)	
Driller's log of well TN-6.			
Navajo Service, owner.			
Surface soil - - - - -	7	7	
Coal - - - - -	1	8	
Dark shale - - - - -	12	20	
Gray shale - - - - -	9	29	
Hard shell - - - - -	3	32	
Light-yellow sand - - - - -	2	34	
Coal - - - - -	2	36	
Brown shale - - - - -	19	55	
Coal - - - - -	5	60	
Brown shale - - - - -	6	66	
Hard gray shale, showing of water - - - - -	10	76	
Gray sand - - - - -	7	83	
Brown shale - - - - -	13	96	
Blue shale - - - - -	4	100	
Brown shale - - - - -	8	108	
Water sand - - - - -	4	112	
Coal - - - - -	2	114	
Gray shale - - - - -	7	121	
Hard shell - - - - -	4	125	
Coal - - - - -	4	129	
Brown shale - - - - -	24	153	
Gray shale - - - - -	3	156	
Brown shale - - - - -	9	165	
Coal - - - - -	2	167	
Brown shale - - - - -	18	185	
TOTAL DEPTH - - - - -		185	

Table 3.- Analyses of water from wells in Torreon area, Sandoval County, N. Mex.
 Analyzed in Southwestern Laboratory of Geological Survey,
 Albuquerque, New Mexico
 (Numbers correspond to those in tables 1 and 2 and on plate 1.)
 (Parts per million except specific conductance.)

Well No.	Date of collection 1948	Depth (feet)	Specific conductance, (Micromhos @ 25° C.)	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
TN-2	July 30	75	1,860	8	3.9	407	656	342	10	4.2	1.8	1,100	36
TN-3	do.	14	1,230	39	5.2	236	426	209	12	1.0	56	768	119
TN-4	do.	17	1,440	44	8.7	296	557	302	8	.8	5.7	940	146




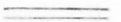





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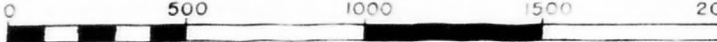
PLATE I. MAP OF TORREON AREA, SANDOVAL COUNTY, NEW MEXICO

SHOWING GEOLOGY AND LOCATIONS OF WELLS.

EXPLANATION

MATERIAL		WATER-BEARING PROPERTIES	
	Qal ALLUVIUM (QUATERNARY)	YIELDS WATER FROM FINE SAND OF ALLUVIAL FILL.	
	Ka ALLISON MEMBER OF THE MESAVERDE FORMATION (CRETACEOUS)	YIELDS SMALL AMOUNT OF WATER OF POOR QUALITY FROM SAND LENSES IN SHALE BEDS	
	UNUSED WELL		GRADED ROAD
	DRILLED WELL		UNIMPROVED ROAD
	DUG WELL		

PLANE TABLE MAPPING AND WELL LOCATIONS BY L. G. HALPENNY, H. A. WHITCOMB, AND R. J. DRAKE. GEOLOGY BY H. A. WHITCOMB

SCALE :  0 500 1000 1500 2000 FEET