RECONNAISSANCE STUDY OF GROUND WATER IN THE VICINITY OF RUIDOSO, NEW MEXICO

By

C. R. Murray and R. S. Jones

1948

48-76

U. S. Geological Survey, in cooperation with the New Mexico State Engineer and New Mexico State Bureau of Mines.

RECONNAISSANCE STUDY OF GROUND WATER
IN THE VICINITY OF RUIDOSO, NEW MEXICO

By

C. R. Murray and R. S. Jones

1948

U. S. Geological Survey
in cooperation with the
New Mexico State Engineer and New Mexico State Bureau of Mines

Purpose of investigation

The village of Ruidoso is obtaining water from the Rio Ruidoso at present. In view of the litigation that may arise over such use, the officials of Ruidoso are interested in learning whether a ground-water supply can be developed for Ruidoso. The Ground Water Division of the U. S. Geological Survey was requested to determine whether sufficient ground water to meet the needs is available in the Ruidoso area. The investigation was made by the writers under the supervision of Chas. V. Theis, District Geologist for New Mexico of the Ground Water Division. Officials of Ruidoso estimate that a supply of 300 gallons of water per minute will be sufficient to take care of present needs and of any development that is likely to take place in the immediate future.

Acknowledgments

Officials and residents of Ruidoso were very cooperative in helping with the prosecution of the work, and the U. S. Soil Conservation Service offices at Capitan and Albuquerque, N. Mex., loaned aerial photos of the area for use in the geologic mapping. Chas. B. Read, of the Fuels Section of the Geological Survey, cooperated by making personnel available for preparing a geologic map of the Ruidoso area.

Field work

The field work was hampered by adverse weather conditions. Three days were spent in the area by A. D. Jones in November 1947, and Mr. Jones and C. R. Murray spent another 3 days in the area in December. Gordon H. Wood, of the Fuels Section of the Geological Survey, spent three days in the field with Mr. Murray in April 1948 and prepared a geologic map of the area surrounding Ruidoso, the final drafting of the map being done by Harold C. Reeder.

Geology and topography

Ruidoso is situated on the southeastern edge of the Sierra-Blanca structural basin in southwestern Lincoln County. Sedimentary rocks ranging in age from Permian to Upper Cretaceous are folded into a north-south trending synclinal basin, the central part of which has been intruded by Tertiary igneous rocks, which culminate in Cerro Blanco peak (12,003 feet), the highest point in the Sierra Blanca. Drainage on the east side of the Sierra Blanca is to the Pecos River in the vicinity of Roswell, and drainage on the west is to the northern part of the Tularosa Basin. In addition to the mature fluvial dissection which has occurred in the Sierra Blanca, the highest peak has been subjected to glacial action. Some of the tributaries of Rio Ruidoso near the town of Ruidoso are of a subsequent type along part of their courses, being affected by faults, dikes, and tilted sedimentary strata. Flat-topped divides, particularly those just east of the Village of Alto, about 5 miles north of Ruidoso, are probably related to similar erosional plains in the Roswell basin to the east, as described by Fiedler and Nye. _/

_/ Fiedler, A. G., and Nye, S. S., Geology and ground-water resources of the Roswell artesian basin, New Mexico. U. S. Geol. Survey Water-Supply Paper 639, pp. 14-15, 1933.

The principal geologic features of the Ruidoso area are shown on the accompanying map, figure 1. Because of the complexity of the intrusive

Figure 1. Geologic map of vicinity of Ruidoso, Lincoln County, N. Mex.

bodies of igneous rock, particularly along the western border of the area mapped, the short time available for the mapping, and the limited number of exposures, it was impossible to delineate the boundaries of each intrusive igneous mass.

Stratigraphy and structure of the area and their hydrologic significance

The oldest rocks exposed in the area are gray limestones belonging to the San Andres formation of Permian age. These rocks crop out only on the eastern side of the area mapped, being covered by younger formations on the west. The preservation of these younger rocks is favored by down-faulting in the structural basin. The San Andres formation has proved to be a valuable aquifer (water-bearing bed) in several areas in New Mexico, including the Roswell artesian basin, and there is a possibility that wells drilled in the limestone of the formation in the eastern part of Ruidoso might encounter solution channels and furnish considerable water. Two features of the geologic structure appear favorable for the occurrence of ground water in the San Andres. The fault separating the San Andres formation and the younger formations to the west may act as a dam to impound water in the San Andres. As the San Andres dips toward the Ruidoso area from a large anticline (structural dome) to the east, Ruidoso should be favorably located with respect to circulation of ground water in the San Andres. There is a possibility that relatively impermeable strata in the formation may prevent the water from draining down to the main water table and thus may keep it near enough to the surface to make pumping feasible.

Red shales assumed to belong to the Dockum group of Triassic age crop out in a few limited exposures near Ruidoso. These beds would normally overlie the San Andres east of the fault, but erosion has removed them from that area. They have, however, been preserved by being down-faulted to the west, and erosion along Rio Ruidoso and other streams has exposed them in a few small areas. These shales are very poor sources of water in other areas in New Mexico, and their limited areas of exposure and their general inaccessibility because of the depth at which they would be encountered in wells over most of the Ruidoso area excludes them from consideration as aquifers.

Overlying the red shales of the Dockum(?) group, and in contact with the San Andres formation along faults in the eastern part of area mapped, are shales, siltstones, limestones, and sandstones, mainly gray in color, which may belong to the Morrison formation of Jurassic age. In general they are poorly exposed, but occasionally good sections can be seen where the Dakota sandstone caps hills in which they occur. Such an exposure underlies the Forest Service lookout tower in Ruidoso. The strata in the Morrison(?) formation, in general, contain too much clay to be very good aquifers; however, a few of the sandstones are soft and friable and might yield some water where they lie below the water table. The Morrison(?) strata just west of the eastern fault are above the water table and are dry; west of the western fault they would be reached at depths of several hundred to perhaps a thousand feet. Considerable gypsum occurs in the shales of the formation and any water obtained would probably be of poor quality.

Above the Morrison (?) formation are conglomerates, sandstones, shales, and quartzites which appear to represent the Dakota sandstone in this area. The sandstones are frequently cross-bedded and iron-stained. The Dakota sandstone is a fair aquifer in several areas in New Mexico. However, the yields are generally limited, and the water is rather highly mineralized in some places. In the Ruidoso area the Dakota strata occurring between the east and west faults are likely to have been metamorphosed into quartzites, and therefore to have lost much of their permeability. The Dakota sandstone west of the west fault would be found at depths ranging from zero to several hundred feet, probably at least 600 feet near the axis of the syncline. If the formation has not been too highly metamorphosed because of faulting, secondary cementation, or igneous intrusion, there is a possibility that some water might be encountered; however, this chance is somewhat lessened by the fact that there appears to be little opportunity for recharge to the formation.

Overlying the Dakota sandstone or in fault contact with it are shales, mudstones, siltstones, and sandstones which apparently belong to the Mancos shale. These beds, which in general are poorly exposed, underlie the open park-like valleys of the Ruidoso area. The Mancos shale is, in general, a poor aquifer, and it is not likely that it will be a good aquifer in the Ruidoso area. The Mancos strata east of the west fault are above the water table and are therefore drained; west of the fault they would be encountered at depths ranging from zero to several hundred feet (about 500 feet in the Chase well in Ruidoso). For the above reasons the Mancos shale has little prospect of being an aquifer in the Ruidoso area, although some sandstone strata included in the formation might yield small amounts of water locally.

Above the Mancos shale or in fault contact with the Mancos shale or Dakota sandstone are sandstones, limestones, coal beds, and shales which are assigned to the Mesaverde formation. Some of the limestone beds are highly fossiliferous, comprising coquina (strata made up largely of shells) of pelecypods, possibly belonging to the genus Ostrea. In a few areas in New Mexico, water in amounts sufficient for municipal use is obtained from sandstones in the Mesaverde formation. Although the Mesaverde in the Ruidoso area contains numerous sandstone beds, as seen in its outcrop areas and in the log of the Chase well (table 1), the Mesaverde has not proved to be very productive or to contain water of very good quality. The upper strata are cut by stream channels, which would drain them, and the lower strata, judging from the well development that has taken place, are not very permeable, perhaps because of alteration caused by igneous intrusion. The opportunity for developing water from the Mesaverde formation in the Ruidoso area does not appear good.

Much younger than the previously named formations are the gravels, sands, and silts which occur along the stream courses and in places cap some of the interstream divides. The alluvium is Recent in age. It is too thin and limited in extent to be of much value as an aquifer in the area west of Ruidoso; however, it thickens and becomes more extensive at the junction of Rio Ruidoso, Cherokee Bill (Tularosa), and Gavilan Canyons. Wells in this area indicate that the alluvium is a good aquifer. A similar condition exists in Eagle Creek, at the north edge of the area mapped, as wells have recently been developed in the alluvium overlying the San Andres formation. These wells are reported to have large yields. The water so obtained represents stream underflow caused by disappearance of surface flow where the streams traverse permeable alluvium.

As stated previously, the main element of geologic structure in the area shown on figure 1 is a syncline underlain by the Mesaverde formation of Cretaceous age, along whose western edge numerous igneous rocks have welled up and along the eastern side of which are two large parallel-trending faults. Along the eastern fault the San Andres formation, which forms the western limb of a large anticline to the east, has been raised relative to the Morrison (?) formation and beds of the Dockum (?) group, which crop out west of the fault. The upthrown side of the western fault also is on the east, where beds of the Mancos shale and Dakota sandstone are brought into contact with the Mesaverde formation to the west. In addition to the major faults, numerous minor faults are also present in the area, some of which are shown on figure 1.

Igneous rocks

Intruded into the sedimentary rocks of the area, either as dikes and sills or as irregularly shaped masses, are igneous rocks of various types. The main mass of the Sierra Blanca is composed of such material. It is to be expected that only small yields of water can be obtained from these rocks, mainly along joints and fault planes. The dikes are intruded into the older sedimentary rocks and probably act as barriers to ground-water movement and tend to dam up ground water in the sedimentary rocks. These dikes tend to restrict the movement of ground water and to divide large ground-water basins into many smaller ones. A detailed study would be necessary to determine the exact extent and position of these dikes in the older sedimentary rocks and their relation to ground water. It is doubtful that such a detailed study of the igneous rocks would materially change the unfavorable outlook for obtaining ground water from them.

Hydrology
Present well development

<u>Wells in the older sedimentary rocks</u>.--Wells in the older sedimentary rocks that have been visited are located as follows:

Location			Well number
1. SW¼SW¼SW¼	Section 9	T. 11 S., R. 13 E.	11.13.9.333
2. NE¼NE¼SE¼	Section 15	"	11.13.15.422a
3. "	"	"	11.13.15.422b
4. Center NE¼NE¼	" 28	"	11.13.28.220
5. SE¼SE¼NE¼	" 22	"	11.13.22.134

The above wells are shown on figure 1.

Well 11.13.9.333 was drilled in the Mesaverde formation and igneous rocks at the edge of Cedar Creek. The ground surface where the well was drilled is estimated to be 40 feet above the bottom of the creek. It was reported by Mr. Chase that during the drilling of the well water was encountered at about 90 feet and rose within 21 feet of the ground surface. On November 18, 1947, the water stood 19.6 feet below the ground surface. This is an estimated 20 feet above the bottom of Cedar Creek. According to Mr. W. C. Edgington, the taste of this water is poor in comparison with that of the water from the Rio Ruidoso.

The log of well 11.13.22.[illegible], drilled in the Mesaverde formation and the underlying Mancos shale, is given herewith (see table 1). The well was logged from samples by C. E. Needham. This well was drilled on the south side of Rio Ruidoso Canyon in the Village of Ruidoso, and is about 45 feet above the river. According to Mr. Chase the water stood about 20 feet from the ground surface about November 1, 1947. Thus the water stood about 25 feet above the river. As can be seen from the log, the first water was encountered during drilling at 45 feet, the approximate depth to the level of Rio Ruidoso. The chief aquifer was reported to be between 490 and 500 feet below the ground surface, apparently about at the base of the Mesaverde formation. The water from the two deepest aquifers is derived from a sandy shale, as shown in the log. An analysis of the water made by C. W. Botkin of New Mexico A. & M. College at Las Cruces, showed that the water contained some oil, and another analysis showed that the water contained about 2,000 parts per million of dissolved mineral matter and had a hardness of about 580 part per million.

Well 11.13.22.134, which is located in the Mancos shale area near the axis of the syncline, is part way up a knoll and the water from it is used to irrigate the golf course at Ruidoso. The depth of this well is reported to be 700 feet. The depth to water was reported by Mr. R. C. Young as about 75 feet.

Wells 11.13.15.422E and W, which started in the Mancos shale, are about 100 feet apart and have approximately the same elevation, but the water level in the west well was about 12 feet higher than the water level in the east well when the water levels were measured on November 19, 1947. Although both wells were reported by Mr. Shorett of Ruidoso to have been drilled to 240 feet, the difference in water level indicates that they probably were either drilled to different depths or that their casings are not perforated to permit the entry of water from the same aquifers. These wells were used for a while to supply Ruidoso with water, but their supply was limited and they were finally abandoned. The west well, where the water stood the highest, is reported to have yielded the most water. According to Mr. Shorett, a better-producing well was drilled about a quarter of a mile west of these two abandoned wells.

Wells in alluvium.—A well owned by Mr. E. R. Poteet of Ruidoso, in the SW¼NW¼NE¼ sec. 36, T. 11 S., R. 13 E. (number 11.13.36.213), in Cherokee Bill (Tularosa) Canyon, was reported to be able to produce about 1,000 g.p.m. According to Mr. Poteet the pump discharges only 125 g.p.m. A well belonging to Mr. Nash an eighth of a mile up the canyon was reported by Mr. Poteet to yield more water. This well was capped and it was not possible to measure the water level. In the draw, near Mr. Poteet's well, no water was flowing. The depth of Mr. Poteet's well was measured and found to be 65 feet. The depth to water on November 19, 1947, was approximately 35 feet from the ground surface. It is estimated that the water level was about 15 feet below the bottom of the draw.

Springs.—Of the several spring areas visited only one was seen which yields a large amount of water. In and adjoining Carrizo Creek in the NW¼NW¼, sec. 3, T. 12 S., R. 13 E., in the Mescalero Apache Indian Reservation, are a series of springs issuing from alluvium and from formations of the San Andres. Within a short distance below these springs Carrizo Creek, which is normally dry above them, flows several second-feet of water. Mr. W. C. Edgington of Ruidoso reports that the flow of these springs is more or less constant during the year. Mr. L. F. Dryden reported a large spring and marsh area in the Mescalero Apache Indian Reservation in Feather Canyon, a tributary of the Rio Ruidoso. This spring was not discovered in the field investigation, but it seems unlikely from its location in the igneous-rock area that it would yield sufficient water to furnish a significant part of Ruidoso's supply. A spring belonging to Mr. McDaniels of Ruidoso is reported in the SE¼ sec. 19, T. 11 S., R. 13 E. Mr. McDaniels reported that this spring had a measured flow of 8 g.p.m. on November 13, 1947. Numerous other small springs occur throughout the area, being more abundant along the major stream courses.

Quality of water

Little specific information is available about the quality of the water in the Ruidoso area. The water derived from Ruidoso Creek is reported to be a soft water of good quality. It undoubtedly varies somewhat seasonally, being best during high-flow stages in the spring when it is derived largely from melting snow. During low-flow stages when it is supplied by spring flow its quality is probably somewhat poorer. Water from wells penetrating the formations of Cretaceous age is reported to be mineralized and to have an objectionable taste. That from the San Andres formation in the eastern part of Ruidoso (Skyland area) is said to be hard and is probably similar to that from Carrizo Springs. (See attached analyses.) Water from wells in the alluvium along Rio Ruidoso is also reported to have considerable hardness, but considerable variation is to be expected, depending on the nearness of a well to the river and the ease with which water moves from the river to any particular well.

Development possibilities

The most apparent source for obtaining water in large amount is the Rio Ruidoso. The next most obvious source which appears to be adequate to furnish water for Ruidoso is Carrizo Springs; however, this water is hard (see attached analyses). Considerable water appears to be available in the alluvium in the Rio Ruidoso and its tributaries near Hollywood. Large yields have been reported from wells in alluvium near the mouth of Cherokee Bill (Tularosa) Canyon. This water is probably hard, and analyses of water from wells in the alluvium should be made before extensive development is undertaken.

It is possible that wells drilled in the limestone of the San Andres formation in the eastern part of Ruidoso (Skyland area) might yield water in sufficient quantities to supply the village. Water in the San Andres may move down the westerly dip of the strata until it reaches the fault boundary of the formation, and be held there in a perched position by impermeable strata where it could be recovered economically. The yield of such wells would probably differ markedly, depending on whether the wells struck solution passages in the limestone. Water from wells in the limestone would probably have considerable hardness.

Water might be obtained in limited quantities from sandstones in the Mesaverde formation in the syncline (structural basin) south of Ruidoso. Inasmuch as the Mesaverde formation is cut by numerous valleys, it is likely that the formation will be drained to a considerable extent. Intrusion of igneous rock into the formation no doubt restricts ground-water circulation, thereby affecting both the quantity and quality of water obtainable from the sandstones in the Mesaverde. Wells drilled in the

Mesaverde up to the present, such as the Chase well in Ruidoso and that near Cedar Creek, have not been very successful. It is therefore believed that, if any additional testing of this source is done, the most favorable area is south of Ruidoso in the SE¼ sec. 28 and in sec. 33, T. 11 S., R. 13 E. This water would, of course, have to be piped a considerable distance to reach Ruidoso.

Analyses of Water from Carrizo Springs and Carrizo Creek FEB 11 1948

Analyses by Geological Survey, United States Department of the Interior
(Parts per million)

Lab. No.	9292	9293	9294
Date of collection 1947	12/19/47	Received 12/22/47	Received 12/22/47
Silica (SiO_2)	--	--	--
Iron (Fe)	--	--	--
Calcium (Ca)	196.	184.	184.
Magnesium (Mg)	50.	57.	56.
Sodium (Na)) Potassium (K))	49.	35.	34.
Bicarbonate (HCO_3)	299.	302.	300.
Sulfate (SO_4)	453.	433.	432.
Chloride (Cl)	58.	50.	48.
Fluoride (F)	.1	.2	.2
Nitrate (NO_3)	1.1	1.1	1.3
Borate (BO_3)	--	--	--
Dissolved solids:			
Sum - ppm.	954.	909.	903.
- tons/a.ft.	1.30	1.24	1.23
Hardness as $CaCO_3$:			
Total	694.	694.	690.
Noncarbonate	450.	446.	444.
Specific conductance Micromhos (~~Kx10~~ at 25° C.)	1,330.	1,280.	1,280.
pH	--	--	--

9292- Near Ruidoso, N. M.; Carrizo Spring; Temp 11.4°C; Flow 3 GPM.
9293- Near Ruidoso, N. M.; Carrizo Spring: Temp 8°C; Flow 3 GPM.
9294- Meacalero Apache Boundry Near Ruidoso, N. M.; Carrizo; Flow 1000 GPM+;
Temp 11.6°C; Sampled where road crosses stream.

Unpublished records, subject to revision

Table 1

Sample log in
C. C. Chase well ~~near~~ Ruidoso in
sw 1/4 NE$\frac{1}{4}$ NE$\frac{1}{4}$ Sec. 28. T. 11 S., R. 13 ~~W.~~ E 11.13.28.223
Cutting examined by C. E. Needham

Sample No.	Feet Depth		Description
1	5		Sand, pale yellow, medium grained.
2	10		Sand, white, medium grained, angular to sub-angular
3	15		Sand, dirty white, calcareous, micaceous, fine to medium grained.
4	20		Same as above.
5	25		Sand as above, but contains more lime
6	30		Sand as above, very limey; some pyrite.
7	35		Mixture of dirty sand and lime
8	40		Sand, gray, medium grained, calcareous
9	45	water	Sand as above, more limey
10	50		Shale, gray, sandy, calcareous
11	55		Shale, as above
12	60		Shale, as above
13	65		Shale, as above, but more limey
14	70		Sand, gray, medium grained, angular to sub-rounded
15	75		Sand, as above, more limey
16	80		Sand, as above, some pyrite
17	85		Sand, as above
18	90		Sand, as above
19	95		Sand, as above
20	100		Sand, as above.
21	105		Sand, as above, some gray shale
22	110		Sand, as above, some shale
23	115		Same as above
24	120		Same as above, some shale
25	125		Sand, as above.
26	130		Sand, as above.
27	135		Sand, as above.
28	140		Sand, as above.
29	145		Sand, as above
30	150		Sand, as above
31	155		Sand, as above
32	160		Sand, as above
33	165		Sand, as above
34	170		Sand, as above
35	175		Sand, as above
36	180		Sand, as above
37	185		Sand, as above
38	190		Sand, as above
39	195		Sand, as above
40	200	Water	Sand, as above, more shaley
41	205		Sand and gray shale
42	210		Sand, and some shale
43	215		Sand, gray, medium grained, angular to sub-rounded
44	220		Sand, as above
45	225		Sand, as above
46	230		Sand, as above
47	235		Sand, as above
48	240		Sand, as above

Sample No.	Feet Depth	Description
49	245	Sand, as above, some shale
50	250	Shale, dark, sandy, calcareous
51	255	Shale, as above,
52	260	Sand, gray, some shale
53	265	Sand, as above
54	270	Sand, as above
55	275	Sand, as above
56	280	Sand, as above, some shale
57	285	Sand, as above, but more yellow
58	290	Same as above
59	295	Sand, yellowish
60	300	Sand, yellowish
61	305	Sand, gray, much gray shale
62	310	Shale, brown
63	315	Shale, brown
64	320	Shale, gray, slightly sandy
65	325	Same as above
66	330	Shale, gray-brown
68	340	Mixture, gray shale and sand
69	345	Shale and sand, as above
70	350	Sand, dirty gray, much shale
71	355	Sand & shale, as above
72	360	Sand, gray, a little shale
73	365	Sand and dark shale
74	370	Sand & shale, as above
75	375	Sand, gray, clean, medium grained, very little shale
76	380	Sand, as above
77	385	Sand, as above
78	390	Sand, as above
79	395	Sand, as above
80	400	Sand, as above, more shale
81	405	Same as above
82	410	Sand & shale, as above
83	415	Shale, gray, calcareous, some sand
84	420	Shale, as above.
85	425	Mixture, shale & sand, calcareous
86	430 Water	Shale, gray, calcareous, slightly sandy
87	435	Shale, as above
88	440	Mixture, shale & sand, very limey; some pyrite
89	445	Sand, gray, medium grained, calcareous, some shale
90	450	Shale, gray, calcareous
91	455	Shale, as above
92	460	Mixture, sand & shale
93	465	Sand & shale, as above
94	470	Shale, gray, calcareous, some sand
95	475	Shale, gray, calcareous, very little sand
96	480	Mixture, shale & sand, calcareous
97	485	Sand, gray, medium grained, some shale
98	490 Water	Shale, gray, sandy
99	495	Shale, as above.
100	500	Sand, dirty gray, much shale
101	505	Shale, dark, carbonaceous, calcareous
102	510	Shale, nearly black, calcareous
103	515	Shale, very dark
104	520	Shale, as above
105	525	Shale, as above
106	530	Shale, as above

Sample No.	Feet Depth	Description
107	535	Shale, black, carbonaceous
108	540	Shale, as above
109	545	Shale, as above
110	550	Shale, as above
111	555	Shale, as above

PRESS RELEASE FOR RUIDOSO REPORT

An investigation of ground-water conditions in the vicinity of Ruidoso, New Mexico has been made by the Geological Survey, United States Department of Interior in cooperation with the New Mexico State Engineer and the New Maxico Bureau of Mines.

A report on the study entitled "Reconnaissance Study of Ground Water Near Ruidoso, New Mexico" has been prepared by R. S. Jones and C. R. Murray. The report which discusses possibilities of using ground water foF the Village of Ruidoso contains a geologic map of the Ruidoso area prepared by G. H. Wood. Concluding the report are recommendations for drilling test wells in selected areas.

Copies of the report may be consulted in the offices of the Geological Survey at Washington, D. C. and at Albuquerque, New Mexico, in the office of the State Engineer, Santa Fe, New Mexico and at the New Mexico Bureau of Mines, Socorro, New Mexico.

RECONNAISSANCE STUDY OF GROUND WATER NEAR RUIDOSO

Purpose of Investigation

The village of Ruidoso is at present obtaining water from the Rio Ruidoso. Because the river water is subject to litigation (Lake J. Frazier, 1947) it became desirable to find another source of water for Ruidoso. Some of the areas that the writer suggests as possible water yielding areas may contain not legally appropriable water but this memorandum is not concerned with the legal status of the water which may be found in the suggested locations. It is Mr. Lake J. Frazier's 1/ (Lake J. Frazier, 1947) understanding that at present a supply of 300 gallons per minute would be largely in excess of present requirements for Ruidoso.

Acknowledgements

The kindness of the people in Ruidoso was of assistance in the progress of the investigation. Mr. C. R. Young and Mr. W. O. Edgington at Ruidoso gave freely of their time and use of their automobiles during this investigation. Their knowledge of the country enabled the writer to accurately locate outcrops, springs and wells. Mr. C. C. Chase of the Chase Realty Company furnished the investigator with a copy of a well log and with water analyses from a deep well near his home. The United States Soil Conservation Service at Capitan, New Mexico loaned 52 aerial photographs for this study.