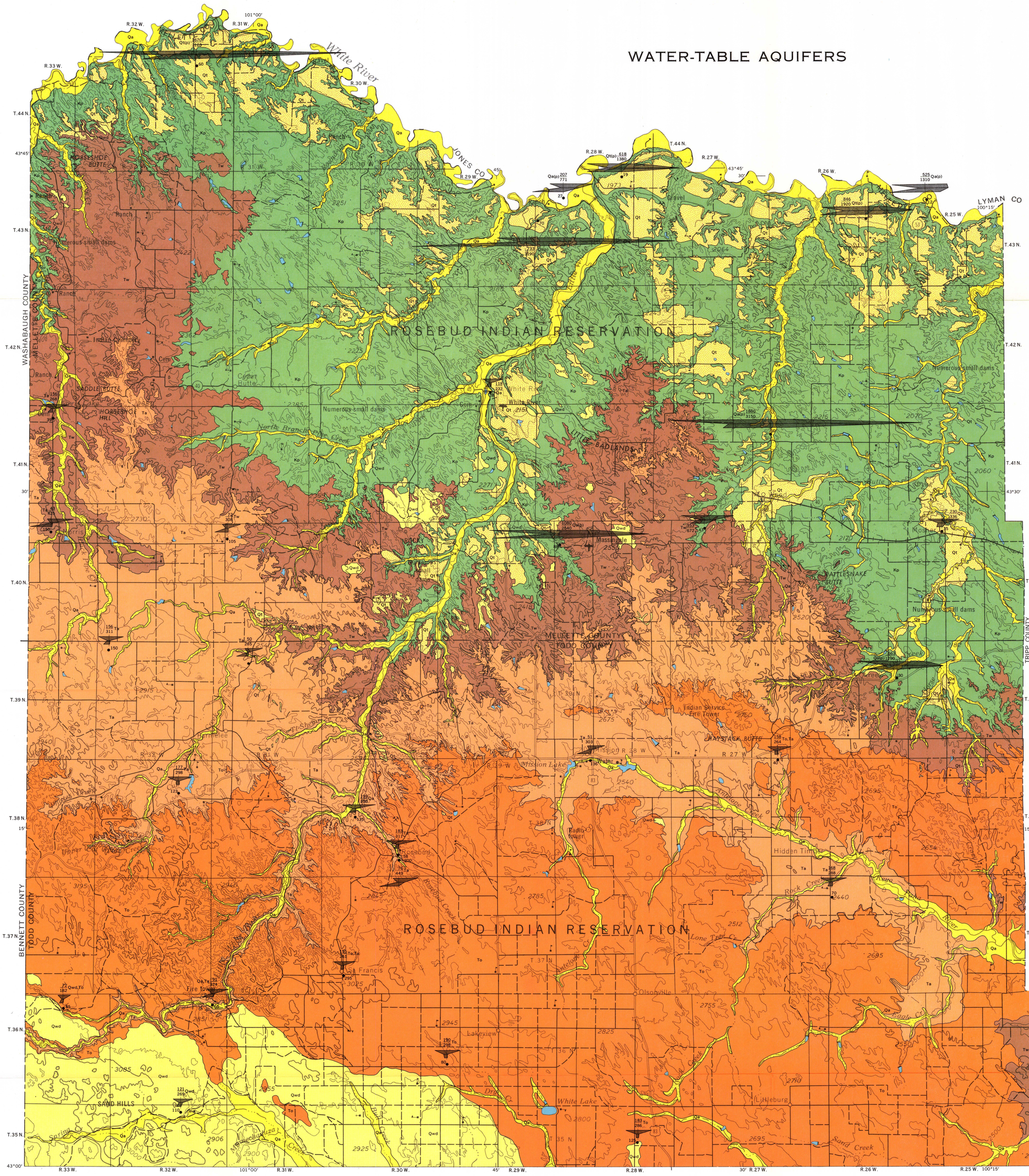
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED AS PART OF THE PROGRAM OF THE
DEPARTMENT OF THE INTERIOR
FOR DEVELOPMENT OF THE MISSOURI RIVER BASIN

HYDROLOGIC INVESTIGATIONS
ATLAS HA-355 (SHEET 1 OF 2)

WATER-TABLE AQUIFERS



Base from U.S. Geological Survey
Martin 1:250,000, 1955

SCALE 1:125 000
2 0 2 4 6 8 10 MILES
2 0 2 4 6 8 10 KILOMETERS
CONTOUR INTERVAL 100 FEET
DATUM IS MEAN SEA LEVEL

APPROXIMATE MEAN DECLINATION, 1971

SURFICIAL GEOLOGIC MAP

EXPLANATION

Qa — Alluvial deposits

Include flood-plain alluvium deposited during the present erosional cycle and terrace alluvium adjacent to the flood-plain alluvium. Deposits along the White River usually composed of, in descending order, 5 to 10 feet of silt; 5 to 15 feet of fine-to-coarse sand; and 1 to 10 feet of coarse sand and gravel. Along the Little White River and the streams that flow over Tertiary deposits the alluvium usually consists of 10 to 20 feet of very fine to medium sand. Deposits along intermittent streams that flow over the Pierre Shale usually consist of 5 to 20 feet of silty clay, which contains scattered thin beds of fine-to-medium sand and clayey gravel and broken shale fragments. Alluvial deposits form the flatlands adjacent to present stream channels and the flat terraces within present stream valleys

Alluvium along the White River contains some very permeable beds of sand and gravel, but the areal extent of these beds is generally small. Some of the beds are not connected hydrologically with the river and yield only small amounts of water. Along the Little White River and along the streams that flow over Tertiary deposits, the alluvium is usually moderately permeable. Alluvium along streams that flow over the Pierre Shale is relatively impermeable, and where it is moderately permeable it has only a small amount of water in storage. Yields from wells in alluvial deposits generally are adequate for domestic and stock needs, except along the intermittent streams that flow over the Pierre Shale. Local very permeable deposits that are hydrologically connected with a perennial stream may yield enough water for limited irrigation. Quality of water in alluvium underlain by Tertiary deposits is good, but that of water in alluvium underlain by the Pierre Shale is poor, except where the aquifer is in direct hydrologic contact with a perennial stream; there the quality of the water usually is similar to that in the stream

Qwd — Windblown sand deposits

Mapped only where areally extensive or water bearing. Consist of unconsolidated very fine to medium grained quartz sand. Thickness in small isolated deposits is usually less than 10 feet. Thickness of large deposits in southwest part of Todd County ranges from 0 to more than 150 feet. Characterized by dune topography and blowouts, often partially stabilized by vegetation

Generally very permeable and water bearing. Small isolated deposits, however, are usually drained so that only the basal few feet are saturated. Springs are common along the margins of the deposits. Yields from wells commonly are adequate for domestic and stock needs, except where the deposits are small. Quality of water is good (dissolved solids content generally less than 300 mg/(l), although water usually has high silica content

Holocene — QUATERNARY

Qt — Terrace deposits

Mapped only where areally extensive or water bearing. Consist of silty clay, sand, and gravel; sandy and silty layers are often partly cemented by calcium carbonate; gravel and sand beds are commonly interbedded with laminated silty clay. Thickness ranges from 0 to 45 feet, and averages about 25 feet. Deposits form nearly flat isolated terraces 150 to 350 feet above present streams. Terraces usually aligned parallel to present stream courses and have gentle slopes toward the rivers

Generally water bearing in the basal few feet. Springs and seeps are common along the sides near streams. Yields from wells and springs are usually adequate for domestic and stock needs. Water quality is generally poor in areas where the water-bearing beds are underlain by the Pierre Shale. Those deposits that overlie Tertiary rocks yield water of good quality

Pleistocene — QUATERNARY

To — Ogallala Formation

Consists of an upper unit composed of well cemented, fine-to-medium grained sandstone and a lower unit composed of poorly consolidated clay, silt, and sand. The contact between the units is commonly marked by a bed of silty volcanic ash in the base of the upper unit. The marker bed ranges in thickness from 1 to 4 feet. Locally, however, silty limestone or gravel beds may be found at the base of the upper unit. The composition of the beds in the lower unit ranges from silty clay to coarse sand, and varies both vertically and horizontally. A 5- to 20-foot thick bed of coarse sand and gravel commonly occurs in the basal part of the lower unit. Thickness of the upper unit ranges from 0 to 40 feet and the lower unit ranges from 0 to 200 feet. The upper unit forms the caprock on the isolated buttes and ridges in the southeastern and northwestern parts of Todd County. The lower unit forms the gently rolling grasslands in southcentral Todd County. The South Dakota Geological Survey maps the upper unit as the Ash Hollow Formation and the lower unit as the Valentine Formation of the Ogallala Group

Upper unit is relatively impermeable, but small seeps do occur near its base. Lower unit is generally water bearing, however, the permeability of the bed varies with the lithology. Yields from wells completed in the lower unit are usually adequate for domestic and stock use, and those of properly constructed wells in large permeable beds may be adequate for irrigation. Water is of good quality, with a dissolved solids content usually less than 350 mg/l

Pliocene — TERTIARY

Ta — Arikaree Formation

Consists of silicified claystone, silty clays, siltstone, and poorly consolidated sandstone which are all characteristically a light pinkish-tan. Basal 50 to 150 feet is usually composed of silty and sandy beds which are commonly separated from the upper clayey part by 5 to 10 feet of thin-bedded limestone. The formation in the project area cannot be subdivided into the distinct lithologic units of the Arikaree which occurs 50 to 75 miles west. Thickness ranges from 0 to 350 feet. Forms gently rolling grass-covered hills similar to those formed by the Ogallala Formation, but the banks it forms along streams are usually steeper. The South Dakota Geological Survey recently redefined the beds in the project area as the Rosebud Formation (South Dakota Geol. Survey Rpt. Inv. 97, 1968)

Beds in upper clayey part are composed of relatively impermeable material, but yield water from fractures, joints, and thin silty zones. Basal sandy and silty part is moderately to slightly permeable. Yields from wells usually are adequate for domestic and stock use. Water is of good quality with a dissolved solids content usually less than 500 mg/l

Miocene — TERTIARY

Tw — White River Group (undifferentiated)

Consists of poorly consolidated siltstone and claystone. Generally the lower part of the group (100 to 120 feet thick) is composed of clayey and calcareous siltstones with thin beds of fine-grained sand. The upper part of the group is generally bentonitic claystone with thin beds of clayey siltstone. Commonly the basal 5 to 10 feet is composed of silty sand and gravel. Thickness ranges from 0 to 225 feet. Forms steep, fluted cliffs and bluffs along streams and edges of mesas. Erodes to form very gently rolling hills having a sparse grass cover on the uplands. The distinct lithologic units of the group are mapped as the Chadron and Brule Formations of the White River Group in the area west of the project, but these formations can only be distinguished locally in the northwest part of Mellette County

Upper clayey part is relatively impermeable, but the lower silty part yields some water to wells, and the basal sands and gravels are moderately permeable. Yields from wells completed in the basal 100 to 120 feet are usually adequate for domestic and stock use. The quality of the water is good to fair, depending on how close the aquifer is to the Pierre Shale. Dissolved solids content known to range from 300 to 700 mg/l, and probably is higher in some water from the basal sands and gravels

Oligocene — TERTIARY

Kp — Pierre Shale

Two distinct lithologic units are recognizable in the project area. The lower unit, of which as much as 200 feet is exposed, consists of slightly calcareous, bentonitic, clay-shale. In fresh exposures it is usually dark gray and blocky, but weathers into light-gray flakes, and then into grayish-brown structureless clay. A 10- to 30-foot zone, in which dark grayish-brown limestone concretions are common, marks the top of the lower unit. Between 150 and 270 feet of the upper unit is exposed. It grades from a light-gray, blocky, calcareous shale at the base to a grayish-brown, thin-bedded, silty shale at the top. On weathering the bottom part becomes a light-gray gumbo clay and the upper part a yellowish-brown silty clay. In the northwestern part of Mellette County, a 10- to 30-foot zone of weathered, yellowish-brown to reddish-brown clay occurs at the top of the Pierre. This zone is probably an Eocene paleosol The shales and weathered clays of the Pierre are too impermeable to yield any significant amounts of water

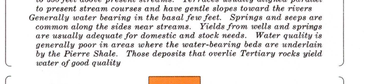
Upper Cretaceous — CRETACEOUS

Contact

136 — Well
Number indicates depth of well, in feet below land surface

Spring

Ta 43 / 425



Water-quality pattern

Upper number indicates hardness (in mg/l as $CaCO_3$) and lower number indicates total dissolved solids (in mg/l). Letters indicate formation or deposit which yields water: Qa-Alluvium; Qa (p)-Alluvium in contact with the Pierre Shale; Qwd-Windblown sand deposits; Qt-Terrace deposits; Qt (p)-Terrace deposits in contact with the Pierre Shale; To-Ogallala Formation; Ta-Arikaree Formation; and Tw-White River Group

Patterns show general chemical character of water and are based on analyses of water from the indicated well or spring. Concentrations, in milliequivalents per liter, are plotted for calcium (Ca), magnesium (Mg), sodium plus potassium (Na+K), bicarbonate plus carbonate (HCO_3+CO_3), sulfate (SO_4), and chloride (Cl) ions. Anions (negatively charged ions) are plotted to the right of the center line and cations (positively charged ions) to the left. The area of the pattern is an indication of dissolved solids content. Differences in configuration reflect differences in chemical character of the water

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Sectionized township

EXPLANATION

Original areas of reservations — Report area

INDEX MAP SHOWING ORIGINAL EXTENT OF INDIAN RESERVATIONS IN SOUTH DAKOTA AND THE AREA DESCRIBED IN THIS REPORT

0 10 20 MILES

EXPLANATION

1 — Area of geologic investigation, number indicates reference cited to right

5 — Area of hydrologic investigation, number indicates reference cited to right

REFERENCES

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2. _____1963, Geology of the Mission quadrangle: South Dakota Geol. Survey Geol. Quadrangle, map and text.
3. Barari, Assad, 1967, Ground-water supply for the City of Mission, South Dakota: South Dakota Geol. Survey Spec. Rpt. 41, 30 p.
4. Cox, E. J., and others, 1962, Geology of selected highway strips in South Dakota: South Dakota Geol. Survey Rpt. Inv. 93, p. 153.
5. Newport, T. G., 1959, Ground-water Resources of the Lower Niobrara River and Ponca Creek basins, Nebraska and South Dakota: U.S. Geol. Survey Water-Supply Paper 1460-G, p. 273-323, pl. 10-12.
6. Rothrock, E. P., 1942, A Hydrologic study of the White River valley: South Dakota Geol. Survey Rpt. Inv. 41, 32 p. and map.
7. Schoon, R. A., 1958, Geology of the Witten quadrangle: South Dakota Geol. Survey Geol. Quadrangle, map and text.
8. Schoon, R. A., and Sevon, W. D., 1958, Geology of the Keyapaha quadrangle: South Dakota Geol. Survey Geol. Quadrangle, map and text.
9. Sevon, W. D., 1959, Geology of the Okreek quadrangle: South Dakota Geol. Survey Geol. Quadrangle, map and text.
10. _____1960, Geology of the Ring Thunder quadrangle: South Dakota Geol. Survey Geol. Quadrangle, map and text.
11. _____1960, Geology of the Spring Creek quadrangle: South Dakota Geol. Survey Geol. Quadrangle, map and text.

MAP SHOWING AREA OR PARTS OF AREAS, WHICH HAVE BEEN DESCRIBED IN GEOLOGIC OR HYDROLOGIC STUDIES MADE PRIOR TO THIS INVESTIGATION. DATA AND MAPS FROM REPORTS ON THESE AREAS HAVE BEEN ADAPTED FOR THIS REPORT

INTRODUCTION

An investigation of the geology and ground-water resources of the Rosebud Indian Reservation, South Dakota, was made at the request of the Bureau of Indian Affairs as part of the U.S. Department of Interior's program for the development of the Missouri River basin. Originally, the Reservation included all of Mellette, Todd, and Tripp Counties; most of Gregory County, and a small part of Lyman County. (See index map.) However, of the 1,500 square miles of land now owned by individual Indians or by the Rosebud Sioux Tribe, nearly 95 percent is located in Mellette and Todd Counties. Accordingly, the area of this investigation (about 2,700 square miles) was restricted to these two counties.

Emphasis in this investigation was placed on mapping the distribution of the major water-bearing deposits and determining their potential as sources of water for domestic and agricultural use. To be defined as "an adequate source of supply" for this investigation, an aquifer should be capable of providing a minimum sustained yield to domestic and stock wells of 5 gpm (gallons per minute); to wells used for limited supplemental irrigation, 50 gpm; and to wells used for full-time irrigation, 500 gpm.

Some previous geologic and hydrologic studies have been made in the project area. (See map showing areas of previous reports.) All of the reports from these studies, except those by Barari (1967) and Rothrock (1942) contain only a small amount of information on ground water.

Most of the geologic mapping done as part of this investigation was based on the interpretive use of soils maps and areal photographs provided by; Dr. E. M. White, South Dakota State University; the South Dakota Geological Survey; and the Bureau of Indian Affairs. Data on wells were obtained from land owners or tenants and from well drillers. Logs of deep wells and information on the stratigraphy and water-bearing properties of artesian aquifers were provided by R. A. Schoon, geologist for the South Dakota Geological Survey, and by the drillers who have installed most of the deep wells in the area. The authors appreciate the cooperation and assistance given by the individuals and agencies named above.

Data on which this report is based—including logs of wells and test holes, chemical analyses of water, and records of wells and springs—have been summarized by the authors in a basic-data report entitled "Water Resources Report 6, Basic hydrogeologic data—Rosebud Indian Reservation, South Dakota," published jointly by the South Dakota Geological Survey and the South Dakota Water Resources Commission. A selected bibliography of reports pertaining to the geology and hydrology of the area is included in the basic-data report. This atlas will be more useful if studied in conjunction with the basic-data report.

GROUND-WATER RESOURCES

Most of the ground water used in Mellette and Todd Counties is obtained from springs and shallow wells completed in water-table aquifers in Tertiary and Quaternary deposits. Where adequate or suitable supplies of water cannot be obtained from water-table aquifers, water is obtained from deep wells drilled into artesian aquifers in Paleozoic and Mesozoic formations.

Water-table aquifers.—The distribution of surficial deposits in the project area is shown on the surficial geologic map and their water-bearing properties are summarized in the map explanation. All of the Tertiary and Quaternary deposits yield water to wells, except locally where they are too thin or impermeable. The Pierre Shale of Cretaceous age does not yield water; however, local unmapped deposits of alluvial and colluvial material derived from the Pierre yield small amounts of water to domestic and stock wells.

Aquifers in the alluvial deposits along the White River, the wind-blown sand deposits in the southwest part of Todd County, and the Ogallala Formation have the greatest potential for further development as sources of ground water. These aquifers are commonly very permeable, are easily recharged, and may yield enough water for irrigation. However, test drilling and pumping tests are often necessary to locate sites for high capacity wells in these deposits because of lateral variations in the permeability and thickness of the water-bearing beds.

Aquifers in the alluvial deposits along the Little White River, the alluvial deposits that overlie Tertiary beds, the Arikaree Formation, and the White River Group also have a good potential for further development as sources of ground water. These deposits usually consist of fine-grained material and are not very permeable. Although wells completed in these aquifers generally yield only moderate amounts of water—enough for most domestic and stock needs—they are ordinarily reliable sources of water even in dry years.

Alluvial deposits and terrace deposits that overlie the Pierre Shale commonly contain beds of coarse-grained material which are very permeable. The beds, however, are thin and drain readily so they usually contain only a few feet of saturated material. The yield of wells tapping these aquifers is usually adequate for most domestic and stock needs, except during dry years.

In a few places, discontinuous beds of impervious clay above the water table in the terrace and alluvial deposits obstruct downward percolation of water; water that remains above the clay barrier is called "perched water." Although a few bodies of perched water may persist even in the driest seasons, most are temporary and are not dependable sources of supply even for domestic purposes.

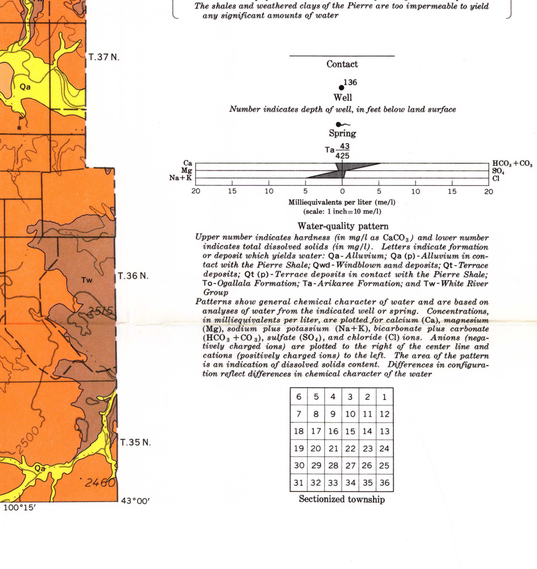
Depth to the water table, especially in the Tertiary formations and the alluvial deposits which overlie them, is not necessarily an accurate indication of the depth to which a well must be drilled to obtain an adequate water supply. Many of the rocks do not yield water readily; therefore, it may be necessary to penetrate 100 feet or more of saturated material to develop an adequate supply. Areas underlain by water-table aquifers and the depth to which wells generally must be drilled to obtain sufficient water for domestic and stock use are shown on the map at the right.

Most of the shallow wells and springs in the report area yield water of satisfactory quality for most uses. However, in some areas, the water-bearing beds in contact with the Pierre Shale yield water that is unsuitable for some domestic and agricultural uses because of high dissolved solids, sulfate, nitrate, iron, manganese, or selenium content. The chemical composition of the water from the aquifers in contact and not in contact with the Pierre Shale are shown by water-quality patterns on the surficial geologic map and are summarized in the following table.

The selenium content of some of the water in the report area presents a potential health hazard not encountered in most saline waters from other parts of the state. Selenium in very small amounts is toxic to both man and animals, and analyses of water from the report area indicates that some of the water contains concentrations of selenium that are in excess of the accepted maximum concentrations recommended for human consumption. Water used for human consumption should be analyzed for selenium, especially if it has been in contact with the Pierre Shale.

Quality of water from water-table aquifers

Concentration	Dissolved solids	Hardness as $CaCO_3$	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Boron (B)	Iron (Fe)	Manganese (Mn)	Selenium (Se)
	Chemical composition of water, in milligrams per liter										
	Water from water-table aquifers in contact with the Pierre Shale (Calculated from analyses of 8 samples)										
Maximum	3190	1860	769	583	1940	174	438	0.94	1.6	0.47	0.45
Average	2510	1000	338	406	1120	86	119	.54	.21	.15	.08
Median	2320	790	278	397	980	92	18	.57	.02	.07	.03
Minimum	1290	525	180	296	288	13	.3	.16	.01	.00	.00
	Water from water-table aquifers not in contact with the Pierre Shale (Calculated from analyses of 22 samples)										
Maximum	771	353	190	469	223	17	13	0.31	0.49	1.2	0.03
Average	340	146	55	261	32	4.8	2.9	.09	.08	.20	.01
Median	300	156	33	238	11	3.6	1.2	.06	.02	.12	.01
Minimum	182	43	15	126	3.5	.8	.0	.02	.00	.00	.00
	Recommended standards of the U.S. Public Health Service (1962)										
Maximum	500	--	--	--	250	250	45	--	0.3	0.05	0.01



0 10 20 MILES

EXPLANATION

No significant aquifers within 500 feet of land surface

Locally significant aquifer within 100 feet of land surface

0-100 / 100-200 / 200-300 / 300-500

Generally one or more significant aquifers within 500 feet of land surface. Numbers indicate ranges in depths of wells in area

Area boundary

MAP SHOWING AREAS UNDERLAIN BY WATER-TABLE AQUIFERS AND RANGES IN WELL DEPTHS ORDINARILY REQUIRED TO INSURE ADEQUATE YIELDS FOR DOMESTIC AND STOCK USE

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1971—W69329

HYDROLOGY OF THE ROSEBUD INDIAN RESERVATION, SOUTH DAKOTA

By
M. J. Ellis, J. H. Ficken, and D. G. Adolphson

1971

For sale by U. S. Geological Survey, price $1.50 per set