STATE OF SOUTH DAKOTA
Ralph Herseth, Governor

STATE GEOLOGICAL SURVEY
Allen F. Agnew, State Geologist

SPECIAL REPORT 7

SHALLOW WATER SUPPLY FOR THE CITY OF ROSHOLT

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SHALLOW WATER SUPPLY FOR THE CITY OF ROSHOLT

INTRODUCTION

At the request of the Rosholt City Council, the State Geological Survey sent a field party to Rosholt to conduct a shallow ground water survey from July 11 to July 29, 1960.

The surficial geology within an area of about 30 square miles (fig. 1) was mapped on air photos by the writer, using topographic expression and hand auger borings. Thicknesses of sand and gravel were determined by 22 holes, drilled with the State Geological Survey's jeep-mounted auger drill operated by Jerry Schweigert and Mark McDermott. A plane table survey was made by the writer and Curt LaClair of Rosholt. Mike Rosenkranz of Rosholt substituted for LaClair on July 29. The services of La Clair and Rosenkranz were supplied by the city. An inventory was made of domestic farm wells within the Rosholt area (Appendix B).

The writer profited from the many helpful suggestions of M. J. Tipton, supervisor of the field project. The writer wishes also to thank the residents of the Rosholt area for their cooperation during the progress of the field work.

PREVIOUS WORK

R. F. Flint (1955) made a reconnaissance study of the glacial deposits of South Dakota east of the Missouri River, which included the Rosholt area.

SURFICIAL GEOLOGY OF THE ROSHOLT AREA

The geologic map of the Rosholt area is a generalization for the following reasons: (1) there was not sufficient time in which to resolve the many complexities of the detailed geological relations, and (2) the mapped area was too limited in extent to permit a regional study of the geology. The above limitations, however, are academic, and they have not affected the practical results of the present survey.

As shown by Figure 1, the surficial geology of the Rosholt area consists of end moraine, ground moraine, glacial lake deposits, and alluvium. End moraine is a ridgelike accumulation of unstratified glacial clay, silt, sand, and gravel that was built along the margin of an ice sheet. Ground moraine is glacial deposits of unstratified clay, silt, sand, and gravel of low relief, and is devoid of transverse linear elements. Glacial lake deposits in this area are of three types--gravel, sand, and silt and mud. The gravel was deposited on beaches, usually above the water line. The sand was deposited along the shore, and may have extended for some distance under water. The silt and mud were deposited on the floor of the lake. Associated with the lake deposits, in the Rosholt area, are sand bars--linear or arcuate ridges of sand formed by current action below wave level. Alluvium is crudely stratified sand and clay, deposited by streams.

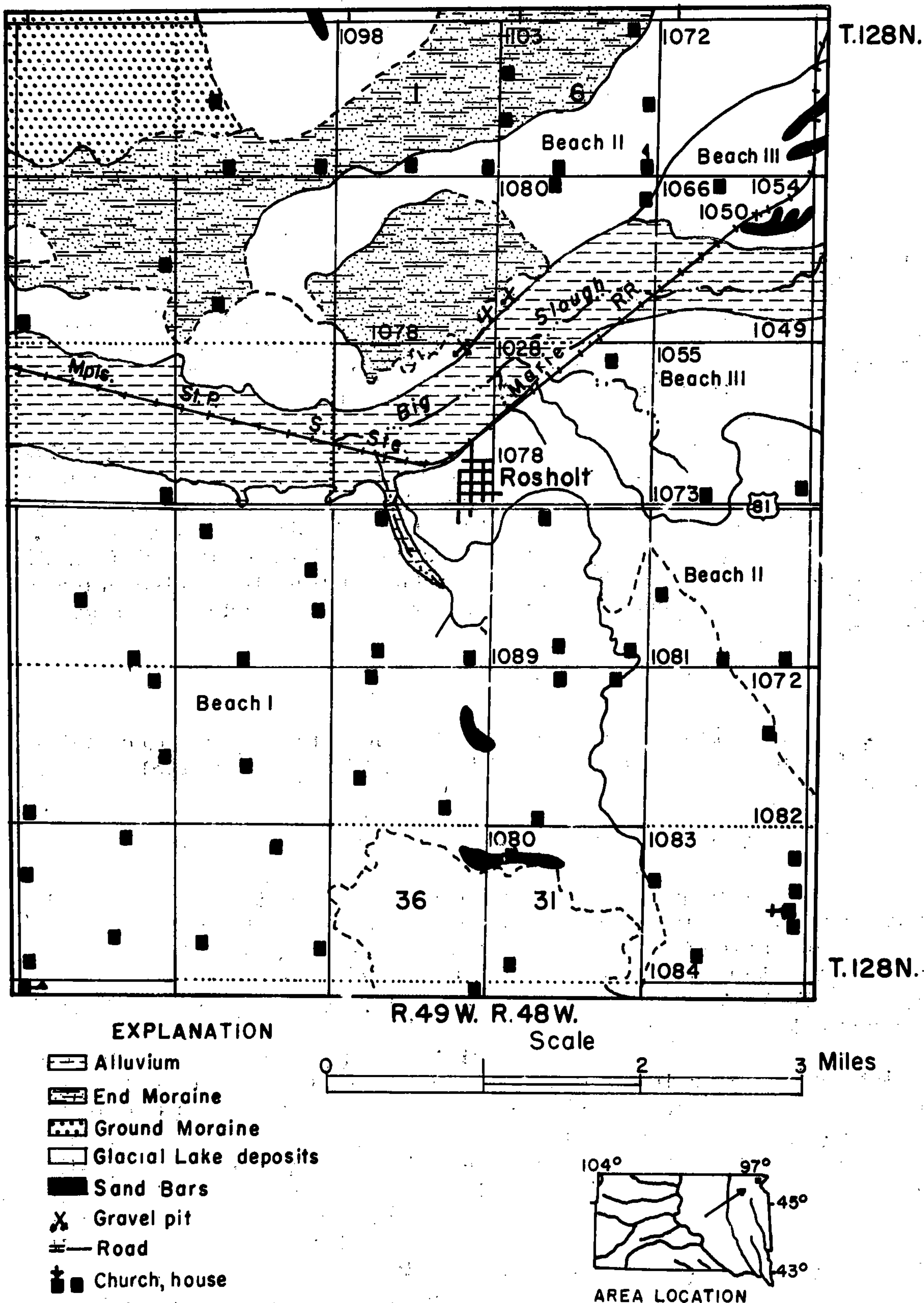

Figure I. Map showing generalized surface geology of the Roshalt area.

by

H. D. Wong

1960

The glacial lake sediments of the Rosholt area were deposited by ancient glacial Lake Agassiz. Rosholt was at the southern tip of this huge lake, which covered an area in eastern North Dakota, western Minnesota, and into Canada; at its maximum extent, this lake was larger than the total area of all of the present Great Lakes. Three beaches made by Lake Agassiz waters appear south of the Big Slough, at approximately 1050, 1070, and 1080 feet above sea level, and three appear to the north at the same elevations; the highest, and therefore the oldest represented in the Rosholt area, was pitted and subsequently dissected by streams. Sand pits in the SE1/4 sec. 12, T. 128 N., R. 49 W., and the SW1/4 sec. 7, T. 128 N., R. 48 W., display cross-bedded deposits typical of foreshore beach sands. Above this beach sand is a 10-15 foot thickness of glacial till, which is younger than the beach deposit.

The city of Rosholt is believed to be located on the second beach level (see fig. 1). The State Geological Survey's test hole No. 17 (fig. 2) showed 5 feet of gravel, 39 feet of sand, and 5 feet of clay under this beach. Because of insufficient drilling equipment, it was not possible to penetrate the water-bearing zone from which the city is presently obtaining its supply of water. However, drill hole logs of 4 tests made by the Don Whaley Well Drilling and Repairing Co. (Wheaton, Minn.) for the city showed the following:

Test Hole No. 1
NW corner of city park
Total depth: 127 feet

0- 1	topsoil, black
1- 22	sand, fine, brown
22- 74	sand, fine; gray silt
74- 87	clay, gray
87- 92	sand, fine, gray, water
92-114	clay, hard, gray
114-124	clay, blue gray
124-126	gravel, water
126-127	shale, gray

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Test Hole No. 2
NE corner of city park
Total depth: 145 feet

0- 1	topsoil, black
1- 24	sand, fine, brown
24- 91	sand, fine; gray silt
91- 98	clay, gray
98-102	sand, fine, water
102-131	clay, gray
131-145	shale, gray

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Test Hole No. 3
Near auditorium
Total depth: 140 feet

0- 2	fill, brown
2- 26	sand, fine, brown
26- 91	sand, fine; gray silt
91- 103	clay, blue gray
103-108	sand, fine, gray, water
108-116	clay, gray
116-118	gravel, colored, water
118-138	clay, gray
138-140	shale, gray

Test Hole No. 4
SW of Punch Risdall Home
Total Depth: 145 feet

0- 1	topsoil, black
1- 21	sand, fine, brown
21- 74	sand, fine; gray silt
74- 87	clay, gray
87-102	sand, fine; silt, gray
102-141	clay, gray
141-145	shale, dark gray

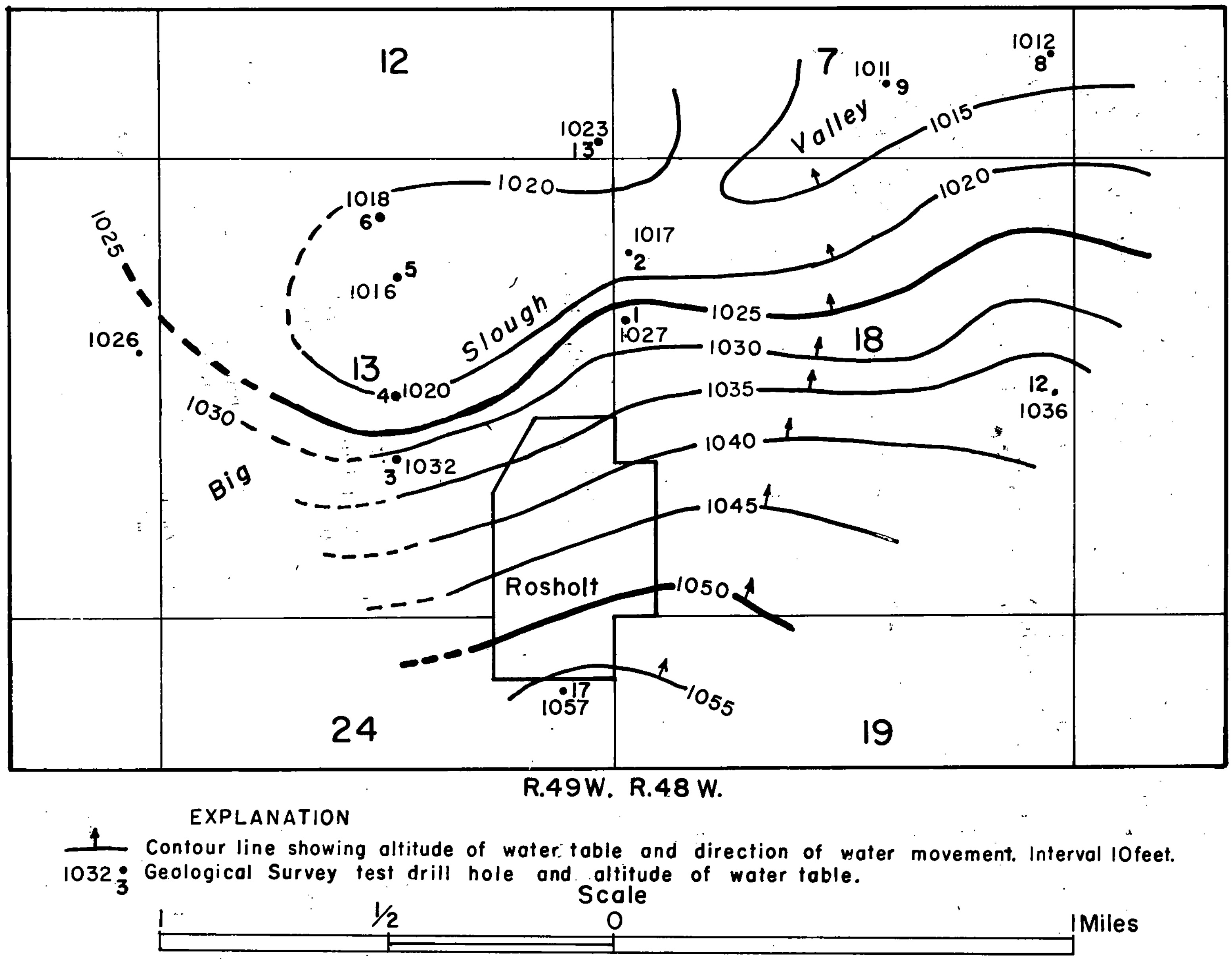

Figure 2. Water table map of part of the Big Slough Valley.

GEOLOGY OF GROUND WATER

Ground water may be defined as the water present in the openings or voids of a rock formation or sediment below the water table; the water table thus marks the upper surface of the main body of ground water. The amount of water held in storage by a reservoir rock, or aquifer, depends on the porosity of the rock. The porosity of a rock is the ratio of the volume of the openings in the rock to the total volume of that rock, expressed in percent. Porosity of sedimentary deposits such as the lake sands and gravel in the Rosholt area depends on: (1) the shape and arrangement of individual particles, (2) the degree of sorting of the particles, (3) the degree of cementation and compaction of the particles, and (4) the amount of mineral matter removed in solution by percolating ground waters.

Unconsolidated deposits of uniform grain size have high porosity regardless of the size of the individual grains. Thus clays and silts have high porosity, and sands and gravels of uniform grain size have equally high porosity. A deposit of different grain sizes, however, has lower porosity, because the smaller grains occupy the openings between larger grains. This variance of grain size not only reduces the porosity but also the permeability, or the ability of a deposit to transmit a fluid. It is to be expected, therefore, that till offers poor prospects for an adequate city water supply.

Ground water is not confined to "veins" as is thought by some, but is present nearly everywhere. The existence of a supply of ground water is controlled by the behavior of the water table, or upper surface of the zone of saturation. The water table is not a stationary level surface, but an irregular surface which, in a general way, reflects the topography of the land. Daily, monthly, seasonal, and yearly fluctuations of the water table are accepted facts. From a study of the water table, information about the depth of water, the direction and rate of flow, and the periodic variations of the depth to water may be obtained. Observations of water table fluctuations over a period of years give indications of supply and recharge conditions in an aquifer.

Figure 2 is a map showing lines of equal elevation above sea level on top of the water table. From such a map the general character of the water-bearing deposit can be inferred with a fair degree of accuracy. Close spacing of contour lines indicates low permeability that is due to fine-grained materials, whereas widely spaced contour lines indicate high permeability that is due to coarse-grained materials.

At any moment the level of the water table represents a condition of dynamic equilibrium between the rate of recharge and the rate of discharge of ground water. Recharge is the replenishment of ground water, which is brought about mainly by precipitation in the form of rain and snow. Discharge of ground water refers to the depletion of water by both natural and artificial means such as evaporation and pumping of wells.

AVAILABILITY OF SHALLOW GROUND WATER NEAR ROSHOLT

It is reported that the Rosholt city well obtains its water from a gravel deposit about 110 feet below the surface of the ground. The present survey was unable to check the reported depth to this gravel deposit, because of inadequate drilling equipment. However, logs of the four test holes drilled by the Don Whaley Well Drilling and Repairs Co. (see page 3) reported gravel in test hole No. 1 at 124-126 feet, and in test hole No. 3 at 116-118 feet; test holes No. 2 and No. 4 did not show gravel. It is believed that the source of the city's supply is a gravel lense or pocket within or at the base of the till. The presence of an extensive lense or pocket of gravel could probably permit a second city well, providing the location of a second well did not affect the drawdown of the first.

The thickness of the beach sand and gravel on which the city is located varies from 44 to 90 feet, with an average of about 74 feet. The State Geological Survey's test hole No. 17 (figs. 2, 3) gave a thickness of 30 feet of beach sand and gravel; it is completely water-saturated.

Deposits of sand and gravel in the valley of the Big Slough were prospected by 8 test holes (fig. 3). The thickness of the sand varies from 19 to 35 feet, with an average of about 27 feet. Amount of water-saturated sand ranges from 19 to 30 feet, with an average of about 26 feet. Depth to water is from zero to 5½ feet.

QUALITY OF GROUND WATER

Table 1 gives the analyses of water taken from wells in the Rosholt area. All ground water has some dissolved salts, but the nature and quantity of the chemical salts in solution may vary from area to area, and from formation to formation. Some dissolved elements, such as iron or sulphur, give to water a disagreeable taste or render the water unfit for certain industrial uses. Among the most abundant soluble salts in ground water are compounds of calcium (Ca), sodium (Na), and magnesium (Mg). In some localities, calcium and magnesium may not be present in amounts large enough to affect the taste of water, but can give it a quality called hardness which affects its domestic and industrial uses. Ground water ordinarily has been filtered through the rocks and sediments for various periods of time before it is used; it is, therefore, relatively free from harmful bacteria, mud, and other suspended materials except where modified by local conditions. The degree of hardness in water is usually expressed in parts of dissolved mineral salts per million parts of water, and water containing more than 120 parts per million is considered hard.

All the waters analyzed in the Rosholt area are of very good quality with the possible exception of the sample from the Kitaman farm (sample C, table 1) which contains an excessive amount of iron. However, iron can be removed easily by filtration. It should also be noted that the water from the Hahn farm (sample D, table 1) is slightly higher in sulfate than is recommended.

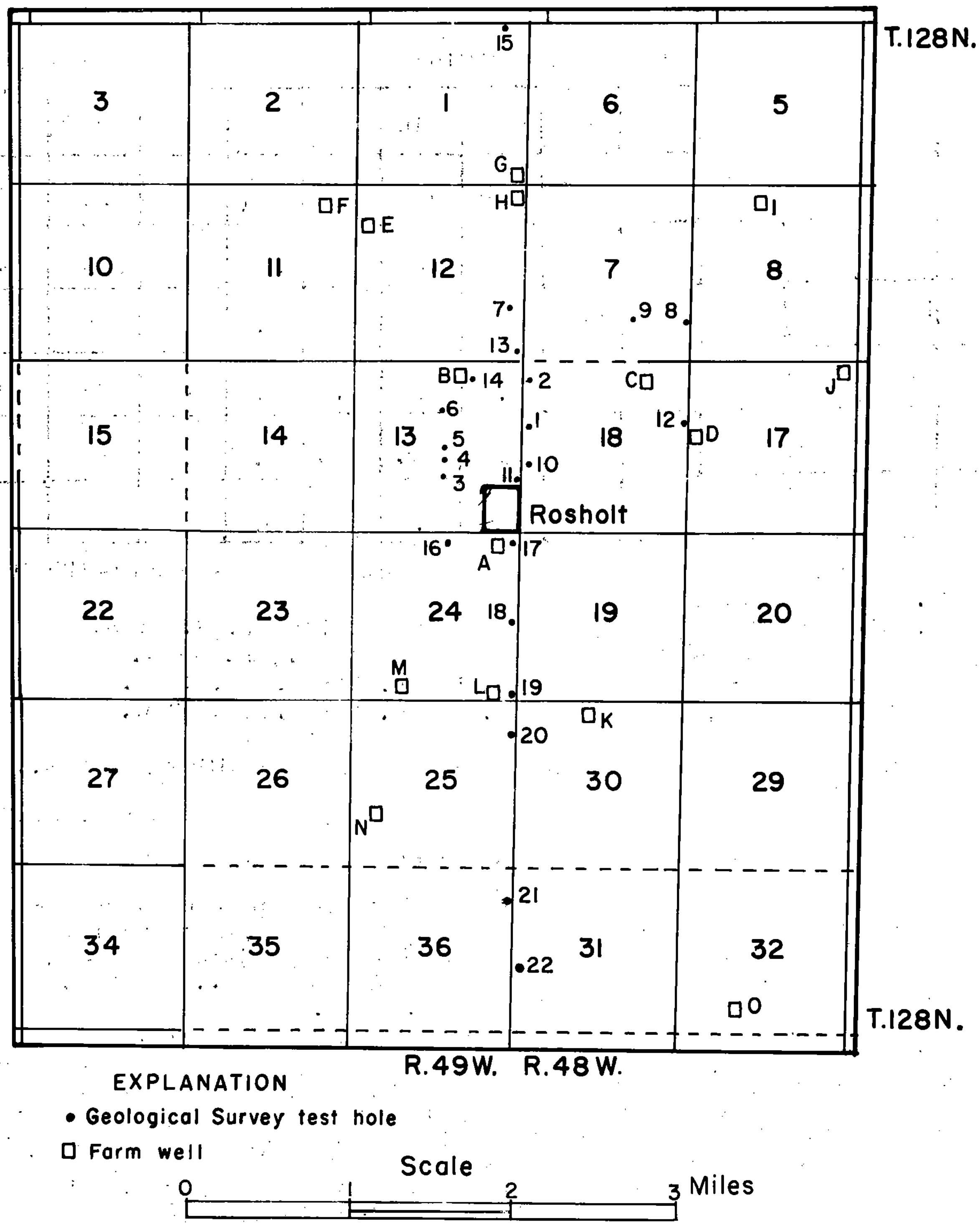

Figure 3. Data map of the Rosholt area.

Table 1. --Chemical Analyses of Water Samples in the Rosholt Area

Sample	Parts Per Million										Hard-ness $CaCO_3$	Total Solids
	Ca	Na	Mg	Cl	SO_4	Fe	Mn	N	F	pH		
A	--	--	50**	250**	250**	0.3**	0.1**	10**	1.0**	--	--	500 to 1000 **
B	77	141	15	23	209	0.0	0.0	0.1	0.0	--	255	686
C	103	10	31	2	179	2.7	0.9	0.1	0.0	--	385	596
D	130	15	67	55	393	0.0	0.9	0.0	0.0	--	599	972
E	83	96	19	9	226	0.0	Tr.	0.1	0.0	--	287	674
F	70	4	20	0	30	0.0	0.0	0.0	0.0	--	258	428

A. U. S. Dept. of Public Health Drinking Water Standards (1960)
B. City Well No. 2
C. Kitaman Farm, SW¼NE¼ sec. 17, T. 128 N., R. 48 W.
D. Hahn Farm, NW¼NE¼ sec. 18, T. 128 N., R. 48 W.
E. Gloede Farm, SE¼SE¼ sec. 13, T. 128 N., R. 49 W.
F. Fogel Farm, NE¼NW¼ sec. 13, T. 128 N., R. 49 W.

* Analyses by State Chemical Laboratory, Vermillion, S. Dak., 1960
** not to exceed

CONCLUSIONS AND RECOMMENDATIONS

It is recommended that the city obtain the services of a commercial well driller licensed by the State of South Dakota, to test further the productive capacity of sands in the following areas: (1) the NE¼ sec. 24, T. 128 N., R. 49 W., (2) the NW¼ sec. 18, T. 128 N., R. 48 W., and (3) the SW¼NE¼ sec. 13, T. 128 N., R. 49 W.

The locations above are recommended for testing because of the thickness of water-saturated sand in the test holes, and because of the relatively high permeability displayed on the water table map (fig. 2).

The city should obtain a water permit from the State Water Resources Commission before any final well installation is made. The State Department of Health should be consulted for bacteriological and chemical analysis of the water, and for requirements of well construction. Finally, it is suggested that the city employ an engineering firm licensed by the State of South Dakota to plan the construction and development of the water wells.

REFERENCES CITED

Flint, R. F., 1955, Pleistocene Geology of Eastern South Dakota: U. S. Geol. Survey, Prof. Paper 262.

Hopkins, O. C., and Gullens, Oscar, 1960, New U. S. Public Health Service Standards: Jour. Amer. Water Works Assoc., v. 52, no. 9, p. 1161-8, Sept.

APPENDIX A

LOGS OF STATE GEOLOGICAL SURVEY TEST HOLES IN THE ROSHOLT AREA
(for location see fig. 3)

G. S. Test Hole No. 1
Surface Elevation: 1032 feet
Depth to water: 5.5 feet

0- 4	topsoil, black; fine brown sand
4- 9	clay with gray, and brown sand
9-13	clay, brown with fine sand; very wet with free water
13-17	sand, grayish brown; free water
17-21	sand, fine; free water
21-26	sand, fine, blue; some clay
26-36	no samples
36-41	clay, blue

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G. S. Test Hole No. 2
Surface Elevation: 1021 feet
Depth to water: 4 feet

0- 4	sand, fine, brown; some clay
4-14	sand, fine, brown; water
14-24	sand, medium, gray; very wet
24-29	sand, medium; very wet
29-34	sand, fine, gray; very wet
34-39	clay, blue

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G. S. Test Hole No. 3
Surface Elevation: 1037 feet
Depth to water: 5 feet

0- 4	topsoil, black; brown sandy clay
4- 9	sand, fine, wet; brown clay
9-14	sand, fine, wet; wet clay
14-29	sand, fine, brown, with water
29-34	clay, blue

G. S. Test Hole No. 4
Surface Elevation: 1025 feet
Depth to water: 5 feet

0- 4	topsoil, sandy, black; fine brown sand
4-14	sand, fine, brown; some clay and water
14-19	no samples
19-34	sand, fine, brown; water
34-39	sand, fine, brown; some medium sand
39-44	clay, blue

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G. S. Test Hole No. 5
Surface Elevation: 1020 feet
Depth to water: 4 feet

0- 4	topsoil, black; fine brown sandy clay
4- 9	sandy clay, brown, wet
9-14	sand, brown; some clay; wet and fluid
14-24	sandy clay, fine, gray; fluid
24-29	sand, medium, gray; very wet
29-34	sand, fine, gray; blue clay
34-39	clay, blue

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G. S. Test Hole No. 6
Surface Elevation: 1023 feet
Depth to water: 4.5 feet

0- 4	topsoil, black; black clay with fine sand
4- 9	clay, brown; fine sand, wet
9-14	sand, fine to medium, brown; some water
14-29	sand, fine, gray; water
29-34	sand, fine, gray; water; blue clay (?)
34-39	clay, blue

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G. S. Test Hole No. 7
Surface Elevation: 1030 feet
No water

0-14	till
14-19	sand, fine to medium; trace of gravel
19-29	sand, medium to coarse; some fine gravel
29-34	sand, medium to coarse; some fine gravel; some brown clay
34-39	clay, brown, moist; fine sand
39-49	sand, fine; water
49-54	no samples
54-59	clay, blue

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G. S. Test Hole No. 8
Surface Elevation: 1012
Depth to water: water flowed from hole as bit was removed

0- 4	clay, black
4- 9	mud, black, very wet
9-14	mud, black; free water
14-19	no samples
19-24	mud, black; free water
24-29	clay, blue

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G. S. Test Hole No. 9
Surface Elevation: 1014 feet
Depth to water: 3 feet

0- 9	mud, black
9-14	mud, black; free water
14-19	clay, blue

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G. S. Test Hole No. 10
Surface Elevation: not surveyed
Depth to water: hole caved

0- 4	clay, brown
4- 9	sand, medium; some brown clay
9-14	sand, coarse; some brown clay
14-24	sand, fine, brown
24-29	sand, fine
29-49	sand, fine, wet
49-59	sand, gray, wet
59-64	clay, blue

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G. S. Test Hole No. 11
Surface Elevation: not surveyed
No water

0- 4	topsoil, black; brown clay
4-14	clay, brown
14-24	clay, brown; some coarse sand, some fine sand
24-29	sand, fine

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G. S. Test Hole No. 12
Surface Elevation: 1048 feet
Depth to water: 12 feet

0- 4	topsoil, sandy, black; light-brown clay
4- 9	clay, sandy, brown
9-14	sand, fine, brown, wet
14-19	sand, fine, clean, wet
19-24	sand, fine, bluish, wet
24-34	sand, fine, wet
34-39	clay, blue

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G. S. Test Hole No. 13
Surface Elevation: 1030 feet
Depth to water: 7 feet

0- 4	topsoil, sandy, black
4- 9	sand, medium, some wet clay
9-14	sand, medium, with clay; fluid
14-34	sand, fine, blue; fluid
34-39	clay, blue

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G. S. Test Hole No. 14
Surface Elevation: 1066 feet
Not reliable for water measurement

0- 4	sand and clay, light brown
4- 9	clay, brown; coarse sand and gravel
9-14	clay, brown, with sand grains
14-19	sand, coarse; clay; some fine to medium sand
19-24	clay, brown
24-29	sand, fine, brown
29-34	clay, brown; grayish clay with fine sand
34-39	sand, fine; brown clay
39-44	sand, fine; brown clay
44-54	sand, fine, brown, wet
54-59	sand, fine, brown; fluid
59-64	clay, blue (?)

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G. S. Test Hole No. 15
Surface Elevation: not surveyed
Clay sucked too much to continue drilling.

0-4	clay, gray and brown, moist, with fine sand
4-9	clay

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G. S. Test Hole No. 16
Surface Elevation: not surveyed
Depth to water: hole caved

0- 4	clay, light brown, with small amounts of gravel and sand
4- 9	clay, light brown, with coarse gravel and sand
9-14	sand, fine to medium, brown
14-19	sand, fine, brown
19-24	sand, fine, brown; fine bluish sand; clay
24-49	sand, fine, blue, with water
49-59	clay, blue

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G. S. Test Hole No. 17
Surface Elevation: 1074 feet
Depth to water: 17 feet

0- 4	sand, fine, light brown
4- 9	sand, fine, light brown; coarse sand with brown clay
9-14	gravel, medium to coarse; medium to coarse sand
14-19	clay, fine, brown, moist
19-44	sand, fine, gray; water
44-49	sand, fine, gray; water; clay (?)
49-59	clay, blue

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G. S. Test Hole No. 18
Surface Elevation: not surveyed
Depth to water: hole caved

0- 4	silt, light brown
4- 9	silt; very fine sand
9-14	sand, fine
14-19	sand, medium, with some clay
19-24	clay, brown, with fine sand
24-29	gravel, medium, with brown clay and fine brown sand
29-34	sand, fine, brown
34-39	sand, fine, gray, moist
39-44	sand, fine, gray, wet
44-49	sand, fine, gray
49-54	clay, blue (?)
54-59	clay, blue

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G. S. Test Hole No. 19
Surface Elevation: not surveyed
Depth to water: hole caved

0- 4	clay, brown, moist
4- 9	clay, brown, moist, with gravel and coarse sand
9-14	gravel, medium to coarse; sand; light-brown clay with fine sand
14-19	clay, blue, moist

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G. S. Test Hole No. 20
Surface Elevation: not surveyed
Depth to water: hole caved

0- 4	topsoil, black; brown clay
4- 9	clay, light brown, moist
9-14	clay, brown; coarse sand; fine gravel; brown clay
14-19	clay, brown, wet; blue clay

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G. S. Test Hole No. 21
Surface Elevation: not surveyed
Depth to water: hole caved

0- 4	sand, fine to medium, tan
4-19	sand, fine to medium; streaks of gravel
19-24	sand, medium; hard brown wet clay
24-29	sand, medium to coarse; medium to coarse gravel
29-34	sand, medium to coarse; blue clay
34-44	clay, blue

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G. S. Test Hole No. 22
Surface Elevation: not surveyed
Depth to water: hole caved

0- 4	clay, brown
4- 9	clay, light brown
9-14	sand, fine, brown
14-19	sand, fine, bluish
19-29	sand, fine
29-39	clay, blue

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APPENDIX B

DATA ON FARM WELLS IN THE ROSHOLT AREA

Location (see fig. 3)	Owner or Tenant	Depth of Well (feet)	Geologic Source	Depth to Water (feet)
A	J. Gloede	110	sandy gravel	?
B	A. H. Fogel	40	sand	14
C	E. Hahn	40	sand	?
D	C Kitzman	44	sand	12
E	E. Foeltz	38	sand	20
F	F. Piersson	60	sand	?
G	W. Voss	60	sand	17?
H	M. Sanders	32	sand	?
I	R. Lick	35	sand	?
J	M. Zack	170	gravel	15
K	A. Nelson	75	?	?
L	A. Brown	42	sand	?
M	H. Daull	55	gravel	10
N	J. Brown	34	sand	10
O	H. Hokenson	60	?	?