STATE OF SOUTH DAKOTA
Richard Kneip, Governor

SOUTH DAKOTA GEOLOGICAL SURVEY
Duncan J. McGregor, State Geologist

Special Report 56

GROUND-WATER INVESTIGATION FOR THE CITY OF BALTIC, SOUTH DAKOTA

by

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CONTENTS

INTRODUCTION

PRESENT INVESTIGATION

This report contains the results of a special ground-water investigation by the South Dakota Geological Survey from June 14 to June 18, 1971, in and around the city of Baltic, Minnehaha County, South Dakota, (fig. 1). This report is the 56th in a continuing series of investigations to assist the cities in South Dakota to locate their future water supplies.

Baltic now obtains its water from two wells. The two city wells are producing water from the Sioux Quartzite but not in sufficient quantity to meet the future demands of the city.

Included in the survey of the Baltic area were: (1) review of the geology as previously mapped by Tipton (1959a and b) and F. V. Steece (1959a and b), (2) drilling of 13 auger test holes, (3) inventory of wells, and (4) collection and analysis of 9 water samples.

As a result of this study, more data on the thickness and areal extent of glacial sand and gravel in the study area was found. It is recommended that a pump test be conducted approximately three-fourths mile west of the city before the construction of a permanent city well.

The cooperation of the residents of Baltic, Mayor R. Nyhaug and former Water Superintendent R. Moan is appreciated. The assistance of the State Chemical Laboratory for analyzing some of the water samples is also acknowledged.

The project was financed by the South Dakota Geological Survey, East Dakota Conservancy Sub-District, and the city of Baltic.

LOCATION AND EXTENT OF AREA

The city of Baltic is located in north-central Minnehaha County in east-central South Dakota. The area is in the Coteau des Prairies division of the Central Lowland physiographic province (fig. 1). The Baltic study area is approximately 4 square miles in size measuring 2 miles north-south and 2 miles east-west.

TOPOGRAPHY AND DRAINAGE

The topography of the Baltic area ranges from an undulating surface on glacial till in the northwest and east part of the study area to a gently sloping surface of glacial outwash and floodplain in the rest of the area. Drainage in the area is controlled entirely by the Big Sioux River which flows from north to south.

GENERAL GEOLOGY

SURFICIAL DEPOSITS

Surficial deposits of the Baltic area were deposited chiefly by glaciers late in the Pleistocene Epoch of geologic time. Glacial deposits are collectively termed drift which is divisible into two broad lithologic groups: till and outwash. Till, commonly called "boulder clay," "blue clay," or "gumbo" consists of a heterogeneous mixture of boulder, pebbles, and sand in a matrix of clay deposited directly by the ice. Outwash material is a more homogeneous deposit, consisting primarily of sand and gravel with minor amounts of silt and clay, which was deposited by melt water streams issuing from a glacier.

Alluvium, a mixture of sand, silt, and clay, which is deposited by the present streams is found on the floodplain of the Big Sioux River. Test hole data indicate that the thickness of the alluvium varies from a few feet to approximately 15 feet.

Figure 2 is a generalized geologic map of the Baltic area. Alluvium deposits are not shown on this map. Figure 3 shows the locations of the test holes drilled in the area.

EXPOSED AND SUBSURFACE BEDROCK

Sioux Quartzite of Precambrian age underlies the surficial deposits in the study area. This rock is exposed northeast of the town and also in spots along the Big Sioux River (fig. 2). In this area the Sioux Quartzite is an orthoquartzite consisting of fine grains of iron-coated quartz sand cemented with silica. The iron coating on the quartz grains imparts a pinkish or reddish color to the formation.

OCCURRENCE OF GROUND WATER

PRINCIPLES OF OCCURRENCE

Nearly all ground water is derived from precipitation in the form of rain, snow, or ice. This water either evaporates, percolates directly downward to the water table and becomes ground water, or drains off as surface water. Surface water either evaporates, escapes to the ocean by streams, or percolates downward into the rocks.

Ground water is defined as water contained in the openings within rocks or sediments below the water table. Practically all open spaces in the rocks that lie below the water table are filled with water; the deposits below the water table are in the zone of saturation. The water table is the upper surface of the zone of saturation and is in equilibrium with atmospheric pressure. Water that occurs in the rocks (and soil) that lie above the water table is in the zone of aeration because some of the open spaces in this zone are filled with air; the remaining pore spaces contain water. Water in the zone of aeration is either held by molecular attraction, returned to the atmosphere by plant use, or is moving downward toward the zone of saturation. Water within the ground above the saturated zone moves downward under the influence of gravity, whereas in the saturated zone it moves in a direction determined by the hydraulic head.

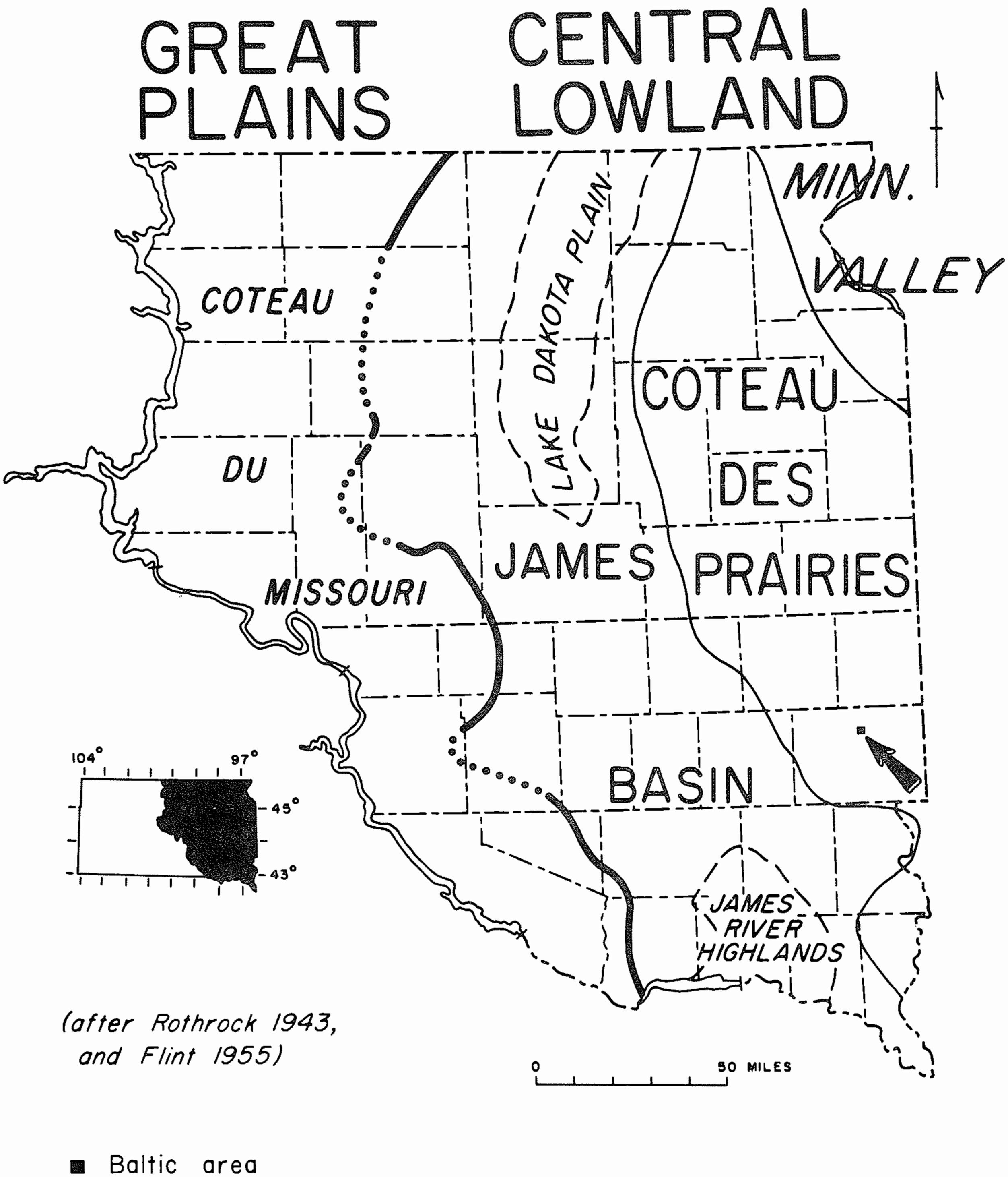
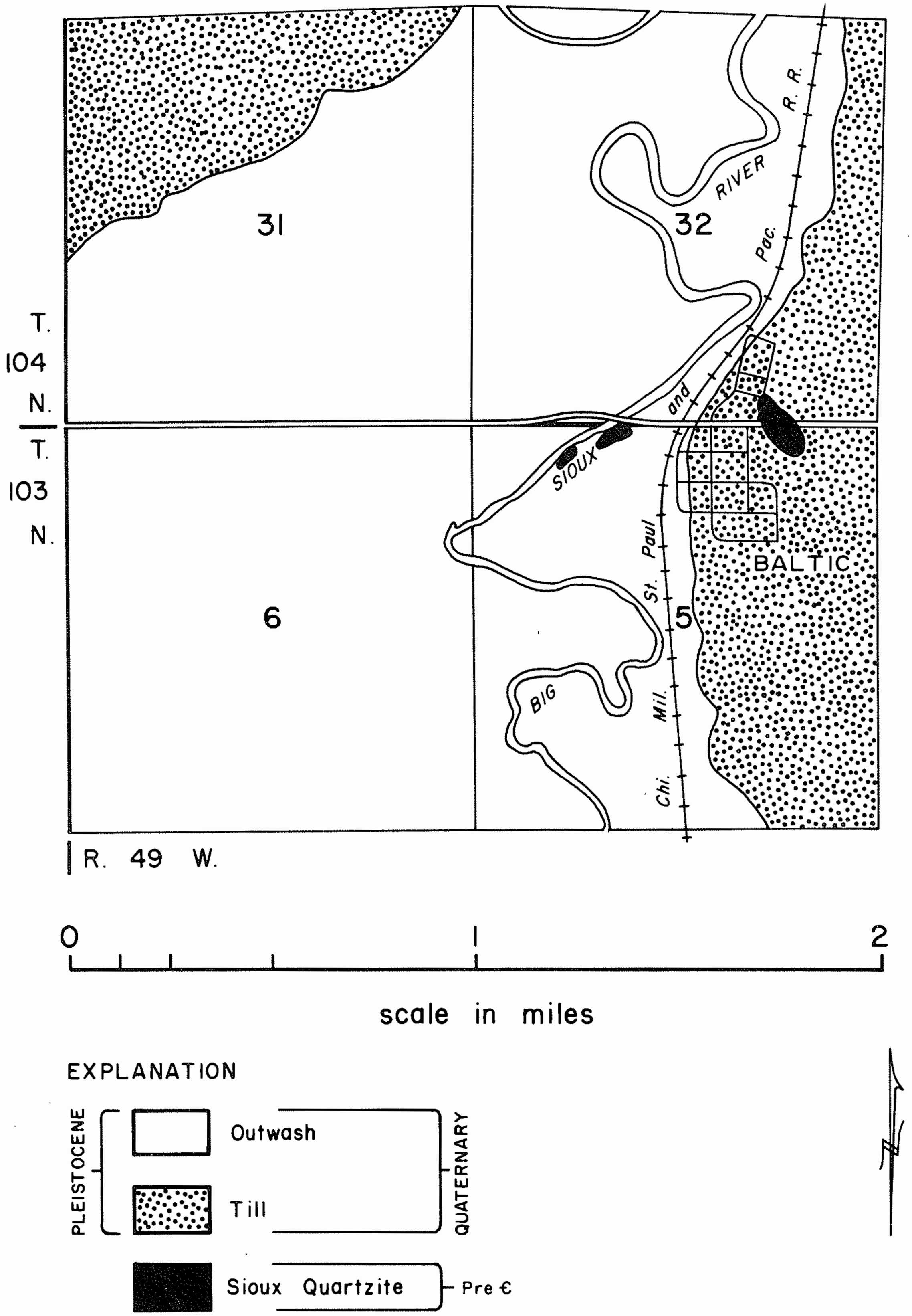


Figure 1. Map of eastern South Dakota showing the major physiographic divisions and location of the Baltic study area.



(Alluvium along the Big Sioux River is not shown on this map)

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Figure 2. Generalized geologic map of the Baltic area.
(Modified from M. J. Tipton, 1959-a, b ; and F. V. Steece, 1959-a and b).

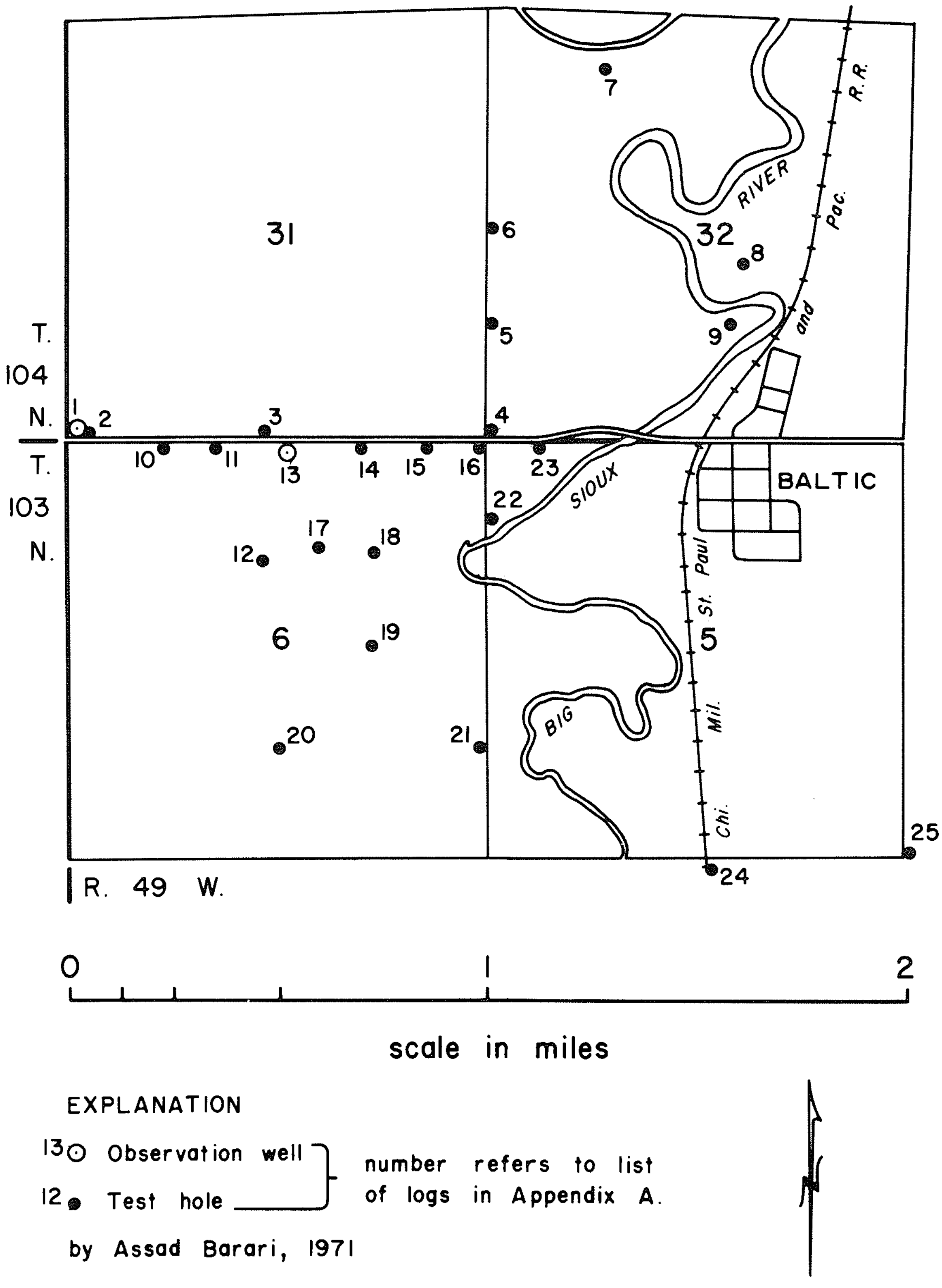

Figure 3. Map showing location of observation wells and test holes in the Baltic area.

Contrary to popular belief, ground water does not occur in "veins" that crisscross the land at random. Instead it can be shown that water is found nearly everywhere beneath the surface, but at varying depths.

Recharge is the addition of water to an aquifer (a deposit having structures that permit appreciable water to move through it under ordinary field conditions). Recharge to an aquifer is accomplished in four main ways: (1) by downward percolation of precipitation, (2) by downward percolation from surface bodies of water, (3) by lateral movement of ground water into the area, and (4) by artificial recharge, which takes place from excess irrigation, seepage from canals, and water purposely applied to augment ground-water supplies.

Discharge of ground water from an aquifer is accomplished in four ways: (1) by evaporation and transpiration by plants, (2) by seepage upward or laterally into surface bodies of water, (3) by lateral movement of ground water out of the area, and (4) by pumping from wells, which constitutes the major artificial discharge of ground water.

The porosity of a rock or soil is a measure of the contained open pore spaces, and it is expressed as the percentage of void spaces to the total volume of the rock. Porosity of a sedimentary deposit depends chiefly on (1) the shape and arrangement of its constituent particles, (2) the degree of sorting of its particles, (3) the cementation and compaction to which it has been subjected since its deposition, (4) the removal of mineral matter through solution by percolating waters, and (5) the fracturing of the rock, resulting in joints and other openings. The size of the material has little or no effect on porosity if all other factors are equal.

Permeability of a rock is its capacity for transmitting a fluid. Water will pass through material with interconnected pores, but will not pass through material with unconnected pores, even if the latter material has a higher porosity. Therefore, permeability and porosity are not synonymous terms.

GROUND WATER IN SURFICIAL DEPOSITS

Alluvium in the floodplain consists mainly of sand, silt, and clay, and as a result the permeability of these deposits is low. Thus, the alluvium does not readily yield large quantities of water to wells.

Till, because of its highly unsorted nature, has low permeability and should not be considered a source of water for the city.

Outwash, consisting mostly of sand and gravel with minor amounts of silt and clay may be considered an aquifer. Figure 4 shows the saturated thickness of sand and gravel in the area.

GROUND WATER IN SIOUX QUARTZITE

Sioux Quartzite is a hard, massive, pink silicious rock which is bedded and jointed. This rock yields water to wells from fractures or joints. The presence of joints and fractures are the main factors controlling the capacity of the rock to yield water.

CHEMICAL QUALITY OF GROUND WATER

Ground water always contains dissolved chemical substances in various amounts. Contained chemicals are derived from: (1) the atmosphere as water vapor condenses and falls, (2) the soil and underlying deposits as the water moves downward to the water table, and (3) the rocks below the water table. In general, the more chemical substances that a water contains, the poorer its quality.

Table 1 shows the chemical quality of water samples collected in the Baltic area (fig. 5). Samples W-1 through W-7 were collected from wells and test holes producing water from the outwash (depth of sample W-1 and source of samples W-1 and W-7 are not accurately known). Water samples from the outwash deposits are within the standard limits set by the South Dakota Department of Health except for the following chemicals: (1) high iron in most samples, (2) slightly high manganese in sample W-1 and W-7, and (3) low fluoride in samples which were analyzed for this chemical. Sample W-8 was collected from the City Well No. 1. This sample has higher sulfate and total solids and less fluoride than the recommended limits. Sample W-9 collected from City Well No. 2 has slightly higher manganese and nitrate than the recommended limits.

Table 2 shows the significance of some physical and chemical properties of drinking water.

CONCLUSIONS AND RECOMMENDATIONS

There are two potential sources of water for the city of Baltic: (1) the outwash deposits, and (2) the Sioux Quartzite.

1. Outwash deposits are the most favorable source of water for the city. Figure 4 shows that the thickness of saturated sand and gravel in NW¼NE¼ sec. 6, T. 103 N., R. 49 W. varies from approximately 20 feet to approximately 30 feet. Water samples from this area have higher iron content than the recommended limits (table 1), and except for low fluoride content, the rest of the chemicals are within the limits set by the South Dakota Department of Health. This area probably will provide the quantity of water required for the city. It is recommended that a pump test be conducted in or in the vicinity of NW¼NE¼ sec. 6, T. 103 N., R. 49 W. The test will provide data, in addition to quantity of water, on design and spacing of wells. Also, water collected during the test for chemical analysis will afford a basis for deciding if an iron removal technique is required.

2. Sioux Quartzite is present on the surface or under the glacial drift in the entire study area. The capacity of the formation for transmitting water is controlled by the presence of joints in the rock. Where the rock is jointed, water will move freely through the rock. If no joints are present the rock is

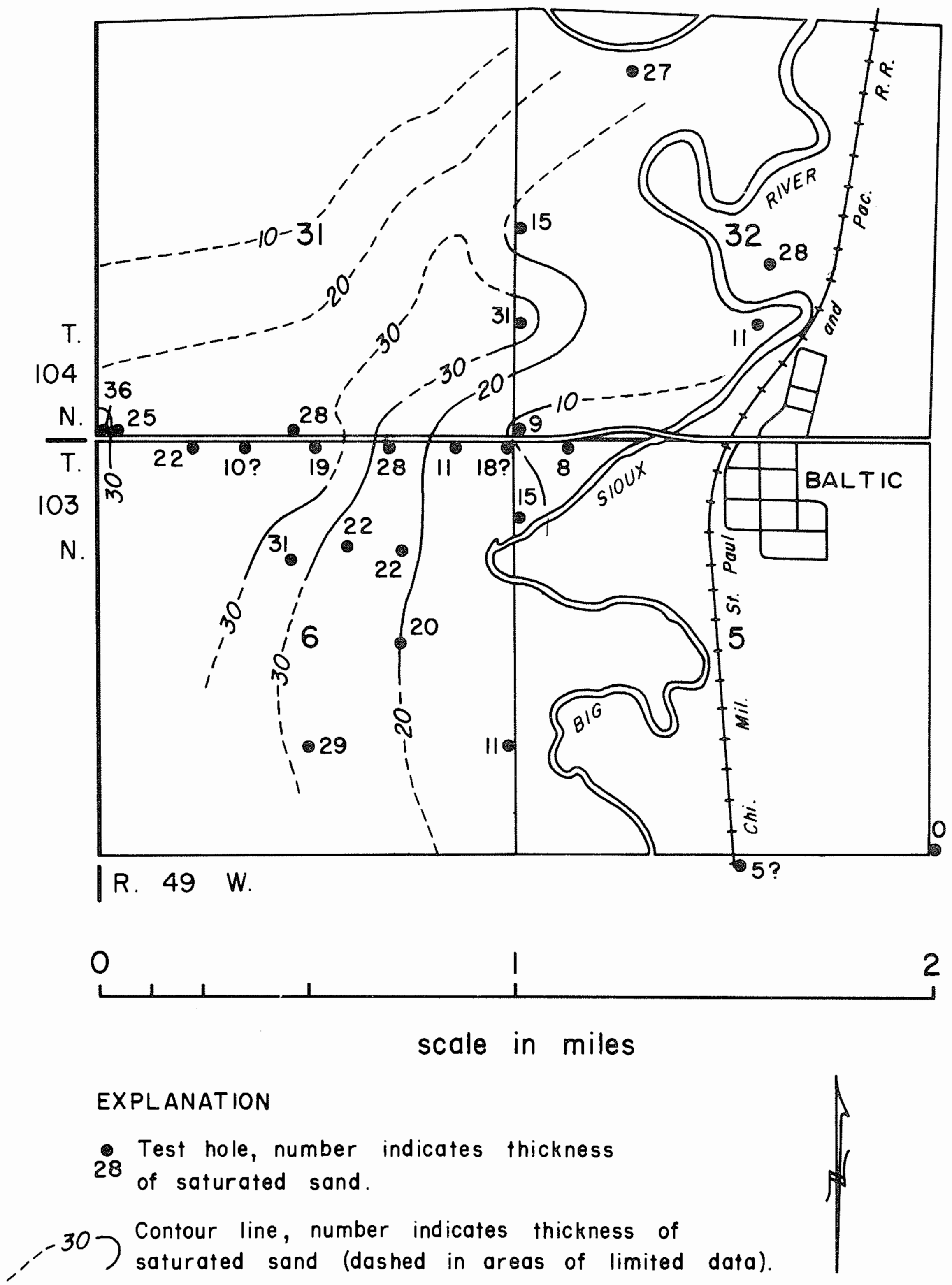

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Figure 4. Map showing thickness of saturated sand and gravel in the Baltic area.

Table 1. Chemical analyses of water samples from the Baltic study area.

Sample	Source	Depth	Parts Per Million											
			Calcium	Sodium	Magnesium	Chlorides	Sulfate	Iron	Manganese	Nitrate Nitrogen	Fluoride	pH	Hardness $CaCO_3$	Total Solids
A			------	----	----	250	500[1]	0.3	0.05	10.0	0.9-1.7[2]	-----	------	1000[1]
W-1	O?	35?	174		53	6	256	0.03	0.07	6.88		7.9	650	874
W-2	O	34	96	26	40	23	206	1.4	0.0	0.0	0.4		404	606
W-3	O	25	97	30	51	13	224	2.5	0.0	0.0	0.4		451	638
W-4	O	30	143	34	60	14	442	5.4	0.0	0.0	0.4		630	926
W-5	O	22	114	33	55	20	206	0.0	0.0	0.3	0.4		513	676
W-6	O	35	71	26	55	9	136	4.6	0.0	0.0	0.4		402	522
W-7	O?	20	151		35	8.75	173	1.60	0.9?	0.75		7.8	521	676
W-8	Q	160	205	48	88	26	714	0.0	0.0	6	0.4		873	1320
W-9	Q	243	181		41	23.0	225	0.05	0.11	10.5		7.7	621	856

A. Drinking water standards, U. S. Public Health Service (1962).

Source: O, outwash or sand lenses; Q, Sioux Quartzite.

Samples W-1, W-7, and W-9 were analyzed by the South Dakota Geological Survey. All other samples were analyzed by the South Dakota Chemical Laboratory.

[1]Modified for South Dakota by the Department of Health (written communication, Water Sanitation Section, September 24, 1968).

[2]1.2 is optimum for South Dakota.

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Location of Water Samples in the Baltic Area

(For map location, see fig. 5.)

W-1. NW¼NW¼NW¼SW¼ sec. 31, T. 104 N., R. 49 W., T. Berg farm well.

W-2. NW¼NW¼NW¼NE¼ sec. 6, T. 103 N., R. 49 W., U.S.G.S. observation well.

W-3. NE¼NW¼SW¼NE¼ sec. 6, T. 103 N., R. 49 W., Test Hole 17.

W-4. NE¼NE¼SW¼NE¼ sec. 6, T. 103 N., R. 49 W., Test Hole 18.

W-5. NW¼SE¼NE¼NE¼ sec. 6, T. 103 N., R. 49 W., G. Stainbrook farm well.

W-6. SE¼SE¼SW¼NE¼ sec. 6, T. 103 N., R. 49 W., Test Hole 19.

W-7. SW¼SW¼NW¼SW¼ sec. 5, T. 103 N., R. 49 W., A. Fryer farm well.

W-8. NE¼NE¼NW¼NW¼ sec. 5, T. 103 N., R. 49 W., Baltic City Well No. 1.

W-9. NE¼SE¼NW¼NE¼ sec. 5, T. 103 N., R. 49 W., Baltic City Well No. 2.

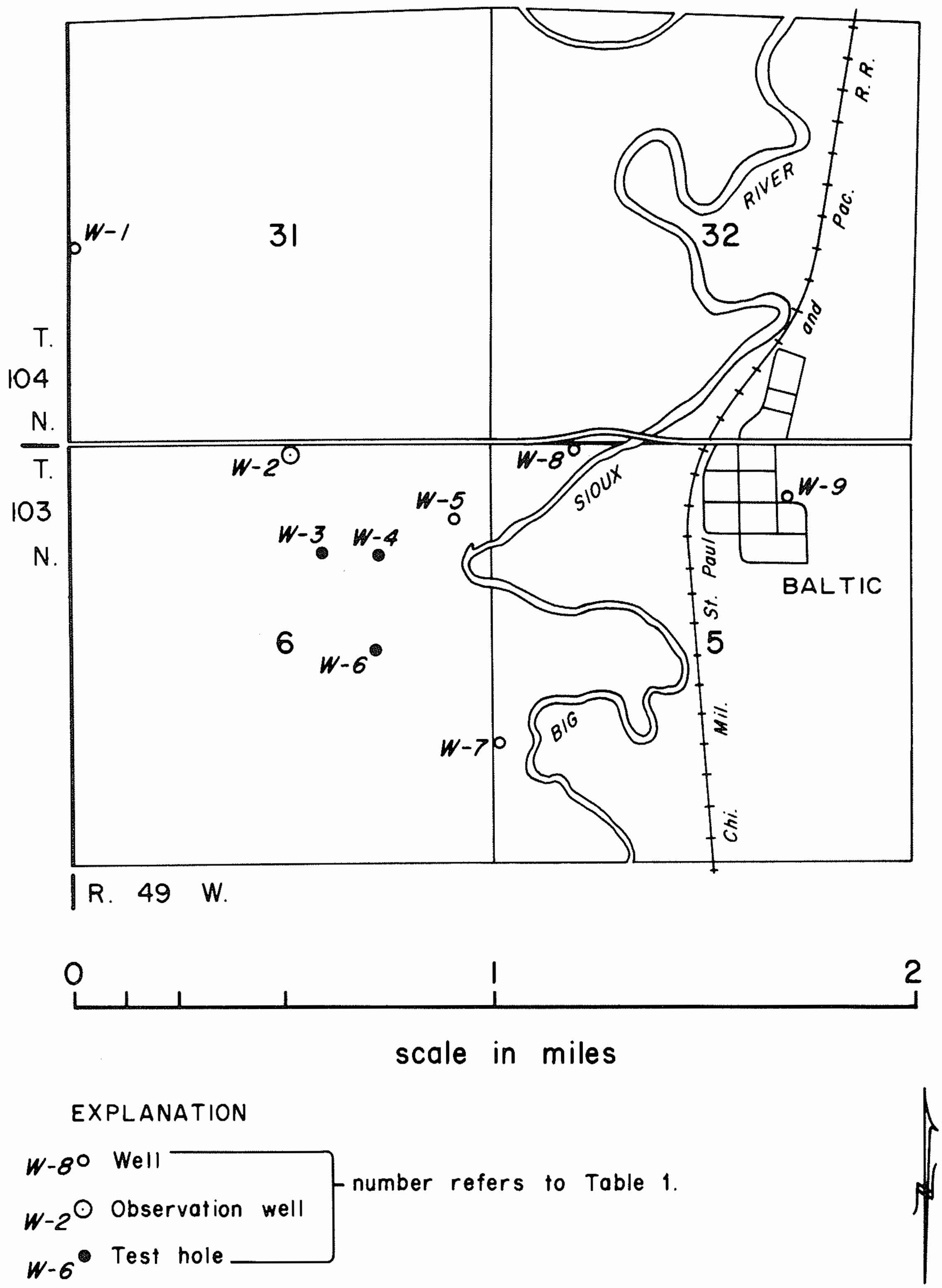

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Figure 5. Map showing location of water samples collected in the Baltic area.

Table 2.--Significance of some chemical and physical properties of drinking water.

Chemical Constituents	Significance	Recommended Limits (ppm)[1]
Calcium (Ca) and Magnesium (Mg)	Cause most of the carbonate hardness and scale-forming properties of water by combining with carbonate and bicarbonate present in the water. Seldom can be tasted except in extreme concentrations.	Ca–None Mg–None
Sodium (Na)	Large amounts in combination with chloride will give water a salty taste. Large amounts will limit water for irrigation and industrial use.	None
Chloride (Cl)	Large amounts in combination with sodium give water a salty taste. Large quantities will also increase corrosiveness of water.	250
Sulfate (SO_4)	Large amounts of sulfate in combination with other ions give a bitter taste to water and may act as a laxative to those not used to drinking it. Sulfates of calcium and magnesium will form hard scale. U. S. Public Health Service recommends 250 ppm maximum concentration.	500[2]
Iron (Fe) and Manganese (Mn)	In excess will stain fabrics, utensils, and fixtures and produce objectionable coloration in the water. Both constituents in excess are particularly objectionable.	Fe–0.3 Mn–0.05
Nitrate Nitrogen (N)	In excess may be injurious when used in infant feeding. The U. S. Public Health Service regards 45 ppm as the safe limit of nitrate (NO_3) or 10 ppm nitrate nitrogen (N).	10
Fluoride (F)	Reduces incidence of tooth decay when optimum fluoride content is present in water consumed by children during period of tooth calcification. Excessive fluoride in water may cause mottling of enamel.	0.9-1.7[3]
pH	A measure of the hydrogen ion concentration; pH of 7.0 indicates a neutral solution, pH values lower than 7.0 indicate acidity, pH values higher than 7.0 indicate alkalinity. Alkalinity tends to aid encrustation and acidity tends to aid corrosion.	None
Hardness	Hardness equivalent to carbonate and bicarbonate is called carbonate hardness. Hardness in excess of this amount is noncarbonate hardness. Hardness in water consumes soap and forms soap curd. Will also cause scale in boilers, water heaters, and pipes. Water containing 0-60 ppm hardness considered soft; 61-120 ppm moderately hard; 121-180 ppm hard, and more than 180 ppm very hard. Good drinking water can be very hard.	None
Total Solids	Total of all dissolved constituents. U. S. Public Health Department recommends 500 ppm maximum concentration. Water containing more than 1000 ppm dissolved solids may have a noticeable taste; it may also be unsuitable for irrigation and certain industrial uses.	1000[2]

Modified from Jorgensen (1966).
[1](ppm) parts per million.
[2]Modified for South Dakota by the South Dakota Department of Health (written communcation, Water Sanitation Section, September 24, 1968.
[3]1.2 is optimum for South Dakota.

practically impermeable to water. For this reason it is possible that two wells a few hundred feet apart, drilled to the same depth into quartzite, will produce a different quantity of water. One could produce significant quantity of water and the other could produce very little if any water. It should be noted that the cost of drilling a Sioux Quartzite well is high.

Samples W-8 and W-9 were collected from the wells producing water from the Sioux Quartzite. Sample W-8, collected from City Well No. 1, (table 1) has higher sulfate and total solids than the recommended limits. Sample W-9, collected from City Well No. 2, has slightly higher manganese and nitrate.

Before a permanent well is drilled the South Dakota Water Resources Commission should be consulted with regard to obtaining water rights and a permit to drill a city well and the State Department of Health with regard to the biological and chemical suitablity of water.

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APPENDIX A

Logs of test holes in the Baltic area

(For map location, see fig. 3.)

Test Hole 1
WRC Auger (Water Resources Commission Observation Well S-24)
Location: SW¼SW¼SW¼SW¼ sec. 31, T. 104 N., R. 49 W.
Surface elevation: 1465.1 feet
Depth to water: 9.1 feet

0- 9	Soil, heavy
9-43	Sand, fine
43-45	Gravel, coarse
45-	Sioux Quartzite

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Test Hole 2
SDGS Auger, drilled in 1958 (Dell Rapids report, Test Hole 133)
Location: SW¼SW¼SW¼SW¼ sec. 31, T. 104 N., R. 49 W.
Surface elevation: 1465 feet
Depth to water: 14 feet

0- 4	Soil
4- 9	Sand, fine
9-14	Sand, fine to medium, saturated
14-19	No cuttings
19-24	Sand, fine, clayey
24-29	No cuttings
29-34	Sand, medium
34-39	No cuttings
39-54	Till, clay, sandy

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Test Hole 3
SDGS Auger (Dell Rapids report, Test Hole 135)
Location: SE¼SE¼SE¼SW¼ sec. 31, T. 104 N., R. 49 W.
Surface elevation: 1465 feet
Depth to water: 7 feet

0- 2	Soil, black
2- 5	Clay, dark-brown
5-35	Sand, clayey, dark-brown; changing to coarse sand and gravel
35-44	Clay, (till)

* * * *

Test Hole 4
SDGS Auger (Dell Rapids report, Test Hole 137)
Location: SW¼SW¼SW¼SW¼ sec. 32, T. 104 N., R. 49 W.
Surface elevation: 1460 feet
Depth to water: 5 feet

0- 2	Soil, black
2- 5	Clay, brown
5-15	Clay, sandy, gray
15-24	Sand, coarse; gravel
24-	Bedrock?

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Test Hole 5
SDGS Auger, drilled in 1971
Location: SW¼SW¼NE¼SW¼ sec. 32, T. 104 N., R. 49 W.
Surface elevation: 1460 feet
Depth to water: 5? feet

0- 2	Soil
2-12	Clay, dark-brown
12-41	Sand, gray
41-43	Gravel, gray
43-55	Clay, gray, pebbly, (till)
55-	Quartzite

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Test Hole 6
SDGS Auger (Dell Rapids report, Test Hole 138)
Location: NW¼NW¼NW¼SW¼ sec. 32, T. 104 N., R. 49 W.
Surface elevation: 1475 feet
Depth to water: 10 feet

0- 2	Soil, black
2-10	Clay, some sand
10-25	Sand, clayey, gray; changing to coarse sand with some clay
25-	Sioux Quartzite?

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Test Hole 7
SDGS Auger (Dell Rapids report, Test Hole 139)
Location: NW¼SW¼NE¼NW¼ sec. 32, T. 104 N., R. 49 W.
Surface elevation: 1465 feet
Depth to water: 10 feet

0- 2	Soil, black
2-25	Sand, clayey, brown
25-28	Rocks
28-37	Sand, coarse; gravel
37-49	Clay

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Test Hole 8
SDGS Auger (Dell Rapids report, Test Hole 140)
Location: SE¼NW¼NW¼SE¼ sec. 32, T. 104 N., R. 49 W.
Surface elevation: 1465 feet
Depth to water: 7 feet

0- 2	Soil, black
2-35	Sand, fine to medium, clayey, black; coarser sand and less clay at 15 feet
35-79	Till, gray

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Test Hole 9
SDGS Auger, drilled in 1971
Location: SE¼SW¼NW¼SE¼ sec. 32, T. 104 N., R. 49 W.
Surface elevation: 1459 feet
Depth to water: 6 feet

0- 2	Soil
2- 6	Clay, dark-gray
6-15	Sand, gray, fine, some clay

Test Hole 9 -- continued.

15-17	Gravel, very coarse
17-	Quartzite

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Test Hole 10
SDGS Auger, drilled in 1971
Location: NE¼NE¼NW¼NW¼ sec. 6, T. 103 N., R. 49 W.
Surface elevation: 1465 feet
Depth to water: 5 feet

0- 1	Soil
1- 8	Clay, brown
8-15	Sand, brown, some gravel
15-30	Sand, gray, some gravel
30-34	Clay, gray, pebbly
34-	Quartzite

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Test Hole 11
Source of data: SDGS, Report of Investigation No. 56 (Test Hole 26)
Location: NE¼NW¼ sec. 6, T. 103 N., R. 49 W.
Surface elevation: 1460 feet
Depth to water: ?

0-15	Soil and clay
15-20	Clay, sand and gravel
20-25	Gravel, very coarse
25-30	Sand and gravel
30-33	Clay, sandy

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Test Hole 12
SDGS Auger, drilled in 1971
Location: NE¼NE¼SE¼NW¼ sec. 6, T. 103 N., R. 49 W.
Surface elevation: 1460 feet
Depth to water: 7 feet

0- 2	Soil
2- 5	Clay and sand
5-11	Clay, grayish-brown, sandy
11-24	Sand, gray, medium
24-27	Gravel, some sand
27-42	Sand, gray, very fine
42-45	Clay, gray, pebbly, (till)
45-	Quartzite

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Test Hole 13
Source of data: SDGS Report of Investigation No. 56 (Test Hole 25) and SDGS Water Resources Report No. 5 (Test Hole 69) City of Sioux Falls observation well H-3
Location: NW¼NW¼NE¼ sec. 6, T. 103 N., R. 49 W.
Surface elevation: 1460.15 feet
Depth to water: 7 feet

0-15	Soil and clay
15-20	Sand, coarse and fine
20-25	Sand, coarse and gravel

Test Hole 13 -- continued.

25-34	Gravel, coarse, and quartzite boulders
34-35	Quartzite

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Test Hole 14
SDGS Auger, drilled in 1971
Location: NE¼NE¼NW¼NE¼ sec. 6, T. 103 N., R. 49 W.
Surface elevation: 1460 feet
Depth to water: 6 feet

0- 1	Soil
1- 6	Clay, dark-gray
6-10	Clay, gray, pebbly
10-38	Sand, gray, medium to coarse, some gravel
38-	Quartzite

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Test Hole 15
SDGS Auger, drilled in 1971
Location: NE¼NW¼NE¼NE¼ sec. 6, T. 103 N., R. 49 W.
Surface elevation: 1450 feet
Depth to water: 7 feet

0- 1	Soil
1-15	Clay, grayish-brown, sandy
15-26	Sand, gray, medium to fine
26-	Quartzite

* * * *

Test Hole 16
Source of data: SDGS Report of Investigation No. 56 (Test Hole 23)
Location: NE¼NE¼ sec. 6, T. 103 N., R. 49 W.
Surface elevation: 1462 feet
Depth to water: ?

0-15	Soil and sand
15-25	Sand, coarse
25-33	Gravel and small amount of sand
33-	Quartzite

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Test Hole 17
SDGS Auger, drilled in 1971
Location: NE¼NW¼SW¼NE¼ sec. 6, T. 103 N., R. 49 W.
Surface elevation: 1460 feet
Depth to water: 9? feet

0- 1	Soil
1- 3	Clay, dark-gray
3-15	Clay, sandy
15-37	Sand and gravel, gray, clean (practically no clay)
37-	Quartzite

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Test Hole 18
SDGS Auger, drilled in 1971
Location: NE¼NE¼SW¼NE¼ sec. 6, T. 103 N., R. 49 W.
Surface elevation: 1460 feet
Depth to water: 7? feet

0- 1	Soil
1- 7	Clay, dark-gray
7-13	Clay, brownish-gray, sandy
13-33	Sand, gray, some gravel
33-35	Gravel
35-	Quartzite

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Test Hole 19
SDGS Auger, drilled in 1971
Location: SE¼SE¼SW¼NE¼ sec. 6, T. 103 N., R. 49 W.
Surface elevation: 1460 feet
Depth to water: 9? feet

0- 2	Soil
2- 6	Clay, dark-gray
6- 9	Clay, brown
9-17	Clay, gray, sandy
17-37	Sand, coarse, some gravel
37-40	Clay, gray, pebbly
40-	Quartzite

* * * *

Test Hole 20
SDGS Auger, drilled in 1971
Location: SW¼SW¼NW¼SE¼ sec. 6, T. 103 N., R. 49 W.
Surface elevation: 1460 feet
Depth to water: 7 feet

0- 2	Soil
2- 8	Clay, pebbly
8-20	Sand, brown, fine
20-36	Sand, gray, medium
36-37	Gravel, very coarse
37-64	Clay, gray, pebbly, (till)

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Test Hole 21
SDGS Auger, drilled in 1971
Location: SE¼SE¼NE¼SE¼ sec. 6, T. 103 N., R. 49 W.
Surface elevation: 1461 feet
Depth to water: 7 feet

0- 1	Soil
1- 7	Clay, dark-gray
7-11	Clay, grayish-brown, pebbly
11-20	Sand, gray, some gravel
20-22	Gravel, very coarse
22-	Quartzite

* * * *

Test Hole 22
SDGS Auger, drilled in 1971
Location: SW¼SW¼NW¼NW¼ sec. 5, T. 103 N., R. 49 W.
Surface elevation: 1458 feet
Depth to water: 8 feet

0- 2	Soil
2- 7	Clay, dark-gray
7-20	Sand, gray, fine
20-23	Gravel, very coarse
23-	Quartzite

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Test Hole 23
SDGS Auger, drilled in 1971
Location: NW¼NE¼NW¼NW¼ sec. 5, T. 103 N., R. 49 W.
Surface elevation: 1460 feet
Depth to water: 7 feet

0- 2	Soil
2- 4	Clay, dark-gray
4-15	Sand, gray, fine
15-	Quartzite

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Test Hole 24
SDGS Auger (Source of data: SDGS, Water Resources Report No. 5, Test Hole 62)
Location: NW¼NE¼ sec. 8, T. 103 N., R. 49 W.
Surface elevation: 1458 feet
Depth to water: ?

0- 4	Soil, black
4-14	Clay, brown-gray, silty
14-19	Clay, sandy
19-24	Sand, medium to coarse
24-28	Clay, light-tan, (till)
28-	Bedrock?

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Test Hole 25
USGS (Source of data: SDGS, Water Resources Report No. 5, Test Hole 61)
Location: SW¼SW¼SW¼ sec. 4, T. 103 N., R. 49 W.
Surface elevation: 1514 feet
Depth to water: ?

0- 1	Soil
1-10	Clay, light-brown, silty, moist
10-20	Clay, brown, silty, moist
20-30	Clay, gray
30-45	Clay, dark-gray

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APPENDIX B

Well Records in the Baltic area

Source: Q, Sioux Quartzite; SD, Sand lenses and outwash

Use: D, domestic; S, stock

Name	Location	Depth of Well (feet)	Depth of Water (feet)	Source	Use
Overbee, L.	NW¼SW¼NW¼NE¼ sec. 4, T. 103 N., R. 49 W.	200?		Q	D
Riswold, P.	NE¼NE¼NE¼NE¼ sec. 4, T. 103 N., R. 49 W.	16		SD?	D
Riswold, P.	NE¼NE¼NE¼NE¼ sec. 4, T. 103 N., R. 49 W.	16-25		SD?	D
City of Baltic	NW¼NE¼ sec. 5, T. 103 N., R. 49 W.	250		Q	D
City of Baltic	NW¼NE¼ sec. 5, T. 103 N., R. 49 W.	160		Q	D
Brendsel, R.	SE¼NE¼ sec. 5, T. 103 N., R. 49 W.	140		Q	D
Berg, C.	NE¼NE¼NW¼NW¼ sec. 5, T. 103 N., R. 49 W.	16?		Q	D,S
Knudson, C.	NE¼SW¼NW¼SE¼ sec. 5, T. 103 N., R. 49 W.	24		SD	D,S
Knudson, C.	NE¼SW¼NW¼SE¼ sec. 5, T. 103 N., R. 49 W.	23		Q?	D,S
Fryer, A.	SE¼SE¼NE¼SE¼ sec. 6, T. 103 N., R. 49 W.	20		Q	D,S
Stainbrook, G.	NW¼SE¼NE¼NE¼ sec. 6, T. 103 N., R. 49 W.	22	16	Q	D,S
Costain, C.	SE¼SW¼SW¼SW¼ sec. 7 T. 103 N., R. 49 W.	25		S	D,S
Tommeraasen, A.	NE¼NE¼NW¼NE¼ sec. 8, T. 103 N., R. 49 W.	25			D,S
Lyngaas, N.	SW¼SW¼ sec. 28, T. 104 N., R. 50 W.	75		SD?	D,S
Wehde, E.	NE¼NW¼SE¼NW¼ sec. 8, T. 103 N., R. 49 W.	22	10	Q	D,S
Riswold, E.	NE¼NE¼SW¼SE¼ sec. 9, T. 103 N., R. 49 W.	19	8	SD	D,S
Tommeraasen, B. L.	NE¼NW¼NW¼NE¼ sec. 9, T. 103 N., R. 49 W.	25		SD?	D,S

Name	Location	Depth of Well (feet)	Depth of Water (feet)	Source	Use
Brobjorg, A.	SE¼SE¼NW¼NE¼ sec. 16, T. 103 N., R. 49 W.	17		SD	D,S
Oyen, A.	NE¼NE¼NE¼SW¼ sec. 1, T. 103 N., R. 50 W.	20	10?	Q	D,S
Berg, R.	SE¼SW¼NE¼SE¼ sec. 1, T. 103 N., R. 50 W.	30?		Q	D,S
Donahue, F.	NW¼SW¼SE¼NE¼ sec. 12, T. 103 N., R. 50 W.	27	6	SD	D,S
Donahue, F.	NW¼SW¼SE¼NE¼ sec. 12, T. 103 N., R. 50 W.	39	6	Q	S
Albers, C.	NE¼SW¼SW¼SW¼ sec. 20, T. 104 N., R. 49 W.	90		Q	D,S
Gurgensen, G.	SW¼NW¼ sec. 21, T. 104 N., R. 49 W.	32		SD?	D,S
Gildemaster, D.	SW¼SW¼SW¼SW¼ sec. 22, T. 104 N., R. 49 W.	180	120?	Q	D,S
Mortvedt, E. R.	SE¼SW¼SW¼SW¼ sec. 27, T. 104 N., R. 49 W.	32	12?	SD	D,S
Stoefen, V.	NW¼NW¼ sec. 28, T. 104 N., R. 49 W.	26		SD?	D,S
Ronning, L.	SW¼SE¼NE¼SE¼ sec. 28, T. 104 N., R. 49 W.	200		Q	D,S
Schwemle, L. E.	NE¼NE¼NW¼NE¼ sec. 29, T. 104 N., R. 49 W.	18		SD	D,S
Thompson, W.	SE¼NW¼NE¼NW¼ sec. 29, T. 104 N., R. 49 W.	35			D,S
Allen, L.	NE¼NE¼NE¼NE¼ sec. 30, T. 104 N., R. 49 W.	180		Q	D,S
Dybvig, C.	NE¼SW¼SW¼SW¼ sec. 30, T. 104 N., R. 49 W.	70	16	Q	D,S
Nelson, W.	NE¼NE¼NW¼NE¼ sec. 31, T. 104 N., R. 49 W.	18		SD	D,S
Berg, T.	NW¼NW¼NW¼SW¼ sec. 31, T. 104 N., R. 49 W.	35?		Q?	D,S
Johnson, R.	SW¼NE¼SE¼NE¼ sec. 32, T. 104 N., R. 49 W.	23	10	SD	D,S
Mortvedt, J. A.	SE¼SE¼NW¼SW¼ sec. 34, T. 104 N., R. 49 W.	180	30-40	Q	D,S
Berg, A. A.	SW¼NW¼SE¼SW¼ sec. 23, T. 104 N., R. 50 W.	60		SD	D,S

Name	Location	Depth of Well (feet)	Depth of Water (feet)	Source	Use
Bohnenkamp, E.	NE¼NW¼SE¼SE¼ sec. 23, T. 104 N., R. 50 W.	180		Q	D,S
Heesch, J.	NW¼NE¼NE¼NE¼ sec. 25, T. 104 N., R. 50 W.	120	60	Q	D,S
Otterby, A.	NW¼NW¼SW¼SW¼ sec. 35, T. 104 N., R. 50 W.	246	146	SD	D,S
Peterson, H.	SE¼NW¼SW¼NW¼ sec. 35, T. 104 N., R. 50 W.	200?		SD	D,S
Mandler, W.	SE¼NE¼SE¼SE¼ sec. 35, T. 104 N., R. 50 W.	147	110	Q	D,S
Thompson, W. M.	NW¼SE¼NE¼SW¼ sec. 36, T. 104 N., R. 50 W.	200?		Q	D,S
Peterson, C.	SW¼SE¼ sec. 21, T. 104 N., R. 49 W.	184		Q	D