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GROUND-WATER STUDY FOR THE CITY OF
BONESTEEL AND EAST GREGORY RURAL WATER DISTRICT

by

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INTRODUCTION

This report contains the results of two ground-water studies by the South Dakota Geological Survey. The first study was conducted in 1973 at the request of the City of Bonesteel. The purpose of this investigation was to assist the City in determining a location in the Bonesteel vicinity for well development. In 1975 the second study was performed to locate a water source for the East Gregory Rural Water District.

CITY OF BONESTEEL STUDY

During the study for the City of Bonesteel 27 test holes were drilled. These holes are designated by B-1 through B-27 on figure 1. A total of nine water samples were collected and analyzed during this study. The locations of these samples are designated by WB-1 through WB-9 on figure 2 and the results of the chemical analyses of these samples are shown on table 1. Except for high nitrate in sample WB-1, the analyzed chemicals did not exceed the recommended limits. Sample WB-1 was collected from the City Well no. 3, located at the east edge of the town.

The saturated sand under the City is fine grained, does not have a significant thickness, and is not expected to produce a large quantity of water. The most promising sand for well development was encountered in Test Hole B-24 south of town. The saturated sand in this hole was more than 30 feet thick (see app. A).

It was recommended that if the City should decide to test the potential of this area, a pilot hole should be drilled in the vicinity of Test Hole B-24. The pilot hole should be converted to a pump test well if the sand (thickness, particle size, and clay content) is satisfactory. A pump test should be conducted in the area and water samples collected and analyzed. The results of the pump test and water analysis will provide a basis for determining the suitability of the quantity and quality of water.

EAST GREGORY RURAL WATER STUDY

During the study for the East Gregory Rural Water District, 64 test holes were drilled in the area from Fairfax to Herrick. The locations of these test holes are shown on figure 1 and the logs of the test holes are in appendix B. A total of 15 water samples were collected and analyzed during this study. The results of the water sample tests are shown on table 2.

The dissolved chemical content in these water samples is low, except for higher than recommended limits of nitrate in samples WE-1, WE-8, WE-9, and WE-13 (the high selenium content in the samples will be discussed later). In most cases of high nitrate in a well, the nitrate is from a source near the well (such as livestock). The high nitrate in the above samples was originally attributed to such a source.

Based on the grain size of aquifer particles and the thickness of saturated sand, two areas were recommended for a pump test. One area was in the vicinity of Test Hole E-18, located southeast of Herrick (see app. B and fig. 1). The other location was in the vicinity of Test Hole E-30, northwest of St. Charles. Water from both areas was to be used if the results of the tests and water analyses were satisfactory.

The Rural Water District could not come to an agreement with the owners of the land southeast of Herrick but a pump test was conducted by Bartlett and West, Consulting Engineers, northwest of St. Charles. This test was supervised and data analyzed by the South Dakota Geological Survey. Results of the test indicated that the area northwest of St.

Charles could yield the required 186 gallons per minute (gpm) of water for the Rural Water District. However, water samples collected during the test had a nitrate content of 14 parts per million (ppm). Because this exceeded the recommended limits for nitrate, additional water samples were collected after the test by the consulting engineer and analyzed by the South Dakota Geological Survey. The nitrate content of the water samples taken at the beginning of pumping was low, but that of later samples increased to 14 ppm, again exceeding the recommended limit.

With the available data, the exact source of nitrate is not understood. It could be coming from material within the aquifer or from material immediately above the shale.

The 15 water samples collected in the summer of 1975 were sent to the Station Biochemistry Section, South Dakota State University, at Brookings, to be analyzed for selenium. The results of these analyses are also included in table 2. Water sample WE-11, collected from the spring used by the City of Fairfax had 25 parts per billion (ppb) selenium. The new limit for selenium set by the federal government is 10 ppb and will become effective in 1977.

In April, 1976, additional water samples from the area were collected by Robert Stach and Ronald Helgerson of the South Dakota Geological Survey. These samples were tested for selenium and nitrate. Sampling site locations are shown on figure 2 and the results of the chemical analyses are shown on table 3. Samples WS-3 and WS-5 had higher nitrate than the recommended limits. Except for samples WS-5 and WS-6, selenium levels were all over the recommended limits. Sample WS-6 was collected from the City of Bonesteel tap water and WS-5, which had 9.5 ppb selenium, was collected from the spring which previously served the City of Bonesteel. Samples WS-1 and WS-2 were collected from Houston Springs (which are presently being used by the City of Fairfax) and have high selenium.

As with the nitrate, the exact source of selenium is also unclear. Selenium could be coming from the aquifer or it could be coming from the shale beneath the aquifer. More data and study are required to determine the exact source of both nitrate and selenium. Further study could provide a basis for safe well design and indicate which springs in the area produce chemically safe drinking water.

This report was prepared by Assad Barari and Dennis Beissel, geologists, South Dakota Geological Survey, Vermillion, South Dakota.

TABLE 1. Chemical analyses of water samples collected in the Bonesteel area

Sample	Parts Per Million											
	Calcium	Sodium	Magnesium	Chlorides	Sulfate	Iron	Manganese	Nitrate Nitrogen	Fluoride	pH	Hardness CaCO ₃	Total Solids
A	-----	---	---	---	500 ¹	0.3	0.05	10.0	0.9-1.7 ²	-----	-----	1000 ¹
WB-1	110	---	26	45	35	0.06	0	25+	-----	7.4	380	360
WB-2	90	---	23	40	86	0.06	0	2	-----	8.0	320	800
WB-3	123	---	20	36	100	0.08	0	-----	-----	7.2	385	600
WB-4	95	---	10	5	40	0.05	0	-----	-----	7.5	275	400
WB-5	123	---	20	8	100	0.05	0	-----	-----	7.6	385	560
WB-6	63	---	15	3	50	0.03	0	-----	-----	7.4	220	280
WB-7	175	---	30	50	75	0.1	0	-----	-----	7.5	560	1280?
WB-8	110	---	47	34	70	0.1	0	-----	-----	7.5	470	920
WB-9	110	---	30	29	85	0.09	0	-----	-----	7.4	400	800

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

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

All samples were analyzed by the South Dakota Geological Survey.

Location of water samples
(For map location, see fig. 2)

WB-1 SW¼NW¼ sec. 6, T. 95 N., R. 68 W., City Well no. 3, 113? feet deep

WB-2 SE¼NE¼SE¼NW¼ sec. 6, T. 95 N., R. 68 W., Houston Springs, used by the city of Fairfax

WB-3 SW¼SW¼SE¼SE¼ sec. 1, T. 95 N., R. 69 W., K. Schmitz, 30 feet deep, water level 25 feet

WB-4 NW¼SE¼SE¼SE¼ sec. 6, T. 95 N., R. 68 W., D. Schmitz, 116 feet deep, 83 feet to water

WB-5 SW¼SE¼SE¼NW¼ sec. 6, T. 95 N., R. 68 W.

WB-6 NE¼NE¼NE¼SW¼ sec. 36, T. 96 N., R. 69 W., 30 feet deep, water level 19 feet

WB-7 NE¼NE¼SE¼SE¼ sec. 2, T. 95 N., R. 69 W., 50 feet deep, water level 5 feet

WB-8 NE¼NE¼NW¼SW¼ sec. 1, T. 95 N., R. 69 W., depth of well?

WB-9 SW¼SE¼SE¼NW¼ sec. 1., T. 95 N., R. 69 W., depth of well?

TABLE 2. Chemical analyses of water samples from the East Gregory area

Sample	Depth of well in feet	Parts Per Million											PPB ³	
		Calcium	Sodium	Magnesium	Chlorides	Sulfate	Iron	Manganese	Nitrate Nitrogen	Fluoride	pH	Hardness CaCO ₃		Total Solids	Selenium
A		.....	....	....	250	500 ¹	0.3	0.05	10.0	0.9-1.7 ²	.....	.....	1000 ¹	10 ⁴
WE- 1	....	95	50	15	9.8	<50	0.3	0.1	12	.....	.....	300	316	2.5
WE- 2	15	95	50	15	11.76	<50	<0.05	<0.05	9	.....	.....	300	312	1.2
WE- 3	56	95	45	10	8.82	<50	<0.05	<0.05	7.5	.....	.....	280	264	1.4
WE- 4	50	95	40	12	4.9	<50	<0.05	<0.05	7.5	.....	.....	290	288	1.1
WE- 5	62	85	45	8	3.92	<50	0.6	<0.05	9	.....	.....	250	248	1.0
WE- 6	50	100	40	10	3.92	50	0.1	<0.05	7.5	.....	.....	300	228	1.3
WE- 7	34	80	50	7	5.88	60	<0.05	<0.05	5	.....	.....	230	204	1.9
WE- 8	56	150	40	12	15.68	50	<0.05	<0.05	22	.....	.....	420	468	1.1
WE- 9	27	110	45	15	11.76	50	<0.05	<0.05	16	.....	.....	340	356	1.5
WE-10	77	70	30	8	3.92	50	0.05	<0.05	6.5	.....	.....	210	176	1.3
WE-11	Springs	.....	....	....	.....	.....	.....	.....	3.5	.....	.....	.....	684	25.7
WE-12	....	.....	....	....	.....	.....	.....	.....	7.5	.....	.....	.....	276	1.5
WE-13	....	.....	....	....	.....	.....	.....	.....	11.5	.....	.....	.....	452	1.5
WE-14	60	50	<5	26	4	<50	<0.05	≤.1	6.7	.....	.....	230	388	....
WE-15	....	40	<5	26	10	<50	<0.05	≤.1	6.4	.....	.....	210	352	1.4

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

All samples were analyzed by the South Dakota Geological Survey except for selenium.

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

³ PPB - parts per billion

⁴ 10 parts per billion is the maximum limit for selenium and will be effective in 1977. Selenium was analyzed by the Station Biochemistry Section, South Dakota State University, Brookings, South Dakota 57006

**Location of Water Samples
(For map location, see fig. 2)**

- WE- 1. SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 27, T. 96 N., R. 70 W., C. Wilsey, 22 feet deep, water table 8 feet
- WE- 2. SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 26, T. 96 N., R. 70 W., R. Hermsen, 16 feet deep, water table 10 feet
- WE- 3. SW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 26, T. 96 N., R. 70 W., L. Krueger, 56 feet deep, water table 15 feet
- WE- 4. NW $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 34, T. 96 N., R. 70 W., L. Wernke, 50 feet deep, water table 25 feet
- WE- 5. SW $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 22, T. 96 N., R. 70 W., E. Pistulka, 59 feet deep, water table 49 feet
- WE- 6. NW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 34, T. 96 N., R. 70 W., F. Baker, 50 feet deep, water table 35 feet
- WE- 7. SW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 36, T. 96 N., R. 71 W., E. Zorba, 34 feet deep, water table 17 feet
- WE- 8. SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 23, T. 96 N., R. 71 W., H. Sieh, 56 feet deep, water table 38 feet
- WE- 9. NW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 29, T. 96 N., R. 70 W., D. Boxa, 27 feet deep, water table 13 feet
- WE-10. NE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 28, T. 96 N., R. 70 W., L. Herrmann, 80 feet deep, water table 75 feet
- WE-11. NE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 6, T. 95 N., R. 68 W., City of Fairfax, Spring water (Houston Springs)
- WE-12. SE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 33, T. 96 N., R. 70 W., L. Herrmann, unknown, unknown
- WE-13. SW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 24, T. 96 N., R. 71 W., City of Herrick, unknown, unknown
- WE-14. SW $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 22, T. 96 N., R. 70 W., R. Lange, 60 feet deep, water table 55 feet
- WE-15. SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 27, T. 96 N., R. 70 W., L. Wernke, unknown, water table 23 feet

TABLE 3. Chemical analyses of water samples collected in the East Gregory area in 1976

Sample	Source	Parts Per Million								Selenium PPB ¹
		Calcium	Sodium	Magnesium	Chlorides	Sulfate	Iron	Nitrate Nitrogen	Total Solids	
WS-1	Springs	55	40	20	35	120	0.2	ND ²	940	23.1
WS-2	Springs	55	40	20	30	120	0.2	5	640	24.0
WS-3	Springs	75	20	21	35	160	0.2	14	1120	10.6
WS-4	Springs	75	40	21	30	140	0.2	ND ²	1060	13.2
WS-5	Springs	75	40	21	35	160	0.2	17	700	9.5
WS-6	Tap water	40	40	20	10	100	0.2	7	560	5.7

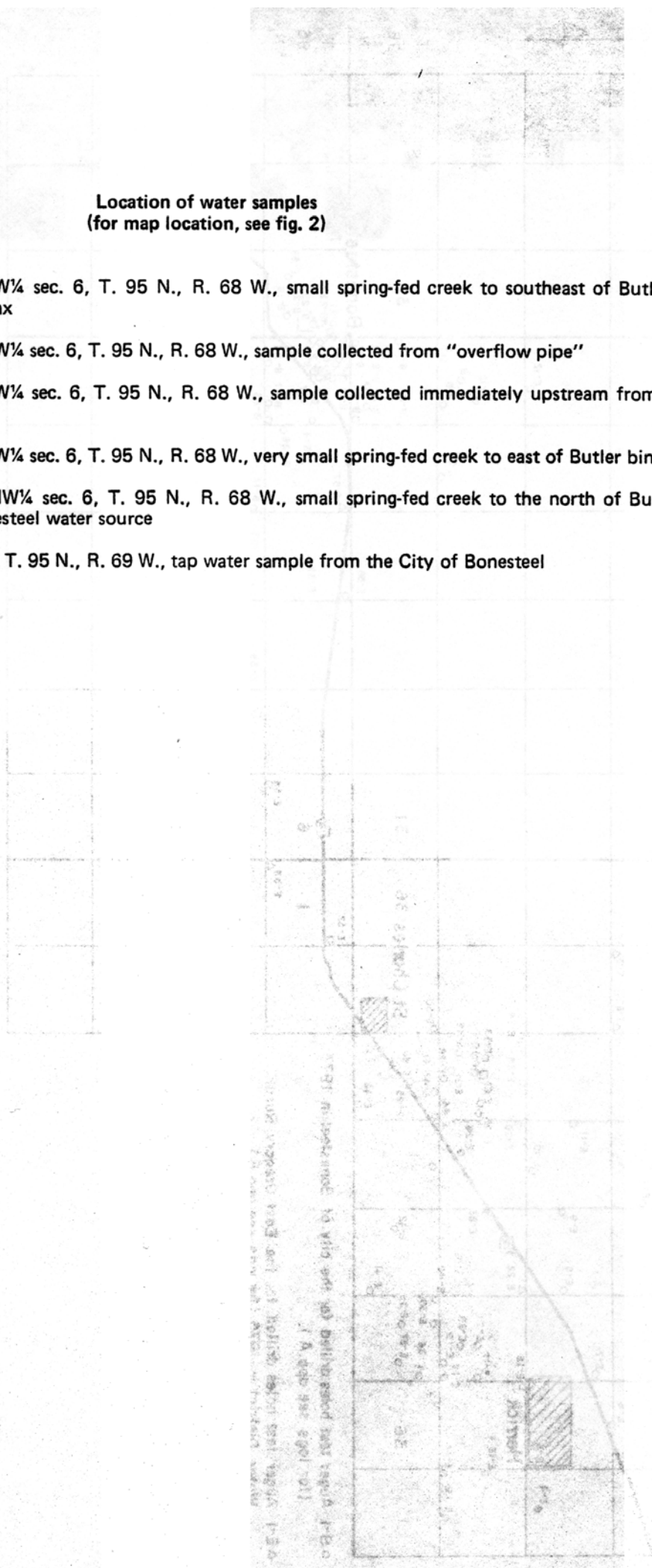
¹ PPB — parts per billion

² ND — not detected

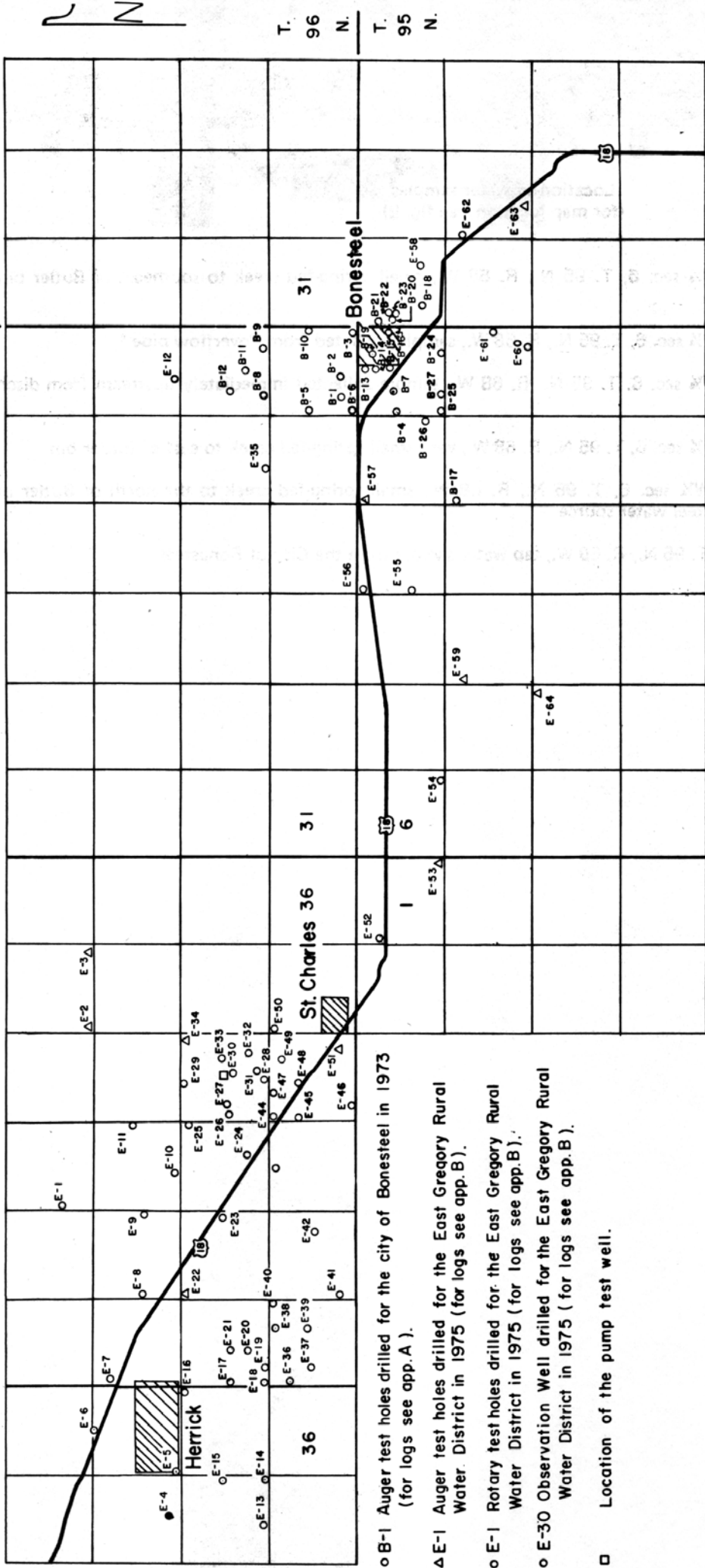
All chemicals were analyzed by the South Dakota Geological Survey, except for selenium, which was analyzed by Station Biochemistry Section, South Dakota State University, Brookings, South Dakota.

**Location of water samples
(for map location, see fig. 2)**

- WS-1. SE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 6, T. 95 N., R. 68 W., small spring-fed creek to southeast of Butler bin, water source for Fairfax
- WS-2. SE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 6, T. 95 N., R. 68 W., sample collected from "overflow pipe"
- WS-3. SE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 6, T. 95 N., R. 68 W., sample collected immediately upstream from discharge of overflow pipe
- WS-4. SE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 6, T. 95 N., R. 68 W., very small spring-fed creek to east of Butler bin
- WS-5. , NE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 6, T. 95 N., R. 68 W., small spring-fed creek to the north of Butler bin; near abandoned Bonesteel water source
- WS-6. SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 1, T. 95 N., R. 69 W., tap water sample from the City of Bonesteel



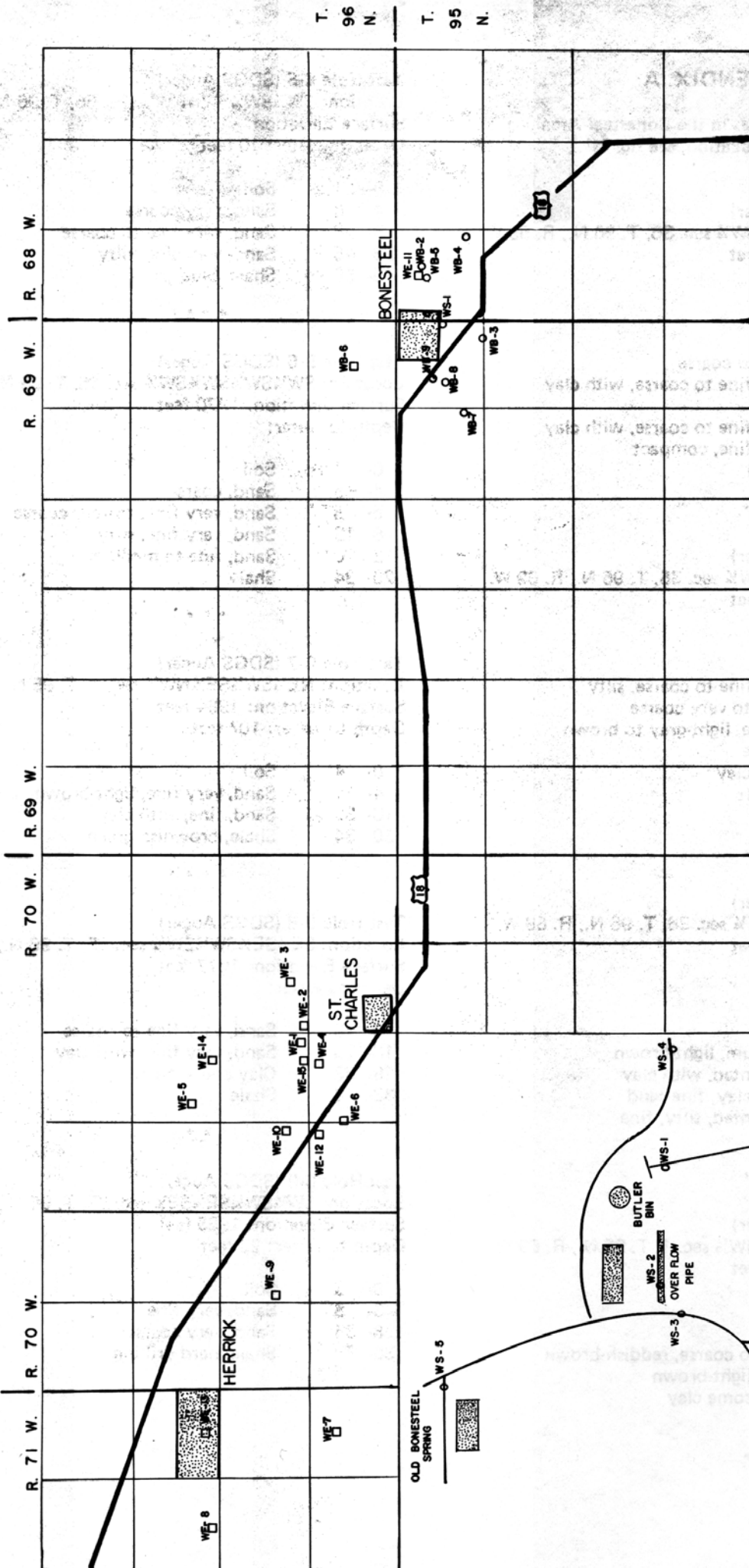
R. 71 W. | R. 70 W. | R. 70 W. | R. 69 W. | R. 68 W.



T. 96 N. | T. 95 N.

- o B-1 Auger test holes drilled for the city of Bonesteel in 1973 (for logs see app.A).
- Δ E-1 Auger test holes drilled for the East Gregory Rural Water District in 1975 (for logs see app.B).
- o E-1 Rotary test holes drilled for the East Gregory Rural Water District in 1975 (for logs see app.B).
- o E-30 Observation Well drilled for the East Gregory Rural Water District in 1975 (for logs see app.B).
- Location of the pump test well.

Figure 1. Location of test holes drilled in the East Gregory Rural Water District.



- WB-1 Water sample collected in 1973 for the Bonesteel study.
- WE-2 Water sample collected in 1975 for the East Gregory Rural Water Study.
- WS-1 Water sample collected in 1976.

FIGURE 2--LOCATION OF WATER SAMPLES COLLECTED IN THE EAST GREGORY RURAL WATER DISTRICT.

APPENDIX A

Logs of Test Holes in the Bonesteel Area
(For map location, see fig. 1)

Test Hole B-1 (SDGS Auger)

Location: SW $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 36, T. 96 N., R. 69 W.

Surface Elevation: 1970 feet

Depth to water:

0- 4 Soil, black
4- 9 Sand, fine
9- 13 Sand, fine to coarse
13- 20 Sand, very fine to coarse, with clay
20- 28 Clay, sandy
28- 35 Sand, very fine to coarse, with clay
35- 37 Sand, very fine, compact
37- 43 Clay (shale)

* * * *

Test Hole B-2 (SDGS Auger)

Location: SE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 36, T. 96 N., R. 69 W.

Surface Elevation: 1974 feet

Depth to water:

0- 4 Soil, black
4- 13 Sand, very fine to coarse, silty
13- 17 Sand, fine, to very coarse
17- 28 Sand, coarse, light-gray to brown
28- 30 Sand, coarse
30- 38 Sand, with clay
38- 51 Sand and silt
51- 70 Shale

* * * *

Test Hole B-3 (SDGS Auger)

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 36, T. 96 N., R. 69 W.

Surface Elevation: 1950 feet

Depth to water: 10 feet

0- 4 Soil
4- 8 Sand, fine
8- 10 Sand, medium, light-brown
10- 13 Sand, cemented, with clay
13- 22 Sand, with clay, fine sand
22- 34 Sand, cemented, silty, fine
34- 78 Sandy clay

* * * *

Test Hole B-4 (SDGS Auger)

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 1, T. 95 N., R. 69 W.

Surface Elevation: 1967 feet

Depth to water: 9 feet

0- 4 Soil
4- 8 Sand, fine to coarse, reddish-brown
8- 13 Sand, fine, light-brown
13- 54 Sand, fine, some clay
54- 74 Shale

* * * *

Test Hole B-5 (SDGS Auger)

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 36, T. 96 N., R. 69 W.

Surface Elevation:

Depth to water: 10 feet

0- 4 Soil
4- 8 Sand, very coarse
8- 28 Sand, very fine to coarse
28- 45 Sand, very fine, silty
45- 58 Shale, blue-gray

* * * *

Test Hole B-6 (SDGS Auger)

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 36, T. 96 N., R. 69 W.

Surface Elevation: 1970 feet

Depth to water:

0- 4 Soil
4- 5 Sand, coarse
5- 8 Sand, very fine, to very coarse
8- 13 Sand, very fine, silty
13- 20 Sand, fine to medium
20- 34 Shale

* * * *

Test Hole B-7 (SDGS Auger)

Location: NE $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 1, T. 95 N., R. 69 W.

Surface Elevation: 1984 feet

Depth to water: 10? feet

0- 4 Soil
4- 10 Sand, very fine, light-brown
10- 30 Sand, fine, with clay
30- 34 Shale, brownish-green

* * * *

Test Hole B-8 (SDGS Auger)

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 25, T. 96 N., R. 69 W.

Surface Elevation: 1977 feet

Depth to water:

0- 18 Sand, very fine to coarse
18- 28 Sand, very fine, with clay
28- 33 Clay and sand
33- 48 Shale

* * * *

Test Hole B-9 (SDGS Auger)

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 25, T. 96 N., R. 69 W.

Surface Elevation: 1985 feet

Depth to water: 23 feet

0- 3 Soil
3- 8 Sand, very fine
8- 36 Sand, very coarse
36- 38 Shale, hard drilling

* * * *

Test Hole B-10 (SDGS Auger)

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 36, T. 96 N., R. 69 W.

Surface Elevation: 1963 feet

Depth to water: 37 feet

0- 4	Soil
4- 13	Sand, medium
13- 40	Sand, very fine
40- 48	Shale

* * * *

Test Hole B-11 (SDGS Auger)

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 25, T. 96 N., R. 69 W.

Surface Elevation: 1995 feet

Depth to water: 23 feet

0- 3	Soil
3- 23	Sand, medium to very coarse
23- 28	Sand and clay
28- 31	Sand, fine to coarse
31- 52	Sand, hard drilling
52- 77	Clay? and sand, hard drilling, with pebbles
77- 98	Shale

* * * *

Test Hole B-12 (SDGS Auger)

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 25, T. 96 N., R. 69 W.

Surface Elevation: 2005 feet

Depth to water:

0- 4	Soil
4- 36	Sand, coarse
36- 45	Sand, very fine, silty
45- 65	Sand, compact, hit a rock at 65 feet

* * * *

Test Hole B-13 (SDGS Auger)

Location: SW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 1, T. 95 N., R. 69 W.

Surface Elevation: 1965 feet

Depth to water: 25 feet

0- 4	Soil
4- 8	Sand, fine to very coarse, some pebbles
8- 21	Sand, medium to very coarse, brown
21- 33	Sand, compact, with clay
33- 50	Sand and clay
50- 75	Shale

* * * *

Test Hole B-14 (SDGS Auger)

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 1, T. 95 N., R. 69 W.

Surface Elevation: 1965 feet

Depth to water: 25 feet

0- 3	Soil
3- 8	Sand, medium
8- 62	Sand, very fine, silty
62- 68	Shale

* * * *

Test Hole B-15 (SDGS Auger)

Location: NW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 1, T. 95 N., R. 69 W.

Surface Elevation: 1940 feet

Depth to water: 11 feet

0- 6	Soil
6- 18	Sand and clay
18- 25	Sand, with clay, tan
25- 33	Sand, fine, tan, silty
33- 42	Sand, compact, tan
42- 60	Shale

* * * *

Test Hole B-16 (SDGS Auger)

Location: NW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 1, T. 95 N., R. 69 W.

Surface Elevation: 1963 feet

Depth to water:

0- 3	Soil
3- 23	Sand, medium
23- 63	Sand, with clay, light-brown
63- 88	Clay, sandy
88-115	Sand, medium, tan
115-118	Shale

* * * *

Test Hole B-17 (SDGS Auger)

Location: NW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 11, T. 95 N., R. 69 W.

Surface Elevation: 1950 feet

Depth to water: 28 feet

0- 6	Soil
6- 33	Clay, sandy
33- 43	Sand, medium to coarse, tan
43- 53	Sand, fine to coarse, tan, with clay
53- 58	Shale

* * * *

Test Hole B-18 (SDGS Auger)

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 6, T. 95 N., R. 68 W.

Surface Elevation: 1950 feet

Depth to water: 58 feet

0- 4	Soil
4- 48	Sand, very fine to medium, tan
48- 63	Clay, sandy, tan
63- 97	Sand, very fine to medium
97-100	Clay, sandy
100-107	Sand, medium, gray
107-113	Sand?, clay
113-120	Shale

* * * *

Test Hole B-19 (SDGS Auger)

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 1, T. 95 N., R. 69 W.

Surface Elevation: 1963 feet

Depth to water: 24 feet

0- 4	Soil
4- 5	Sand, very fine, clean

Test Hole B-19 -- continued.

5- 14 Sand, fine, tan
 14- 23 Clay, sandy
 23- 28 Sand, with clay, brown
 28- 96 Clay, with small concretions
 96- 98 Shale

* * * *

Test Hole B-20 (SDGS Auger)

Location: NE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 6, T. 95 N., R. 68 W.

Surface Elevation:

Depth to water:

0- 4 Soil
 4- 8 Sand, fine to coarse
 8- 13 Clay, sandy
 13- 28 Sand, very fine to medium
 28- 83 Clay, sandy
 83-110 Sand, medium, brown, some silt
 110-112 Shale

* * * *

Test Hole B-21 (SDGS Auger)

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 6, T. 95 N., R. 68 W.

Surface Elevation:

Depth to water:

0- 4 Soil
 4- 12 Sand, fine to very coarse
 12- 48 Sand, with clay, tan, concretions from
 46 to 48 feet
 48- 70 Sand, very fine to fine, tan
 70- 76 Sand, medium
 76- 93 Clay, compact, tan
 93- 96 Sand?, tan
 96-101 Sand, very fine to medium
 101-105 Shale

* * * *

Test Hole B-22 (SDGS Auger)

Location: SE $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 6, T. 95 N., R. 68 W.

Surface Elevation:

Depth to water:

0- 2 Soil
 2- 5 Sand, with clay, brown
 5- 33 Clay, brown
 33- 72 Clay, tan, sandy
 72- 81 Sand, very fine to medium
 81- 89 Shale

* * * *

Test Hole B-23 (SDGS Auger)

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 6, T. 95 N., R. 68 W.

Surface Elevation: 1935 feet

Depth to water: 52 feet

0- 4 Soil
 4- 49 Clay, sandy
 49- 54 Sand, medium, few clay layers

Test Hole-23 -- continued.

54- 81 Sand
 81- 89 Shale

* * * *

Test Hole B-24 (SDGS Auger)

Location: SW $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 1, T. 95 N., R. 68 W.

Surface Elevation: 1930 feet

Depth to water: 21 feet

0- 4 Soil
 4- 13 Sand, with clay
 13- 21 Clay
 21- 28 Sand, very fine to medium; clean sand
 28- 30 Sand, with clay, hard drilling
 30- 60 Sand, medium, tan, clean
 60- 63 Clay? sandy (shale?)

* * * *

Test Hole B-25 (SDGS Auger)

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 1, T. 95 N., R. 69 W.

Surface Elevation: 1944 feet

Depth to water: 17 feet

0 - $\frac{1}{2}$ Soil
 $\frac{1}{2}$ - 5 Sand, medium
 5 - 11 Sand, brown, some clay
 11 - 32 Sand, fine, some clay
 32 - 42 Sand, medium, light-brown
 42 - 49 Clay, gray
 49 - 59 Shale

* * * *

Test Hole B-26 (SDGS Auger)

Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 2, T. 95 N., R. 69 W.

Surface Elevation: 1965 feet

Depth to water: 18 feet

0 - $\frac{1}{2}$ Soil
 $\frac{1}{2}$ - 9 Clay, brown
 9 - 24 Clay, with sand
 24 - 29 Sand, with clay
 29 - 39 Clay, brown
 39 - 41 Sand, much clay
 41 - 51 Sand, medium, light-brown
 51 - 61 Clay, green
 61 - 74 Shale

* * * *

Test Hole B-27 (SDGS Auger)

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 1, T. 95 N., R. 69 W.

Surface Elevation: 1930 feet

Depth to water: 5 feet

0- 2 Soil
 2- 9 Clay
 9- 12 Sand, very fine, with clay, yellow
 12- 44 Sand, medium, with clay
 44- 46 Clay, yellow
 46- 54 Shale

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APPENDIX B

Logs of Test Holes in the
East Gregory Rural Water Study Area
(For map location, see fig. 1)

Test Hole E-1 (SDGS Rotary)

Location: SW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 16, T. 96 N., R. 70 W.

Surface Elevation: 2142 feet

Depth to water: not measured

0- 2	Soil
2- 55	Clay, light-green, sandy
55- 95	Clay, light-brown, oxidized shale
95-110	Shale

* * * *

Test Hole E-2 (SDGS Auger)

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 14, T. 96 N., R. 70 W.

Surface Elevation: 2105 feet

Depth to water: 11 feet

0- 4	Soil
4- 7	Clay, dark-brown, silty
7- 8	Clay, dark-brown, sandy
8- 9	Clay, brown, sandy
9- 11	Sand, dark-brown, medium to coarse, clayey
11- 30	Silt, gray
30- 44	Clay, brown and gray

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Test Hole E-3 (SDGS Auger)

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 14, T. 96 N., R. 70 W.

Surface Elevation: 2105 feet

Depth to water: not measured

0- 2	Soil
2- 5	Silt, brown, clayey
5- 7	Silt, brown, sandy
7- 55	Sand, brown, fine to coarse
55- 74	Clay, gray, silty

* * * *

Test Hole E-4 (SDGS Rotary)

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 23, T. 96 N., R. 71 W.

Surface Elevation: 2167 feet

Depth to water: not measured

0- 2	Soil
2- 5	Clay, light-brown, sandy
5- 11	Sand, fine to medium
11- 28	Gravel
28- 38	Gravel with clay stringers
38- 55	Clay, off-white to light-brown, sandy
55- 95	Clay, light-gray, sandy
95-130	Clay, dark-gray, grading to shale

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Test Hole E-5 (SDGS Rotary) (Observation Well)

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 24, T. 96 N., R. 71 W.

Surface Elevation: 2166 feet

Depth to water: 33 feet

0- 43	Sand, very coarse to gravel
43- 65	Clay, layered, interbedded gravel
65- 77	Sand, fine, some clay
77-107	Clay, interbedded gravel
107-129	Oxidized shale
129-140	Shale

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Test Hole E-6 (SDGS Rotary)

Location: NW $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 24, T. 96 N., R. 71 W.

Surface Elevation: 2160 feet

Depth to water: not measured

0- 2	Soil
2- 5	Clay, light-brown
5- 22	Gravel
22- 40	Sand, fine to medium, clayey
40- 65	Sand, fine to medium
65-115	Clay, green to gray, oxidized shale
115-130	Shale

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Test Hole E-7 (SDGS Rotary)

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 19, T. 96 N., R. 70 W.

Surface Elevation: 2155 feet

Depth to water: not measured

0- 2	Soil
2- 15	Sand, very coarse, some clay
15- 45	Gravel, some clay layers.
45- 52	Sand, fine to medium, clayey
52-105	Clay, brown, sandy, grading to oxidized shale
105-120	Shale

* * * *

Test Hole E-8 (SDGS Rotary)

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 20, T. 96 N., R. 70 W.

Surface Elevation: 2147 feet

Depth to water: not measured

0- 2	Soil
2- 10	Sand, medium to coarse
10- 37	Gravel
37- 52	Clay, green, cemented layers
52- 86	Clay, gray, grading to oxidized shale
86-100	Shale

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Test Hole E-9 (SDGS Rotary)

Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 20, T. 96 N., R. 70 W.

Surface Elevation: 2146 feet

Depth to water: not measured

0- 1	Soil
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Test Hole E-9 -- continued.

1- 36 Sand, very coarse
 36- 87 Gravel, with clay layers
 87-104 Oxidized shale
 104-110 Shale

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Test Hole E-10 (SDGS Rotary)

Location: SW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 21, T. 96 N., R. 70 W.
 Surface Elevation: 2143 feet
 Depth to water: not measured

0- 2 Soil
 2- 4 Clay, dark-brown, sandy
 4- 48 Sand, medium to gravel
 48- 98 Gravel, medium sand, clayey
 98-110 Clay, light-brown, grading to oxidized shale
 110-130 Shale

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Test Hole E-11 (SDGS Rotary)

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 21, T. 96 N., R. 70 W.
 Surface Elevation: 2135 feet
 Depth to water: not measured

0- 1 Soil
 1- 6 Sand, coarse
 6- 38 Gravel
 38- 65 Clay, white to green, sandy with some pebbles
 65-105 Clay, light-brown, sandy, grading to oxidized shale
 105-120 Shale

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Test Hole E-12 (SDGS Rotary)

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 24, T. 96 N., R. 69 W.
 Surface Elevation: 1996 feet
 Depth to water: not measured

0- 1 Soil
 1- 46 Sand, very coarse
 46- 65 Clay, interbedded gravels
 65-117 Oxidized shale
 117-120 Shale

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Test Hole E-13 (SDGS Rotary)

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 26, T. 96 N., R. 71 W.
 Surface Elevation: 2165 feet
 Depth to water: not measured

0- 36 Sand, medium to gravel
 36- 55 Gravel, with clay layers
 55- 76 Sand, medium, clay layers
 76- 96 Oxidized shale
 96- 98 Cemented layer, possibly siltstone
 98-110 Shale

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Test Hole E-14 (SDGS Rotary)

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 26, T. 96 N., R. 71 W.
 Surface Elevation: 2083 feet
 Depth to water: not measured

0- 2 Soil
 2- 7 Clay, gray
 7- 12 Gravel
 12- 46 Clay, blue, grading to oxidized shale
 46- 60 Shale

* * * *

Test Hole E-15 (SDGS Rotary)

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 26, T. 96 N., R. 71 W.
 Surface Elevation: 2152 feet
 Depth to water: not measured

0- 2 Soil
 2- 38 Gravel
 38- 58 Clay, white to light-brown
 58-123 Clay, blue, with sand, brown clay and blue silt layers
 123-140 Shale

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Test Hole E-16 (SDGS Rotary)

Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 25, T. 96 N., R. 71 W.
 Surface Elevation: 2156 feet
 Depth to water: not measured

0- 1 Soil
 1- 40 Gravel
 40- 60 Clay, gray, sandy
 60- 97 Oxidized shale
 97-110 Shale

* * * *

Test Hole E-17 (SDGS Rotary)

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 30, T. 96 N., R. 70 W.
 Surface Elevation: 2158 feet
 Depth to water: not measured

0- 2 Soil
 2- 6 Clay, dark-brown, sandy
 6- 54 Gravel
 54- 63 Clay, white to light-gray
 63- 72 Gravel
 72-113 Clay, dark-gray to light-black, grading to oxidized shale
 113-130 Shale

* * * *

Test Hole E-18 (SDGS Rotary) (Observation Well)

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 30, T. 96 N., R. 70 W.
 Surface Elevation: 2159 feet
 Depth to water: 48.5 feet

0- 2 Soil
 2- 5 Clay, dark-brown, sandy
 5- 58 Gravel

Test Hole E-18 -- continued.

58- 63	Clay, white to gray
63- 97	Sand, medium, some clay layers
97-127	Clay, blue-gray
127-147	Oxidized shale
147-160	Shale

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Test Hole E-19 (SDGS Rotary)

Location: SW $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 30, T. 96 N., R. 70 W.
 Surface Elevation: 2150 feet
 Depth to water: not measured

0- 2	Soil
2- 56	Gravel
56- 85	Clay, off-white to light-brown, gravel stringers
85-110	Clay, blue

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Test Hole E-20 (SDGS Rotary)

Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 30, T. 96 N., R. 70 W.
 Surface Elevation: 2139 feet
 Depth to water: not measured

0- 2	Soil
2- 8	Clay, brown, sandy
8- 14	Sand, coarse to gravel
14- 48	Gravel, with medium sand
48- 51	Clay, white to light-gray
51- 53	Gravel
53- 55	Clay, white to light-gray
55- 58	Gravel
58- 96	Clay, blue, some gravel
96-105	Oxidized shale

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Test Hole E-21 (SDGS Rotary)

Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 30, T. 96 N., R. 70 W.
 Surface Elevation: 2142 feet
 Depth to water: not measured

0- 2	Soil
2- 13	Sand, coarse to very coarse
13- 30	Gravel
30- 65	Clay, off-white to light-brown, sandy
65- 90	Clay, light-brown to light-gray, grading to oxidized shale
90-100	Shale

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Test Hole E-22 (SDGS Auger)

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 29, T. 96 N., R. 70 W.
 Surface Elevation: 2152 feet
 Depth to water: 31 feet

0- 3	Soil
3- 6	Clay, dark-brown
6- 7	Clay, dark-brown, sandy
7- 8	Sand, medium to coarse

Test Hole E-22 -- continued.

8- 11	Clay, brown, sandy
11- 38	Sand, brown, some gravel
38- 55	Clay, brown, gravel and interbedded sand
55- 67	Oxidized shale

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Test Hole E-23 (SDGS Rotary)

Location: SE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 29, T. 96 N., R. 70 W.
 Surface Elevation: 2135 feet
 Depth to water: not measured

0- 1	Soil
1- 33	Sand, coarse
33- 48	Clay, green, sandy
48-103	Oxidized shale
103-120	Shale

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Test Hole E-24 (SDGS Rotary)

Location: NE $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 28, T. 96 N., R. 70 W.
 Surface Elevation: 2145 feet
 Depth to water: 44 feet

0- 2	Soil
2- 7	Clay, light-brown, sandy
7- 66	Gravel
66- 86	Clay, light-green, sandy
86-120	Shale

* * * *

Test Hole E-25 (SDGS Rotary)

Location: SE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 28, T. 96 N., R. 70 W.
 Surface Elevation: 2142 feet
 Depth to water: not measured

0- 1	Soil
1- 69	Sand, very coarse
69- 73	Clay, white
73- 86	Clay, white, sandy
86-112	Oxidized shale
112-120	Shale

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Test Hole E-26 (SDGS Rotary)

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 27, T. 96 N., R. 70 W.
 Surface Elevation: 2144 feet
 Depth to water: not measured

0- 2	Soil
2- 4	Clay, dark-brown, sandy
4- 58	Sand, medium
58-105	Clay, light-green, sandy, cemented layers
105-125	Oxidized shale
125-140	Shale

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Test Hole E-27 (SDGS Rotary) (Observation Well)
 Location: SW $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 27, T. 96 N., R. 70 W.
 Surface Elevation: 2141 feet
 Depth to water: 50 feet

0- 3	Soil
3- 9	Sand, very coarse to gravel
9- 30	Gravel
30- 32	Clay, light-brown, sandy
32- 68	Gravel
68- 96	Clay, light-green, sandy
96-	Bijou Quartzite

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Test Hole E-28 (SDGS Rotary)
 Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 27, T. 96 N., R. 70 W.
 Surface Elevation: 2115 feet
 Depth to water: not measured

0- 2	Soil
2- 9	Clay, dark-brown, sandy
9- 64	Sand, medium to gravel
64-	Bijou Quartzite

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Test Hole E-29 (SDGS Rotary)
 Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 27, T. 96 N., R. 70 W.
 Surface Elevation: 2139 feet
 Depth to water: not measured

0- 2	Soil
2- 13	Sand, medium to coarse
13- 85	Gravel
85-100	Gravel, clay lenses, cemented layers
100-150	Clay, sandy, cemented layers
150-	Bijou Quartzite(?)

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Test Hole E-30 (SDGS Rotary) (Observation Well)
 Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 27, T. 96 N., R. 70 W.
 Surface Elevation: 2141 feet
 Depth to water: 60.5 feet

0- 1	Soil
1- 4	Clay, dark-brown, sandy
4- 15	Sand, medium to coarse
15- 98	Sand, very coarse to gravel
98-	Bijou Quartzite

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Test Hole E-31 (SDGS Rotary) (Observation Well)
 Location: SW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 27, T. 96 N., R. 70 W.
 Surface Elevation: 2139 feet
 Depth to water: 53.5 feet

0- 2	Soil
2- 6	Clay, light-brown, sandy
6- 30	Sand, medium
30- 85	Gravel
85-	Bijou Quartzite

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Test Hole E-32 (SDGS Rotary) (Observation Well)
 Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 27, T. 96 N., R. 70 W.
 Surface Elevation: 2130 feet
 Depth to water: 46 feet

0- 2	Soil
2- 4	Clay, brown, sandy
4- 15	Sand, fine to medium
15- 45	Sand, coarse to gravel
45- 66	Gravel
66- 68	Clay, green
68- 78	Gravel
78- 79	Cemented layer
79- 81	Gravel
81-	Bijou Quartzite

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Test Hole E-33 (SDGS Rotary)
 Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 27, T. 96 N., R. 70 W.
 Surface Elevation: 2135 feet
 Depth to water: 55 feet

0- 2	Soil
2- 5	Clay, dark-brown, sandy
5- 68	Gravel
68- 83	Gravel, clay layers
83- 84	Cemented layer
84- 89	Clay, light-green to brown, gravelly
89-	Bijou Quartzite

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Test Hole E-34 (SDGS Auger)
 Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 27, T. 96 N., R. 70 W.
 Surface Elevation: 2110 feet
 Depth to water: 50 feet

0- 2	Sand, dark-brown, clayey
2- 3	Silt, black, clayey
3- 60	Sand, brown, medium to coarse
60- 61	Oxidized shale

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Test Hole E-35 (SDGS Rotary)
 Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 26, T. 96 N., R. 69 W.
 Surface Elevation: 2013 feet
 Depth to water: not measured

0- 2	Soil
2- 6	Gravel, clayey
6- 46	Gravel
46- 65	Clay, light-brown to off-white, sand
65-105	Oxidized shale
105-110	Shale

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Test Hole E-36 (SDGS Rotary)
 Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 31, T. 96 N., R. 70 W.
 Surface Elevation: 2155 feet
 Depth to water: not measured

0- 2	Soil
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Test Hole E-36 -- continued.

2- 8	Clay, light-brown, sandy
8- 49	Gravel
49- 59	Clay, light-brown, sandy
59- 85	Clay, light-brown, gravel stringers
85- 95	Oxidized shale
95-110	Shale

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Test Hole E-37 (SDGS Rotary)

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 31, T. 96 N., R. 70 W.

Surface Elevation: 2150 feet

Depth to water: not measured

0- 2	Soil
2- 7	Clay, light-brown, sandy
7- 58	Gravel
58- 95	Clay, light-brown, gravel
95-143	Clay, light-brown, sandy, grades to oxidized shale
143-150	Shale

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Test Hole E-38 (SDGS Rotary)

Location: NW $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 31, T. 96 N., R. 70 W.

Surface Elevation: 2143 feet

Depth to water: not measured

0- 2	Soil
2- 6	Clay, dark-brown, sandy
6- 54	Sand, fine to medium, intermixed gravel
54- 62	Clay, white to light-gray
62- 69	Gravel, some clay layers
69- 73	Clay, white to light-gray
73-100	Oxidized shale, grading to shale

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Test Hole E-39 (SDGS Rotary)

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 31, T. 96 N., R. 70 W.

Surface Elevation: 2145 feet

Depth to water: not measured

0- 2	Soil
2- 9	Clay, light-brown, sandy
9- 54	Gravel
54- 90	Clay, light-brown to off-white, gravel layers
90-105	Clay, light-brown to off-white
105-125	Clay, light-green
125-	Shale

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Test Hole E-40 (SDGS Rotary)

Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 31, T. 96 N., R. 70 W.

Surface Elevation: 2145 feet

Depth to water: not measured

0- 1	Soil
1- 3	Clay, brown, sandy
3- 65	Sand, very coarse, grades to gravel

Test Hole E-40 -- continued.

65- 87	Sand, medium, gravel, clay layers
87-115	Oxidized shale
115-120	Shale

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Test Hole E-41 (SDGS Rotary)

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 32, T. 96 N., R. 70 W.

Surface Elevation: 2118 feet

Depth to water: not measured

0- 2	Soil
2- 25	Sand, very coarse to gravel
25- 48	Gravel
48- 58	Sand, medium, clay layers
58-105	Clay, light-brown, sandy
105-128	Oxidized shale
128-140	Shale

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Test Hole E-42 (SDGS Rotary)

Location: NW $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 32, T. 96 N., R. 70 W.

Surface Elevation: 2080 feet

Depth to water: not measured

0- 1	Soil
1- 3	Silt, green, cemented
3- 23	Sand, medium to gravelly, clayey
23- 32	Clay, white, some gravel
32- 52	Oxidized shale
52- 60	Shale

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Test Hole E-43 (SDGS Rotary)

Location: NW $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 33, T. 96 N., R. 70 W.

Surface Elevation: 2120 feet

Depth to water: not measured

0- 2	Soil
2- 12	Sand, very coarse
12- 22	Gravel, clayey
22- 30	Sand, fine to medium, clayey
30- 45	Clay, light-green, sandy, cemented layers
45- 85	Clay, light-brown, grading to oxidized shale
85-100	Shale

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Test Hole E-44 (SDGS Rotary) (Observation Well)

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 34, T. 96 N., R. 70 W.

Surface Elevation: 2140

Depth to water: 54 feet

0- 1	Soil
1- 55	Sand, coarse to very coarse
55- 85	Gravel
85-105	Clay, white to light-brown, sandy
105-130	Oxidized shale
130-150	Shale

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Test Hole E-45 (SDGS Rotary)

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 34, T. 96 N., R. 70 W.

Surface Elevation: 2120 feet

Depth to water: not measured

0- 2	Soil
2- 6	Clay, dark-brown, sandy
6- 14	Sand, very coarse to gravel
14- 19	Gravel, intermixed sand, fine to medium
19- 24	Clay, gray, sandy
24- 48	Gravel
48- 52	Clay, green
52- 59	Gravel
59- 61	Clay, green
61- 67	Clay, white to light-gray
67-108	Oxidized shale
108-	Shale

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Test Hole E-46 (SDGS Rotary)

Location: SW $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 34, T. 96 N., R. 70 W.

Surface Elevation: 2090 feet

Depth to water: not measured

0- 2	Soil
2- 10	Sand, medium
10- 18	Gravel
18- 45	Clay, white to light-brown, sandy
45- 85	Clay, light-brown, grading to oxidized shale
85-100	Shale

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Test Hole E-47 (SDGS Rotary)

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 34, T. 96 N., R. 70 W.

Surface Elevation: 2142 feet

Depth to water: not measured

0- 2	Soil
2- 6	Clay, dark-brown, sandy
6- 16	Sand, medium to coarse
16- 18	Clay, light-tan
18- 23	Sand, coarse to gravel
23- 33	Sand, medium
33- 76	Gravel
76- 77	Clay, light-green
77- 88	Gravel
88- 90	Clay, light-green

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Test Hole E-48 (SDGS Rotary)

Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 34, T. 96 N., R. 70 W.

Surface Elevation: 2098 feet

Depth to water: 15.5 feet

0- 2	Soil
2- 5	Clay, dark-brown, sandy
5- 12	Sand, very coarse to gravel
12- 34	Gravel
34- 41	Clay, green
41- 48	Gravel
48- 68	Gravel, layers of clay

Test Hole E-48 -- continued.

68- 69	Cemented layer
69- 73	Clay, green
73-	Bijou Quartzite

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Test Hole E-49 (SDGS Rotary)

Location: SE $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 34, T. 96 N., R. 70 W.

Surface Elevation: 2096 feet

Depth to water: 12 feet

0- 2	Soil
2- 8	Clay, light-brown, sandy
8- 25	Gravel
25- 55	Clay, light-green, gravel stringers
55-	Bijou Quartzite

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Test Hole E-50 (SDGS Rotary)

Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 34, T. 96 N., R. 70 W.

Surface Elevation: 2086 feet

Depth to water: not measured

0- 2	Soil
2- 22	Sand, medium to coarse
22- 28	Gravel
28- 35	Clay, brown to green, gravel layers
35- 75	Oxidized shale
75- 90	Shale

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Test Hole E-51 (SDGS Auger)

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 34, T. 96 N., R. 70 W.

Surface Elevation: 2073 feet

Depth to water: 4.5 feet

0- 2	Soil
2- 5	Clay, gray
5- 12	Sand, gray-brown, clayey
12- 26	Sand, coarse, silty
26- 43	Clay, tan, sandy
43- 54	Clay, gray-green, sandy

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Test Hole E-52 (SDGS Rotary)

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 1, T. 95 N., R. 70 W.

Surface Elevation: 2065 feet

Depth to water: not measured

0- 1	Soil
1- 10	Sand, very coarse to gravel
10- 35	Gravel
35- 60	Clay, white-brown, sandy
60- 85	Oxidized shale
85-100	Shale

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Test Hole E-53 (SDGS Auger)

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 1, T. 95 N., R. 70 W.
 Surface Elevation: 2030 feet
 Depth to water: 9 feet

0- 3	Soil
3- 6	Clay, brown, sandy
6- 7	Clay, brown, gravelly
7- 8	Sand, medium to coarse
8- 13	Sand, medium to coarse, clay
13- 18	Sand, medium to coarse
18- 39	Clay, gray-green, gravelly

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Test Hole E-54 (SDGS Rotary)

Location: SW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 6, T. 95 N., R. 69 W.
 Surface Elevation: 2050 feet
 Depth to water: not measured

0- 38	Sand, coarse to very coarse
38- 53	Gravel
53- 65	Clay, light-brown, sandy
65-100	Oxidized shale
100-120	Shale

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Test Hole E-55 (SDGS Rotary)

Location: NW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 3, T. 95 N., R. 69 W.
 Surface Elevation: 2005 feet
 Depth to water: not measured

0- 1	Soil
1- 11	Sand, coarse
11- 25	Gravel
25- 75	Clay, light-brown
75- 90	Clay, grading to shale

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Test Hole E-56 (SDGS Rotary)

Location: SW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 3, T. 95 N., R. 69 W.
 Surface Elevation: 2020 feet
 Depth to water: not measured

0- 1	Soil
1- 4	Clay, dark-brown
4- 24	Sand, very coarse
24- 37	Gravel
37- 95	Clay, brown to green, gravelly
95-105	Oxidized shale

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Test Hole E-57 (SDGS Auger)

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 2, T. 95 N., R. 69 W.
 Surface Elevation: 2003 feet
 Depth to water: 20 feet

0- 2	Soil
2- 14	Sand, brown, silty
14- 25	Sand
25- 34	Clay, green-brown, sandy

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Test Hole E-58 (SDGS Rotary)

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 6, T. 95 N., R. 68 W.
 Surface Elevation: 1942 feet
 Depth to water: not measured

0- 3	Soil
3- 15	Clay, brown, sandy
15- 60	Clay, light-gray to brown, sandy
60- 65	Cemented layer
65- 97	Sand, fine, clay layers
97-116	Clay, gray, sandy
116-130	Shale

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Test Hole E-59 (SDGS Auger)

Location: NW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 9, T. 95 N., R. 69 W.
 Surface Elevation: 2030 feet
 Depth to water: 35 feet

0- 1	Soil
1- 35	Sand, fine to coarse
35- 41	Sand, medium to coarse, clayey
41- 54	Oxidized shale

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Test Hole E-60 (SDGS Rotary)

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 12, T. 95 N., R. 69 W.
 Surface Elevation: 1924 feet
 Depth to water: not measured

0- 2	Soil
2- 8	Clay, brown, sandy
8- 42	Sand, fine to medium, clay stringers
42- 65	Clay, light-brown
65- 75	Oxidized shale
75- 90	Shale

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Test Hole E-61 (SDGS Rotary)

Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 12, T. 95 N., R. 69 W.
 Surface Elevation: 1924 feet
 Depth to water: not measured

0- 2	Soil
2- 11	Clay, sandy
11- 45	Sand, very fine to fine, clayey
45- 65	Clay, brown to black, sandy
65- 80	Sand, medium to coarse, clay layers
80-100	Shale

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Test Hole E-62 (SDGS Rotary)

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 8, T. 95 N., R. 68 W.
 Surface Elevation: 1938 feet
 Depth to water: not measured

0- 2	Soil
2- 54	Clay, brown to gray
54- 55	Cemented layer
55- 69	Clay, brown to gray
69- 80	Shale

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Test Hole E-63 (SDGS Auger)

Location: SW $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 8, T. 95 N., R. 68 W.

Surface Elevation: 1980 feet

Depth to water: not measured

0- 7	Clay, dark-brown, sandy
7- 30	Clay, green to brown
30- 44	Clay, dark-gray

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Test Hole E-64 (SDGS Auger)

Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 17, T. 95 N., R. 69 W.

Surface Elevation: 2004 feet

Depth to water: 21 feet

0- 5	Silt, brown, clayey
5- 9	Sand, medium to very coarse, silty
9- 15	Sand, medium to coarse
15- 21	Sand, clayey
21- 34	Clay, tan

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