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GROUND-WATER STUDY FOR THE  
CITY OF MITCHELL

by

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## INTRODUCTION

This report contains the results of a special ground-water investigation conducted by the South Dakota Geological Survey in and around the City of Mitchell, Davison County, South Dakota. The purpose of the investigation was to evaluate the ground-water resources in the Mitchell area.

The field work for the study was conducted in the summer of 1977. Additional data were collected from the test holes drilled by private drilling companies for the City and during the county ground-water study conducted in 1977, 1978, 1979, and 1980 by the United States Geological Survey and the South Dakota Geological Survey.

The City of Mitchell obtains its water from Lake Mitchell, which was created by the damming of Firesteel Creek 1 mile north of the City. The City, on the average, pumps approximately 2 million gallons of water per day which serves a population of 13,917 (preliminary data of 1980 census). The peak pumping rate is approximately 5.6 million gallons per day. Because the level of Lake Mitchell had dropped critically low during the low precipitation years of 1975 and 1976, the City has been pumping water from the James River to the Lake periodically since 1977.

A previous ground-water study for the City of Mitchell was conducted by the South Dakota Geological Survey (Barari, 1966, Special Report No. 42). The results of this survey showed that there was not an aquifer or aquifers in the Mitchell area from which a suitable municipal water supply could be obtained. Recommendations for further study were indicated for the evaluation of supplementary or emergency water supplies.

The general geology of the area was discussed in the South Dakota Geological Survey Special Report No. 42. A more detailed discussion of the geology and hydrology of Davison and Hanson Counties will be published in the near future by the U.S. Geological Survey and the South Dakota Geological Survey. To eliminate duplication, the present report summarizes the findings related to the water supply for the City of Mitchell.

Figure 1 shows the locations of test holes and observation wells drilled in the Mitchell area. Appendix A shows the logs of the test holes and observation wells drilled in the area except for those published in Special Report No. 42. Appendix B shows the logs of the test holes and observation wells drilled for the City by commercial drilling companies. Figure 2 shows the thickness of saturated glacial sand and gravel.

## SURFACE WATER

The two main bodies of surface water in the area are the James

River and Firesteel Creek. As previously mentioned, Lake Mitchell was created by the damming of Firesteel Creek, and the City periodically pumps water from the James River to augment the water supply in Lake Mitchell.

The quality of Lake Mitchell water varies depending on the precipitation and on the amount and period of water pumped from the James River (quality of James River water fluctuates seasonally). Table 1 shows the quality of water samples collected from the area. Samples W1 (raw water) and W2 (treated water) were lake water collected in September 1970. Samples W3 (raw water) and W4 (treated water) were collected in March 1977. Total dissolved solids, sulfate, and hardness values of water samples collected in 1977 are approximately twice the values of samples collected in 1970. For example, the hardness in treated water sample W4 (373 parts per million) is higher than the raw sample W1 (261 parts per million). Sample W5 was collected from the James River in August 1966 and had relatively low total dissolved solids (568 ppm). However, other data show that the quality of the James River water varies substantially during a year.

#### GROUND WATER IN GLACIAL DEPOSITS

Surficial deposits in the Mitchell area consist primarily of glacial drift resulting from past glaciations. Sand and gravel layers within these deposits yield water to wells. The most significant saturated sand and gravel (glacial outwash) layers are located north of Lake Mitchell in sec. 29, T. 104 N., R. 60 W. (fig. 2).

A production (pump test) well (designated by E-P, app. B) was constructed in the NE NW SW SE sec. 29, T. 104 N., R. 60 W. (for map location, see fig. 1). This well penetrated 51 feet of sand and gravel. The thickness of sand and gravel varies rapidly in the area (fig. 2). Test hole E-12 (see fig. 1 and app. B), approximately one-fourth mile east of the production well had only 8 feet of gravel and test hole E-10, approximately one-half mile to the northwest, had no gravel layer. In March, 1976 the production (pump test) well was pumped at a rate of 500 gallons per minute for 96 hours. Based on the data collected during the test, a transmissivity of 41,000 gallons per day per foot and a storage coefficient of  $8.6 \times 10^{-4}$  are reasonable. The results of the water analysis from this well are in table 1 (samples W6 and W7); the map location (fig. 3) will be discussed later in the report.

Data provided by the Mitchell City Engineer's Office show that in March, 1976 the Lake level was 1253.51 feet above mean sea level. At the same time the water level in Observation Well E-15 (fig. 1) near the Lake was 1251.31 feet; test hole 89 (Water Rights Observation well DN-67A) - 1248.87 feet; test hole E-14 - 1247.36 feet; and test hole E-9 - 1245.91 feet. The elevation of

Table 1. Chemical analyses of water samples from the Mitchell area (for map location see fig. 3)

Sample	Source	Depth of Well	PARTS PER MILLION										Conductivity Micro mhos	
			Calcium	Magnesium	Sodium	Chloride	Sulfate	Iron	Manganese	Nitrate Nitrogen	Fluoride	Hardness		Total Dissolved Solids
A						250 <sup>2</sup>	250 <sup>2</sup>	0.3 <sup>2</sup>	0.05 <sup>2</sup>	10.0 <sup>1</sup>	2.4 <sup>1</sup>		500 <sup>2</sup>	
W1	Lake Raw		84	12.0	55.0	18.0	233	0.10	0.40	1.00*	0.50	261	575	
W2	Lake Treated		47	8.0	70.0	24.0	227	0.00	0.00	1.00*	1.50	152	448	
W3	Lake Raw		108	67.0	129.0	55.0	570	1.50	0.53	0.10	0.30	545	1159	
W4	Lake Treated		59	55.0	167.0	61.0	570	0.10*	0.04	0.10*	1.60	373	1044	
W5	James River		65	28.0	78.0	31.0	108	0.30	0.20	0.30	0.40	276	568	
W6	Glacial	120	208	83.7	83.5	13.8	550	1.83	0.56	1.00*	0.40	864	1403	1750
W7	Glacial	120	206	80.3	80.0	10.4	554	1.94	0.54	1.00*	0.35	845	1358	1670
W8	Glacial	82	540	145.0	260.0	48.0	1250	4.00	0.50	0.50*		1840	2036	2250
W9	Glacial	55	1300	400.0	330.0	31.0	1850	10.00	3.20	0.50*		4880	3140	2970
W10	Glacial	100	140	40.0	365.0	60.0	788	0.48		5.50			1764	2304
W11	Glacial? Code11?	34? 118?	220	130.0	125.0	18.0	530	8.00	0.60	0.50*		1032	1340	1750
W12	Glacial? Code11?	17? 120?	185	105.0	170.0	38.0	660	4.00	0.10	0.50*		892	1592	2000
W13	Code11	120	149	67.0	38.0	6.0	472	0.83	0.18	0.08	0.40	649	1070	
W14	Code11	136	150	95.0	75.0	20.0	620	0.20	0.05	0.50*		765		
W15	Chalk	35	150	58.0	130.0	58.0	560	0.15	0.10	0.50*		612	1220	1465
W16	Chalk?	77	140	54.0	200.0	37.0	480	0.75	1.40	0.50*		571	1390	1720
W17	Chalk	78	720	260.0	258.0		2550	0.01		3.00		2868	4296	4058
W18	Chalk	112	210	74.0	252.0	22.0	1140	0.72		2.30		827	1884	2439
W19	Dakota	538	510	135.0	220.0	122.0	1721	1.40				1825	2220	
W20	Floyd Aquifer		181	56.0	219.0	80.0	773	0.74	1.04	1.97	0.63	688	1510	2060

\* - Less Than

Sample A

<sup>1</sup>United States Environmental Protection Agency "National Primary Drinking Water Regulations" - December 24, 1975 (enforceable limits)<sup>2</sup>United States Environmental Protection Agency "National Secondary Drinking Water Regulations" - July 19, 1979 (recommended limits)

Location of water samples and the source of data  
(for map location, see fig. 3)

- W 1. Lake Mitchell raw water; analyzed in September 1970 by the South Dakota Department of Environmental Protection. South Dakota Public Water Supply Data 1976.
- W 2. Lake Mitchell treated water; analyzed in September 1970 by the South Dakota Department of Environmental Protection. South Dakota Public Water Supply Data 1976.
- W 3. Lake Mitchell raw water; analyzed in March 1977 by the South Dakota Department of Environmental Protection. South Dakota Public Water Supply Data 1979.
- W 4. Lake Mitchell treated water; analyzed in March 1977 by the South Dakota Department of Environmental Protection. South Dakota Public Water Supply Data 1979.
- W 5. SW SW SW sec. 19, T. 103 N., R. 59 W., James River, collection date 8-18-1966; analyzed by the South Dakota Geological Survey.
- W 6. NE NW SW SE sec. 29, T. 104 N., R. 60 W., collected after pumping 500 gallons per minute for 30 hours; collected on 3-3-1976; analyzed by the South Dakota Department of Environmental Protection.
- W 7. NE NW SW SE sec. 29, T. 104 N., R. 60 W., collected after pumping 500 gallons per minute for 96 hours; collected on 3-8-1976; analyzed by the South Dakota Department of Environmental Protection.
- W 8. NE NE SE NE sec. 4, T. 104 N., R. 61 W., collected and analyzed by the South Dakota Geological Survey in 1976.
- W 9. NW NW NE NW sec. 3, T. 104 N., R. 61 W., collected and analyzed by the South Dakota Geological Survey in 1976.
- W 10. SW SW SW SW sec. 33, T. 101 N., R. 60 W., collected by the Division of Water Rights and analyzed by the Water Resources Research Institute in Brookings.
- W 11. NW NW NW NE sec. 19, T. 104 N., R. 60 W., appendix A, test hole 81 flowed after drilling; water was collected and analyzed by the South Dakota Geological Survey in 1977.
- W 12. SW NW NW SW sec. 21, T. 104 N., R. 60 W., appendix A, test hole 84 flowed after drilling; water was collected and analyzed by the South Dakota Geological Survey in 1977.

- W 13. SE SE SE SE sec. 14, T. 104 N., R. 61 W., (Test Hole 7, Special Report No. 42) sample was taken after pumping to 2 hours at a rate of 100 gallons per minute. The sample was collected and analyzed by the South Dakota Geological Survey in 1966.
- W 14. NE NW NW SE sec. 16, T. 103 N., R. 60 W., Cadwell Park well, the well was pumped at a rate of 100 gallons per minute (designated by production well H-P in app. B). Sample was analyzed by the South Dakota Geological Survey in 1977.
- W 15. SE SW NW SW sec. 1, T. 103 N., R. 60 W., the observation well (test hole 103, app. A) was pumped for 3 hours. The sample was collected and analyzed by the South Dakota Geological Survey in 1977.
- W 16. SE SE NE SE sec. 13, T. 103 N., R. 60 W.; the observation well (test hole 118, app. A) was pumped for 3 hours. The sample was collected and analyzed by the South Dakota Geological Survey in 1977.
- W 17. SE SE SE SE sec. 22, T. 101 N., R. 61 W.; the observation well (test hole 217, app. A) was pumped by the Water Rights Division. Water was analyzed by the Water Resources Research Institute in Brookings in 1974.
- W 18. SW SE SE SE sec. 19, T. 101 N., R. 60 W.; the observation well (test hole 223, app. A) was pumped by the Water Rights Division. Water was analyzed by the Water Resources Research Institute in Brookings in 1975.
- W 19. NE sec. 22, T. 103 N., R. 60 W.; old city well no. 4 (from the file in the City Engineer's Office), 538 feet deep. Source of data - Special Report No. 42.
- W 20. Average of 8 water samples collected from Floyd Aquifer in T. 103 N., R. 57 W.; T. 104 N., R. 57 and 58 W.; T. 105 N., R. 58 W. The samples were collected and analyzed by the U.S. Geological Survey.

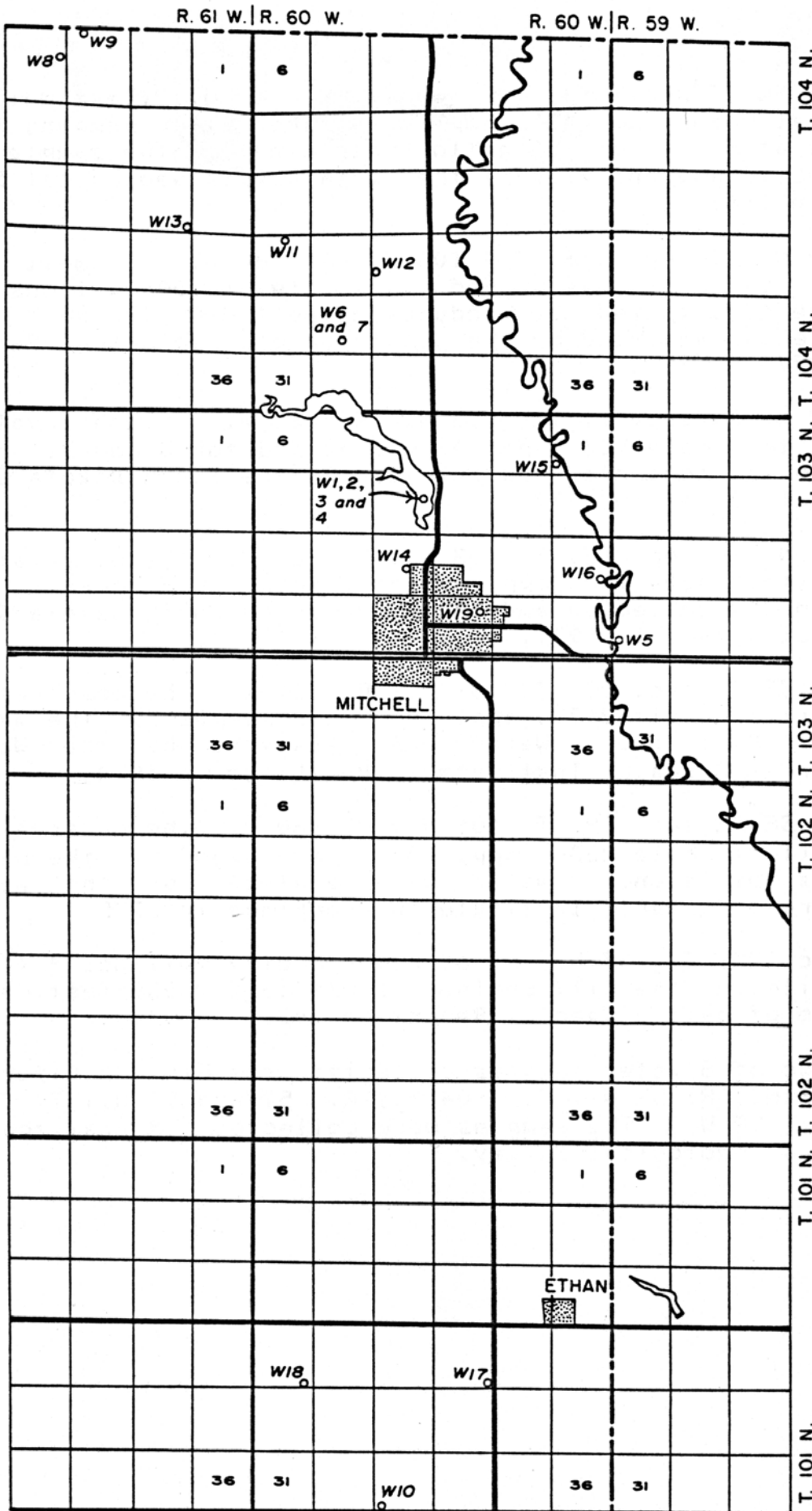


Figure 3.  
Location of  
water samples  
in the Mitchell  
area.

○ W12  
Water sample.  
Number corresponds  
to water sample  
number in Table 1.  
(W20 is the average  
of 8 water samples  
from the Floyd  
aquifer, Hanson Co.,  
which is located  
outside the mapped  
area).

0 1 2  
MILES





Dry Run Creek is approximately 1230 feet north of test hole E-9. Based on these data and the logs in appendix B, figure 4 was constructed. This figure shows there is a ground-water connection between Lake Mitchell, the aquifer north of the Lake and Dry Run Creek, and the gradient of water level is from the Lake to Dry Run Creek. This indicates that water from Lake Mitchell was seeping to the aquifer north of the lake.

Figure 2 shows there are other locations north and northwest of Lake Mitchell with sand and gravel layers. Test hole 39 located in NE NE SE NE sec. 4, T. 104 N., R. 61 W. had a gravel layer from 64 to 85 feet below the land surface. There are also sand and gravel deposits south of Mitchell. Test hole 239 (see app. A and fig. 2) located approximately 14 miles south of town in SW SW SW SW sec. 33, T. 101 N., R. 60 W. penetrates more than 30 feet of sand and gravel.

#### Quality of Water in Glacial Deposits

Water samples W6 and W7 had the lowest amount of dissolved chemicals from the glacial deposits. They were collected approximately 1 mile north of Lake Mitchell from production well E-P, located in NE NW SW SE sec. 29, T. 104 N., R. 60 W. (fig. 3). Sample W6 was taken after 30 hours of pumping and sample W7 after 96 hours of pumping. According to table 1 the total dissolved solids contents in sample W7 was 1358 ppm (parts per million), the hardness content was 845 ppm and the sulfate content was 554 ppm. The levels of sulfate, iron, manganese, and total dissolved solids in this sample exceeded the recommended National Secondary Drinking Water Regulations. This sample was within the limits for other chemicals listed in table 1. The hardness of this sample was 300 ppm higher than raw lake water collected in March 1977.

Samples W8 and W9 were collected from approximately 11 miles northwest of Mitchell (fig. 3). These samples were very high in total dissolved solids (2036 ppm and 3140 ppm), hardness (1840 ppm and 4880 ppm), and sulfate (1250 ppm and 1850 ppm). Sample W10, collected from another glacial aquifer, located approximately 14 miles south of Mitchell (fig. 3), had a total dissolved solids content of 1764 ppm and a sulfate content of 788 ppm.

#### GROUND WATER IN BEDROCK

The Niobrara Marl (chalk) and Codell Sandstone are hydraulically connected in several locations within the area. For the purposes of this report, they are considered together as the Niobrara-Codell Aquifer. In addition, some of the test holes north of Lake Mitchell showed a connection between the outwash and the Niobrara-Codell Aquifer (see test holes E-9, E-12, and

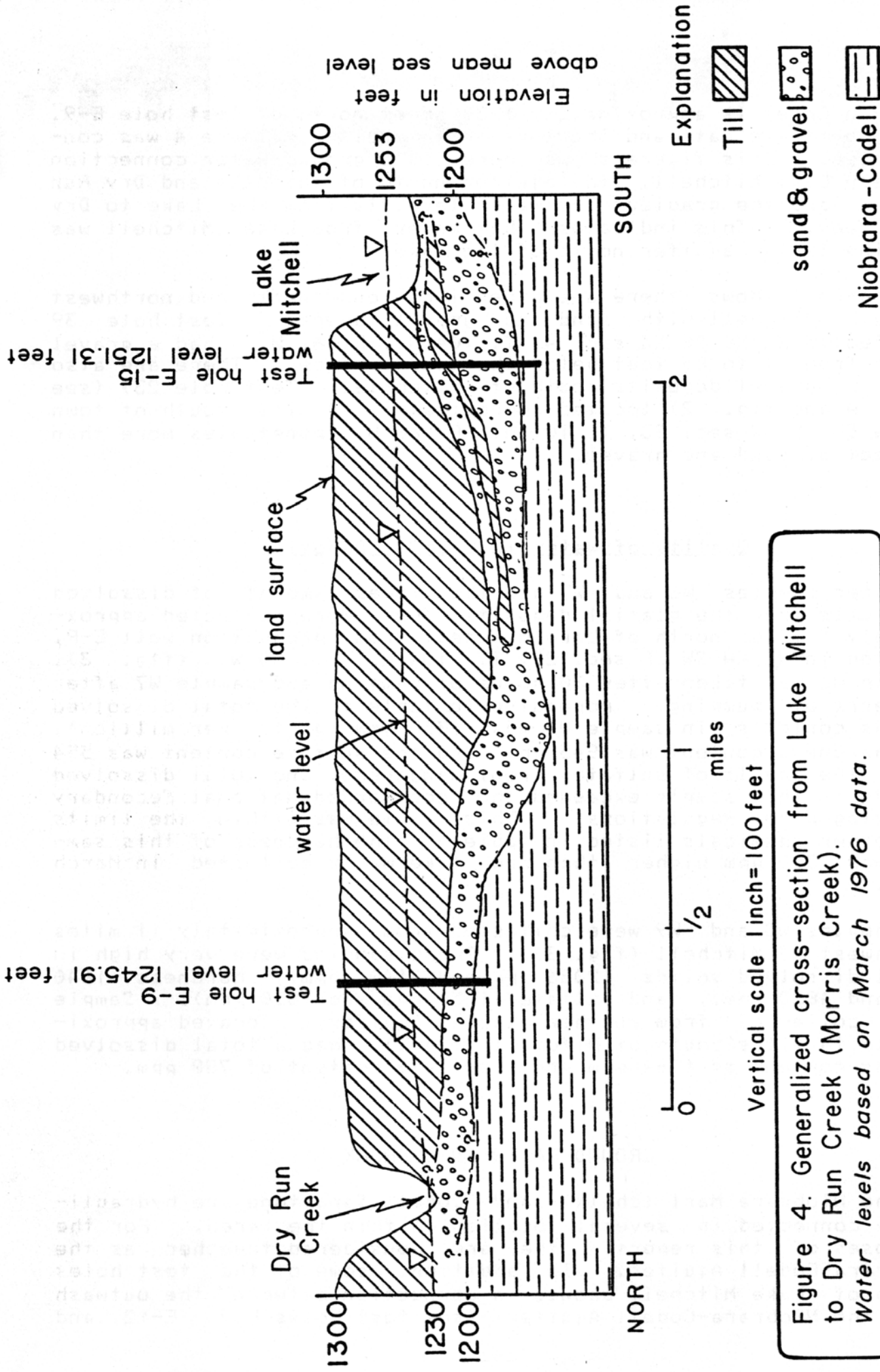


Figure 4. Generalized cross-section from Lake Mitchell to Dry Run Creek (Morris Creek). Water levels based on March 1976 data.

E-15, app. B). The thickness of the Niobrara-Codell Aquifer exceeds 120 feet in test hole 73 which is located in NW NW NW SW sec. 20, T. 104 N., R. 61 W, 4 miles west of Loomis (see fig. 1 and app. A). Test hole 178 (SE SE SE SE sec. 33, T. 102 N., R. 61 W.) located approximately 10 miles southwest of Mitchell had 151 feet of Niobrara-Codell Aquifer.

Water flows through solution cavities and fractures within the chalk. In the Codell Sandstone the extent of cementation and fractures govern the rate of flow. The size and number of fractures and solution cavities within the chalk, and the degree of cementation within the Codell Sandstone varies locally. Therefore, the thickness alone is not a good indicator of the potential yield of the Niobrara-Codell Aquifer. Approximately 12 miles southwest of Mitchell the fractures and solution cavities are well developed and there are some large capacity (irrigation) wells in the area.

A well northwest of Loomis penetrated 82 feet of Niobrara-Codell Aquifer in the SE SE SE SE sec. 14, T. 104 N., R. 61 W. The well was pumped at a rate of 100 gallons per minute for 2 hours to collect water samples (see test hole 7, Special Report No. 42). It should be noted that 100 gallons per minute was pumped by forced air and it does not mean the pumping capacity of the aquifer.

A test well (designated by test hole H-P in app. B and fig. 1) drilled for the City of Mitchell is located NE NW NW SE sec. 16, T. 103 N., R. 60 W. in Cadwell Park. This well was pumped at a rate of 100 gallons per minute with a drawdown of approximately 35 feet.

Test hole 103 (see fig. 1 and app. A) located in NW SW NW SW sec. 1, T. 103 N., R. 60 W. (approximately 50 feet from the James River) showed the presence of solution cavities and/or fractures at a depth of 35 feet. The drilling was halted because circulation was lost and could not be regained. A 2 1/2-inch casing was installed and the observation well was pumped 3 hours before collecting the water sample (W15, table 1). Judging from nearby test holes, the chalk is likely to be 80 to 90 feet thick in this location. Chalk which shows this great degree of fractures, with such thickness, and such proximity to the river is likely to be a good potential ground-water source.

The Dakota Formation yields water to wells in the area. There is not adequate data to determine the pumping capacity of this aquifer in town. However, data from the City Engineer's Office indicated that the City used to pump water from a 538-foot well. The City also constructed a 454-foot well in 1977, but pumping data are not available from this well.

## Quality of Water in Bedrock

The quality of water in the Niobrara-Codell Aquifer varies considerably at different locations. Water sample W13 in table 1 was collected from Codell Sandstone of the Niobrara-Codell Aquifer. This sample was collected from a test hole approximately 9 miles northwest of Mitchell at the location SE SE SE SE sec. 14, T. 104 N., R. 61 W. The total dissolved solids content in this sample was 1070 ppm, hardness content was 649 ppm, and the sulfate content was 472 ppm. Samples W17 and W18 were collected from the chalk layers of the Niobrara-Codell Aquifer located approximately 12 miles south of Mitchell. Sample W17 had 2550 ppm sulfate, 2868 ppm hardness, and 4296 ppm total dissolved solids and sample W18 had 1140 ppm sulfate, 827 ppm hardness, and 1884 ppm total dissolved solids. Sample W-14 was collected from an 8-inch diameter test well in Cadwell Park (see table 1, fig. 3, and test hole H-P, app. B). This sample had 765 ppm hardness and 620 ppm sulfate. Sample W15 was collected from a 35-foot observation well next to the James River (see fig. 3 and test hole 103, app. A). This sample had 560 ppm sulfate, 612 ppm hardness, and 1220 ppm total dissolved solids.

Water from the Dakota Formation is also high in dissolved chemicals content. Sample W19 (from old City Well 4) had 1721 ppm sulfate, 1825 ppm hardness, and 2220 ppm total dissolved solids. A report on the chemical quality of water from the new city well is not available. Apparently this well has never been used because of reported very high dissolved chemicals content.

## CONCLUSIONS AND RECOMMENDATIONS

The results of the present investigation support the conclusions of the previous study that there is not an aquifer (or aquifers) in the study area (fig. 1) capable of yielding satisfactory quality and quantity of water for a municipal water supply.

There are two general categories of water supply for the City of Mitchell: (1) Emergency or supplementary water supply and (2) Comprehensive water supply.

**Emergency or Supplementary Water Supply** - - Sand and gravel deposits are located north of Lake Mitchell. The thickness of these deposits varies through this locale and in some locations the thickness exceeds 50 feet (fig. 2). A pump test was conducted in the NE NW SW SE sec. 29, T. 104 N., R. 60 W. at a rate of 500 gallons per minute. Water samples collected from this well during the test are W6 and W7 in table 1. The water from this location is approximately 300 ppm higher in hardness and total dissolved solids than the water collected from Lake Mitchell in March 1977 (sample W3, table 1). Wells drilled in the area are expected to produce water of comparable quality and

quantity as that which was pumped during the test. The sand and gravel in this area is hydraulically connected to the Lake Mitchell. Extensive pumping in this area will most likely affect the lake level (fig. 4). However, some water could be pumped from this area after the lake is practically dry. This water will be coming from storage within the aquifer, however, during extended periods of drought the pumping capacity of this aquifer will decline due to limited extent of the aquifer.

The quality and quantity of water pumped from the Niobrara-Coddell Aquifer varies locally. A test well in Cadwell Park was pumped at a rate of 100 gallons per minute. The water from this well is designated by W14 in table 1. This sample has a hardness that is 220 ppm greater than sample W3 which was collected from Lake Mitchell. The rate of water flow in the bedrock is controlled by the number of fractures and solution cavities within the chalk and the amount of cementation within the sandstone. For this reason, it is difficult to accurately predict the rate of production from a well. However, in the vicinity of Mitchell, this aquifer is expected to produce approximately 100 gallons per minute and quality will be comparable to W13 and W14 in table 1.

A small observation well (test hole 103, app A) next to the James River was pumped for 3 hours before collecting sample W15. The total dissolved solids content in this sample was 1220 ppm, the hardness content was 612 ppm and the sulfate content was 560 ppm. This sample has a hardness that is 67 ppm higher than sample W3 which was collected from the Lake. Because of the close proximity of this location to the River, water could be induced from the River and it is likely to be a good producing area. However, if there is no flow in the River, the production of a well along the James River could be reduced.

Comprehensive Water Supply - - -The following are potential sources of water for the City of Mitchell. During this study these sources were not investigated, however, data collected from county studies in Sanborn and Hanson Counties and other sources show a potential for water development.

The Floyd Aquifer, located in northern Hanson County approximately 15 miles from the City, has a thickness greater than 60 feet. The average of eight water samples collected from this area are designated by W20 in table 1. The average total dissolved solids content was 1510 ppm, the average hardness content was 688 ppm and the average sulfate content was 773 ppm.

The Warren Aquifer is an extensive aquifer located approximately 25 miles north of Mitchell. The quality of the water varies in this aquifer. Generally the Warren Aquifer has a less total dissolved solids content than the Floyd Aquifer and it could be considered as another source of ground water for the

city. Additional testing is necessary in both of the above aquifers before the construction of permanent municipal wells.

Another possible source is the Missouri River. This source could provide water either directly from the River by pipeline or indirectly by augmenting the James River flow.

#### REFERENCES CITED

- Barari, Assad, 1966, Ground-water supply for the city of Mitchell: South Dakota Geol. Survey, Spec. Rept. no. 42, 45 p., 4 fig.
- South Dakota Department of Environmental Protection, 1976, South Dakota Public Water Supply Data.
- South Dakota Department of Environmental Protection, 1979, South Dakota Public Water Supply Data.
- United States Environmental Protection Agency "National Interim Primary Drinking Water Regulations", Federal Register, v. 40, no. 248, Dec. 24, 1975.
- United States Environmental Protection Agency "National Secondary Drinking Water Regulations", Federal Register, v. 44, no. 140, July 19, 1979.

## APPENDIX A

### Logs of test holes drilled in the Mitchell area (for map location, see fig. 1)

All numbers in parentheses following the test hole numbers signify Water Rights Observation wells.

The locations are given as quarter sections, section number, township, and range.

All elevations have been estimated using a 7 1/2 minute topographic base and are presented in feet above mean sea level.

Date Drilled: Letter after year designates source of data as follows:

- A, South Dakota Geological Survey, Auger
- B, South Dakota Geological Survey, Rotary Drill
- D, United States Geological Survey, Auger
- E, United States Geological Survey, Contract Rotary Drilling
- F, United States Bureau of Reclamation
- G, Commercial Well Driller

#### Test Hole 1

Location: NW NW NE NW sec. 29, T. 105 N., R. 59 W.

Elevation: 1303

Date Drilled: 1959, G

0-180	Unreported
180-230	Sand (Codell?)
230-380	Shale (Carlile Shale?)
380-400	Sand, hard; rock at 400 feet (Greenhorn Limestone?)
400-450	Shale (Graneros Shale?)
450-460	Sand, good (Dakota Group?)
460-470	Shale
470-478	Sand
478-503	Shale
503-510	Sand
510-540	Shale
540-580	Sand, good

Remarks: Flowed 20 gallons per minute

\* \* \* \*

#### Test Hole 2

Location: NE NW NW NW sec. 30, T. 105 N., R. 59 W.

Elevation: 1299

Date Drilled: 1958, G

Test Hole 2 -- continued.

0-115 Drift  
115-170 Sandstone (Codell Sandstone)  
170-230 Shale, sticky (Carlile Shale)  
230-310 Shale  
310-330 Shale, hard  
330-340 Sand; contains shells (Greenhorn Limestone)  
340-360 Sand, hard; contains shells  
360-384 Shale (Graneros Shale)  
384-416 Sand (Dakota Group?)

\* \* \* \*

Test Hole 3

Location: SW SW SE SE sec. 26, T. 105 N., R. 60 W.  
Elevation: 1225  
Date Drilled: 1960, D

0- 2 Soil  
2- 44 Alluvium(?); silt and fine sand; very easy drilling  
44- 51 Clay, light-gray; containing well-rounded pebbles  
51- 54 Rock (sandstone bands?) (Codell Sandstone)

\* \* \* \*

Test Hole 4

Location: NE SW NE NE sec. 28, T. 105 N., R. 60 W.  
Elevation: 1304  
Date Drilled: 1904, G

0-160 Till, yellow and blue  
160-190 Sandstone, water (Codell Sandstone)  
190-220 Shale(?), blue and grit (Carlile Shale)  
220-361 Shale(?), blue, without grit. Flow from 360 to 361 feet  
361-441 Shale(?), blue (Greenhorn Limestone)  
441-442 Sandstone; flow (Dakota Group)

\* \* \* \*

Test Hole 5

Location: SE SE SE SE sec. 25, T. 105 N., R. 61 W.  
Elevation: 1303  
Date Drilled: June 30, 1977, B

0- 2 Topsoil, dark-brown, silty  
2- 29 Clay, yellow, silty, pebbly (till)  
29- 34 Clay, yellow-gray, silty, pebbly (till)  
34- 60 Clay, gray, silty, pebbly, sandy in spots (till)  
60- 62 Sand, medium to coarse  
62- 98 Clay, gray, silty, sandy, pebbly (till)  
98-108 Clay, gray, pebbly, very sandy (till)  
108-112 Chalk, gray, pebbly (till)  
112-124 Clay, silty, sandy, pebbly, small gravel layers (till)



Test Hole 5 -- continued.

124-128 Gravel, fine to medium, some clay  
128-154 Chalk, light gray to white  
154-161 Sandstone, cemented, hard  
161-180 Sand, with interbedded shaley layers  
180-187 Shale, with sandy layers  
187-215 Shale

\* \* \* \* \*

Test Hole 6

Location: SE SE SE SE sec. 26, T. 105 N., R. 61 W.

Elevation: 1303

Date Drilled: 1960, D

0- 1 Soil  
1- 51 Till  
51- 53 Sand, silt, and clay  
53-113 Silt to medium sand; occasionally somewhat clayey;  
saturated  
113-117 Till, unoxidized

\* \* \* \* \*

Test Hole 7

Location: NE NE NE SE sec. 28, T. 105 N., R. 61 W.

Elevation: 1304

Date Drilled: June 30, 1977, B

0- 2 Topsoil, dark-brown, silty  
2- 19 Clay, yellow, silty, pebbly (till)  
19- 28 Clay, yellow-gray, silty, pebbly (till)  
28- 60 Clay, gray, silty, pebbly (till)  
60- 89 Gravel, fine to medium  
89-123 Clay, gray, silty, sandy, pebbly (till)  
123-145 Gravel, fine to medium, shaley, with gray clay layers  
145-191 Sand, gray, fine, with shale layers  
191-215 Shale

\* \* \* \* \*

Test Hole 8

Location: SW SE NE NE sec. 29, T. 105 N., R. 61 W.

Elevation: 1302

Date Drilled: 1904, G

0-409 Soft rock and shale  
409-418 Sandstone, slight flow of soft water  
418-500 Very hard rock; pyrite  
500-512 Sandstone(?); flow at 512 feet (Dakota Group)  
512-670 Caprock

Test Hole 8 -- continued.

670-683 Sandstone, soft; large flow at 683 feet

\* \* \* \*

Test Hole 9

Location: SW SW SW SW sec. 31, T. 105 N., R. 61 W.

Elevation: 1308

Date Drilled: 1961, B

0- 22 Till, buff, sandy clay  
22- 88 Till, gray, sandy clay  
88-100 Marl, light-gray (N7), silty, sandy, contains foraminifera; strongly calcareous; bentonitic (Niobrara Chalk)

\* \* \* \*

Test Hole 10

Location: SE SE SE SE sec. 32, T. 105 N., R. 61 W.

Elevation: 1308

Date Drilled: 1954, F

0- 35 Till, clayey silt, oxidized; contains thin layers of water-laid silt from 2 to 3 feet; concentration of salts from 3 to 5 feet; mostly unoxidized from 32 to 35 feet  
35- 99 Till, clay silt to silty clay, unoxidized; very sandy from 87 to 90 feet  
99-105 Chalkstone, gray to light-gray (Niobrara Chalk)

\* \* \* \*

Test Hole 11

Location: SW SE SW SW sec. 33, T. 105 N., R. 61 W.

Elevation: 1308

Date Drilled: June 6, 1979, B

0- 1 Topsoil, dark-gray, sandy  
1- 8 Clay, yellow, silty, sandy (till)  
8- 28 Clay, yellow, silty, pebbly (till)  
28- 31 Chalk, gray, silty, pebbly (till)  
31- 33 Sand, medium  
33- 71 Clay, gray, silty, pebbly, some sand (till)  
71- 75 Sand, fine to medium, clayey  
75- 87 Clay, gray, sandy, shaley (till)  
87- 89 Sand, medium  
89- 99 Clay, gray, silty, pebbly (till)  
99-143 Chalk, light-gray; compact  
143-177 Sandstone, gray, fine, interbedded with shale, sandy

Test Hole 11 -- continued.

177-185 Shale, gray

\* \* \*

Test Hole 12

Location: SW SW SW SE sec. 33, T. 105 N., R. 61 W.

Elevation: 1306

Date Drilled: July 15, 1977, B

0- 2 Topsoil, black, gravelly  
2- 22 Clay, yellow-brown, silty, pebbly (till)  
22- 69 Clay, gray, silty, pebbly, gravelly (till)  
69- 78 Gravel, lots of clay mixed in, some clean gravel  
stringers  
78- 81 Gravel  
81- 89 Gravel, lots of clay mixed in  
89- 92 Gravel  
92- 97 Gravel, lots of clay mixed in  
97-110 Clay, white (Niobrara Formation?)

\* \* \* \*

Test Hole 13

Location: SW NW NW NW sec. 35, T. 105 N., R. 61 W.

Elevation: 1305

Date Drilled: July 1, 1977, B

0- 4 Soil, light-brown, silty, sandy  
4- 12 Clay, brown, silty, pebbly, very sandy and loose  
(till)  
12- 18 Clay, brown, silty, sandy, pebbly (till)  
18- 29 Clay, gray, silty, pebbly, very sandy (till)  
29- 31 Sand, coarse, and gravel, fine  
31- 68 Clay, gray, silty, sandy, pebbly, fairly loose  
(till)  
68- 77 Sand, coarse, and gravel, fine  
77- 96 Sand, fine to medium  
96-121 Sand, coarse, and gravel, fine to medium, with thin  
layers of clay and silt  
121-136 Clay, gray, silty, sandy, pebbly  
136-139 Shale, medium gray, very silty and sandy  
139-185 Shale, medium gray, silty, sandy

\* \* \* \*

Test Hole 14

Location: SE SE NE SE sec. 36, T. 105 N., R. 61 W.

Elevation: 1312

Date Drilled: 1961, B

0- 23 Clay, buff, sandy and pebbly (till)  
23- 87 Clay, gray, sandy and pebbly (till)

Test Hole 14 -- continued.

87- 92 Gravel, medium  
92-110 Clay, gray, sandy (till)  
110-137 Clay, gray, very silty and sandy (till)  
137-160 Siltstone, medium-gray (N5) and very fine sandstone,  
medium-gray (N5); weakly calcareous; micaceous  
(Codell Sandstone)

\* \* \* \*

Test Hole 15

Location: NE NE NE NE sec. 31, T. 105 N., R. 60 W.

Elevation: 1302

Date Drilled: 1961, D

0- 10 Till, yellow-brown, sandy clay, oxidized  
10- 30 Till, brown, sandy clay, partially oxidized  
30- 40 Till, gray, sandy clay, unoxidized, saturated  
40- 50 Till, gray, very sandy (fine) clay, unoxidized  
50-140 Till, gray, sandy clay, unoxidized  
140-152 Shale, light- to dark-gray (Niobrara Formation)

\* \* \* \*

Test Hole 16

Location: SE SE SE SE sec. 31, T. 105 N., R. 60 W.

Elevation: 1301

Date Drilled: 1954, F

0- 31 Till, silty clay, oxidized, humified to 2 feet; con-  
centration of salts at 4 to 6 1/2 feet; partly un-  
oxidized from 28 to 31 feet  
31-126 Till, silty clay, unoxidized; sandy till from 37 to  
85 feet; water-laid sand from 42 to 43 feet; coal  
from 64 to 65 feet; water-laid silt from 82 to 85,  
105 to 106, 109 to 110, and 113 to 115 feet; thin  
oxidized zone at 61 feet; very pebbly from 121 to  
126 feet  
126-130 Sandstone, fine, cemented, contains marcasite (as  
cement?) (Codell Sandstone)  
130-135 Clay, light-gray to black, laminated with fine sand  
and silt

\* \* \* \*

Test Hole 17

Location: NE NE NE NE sec. 33, T. 105 N., R. 60 W.

Elevation: 1304

Date Drilled: 1961, E

0- 1 Soil  
1- 29 Till, yellow-brown, oxidized  
29- 40 Till, unoxidized; shale pebbles

Test Hole 17 -- continued.

40-133 Till, unoxidized; sand streaks  
133-137 Till, or clay; sand streaks  
137-140 Sandstone, dark yellowish-orange (10YR6/6) to moderate yellowish-brown (10YR5/4); quartzose cemented, somewhat calcareous; very fine to medium, sub-angular to rounded; abundant cavings include rounded shale pebbles, coal fragments and assorted rock fragments from fine to very coarse sand size (Codell Sandstone)

\* \* \* \*

Test Hole 18

Location: SW SW SE SE sec. 33, T. 105 N., R. 60 W.

Elevation: 1302

Date Drilled: June 24, 1977, B

0- 2 Soil, brown, silty, sandy  
2- 26 Clay, brown, silty, pebbly, quite sandy (till)  
26- 38 Clay, gray, silty, sandy, pebbly (till)  
38- 42 Sand, coarse, and gravel, fine to medium  
42- 45 Clay, gray, silty, sandy, pebbly (till)  
45- 49 Sand, coarse, and gravel, fine  
49- 52 Clay, gray, silty, sandy, pebbly  
52- 56 Sand, coarse, and gravel, fine to medium  
56- 93 Clay, gray, silty, sandy, pebbly (till)  
93-101 Clay, gray, silty, pebbly, very sandy (till)  
101-115 Shaley material, with silt and sand layers, some moderately cemented layers also  
115-138 Sandstone, yellow, well cemented  
138-155 Shale, medium gray, silty, sandy

\* \* \* \*

Test Hole 19

Location: NW NW NW sec. 35, T. 105 N., R. 60 W.

Elevation: 1305

Date Drilled: 1950, G

0-126 Unreported  
126-134 Sandstone, hard (Codell Sandstone)

\* \* \* \*

Test Hole 20

Location: SW SW SW SW sec. 35, T. 105 N., R. 60 W.

Elevation: 1298

Date Drilled: June 2, 1977, B

0- 1 Topsoil, dark-brown, silty  
1- 39 Clay, yellow, silty, pebbly (till)  
39- 56 Clay, gray and yellow, silty, pebbly (till)

Test Hole 20 -- continued.

56- 60 Gravel, coarse  
60- 62 Clay, gray, silty, pebbly (till)  
62- 81 Gravel, medium  
81-108 Clay, gray, silty, sandy, pebbly (till)  
108-111 Gravel, coarse  
111-134 Sandstone, gray, fine to medium, interbedded (Codell  
Sandstone)  
134-155 Shale, gray

\* \* \* \*

Test Hole 21

Location: SE NE SE SE sec. 35, T. 105 N., R. 60 W.

Elevation: 1215

Date Drilled: 1962, F

0- 10 Clay, dark-brown to black, soft, wet  
10- 20 Clay, dark-brown, soft, wet  
20- 33 Clay, gray, soft  
33- 39 Sand, grayish-brown, fine  
39- 45 Sand, and gravel, brown; large boulders 43 to 45  
feet

\* \* \* \*

Test Hole 22

Location: NW NW SE SE sec. 35, T. 105 N., R. 60 W.

Elevation: 1215

Date Drilled: 1962, F

0- 10 Clay, grayish-black, soft  
10- 20 Clay, blue-green; soft  
20- 30 Clay, gray, soft, sandy layers  
30- 44 Clay, gray, soft  
44- 60 Sand, fine, gray (valley fill?)

\* \* \* \*

Test Hole 23

Location: NE NE NW NE sec. 9, T. 104 N., R. 60 W.

Elevation: 1304

Date Drilled: June 14, 1977, B

0- 1 Topsoil, dark brown, silty  
1- 29 Clay, yellow, silty, pebbly (till)  
29- 32 Clay, gray-yellow, silty, pebbly (till)  
32- 66 Clay, gray, sandy, silty, pebbly (till)  
66- 82 Gravel, fine to medium, shaley  
82- 88 Gravel, coarse  
88-114 Clay, gray, sandy, silty, pebbly, with gravel  
stringers

Test Hole 23 -- continued.

114-120 Chalk, dark gray, with white specks  
120-155 Shale, dark gray

\* \* \* \*

Test Hole 24

Location: SE SW SW SW sec. 2, T. 104 N., R. 60 W  
Elevation: 1292  
Date Drilled: August 3, 1977, B

0- 2 Topsoil, black  
2- 4 Silt, black, clayey  
4- 9 Silt, dark brown to light gray, clayey  
9- 18 Clay, dark gray to black; numerous small mollosca shells  
18- 44 Clay, dark gray, silty  
44- 47 Gravel, dark reddish-brown; coarse  
47-100 Shale, dark gray, greasy; hard (Carlisle Shale)

\* \* \* \*

Test Hole 25 (DN-79A)

Location: SW SW SW SW sec. 4, T. 104 N., R. 62 W.  
Elevation: 1342  
Date Drilled: June 5, 1979

0- 1 Topsoil, brown, silty  
1- 21 Clay, yellow, silty, pebbly (till)  
21- 22 Gravel  
22- 39 Clay, yellow-brown, silty, pebbly (till)  
39-110 Clay, gray, silty, pebbly, sandy (till)  
110-120 Chalk, white

Observation well: 120 feet of plastic casing

\* \* \* \*

Test Hole 26

Location: NE NE NE NW sec. 5, T. 104 N., R. 60 W.  
Elevation: 1300  
Date Drilled: June 23, 1977, B

0- 1 Topsoil, brown, silty  
1- 23 Clay, yellow, silty, pebbly (till)  
23- 34 Clay, yellow, gray, silty, pebbly, some thin gravel layers (till)  
34-113 Clay, gray, silty, sandy, pebbly, some thin gravel layers (till)  
113-117 Gravel, fine to medium  
117-123 Clay, gray, sandy, silty (till)

Test Hole 26 -- continued.

123-155 Shale, dark gray

\* \* \* \*

Test Hole 27

Location: NE NW NW NW sec. 6, T. 104 N., R. 60 W.

Elevation: 1295

Date Drilled: June 16, 1977, B

0- 1 Topsoil, brown, silty  
1- 26 Clay, yellow, silty, pebbly (till)  
26- 30 Clay, yellow-gray, silty, pebbly (till)  
30- 35 Clay, gray, silty, pebbly (till)  
35- 39 Sand, coarse, and gravel, fine  
39- 48 Clay, gray, silty, very sandy (till)  
48- 49 Gravel, fine  
49- 80 Clay, gray, sandy, pebbly (till)  
80-102 Silt, gray, clayey, pebbly; soft (till)  
102-122 Clay, gray, silty, pebbly, gravelly in spots (till)  
122-140 Shale

\* \* \* \*

Test Hole 28

Location: NE NW NE NW sec. 1, T. 104 N., R. 61 W.

Elevation: 1298

Date Drilled: June 15, 1977, B

0- 1 Topsoil, brown, silty  
1- 30 Clay, yellow, silty, pebbly; soft (till)  
30- 31 Gravel, fine to medium  
31- 32 Clay, yellow, silty, pebbly (till)  
32- 42 Clay, gray, yellow, silty, pebbly (till)  
42- 90 Clay, gray, silty, pebbly (till)  
90- 95 Gravel, medium  
95- 96 Clay, gray, silty, pebbly (till)  
96- 98 Sand, medium  
98-102 Clay, gray, sandy; compact (till)  
102-108 Gravel and sand interbedded with gray, sandy clay  
108-114 Shale, silty, sandy  
114-122 Sand, gray, very fine, clayey  
122-155 Shale, light gray (Carlile Shale)

\* \* \* \*

Test Hole 29

Location: NW NW NE NE sec. 2, T. 104 N., R. 61 W.

Elevation: 1304

Date Drilled: July 14, 1977, B

0- 8 Clay, yellow, silty, pebbly (till)  
8- 10 Gravel



Test Hole 29 -- continued.

10- 18 Clay, yellow, silty, pebbly (till)  
18- 29 Clay, gray, silty (till)  
29- 32 Sand and gravel  
32- 66 Clay, gray, silty, pebbly  
66- 68 Sand and gravel  
68- 80 Clay, gray, silty, pebbly (till)

\* \* \* \*

Test Hole 30

Location: NW NW NW NE sec. 2, T. 104 N., R. 61 W.

Elevation: 1308

Date Drilled: June 15, 1977, B

0- 2 Sand, brown, silty  
2- 13 Clay, brown, silty, pebbly, sandy (till)  
13- 16 Clay, brown, silty, sandy (till?)  
16- 30 Clay, gray, silty, sandy, pebbly (till)  
30- 52 Sand, fine to coarse, and gravel, medium  
52-118 Clay, gray, silty, sandy, pebbly (till)  
118-140 Shale, gray, silty, sandy (Carlile Shale)

\* \* \* \*

Test Hole 31

Location: NE NE NW NW sec. 2, T. 104 N., R. 61 W.

Elevation: 1308

Date Drilled: July 14, 1977, B

0- 1 Topsoil, black  
1- 11 Clay, yellow-brown, pebbly (till)  
11- 40 Clay, gray, silty, pebbly (till)  
40- 41 Gravel  
41- 95 Clay, gray, gravelly (till)

\* \* \* \*

Test Hole 32

Location: SW NW NW NW sec. 2, T. 104 N., R. 61 W.

Elevation: 1309

Date Drilled: June 29, 1977, B

0- 1 Topsoil, brown, silty  
1- 17 Clay, yellow, silty, pebbly (till)  
17- 40 Clay, gray, silty, sandy, pebbly (till)  
40- 45 Gravel, fine to medium  
45- 98 Clay, gray, silty, pebbly, sandy (till)  
98-110 Gravel, medium to coarse, with clay layers  
110-120 Chalk, light gray  
120-130 Chalk, silty, with hard layers

Test Hole 32 -- continued.

130-140 Sand, interbedded with shale

\* \* \* \*

Test Hole 33

Location: SE SE SW SW sec. 2, T. 104 N., R. 61 W.

Elevation: 1300

Date Drilled: June 15, 1977, B

0- 1 Topsoil, brown, silty  
1- 3 Silt, yellow  
3- 15 Clay, yellow, silty, pebbly (till)  
15- 17 Gravel, fine to medium  
17- 25 Clay, yellow, silty, pebbly (till)  
25- 71 Clay, gray, silty, pebbly (till)  
71- 76 Gravel, medium  
76- 78 Clay, gray, pebbly, silty (till)  
78-137 Chalk, gray, very compact (Niobrara Formation)  
137-151 Chalk, dark gray  
151-162 Shale, gray, silty, sandy (Carlile Shale?)  
162-173 Sandstone, light brown, fine (Codell Sandstone)  
173-215 Shale, gray, silty (Carlile Shale)

\* \* \* \*

Test Hole 34

Location: NW NW NE NW sec. 3, T. 104 N., R. 61 W.

Elevation: 1301

Date Drilled: July 16, 1977, B

0- 3 Topsoil, brown, silty, sandy  
3- 26 Clay, brown, silty, pebbly, sandy (till)  
26- 41 Clay, gray, silty, sandy, pebbly (till)  
41- 65 Gravel, medium to coarse; hole collapsed, abandoned  
at 65 feet

Temporary Observation Well: 55 feet of 2-inch PVC casing

\* \* \* \*

Test Hole 35

Location: NW NW NW NW sec. 3, T. 104 N., R. 61 W.

Elevation: 1301

Date Drilled: July 28, 1978, B

0- 25 Clay, yellow-brown (till)  
25- 34 Clay, gray, silty, pebbly (till)  
34- 43 Sand and gravel, clayey  
43- 64 Clay, gray, silty, pebbly (till)  
64- 78 Sand and gravel, medium to coarse  
78-112 Clay, gray, silty, sandy (till)  
112-165 Chalk, light gray (Niobrara Formation)

Test Hole 35 -- continued.

165-210 Sandstone  
210-230 Shale

\* \* \* \* \*

Test Hole 36

Location: NW NE NE NE sec. 4, T. 104 N., R. 61 W.

Elevation: 1295

Date Drilled: July 14, 1977, B

0- 1 Topsoil, black  
1- 21 Clay, yellow-brown, silty, pebbly (till)  
21- 50 Clay, gray, silty, pebbly (till)  
50- 51 Gravel, medium to coarse  
51- 63 Clay, gray, silty, gravelly (till)  
63- 71 Gravel, medium to coarse  
71- 74 Clay, gray, pebbly (till)  
74- 75 Gravel  
75- 91 Clay, gray, gravelly (till)  
91- 95 Gravel, medium to coarse  
95-110 Chalk? (Niobrara Formation)

\* \* \* \* \*

Test Hole 37

Location: NE NW NW NE sec. 4, T. 104 N., R. 61 W.

Elevation: 1304

Date Drilled: July 15, 1977, B

0- 26 Clay  
26- 61 Clay, gray, pebbly (till)  
61- 66 Clay, gray, silty (till)  
66- 74 Sand, gray  
74- 81 Sand and gravel, fairly clean, some clay  
81- 87 Sand, medium, dirty  
87- 94 Clay, gray, silty, pebbly, some wood in samples  
(till)  
94-104 Clay, gray, silty, some chalk  
104-110 Clay, white (chalk)

\* \* \* \* \*

Test Hole 38

Location: NE NE SE NE sec. 4, T. 104 N., R. 61 W.

Elevation: 1295

Date Drilled: July 15, 1977, B

0- 2 Topsoil, black, gravelly  
2- 22 Clay, yellow-brown, silty, pebbly (till)  
22- 64 Clay, gray, silty, pebbly, gravel stringer from 29  
feet to 31 feet (till)  
64- 81 Sand and gravel, fine to medium

Test Hole 38 -- continued.

81- 93 Clay, gray, gravelly, with gravel stringers (till)  
93- 94 Clay, white (chalk?)  
94-102 Gravel, with some white clay mixed in  
102-135 Clay, white (chalk?); lost circulation at 135 feet

\* \* \* \*

Test Hole 39

Location: NE NE SE NE sec. 4, T. 104 N., R. 61 W.

Elevation: 1293

Date Drilled: July 18, 1977, B

0- 2 Clay, yellow (till)  
2- 5 Sand, medium to coarse  
5- 18 Clay, yellow, silty, pebbly (till)  
18- 64 Clay, gray, silty, pebbly, sandy (till)  
64- 85 Sand and gravel, medium to coarse, clayey

Observation well: 85 feet of 2-inch PVC casing

\* \* \* \*

Test Hole 40

Location: NW NW NW NE sec. 4, T. 104 N., R. 61 W.

Elevation: 1300

Date Drilled: June 15, 1977, B

0- 3 Topsoil, light brown, silty, sandy  
3- 27 Clay, brown, silty, sandy, pebbly (till)  
27- 66 Clay, gray, silty, sandy, pebbly (till)  
66- 97 Sand, coarse, and gravel, fine  
97-103 Clay, gray, silty, sandy, pebbly (till)  
103-140 Clay, light gray  
140-223 Sandstone, light brown, shaley (Codell Sandstone)  
223-245 Shale (Carlisle Shale?)

\* \* \* \*

Test Hole 41

Location: SE NE NE NE sec. 5, T. 104 N., R. 61 W.

Elevation: 1305

Date Drilled: July 14, 1977, B

0- 32 Clay, yellow, silty, pebbly, sandy (till)  
32- 40 Clay, gray, silty, pebbly (till)  
90- 95 Chalk (Niobrara Formation)

Temporary Observation Well: 82 feet of 2-inch PVC casing

\* \* \* \*

Test Hole 42

Location: SW SW NW NW sec. 5, T. 104 N., R. 61 W.

Elevation: 1299

Date Drilled: June 23, 1977, B

0- 1 Topsoil, brown, silty  
1- 14 Clay, yellow, silty, pebbly (till)  
14- 48 Clay, gray, silty, pebbly, sandy (till)  
48- 74 Clay, pebbly, very sandy (till)  
74- 76 Gravel, shale fragments  
76- 79 Clay, gray, silty, sandy (till)  
79-108 Chalk, light gray (Niobrara Formation)  
108-111 Shale, dark gray  
111-114 Sandstone  
114-141 Shale, silty  
141-192 Sandstone, interbedded with soft shale  
192-215 Shale, gray, compact

\* \* \* \*

Test Hole 43

Location: NW NW NW NW sec. 6, T. 104 N., R. 61 W.

Elevation: 1303

Date Drilled: July 31, 1978, B

0- 1 Topsoil, gray to black  
1- 13 Clay, brown, silty, sandy, pebbly (till)  
13- 19 Gravel, medium to coarse, poorly sorted, clayey  
19- 25 Clay, gray, silty, sandy, pebbly (till)  
25- 30 Gravel, medium to coarse, sandy  
30- 80 Clay, gray, silty, sandy, pebbly (till)  
80-108 Chalk, light gray, calcareous (Niobrara Formation)  
108-115 Chalk, gray-brown, calcareous  
115-145 Sandstone, fine, some loose sand  
145-182 Shale, gray, sandy  
182-200 Shale, gray

\* \* \* \*

Test Hole 44

Location: NW NW NW NE sec. 1, T. 104 N., R. 62 W.

Elevation: 1299

Date Drilled: June 23, 1977, B

0- 1 Topsoil, brown, silty  
1- 5 Clay, yellow, pebbly, silty (till)  
5- 26 Clay, tan-yellow, silty, pebbly (till)  
26- 44 Clay, gray, silty, pebbly (till)  
44- 80 Clay, gray, sandy, pebbly (till)  
80-107 Chalk, light gray to white (Niobrara Formation)  
107-117 Chalk, interbedded with shale  
117-127 Sandstone, gray; soft, interbedded with shale and  
compact sandstone layers

Test Hole 44 -- continued.

127-148 Shale, interbedded, with shaley sandstone  
148-170 Shale, dark gray, some compact layers

\* \* \* \*

Test Hole 45

Location: SW SW SW NE sec. 1, T. 104 N., R. 62 W.

Elevation: 1312

Date Drilled: June 23, 1977, B

0- 1 Topsoil, brown, silty  
1- 6 Clay, yellow, silty, pebbly, very soft (till)  
6- 15 Clay, yellow, silty, pebbly (till)  
15- 76 Clay, gray, silty, pebbly (till)  
76- 77 Gravel, medium  
77- 78 Clay, gray, sandy, silty (till)  
78- 79 Gravel, clayey  
79- 81 Chalk, light gray to white  
81- 86 Chalk, gray  
86-123 Chalk, light gray to white  
123-127 Sandstone, fine, shaley  
127-140 Shale, dark gray, sandy  
140-150 Sandstone, dark gray, soft, with interbedded shale  
150-156 Shale, sandy, with interbedded hard layers  
156-185 Shale, with interbedded harder layers

Remarks: Water flowed after drilling

\* \* \* \*

Test Hole 46

Location: NE NE SE NE sec. 7, T. 104 N., R. 61 W.

Elevation: 1303

Date Drilled: June 21, 1977, B

0- 3 Topsoil, dark brown, silty, sandy  
3- 9 Clay, brown, silty, pebbly, sandy (till)  
9- 16 Clay, brown, silty, sandy, pebbly; compact (till)  
16- 77 Clay, gray, silty, sandy, pebbly (till)  
77-112 Clay, light gray, chalky  
112-123 Shale, gray, silty, sandy  
123-204 Sand, fine, silty, with cemented and shale layers  
(Codell Sandstone)  
204-230 Shale, gray, silty, sandy

\* \* \* \*

Test Hole 47

Location: NW NW NW SW sec. 7, T. 104 N., R. 61 W.

Elevation: 1313

Date Drilled: June 23, 1977, B

Test Hole 47 -- continued.

0- 5 Topsoil, brown, sandy  
5- 29 Clay, brown, silty, sandy, pebbly (till)  
29- 56 Clay, gray, silty, pebbly, sandy (till)  
56- 57 Sand, medium to coarse, and gravel, fine  
57- 60 Clay, gray, silty, sandy, pebbly (till)  
60- 74 Shale, dark gray  
74- 89 Shale, medium gray, silty, chalky  
89-129 Clay, light gray  
129-167 Sandstone, silty, shaley  
167-185 Shale, gray, silty, sandy, some bentonite layers

\* \* \* \*

Test Hole 48

Location: NW NE NW NE sec. 9, T. 104 N., R. 61 W.

Elevation: 1300

Date Drilled: June 17, 1977, B

0- 1 Topsoil, brown, silty  
1- 18 Clay, yellow, silty, pebbly, rocky (till)  
18- 65 Clay, gray, silty, pebbly (till)  
65- 98 Chalk, light gray (Niobrara Formation)  
98-117 Chalk, gray, alternating hard and soft layers with  
shale beds  
117-124 Shale and chalk beds  
124-178 Sandstone, very fine, partially cemented, soft  
(Codell Sandstone)  
178-200 Shale

\* \* \* \*

Test Hole 49

Location: NE NE SE SE sec. 10, T. 104 N., R. 61 W.

Elevation: 1290

Date Drilled: June 20, 1977, B

0- 1 Topsoil, brown, silty  
1- 23 Clay, yellow, silty, pebbly (till)  
23- 26 Clay, gray, silty, pebbly (till)  
26- 42 Gravel, medium to coarse  
42- 47 Clay, gray, silty, pebbly (till)  
47- 49 Sand and gravel, shaley, fine  
49- 61 Clay, gray, silty, pebbly (till)  
61- 64 Gravel, fine to medium  
64- 88 Chalk, dark gray (Niobrara Formation)  
88-131 Chalk, light gray, stiff  
131-136 Silt, with chalk  
136-151 Shale, gray, sandy, silty  
151-167 Sandstone, light brown, fine, shaley  
167-172 Shale, sandy, with hard sandstone layers  
172-183 Sandstone, hard; well-cemented

Test Hole 49 -- continued.

183-200 Shale, gray, sandy, silty

\* \* \* \*

Test Hole 50

Location: NW NW NW NE sec. 12, T. 104 N., R. 61 W.

Elevation: 1295

Date Drilled: June 14, 1977, B

0- 3 Topsoil, brown, clayey, silty, sandy  
3- 17 Clay, brown, silty, pebbly, fairly sandy (till)  
17- 19 Sand, coarse, and gravel, fine  
19- 28 Clay, brown, silty, pebbly, very sandy (till)  
28- 36 Clay, gray, sandy, very gravelly (till)  
36- 38 Sand, coarse, and gravel, fine, quite silty  
38- 72 Clay, gray, silty, pebbly, very sandy (till)  
72- 83 Sand, coarse, and gravel, fine with some coarse  
83- 91 Clay, gray-white  
91- 93 Clay, gray, chalky, quite silty  
93- 98 Shale, gray, silty, sandy  
98-106 Chalk, gray-white, with silty layers  
106-112 Shale, with silt and sand stringers  
112-127 Sand, partially cemented  
127-140 Shale, gray, with sand stringers

\* \* \* \*

Test Hole 51

Location: SW SW SW NW sec. 12, T. 104 N., R. 61 W.

Elevation: 1298

Date Drilled: June 14, 1977, B

0- 2 Topsoil, light brown, silty, sandy  
2- 16 Clay, brown, silty, pebbly, very sandy (till)  
16- 17 Sand  
17- 24 Clay, yellow-brown, sandy, gravelly (till)  
24- 81 Clay, gray, sandy, gravelly (till)  
81-108 Chalk, gray; soft (Niobrara Formation)  
108-179 Chalk, light gray to white  
179-207 Sandstone, brown to gray, fine, compact and soft  
layers  
207-230 Shale, gray, with silty compact layers

\* \* \* \*

Test Hole 52

Location: NW NE NE NW sec. 7, T. 104 N., R. 60 W.

Elevation: 1295

Date Drilled: June 14, 1977, B

0- 2 Topsoil, brown, silty, some clay  
2- 33 Clay, brown, silty, sandy, pebbly (till)



Test Hole 52 -- continued.

33- 71 Clay, gray, silty, pebbly, very sandy (till)  
71- 76 Clay, silty, sandy, quite gravelly (till)  
76- 83 Clay, gray, silty, sandy, pebbly, interbedded with  
coarse sand and gravel (till)  
83- 96 Sand, coarse, and gravel, medium to coarse, very  
silty and clayey  
96-104 Sand, medium to coarse, and gravel, fine  
104-140 Shaley material, gray, silty, very sandy, possibly  
thinly interbedded sand

\* \* \* \*

Test Hole 53

Location: NE NE NE NW sec. 8, T. 104 N., R. 60 W.

Elevation: 1303

Date Drilled: June 14, 1977, B

0- 1 Topsoil  
1- 34 Clay, yellow, silty, pebbly, gravelly in spots;  
soft (till)  
34- 38 Clay, yellow-gray, silty, pebbly (till)  
38- 48 Clay, gray, silty, pebbly (till)  
48- 50 Sand, coarse, and gravel, fine  
50-108 Clay, gray, silty, pebbly, increasing sand content  
with depth; soft (till)  
108-111 Clay, shaley, pebbly; compact  
111-117 Gravel, fine  
117-140 Shale

\* \* \* \*

Test Hole 54

Location: SE SW SW SW sec. 8, T. 104 N., R. 60 W.

Elevation: 1310

Date Drilled: June 10, 1977, B

0- 2 Sand, brown, silty  
2- 9 Clay, brown, silty, pebbly, very sandy (till)  
9- 23 Clay, brown, silty, sandy, pebbly (till)  
23- 46 Clay, brown, silty, pebbly, very sandy (till)  
46- 47 Clay, gray, silty, sandy, pebbly (till)  
47- 48 Sand, coarse, and gravel, medium, clayey  
48- 50 Clay, gray, silty, sandy, pebbly (till)  
50- 58 Sand, coarse and gravel, fine to medium  
58- 61 Shale, gray, silty, sandy  
61-106 Gravel, with shale pebbles  
106-123 Chalk, light gray, interbedded with shale (Niobrara  
Formation)  
123-126 Sandstone, tan, interbedded with shale  
126-140 Sandstone, tan, cemented; compact and soft

Test Hole 54 -- continued.

140-170 Shale, dark gray, some concentrations

\* \* \* \*

Test Hole 55

Location: SE SW SE SE sec. 8, T. 104 N., R. 60 W.

Elevation: 1306

Date Drilled: June 13, 1977, B

0- 18 Clay, yellow-brown, pebbly (till)  
18- 39 Clay, gray, silty, sandy, pebbly (till)  
39- 40 Gravel, medium to coarse  
40- 67 Clay, gray, sandy, pebbly, with layers of sand and  
gravel  
67- 71 Gravel, coarse  
71- 77 Clay, gray, gravelly  
77- 78 Gravel, fine to medium  
78-106 Clay, gray, sandy, gravelly (till)  
106-123 Gravel?, much white chalk (lots of gravel in sam-  
ples, drills like gravel)  
123-155 Shale, sandy

\* \* \* \*

Test Hole 56

Location: NE NE NW NE sec. 9, T. 104 N., R. 60 W.

Elevation: 1304

Date Drilled: June 14, 1977, B

0- 1 Topsoil, dark brown, silty  
1- 29 Clay, yellow, silty, pebbly (till)  
29- 32 Clay, gray-yellow, silty, pebbly (till)  
32- 66 Clay, gray, sandy, silty, pebbly (till)  
66- 82 Gravel, fine to medium, shaley  
82- 88 Gravel, coarse  
88-114 Clay, gray, sandy, silty, pebbly, with gravel  
stringers  
114-120 Chalk, dark gray with white specks (Niobrara Forma-  
tion)  
120-155 Shale, dark gray

\* \* \* \*

Test Hole 57

Location: NE NW NW NW sec. 9, T. 104 N., R. 60 W.

Elevation: 1305

Date Drilled: June 14, 1977, B

0- 1 Topsoil, black, silty  
1- 14 Clay, yellow, silty, pebbly; soft (till)  
14- 18 Clay, yellow-gray, silty, pebbly, compact (till)  
18- 35 Clay, gray, silty, pebbly (till)

Test Hole 57 -- continued.

35- 40 Sand, or very sandy clay  
40- 73 Clay, gray, silty, pebbly, much organic matter  
(till)  
73- 78 Gravel, fine and sand, coarse  
78- 82 Clay, gray, sandy, pebbly; very soft (till)  
82- 85 Sand, medium  
85-101 Clay, gray, silty, very sandy, pebbly, with sand  
and gravel layers; soft (till)  
101-106 Sand, coarse and gravel, fine  
106-119 Clay, gray, pebbly, very sandy; compact (till)  
119-140 Shale, gray

\* \* \* \*

Test Hole 58

Location: SW SE SW SE sec. 15, T. 104 N., R. 60 W.

Elevation: 1220

Date Drilled: August 3, 1977, B

0- 2 Topsoil, black  
2- 8 Clay, light to red brown, silty  
8- 18 Silt and clay, dark gray to black, some shell frag-  
ments  
18- 24 Hard layer, concretion?, deep red brown (Carlile  
Shale)  
24- 30 Shale, black to dark gray, appears weathered, greasy  
30- 31 Hard layer, concretion:, deep red brown  
31-100 Shale, dark gray, appears weathered, greasy

\* \* \* \*

Test Hole 59

Location: NE NE NE NW sec. 16, T. 104 N., R. 60 W.

Elevation: 1301

Date Drilled: June 30, 1977, B

0- 4 Soil, brown, silty, sandy, clayey  
4- 9 Clay, brown, silty, pebbly, very sandy (till)  
9- 29 Clay, brown, silty, sandy, pebbly (till)  
29- 46 Clay, gray, silty, pebbly, sandy (till)  
46- 55 Sand, medium to coarse  
55- 76 Gravel, fine to medium  
76-109 Clay, silty, sandy, very gravelly  
109-114 Shale, medium gray, silty, with sandy layers  
114-140 Shale, medium gray, silty, with bentonite layers

\* \* \* \*

Test Hole 60

Location: NW NW NW SW sec. 16, T. 104 N., R. 61 W.

Elevation: 1308

Date Drilled: June 14, 1977, B

Test Hole 60 -- continued.

0- 1 Topsoil, silty  
1- 23 Clay, yellow, silty, pebbly; soft  
23- 25 Gravel, fine  
25- 39 Clay, yellow, hard, silty, pebbly (till)  
39- 41 Sand, fine to medium  
41- 44 Clay, yellow, silty, pebbly; compact (till)  
44- 46 Gravel, fine and sand, coarse  
46- 63 Clay, gray, silty, pebbly; compact  
63- 88 Gravel, fine and sand, coarse, shaley, coarser with  
increasing depth  
88-100 Clay, gray, sandy, pebbly  
100-119 Chalk, light and dark gray (Niobrara Formation)  
119-127 Sandstone, gray; soft  
127-131 Sandstone, very compact layers  
131-148 Shale, with softer, sandy shale layers  
148-155 Shale, compact

\* \* \* \*

Test Hole 61

Location: SW SE SW SW sec. 17, T. 104 N., R. 60 W.  
Elevation: 1276  
Date Drilled: May 15, 1979, A

0- 12 Clay, brown, sandy; well-sorted (till)  
12- 18 Marl, gray; very moist  
18- 22 Marl, gray; saturated  
22- 23 Clay, dark blue; moist  
23- 28 Sand, dark brown, medium, some pebbles; well-sorted

\* \* \* \*

Test Hole 62

Location: SE SE SW SW sec. 17, T. 104 N., R. 60 W.  
Elevation: 1279  
Date Drilled: June 9, 1977, B

0- 2 Topsoil, dark brown  
2- 4 Clay, brown, silty, sandy, pebbly (till)  
4- 8 Gravel  
8- 12 Clay, brown, silty, sandy, pebbly (till)  
12- 61 Clay, gray, silty, sandy, pebbly (till)  
61- 67 Sand, fine to medium, very woody  
67- 98 Chalk, gray, silty (Niobrara Formation)  
98-104 Chalk, gray, slightly sandy; lost circulation at  
104 feet, abandoned hole

\* \* \* \*

Test Hole 63

Location: SE SE SE SW sec. 17, T. 104 N., R. 60 W.

Elevation: 1300

Date Drilled: June 9, 1977, B

0- 2 Soil, brown, silty, sandy, clayey  
2- 11 Clay, brown, silty, pebbly, very sandy (till)  
11- 26 Clay, brown, silty, sandy, pebbly (till)  
26- 43 Clay, gray, silty, sandy, pebbly (till)  
43- 58 Sand, medium to coarse, and gravel, medium to coarse  
58- 73 Clay, gray, silty, sandy, gravelly, quite sandy (till)  
73- 77 Clay, gray, silty, sandy, pebbly, some shale pebbles (till)  
77- 86 Clay, gray-white  
86-126 Clay, gray-white, sandy, pebbly (Niobrara Formation)  
126-128 Sandstone  
128-143 Chalk, light gray, hard, interbedded with shale  
143-153 Sandstone, gray, fine; soft  
153-166 Sandstone, yellow changing to gray at about 160 feet, fine; very compact, cemented  
166-185 Shale, gray; soft

\* \* \* \*

Test Hole 64

Location: SE SE SE NE sec. 18, T. 104 N., R. 60 W.

Elevation: 1307

Date Drilled: September 13, 1979, B

0- 2 Topsoil, black  
2- 17 Clay, tan, sandy, pebbly (till)  
17- 38 Clay, light gray, silty, with red-brown streaks  
38- 82 Clay, gray, sandy, pebbly (till)  
82- 91 Sand, medium to coarse  
91- 97 Gravel, medium  
97-101 Sand, slightly clayey  
101-125 Chalk, white to light gray; calcareous (Niobrara Formation)

\* \* \* \*

Test Hole 65

Location: NW NE NW NW sec. 18, T. 104 N., R. 60 W.

Elevation: 1302

Date Drilled: June 10, 1977, B

0- 1 Topsoil  
1- 39 Clay, yellow, silty, pebbly (till)  
39- 47 Clay, gray, silty, pebbly (till)  
47- 49 Gravel, fine  
49- 85 Clay, gray, silty, pebbly (till)  
85- 95 Gravel, fine to medium

Test Hole 65 -- continued.

95-126 Chalk, light gray to white (Niobrara Formation)  
126-153 Chalk, interbedded light and dark gray zones  
153-168 Sand, cemented  
168-172 Sandstone, yellow; cemented, compact  
172-183 Sandstone, softer, interbedded with very compact  
cemented sandstone  
183-200 Shale, dark gray

\* \* \* \*

Test Hole 66

Location: SE SE SW SW sec. 13, T. 104 N., R. 61 W.

Elevation: 1300

Date Drilled: June 7, 1977, B

0- 1 Topsoil, brown, sandy  
1- 6 Clay, yellow, very sandy (till)  
6- 8 Sand, fine  
8- 10 Clay, yellow, silty, sandy (till)  
10- 16 Sand, fine  
16- 29 Clay, yellow, silty, pebbly (till)  
29- 63 Clay, gray, silty, pebbly (till)  
63- 75 Sandstone, fine, interbedded with shale (Codell  
Sandstone)  
75- 76 Sandstone, yellow, fine, very compact

\* \* \* \*

Test Hole 67

Location: SE SE SE SE sec. 13, T. 104 N., R. 61 W.

Elevation: 1290

Date Drilled: June 8, 1977, B

0- 2 Topsoil, yellow, silty, sandy  
2- 21 Clay, brown, silty, sandy, pebbly (till)  
21- 25 Sand, coarse, gravelly, fine  
25- 34 Clay, yellow, silty, pebbly (till)  
34- 47 Clay, gray, silty, pebbly (till)  
47- 64 Clay, light gray, chalky  
64- 82 Chalk, shaley, interbedded with shale (Niobrara  
Formation)  
82-109 Sandstone, gray, very fine  
109-125 Shale, gray, soft

\* \* \* \*

Test Hole 68

Location: NW NW NE NE sec. 14, T. 104 N., R. 61 W.

Elevation: 1280

Date Drilled: June 13, 1977, B

0- 1 Topsoil, dark brown, sandy

Test Hole 68 -- continued.

1- 4 Sand, very fine, silty  
4- 17 Clay, yellow, silty, pebbly (till)  
17- 24 Gravel, fine, sandy  
24- 41 Clay, gray, silty, pebbly (till)  
41- 45 Shale, silty, chalky  
45- 52 Chalk, dark gray, shaley with white specks  
52- 70 Chalk, light gray  
70-109 Chalk, light gray, interbedded with compact gray  
chalk  
109-143 Chalk, gray, with white specks, interbedded hard and  
soft layers  
143-165 Sandstone, soft, interbedded shale layer  
165-175 Shale, dark gray, soft  
175-200 Shale, dark gray, compact

\* \* \* \*

Test Hole 69

Location: NW NW NW NW sec. 15, T. 104 N., R. 61 W.

Elevation: 1301

Date Drilled: June 18, 1977, B.

0- 3 Topsoil, light brown, silty, sandy  
3- 14 Clay, brown, silty, pebbly, very sandy (till)  
14- 31 Clay, brown, silty, sandy, pebbly (till)  
31- 37 Clay, gray-brown, silty, sandy, pebbly; quite com-  
pact (till)  
37- 56 Clay, gray, silty, sandy, pebbly (till)  
56- 61 Sand, coarse, gravel, fine  
61- 67 Shale  
67- 69 Clay, silty, sandy, pebbly  
69- 75 Chalk, loss of circulation, abandoned hole at 75  
feet (Niobrara Formation)

\* \* \* \*

Test Hole 70

Location: SW SW SW SW sec. 13, T. 104 N., R. 62 W.

Elevation: 1327

Date Drilled: June 6, 1979, B

0- 1 Topsoil, dark gray, silty  
1- 3 Clay, light gray, silty  
3- 13 Clay, yellow, silty, pebbly (till)  
13- 15 Gravel, fine  
15- 17 Clay, yellow, silty, pebbly (till)  
17- 31 Clay, gray, silty, pebbly (till)  
31- 33 Chalk, light gray-white (Niobrara Formation)  
33- 36 Chalk, gray  
36- 41 Sand, dark gray, sandy  
41- 96 Shale, dark gray, sandy  
96-104 Sandstone (Codell Sandstone)

Test Hole 70 -- continued.

104-120 Sandstone with shale layers, sandy  
120-137 Shale, dark gray (Carlile Shale)  
137-140 Shale, gray, silty; soft

\* \* \* \*

Test Hole 71

Location: NW NW NE NW sec. 14, T. 104 N., R. 62 W.

Elevation: 1326

Date Drilled: June 23, 1977, B

0- 3 Soil, yellow, clayey, silty, sandy  
3- 12 Clay, brown, silty, pebbly, very sandy (till)  
12- 16 Sand, coarse, and gravel, medium to fine  
16- 26 Clay, brown, silty, sandy, pebbly (till)  
26- 45 Clay, gray, silty, sandy, pebbly (till)  
45- 58 Sand, coarse, gravel, medium to fine  
58- 65 Shale, dark gray, abandoned hole at 65 feet due to  
gravel caving in

\* \* \* \*

Test Hole 72

Location: NE NE NE NE sec. 24, T. 104 N., R. 62 W.

Elevation: 1327

Date Drilled: July 27, 1978, B

0- 1 Topsoil, brown, silty  
1- 19 Clay, yellow-brown, silty, pebbly (till)  
19- 26 Clay, gray, silty, pebbly (till)  
26- 28 Gravel, medium, oxidized  
28- 34 Clay, gray, silty, pebbly (till)  
34-137 Chalk, light gray, some calcareous shale (Niobrara  
Formation)  
137-230 Shale, gray and dark gray, very sandy at 171 feet to  
218 feet

\* \* \* \*

Test Hole 73

Location: NW NW NW SW sec. 20, T. 104 N., R. 61 W.

Elevation: 1330

Date Drilled: June 22, 1977, B

0- 1 Topsoil, dark brown, silty  
1- 26 Clay, yellow, silty, pebbly, some gravel layers  
(till)  
26- 33 Clay, yellow-gray, silty, pebbly (till)  
33- 41 Clay, gray, silty, pebbly (till)  
41- 96 Chalk, gray turning darker and finer with depth  
(Niobrara Formation)  
96-106 Chalk, lighter gray



Test Hole 73 -- continued.

106-153 Chalk, light gray to white  
153-167 Sand, dark gray, very fine; cemented (Codell Sandstone)  
167-174 Shale, gray  
174-195 Shale, sandy, with compact sandstone layers  
195- Sandstone, yellow-orange, very hard, could not drill through it

\* \* \* \*

Test Hole 74

Location: NW NE NW NE sec. 21, T. 104 N., R. 61 W.

Elevation: 1307

Date Drilled: July 28, 1978, B

0- 38 Clay, yellow-brown, with thin sand layers (till)  
38- 41 Clay, gray, silty, pebbly (till)  
41- 78 Chalk, light gray (Niobrara Formation)  
78- 81 Chalk, gray  
81-121 Sandstone  
121-133 Shale, gray, sandy  
133-140 Shale, gray

\* \* \* \*

Test Hole 75

Location: NW NW NW NE sec. 21, T. 104 N., R. 61 W.

Elevation: 1312

Date Drilled: June 22, 1977, B

0- 1 Topsoil, brown, silty  
1- 24 Clay, yellow, silty, pebbly, some gravel layers (till)  
24- 37 Clay, gray, silty, pebbly (till)  
37- 78 Chalk, light gray (Niobrara Formation)  
78- 79 Sandstone, white; very hard  
79- 93 Sandstone, gray, some shale; soft  
93- 96 Shale, dark gray; soft  
96-120 Sandstone, dark gray, with interbedded shale  
120- Sandstone, yellow; very hard, could not drill through it

\* \* \* \*

Test Hole 76

Location: SE NE NE NE sec. 22, T. 104 N., R. 61 W.

Elevation: 1300

Date Drilled: June 7, 1977, B

0- 3 Topsoil, yellow, clayey, silty, sandy  
3- 21 Clay, brown, silty, sandy, pebbly (till)  
21- 26 Sand, coarse, gravel, fine

Test Hole 76 -- continued.

26- 28 Clay, brown, silty, sandy, quite gravelly (till)  
28- 32 Clay, gray, silty, sandy (till)  
32- 39 Gravel, medium to coarse  
39- 41 Clay, gray, chalky  
41- 76 Clay, light blue  
76- 82 Clay, gray, chalky  
82- 90 Clay, gray, chalky, some pebbles, coarse sand, some  
organic  
90- 98 Shale, chalky  
98-104 Clay, chalky, silty, sandy, pebbly  
104-119 Shale, sandy, pebbly, interbedded with thin layers  
of fine to medium sand, hard cemented zone at  
116 feet (Carlile Shale)  
119-134 Sandstone, fine, pebbly; cemented, very hard

\* \* \* \*

Test Hole 77

Location: NE NW NW NE sec. 23, T. 104 N., R. 61 W.

Elevation: 1299

Date Drilled: June 7, 1977, B

0- 1 Topsoil, brown, silty  
1- 18 Clay, yellow, silty, pebbly (till)  
18- 19 Gravel, fine to medium  
19- 22 Clay, yellow, silty, pebbly (till)  
22- 39 Shale, dark gray, sandy  
39- 41 Gravel, coarse  
41- 47 Silt, gray  
47-107 Chalk, white, clayey, silty (Niobrara Formation)  
107-111 Shale, very sandy  
111-127 Sandstone, fine to medium, interbedded with gray  
shale  
127-130 Sandstone, yellow, very fine; too hard to drill  
through

\* \* \* \*

Test Hole 78

Location: SW SW SW NW sec. 24, T. 104 N., R. 61 W.

Elevation: 1304

Date Drilled: June 7, 1977, B

0- 2 Topsoil, dark brown  
2- 5 Sand, brown, coarse, silty  
5- 17 Clay, brown, silty, sandy, pebbly (till)  
17- 27 Clay, gray, silty, sandy, pebbly (till)  
27- 38 Clay, gray, silty, pebbly, very sandy (till)  
38- 43 Sand, medium to coarse, clayey, silty  
43- 51 Clay, gray, fairly chalky; soft  
51- 56 Chalk, gray-white, interbedded with darker and more  
clayey material (Niobrara Formation)

Test Hole 78 -- continued.

56- 58 Chalk, gray, sandy, pebbly  
58- 63 Sand, brown, pebbly; cemented, interbedded with less  
cemented sand  
63- 72 Sand, brown-gray, medium to fine, some small peb-  
bles, cemented, interbedded with thin layers of  
hard, well-sorted sand  
72- Quartzite(?)

\* \* \* \*

Test Hole 79

Location: NE NE NE SE sec. 24, T. 104 N., R. 61 W.

Elevation: 1295

Date Drilled: June 9, 1977, B

0- 1 Topsoil, black, sandy  
1- 11 Sand, fine  
11- 14 Clay, yellow, very sandy, very pebbly (till)  
14- 53 Clay, gray, silty, pebbly (till)  
53- 62 Sandstone, light brown, fine (Codell Sandstone)  
62- 64 Sandstone; cemented  
64- 75 Sandstone, soft, interbedded with hard cemented  
layers  
75- 95 Shale, dark gray

\* \* \* \*

Test Hole 80

Location: SE SW SW SE sec. 24, T. 104 N., R. 61 W.

Elevation: 1305

Date Drilled: June 2, 1977, B

0- 15 Clay, yellow-brown, sandy, silty (till)  
15- 25 Clay, gray, silty, sandy, pebbly, some gravel  
stringers (till)  
25- 47 Clay, gray, sandy, gravelly (till)  
47- 84 Sandstone, brown; well cemented, very compact  
(Codell Sandstone)  
84-117 Shale, gray, bentonite at 105 feet  
117- Quartzite

\* \* \* \*

Test Hole 81

Location: NW NW NW NE sec. 19, T. 104 N., R. 60 W.

Elevation: 1245

Date Drilled: June 8, 1977, B

0- 1 Topsoil, black  
1- 2 Clay, silty  
2- 9 Sand, fine to coarse  
9- 12 Silt, dark gray

Test Hole 81 -- continued.

12- 23 Clay, gray, silty, pebbly (till)  
23- 34 Gravel, fine to medium  
34- 59 Chalk, light gray, silty, some interbedded shale;  
compact (Niobrara Formation)  
59- 77 Sandstone, gray, some interbedded shale; compact  
77- 91 Shale, light gray, some bentonite  
91-118 Sandstone, interbedded with thin layers of shaley  
material, some pebbles, some layers of highly  
cemented sandstone  
118-126 Shale, gray, silty  
126-155 Shale, gray, silty, sandy, some bentonite, grades  
into more pure gray shale

Remarks: Water flowed after drilling

\* \* \* \* \*

Test Hole 82

Location: SW SW SE SE sec. 19, T. 104 N., R. 60 W.

Elevation: 1293

Date Drilled: June 1, 1977, B

0- 9 Sand, medium to fine  
9- 10 Gravel, fine  
10- 21 Clay, gray, silty, pebbly (till)  
21- 26 Sand  
26- 67 Clay, gray, sandy, pebbly; rock at 34 feet (till)  
67- 71 Gravel, fine to medium  
71- 84 Chalk, light gray to white (Niobrara Formation)  
84- 85 Gravel(?), concretion(?)  
85- 91 Sandstone, brown, cemented  
91-111 Sandstone, brown, less cemented  
111- Rock, hard, quartzite cuttings

\* \* \* \* \*

Test Hole 83

Location: SW SW SW SW sec. 20, T. 104 N., R. 60 W.

Elevation: 1287

Date Drilled: June 28, 1978, A

0- 1 Topsoil  
1- 12 Clay, yellow-brown, sandy; moist  
12- 17 Clay, brown, sandy; moist  
17- 35 Sand, gray, medium to fine, clayey; saturated  
35- 38 Silt, black; dry

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Test Hole 84

Location: SW NW NW SW sec. 21, T. 104 N., R. 60 W.

Elevation: 1240

Date Drilled: June 13, 1977, B

0- 1 Topsoil, brown  
1- 4 Silt, dark brown  
4- 17 Gravel, medium, with clay layers  
17- 64 Chalk, light gray (Niobrara Formation)  
64- 89 Shale, gray, some sand and silt  
89- 90 Clay, light gray, chalky  
90- 93 Sandstone, fine to medium, well-sorted, partially  
cemented, interbedded with silts and shales  
93- 99 Sandstone, light brown  
99-103 Sandstone, yellow, partially cemented, silty  
103-120 Sandstone, brown, fine, cemented, interbedded with  
thin gray shale layers  
120-140 Shale, gray

Remarks: Water flowed after drilling

\* \* \* \*

Test Hole 85

Location: NE NE NE SE sec. 21, T. 104 N., R. 60 W.

Elevation: 1297

Date Drilled: June 27, 1977, B

0- 2 Topsoil, dark brown  
2- 41 Clay, yellow, silty, pebbly (till)  
41- 49 Clay, yellow, silty, pebbly, very compact (till)  
49- 56 Clay, gray, silty, sandy, pebbly (till)  
56- 61 Sand, medium to coarse  
61- 63 Clay, gray, silty, pebbly (till)  
63- 70 Gravel, fine to medium  
70- 76 Clay, gray, sandy, pebbly (till)  
76-102 Chalk, light gray (Niobrara Formation)  
102-107 Siltstone, gray, chalky, with interbedded sand  
(Codell Sandstone)  
107-110 Sandstone, yellow, with cemented layers  
110-116 Shale, gray, silty, with layers of sand  
116-140 Shale, gray, silty, sandy

\* \* \* \*

Test Hole 86

Location: NW NW NW NW sec. 19, T. 104 N., R. 59 W.

Elevation: 1297

Date Drilled: August 10, 1978, B

0- 1 Topsoil, black  
1- 25 Clay, yellow, silty, pebbly (till)  
25- 88 Clay, gray, silty, pebbly (till)  
88- 92 Gravel, fine

Test Hole 86 -- continued.

92-106 Clay, gray, very sandy (till)  
106-109 Gravel, fine  
109-121 Clay, gray, silty, pebbly (till)  
121-188 Shale, gray (Pierre Shale)  
188-194 Sandstone, brown to tan; very compact  
194-195 Quartzite

\* \* \* \* \*

Test Hole 87

Location: SW SW SE NE sec. 28, T. 104 N., R. 60 W.  
Elevation: 1280  
Date Drilled: June 28, 1977, B

0- 2 Topsoil, dark brown, silty  
2- 33 Clay, yellow, silty, pebbly (till)  
33- 39 Clay, gray, silty, sandy, pebbly (till)  
39- 58 Sand, coarse, and gravel, fine to medium  
58- 60 Clay, gray, silty, pebbly (till)  
60- 63 Gravel, medium to coarse  
63- 65 Clay, gray, very gravelly  
65- 85 Chalk, light gray, loss of circulation (Niobrara  
Formation)

\* \* \* \* \*

Test Hole 88

Location: SE SE NE NW sec. 28, T. 104 N., R. 60 W.  
Elevation: 1280  
Date Drilled: June 28, 1977, B

0- 1 Topsoil, light brown, silty  
1- 2 Silt, tan  
2- 17 Clay, yellow, silty, pebbly (till)  
17- 24 Clay, gray, silty, pebbly (till)  
24- 26 Sand, medium  
26- 52 Clay, gray, silty, pebbly (till)  
52- 67 Sand, gray, fine to medium  
67- 84 Gravel, fine to medium, and sand, coarse  
84-118 Shale, gray, and light gray (Niobrara Formation)  
118-133 Shale, gray, with silt and sand layers  
133-155 Shale, gray, silty

\* \* \* \* \*

Test Hole 89 (Observation Well DN-67A)

Location: SE SW SW SE sec. 29, T. 104 N., R. 60 W.  
Elevation: 1295.91  
Date Drilled: June 8, 1967, G

0- 3 Topsoil  
3- 4 Sand

Test Hole 89 -- continued.

4- 9 Gray clay  
9- 19 Yellow clay  
19- 74 Blue clay  
74- 79 Chalk and blue clay  
79-103 Blue clay and white clay  
103-108 Gray and white clay mixed  
108-112 Gray clay  
112-117 Coarse sand  
117-122 Interbedded blue clay and gravel  
122-125 Gravel  
125-133 Blue clay  
133-140 Gravel and interbedded clay  
140- Rock, bottom of the hole

NOTE: Took water from 122 feet

\* \* \* \* \*

Test Hole 90

Location: NW SW SW NW sec. 30, T. 104 N., R. 60 W.

Elevation: 1301

Date Drilled: June 8, 1977, B

0- 1 Topsoil, black, silty  
1- 9 Clay, yellow, silty (till)  
9- 23 Clay, gray, silty, pebbly (till)  
23- 26 Sand, fine to medium  
26- 46 Clay, very sandy, pebbly (till)  
46- 48 Sand, fine  
48- 67 Chalk, light gray (Niobrara Formation)  
67-108 Sandstone, gray, fine, hard layers, shale layers at  
76 feet to 78 feet  
108-125 Shale, dark gray

\* \* \* \* \*

Test Hole 91

Location: SE SW SE SW sec. 30, T. 104 N., R. 60 W.

Elevation: 1300

Date Drilled: June 10, 1977, B

0- 11 Sand, brown, medium, well-sorted  
11- 48 Clay, gray, silty, pebbly, sandy (till)  
48- 76 Clay, light gray  
76- 79 Clay, light gray, chalky, silty, sandy, pebbly  
79-104 Shale, gray, silty, sandy  
104-127 Sandstone, partially cemented, shaley (Codell Sand-  
stone)  
127-134 Shale, gray, silty (Carlile Shale)  
134- Quartzite? (Sioux Quartzite)

\* \* \* \* \*

Test Hole 92

Location: NW NE NE NE sec. 26, T. 104 N., R. 61 W.

Elevation: 1307

Date Drilled: June 3, 1977, B

0- 11 Sand, brown, medium to coarse  
11- 43 Clay, gray, sandy, pebbly (till)  
43- 49 Gravel, medium to coarse  
49- 75 Sandstone, brown, well cemented; compact (Codell  
Sandstone)  
75- 92 Sandstone, brown, less cemented  
92-104 Shale, gray

\* \* \* \*

Test Hole 93

Location: NE NW NW NE sec. 26, T. 104 N., R. 61 W.

Elevation: 1312

Date Drilled: June 6, 1977, B

0- 1 Topsoil, dark brown  
1- 37 Clay, brown, silty, sandy, pebbly (till)  
37- 42 Sand, brown, silty, pebbly  
42- 43 Siltstone, red  
43- Quartzite

\* \* \* \*

Test Hole 94

Location: NW NW NW NW sec. 26, T. 104 N., R. 61 W.

Elevation: 1311

Date Drilled: June 6, 1977, B

0- 3 Topsoil, dark brown, silty, sandy  
3- 8 Sand, brown, fine, very silty  
8- 25 Clay, brown, silty, sandy, pebbly (till)  
25- 30 Sand, coarse, gravel, fine, orange-brown; partially  
cemented  
30- 47 Clay, gray, silty, sandy, pebbly (till)  
47- Boulder, abandoned hole at 47 feet

\* \* \* \*

Test Hole 95

Location: NE NE NE NE sec. 27, T. 104 N., R. 62 W.

Elevation: 1349

Date Drilled: June 5, 1979, B

0- 1 Topsoil, black  
1- 26 Clay, yellow-brown, silty, pebbly (till)  
26- 38 Clay, gray, silty, pebbly (till)  
38- 46 Sandstone, brown; some black sandstone; hard  
46- 55 Sandstone, brown; chunks of black sandstone  
55- 63 Sand, black



Test Hole 95 -- continued.

63-135 Shale, black; interbedded sand lenses  
135-140 Shale, dark gray

\* \* \* \*

Test Hole 96

Location: SE SE SE SE sec. 33, T. 104 N., R. 61 W.

Elevation: 1318

Date Drilled: July 27, 1978, B

0- 1 Topsoil, brown, sandy  
1- 4 Sand, fine, oxidized  
4- 14 Clay, yellow, silty, pebbly (till)  
14- 33 Chalk, light gray (Niobrara Formation)  
33- 37 Chalk, gray, shaley  
37- 46 Chalk, light gray  
46- 50 Shale, brown and gray; compact  
50- 55 Sandstone, brown and gray  
55- 87 Sandstone, brown; very compact  
87-125 Shale, gray

\* \* \* \*

Test Hole 97

Location: SW NW SW SW sec. 31, T. 104 N., R. 60 W.

Elevation: 1285

Date Drilled: May 16, 1979, A

0- 3 Sand, dark brown, medium, pebbly, well-sorted; dry  
3- 6 Gravel, light brown, sandy  
6- 23 Chalk, white and yellow, calcareous; moist

\* \* \* \*

Test Hole 98

Location: SW SE SE SW sec. 34, T. 104 N., R. 60 W.

Elevation: 1270

Date Drilled: May 15, 1979, A

0- 12 Sand, brown, silty, well-sorted  
12- 23 Clay, gray, sandy, pebbly, non-calcareous (till)

\* \* \* \*

Test Hole 99

Location: SW SE SE SE sec. 35, T. 104 N., R. 60 W.

Elevation: 1220

Date Drilled: August 3, 1977, B

0- 75 Silt, brown, clayey  
75- 77 Silt, dark brown, gravelly, sandy; compact  
77- 84 Gravel, medium, subrounded

Test Hole 99 -- continued.

84- 95 Clay, shaley, chalky

\* \* \* \*

Test Hole 100

Location: SW NE NW SW sec. 36, T. 104 N., R. 60 W.

Elevation: 1210

Date Drilled: August 3, 1977, B

0- 2 Topsoil, black; dry  
2- 7 Sand, fine to medium, clayey, silty  
7- 12 Clay, brown, silty, sandy  
12- 18 Chalk, weathered (Niobrara Formation)  
18- 25 Chalk, gray

\* \* \* \*

Test Hole 101

Location: NW NE SW SW sec. 36, T. 104 N., R. 60 W.

Elevation: 1223

Date Drilled: May 15, 1979, A

0- 2 Topsoil, dark brown, silty, sandy  
2- 15 Clay, brown and yellow-brown, silty, sandy; saturated (Niobrara Formation)  
15- 23 Clay, dark gray, very compact; moist (Niobrara Formation)

\* \* \* \*

Test Hole 102

Location: NE NW NW NW sec. 6, T. 103 N., R. 59 W.

Elevation: 1294

Date Drilled: July 31, 1978, B

0- 1 Topsoil, black  
1- 18 Clay, light brown (till)  
18- 30 Clay, gray (till)  
30- 36 Sand, gray, fine to medium, subrounded  
36- 45 Clay, gray (till)  
45- 47 Gravel, medium to coarse, subangular  
47- 49 Clay, gray, pebbly (till)  
49- 53 Sand, gray, fine to medium, subrounded to subangular  
53- 92 Clay, gray (till); gray silt from 53 feet to 54 feet  
92-102 Sandstone, white to brownish-white; hard, cemented (Codell Sandstone)  
102-147 Shale, gray; hard, greasy  
147-149 Sandstone; hard, well-cemented  
149-222 Shale, gray; hard, greasy (Carlile Shale)  
222-223 Quartzite; extremely hard

\* \* \* \*

Test Hole 103

Location: NW SW NW SW sec. 1, T. 103 N., R. 60 W.

Elevation: 1292

Date Drilled: August 5, 1977, B

- 0- 4 Silt, brown, sandy, clayey
- 4- 11 Chalk, light brown, appears weathered (Niobrara Formation)
- 11- 22 Chalk, gray; compact
- 22- 35 Chalk, brown, compact; lost circulation at 35 feet

Temporary Observation Well: 50 feet from James River; 35 feet of 2-inch PVC casing

\* \* \* \*

Test Hole 104

Location: SE SW SW SW sec. 1, T. 103 N., R. 60 W.

Elevation: 1218

Date Drilled: August 5, 1977, B

- 0- 2 Alluvium, silty, sandy
- 2- 12 Chalk, light brown, appears weathered; compact (Niobrara Formation)
- 12- 39 Chalk, gray; compact
- 39- 83 Chalk, dark gray; compact
- 83- 95 Shale, black; greasy

\* \* \* \*

Test Hole 105

Location: NW NW NW NE sec. 2, T. 103 N., R. 60 W.

Elevation: 1225

Date Drilled: June 28, 1977, B

- 0- 3 Topsoil, brown, silty, sandy
- 3- 5 Clay, brown, silty, sandy
- 5- 12 Chalk, yellow (Niobrara Formation)
- 12- 14 Shale, gray, interbedded with yellow chalk
- 14- 17 Shale, gray, chalky; compact
- 17- 35 Shale, gray

\* \* \* \*

Test Hole 106

Location: NE NE SW SW sec. 2, T. 103 N., R. 60 W.

Elevation: 1290

Date Drilled: June 28, 1977, B

- 0- 2 Topsoil, light brown
- 2- 18 Clay, yellow, silty, pebbly (till)
- 18- 48 Clay, gray, silty, pebbly (till)
- 48- 52 Gravel, very coarse
- 52- 78 Clay, gray, silty, sandy, pebbly (till)

Test Hole 106 -- continued.

78- 87 Gravel, fine to medium  
87- 90 Gravel, medium to coarse  
90- 95 Chalk, light gray to white (Niobrara Formation)

\* \* \* \*

Test Hole 107

Location: NE NE SE NW sec. 3, T. 103 N., R. 60 W.

Elevation: 1289

Date Drilled: June 29, 1977, B

0- 11 Sand, brown, fine to medium  
11- 22 Clay, gray, silty, pebbly, very sandy (till)  
22- 58 Clay, gray, silty, sandy, pebbly (till)  
58-111 Clay, light gray  
111-118 Shale, medium gray, silty, interbedded with chalky  
clay  
118-142 Shale, gray, silty, sandy, chalky in places, some  
bentonite  
142-147 Shale, sand lenses  
147-170 Sand, fine to medium  
170-200 Shale, contains silty hard layers

\* \* \* \*

Test Hole 108

Location: NW NW NW NW sec. 6, T. 103 N., R. 60 W.

Elevation: 1310

Date Drilled: August 2, 1978, B

0- 2 Topsoil, brown, sandy  
2- 26 Clay, brown, silty, sandy, pebbly (till)  
26- 42 Clay, gray, silty, sandy, pebbly (till)  
42- 63 Chalk, light gray, highly calcareous; appears to be  
a sandstone lens from 45 to 46 feet; chalk is  
very brittle from 46 to 63 feet (Niobrara Forma-  
tion)  
63-118 Sandstone, and sand, well-sorted; well-cemented be-  
low 103 feet  
118-140 Shale, gray

\* \* \* \*

Test Hole 109

Location: SE SW SE SW sec. 4, T. 103 N., R. 61 W.

Elevation: 1326

Date Drilled: June 8, 1978, A

0- 1 Topsoil, black, silty, sandy; dry  
1- 6 Sand, yellow-brown, clayey; moist  
6- 11 Silt, brown, sandy, pebbly; moist  
11- 21 Chalk, gray; moist (Niobrara Formation)

Test Hole 109 -- continued.

21- 25 Chalk, light gray, sandy; saturated, very compact

\* \* \* \*

Test Hole 110

Location: SE SE SE SE sec. 4, T. 103 N., R. 61 W.

Elevation: 1341

Date Drilled: June 8, 1979, A

0- 16 Silt, yellow-brown, clayey, pebbly; moist (till)

16- 25 Chalk, gray; moist (Niobrara Formation)

\* \* \* \*

Test Hole 111

Location: NE NE NE NE sec. 5, T. 103 N., R. 61 W.

Elevation: 1333

Date Drilled: June 28, 1978, A

0- 2 Topsoil

2- 20 Clay, yellow-brown, sandy; moist

20- 23 Clay, gray-brown; moist

23- 25 Chalk, gray; moist, compact

\* \* \* \*

Test Hole 112

Location: NW NW NW NW sec. 6, T. 103 N., R. 61 W.

Elevation: 1342

Date Drilled: July 26, 1978, B

0- 1 Topsoil, dark gray, sandy

1- 20 Gravel, medium

20- 42 Chalk, light gray

42- 47 Sandstone, dark gray, chalky

47- 53 Sandstone, brown, hard

53- 79 Shale, gray, very sandy

79- 95 Sandstone, yellow, very hard

95-125 Shale, gray

\* \* \* \*

Test Hole 113

Location: NW NW NW SW sec. 7, T. 103 N., R. 61 W.

Elevation: 1353

Date Drilled: May 17, 1979, A

0- 1 Topsoil, black, sandy

1- 5 Gravel, brown, coarse; dry

5- 20 Chalk, yellow-tan, clayey; very moist, saturated at  
6 feet (Niobrara Formation)

Test Hole 113 -- continued.

20- 23 Chalk, light blue, clayey; saturated, slightly calcareous

\* \* \* \*

Test Hole 114

Location: NW NW NW NW sec. 12, T. 103 N., R. 61 W.

Elevation: 1320

Date Drilled: June 6, 1979, B

0- 1 Topsoil, black  
1- 18 Clay, yellow-brown, silty, pebbly, rock at 18 feet  
18- 27 Chalk, white  
27- 48 Chalk, grayish-brown, silty  
48- 99 Sandstone, alternating compact and soft layers  
99-110 Shale, light gray; compact, greasy

Observation well: 100 feet of 2-inch PVC casing

\* \* \* \*

Test Hole 115

Location: NE NE NE NE sec. 11, T. 103 N., R. 60 W.

Elevation: 1227

Date Drilled: August 3, 1977, B

0- 2 Topsoil  
2- 3 Sand, fine, rounded  
3- 18 Silt, brown, some fine sand, light to dark brown  
18- 25 Silt, light brown, clayey, very compact  
25- 60 Silt, light gray, clayey, very compact  
60- 85 Silt, gray to greenish, clayey, very compact

\* \* \* \*

Test Hole 116

Location: SE NW SW NE sec. 12, T. 103 N., R. 60 W.

Elevation: 1205

Date Drilled: August 5, 1977, B

0- 2 Topsoil, brown  
2- 13 Silt, black, very clayey  
13- 34 Silt, dark green to black, sandy, fine, subrounded to rounded, very clayey, abundant shell fragments  
34- 42 Silt, gray-white, chalky, clayey, sandy, fine, subrounded  
42- 54 Chalk, yellow-white to brown, compact (Niobrara Formation)  
54- 75 Silt, black, very compact  
75-100 Silt, gray-white, chalky, clayey

\* \* \* \*

Test Hole 117

Location: NE NE NW NE sec. 13, T. 103 N., R. 60 W.

Elevation: 1212

Date Drilled: August 5, 1977, B

0- 2 Topsoil, black  
2- 14 Silt, black, clayey  
14- 22 Silt, black to dark brown, clayey, some shell fragments  
22- 29 Silt, greenish-black, clayey, some shell fragments  
29- 33 Silt, gray-white to cream color, chalky  
33- 37 Chalk, gray-white to yellowish-cream color; compact (Niobrara Formation)  
37- 55 Chalk, gray-white; compact  
55- 75 Silt, black, clayey; compact  
75-100 Silt, gray-white, chalky; compact

\* \* \* \*

Test Hole 118

Location: SE SE NE SE sec. 13, T. 103 N., R. 60 W.

Elevation: 1212

Date Drilled: August 2, 1977, B

0- 1 Topsoil  
1- 4 Sand, brown to blackish-brown, fine to medium, rounded  
4- 8 Clay, dark brown  
8- 18 Silt interbedded with fine to medium sand, brownish-black; sulfate odor on samples, very clayey, some chalk and small shells  
18- 55 Clay, gray, silty, some chalk and a few small shells, some intermittent layers of light green clay  
55- 64 Clay, light green to gray, silty, some very fine sand  
64- 75 Gravel, red-brown, predominantly chalk pebbles, fine to medium, subrounded to subangular  
75- 83 Chalk, white to light gray; dry, compact (Niobrara Formation)  
83-100 Clay, light gray, very compact, chalky and shaley

Temporary Observation Well: 77 feet of 2-inch PVC casing

\* \* \* \*

Test Hole 119

Location: SE SE SE NE sec. 13, T. 103 N., R. 61 W.

Elevation: 1329

Date Drilled: June 9, 1978, A

0- 3 Topsoil  
3- 4 Clay, brown-yellow; calcareous  
4- 6 Sand, red-brown, medium to fine; saturated, clean  
6- 10 Sand, brown, coarse to medium; saturated, clean

Test Hole 119 -- continued.

10- 15 Sand, brown, medium, pebbly; saturated, clean  
15- 20 Sand, gray, silty  
20- 33 Chalk?; difficult drilling (Niobrara Formation)

\* \* \* \*

Test Hole 120

Location: SE SW SW SE sec. 13, T. 103 N., R. 61 W.

Elevation: 1315

Date Drilled: May 22, 1979, A

0- 6 Gravel, brown, medium, sandy; moist  
6- 8 Clay, brown, sandy; moist  
8- 13 Silt, gray, sandy, calcareous; moist (Niobrara Formation)

\* \* \* \*

Test Hole 121

Location: SE SE SE SE sec. 13, T. 103 N., R. 61 W.

Elevation: 1307

Date Drilled: August 1, 1978, B

0- 1 Topsoil, black  
1- 14 Clay, yellowish-brown (till)  
14- 18 Clay, gray, silty, pebbly (till)  
18- 26 Sand, medium to coarse (reworked Codell?)  
26-125 Shale, gray, some bentonite at 70 feet; plastic non-calcareous

\* \* \* \*

Test Hole 122

Location: NE NW NE NW sec. 15, T. 103 N., R. 61 W.

Elevation: 1321

Date Drilled: June 8, 1978, A

0- 3 Silt, gray to brown, organic; moist (topsoil)  
3- 9 Sand, brown, medium; moist  
9- 13 Silt, gray; dry  
13- 26 Sand, gray, fine; saturated, compact (Codell Sandstone)

\* \* \* \*

Test Hole 123

Location: NE SE NE SE sec. 15, T. 103 N., R. 61 W.

Elevation: 1330

Date Drilled: May 22, 1979, A

0- 12 Chalk, white, clayey; moist, saturated at 5 feet  
12- 14 Chalk, light brown



Test Hole 123 -- continued.

14- 20 Clay, blue; saturated (shale)  
20- 23 Clay, brown; saturated (shale)

\* \* \* \*

Test Hole 124

Location: NW NW NW NW sec. 16, T. 103 N., R. 61 W.

Elevation: 1350

Date Drilled: June 7, 1979, B

0- 1 Topsoil, gray  
1- 7 Clay, yellow, sandy  
7- 13 Clay, yellow, silty, pebbles (till)  
13- 15 Chalk, yellow, oxidized  
15- 26 Chalk, gray; stiff  
26- 50 Chalk, light gray to white  
50- 52 Sandstone, pink (quartzose?)  
52- 55 Shale, gray, sandy  
55- 56 Sandstone, black, medium  
56- 69 Shale, gray, sandy, interbedded with sandstone  
69- 89 Sandstone, brown to gray; compact  
89- 93 Shale, gray, sandy  
93-100 Shale, gray

\* \* \* \*

Test Hole 125

Location: SW SW SW SW sec. 18, T. 103 N., R. 61 W.

Elevation: 1382

Date Drilled: July 26, 1978, B

0- 1 Topsoil, dark gray, silty  
1- 24 Clay, tan  
24- 41 Chalk, dark gray, shaley (Niobrara Formation)  
41- 55 Chalk, light gray  
55- 97 Chalk, white, shaley; compact  
97-102 Chalk, light gray to gray, sandy  
102-112 Sandstone, gray, chalky, compact  
112-114 Shale, dark gray  
114-144 Sandstone, brownish-gray, shaley in places  
144-170 Shale, dark gray; some compact zones

\* \* \* \*

Test Hole 126

Location: NE SE NE SE sec. 24, T. 103 N., r. 62 W.

Elevation: 1368

Date Drilled: May 23, 1979, A

0- 1 Topsoil, brown; dry  
1- 6 Clay, light brown, chalky; moist (till)  
6- 17 Chalk, yellow-brown; moist, saturated at 8 feet

Test Hole 126 -- continued.

- 17- 20 Clay, dark brown, calcareous; saturated (Niobrara Formation)
- 20- 23 Clay, black, very calcareous; saturated

\* \* \* \*

Test Hole 127

Location: SE SW SE SE sec. 19, T. 103 N., R. 61 W.

Elevation: 1361

Date Drilled: May 23, 1979, B

- 0- 1 Topsoil, black, sandy; moist
- 1- 18 Clay, orangish-brown; sandy; moist (till)
- 18- 20 Chalk, orangish-brown, very saturated (Niobrara Formation)
- 20- 23 Clay, gray; saturated, very sticky

\* \* \* \*

Test Hole 128

Location: NW NW NW SW sec. 20, T. 103 N., R. 61 W.

Elevation: 1357

Date Drilled: May 23, 1979, A

- 0- 4 Topsoil, black
- 4- 9 Clay, yellowish-brown, chalky; moist (till)
- 9- 15 Gravel, brown, medium, sandy; saturated
- 15- 18 Chalk (Niobrara Formation)

\* \* \* \*

Test Hole 129

Location: SE SE NE NE sec. 21, T. 103 N., R. 61 W.

Elevation: 1344

Date Drilled: May 24, 1979, A

- 0- 19 Clay, light brown, sandy; moist
- 19- 21 Chalk, white; saturated (Niobrara Formation)
- 21- 23 Clay, blue-gray; saturated

\* \* \* \*

Test Hole 130

Location: SW SW NW NW sec. 21, T. 103 N., R. 61 W.

Elevation: 1349

Date Drilled: May 23, 1979, A

- 0- 5 Topsoil, black; very moist
- 5- 7 Clay, gray, sandy; saturated (till)
- 7- 9 Clay, brown to yellow, chalky; saturated (till)
- 9- 12 Chalk, yellow, clayey; saturated (Niobrara Formation)

Test Hole 130 -- continued.

12- 23 Clay, blue-gray; saturated

\* \* \* \*

Test Hole 131

Location: SW SW SW NW sec. 21, T. 103 N., R. 61 W.

Elevation: 1345

Date Drilled: May 23, 1979, A

0- 1 Topsoil, black  
1- 10 Clay, light brown, silty, pebbly; moist (till)  
10- 16 Chalk, orangish-brown; saturated (Niobrara Formation)  
16- 20 Clay, gray; moist to saturated  
20- 23 Clay, light gray; saturated

\* \* \* \*

Test Hole 132

Location: SE NE NE NE sec. 22, T. 103 N., R. 61 W.

Elevation: 1336

Date Drilled: May 22, 1979, A

0- 1 Sand, brown, slightly pebbly; moist  
1- 11 Clay, brown, pebbly; moist  
11- 14 Sand, light brown, fine, slightly pebbly; moist  
14- 17 Sand, dark brown, fine, slightly pebbly; very moist  
17- 20 Chalk, white; moist (Niobrara Formation)  
20- 23 Chalk, light gray; moist

\* \* \* \*

Test Hole 133

Location: SE SE SE NE sec. 22, T. 103 N., R. 61 W.

Elevation: 1331

Date Drilled: May 22, 1979, A

0- 2 Gravel, brown, medium, sandy; moist  
2- 6 Clay, light brown; moist (till)  
6- 17 Clay, light brown, sandy; moist (till)  
17- 19 Chalk, tan, clayey; moist (Niobrara Formation)  
19- 21 Chalk, white, clayey; saturated  
21- 23 Shale

\* \* \* \*

Test Hole 134 (DN-67B)

Location: NE NE NE sec. 19, T. 103 N., R. 60 W.

Elevation: 1310

Date Drilled: June 13, 1967, G

Test Hole 134 -- continued.

0- 3 Topsoil  
3- 12 Clay, yellow  
12- 70 Clay, blue  
70-101 Sand, fine to medium; some hard sandstone

Observation well: 100 feet

\* \* \* \* \*

Test Hole 135

Location: NE NE NE NW sec. 19, T. 103 N., R. 60 W.

Elevation: 1302

Date Drilled: June 18, 1979, A

0- 3 Clay, light yellow-brown and gray, sandy, silty, pebbly, calcareous; moist (till)  
3- 5 Clay, light brown, sandy, silty, pebbly, calcareous (till)  
5- 10 Clay, dark brown, sandy, silty, pebbly, calcareous; moist (till)  
10- 23 Chalk, gray, very silty (Niobrara Formation)

\* \* \* \* \*

Test Hole 136

Location: NW NE NE NE sec. 25, T. 103 N., R. 60 W.

Elevation: 1215

Date Drilled: August 2, 1977, B

0- 3 Sand, fine to medium, round to subround  
3- 9 Silt, dark brown  
9- 10 Clay, brown, sandy, very silty (till)  
10- 30 Clay, gray, silty, sandy (till)  
30- 64 Clay, black; soft  
64- 65 Sand, coarse, subround and gravel, fine  
65- Hard layer - abandoned hole

\* \* \* \* \*

Test Hole 137

Location: SE NE NE SE sec. 25, T. 103 N., R. 60 W.

Elevation: 1213

Date Drilled: August 1, 1977, B

0- 13 Fill  
13- 17 Clay, brown, sandy (till)  
17- 82 Clay, gray, sandy (till)  
82- Sandstone, yellow; hard

\* \* \* \* \*

Test Hole 138

Location: SE SE SE SE sec. 36, T. 103 N., R. 62 W.

Elevation: 1424

Date Drilled: July 25, 1978, B

0- 27 Clay, yellow, silty, sandy, pebbly (till)  
27- 34 Clay, gray, silty, sandy, pebbly (till)  
34-104 Chalk, brown, dark gray-brown from 55 to 95 feet,  
very silty, black fragments; calcareous (Niobrara  
Formation)  
104-133 Chalk, very light gray, shaley from 120 to 130 feet;  
calcareous  
133-152 Chalk, gray-brown, very silty, several 1 foot thick  
shale beds; calcareous  
152-172 Sandstone, reddish-brown, fine, moderate to well  
cemented, thinly bedded; very compact  
172-200 Shale, gray; compact

\* \* \* \*

Test Hole 139

Location: SE SE SE SE sec. 33, T. 103 N., R. 61 W.

Elevation: 1389

Date Drilled: July 25, 1978, B

0- 27 Clay, yellow, silty, sandy, pebbly (till)  
27- 39 Clay, gray, silty, sandy, pebbly (till)  
39- 72 Chalk, dark grayish-brown, very silty, shaley layers;  
calcareous (Niobrara Formation)  
72- 79 Chalk, white, blocky; calcareous  
79-109 Chalk, light gray to gray, very silty, shaley  
109-122 Siltstone, dark reddish-brown, sandy, chalky, several  
122-146 Sandstone, reddish-brown, fine, silty, thin bedded  
with dark brown to black shale; compact, hard and  
well cemented  
146-185 Shale, gray-brown, a few thin sandstone layers from  
146 to 150; compact

\* \* \* \*

Test Hole 140

Location: SW SW SW SW sec. 31, T. 103 N., R. 60 W.

Elevation: 1346

Date Drilled: July 25, 1978, B

0- 21 Clay, yellow, silty, sandy, pebbly (till)  
21- 25 Gravel, coarse, sandy, poorly sorted, numerous chalk  
fragments  
25- 48 Chalk, dark gray to gray-brown, very calcareous,  
very silty, a few thin shale layers  
48- 72 Sandstone, reddish-brown, silty, well-cemented to  
poorly cemented; several thin black shale layers

Test Hole 140 -- continued.

72- 95 Shale, gray; hard, greasy

\* \* \* \*

Test Hole 141

Location: SE SE SE SE sec. 31, T. 103 N., R. 60 W.

Elevation: 1326

Date Drilled: July 9, 1979, B

0- 1 Topsoil  
1- 8 Gravel, coarse, some shale pebbles; some clayey till  
8- 14 Clay, brown, pebbly (till)  
14- 16 Clay, gray, pebbly (till)  
16- 37 Gravel, medium; (shale pebbles), clayey at 22 feet  
to 37 feet  
37- 59 Sand, fine; gravelly  
59- 60 Hard layer (Codell Sandstone)  
60- 66 Sand, gray, fine to medium  
66- 76 Sandstone, hard (Codell Sandstone)  
76-220 Shale, gray, silty  
220- Quartzite? - no penetration

Observation well: 80 feet of 2-inch PVC casing

\* \* \* \*

Test Hole 142

Location: SW SW SW SW sec. 34, T. 103 N., R. 60 W.

Elevation: 1318

Date Drilled: July 25, 1978, B

0- 22 Sand, gray, fine to medium, silty  
22- 24 Clay, dark gray, silty, sandy, pebbly (till)  
24- 41 Chalk, dark gray, very silty, calcareous; some thin  
shale beds from 25 feet to 30 feet  
41- 67 Sandstone, fine; uncemented to 45 feet, well cemented  
from 45 feet to 67 feet  
67- 95 Shale, dark gray; greasy

\* \* \* \*

Test Hole 143

Location: SE SE SE NE sec. 1, T. 102 N., R. 60 W.

Elevation: 1339

Date Drilled: July 26, 1978, B

0- 1 Topsoil, black  
1- 31 Clay, yellow-brown, silty, sandy, pebbly (till)  
31- 48 Clay, gray, silty, pebbly (till)  
48- 64 Sand, fine to medium, much coal  
64- 96 Clay, gray, very sandy, pebbly (till)

Test Hole 143 -- continued.

96-140 Shale, dark gray, greasy

\* \* \* \*

Test Hole 144

Location: NE NW NE NW sec. 3, T. 102 N., R. 60 W.

Elevation: 1316

Date Drilled: May 29, 1979, A

0- 1 Clay, blue, moist  
1- 4 Gravel, brown, medium to coarse, sandy; moist  
4- 13 Clay, gray; moist (till)

\* \* \* \*

Test Hole 145

Location: NW NW NE NW sec. 3, T. 102 N., R. 60 W.

Elevation: 1317

Date Drilled: June 12, 1978, A

0- 2 Silt, brown, sandy; dry (topsoil)  
2- 20 Sand, brown, medium; moist, saturated at 6 feet  
20- 28 Silt, gray, sandy; dry, saturated at 22 feet

\* \* \* \*

Test Hole 146

Location: SW SW SW SW sec. 18, T. 102 N., R. 59 W.

Elevation: 1323

Date Drilled: July 24, 1978, B

0- 1 Topsoil  
1- 6 Sand, medium  
6- 30 Clay, yellow-brown, silty, pebbly (till)  
30- 55 Clay, gray, silty, pebbly (till)  
55- 64 Sand, medium to coarse  
64- 66 Clay, gray, silty, pebbly (till)  
66- 73 Gravel, medium, with thin clay layers and boulders  
73- 75 Shale, silty, reworked  
75-155 Shale, gray  
155-158 Sandstone, pink, very hard; weathered quartzite  
158-159 Quartzite, pink; very hard

\* \* \* \*

Test Hole 147

Location: SW SW SW NW sec. 14, T. 102 N., R. 60 W.

Elevation: 1347

Date Drilled: June 14, 1978, A

0- 3 Sand, yellow-brown, medium, pebbly, sandstone chips;  
dry

Test Hole 147 -- continued.

3- 5 Sand, red-brown, pebbly; dry  
5- 7 Sand, yellow-brown; moist  
7- 12 Sand, yellow-brown, clayey; moist  
12- 25 Sand, brown, clayey; moist  
25- 30 Sand, light brown, medium; moist  
30- 45 Sand, brown, medium; moist  
45- 46 Clay?, no sample return

\* \* \* \*

Test Hole 148

Location: NW NW NW NW sec. 17, T. 102 N., R. 60 W.

Elevation: 1350

Date Drilled: July 9, 1979, B

0- 1 Topsoil, gray  
1- 17 Clay, yellow, silty, pebbly (till)  
17- 21 Clay, gray, silty, pebbly (till)  
21- 30 Clay, gray, silty, sandy; soft (till)  
30- 33 Clay, gray, silty, pebbly; some gravel at 31 feet  
(till)  
33- 35 Clay, gray, shaley, pebbly (till)  
35- 45 Marl, light gray; noncalcareous  
45- 52 Shale, gray  
52- 74 Sandstone, gray, some shale layers; hard and soft  
layers  
74- 97 Shale, gray, silty

Observation well: 80 feet of 2-inch PVC casing

\* \* \* \*

Test Hole 149

Location: NE NE SE NE sec. 18, T. 102 N., R. 60 W.

Elevation: 1349

Date Drilled: July 19, 1977, B

0- 1 Topsoil, black  
1- 3 Clay, yellow, silty, pebbly (till)  
3- 12 Sand, medium to coarse, with some clay  
12- 28 Clay, gray, silty, pebbly (till)  
28- 44 Clay, brownish-gray with some white (chalk?)  
44- 55 Sand, gray, medium to coarse, some wood in the 50-  
foot sample  
55- 66 Sandstone; cemented (Codell?)  
66- 95 Clay, gray, shale-like (Carlile?)

\* \* \* \*



Test Hole 150

Location: SW SW SW SW sec. 18, T. 102 N., R. 60 W.

Elevation: 1340

Date Drilled: July 24, 1978, B

0- 1 Topsoil, gray, silty  
1- 8 Clay, yellow-brown, silty, pebbly (till)  
8- 13 Silt, white (weathered Niobrara Formation)  
13- 18 Silt, tan (weathered Niobrara Formation)  
18- 38 Chalk, light gray to white  
38- 61 Chalk, interbedded gray and white  
61- 65 Sandstone, gray, fine, medium hardness  
65- 75 Sand, brown to gray, fine  
75- 78 Sand, gray, interbedded with gray shale  
78- 89 Shale, gray, sandy; soft  
89- 98 Shale, gray; compact  
98-108 Shale, gray, silty, soft  
108-200 Shale, gray; hard, taking water

\* \* \* \*

Test Hole 151

Location: NE SE SE NE sec. 14, T. 102 N., R. 61 W.

Elevation: 1344

Date Drilled: May 23, 1979, A

0- 1 Sand, brown, pebbly, calcareous; moist  
1- 5 Clay, yellow-brown, sandy, pebbly, calcareous;  
moist  
5- 7 Clay, red-brown, sandy, pebbly, calcareous; moist  
7- 23 Chalk, tan and gray, silty, calcareous; moist

\* \* \* \*

Test Hole 152

Location: NW SW NW NW sec. 14, T. 102 N., R. 61 W.

Elevation: 1375

Date Drilled: June 14, 1979, A

0- 8 Clay, dark brown, silty, calcareous; moist  
8- 12 Clay, brownish-gray, silty, pebbly; moist (till)  
12- 19 Chalk, buff; saturated  
19- 23 Chalk, gray; moist, very compact

\* \* \* \*

Test Hole 153

Location: NW NW SW NW sec. 14, T. 102 N., R. 61 W.

Elevation: 1361

Date Drilled: June 14, 1979, A

0- 8 Silt, red-brown, sandy, pebbly; dry  
8- 12 Silt, light brown, pebbly, calcareous; moist

Test Hole 153 -- continued.

12- 17 Chalk, brown, silty (Niobrara Formation)

\* \* \* \*

Test Hole 154

Location: SW SW NW SW sec. 14, T. 102 N., R. 61 W.

Elevation: 1372

Date Drilled: June 14, 1979, A

0- 16 Clay, brown, very pebbly, sandy, silty, calcareous;  
moist  
16- 20 Chalk, orange-brown, silty, calcareous; moist  
20- 23 Chalk, gray, calcareous

\* \* \* \*

Test Hole 155

Location: SW NW NW SW sec. 15, T. 102 N., R. 61 W.

Elevation: 1373

Date Drilled: May 21, 1979, A

0- 1 Sand, brown, medium, pebbly; moist  
1- 18 Chalk, yellow, silty; moist (Niobrara Formation)  
18- 23 Chalk, gray, silty (Niobrara Formation)

\* \* \* \*

Test Hole 156

Location: SE SE NE SE sec. 15, T. 102 N., R. 61 W.

Elevation: 1364

Date Drilled: June 14, 1979, A

0- 6 Clay, black, silty, calcareous; moist  
6- 23 Chalk, gray, silty; thin white chalk layers at 13  
feet to 14 feet; thin light reddish-brown lenses  
at 15 feet to 18 feet; moist (Niobrara Formation)

\* \* \* \*

Test Hole 157

Location: SW SW SW SW sec. 18, T. 102 N., R. 61 W.

Elevation: 1413

Date Drilled: July 25, 1978, B

0- 14 Clay, yellow-brown (till)  
14- 25 Chalk, soft, weathered (Pierre Shale?)  
25- 85 Chalk, gray (Niobrara Formation)  
85-110 Chalk, light gray  
110-140 Chalk, dark gray  
140-170 Sandstone, brown, fine, well cemented layers  
(Codell Sandstone)

Test Hole 157 -- continued.

170-185 Shale, gray (Carlile Shale)

\* \* \* \*

Test Hole 158

Location: NE NW NW NW sec. 19, T. 102 N., R. 61 W.

Elevation: 1425

Date Drilled: June 11, 1979, A

0- 1 Clay, dark brown, silty; moist (topsoil)  
1- 11 Clay, yellow-brown, silty, pebbly; moist (till)  
11- 18 Clay, brown, silty, pebbly; moist (till)  
18- 19 Clay, black, silty, pebbly; moist (till)  
19- 23 Chalk, gray, silty; moist (Niobrara Formation)

\* \* \* \*

Test Hole 159

Location: NW NW NW NW sec. 22, T. 102 N., R. 61 W.

Elevation: 1363

Date Drilled: July 25, 1978, B.

0- 14 Clay, reddish-tan to white; weathered Niobrara Chalk  
14- 25 Chalk, gray (Niobrara Formation)  
25- 58 Chalk, light gray  
58- 70 Chalk, dark gray  
70- 88 Sandstone, brown, fine, interbedded sand and cement-  
ed sandstone layers (Codell Sandstone)  
88-110 Shale, gray (Carlile Shale)

\* \* \* \*

Test Hole 160

Location: SE NE NE SE sec. 22, T. 102 N., R. 61 W.

Elevation: 1379

Date Drilled: June 6, 1979, A

0- 6 Till, light yellow-brown, sandy, silty, pebbly, cal-  
careous; moist  
6- 17 Chalk, dirty white, silty, color changes to orangish-  
yellow (Niobrara Formation)  
17- 23 Clay, blue-green gray, silty; moist, calcareous,  
color changes to darker gray (Niobrara Formation)

\* \* \* \*

Test Hole 161

Location: NW NE NE NE sec. 23, T. 102 N., R. 61 W.

Elevation: 1362

Date Drilled: May 21, 1979, A

0- 6 Gravel, coarse, brown, sandy; moist

Test Hole 161 -- continued.

- 6- 16 Chalk, light tan, sandy; moist (Niobrara Formation)
- 16- 23 Chalk, sandy; moist (Niobrara Formation)

\* \* \* \*

Test Hole 162

Location: NE SE SE NE sec. 23, T. 102 N., R. 61 W.

Elevation: 1339

Date Drilled: June 6, 1979, A

- 0- 1 Clay, brown, chalky; moist (till)
- 1- 10 Chalk, yellow; saturated (Niobrara Formation)
- 10- 23 Chalk, gray, calcareous; moist (Niobrara Formation)

\* \* \* \*

Test Hole 163

Location: NE NE NE SE sec. 23, T. 102 N., R. 61 W.

Elevation: 1371

Date Drilled: June 6, 1979, A

- 0- 5 Topsoil, brown; dry
- 5- 7 Clay, brown, sandy, silty, pebbly; moist (till)
- 7- 23 Chalk, light brown, silty; moist (Niobrara Formation)

\* \* \* \*

Test Hole 164

Location: NW NW NW SW sec. 19, T. 102 N., R. 60 W.

Elevation: 1339

Date Drilled: June 6, 1979, A

- 0- 5 Gravel, light tan, poorly sorted, sandy; dry calcareous
- 5- 10 Gravel, brown, poorly sorted, sandy; dry, calcareous
- 10- 12 Chalk, yellow, pebbly; calcareous (Niobrara Formation)
- 12- 23 Clay, blue-gray, silty, pebbly; moist-dry, calcareous, compact, brittle

\* \* \* \*

Test Hole 165

Location: SW NW SW SW sec. 19, T. 102 N., R. 60 W.

Elevation: 1347

Date Drilled: June 6, 1979, A

- 0- 6 Gravel, brown, medium, sandy; moist
- 6- 20 Chalk, yellow, gravelly; saturated, calcareous (Niobrara Formation)

Test Hole 165 -- continued.

20- 23 Clay, blue, sandy; moist, calcareous

\* \* \* \*

Test Hole 166

Location: NE NE NE NE sec. 21, T. 102 N., R. 60 W.

Elevation: 1315

Date Drilled: July 24, 1978, B

0- 2 Topsoil  
2- 4 Clay, yellow-brown, silty (till)  
4- 33 Sand, coarse, fine to medium gravel  
33- 37 Clay, gray, silty, pebbly (till)  
37- 58 Sand, brown, coarse, with alternating layers of  
sandstone  
58- 60 Sandstone, white to pinkish  
60- 63 Clay, gray, sandy, shaley  
63-164 Shale, gray  
164-165 Quartzite, very hard

\* \* \* \*

Test Hole 167

Location: SE SE SE SW sec. 24, T. 102 N., R. 60 W.

Elevation: 1327

Date Drilled: July 19, 1977, B

0- 12 Clay, yellow, silty, pebbly (till)  
12- 40 Clay, gray, silty, pebbly, sandy, with some coal and  
and wood (till)  
40- 54 Clay, brownish-gray (chalk?)  
54- 64 Sand; some cemented (Codell?)  
64- 80 Clay, gray; shale-like

\* \* \* \*

Test Hole 168 (DN-79F)

Location: NW NW NW SW sec. 28, T. 102 N., R. 60 W.

Elevation: 1329.47 (I) - surveyed by instrument

Date Drilled: July 10, 1979, B

0- 1 Topsoil, black  
1- 8 Gravel, coarse  
8- 23 Clay, gray, silty, pebbly (till)  
23- 31 Gravel, fine to medium; shaley  
31- 35 Clay, gray, shaley, pebbly (till)  
35- 40 Clay, dark gray, pebbly (till)  
40- 46 Clay, gray, noncalcareous  
46- 67 Sand, hard and soft layers; interbedded shale  
67- 74 Shale, gray; interbedded sand lenses

Test Hole 168 -- continued.

74- 80 Shale, gray

Observation well: 70 feet of plastic casing

\* \* \* \*

Test Hole 169

Location: SE NE SE NE sec. 27, T. 102 N., R. 61 W.

Elevation: 1392

Date Drilled: June 6, 1979, A

0- 4 Clay, black; moist (topsoil)  
4- 9 Clay, brown, silty; moist (till)  
9- 23 Chalk, yellow, sandy; moist (Niobrara Formation)

\* \* \* \*

Test Hole 170

Location: NE NE NE NE sec. 28, T. 102 N., R. 61 W.

Elevation: 1425

Date Drilled: June 22, 1979, B

0- 23 Clay, brown, sandy (till)  
23- 78 Chalk, gray

Observation well: 80 feet of 2-inch PVC casing

\* \* \* \*

Test Hole 171

Location: NW NW NW NE sec. 28, T. 102 N., R. 60 W.

Elevation: 1326

Date Drilled: July 10, 1979, B

0- 1 Topsoil, black  
1- 8 Gravel, coarse  
8- 23 Clay, gray, silty, pebbly (till)  
23- 31 Gravel, fine to medium, shaley  
31- 35 Clay, gray, pebbly, shaley (till)  
35- 40 Marl, dark gray, pebbly (till)  
40- 46 Marl, gray; noncalcareous  
46- 67 Sand, brown, some shale layers; compact and soft  
layers  
67- 74 Shale, gray, sandy  
74- 80 Shale, gray

Observation well: 70 feet of 2-inch PVC casing

\* \* \* \*

Test Hole 172

Location: NW NW NW NW sec. 29, T. 102 N., R. 61 W.

Elevation: 1449

Date Drilled: June 13, 1979, B

0- 1 Topsoil, black  
1- 20 Clay, yellow-brown, silty, pebbly (till)  
20- 24 Gravel, fine to medium  
24- 34 Clay, gray, silty, pebbly (till)  
34-108 Chalk, grayish-brown (Niobrara Formation)  
108-192 Chalk, white, silty  
192-352 Shale, gray, compact (Carlisle Shale)  
352-357 Sandstone (Quartzite Wash)  
357- Quartzite

Observation well: 360 feet of 2-inch PVC casing

\* \* \* \*

Test Hole 173

Location: SE SE SE SE sec. 30, T. 102 N., R. 61 W.

Elevation: 1440

Date Drilled: June 27, 1978, A

0- 2 Sand, red-brown, clean  
2- 19 Clay, yellow-brown, sandy; dry, moist at 13 feet  
19- 21 Chalk, orange, sandy; saturated  
21- 28 Chalk, gray, sandy, compact; dry

\* \* \* \*

Test Hole 174

Location: NW NW NW NW sec. 36, T. 102 N., R. 62 W.

Elevation: 1470

Date Drilled: June 13, 1979, B

0- 1 Topsoil  
1- 20 Clay, yellow (till)  
20- 25 Chalk, white, silty (Pierre Shale?)  
25- 43 Shale, black; greasy  
43- 48 Shale, gray  
48-118 Chalk, gray-brown; calcareous, compact  
118-170 Chalk, white  
170-188 Sandstone, yellow-brown

\* \* \* \*

Test Hole 175

Location: NW NW NW SW sec. 36, T. 102 N., R. 62 W.

Elevation: 1435

Date Drilled: June 16, 1978, A

0- 4 Silt, black; moist (topsoil)  
4- 9 Chalk, gray-brown; moist (Pierre Shale)

Test Hole 175 -- continued.

9- 21 Shale, black; very compact  
21- 28 Chalk, black; saturated, calcareous (Pierre Shale?)

\* \* \* \*

Test Hole 176

Location: NE NE SE NE sec. 31, T. 102 N., R. 61 W.

Elevation: 1388

Date Drilled: June 20, 1978, A

0- 1 Topsoil  
1- 3 Clay, gray-brown, sandy, silty; moist  
3- 28 Chalk, light gray; moist, saturated at 4 feet

\* \* \* \*

Test Hole 177

Location: NE NE NE SE sec. 32, T. 102 N., R. 61 W.

Elevation: 1410

Date Drilled: June 11, 1979, A

0- 1 Clay, black, silty; moist (topsoil)  
1- 7 Clay, light brown, silty, pebbly; moist (till)  
7- 15 Chalk, light brown, silty; moist (Pierre Formation?)  
15- 23 Chalk, orange-brown, silty; moist

\* \* \* \*

Test Hole 178

Location: SE SE SE SE sec. 33, T. 102 N., R. 61 W.

Elevation: 1426

Date Drilled: August 8, 1978, B

0- 2 Topsoil, black  
2- 23 Clay, brown, silty, sandy, pebbly (till)  
23- 24 Clay, gray, silty, sandy, pebbly (till)  
24- 33 Chalk, brownish-gray, gritty, brittle, calcareous  
33- 47 Chalk, gray, silty, calcareous  
47- 49 Shale, dark gray, silty, calcareous  
49- 97 Chalk, gray, silty, calcareous  
97-128 Chalk, light gray, silty, calcareous  
128-133 Chalk, brownish-gray, silty, calcareous  
133-175 Sandstone, interbedded with clay, brown, silty,  
sandy (Codell Sandstone)  
175-185 Shale, gray, greasy

\* \* \* \*

Test Hole 179

Location: NE NE NW NW sec. 34, T. 102 N., R. 61 W.

Elevation: 1385

Date Drilled: June 7, 1979, A



Test Hole 179 -- continued.

0- 4 Clay, brown; moist  
4- 6 Clay, gray, calcareous; dry  
6- 19 Clay, reddish-brown, calcareous; moist  
19- 21 Clay, dark gray, noncalcareous (Pierre Shale?)  
21- 23 Chalk, gray, calcareous (Niobrara Formation)

\* \* \* \*

Test Hole 180

Location: NW NW NW SW sec. 34, T. 102 N., R. 61 W.

Elevation: 1372

Date Drilled: June 20, 1978, A

0- 1 Topsoil, brown  
1- 8 Silt, black; moist  
8- 13 Sand, gray-brown, medium, clayey, silty; moist  
13- 15 Chalk, yellow-brown; saturated (Niobrara Formation?)  
15- 25 Chalk, gray and dark gray; saturated (Niobrara  
Formation)

\* \* \* \*

Test Hole 181

Location: NE NE SE SE sec. 34, T. 102 N., R. 61 W.

Elevation: 1399

Date Drilled: June 8, 1979, A

0- 16 Clay, light brown, sandy, silty, pebbly calcareous;  
moist (till)  
16- 19 Clay, dark brown, sandy, silty, pebbly; moist (till)  
19- 23 Chalk, yellow, sandy, calcareous; moist (Niobrara  
Formation)

\* \* \* \*

Test Hole 182

Location: SW SW SE SW sec. 35, T. 102 N., R. 61 W.

Elevation: 1388

Date Drilled: June 8, 1979, A

0- 2 Topsoil, black  
2- 6 Clay, yellow, chalky; moist (till)  
6- 15 Chalk, yellow, silty; moist (Niobrara Formation)  
15- 23 Chalk, gray, silty; moist (Niobrara Formation)

\* \* \* \*

Test Hole 183 (D-69A)

Location: NW sec. 36, T. 102 N., R. 61 W.

Elevation: 1382

Date Drilled: July 16, 1969, G

Test Hole 183 -- continued.

0- 4 Topsoil  
4- 22 Clay, yellow, gritty  
22- 23 Chalk, yellow  
23- 27 Chalk, dark gray, solid  
27- 31 Chalk, dark gray, soft  
31- 56 Chalk, dark gray, solid  
56- 58 Clay, blue

Observation well: 52 feet of casing

\* \* \* \*

Test Hole 184

Location: NW NW NW SW sec. 36, T. 102 N., R. 61 W.

Elevation: 1382

Date Drilled: June 7, 1979, A

0- 17 Clay, brown, sandy, pebbly, calcareous; moist (till)  
17- 23 Chalk, white, sandy, calcareous; moist (Niobrara  
Formation)

\* \* \* \*

Test Hole 185

Location: SW SW SW SW sec. 31, T. 102 N., R. 60 W.

Elevation: 1373

Date Drilled: August 8, 1978, B

0- 1 Topsoil, black  
1- 21 Clay, brown, silty, sandy, pebbly (till)  
21- 24 Clay, gray, silty, sandy, pebbly (till)  
24-104 Chalk, white to gray, silty; highly calcareous  
104-132 Sandstone, brownish-gray, fine; compact layers  
132-142 Shale, light gray, sandy, some interbedded sandstone  
layers  
142-170 Shale, gray

\* \* \* \*

Test Hole 186

Location: SE SE SE SE sec. 33, T. 102 N., R. 60 W.

Elevation: 1335

Date Drilled: August 8, 1979, B

0- 1 Topsoil, brown, silty  
1- 16 Clay, yellow, silty, pebbly (till)  
16- 36 Clay, gray, silty, pebbly; compact (till)  
36- 80 Chalk, light gray to white, calcareous  
80-102 Sandstone, brownish-gray, some very compact layers  
102-155 Shale, gray

\* \* \* \*

Test Hole 187

Location: NW NW SW SW sec. 34, T. 102 N., R. 60 W.

Elevation: 1321

Date Drilled: July 19, 1977, B

0- 2 Clay, yellow, silty, pebbly (till)  
2- 7 Gravel, coarse  
7- 11 Clay, gray, silty, pebbly (till)  
11- 22 Sand, gray, medium to coarse  
22- 34 Chalk, gray-white, with layers of darker gray, silty  
34- 37 Clay, gray, silty, quite pebbly  
37- 54 Clay, yellowish-gray, silty, sandy, slightly chalky  
54- 57 Clay, gray, very silty, some sand, compact  
57- 61 Clay, gray-white  
61- 63 Silt, gray; fairly compact  
63- 69 Shale, gray, silty, sandy  
69- 73 Sand, fine to medium, interbedded with silt and  
compact cemented sandstone  
73- 81 Sandstone, light tan, some pebbles, well cemented  
81- 95 Shale, medium gray, some bentonite

\* \* \* \*

Test Hole 188

Location: NW NW NW NW sec. 31, T. 102 N., R. 59 W.

Elevation: 1329

Date Drilled: August 9, 1978, B

0- 1 Topsoil, brown, silty  
1- 17 Clay, yellow, silty, pebbly (till)  
17- 20 Clay, tan-gray, silty, pebbly (till)  
20- 24 Clay, gray, silty, pebbly (till)  
24- 32 Clay, gray, silty, sandy, pebbly (till)  
32- 72 Chalk, light gray to white  
72- 82 Sandstone, brownish-gray, shaley in places  
82-150 Shale, gray  
150-225 Shale, light gray; greasy  
225-232 Limestone, white; calcareous, massive, compact  
232-252 Clay, dark brown, shaley, gritty, some white lime-  
stone and brown sandstone  
252-253 Quartzite, pink; very hard

\* \* \* \*

Test Hole 189

Location: SE SE SE NE sec. 1, T. 101 N., R. 60 W.

Elevation: 1339

Date Drilled: July 26, 1978, A

0- 1 Topsoil, black  
1- 31 Clay, yellow-brown, silty, sandy, pebbly (till)  
31- 48 Clay, gray, silty, pebbly (till)  
48- 64 Sand, fine to medium, much coal  
64- 96 Clay, gray, very sandy, pebbly (till)

Test Hole 189 -- continued.

96-140 Shale, dark gray, greasy

\* \* \* \*

Test Hole 190

Location: NW NW NW NW sec. 2, T. 101 N., R. 60 W.

Elevation: 1326

Date Drilled: June 27, 1979, A

0- 4 Sand, light brown, coarse-grained; dry  
4- 19 Sand, brown, very coarse-grained, pebbly; moist,  
saturated at 15 feet  
19- 27 Silt, gray, pebbly; sandy; moist

\* \* \* \*

Test Hole 191

Location: SW SW SW NW sec. 4, T. 101 N., R. 60 W.

Elevation: 1332

Date Drilled: July 19, 1977, A

0- 9 Gravel, brown, medium to coarse  
9- 10 Clay, brown, silty, sandy, pebbly (till)  
10- 13 Clay, gray, silty, sandy, pebbly (till)  
13- 15 Clay, gray-white  
15- 34 Clay, gray, silty, sandy, pebbly (till)  
34- 41 Clay, gray, silty, pebbly, very sandy (till)  
41- 63 Clay, gray-white  
63- 72 Silt, brownish-gray, with some clay and sand; lost  
circulation at 72 feet

\* \* \* \*

Test Hole 192

Location: SE SE SE SE sec. 4, T. 101 N., R. 61 W.

Elevation: 1432

Date Drilled: June 22, 1979, B

0- 1 Topsoil, black  
1- 4 Sand, coarse  
4- 18 Clay, yellow-brown, sandy, silty (till)  
18- 36 Clay, black, silty, a lot of bentonite (shale?), rock  
at 18 feet  
36-118 Clay, medium gray, silty; compact (chalk?)  
118-137 Clay, light gray, silty, sandy; compact (chalk?)

Observation well: 140 feet of 2-inch PVC casing

\* \* \* \*

Test Hole 193

Location: NE NE NE NE sec. 1, T. 101 N., R. 62 W.

Elevation: 1460

Date Drilled: August 8, 1978, B

0- 1 Topsoil, brown, silty  
1- 19 Clay, yellow, silty, pebbly (till)  
19- 25 Clay, yellow-gray, silty, gravelly (till)  
25- 33 Silt, tan; calcareous (loess?)  
33- 52 Shale, black; bentonite  
52- 57 Shale, light gray  
57- 80 Chalk, light gray  
80-104 Chalk, gray, brittle; compact  
104-143 Chalk, gray  
143-179 Chalk, white to light gray  
179-206 Sandstone, brown  
206-213 Shale, blue-gray, silty; soft  
213-230 Shale, blue-gray, greasy

\* \* \* \*

Test Hole 194

Location: NW NW NW NW sec. 1, T. 101 N., R. 62 W.

Elevation: 1472

Date Drilled: July 25, 1977, B

0- 2 Topsoil, black  
2- 11 Clay, yellow-brown, silty, pebbly (till)  
11- 12 Sand and gravel  
12- 31 Clay, yellow-brown, silty, pebbly (till)  
31- 42 Shale, dark gray; much bentonite  
42- 48 Chalk(?), light colored; compact, taking water  
48- 75 Shale, black  
75-181 Chalk(?), light colored  
181-194 Sand, interbedded with silty shale; partially  
cemented  
194-211 Shale, gray, silty; with much pyrite and thin lenses  
of sand  
211-218 Sandstone; cemented and uncemented layers  
218-245 Shale

\* \* \* \*

Test Hole 195

Location: SE SE NE NE sec. 9, T. 101 N., R. 61 W.

Elevation: 1413

Date Drilled: June 7, 1979, A

0- 8 Clay, light brown, sandy, silty, pebbly (till)  
8- 15 Clay, light gray, sandy, silty, pebbly; moist (till)  
15- 18 Chalk, gray, sandy, calcareous; dry, compact

\* \* \* \*

Test Hole 196

Location: NE SE SE NE sec. 9, T. 101 N., R. 61 W.

Elevation: 1412

Date Drilled: June 7, 1979, A

- 0- 4 Clay, reddish-brown, silty, calcareous; moist
- 4- 14 Clay, dark gray, sandy, pebbly (chalk); moist (till)
- 14- 19 Chalk, dark gray; dry, very compact

\* \* \* \*

Test Hole 197

Location: SW SW SE SE sec. 11, T. 101 N., R. 61 W.

Elevation: 1414

Date Drilled: July 4, 1979, B

- 0- 1 Topsoil, black
- 1- 21 Clay, yellow-brown, silty, pebbly (till)
- 21- 32 Clay, gray, silty, pebbly (till)
- 32- 36 Clay, light gray (Pierre Shale)
- 36- 41 Clay, light gray, calcareous (Pierre Shale?)
- 41- 59 Clay, black, calcareous; greasy, bentonite layers  
from 55 feet to 59 feet
- 59-120 Chalk, gray-brown, calcareous, silty

Observation well: 120 feet of 2-inch PVC casing

\* \* \* \*

Test Hole 198 (DN-69B)

Location: NE NE NE NE sec. 7, T. 101 N., R. 60 W.

Elevation: 1343

Date Drilled: July 15, 1969, G

- 0- 2 Topsoil, sandy loam
- 2- 5 Loam, gray
- 5- 10 Clay, gray, sandy, gravelly
- 10- 23 Gravel, gray; chalky
- 23- 32 Chalk; some gravel
- 32- 37 Clay, light gray

Observation well: 33 feet of casing

\* \* \* \*

Test Hole 199

Location: NW NW NW SW sec. 10, T. 101 N., R. 60 W.

Elevation: 1335

Date Drilled: July 19, 1979, A

- 0- 8 Clay, yellow-brown, silty, pebbly, quite sandy  
(till)
- 8- 10 Clay, brown, silty, sandy, pebbly (till)
- 10- 32 Clay, gray, silty, sandy, pebbly (till)

Test Hole 199 -- continued.

32- 39 Sand, coarse, well sorted  
39- 43 Gravel, fine to medium  
43- 56 Silt, gray, with chalky layers  
56-106 Clay, gray, silty; takes water  
106-125 Shale, gray, quite silty

\* \* \* \*

Test Hole 200

Location: SW SE SW SE sec. 12, T. 101 N., R. 60 W.

Elevation: 1321

Date Drilled: May 30, 1979, A

0- 1 Clay, dark brown, silty, sandy; noncalcareous,  
moist  
1- 2 Clay, reddish-brown, sandy, medium- to fine-grained,  
silty; moist, slightly calcareous  
2- 5 Clay, light brown, silty, sandy, some pebbles;  
moist, slightly calcareous  
5- 7 Clay, reddish-brown, sandy; noncalcareous, some  
gray marl strips, saturated at 5 feet  
7- 13 Clay, medium to light brown, silty, sandy, medium-  
to fine-grained; slightly calcareous, saturated  
13- 23 Marl, medium to light gray, silty; moist, calcare-  
ous, compact (Niobrara Chalk?)

\* \* \* \*

Test Hole 201

Location: NE NE SE SE sec. 12, T. 101 N., R. 60 W.

Elevation: 1310

Date Drilled: June 14, 1978, A

0- 1 Clay, black, sandy; moist (topsoil)  
1- 3 Clay, light brown, sandy; moist  
3- 8 Gravel, yellow-brown, clayey, sandy; moist  
8- 10 Clay, gray, sandy, pebbly; moist  
10- 14 Clay, tan-gray, pebbly; saturated  
14- 23 Clay, gray, sandy; saturated, compact (Niobrara  
Chalk)

\* \* \* \*

Test Hole 202

Location: SW NW NW SW sec. 18, T. 101 N., R. 59 W.

Elevation: 1328

Date Drilled: May 30, 1979, A

0- 9 Clay, light buff, very silty, numerous weathered  
chalk pebbles; moist  
9- 13 Silt, white to light gray; very marly (weathered  
Niobrara Formation?)

Test Hole 202 -- continued.

13- 23 Chalk, light gray, very silty; moist (Niobrara Formation)

\* \* \* \*

Test Hole 203 (DN-78B)

Location: NW NW NW NW sec. 15, T. 101 N., R. 60 W.

Elevation: 1344

Date Drilled: August 28, 1978, G

0- 2 Topsoil, black, silty  
2- 10 Clay, light brown, silty (till)  
10- 11 Rocks, red-brown  
11- 30 Clay, gray, silty, sandy, pebbly (till)  
30- 34 Clay, gray, chalky  
34- 39 Clay, gray, sandy, gravelly  
39- 47 Clay, gray, chalky  
47- 54 Clay, dark gray; brittle, greasy  
54- 66 Chalk, gray-white, silty  
66- 80 Chalk, white, silty

\* \* \* \*

Test Hole 204 (DN-78C)

Location: SE SE SE NE sec. 18, T. 101 N., R. 60 W.

Elevation: 1368

Date Drilled: August 28, 1978, G

0- 1 Topsoil, black  
1- 3 Gravel, red-brown  
3- 12 Clay, light brown, silty, pebbly (till)  
12- 16 Gravel, red-brown, coarse  
16- 23 Clay, brown, silty (till),  
23- 33 Clay, gray, sandy, pebbly, gravelly (till)  
33- 34 Gravel, coarse, chalky, shaley  
34- 42 Clay, gray-brown, chalky (reworked Niobrara?)  
42- 45 Shale, dark gray, silty  
45- 57 Chalk, dark gray, silty  
57- 62 Shale, dark gray, silty; greasy  
62- 85 Clay, gray-brown, silty; chalky  
85-110 Clay, gray-white; some water loss last 5 feet

Observation well: 105 feet of plastic

\* \* \* \*

Test Hole 205

Location: SW SW SW NW sec. 18, T. 101 N., R. 60 W.

Elevation: 1379

Date Drilled: June 8, 1979, A

0- 5 Clay, brown, chalky; moist, calcareous (till)



Test Hole 205 -- continued.

5- 7 Chalk, tan, silty; moist, calcareous (Niobrara?)  
7- 10 Chalk, yellow, sandy; moist, calcareous (Niobrara  
Formation)  
10- 14 Chalk, tan, sandy; dry, calcareous

\* \* \* \*

Test Hole 206

Location: SE SE NE SE sec. 13, T. 101 N., R. 61 W.

Elevation: 1362

Date Drilled: June 11, 1979, A

0- 7 Clay, black, silty; moist (till)  
7- 15 Clay, brown, silty; saturated (till)  
15- 20 Chalk, yellow, silty; calcareous  
20- 23 Clay, gray, silty; moist (Carlisle Shale)

\* \* \* \*

Test Hole 207

Location: SW NW SW SW sec. 14, T. 101 N., R. 61 W.

Elevation: 1390

Date Drilled: June 11, 1979, A

0- 15 Clay, light brown, sandy, silty, pebbly; moist  
(till)  
15- 20 Clay, gray, sandy, silty, pebbly; calcareous, moist  
(till)  
20- 23 Chalk, gray; calcareous, moist (Niobrara Formation)

\* \* \* \*

Test Hole 208

Location: SE NE NE SE sec. 15, T. 101 N., R. 61 W.

Elevation: 1388

Date Drilled: June 20, 1978, A

0- 3 Clay, yellow-brown, sandy, pebbly; moist  
3- 8 Silt, brown, pebbly, sandy; dry (till)  
8- 23 Chalk, white; dry (Niobrara Formation)

\* \* \* \*

Test Hole 209

Location: SE SE SE SE sec. 16, T. 101 N., R. 61 W.

Elevation: 1484

Date Drilled: June 23, 1978, A

0- 1 Clay, brown, sandy; moist  
1- 3 Clay, black, sandy, pebbly; moist (till)  
3- 7 Clay, brown, sandy, pebbly; moist (till)  
7- 11 Silt, yellow-brown, sandy; moist (loess?)

Test Hole 209 -- continued.

11- 20 Clay, gray, with thin white beds; moist  
20- 25 Chalk, gray, silty; moist

\* \* \* \* \*

Test Hole 210

Location: NE NE NE NE sec. 17, T. 101 N., R. 61 W.

Elevation: 1453

Date Drilled: July 21, 1977, A

0- 2 Clay, dark brown, silty, sandy (topsoil)  
2- 21 Clay, brown, silty, pebbly, very sandy (till)  
21- 43 Clay, gray, silty, pebbly, very sandy (till)  
43- 60 Shale, dark gray, with bentonite layers  
60- 69 Clay, medium gray  
69- 85 Shale, dark gray, petroleum smell  
85-112 Clay, gray, silty  
112-174 Shale, medium gray, chalky, slightly silty  
174-188 Clay, light gray, slightly sandy  
188-199 Clay, dark gray-brown, silty, interbedded with gray-  
white clay  
199-214 Shale, silty, sandy, slightly chalky  
214-227 Sandstone, with fine sand lenses, silty, shaley,  
well cemented  
227-245 Shale, gray, silty

\* \* \* \* \*

Test Hole 211

Location: SE SE SE SE sec. 13, T. 101 N., R. 62 W.

Elevation: 1502

Date Drilled: June 11, 1979, B

0- 1 Topsoil, black  
1- 32 Clay, yellow, silty, pebbly (till)  
32- 47 Clay, gray, silty, pebbly (till)  
47- 49 Shale, light gray, pebbly (reworked)  
49- 98 Shale, light gray and gray; some bentonite at 76  
feet to 98 feet  
98-107 Shale, light gray; compact, chalky  
107-114 Chalk, light gray, shaley  
114-145 Shale, black  
145-218 Shale, brown, silty; calcareous  
218-242 Limestone, white, silty  
242-250 Shale, black, sandy, compact layers  
250-286 Sandstone, yellow-brown, sandy, silty, hard spots  
286-320 Shale, gray, smooth

\* \* \* \* \*

Test Hole 212

Location: NW NW NW NW sec. 19, T. 101 N., R. 61 W.

Elevation: 1502

Date Drilled: July 21, 1977, A

0- 2 Topsoil, brown, silty, sandy  
2- 26 Clay, brown, silty, sandy, pebbly (till)  
26- 47 Clay, gray, silty, sandy; pebbly (till)  
47-103 Shale, dark gray; thin bentonite layers (Pierre  
Shale)  
103-113 Clay, light gray (Pierre Shale)  
113-136 Shale, dark gray, petroleum smell  
136-200 Clay, dark gray, silty (Pierre Shale)

\* \* \* \*

Test Hole 213

Location: NE NE NE NE sec. 22, T. 101 N., R. 61 W.

Elevation: 1413

Date Drilled: June 26, 1979, B

0- 1 Topsoil  
1- 4 Clay, brown, sandy (till)  
4- 14 Chalk, tan, silty (Pierre Shale)  
14- 18 Clay, gray (Pierre Shale)  
18- 24 Clay, gray; sandy (Pierre Shale)  
24- 70 Clay, gray (Pierre Shale)  
70-142 Chalk, gray, silty (Niobrara Formation)  
142-175 Chalk, white, silty, sandy (Niobrara Formation)  
175-235 Sandstone, silty (Codell Sandstone)  
235-245 Shale, gray, silty (Carlile Shale)

Observation well: 245 feet of 2-inch PVC casing

\* \* \* \*

Test Hole 214

Location: SE SE NE NE sec. 22, T. 101 N., R. 61 W.

Elevation: 1412

Date Drilled: June 21, 1978, A

0- 3 Silt, light brown, sandy, pebbly; dry (till)  
3- 8 Silt, brown, pebbly; calcareous, dry  
8- 25 Chalk, gray; calcareous, dry (Pierre Shale?)

\* \* \* \*

Test Hole 215

Location: SE NE SE NE sec. 22, T. 101 N., R. 61 W.

Elevation: 1386

Date Drilled: May 31, 1979, A

0- 2 Clay, dark brown, silty, sandy; calcareous, moist  
2- 19 Clay, gray, silty, sandy; calcareous; moist

Test Hole 215 -- continued.

19- 23 Chalk, gray, silty; calcareous (Niobrara Formation)

\* \* \* \*

Test Hole 216

Location: NE NE NE SE sec. 22, T. 101 N., R. 61 W.

Elevation: 1425

Date Drilled: June 25, 1979, B

0- 1 Topsoil  
1- 18 Clay, yellow-brown, sandy (till)  
18- 32 Clay, gray, sandy, compact (till)  
32- 44 Shale, black (Pierre Shale)  
44- 50 Chalk, gray-brown; lost circulation at 50 feet

Observation well: 50 feet of 2-inch PVC casing

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Test Hole 217 (DN-79J)

Location: SE SE SE SE sec. 22, T. 101 N., R. 61 W.

Elevation: 1433

Date Drilled: September 2, 1966, G

0- 10 Clay, yellow  
10- 15 Sand; some gravel  
15- 30 Clay, yellow  
30-100 Chalk

Observation well: 78 feet of casing

\* \* \* \*

Test Hole 218

Location: SE NE NE NE sec. 23, T. 101 N., R. 61 W.

Elevation: 1390

Date Drilled: June 11, 1979, A

0- 5 Clay, brown, sandy, silty, pebbly, calcareous; moist  
(till)  
5- 19 Chalk, tan, silty, calcareous; moist (Pierre Shale)  
19- 23 Shale, dark gray; with gypsum crystals and thin  
bentonite beds, moist (Pierre Shale)

\* \* \* \*

Test Hole 219

Location: SE SE SE SE sec. 23, T. 101 N., R. 61 W.

Elevation: 1415

Date Drilled: June 25, 1979, B

0- 1 Topsoil, black

Test Hole 219 -- continued.

1- 17 Clay, yellow, silty, pebbly (till)  
17- 28 Marl, tan (Pierre Shale)  
28- 34 Marl, gray, shaley (Pierre Shale)  
34- 39 Shale, black (Pierre Shale)  
39-122 Chalk, gray (Niobrara Formation); lost circulation  
at 122 feet, abandoned hole

\* \* \* \*

Test Hole 220

Location: NE NW NE NE sec. 24, T. 101 N., R. 61 W.

Elevation: 1383

Date Drilled: June 11, 1979, A

0- 3 Clay, light brown, sandy, silty, pebbly, calcareous,  
moist (till)  
3- 5 Clay, dark gray, sandy, silty, pebbly; moist (till)  
5- 8 Clay, white, silty, noncalcareous; moist  
8- 11 Clay, dark brown, sandy, silty, pebbly; moist (till)  
11- 16 Chalk, red-brown, silty; moist (Niobrara Formation)  
16- 23 Chalk, gray; moist (Niobrara Formation)

\* \* \* \*

Test Hole 221

Location: NW NW NE NE sec. 19, T. 101 N., R. 60 W.

Elevation: 1389

Date Drilled: June 20, 1977, B

0- 5 Soil, brown, silty, sandy  
5- 27 Clay, brown, silty, pebbly, quite sandy (till)  
27- 38 Clay, gray, silty, sandy, pebbly (till)  
38- 43 Clay, gray, silty, sandy, pebbly, with some shale  
containing bentonite (till)  
43- 47 Shale, gray, silty, appears highly weathered  
47- 68 Clay, gray, silty, takes some water  
68-106 Clay, light gray  
106-113 Clay, gray, silty  
113-123 Clay, gray, silty, with bentonite  
123-126 Clay, light gray  
126-135 Sand, fine- to medium-cemented, with silt and clay  
layers  
135-156 Shale, gray, silty, with sand lenses  
156-170 Shale, silty, some sand

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Test Hole 222 (DN-78D)

Location: SW SW SW SW sec. 19, T. 101 N., R. 60 W.

Elevation: 1413

Date Drilled: August 29, 1978, G

Test Hole 222 -- continued.

0- 1 Topsoil, black  
1- 16 Clay, tan, silty, pebbly (till)  
16- 17 Clay, red-brown, silty (till)  
17- 21 Clay, light brown, silty (till)  
21- 25 Clay, light brown, silty, gravelly (till)  
25- 32 Clay, light brown, silty (till)  
32- 35 Clay, black; some bentonite, brittle, oil film on  
drilling mud  
35- 95 Clay, gray, silty; some interbedded shale  
95-105 Clay, gray-white (Niobrara)  
105-125 Clay, gray-white

\* \* \* \*

Test Hole 223 (DN-69C)

Location: SW SE SE SE sec. 19, T. 101 N., R. 60 W.

Elevation: 1399

Date Drilled: July 16, 1969, G

0- 1 Topsoil  
1- 28 Clay, yellow  
28- 35 Clay, blue with gray and yellow layers  
35- 52 Clay, blue; hard  
52- 54 Clay, blue; chalky  
54- 80 Chalk, dark gray; solid  
80- 90 Chalk, light gray; solid  
90-100 Chalk, gray-white  
100-111 Chalk, fractured; lost some water  
111-136 Chalk, hard

Observation well: 112 feet of casing

\* \* \* \*

Test Hole 224

Location: NE NE NE NE sec. 20, T. 101 N., R. 60 W.

Elevation: 1360

Date Drilled: September 7, 1979, B

0- 1 Topsoil, gray, silty  
1- 26 Clay, yellow, silty, pebbly (till)  
26- 35 Clay, gray, silty, pebbly (till)  
35- 50 Clay, gray, silty, gravelly (till)  
50- 63 Gravel, medium to coarse grained, coal  
63- 65 Chalk, gray; calcareous

\* \* \* \*

Test Hole 225 (DN-78E)

Location: SW SW SW SW sec. 22, T. 101 N., R. 60 W.

Elevation: 1376

Date Drilled: August 29, 1978, G

Test Hole 225 -- continued.

0- 16 Clay, yellow-brown, silty, pebbly (till)  
16- 21 Clay, red-brown, silty, pebbly; soft (till)  
21- 55 Clay, gray, silty, pebbly (till)  
55- 70 Clay, gray-olive; shaley  
70-105 Chalk, gray-white  
105-122 Chalk, green-gray, silty  
122-125 Clay, gray-white; shaley, abundant organic material  
at base  
125-145 Sandstone, gray-white, fine to medium; clean

Observation well: 145 feet of plastic casing

\* \* \* \*

Test Hole 226

Location: SE SE SE SW sec. 29, T. 101 N., R. 60 W.

Elevation: 1397

Date Drilled: July 5, 1979, B

0- 1 Topsoil  
1- 34 Clay, sandy, silty; oxidized (till)  
34- 95 Clay, gray, sandy, silty (till)  
95-120 Sand? (no sample)  
120-123 Compact layer

Observation well: 2-inch PVC plastic to 123 feet

\* \* \* \*

Test Hole 227

Location: NW NW NW SW sec. 30, T. 101 N., R. 60 W.

Elevation: 1413

Date Drilled: July 21, 1977, B

0- 40 Clay, yellow, silty, pebbly (till)  
40- 46 Clay, light gray  
46- 52 Clay, gray, and bentonitic shale  
52- 55 Clay or chalk; lost circulation

\* \* \* \*

Test Hole 228

Location: NE NE NE NE sec. 27, T. 101 N., R. 61 W.

Elevation: 1432

Date Drilled: July 4, 1979, B

0- 1 Topsoil  
1- 25 Clay, brown, sandy (till)  
25- 42 Clay, light gray, silty (till)  
42- 52 Shale, dark gray and red; with few bentonite layers

Test Hole 228 -- continued.

52-140 Chalk, tan (Niobrara Formation); lost circulation at  
140 feet, abandoned hole

Observation well: 140 feet of 2-inch PVC casing

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Test Hole 229

Location: NE NE NE SE sec. 27, T. 101 N., R. 61 W.

Elevation: 1443

Date Drilled: July 4, 1979, B

0- 1 Topsoil, black  
1- 39 Clay, yellow-brown, silty, pebbly; rock at 23 feet;  
rock at 30 feet (till)  
39- 41 Clay, gray, silty, pebbly (till)  
41- 42 Gravel, medium  
42- 51 Clay, gray, very shaley, pebbly (till)  
51- 66 Clay, whitish, sandy; slightly calcareous  
66- 68 Shale, reworked?  
68- 71 Shale, with green and white bentonite  
71- 73 Clay, black, sandy, with a lot of white bentonite  
73- 80 Clay, dark brown, sandy; slightly calcareous; a lot  
of water lost (Niobrara Formation)  
80- Lost circulation

Observation well: 85 feet of 2-inch PVC casing

\* \* \* \*

Test Hole 230

Location: SE SE SW NE sec. 27, T. 101 N., R. 61 W.

Elevation: 1438

Date Drilled: July 4, 1979, B

0- 2 Topsoil  
2- 17 Clay, brown, sandy; oxidized (till)  
17- 25 Sand, coarse, gravelly, fine to medium  
25- 41 Clay, gray, silty, pebbly (till)  
41- 60 Clay, gray, silty, pebbly, reworked shale pebbles  
60- 61 Gravel layer  
61- 62 Clay, gray, silty, pebbly, reworked shale pebbles  
62- 63 Gravel layer  
63- 66 Clay, light brownish-gray, sandy, pebbly; slightly  
calcareous  
66- 75 Clay, light brownish-gray; calcareous; lost circu-  
lation at 75 feet

Observation well: 75 feet of 2-inch PVC casing

\* \* \* \*



Test Hole 231

Location: SE NE NE SE sec. 27, T. 101 N., R. 61 W.

Elevation: 1435

Date Drilled: July 4, 1979, B

0- 1 Topsoil, black  
1- 18 Clay, yellow-brown, silty, pebbly (till)  
18- 27 Clay, gray, silty, pebbly (till)  
27- 28 Gravel, sandy  
28- 32 Clay, gray, sandy, pebbly (till)  
32- 33 Gravel, fine; sand, coarse  
33- 57 Clay, gray, sandy, pebbly (till)  
57- 58 Gravel  
58- 62 Clay, gray, sandy, pebbly (till)  
62- 63 Shale, pebbles, reworked; much bentonite  
63- 72 Gravel, with brown clay; calcareous; lost circulation at 72 feet

Observation well: 70 feet of 2-inch plastic casing

\* \* \* \*

Test Hole 232

Location: NW NW NW NW sec. 29, T. 101 N., R. 61 W.

Elevation: 1489

Date Drilled: July 3, 1979, B

0- 1 Topsoil  
1- 45 Clay, brown-buff, silty, sandy, medium cobbles, chert; sandier with depth (till)  
45- 60 Clay, gray, sandy, silty, with coal and organics (till)  
60- 85 Shale, dark gray, slightly bentonitic; slightly calcareous  
85- 87 Shale, dark gray, very bentonitic; slightly calcareous  
87-110 Shale, dark gray, slightly bentonitic  
110-145 Shale, light gray, sandy, silty  
145-161 Shale, buff-gray, slightly sandy; very cohesive  
161-162 Compact layer  
162-185 Shale, light gray, sandy  
185-186 Compact layer  
186-205 Shale, light gray, sandy  
205- Lost water

Observation well: 205 feet of 2-inch PVC casing

\* \* \* \*

Test Hole 233

Location: SW SW SW SW sec. 31, T. 101 N., R. 61 W.

Elevation: 1568

Date Drilled: July 24, 1978, B

Test Hole 233 -- continued.

0- 1 Topsoil, black  
1- 28 Clay, yellow-brown, silty, pebbly (till)  
28- 97 Clay, gray, silty, pebbly (till)  
97-101 Shale, dark gray; reworked, soft  
101-189 Shale, dark gray, hard, bentonite; concretions  
189-203 Siltstone, light gray, chalky; moderately calcareous  
203-218 Shale, black; compact, massive  
218-248 Chalk, gray-brown, very silty; highly calcareous  
248-277 Sandstone, fine  
277-331 Siltstone, light gray, chalky; calcareous  
331-333 Sandstone, fine  
333-338 Siltstone, light gray, chalky; calcareous  
338-355 Sandstone, fine; fairly well cemented  
355-358 Shale, dark gray, thin bedded with sandstone layers; a few concretions  
358-374 Sandstone, fine, some thin shale beds; some concretions  
374-380 Concretions(?); difficult drilling

\* \* \* \*

Test Hole 234

Location: SE SE SE SE sec. 33, T. 101 N., R. 61 W.

Elevation: 1470

Date Drilled: July 24, 1978, B

0- 23 Clay, yellow-brown, silty, pebbly (till)  
23- 24 Gravel, fine  
24- 44 Clay, yellow-brown, silty, pebbly (till)  
44- 53 Clay, gray, silty, pebbly, much reworked shale (till)  
53- 71 Shale, dark gray, reworked; bentonite  
71- 73 Shale, light gray; greasy, compact, slightly calcareous (Pierre Shale)  
73- 88 Shale, light gray, sandy; compact, slightly calcareous  
88- 97 Shale, black; bentonite (Pierre Shale)  
97-200 Chalk(?), brownish-gray, sandy; very calcareous (Niobrara Formation)

\* \* \* \*

Test Hole 235 (ET-3)

Location: NE NE NE NE sec. 35, T. 101 N., R. 61 W.

Elevation: 1430

Date Drilled: September 4, 1966, G

0- 35 Clay, yellow  
35- 50 Clay, blue  
50- 55 Sand, gravel streaks  
55- 65 Clay, blue  
65- 70 Sand, gravel, clay

Test Hole 235 -- continued.

70- 80 Chalk

Observation well: 77 feet of casing

\* \* \* \*

Test Hole 236 (ET-2)

Location: NW sec. 35, T. 101 N., R. 61 W.

Elevation: 1448

Date Drilled: August 31, 1966, G

0- 30 Clay, yellow  
30- 40 Clay, blue  
40- 45 Sand and gravel  
45- 80 Clay, blue  
80-135 Shale(?), gray  
135-150 Sand, coarse and gravel  
150-170 Chalk  
170-195 Sandstone (Codell?)  
195-200 Shale, gray

Observation well: 186 feet of plastic

\* \* \* \*

Test Hole 237 (D-69E)

Location: SE NE NE SE sec. 35, T. 101 N., R. 61 W.

Elevation: 1456

Date Drilled: July 8, 1969, G

0- 2 Topsoil  
2- 30 Clay, yellow, silty, sandy, pebbly  
30- 33 Clay, yellow, sandy, gravelly  
33- 35 Clay, blue, silty; hard  
35- 45 Clay, yellow, sandy, gravelly  
45- 73 Clay, white, blue dark gray, very silty; hard and  
soft layers  
73- 75 Clay, dark gray, silty; chalky  
75- 92 Chalk, light gray with black streaks

Observation well: 86 feet of casing

\* \* \* \*

Test Hole 238

Location: SE SE NE NE sec. 32, T. 101 N., R. 60 W.

Elevation: 1391

Date Drilled: July 20, 1977, B

0- 2 Soil, brown, sandy, silty  
2- 27 Clay, brown, silty, pebbly, quite sandy (till)  
27- 82 Clay, gray, silty, sandy, pebbly (till)

Test Hole 238 -- continued.

82-100 Sand and gravel, with clay  
100-104 Clay, white, with wood  
104-112 Sand, mostly limestone; cemented  
112-120 Clay, gray  
120-126 Sand; cemented  
126-134 Clay, gray  
134-169 Sand, fine to medium; cemented  
169-200 Clay, gray, shale-like (Carlile?)

\* \* \* \* \*

Test Hole 239 (DN-78F)

Location: SW SW SW SW sec. 33, T. 101 N., R. 60 W.

Elevation: 1396

Date Drilled: August 30, 1978, G

0- 1 Topsoil, black  
1- 30 Clay, yellow-brown, silty, pebbly (till)  
30- 44 Clay, gray-brown, silty, pebbly (till)  
44- 46 Gravel  
46- 50 Clay, gray-brown, silty, pebbly (till)  
50- 55 Sand and gravel, medium to coarse; limestone and  
shale pebbles  
55- 75 Clay, gray, silty, gravelly; some coal (till)  
75-112 Sand and gravel, medium to coarse; limestone and  
shale pebbles, some clay  
112-125 Clay, gray-brown, silty (Niobrara?)

Observation well: 100 feet of casing

\* \* \* \* \*

Test Hole 240

Location: SE SE SE SE sec. 33, T. 101 N., R. 60 W.

Elevation: 1378

Date Drilled: July 20, 1978, B

0- 2 Topsoil, black  
2- 18 Clay, light brown, pebbly (till)  
18- 48 Clay, gray, pebbly (till)  
48- 53 Sand, fine to medium, subangular to subrounded  
53- 64 Clay, gray, pebbly (till)  
64- 75 Sand and gravel, medium to coarse, subangular, poorly  
sorted  
75-116 Chalk, gray to white; compact, calcareous  
116-142 Shale, gray to black, greasy  
142-145 Shale and sandstone interbedded  
145-146 Sandstone, brown, silty layers; very compact  
146-155 Shale, gray, greasy, interbedded with compact brown  
sandstone  
155-224 Shale, gray, greasy, soft

Test Hole 240 -- continued.

224-225 Quartzite, very compact

\* \* \* \*

Test Hole 241 (DN-78G)

Location: SE SW SW SW sec. 35, T. 101 N., R. 60 W.

Elevation: 1362

Date Drilled: August 30, 1978, G

0- 1 Topsoil, black  
1- 12 Clay, light brown, silty, pebbly (till)  
12- 19 Sand and gravel, clayey  
19- 31 Clay, gray, silty, pebbly, gravelly (till)  
31- 35 Sand, coarse; some fine gravel  
35- 59 Clay, gray, silty, pebbly; soft, organic material  
at 44 feet  
59- 90 Clay, gray-white, silty  
90-95 Chalk, gray-brown, silty; shaley

Observation well: 95 feet of plastic casing

\* \* \* \*

Test Hole 242

Location: SE SE SE SE sec. 36, T. 101 N., R. 60 W.

Elevation: 1355

Date Drilled: July 20, 1978, B

0- 16 Clay, yellow, silty, pebbly (till)  
16- 18 Clay, gray, silty, sandy, pebbly (till)  
18- 24 Sand, reddish-brown, medium, subrounded  
24- 34 Clay, gray, silty, sandy, pebbly (till)  
34- 58 Chalk, white to light brown; weathered, calcareous  
58- 84 Chalk, dark brown, silty; calcareous  
84- 97 Shale, dark gray, hard, some thin layers of bentonite, a few small concretions  
97-116 Sandstone, buff, fine, silty; moderately to well cemented  
116-122 Siltstone, buff; very compact, brittle  
122-190 Shale, dark gray; soft  
190-279 Shale, dark gray, intermittent compact layers  
279-280 Quartzite

\* \* \* \*

## APPENDIX B

### Logs of test holes and observation wells drilled by commercial well drillers for the City of Mitchell, 1975-1977

The locations are given as quarter sections, section number, township, and range.

All elevations have been estimated using a 7 1/2 minute topographic base and are presented in feet above mean sea level.

Prefix before test hole number designates the commercial well driller:

E - Empire Irrigation Drilling Co., Inc., Huron, SD  
H - Huron Drilling Inc., Huron, SD

#### Test Hole E-1

Location: NW NW SW SE sec. 33, T. 104 N., R. 60 W.

Elevation: 1292

Date Drilled: September 18, 1975

0- 2	Topsoil
2- 25	Yellow till
25- 85	Gray till
85- 94	Clay with sand layers
94-176	Chalk rock
176-198	Sandstone
198-250	Clay

Observation well: 190 feet of 2-inch PVC casing

\* \* \* \*

#### Test Hole E-2

Location: NW NW SW NE sec. 29, T. 104 N., R. 60 W.

Elevation: 1290

Date Drilled: September 18, 1975

0- 2	Topsoil
2- 25	Yellow till
25- 75	Gray till
75-101	Gravel and sand
101-120	Chalk rock

Observation well: 90 feet of 2-inch PVC casing

\* \* \* \*

Test Hole E-3

Location: NE NE SE NE sec. 29, T. 104 N., R. 60 W.

Elevation: 1291

Date Drilled: September 18, 1975

0- 2	Topsoil
2- 25	Yellow till
25- 53	Gray till
53- 57	Sand
57- 75	Gray till
75- 85	Clay with sand layers
85-100	Chalk rock

\* \* \* \*

Test Hole E-4

Location: SW NW NW SE sec. 29, T. 104 N., R. 60 W.

Elevation: 1291

Date Drilled: September 14, 1975

0- 2	Topsoil
2- 25	Yellow till
25- 84	Gray till
84-120	Sand and gravel
120-127	Gravel (rocks)
127-140	Chalk rock

Observation well: 130 feet of 2-inch PVC casing

\* \* \* \*

Test Hole E-5

Location: SW SW SE SE sec. 5, T. 103 N., R. 60 W.

Elevation: 1270

Date Drilled: September 19, 1975

0- 2	Topsoil
2- 25	Yellow till
25- 45	Clay with sand
45- 57	Sand
57-100	Sandstone

\* \* \* \*

Test Hole E-6

Location: SW SW SW SW sec. 30, T. 104 N., R. 60 W.

Elevation: 1295

Date Drilled: September 22, 1975

0- 10	Sand
10- 18	Yellow till
18- 48	Gray till
48- 61	Brown gravel

Test Hole E-6 -- continued.

61 -80 Chalk rock, white

\* \* \* \*

Test Hole E-7

Location: SW SE SE NE sec. 5, T. 103 N., R. 60 W.

Elevation: 1285

Date Drilled: September 22, 1975

0- 2 Topsoil  
2- 5 Sand and gravel  
5- 15 Yellow till  
15- 43 Gray till  
43- 71 Sand and gravel  
71- 85 Chalk rock

\* \* \* \*

Test Hole E-8

Location: SE SE SW SW sec. 20, T. 104 N., R. 60 W.

Elevation: 1291.27

Date Drilled: September 22, 1975

0- 2 Topsoil  
2- 25 Yellow till  
25- 38 Gray till  
38- 42 Gravel  
42- 67 Gray till  
67- 76 Sand and gravel  
76- 90 Chalk rock

Observation well: 80 feet of 2-inch PVC casing

\* \* \* \*

Test Hole E-9

Location: SE SE SE SW sec. 20, T. 104 N., R. 60 W.

Elevation: 1291.47

Date Drilled: September 23, 1975

0- 2 Topsoil  
2- 25 Yellow till  
25- 71 Gray till  
71- 90 Sand and gravel  
90-100 Chalk rock

Observation well: 96 feet of 2-inch PVC casing

\* \* \* \*



Test Hole E-10

Location: SW SW SE NW sec. 29, T. 104 N., R. 60 W.

Elevation: 1290

Date Drilled: September 22, 1975

0- 2 Topsoil  
2- 20 Yellow till  
20- 70 Gray till  
70- 80 Chalk

\* \* \* \*

Test Hole E-11

Location: SE SW SE SW sec. 20, T. 104 N., R. 60 W.

Elevation: 1291

Date Drilled: September 22, 1975

0- 2 Topsoil  
2- 15 Yellow till  
15- 69 Gray till  
69- 88 Sand and gravel  
88-100 Chalk rock

\* \* \* \*

Test Hole E-12

Location: NW SW NE SE sec. 29, T. 104 N., R. 60 W.

Elevation: 1291

Date Drilled: September 22, 1975

0- 2 Topsoil  
2- 18 Yellow till  
18- 78 Gray till  
78- 88 Gravel  
88- 95 Chalk rock

Observation well: 90 feet of 2-inch PVC casing

\* \* \* \*

Test Hole E-13

Location: SW NE NW SE sec. 29, T. 104 N., R. 60 W.

Elevation: 1290

Date Drilled: September 23, 1975

0- 2 Topsoil  
2- 15 Yellow till  
15- 25 Gray till  
25- 33 Sand  
33- 82 Gray till  
82- 96 Sand and gravel  
96-134 Gray till  
134-153 Sand and gravel

Test Hole E-13 -- continued.

153-160 Shale

\* \* \* \* \*

Test Hole E-14

Location: NW NW SW SE sec. 29, T. 104 N., R. 60 W.

Elevation: 1292

Date Drilled: September 23, 1975

0- 2 Topsoil  
2- 10 Sand  
10- 96 Gray till  
96-147 Sand and gravel  
147-155 Shale

Observation well: 150 feet of 2-inch PVC casing

\* \* \* \* \*

Test Hole E-15

Location: NE NE SW SE sec. 32, T. 104 N., R. 60 W.

Elevation: 1290

Date Drilled: September 23, 1975

0- 2 Topsoil  
2- 15 Sand and gravel  
15- 33 Gray till  
33- 37 Gravel  
37- 74 Gray till  
74- 78 Gravel  
78- 90 Gray till  
90-148 Sand and gravel  
148-155 Chalk rock

Observation well: 135 feet of 2-inch PVC casing

\* \* \* \* \*

Test Hole E-16

Location: SE sec. 29, T. 104 N., R. 60 W.

Elevation: not measured

Date Drilled: January 30, 1976

0- 2 Topsoil  
2- 18 Yellow till  
18- 75 Gray till  
75- 84 Sand and gravel  
84-125 Gray till  
125-147 Sand and gravel

Test Hole E-16 -- continued.

147-150 Sandstone

Observation well: 145 feet of 2-inch casing

NOTE: Exact location of observation well is unknown, but the driller's log indicates that the well is north of the production well.

This well is not plotted on figure 1.

\* \* \* \*

Test Hole E-17

Location: NW NE SW SE sec. 29, T. 104 N., R. 60 W.

Elevation: 1292

Date Drilled: January 30, 1976

0- 2 Topsoil  
2- 19 Yellow till  
19- 75 Gray till with sand layers  
75- 84 Sand  
84-123 Gray till  
123-140 Sand and gravel

Observation well depth: 135 feet

\* \* \* \*

Test Hole E-18

Location: NE NE SE SW sec. 29, T. 104 N., R. 60 W.

Elevation: 1291

Date Drilled: January 30, 1976

0- 2 Topsoil  
2- 18 Yellow till  
18- 75 Gray till  
75- 80 Gravel  
80- 85 Gray till  
85-123 Sand and gravel  
123-135 Sand rock

Observation well depth: 105 feet

\* \* \* \*

Test Hole E-19

Location: NW NW SW SE sec. 29, T. 104 N., R. 60 W.

Elevation: 1292

Date Drilled: January 31, 1976

0- 2 Topsoil  
2- 18 Yellow till

Test Hole E-19 -- continued.

18- 84 Gray till  
84-134 Sand and gravel  
134-136 Gray till  
136-140 Sand and gravel

Observation well depth: 135 feet

\* \* \* \*

Test Hole E-20

Location: SW NW SW SE sec. 29, T. 104 N., R. 60 W.

Elevation: 1292

Date Drilled: February 2, 1976

0- 2 Topsoil  
2- 18 Yellow till  
18- 84 Gray till  
84-136 Sand and gravel  
136-138 Clay  
138-140 Sand and gravel

Observation well depth: 135 feet

\* \* \* \*

Test Hole E-21

Location: NW NW SW SE sec. 29, T. 104 N., R. 60 W.

Elevation: 1292

Date Drilled: February 3, 1976

0- 2 Topsoil  
2- 18 Yellow till  
18- 82 Gray till  
82-136 Sand and gravel  
136-138 Clay  
138-140 Gravel

Observation well depth: 120 feet

\* \* \* \*

Test Hole E-Production Well (E-P)

Location: NE NW SW SE sec. 29, T. 104 N., R. 60 W.

Elevation: 1292

Date Drilled: January 30, 1976

0- 2 Topsoil  
2- 18 Yellow till  
18- 92 Gray till  
92-143 Sand and gravel

Test Hole E-Production Well -- continued.

143- Clay

Production well depth: 128 feet

\* \* \* \*

Test Hole E-Water Works Well (E-WW)

Location: SW NW NW SW sec. 10, T. 103 N., R. 60 W.

Elevation: 1295

Date Drilled: February 3, 1977

0- 2	Topsoil
2- 12	Clay
12- 50	Chalk rock
50- 60	Sand
60-217	Clay
217-227	Limestone
227-345	Shale
345-347	Coal layers
347-428	Shale
428-450	Sandstone
450-454	Shale
454-	Granite (Sioux Quartzite?)

220 feet of 6-inch casing was used to construct well; remaining casing length unknown.

NOTE: This observation well was finished by Huron Drilling Company.

\* \* \* \*

Test Hole H-1

Location: NE SW NW NW sec. 29, T. 104 N., R. 60 W.

Elevation: 1293

Date Drilled: February 27, 1977

0- 15	Yellow clay
15- 24	Blue clay
24- 27	Sand
27- 35	Clay
37- 40	Sand
40- 73	Blue clay
73-100	Sand and gravel
100-110	Chalk, white
110-137	Chalk
137-155	Hard sand
155-170	Real hard sand
170-185	Shale

\* \* \* \*

Test Hole H-2

Location: NW SW SW SE sec. 29, T. 104 N., R. 60 W.

Elevation: 1292

Date Drilled: February 8, 1977

0- 10	Yellow clay
10- 72	Blue clay
72- 80	Chalk, white
80-110	Chalk, gray
110-115	Chalk
115-145	Codell
145-155	Shale

\* \* \* \*

Test Hole H-3

Location: NW NE NW SE sec. 16, T. 103 N., R. 60 W.

Elevation: 1310

Date Drilled: February 9, 1977

0- 10	Yellow clay
10- 20	Blue clay
20- 50	Hard clay
50- 65	Chalk, some water loss
65- 80	Chalk
80- 90	Shale
90-110	Codell
110-135	Hard sand
135-140	Shale

\* \* \* \*

Test Hole H-4

Location: NE SW SW SE sec. 16, T. 103 N., R. 60 W.

Elevation: 1317

Date Drilled: February 10, 1977

0- 20	Yellow clay
20- 49	Blue clay
49- 50	Sand
50- 54	Blue clay and sand
54- 80	Chalk
80- 99	Shale
99-130	Codell
130-135	Shale

\* \* \* \*

Test Hole H-5

Location: SW NW NW NW sec. 33, T. 104 N., R. 60 W.

Elevation: 1295

Date Drilled: February 10, 1977

0- 10	Yellow clay
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Test Hole H-5 -- continued.

10- 20	Blue clay
20- 35	Blue clay; some gravel
35- 50	Blue clay; some sand streaks
50- 55	Sand
55- 65	Blue clay; sand streaks
65- 70	Blue clay
70-150	Chalk
150-175	Codell
175-	Shale

\* \* \* \*

Test Hole H-6

Location: NE NE NE NE sec. 36, T. 104 N., R. 61 W.  
Elevation: 1306  
Date Drilled: February 11, 1977

0- 10	Yellow sand
10- 44	Blue clay
44- 60	Chalk
60- 65	Dark chalk; some water loss
65- 85	Chalk
85- 90	Shale
90-118	Codell
118-125	Shale

\* \* \* \*

Test Hole H-7

Location: SE NW NW NW sec. 5, T. 103 N., R. 60 W.  
Elevation: 1282  
Date Drilled: February, 1977

0- 1	Topsoil
1- 10	Gravel
10- 20	Clay; some gravel
20- 42	Blue clay
42- 60	Chalk
60- 70	Shale
70- 98	Codell
98-225	Shale
225-230	Hard sand
230-240	Shale; some sand
240-288	Shale
288-300	Sand
300-305	Shale
305-315	Sand streaks
315-330	Shale
330-355	Tuff shale

Test Hole H-7 -- continued.

355-388 Hard sand  
388-394 Hard rock

\* \* \* \* \*

Test Hole H-8

Location: SE NE NE NE sec. 26, T. 104 N., R. 61 W.

Elevation: 1309

Date Drilled: February, 1977

0- 20 Yellow clay  
20- 35 Clay; gravel streaks  
35- 43 Blue clay  
43- 60 Brown sand  
60- 65 Shale  
65- 70 Chalk  
70- 85 Hard sand, round pellets  
85-140 Shale

\* \* \* \* \*

Test Hole H-9

Location: SW NW SW SE sec. 9, T. 103 N., R. 60 W.

Elevation: 1295

Date Drilled: February, 1977

0- 20 Yellow clay  
20- 30 Blue clay  
30- 59 Clay  
59- 85 Codell  
85- 95 Shale

\* \* \* \* \*

Test Hole H-Production Well (H-P)

Location: NE NW NW SE sec. 16, T. 103 N., R. 60 W.

Elevation: 1308

Date Drilled: March 5, 1977

0- 5 Topsoil and gravel  
5- 12 Yellow clay  
12- 20 Blue clay  
20- 40 Blue clay with sand streak  
40- 52 Blue clay  
52- 78 Chalk  
78-100 Sandy shale  
100-106 Sand  
106-125 Hard sand; open streaks



Test Hole H-Production Well (H-P) -- continued.

125-136 Sand  
136-140 Shale

Production well in Cadwell Park. 136 feet deep. 100 feet of 8-inch PVC and 36 feet of 8-inch screen; was pumped for 67 minutes at a rate of 100 gallons per minute. The drawdown was approximately 35 feet.

\* \* \* \*