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DEPARTMENT OF WATER AND NATURAL RESOURCES
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GEOLOGICAL SURVEY
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SANITARY LANDFILL INVESTIGATIONS FOR THE CITY OF HURON

by

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CONTENTS

FIGURES

TABLES

APPENDICES

Introduction

The study was divided into two parts and each will be discussed separately. One part involved the present Huron city landfill and the other involved a search for a new landfill location.

The entire study was financed by the South Dakota Geological Survey and the City of Huron, South Dakota.

Investigation of the Present Landfill Site

This part of the study was undertaken to determine the acceptability, in the geologic and hydrologic sense, of the present landfill for the City of Huron, South Dakota. This part of the study included the drilling of 10 rotary test holes, 1 auger test hole, the installation of 2 observation wells, and collecting and analyzing 6 water samples. The locations of the test holes, observation wells, and water samples are shown in figure 1. The results of the water analyses are presented in table 1 and appendix A contains the test hole logs.

According to the City Engineer of Huron, the lowest operating excavation of the landfill is to be 1264.75 feet above mean sea level. In many of the test holes there was a sand or gravel layer which was encountered near this elevation. Water level measurements taken in the two observation wells on two occasions show the elevation of the water table to be slightly above the lowest operating excavation.

Because of the proximity of the shallow sand or gravel, the water table, and the lowest operating excavation there exists a potential for the direct loss of leachate through the shallow sand

Figure 1

Location of test holes, observation wells, and water samples for the investigation of the present landfill site.

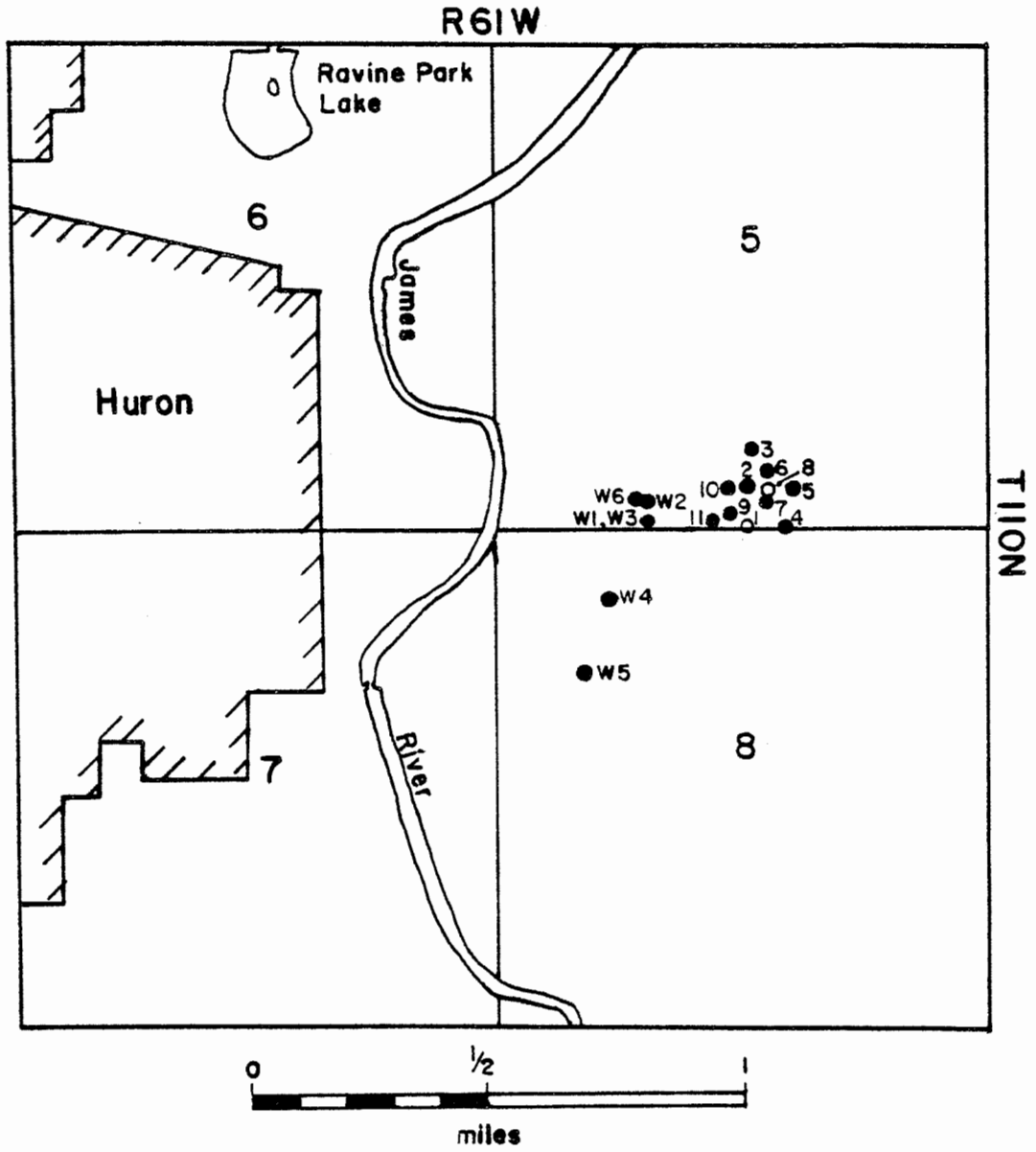

TABLE 1. Water analyses for the investigation of the present landfill site

Sample	Source	Parts Per Million										
		Calcium	Sodium	Magnesium	Chloride	Sulfate	Iron	Manganese	Nitrate Nitrogen	Zinc	Total Conductivity	Total Solids
A		---	---	--	250[1]	250[1]	0.3[1]	0.05[1]	10.0[2]	5.00[1]	----	500[1]
W1[3]	S	380	280	85	140	1430	8.70	2.10	0.5	0.25	2700	3090
W2	Dp	360	265	75	160	1380	2.75	0.07	0.5*	----	----	2480
W3	S	350	270	78	160	1400	1.75	0.65	0.5	----	----	2420
W4	S	350	290	90	165	1450	0.45	0.77	0.5*	----	----	2460
W5	S	360	297	91	155	1500	0.60	0.25	0.5*	----	----	2510
W6	D	345	260	80	155	1380	1.45	0.05	0.5*	----	----	2410

* Less Than

Sample A: [1]Proposed National Secondary Drinking Water Regulations, March 31, 1977 (recommended limits)

[2]National Interim Primary Drinking Water Regulations, December 24, 1975 (enforceable limits)

[3]Organic (plant remains) and inorganic materials present; use results with caution.

SOURCE: S, surface water; D, water from a well drawing from the Dakota Sandstone; Dp, Dakota Sandstone water after it has run through an overflow drain pipe on a stock tank.

Location of water samples
(For map location, see fig. 1)

W1	SW¼SW¼SE¼SW¼ sec. 5, T. 110 N., R. 61 W.
W2	SW¼SW¼SE¼SW¼ sec. 5, T. 110 N., R. 61 W.
W3	SW¼SW¼SE¼SW¼ sec. 5, T. 110 N., R. 61 W.
W4	NE¼SE¼NW¼NW¼ sec. 8, T. 110 N., R. 61 W.
W5	NW¼NE¼SW¼NW¼ sec. 8, T. 110 N., R. 61 W.
W6	NW¼SW¼SE¼SW¼ sec. 5, T. 110 N., R. 61 W.

or gravel into the gully to the west of the landfill and ultimately into the James River without any substantial filtration.

The first water sample, taken from the gully to the west of the landfill, showed an anomalous amount of zinc to be present but further sampling and analyses have failed to confirm this. This does not mean, however, that there is no leachate with a high amount of zinc escaping from the landfill but rather that the water analyses are inconclusive. The failure to detect zinc with further sampling may have been due to a lack of substantial precipitation between the two sampling times. Without the precipitation there would be a decrease in the amount of leachate escaping from the landfill which would allow the flowing well at the head of the gully to dilute any leachate which might be present. Data which supports this idea are the lower water levels observed in the observation wells on the second date of measurement (table 2).

At this time, any conclusion as to whether or not there is leachate escaping into the gully to the west of the landfill would be speculative. There is, however, a specific site location criteria which requires that the lowest portion of fill must be at least 6 feet above the area's normal high water table (Department of Environmental Protection regulation). As is indicated by the data, this 6-foot zone does not exist at the present Huron landfill site.

Investigation of Potential Landfill Sites

This part of the study was undertaken to locate new areas

TABLE 2. Water level measurements in the observation wells at the present landfill site

Hole Number	Date	Elevation of water surface (feet)
1	10-14-77	1265.20
1	10-27-77	1265.04
8	10-14-77	1265.98
8	10-27-77	1265.67

which would be geologically and hydrologically acceptable for use as a sanitary landfill and included the drilling of 52 auger test holes, 2 rotary test holes and the installation of 9 observation wells. The locations of the test holes and observation wells are shown in figure 2 and the test hole logs are contained in appendix B. The study area included all of Beadle County.

Potential landfill sites were first located by examining the topography of an area and the existing test hole information. If the topography was relatively flat so as not to pose any major problems in dealing with surface runoff and the existing test hole information did not show any sand or gravel to be present within 40 feet of the ground surface, the area was considered as potentially acceptable.

One or more test holes were then drilled in each area to determine if any sand or gravel was present which may cause problems with respect to a landfill. If such sand and/or gravel was present, the area was eliminated from consideration as a potential landfill site. If the test holes in a particular area showed no presence of such sand and gravel, an observation well was installed in order that the level of the water table could be measured. No observation well was installed in the area with test holes 7 and 8 (app. B) because of the high water level in the open hole one day after drilling.

After checking the water levels in the observation wells on two separate occasions (table 3), five areas which appeared

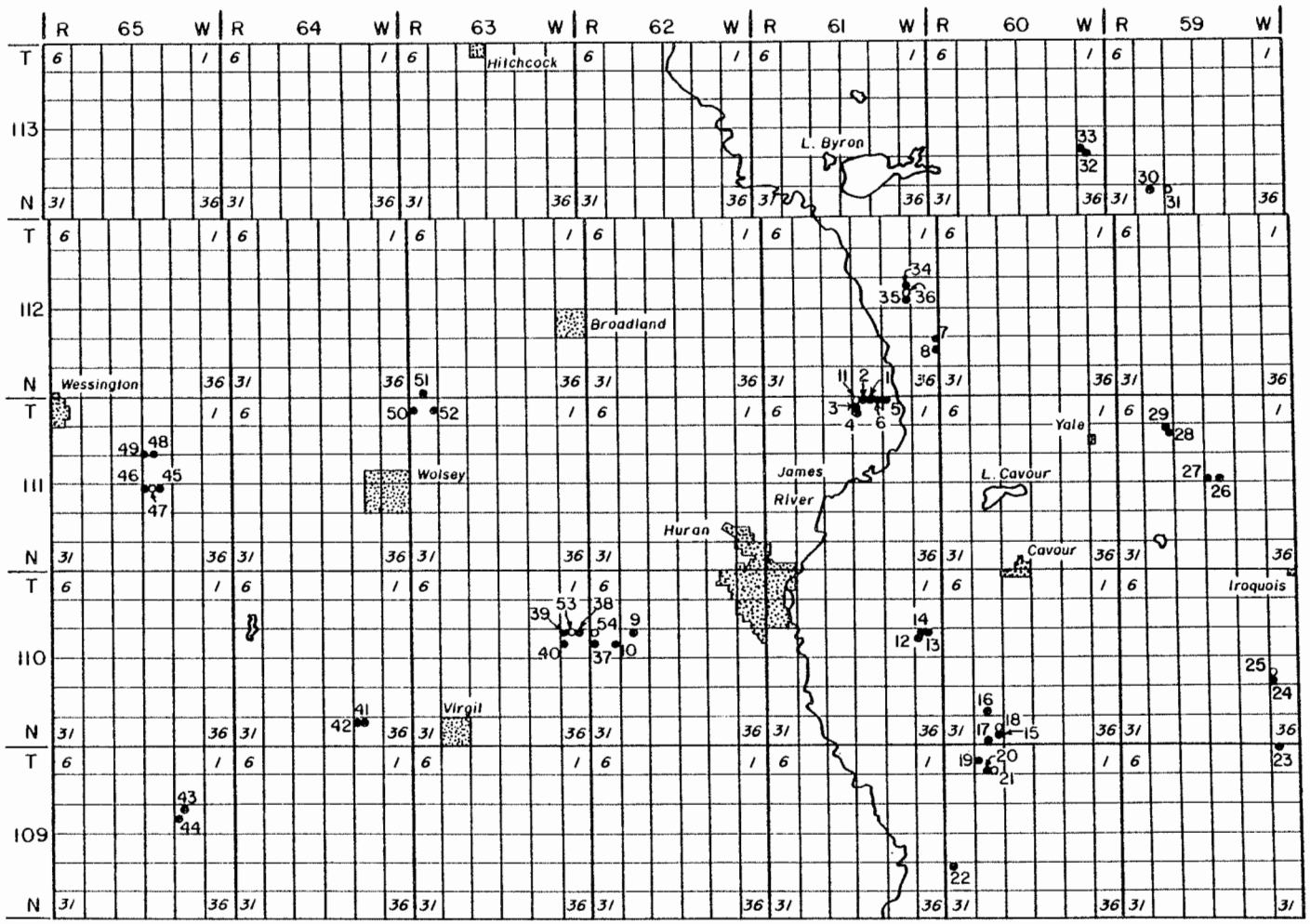

Figure 2

Locations of test holes and observation wells for the investigation of potential landfill sites.

30 Test hole

31 Test hole with observation well.

N

0 1 2 3 4 5
Miles

TABLE 3. Areas which appear to be topographically, geologically, and hydrologically acceptable for landfill placement and the water level measurements therein.

Areas which appear to be topographically, geologically, and hydrologically acceptable	Test hole with observation well	Depth to water from the ground surface in the observation well	
		2-2-78	2-14-78
N½ sec. 3 & E½ sec. 4, T. 111 N., R. 61 W.	11	16.58'	17.31'
NE¼ sec. 14, T. 112 N., R. 61 W.	36	24.63'	--
SW¼ sec. 5, T. 109 N., R. 60 W.	21	18.06'	--
N½ sec. 13, T. 110 N., R. 63 W.	53	--	20.50'
SW¼ sec. 15, T. 111 N., R. 65 W.	47	--	17.50'

to be topographically, geologically, and hydrologically acceptable were located. The lack of data for some of the observation wells in table 3 is due to two reasons. Test holes 47 and 53 had not yet been drilled on the first date of water level measurements and wells in holes 21 and 36 had been destroyed by the second date.

Four other areas (table 4) were topographically and geologically acceptable but had water levels which were too high to meet practical landfill operational requirements. The lack of data for hole 31 on the second date of water level measurements is because the well had been destroyed.

The City of Huron expressed an interest in one of the recommended areas and as a result the Geological Survey drilled test hole 54 and put an observation well in it. This well was to serve as an additional check on the level of the water table.

The five areas listed in table 3 are recommended as potential landfill sites. Should the City of Huron decide to put a landfill in any of these locations, it is recommended that additional test drilling be done in the particular area to insure the absence of any sand or gravel which may cause problems with respect to a landfill. Also, additional checking of the water levels should be done to establish the normal high water table.

TABLE 4. Areas which appear to be topographically and geologically acceptable for landfill placement and the water level measurements therein.

Areas which appear to be topographically and geologically acceptable	Test hole with observation well	Depth to water from the ground surface in the observation well	
		2-2-78	2-14-78
NE¼ sec. 25, T. 112 N., R. 61 W.	none	--	--
NE¼ sec. 32, T. 113 N., R. 59 W.	31	6.66'	--
SE¼ sec. 23, T. 110 N., R. 59 W.	25	11.17'	11.17'
SE¼ sec. 32, T. 110 N., R. 60 W.	18	17.54'	12.63'

APPENDIX A

Test hole logs for the investigation of the present landfill site

All test holes are rotary holes except for BD-8-77 which is an auger hole.

All elevations have been surveyed to ground level and are presented in feet above mean sea level.

Test Hole BD-1-77
Location: SW¼SW¼SW¼SE¼ sec. 5, T. 110 N., R. 61 W.
Date Drilled: September 13, 1977
Elevation: 1277.62

0- 2	Topsoil, black, silty
2- 13	Clay, yellow, silty, pebbly (till)
13- 14	Gravel, fine
14- 19	Clay, yellow, silty, pebbly (till)
19- 24	Clay, gray, silty, pebbly (till)
24- 33	Clay, gray, silty, sandy (till)
33- 39	Clay, gray, silty, pebbly (till)
39- 41	Sand, fine to medium
41- 46	Clay, gray, silty, pebbly, interbedded gravel, fine to medium, approximately 6 inches to 1 foot intervals (till)
46- 57	Clay, gray, silty, pebbly (till)

Observation well: 38 feet deep, slotted from 18 feet to 38 feet.

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Test Hole BD-2-77
Location: NW¼SW¼SW¼SE¼ sec. 5, T. 110 N., R. 61 W.
Date Drilled: September 13, 1977
Elevation: 1277.96

0- 1	Topsoil, black, silty
1- 16	Clay, yellow, silty, pebbly (till)
16- 17	Gravel, fine
17- 19	Clay, yellow, gravelly (till)
19- 34	Clay, gray, silty, pebbly (till)
34- 40	Clay, gray, silty, sandy (till)
40- 42	Sand, coarse, and gravel, fine
42- 48	Clay, gray, silty, pebbly, interbedded gravel layers, fine, 6 inches to 1 foot thick (till)
48- 53	Clay, gray, silty, pebbly (till)
53- 71	Gravel, medium to coarse, shaley

Test Hole BD-2-77 -- continued.

71- 85	Gravel, medium, and sand, coarse, shaley
85- 96	Clay, light-gray, silty, pebbly (till)
96- 98	Gravel, medium
98-107	Clay, gray, silty, gravelly (till)

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Test Hole BD-3-77
Location: SW¼NW¼SW¼SE¼ sec. 5, T. 110 N., R. 61 W.
Date Drilled: September 14, 1977
Elevation: 1276.10

0- 1	Topsoil, black, silty
1- 10	Clay, yellow, silty, pebbly (till)
10- 14	Gravel, fine to medium
14- 19	Clay, yellow, silty, pebbly (till)
19- 34	Clay, gray, silty, pebbly (till)
34- 36	Gravel, medium to coarse
36- 41	Clay, gray, silty, sandy (till)
41- 43	Gravel, medium to fine
43- 62	Clay, gray, silty, pebbly (till)
62- 66	Gravel, coarse
66- 85	Clay, gray, silty, gravelly (till)
85- 95	Chalk (Niobrara)

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Test Hole BD-4-77
Location: SE¼SW¼SW¼SE¼ sec. 5, T. 110 N., R. 61 W.
Date Drilled: September 14, 1977
Elevation: 1282.18

0- 2	Topsoil, black, silty
2- 21	Clay, yellow, silty, pebbly (till)
21- 26	Clay, gray, silty, pebbly (till)
26- 28	Gravel, medium
28- 43	Clay, gray, silty, sandy, some interbedded gravel in 3 inch to 4 inch stringers (till)
43- 46	Gravel, medium
46- 63	Clay, gray, silty, pebbly (till)
63- 65	Gravel, coarse
65- 72	Clay, gray, silty, gravelly (till)
72- 75	Gravel, medium to coarse
75- 77	Clay, gray, silty, pebbly (till)
77- 83	Shale, dark-gray, silty
83- 96	Clay, gray, silty, pebbly (till)
96- 98	Sand, coarse
98-105	Gravel, fine, and sand, coarse
105-107	Clay, gray, silty, pebbly (till)

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Test Hole BD-5-77
Location: NE¼SW¼SW¼SE¼ sec. 5, T. 110 N., R. 61 W.
Date Drilled: September 14, 1977
Elevation: 1281.63

0- 1	Topsoil, black, silty
1- 19	Clay, yellow, silty, pebbly (till)
19- 21	Clay, gray, silty, pebbly (till)
21- 23	Gravel, fine
23- 42	Clay, gray, silty, pebbly (till)
42- 44	Gravel, medium to fine
44- 51	Clay, gray, silty, pebbly (till)
51- 59	Sand, coarse and gravel, fine
59- 64	Gravel, medium to coarse
64- 73	Clay, gray, silty, pebbly, gravelly (till)
73- 74	Gravel, medium
74- 75	Clay, gray, silty, pebbly (till)
75- 76	Sand, coarse
76- 93	Clay, gray, gravelly, shaley (till)
93- 97	Clay, gray, silty, shaley (till)

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Test Hole BD-6-77
Location: SW¼NW¼SW¼SE¼ sec. 5, T. 110 N., R. 61 W.
Date Drilled: September 15, 1977
Elevation: 1279.29

0- 1	Topsoil, black, silty
1- 6	Clay, yellow, silty, pebbly (till)
6- 8	Sand, fine to medium
8- 40	Clay, yellow, silty, pebbly (till)
40- 41	Gravel, medium
41- 43	Clay, gray, silty, pebbly (till)
43- 44	Gravel, coarse
44- 86	Clay, gray, silty, pebbly, gravel layers 4 inches to 6 inches thick (till)
86- 88	Sand, fine to medium
88- 93	Shale, dark-gray, silty
93- 95	Clay, gray, silty, pebbly (till)
95-100	Sand, fine to medium
100-107	Clay, gray, silty, pebbly (till)

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Test Hole BD-7-77
Location: NW¼SW¼SW¼SE¼ sec. 5, T. 110 N., R. 61 W.
Date Drilled: September 15, 1977
Elevation: 1279.47

0- 2	Gravel, medium to coarse
2- 16	Clay, yellow, silty, pebbly (till)

Test Hole BD-7-77 -- continued.

16- 33	Clay, gray, silty, pebbly (till)
33- 34	Gravel, fine
34- 35	Clay, gray, silty, pebbly (till)
35- 36	Gravel, coarse
36- 43	Clay, gray, silty, pebbly (till)
43- 46	Gravel, fine
46- 55	Clay, gray, silty, pebbly (till)
55- 72	Gravel, medium
72- 86	Clay, gray, silty, gravelly (till)
86- 89	Shale, dark-gray, silty, gravelly
89- 97	Clay, light-gray, silty, pebbly, chalky? (till)

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Test Hole BD-8-77
Location: NW¼SW¼SW¼SE¼ sec. 5, T. 110 N., R. 61 W.
Date Drilled: September 15, 1977
Elevation: 1278.56

0- 1	Topsoil, black, silty
1- 19	Clay, yellow-brown, silty, pebbly (till)
19- 45	Clay, gray, silty, pebbly (till)

Observation well: 38 feet deep, slotted from 15 feet to 38 feet

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Test Hole BD-9-77
Location: SE¼SE¼SE¼SW¼ sec. 5, T. 110 N., R. 61 W.
Date Drilled: September 29, 1977
Elevation: 1276.50

0- 1	Topsoil, dark-gray, silty, sandy
1- 2	Gravel, fine to medium
2- 7	Clay, yellow, silty, pebbly (till)
7- 9	Gravel, fine to medium
9- 18	Clay, yellow, silty, pebbly (till)
18- 24	Clay, yellow-gray, silty, pebbly (till)
24- 42	Clay, gray, silty, sandy (till)
42- 43	Sand, coarse
43- 61	Clay, gray, silty, pebbly (till)
61- 64	Gravel, fine, and sand, coarse
64- 76	Clay, gray, silty, pebbly (till)
76- 78	Gravel, fine to medium
78- 92	Clay, gray, silty, gravelly (till)
92- 98	Sand, coarse, and gravel, fine
98-108	Chalk, gray, silty, loss of water

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Test Hole BD-10-77
Location: NE¼SE¼SE¼SW¼ sec. 5, T. 110 N., R. 61 W.
Date Drilled: September 29, 1977
Elevation: 1275.15

0- 1	Topsoil, gray, sandy
1- 3	Sand, medium
3- 18	Clay, yellow, silty, pebbly (till)
18- 22	Clay, gray, silty, pebbly (till)
22- 24	Gravel, fine to medium
24- 60	Clay, gray, silty, pebbly (till)
60- 66	Sand, coarse, and gravel, fine
66- 76	Clay, gray, silty, pebbly (till)
76- 77	Gravel, coarse
77- 93	Shale, dark-gray, pebbly
93-100	Clay, gray, silty, pebbly (till)

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Test Hole BD-11-77
Location: SW¼SE¼SE¼SW¼ sec. 5, T. 110 N., R. 61 W.
Date Drilled: September 29, 1977
Elevation: 1273.81

0- 1	Topsoil, gray, sandy
1- 2	Gravel, fine to medium
2- 15	Clay, yellow, silty, pebbly (till)
15- 17	Clay, gray, silty, pebbly (till)
17- 21	Gravel, fine to medium
21- 25	Sand, coarse, and gravel, fine
25- 36	Clay, gray, silty, sandy (till)
36- 41	Gravel, fine to medium
41- 73	Clay, gray, silty, gravelly, with interbedded 6 inch gravel layers, medium (till)
73- 89	Sand, coarse, shaley
89- 96	Clay, gray, silty, shaley (till)
96-111	Sand, coarse, and gravel, fine
111-117	Clay, gray, silty, pebbly shaley (till)
117-120	Shale, dark-gray to black

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APPENDIX B

Test hole logs for the investigation of potential landfill sites

All test holes are auger holes except for BDS-1-77 and BDS-54-78 which are rotary holes.

All elevations have been estimated using a topographic map and are presented in feet above mean sea level.

Test Hole BDS-1-77
Location: NE¼NE¼NE¼NW¼ sec. 3, T. 111 N., R. 61 W.
Date Drilled: November 7, 1977
Elevation: 1299

0- 2	Topsoil, gray, silty
2-26	Clay, yellow, silty, pebbly (till)
26-34	Clay, gray, silty, pebbly (till)
34-35	Gravel, fine to medium
35-60	Clay, gray, silty, pebbly (till)

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Test Hole BDS-2-77
Location: NE¼NE¼NW¼NW¼ sec. 3, T. 111 N., R. 61 W.
Date Drilled: November 29, 1977
Elevation: 1300

0- 1	Topsoil, dark-brown, silty
1-24	Clay, yellow-brown, silty, pebbly (till)
24-44	Clay, gray-brown, silty, pebbly (till)
44-48	Clay, gray, silty, pebbly (till)

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Test Hole BDS-3-77
Location: SW¼SW¼NW¼NW¼ sec. 3, T. 111 N., R. 61 W.
Date Drilled: November 29, 1977
Elevation: 1305

0- 1	Topsoil, black, silty
1- 8	Clay, yellow, silty, pebbly (till)
8-31	Clay, brown, silty, pebbly (till)
31-42	Clay, brown-gray, very silty, pebbly, saturated (till)
42-48	Clay, gray, silty, pebbly (till)

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Test Hole BDS-4-77
Location: NW¼NW¼NW¼SW¼ sec. 3, T. 111 N., R. 61 W.
Date Drilled: November 29, 1977
Elevation: 1306

0- 1	Topsoil, black, silty
1- 7	Clay, yellow, silty, pebbly (till)
7-28	Clay, brown, silty, pebbly (till)
28-32	Clay, brown-gray, silty, pebbly, saturated (till)
32-48	Clay, gray, silty, pebbly (till)

Water level at 13 feet one day after drilling

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Test Hole BDS-5-77
Location: NW¼NW¼NW¼NW¼ sec. 2, T. 111 N., R. 61 W.
Date Drilled: November 30, 1977
Elevation: 1298

0- 1	Topsoil, dark-brown
1-13	Clay, yellow, silty, pebbly (till)
13-22	Clay, brown-gray, silty, pebbly (till)
22-31	Clay, brown-gray, very silty, pebbly, saturated (till)
31-33	Sand, medium
33-45	Clay, brown-gray, silty, pebbly (till)
45-46	Gravel, fine?
46-48	Clay, gray, silty, pebbly (till)

Water level at 19 feet one day after drilling

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Test Hole BDS-6-77
Location: NE¼NE¼NW¼NE¼ sec. 3, T. 111 N., R. 61 W.
Date Drilled: November 30, 1977
Elevation: 1296

0- 1	Topsoil, dark-brown, silty
1-16	Clay, yellow, silty, pebbly (till)
16-31	Clay, brown-gray, silty, pebbly (till)
31-42	Clay, gray, very silty, pebbly (till)
42-48	Clay, gray, silty, pebbly, hard (till)

Water level at 12½ feet one day after drilling

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Test Hole BDS-7-77
Location: NE¼NE¼NE¼NE¼ sec. 25, T. 112 N., R. 61 W.
Date Drilled: November 30, 1977
Elevation: 1298

0- 1	Topsoil, brown, silty
1- 8	Clay, yellow-brown, silty, pebbly (till)
8-48	Clay, gray, silty, pebbly (till)

Water level at 10 feet one day after drilling

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Test Hole BDS-8-77
Location: SE¼SE¼SE¼NE¼ sec. 25, T. 112 N., R. 61 W.
Date Drilled: November 30, 1977
Elevation: 1297

0- 1	Topsoil, black, silty
1-16	Clay, brown, silty, pebbly (till)
16-48	Clay, gray, silty, pebbly (till)

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Test Hole BDS-9-77
Location: NW¼NW¼NW¼NE¼ sec. 17, T. 110 N., R. 62 W.
Date Drilled: December 1, 1977
Elevation: 1321

0- 1	Topsoil, brown, silty
1-16	Clay, yellow, silty, pebbly (till)
16-21	Clay, gray, silty, pebbly (till)
21-24	Clay, brown, very silty, sandy (till)
24-29	Clay, gray, silty, pebbly, sandy (till)
29-48	Clay, gray, silty, pebbly (till)

Water level at 23 feet one day after drilling

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Test Hole BDS-10-77
Location: SE¼SE¼SE¼NE¼ sec. 18, T. 110 N., R. 62 W.
Date Drilled: December 1, 1977
Elevation: 1312

0- 1	Topsoil, brown, silty
1-11	Clay, yellow, silty, pebbly (till)
11-21	Clay, brown, silty, pebbly (till)
21-48	Clay, gray, silty, pebbly (till)

Water level at 36 feet one day after drilling

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Test Hole BDS-11-77
Location: NW¼NW¼NW¼NW¼ sec. 3, T. 111 N., R. 61 W.
Date Drilled: December 22, 1977
Elevation: 1299

0- 1	Topsoil, black, silty
1- 4	Clay, yellow, silty, pebbly (till)
4-24	Clay, brown, silty, pebbly (till)

Observation well: 24 feet deep, slotted from 15 to 19 feet, sandpoint from 19 to 24 feet.

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Test Hole BDS-12-78
Location: SW¼SW¼NW¼NW¼ sec. 13, T. 110 N., R. 61 W.
Date Drilled: January 24, 1978
Elevation: 1291

0- 3	Topsoil, dark gray to black, silty
3-16	Clay, tan-brown, silty, pebbly (till)
16-37	Clay, gray, very silty, pebbly (till)
37-48	Clay, gray, silty, pebbly, more compact (till)

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Test Hole BDS-13-78
Location: NE¼NE¼NW¼NW¼ sec. 13, T. 110 N., R. 61 W.
Date Drilled: January 24, 1978
Elevation: 1289

0- 2	Topsoil, dark gray, silty
2-19	Clay, yellow-brown, silty, pebbly (till)
18-48	Clay, gray, silty, pebbly (till)

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Test Hole BDS-14-78
Location: NE¼NE¼NW¼NW¼ sec. 13, T. 110 N., R. 61 W.
Date Drilled: January 24, 1978
Elevation: 1291

0- 2	Topsoil, dark gray, silty
2-13	Clay, yellow-brown, silty, pebbly (till)
13-18	Sand, medium to coarse
18-23	Clay, gray, silty, pebbly (till)

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Test Hole BDS-15-78
Location: NE¼NE¼NE¼SE¼ sec. 32, T. 110 N., R. 60 W.
Date Drilled: January 24, 1978
Elevation: 1305

Test Hole BDS-15-78 -- continued.

0- 2	Topsoil, dark gray, silty
2-17	Clay, yellow-brown, silty, pebbly (till)
17-48	Clay, gray, silty, pebbly (till)

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Test Hole BDS-16-78
Location: SE¼SE¼SE¼SW¼ sec. 29, T. 110 N., R. 60 W.
Date Drilled: January 24, 1978
Elevation: 1313

0- 2	Topsoil, black, silty
2-18	Clay, yellow-tan, silty, pebbly (till)
18-36	Sand, medium to coarse
36-48	Clay, brown-gray, very silty, sandy (till)

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Test Hole BDS-17-78
Location: SE¼SE¼SE¼SW¼ sec. 32, T. 110 N., R. 60 W.
Date Drilled: January 24, 1978
Elevation: 1303

0- 2	Topsoil, black, silty
2-17	Clay, yellow-brown, silty, pebbly (till)
17-48	Clay, gray, silty, pebbly (till)

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Test Hole BDS-18-78
Location: NE¼NE¼NE¼SE¼ sec. 32, T. 110 N., R. 60 W.
Date Drilled: January 26, 1978
Elevation: 1305

0- 2	Topsoil, dark gray to black, silty
2-16	Clay, yellow-brown, silty, pebbly (till)
16-23	Clay, gray, silty, pebbly (till)

Observation well: 23 feet deep, slotted from 13 feet to 23 feet

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Test Hole BDS-19-78
Location: SW¼SW¼SW¼NW¼ sec. 5, T. 109 N., R. 60 W.
Date Drilled: January 26, 1978
Elevation: 1293

0- 2	Topsoil, dark gray, silty
2- 5	Clay, tan, silty (till)

Test Hole BDS-19-78 -- continued.

5-21	Clay, yellow-brown, silty, pebbly (till)
21-48	Clay, gray, silty, pebbly (till)

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Test Hole BDS-20-78
Location: SE¼SE¼SE¼SW¼ sec. 5, T. 109 N., R. 60 W.
Date Drilled: January 26, 1978
Elevation: 1294

0- 2	Topsoil, gray, silty
2- 4	Clay, tan, silty (till)
4-16	Clay, yellow-brown, silty, pebbly (till)
16-32	Clay, gray, silty, pebbly (till)
32-44	Clay, gray, very silty, pebbly (till)
44-48	Clay, gray, silty, pebbly, compact (till)

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Test Hole BDS-21-78
Location: SE¼SE¼SE¼SW¼ sec. 5, T. 109 N., R. 60 W.
Date Drilled: January 26, 1978
Elevation: 1294

0- 2	Topsoil, yellow-gray, silty
2- 4	Clay, tan, silty (till)
4-16	Clay, yellow, silty, pebbly (till)
16-23	Clay, gray, silty, pebbly (till)

Observation well: 23 feet deep, slotted from 13 feet to 23 feet

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Test Hole BDS-22-78
Location: NW¼NW¼NE¼NW¼ sec. 30, T. 109 N., R. 60 W.
Date Drilled: January 26, 1978
Elevation: 1296

0-18	Sand, fine to medium

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Test Hole BDS-23-78
Location: NW¼NW¼NE¼NW¼ sec. 1, T. 109 N., R. 59 W.
Date Drilled: January 27, 1978
Elevation: 1366

0- 3	Clay, tan, silty (till)

Test Hole BDS-23-78 -- continued.

3-16	Clay, yellow-brown, silty, pebbly (till)
16-31	Clay, gray, silty, pebbly (till)
31-38	Sand, fine to medium

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Test Hole BDS-24-78
Location: SW¼SW¼SW¼SW¼ sec. 24, T. 110 N., R. 59 W.
Date Drilled: January 27, 1978
Elevation: 1366

0- 2	Topsoil, black
2-21	Clay, yellow-brown, silty, pebbly (till)
21-23	Shale, dark gray to black, appears weathered
23-33	Shale, black, bedrock

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Test Hole BDS-25-78
Location: SW¼SW¼SW¼NW¼ sec. 24, T. 110 N., R. 59 W.
Date Drilled: January 27, 1978
Elevation: 1371

0- 2	Topsoil, black
2- 4	Clay, tan, silty (till)
4-21	Clay, yellow-brown, silty, pebbly (till)
21-23	Shale, dark gray, reworked?

Observation well: 23 feet deep, slotted from 13 feet to 23 feet

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Test Hole BDS-26-78
Location: SE¼SE¼SE¼SW¼ sec. 15, T. 111 N., R. 59 W.
Date Drilled: January 31, 1978
Elevation: 1383

0- 2	Topsoil, gray, silty
2-16	Clay, yellow-brown, silty, pebbly (till)
16-18	Sand, medium to coarse
18-20	Clay, gray, silty, pebbly (till)
20-23	Shale, dark gray to black

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Test Hole BDS-27-78
Location: SW¼SW¼SW¼SW¼ sec. 15, T. 111 N., R. 59 W.
Date Drilled: January 31, 1978
Elevation: 1374

Test Hole BDS-27-78 -- continued.

0- 2	Topsoil, gray, silty
2-20	Clay, yellow-brown, silty, pebbly (till)
20-23	Shale, dark gray, reworked?; hard, oxidized in spots

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Test Hole BDS-28-78
Location: NE¼NE¼SE¼NE¼ sec. 8, T. 111 N., R. 59 W.
Date Drilled: January 31, 1978
Elevation: 1373

0- 1	Topsoil, brown, silty
1-15	Clay, brown, silty, pebbly (till)
15-17	Clay, gray, silty, pebbly (till)
17-21	Shale, dark gray, reworked?
21-23	Shale, black

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Test Hole BDS-29-78
Location: NW¼NW¼NE¼NE¼ sec. 8, T. 111 N., R. 59 W.
Date Drilled: January 31, 1978
Elevation: 1368

0- 1	Topsoil, brown, silty
1-12	Clay, tan, silty, pebbly (till)
12-18	Sand, fine to medium, oxidized

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Test Hole BDS-30-78
Location: NW¼NW¼NW¼NE¼ sec. 32, T. 113 N., R. 59 W.
Date Drilled: January 31, 1978
Elevation: 1392

0- 2	Topsoil, dark brown
2-16	Clay, brown, silty, pebbly (till)
16-17	Shale reworked?
17-18	Shale, dark gray to black

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Test Hole BDS-31-78
Location: NW¼NW¼NW¼NW¼ sec. 33, T. 113 N., R. 59 W.
Date Drilled: January 31, 1978
Elevation: 1400

0- 1	Topsoil, brown, silty
1-18	Clay, brown, silty, pebbly (till)

Test Hole BDS-31-78 -- continued.

18-21	Clay, gray, silty, pebbly (till)
21-33	Shale, dark gray reworked?

Observation well: 33 feet deep, slotted from 18 feet to 33 feet

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Test Hole BDS-32-78
Location: SW¼SW¼SE¼SW¼ sec. 24, T. 113 N., R. 60 W.
Date Drilled: January 31, 1978
Elevation: 1381

0- 2	Topsoil, black, silty
2-48	Clay, brown, silty, pebbly, very compact (till)

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Test Hole BDS-33-78
Location: NW¼NW¼SW¼SW¼ sec. 24, T. 113 N., R. 60 W.
Date Drilled: January 31, 1978
Elevation: 1382

0- 2	Topsoil, black, silty
2-16	Clay, brown, silty, pebbly (till)
16-20	Sand, fine to medium
20-23	Clay, brown, silty, pebbly (till)

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Test Hole BDS-34-78
Location: NE¼NE¼SE¼NE¼ sec. 14, T. 112 N., R. 61 W.
Date Drilled: January 31, 1978
Elevation: 1298

0- 2	Topsoil, dark brown, silty
2-14	Clay, brown, silty, pebbly (till)
14-27	Clay, gray, silty, pebbly (till)
27-48	Clay, gray, very silty

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Test Hole BDS-35-78
Location: SE¼SE¼SE¼NE¼ sec. 14, T. 112 N., R. 61 W.
Date Drilled: February 1, 1978
Elevation: 1298

0- 2	Topsoil, dark brown
2-15	Clay, brown, silty, pebbly (till)

Test Hole BDS-35-78 -- continued.

15-31	Clay, gray, silty, pebbly (till)
13-45	Clay, gray, very silty, pebbly (till)
45-48	Clay, gray, silty, pebbly, compact (till)

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Test Hole BDS-36-78
Location: SE¼SE¼SE¼NE¼ sec. 14, T. 112 N., R. 61 W.
Date Drilled: February 1, 1978
Elevation: 1298

0- 2	Topsoil, dark brown
2-16	Clay, yellow-brown, silty, pebbly (till)
16-23	Clay, gray, silty, pebbly (till)
	Observation well: 23 feet deep, slotted from 8 feet to 23 feet

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Test Hole BDS-37-78
Location: SW¼SW¼SW¼NW¼ sec. 18, T. 110 N., R. 62 W.
Date Drilled: February 1, 1978
Elevation: 1310

0- 2	Topsoil, black
2-19	Clay, yellow-brown, silty, pebbly (till)
19-48	Clay, gray, silty, pebbly (till)

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Test Hole BDS-38-78
Location: NW¼NW¼NW¼NE¼ sec. 13, T. 110 N., R. 63 W.
Date Drilled: February 8, 1978
Elevation: 1308

0- 2	Topsoil
2-15	Clay, yellow, sandy, silty, pebbly (till)
15-23	Clay, gray, sandy, silty, pebbly (till)
23-48	Clay, gray, silty

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Test Hole BDS-39-78
Location: NW¼NW¼NW¼NW¼ sec. 13, T. 110 N., R. 63 W.
Date Drilled: February 7, 1978
Elevation: 1314

0- 8	Clay, light brown, silty, pebbly (till)

Test Hole BDS-39-78 -- continued.

8- 9	Sand, dark brown, medium, dry
9-23	Clay, light yellow-brown, silty, gravelly, moist, a few large rocks (till)
23-35	Clay, light gray, silty, moist (till)
35-48	Clay, dark gray, very silty, sandy, wet (till)

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Test Hole BDS-40-78
Location: SW¼SW¼SW¼NW¼ sec. 13, T. 110 N., R. 63 W.
Date Drilled: February 7, 1978
Elevation: 1312

0- 2	Topsoil, black, silty
2-16	Clay, yellow-brown, silty, pebbly (till)
16-48	Clay, gray, silty, pebbly (till)

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Test Hole BDS-41-78
Location: NE¼NE¼NE¼NW¼ sec. 35, T. 110 N., R. 64 W.
Date Drilled: February 7, 1978
Elevation: 1390

0- 2	Topsoil, black
2-22	Clay, yellow, silty, pebbly (till)
22-27	Sand, fine to medium, wet
27-33	Clay, gray, silty, pebbly (till)

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Test Hole BDS-42-78
Location: NW¼NW¼NW¼NW¼ sec. 35, T. 110 N., R. 64 W.
Date Drilled: February 7, 1978
Elevation: 1392

0- 4	Clay, yellow, silty (till)
4- 7	Gravel, coarse to very coarse, very sandy
7-28	Clay, light brown, silty, sandy, pebbly, moist, large rock at 18 feet to 20 feet (till)
28-38	Clay, light gray, very silty and sandy, wet (till)

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Test Hole BDS-43-78
Location: NW¼NW¼NE¼NW¼ sec. 14, T. 109 N., R. 65 W.
Date Drilled: February 7, 1978
Elevation: 1480

0- 4	Clay, yellow, very silty (till)

Test Hole BDS-43-78 -- continued.

4- 7	Sand, fine, silty
7-39	Clay, yellow-brown, silty, pebbly, moist (till)
39-48	Clay, light gray, very silty, wet (till)

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Test Hole BDS-44-78
Location: NW¼NW¼SW¼NW¼ sec. 14, T. 109 N., R. 65 W.
Date Drilled: February 7, 1978
Elevation: 1465

0- 2	Topsoil, black, silty
2-18	Clay, brown, silty, pebbly (till)
18-32	Clay, gray, silty, pebbly (till)
32-41	Clay, gray, very silty, sandy (till)
41-48	Clay, gray, silty, pebbly (till)

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Test Hole BDS-45-78
Location: NE¼NE¼NE¼NW¼ sec. 22, T. 111 N., R. 65 W.
Date Drilled: February 7, 1978
Elevation: 1415

0- 2	Topsoil
2-32	Clay, yellow-brown, silty, pebbly (till)
32-41	Clay, gray, silty, pebbly (till)
41-48	Clay, dark gray, silty, pebbly (till)

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Test Hole BDS-46-78
Location: NW¼NW¼NW¼NW¼ sec. 22, T. 111 N., R. 65 W.
Date Drilled: February 7, 1978
Elevation: 1402

0-10	Clay, light brown, very silty (till)
10-19	Clay, light brown (till)
19-48	Clay, dark gray, silty, pebbly, very compact, slightly moist (till)

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Test Hole BDS-47-78
Location: NE¼NE¼NE¼NW¼ sec. 22, T. 111 N., R. 65 W.
Date Drilled: February 7, 1978
Elevation: 1415

0- 2	Topsoil, black, silty

Test Hole BDS-47-78 -- continued.

2-23	Clay, yellow-brown, silty, pebbly (till)
	Observation well: 21 feet deep, slotted from 6 feet to 21 feet

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Test Hole BDS-48-78
Location: SE¼SE¼SE¼SW¼ sec. 10, T. 111 N., R. 65 W.
Date Drilled: February 7, 1978
Elevation: 1401

0- 2	Topsoil, black, silty
2-15	Clay, yellow-brown, silty, pebbly (till)
15-36	Clay, gray, silty, pebbly (till)
36-48	Silt, gray, clayey

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Test Hole BDS-49-78
Location: SW¼SW¼SW¼SW¼ sec. 10, T. 111 N., R. 65 W.
Date Drilled: February 7, 1978
Elevation: 1412

0- 7	Clay, dark brown, silty (till)
7-27	Clay, yellow, very silty, pebbly (till)
27-42	Clay, dark brown, very silty, sandy, very wet (till)
42-48	Clay, dark gray, pebbly, very stiff, moist (till)

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Test Hole BDS-50-78
Location: SW¼SW¼SW¼NW¼ sec. 6, T. 111 N., R. 63 W.
Date Drilled: February 8, 1978
Elevation: 1340

0- 4	Sand, fine to medium
4-21	Clay, yellow-brown, silty, pebbly (till)
21-26	Clay, gray, silty, pebbly (till)
26-48	Clay, gray, very silty, sandy (till)

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Test Hole BDS-51-78
Location: SE¼SE¼SE¼SW¼ sec. 31, T. 112 N., R. 63 W.
Date Drilled: February 8, 1978
Elevation: 1335

0-19	Clay, yellow, silty, pebbly, moist (till)

Test Hole BDS-51-78 -- continued.

19-28	Sand, dark brown, fine to medium, very silty, wet

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Test Hole BDS-52-78
Location: SE¼SE¼SE¼NE¼ sec. 6, T. 111 N., R. 63 W.
Date Drilled: February 8, 1978
Elevation: 1343

0-22	Clay, yellow, silty, pebbly, dry (till)
22-38	Clay, dark gray, pebbly (till)

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Test Hole BDS-53-78
Location: NW¼NW¼NW¼NE¼ sec. 13, T. 110 N., R. 63 W.
Date Drilled: February 8, 1978
Elevation: 1308

0- 2	Topsoil
2-15	Clay, yellow, sandy, silty, pebbly (till)
15-23	Clay, gray, sandy, silty, pebbly (till)
23-28	Clay, gray, silty

Observation well: 28 feet deep, slotted from 14 feet to 28 feet

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Test Hole BDS-54-78
Location: NW¼NW¼NW¼NW¼ sec. 18, T. 110 N., R. 62 W.
Date Drilled: May 18, 1978
Elevation: 1305

0- 2	Topsoil, black, clayey
2-13	Clay, brown, sandy, pebbly (till)
13-40	Clay, gray, sandy, pebbly (till)

Observation well: 37 feet deep, slotted from 17 feet to 37 feet

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