

# Site Suitability Review of the New Rockford Landfill

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Prepared by the  
North Dakota Geological Survey  
and the  
North Dakota State Water Commission

ND Landfill Site Investigation No. 40

SITE SUITABILITY REVIEW  
OF THE  
NEW ROCKFORD LANDFILL

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Prepared by the NORTH DAKOTA GEOLOGICAL SURVEY  
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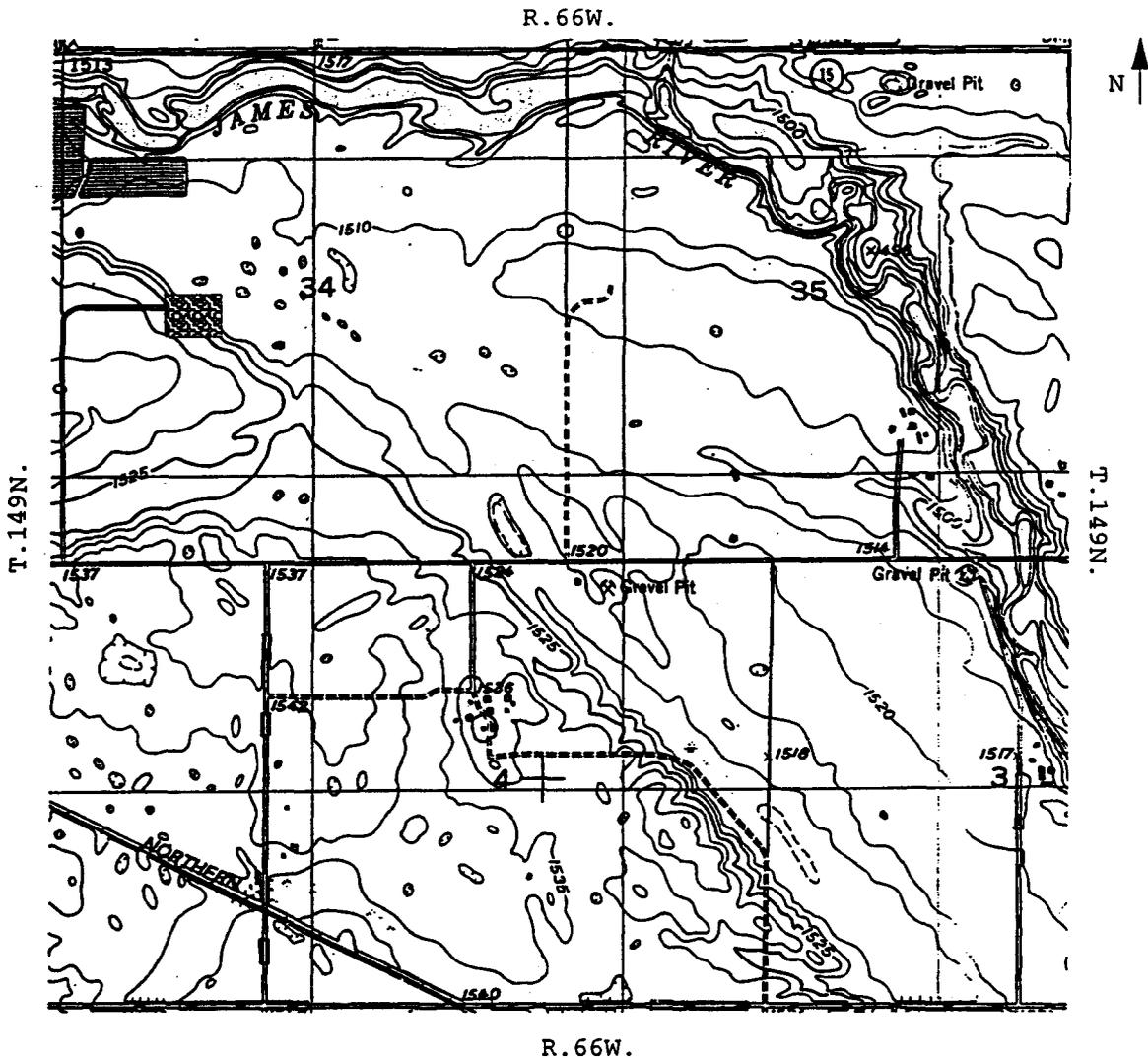
## INTRODUCTION

### Purpose

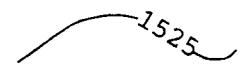
The North Dakota State Engineer and the North Dakota State Geologist were instructed by the 52<sup>nd</sup> State Legislative Assembly to conduct site-suitability reviews of the solid waste landfills in the state of North Dakota. These reviews are to be completed by July 1, 1995 (North Dakota Century Code 23-29-07.7). The purpose of this program is to evaluate site suitability of each landfill for disposal of solid waste based on geologic and hydrologic characteristics. Reports will be provided to the North Dakota State Department of Health and Consolidated Laboratories (NDS DHCL) for use in site improvement, site remediation, or landfill closure. A one time ground-water sampling event was performed at each site, and additional studies may be necessary to meet the requirements of the NDS DHCL for continued operation of solid waste landfills. The New Rockford solid-waste landfill is one of the landfills being evaluated.

### Location of the New Rockford Landfill

The New Rockford solid waste landfill is located about one mile east of the City of New Rockford in the N 1/2, SW 1/4, Section 34, Township 149 North, Range 66 West (Fig. 1). The landfill encompasses approximately 15 acres.



 Landfill Boundary

  
Elevation in feet above  
MSL (NGVD, 1929)

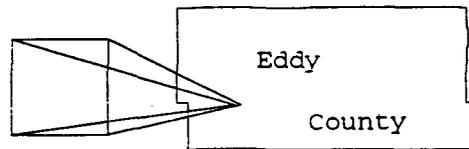


Figure 1. Location of the New Rockford landfill in the SW 1/4, Section 34, T.149N., R.66W.

## Previous Site Investigations

Three test borings were drilled at the landfill in 1982. The boring logs report clay and till material with gravel layers at two sites.

## Methods of Investigation

The New Rockford landfill study was accomplished by means of: 1) drilling test holes; 2) constructing and developing monitoring wells; 3) collecting and analyzing water samples; and 4) measuring water levels. Well abandonment procedures were followed for non-permanent monitoring wells.

## Test-Drilling Procedure

The drilling method was based on the site's geology and depth to ground water, as determined by the preliminary site evaluation. A hollow stem auger was used at the New Rockford landfill because the water table was expected to be relatively shallow. The lithologic descriptions were determined from the drill cuttings. The water used with the rig was obtained from municipal water supplies.

## Monitoring Well Construction and Development

Four test holes were drilled at the New Rockford landfill, and a monitoring well was installed in each test hole. The number of wells installed was based on the geologic and topographic characteristics of the site. The depth and intake interval of each well was selected to monitor the water level at the top of the uppermost aquifer. The wells were placed around the perimeter of the landfill.

Wells were constructed following a standard design (Fig. 2) intended to comply with the construction regulations of the NDSHCL and the North Dakota Board of Water Well Contractors (North Dakota Department of Health, 1986). The wells were constructed using a 2-inch diameter, SDR21, polyvinyl chloride (PVC) well casing and a PVC screen, either 5 or 10 feet long, with a slot-opening size of 0.012 or 0.013 inches. The screen was fastened to the casing with stainless steel screws (no solvent weld cement was used). After the casing and screen were installed into the drill hole, the annulus around the screen was filled with No. 10 (grain-size diameter) silica sand to a height of two feet above the top of the screen. High-solids bentonite grout and/or neat cement was placed above the silica sand to seal the annulus to approximately five feet below land surface. The remaining annulus was filled with drill cuttings. The permanent wells were secured with a protective steel casing and a locking cover protected by a two-foot-square concrete pad.

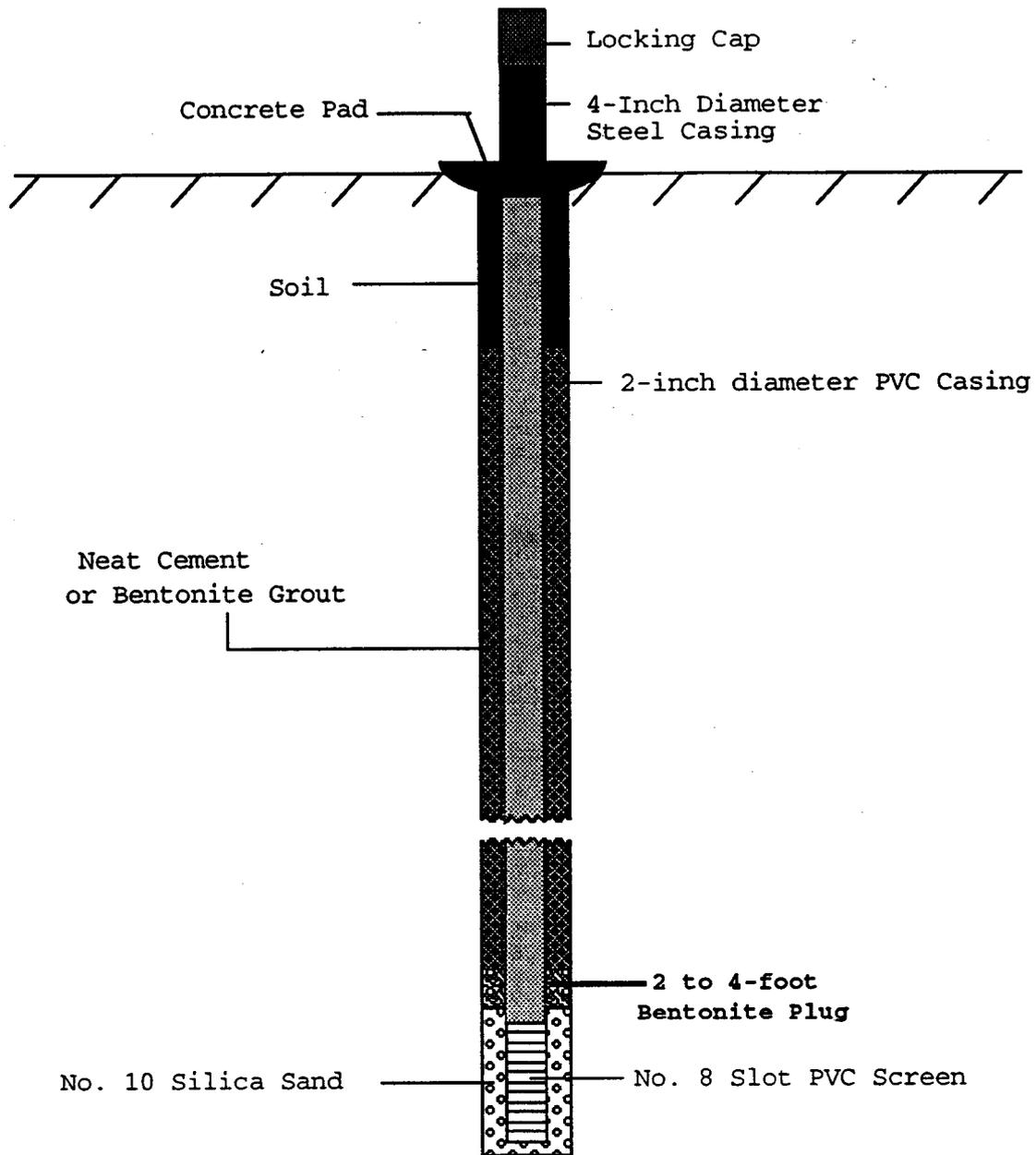


Figure 2. Construction design used for monitoring wells installed at the New Rockford landfill.

All monitoring wells were developed using a stainless steel bladder pump or a teflon bailer. Any drilling fluid and fine materials present near the well were removed to insure movement of formation water through the screen.

The Mean Sea Level (MSL) elevation was established for each well by differential leveling to Third Order accuracy. The surveys established the MSL elevation at the top of the casing and the elevation of the land surface next to each well.

#### Collecting and Analyzing Water Samples

Water-quality analyses were used to determine if leachate is migrating from the landfill into the underlying ground-water system. Selected field parameters, major ions, and trace elements were measured for each water sample. These field parameters and analytes are listed in Appendix A with their Maximum Contaminant Levels (MCL). MCLs are enforceable drinking water standards that represent the maximum permissible level of a contaminant as stipulated by the U.S. Environmental Protection Agency (EPA).

Water samples were collected using a bladder pump constructed of stainless steel with a teflon bladder. A teflon bailer was used in monitoring wells with limited transmitting capacity. Before sample collection, three to four well volumes were extracted to insure that unadulterated formation water was sampled. Four samples from each well

were collected in high density polyethylene plastic bottles as follows:

- 1) Raw (500 ml)
- 2) Filtered (500 ml)
- 3) Filtered and acidified (500 ml)
- 4) Filtered and double acidified (500 ml)

The following parameters were determined for each sample. Specific conductance, pH, bicarbonate, and carbonate were analyzed using the raw sample. Sulfate, chloride, nitrate\*, and dissolved solids were analyzed using the filtered sample. Calcium, magnesium, sodium, potassium, iron, and manganese were analyzed from the filtered, acidified sample. Cadmium, lead, arsenic, and mercury were analyzed using the filtered double-acidified samples.

One well was sampled for Volatile Organic Compounds (VOC) analysis. This sample was collected at a different time than the standard water-quality sample. The procedure used for collecting the VOC sample is described in Appendix B. Each sample was collected with a plastic throw-away bailer and kept chilled. These samples were analyzed within the permitted 14-day holding period. The standard water-quality analyses were performed at the North Dakota State Water Commission (NDSWC) Laboratory and VOC analyses were performed by the NDS DHCL.

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\* No special preservative techniques were applied to nitrate samples and as a result reported nitrate concentrations may be lower than actual.

## Water-Level Measurements

Water-level measurements were taken at least three times at a minimum of two-week intervals. The measurements were taken using a chalked-steel tape or an electronic (Solnist 10078) water-level indicator. These measurements were used to determine the shape and configuration of the water table.

## Well-Abandonment Procedure

The test holes and monitoring wells that were not permanent were abandoned according to NDS DHCL and Board of Water Well Contractors regulations (North Dakota Department of Health, 1986). The soil around the well was dug to a depth of approximately three to four feet below land surface (Fig. 3) to prevent disturbance of the sealed wells. The screened interval of the well was plugged with bentonite chips to a height of approximately one foot above the top of the screen and the remaining well casing was filled with neat cement. The upper three to four feet was then filled with cuttings and the disturbed area was blended into the surrounding land surface. Test holes were plugged with high-solids bentonite grout and/or neat cement to a depth approximately five feet below land surface. The upper five feet of the test hole was filled with soil cuttings.

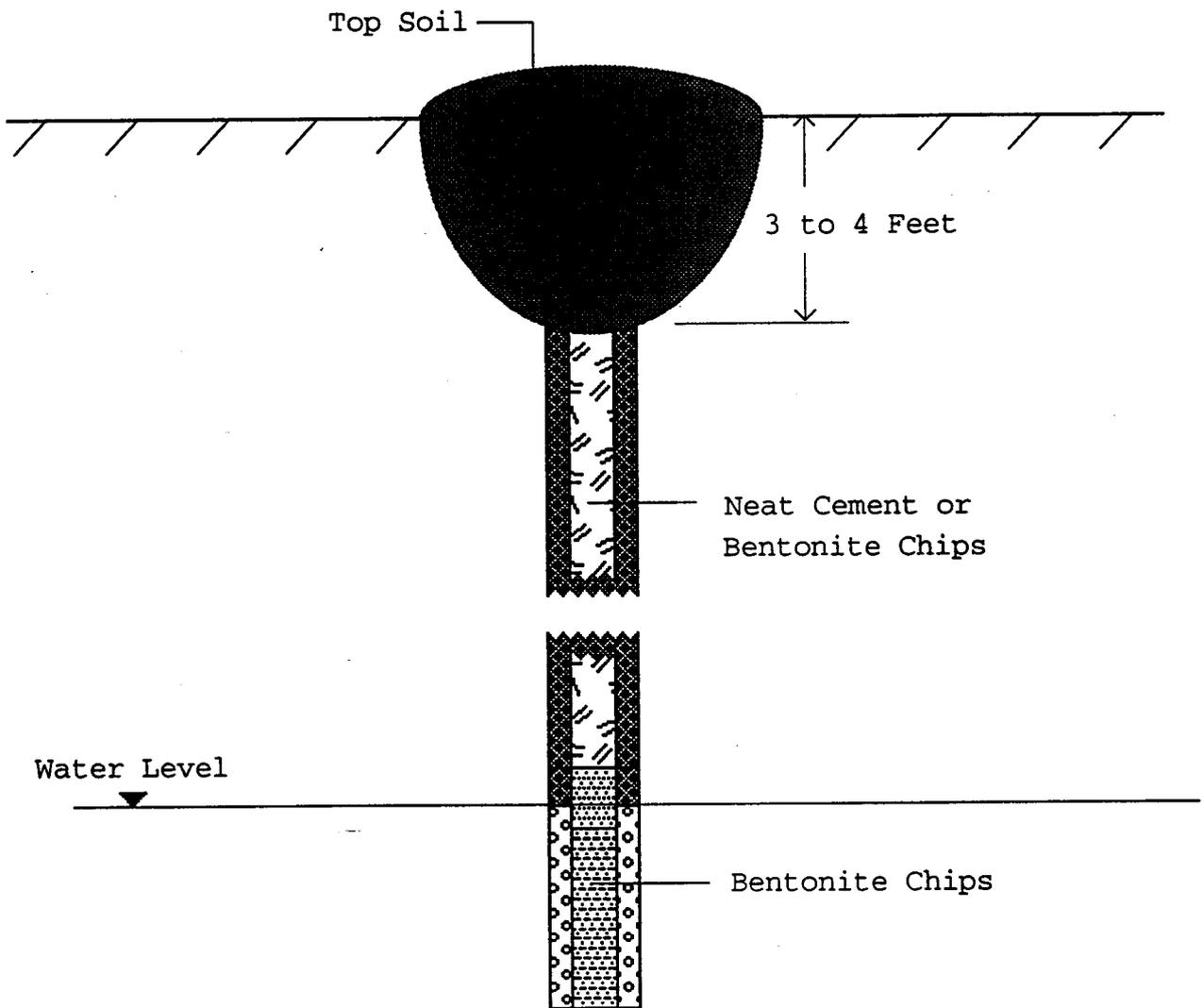


Figure 3. Monitoring well abandonment procedures.

## Location-Numbering System

The system for denoting the location of a test hole or observation well is based on the federal system of rectangular surveys of public land. The first and second numbers indicate Township north and Range west of the 5th Principle Meridian and baseline (Fig. 4). The third number indicates the section. The letters A, B, C, and D designate, respectively, the northeast, northwest, southwest, and southeast quarter section (160-acre tract), quarter-quarter section (40-acre tract), and quarter-quarter-quarter section (10-acre tract). Therefore, a well denoted by 149-066-34CBA would be located in the NE1/4, NW1/4, SW1/4, Section 34, Township 149 North, Range 66 West. Consecutive numbers are added following the three letters if more than one well is located in a 10-acre tract, e.g. 149-066-34CBA1 and 149-066-34CBA2.

## GEOLOGY

### Regional Geology

The New Rockford region contains a variety of glacial deposits which originated from several phases of glacial activity. A large buried valley located south of the City of New Rockford extends from the Minot area in Ward County to southeastern Foster County, a distance of about 150 miles.

149-066-34CBA

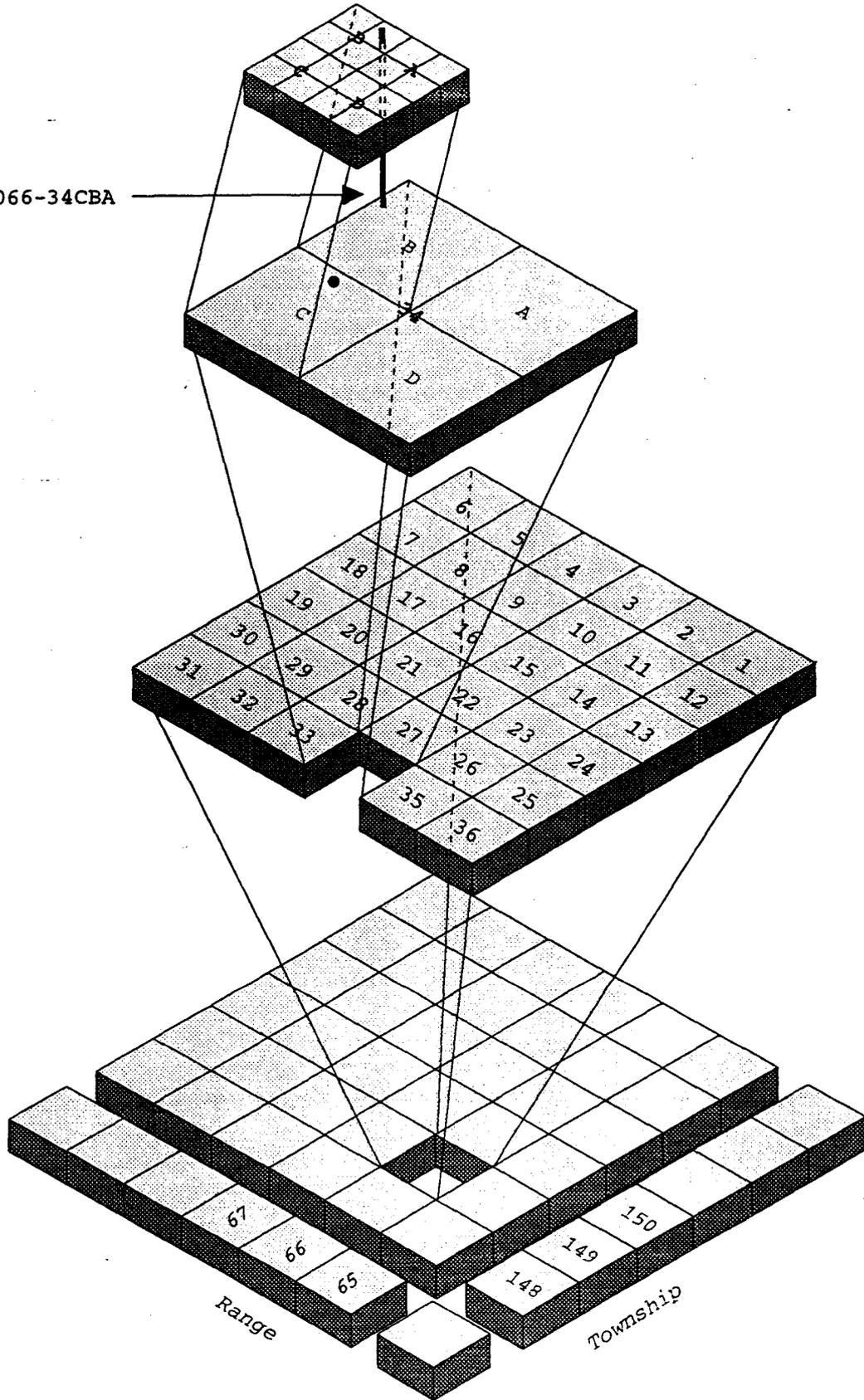


Figure 4. Location-numbering system for the New Rockford landfill.

This feature was originally called the Heimdal trench but is now generally referred to as the New Rockford channel. Test holes drilled in the channel (Trapp, 1966) indicate that it is about 250 feet deep and contains as much as 150 feet of sand and gravel. The channel probably developed when Pleistocene glaciers advanced southward and blocked the north-flowing Knife and Cannonball Rivers (Patch and Knell, 1988).

The New Rockford channel is overlain by about 100 feet of sediments formed during the recession of the late Wisconsin ice sheet from the area (Bluemle, 1965). These sediments include till, outwash, and minor lake deposits. An outwash plain to the north and east of the New Rockford landfill occupies much of central Eddy County. This low-relief area is blanketed with 5 to 20 feet of Pleistocene river sediment. Part of the outwash plain is now occupied by the floodplain of the James River. South of the landfill the near-surface deposits consist of collapsed glacial sediments with a few small abandoned stream valleys.

The total thickness of glacial deposits in the area is extremely variable because of erosion on the bedrock surface. The thickness ranges from 10 feet west of New Rockford (test hole 149-66-32BAD, Trapp, 1966) to more than 250 feet in the New Rockford channel. The uppermost bedrock unit is the Cretaceous Pierre Formation.

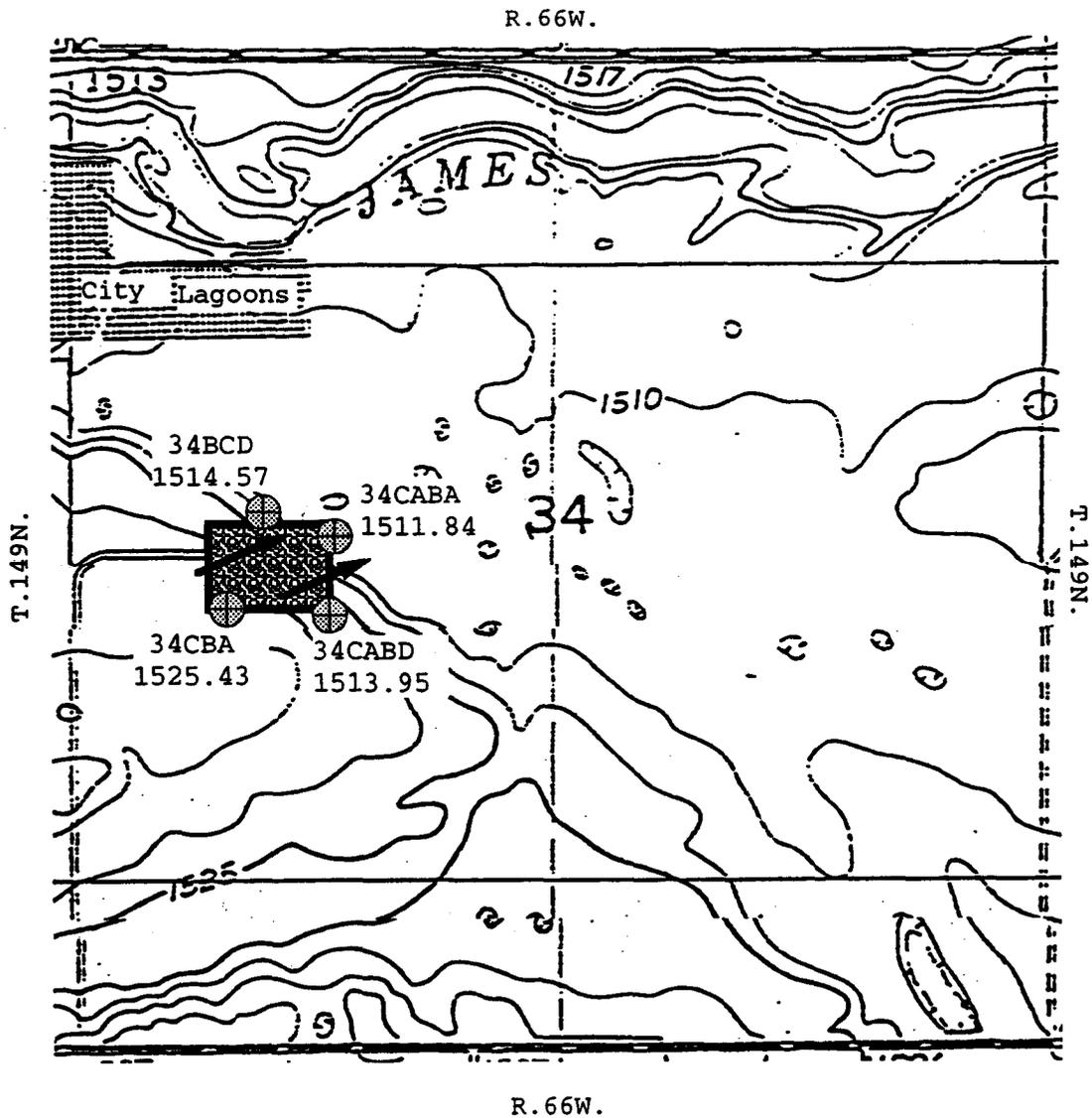
## Local Geology

The landfill is located on the southern edge of the outwash plain and partially in the floodplain of the James River. Surface elevations at the landfill range from about 1515 to 1530 feet. The ground surface slopes northeast toward the outwash plain (Fig. 5). The buried New Rockford channel is south of the landfill.

The geologic materials at the landfill site include till, sand, and gravel. A thick layer of sand occurs at the surface in test hole 149-066-34CBA, located at the southwest corner of the landfill (Fig. 6, lithologic logs in Appendix C). Sand also occurs at the surface at test hole 34BCD near the northwest corner of the landfill (not shown on cross section). On the east side of the landfill the surficial material is till.

A layer of gravel is present at the base of test holes 34CBA and 34CABD on the south side of the landfill. The thickness and lateral extent of the gravel are not known.

The upper surface of the New Rockford channel deposits has an elevation of about 1420 to 1430 feet (test holes 148-66-3DDC, 6CCB, 7BBC, and 7CBC, Trapp, 1966), whereas the gravel layer beneath the landfill occurs at an elevation of 1490 to 1500 feet. This gravel is unlikely to be connected with the New Rockford channel; it is probably a local outwash deposit formed during the recessionary phase of glaciation.



● SWC Monitoring Wells

—— Landfill Boundary

■ Buried Refuse

→  
Direction of  
Ground-Water Flow

1525  
Elevation in feet  
above MSL (NGVD, 1929)

34CBA  
1525.43  
Well Number and  
Water-Level Elevation  
10/25/94

Figure 5. Location of monitoring wells and the direction of ground-water flow.

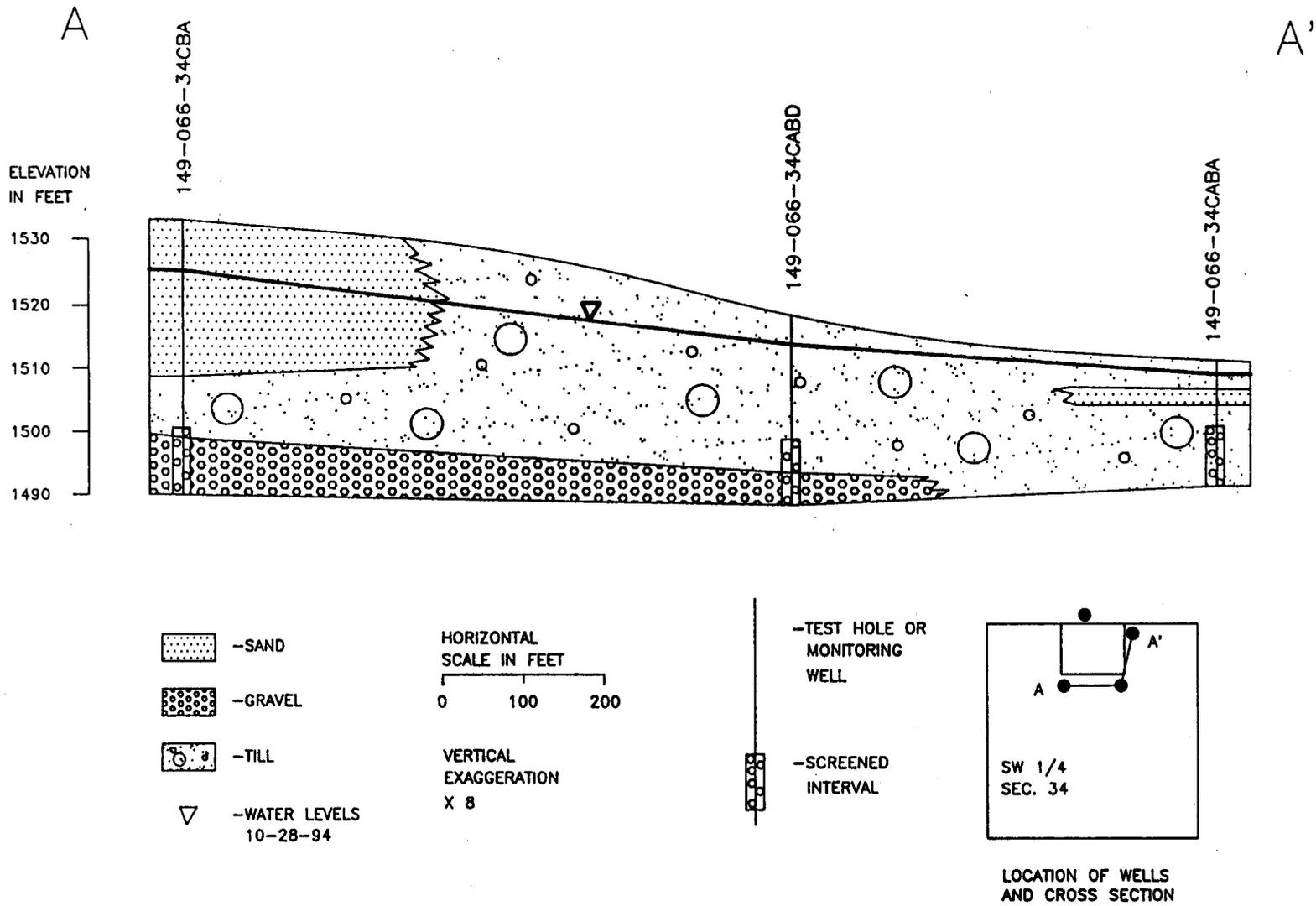


Figure 6. Geohydrologic section A-A' in the New Rockford landfill.

## HYDROLOGY

### Surface-Water Hydrology

The James River is located within one-half mile north-northeast of the landfill. The James River valley appears to be inundated due to the heavy rains during the summer of 1993 and 1994. The northern and eastern boundaries of the landfill intersect the James River valley. The James River valley may be susceptible to contaminant migration by surface runoff from the landfill.

### Regional Ground-Water Hydrology

Regional aquifers near the New Rockford landfill consist of bedrock and glacial lithologies. The most extensive bedrock aquifer is located in the Dakota Formation. The Dakota aquifer is greater than 1500 feet below land surface (Trapp, 1968). The Dakota aquifer is characterized by a sodium-chloride, bicarbonate type water (Trapp, 1968).

The Pierre Formation underlies the glacial drift and may contain small quantities of water located in highly fractured zones. The water chemistry is variable in the Pierre aquifer and is characterized by a sodium-bicarbonate to a sodium-chloride type water. This aquifer should not be affected by contaminant migration due to the thickness and low transmitting capacity of the overlying till near the landfill.

The New Rockford landfill overlies the northern edge of the New Rockford aquifer. The New Rockford aquifer consists of outwash sand and gravel with an average thickness of about 160 feet (Trapp, 1968). The City of New Rockford obtains its water supply from the New Rockford aquifer southwest of the city limits. This aquifer is recharged by precipitation and infiltration of lakes, wetlands, streams, and rivers and by upward ground-water movement from the Pierre aquifer. The New Rockford aquifer is characterized by a sodium-bicarbonate type water (Trapp, 1968). This aquifer may be susceptible to contaminant migration from the landfill.

Undifferentiated aquifers are present in isolated sand and gravel deposits. These aquifers are generally small in size and contain small amounts of water. The ground-water chemistry in these aquifers is variable. It is not known if undifferentiated aquifers exist near the New Rockford landfill.

#### Local Ground-Water Hydrology

Four test holes were drilled at the New Rockford landfill and monitoring wells were installed at each site (Fig. 4). The well screens were placed near the top of the uppermost aquifer. Five water-level measurements were taken over a five week period (Appendix D). The sand and gravel aquifer underlying the landfill, appears to be confined

beneath a 10-foot layer of till. The direction of groundwater flow is to the east-northeast toward the James River.

Well 34CABA is located at the northeast corner of the landfill down-gradient of the landfill on the western edge of the James River Valley and is screened in a layer of sandy-gravelly till (Fig. 4). Well 34CBA is located at the southwest corner of the landfill and is used as the up-gradient well. This well is screened in a layer of gravelly sand.

#### Water Quality

Chemical analyses of water samples are shown in Appendix E. Monitoring well 34CABA detected an elevated chloride concentration of 280 mg/L. This concentration exceeds the SMCL of 250 mg/L and is significantly higher than the other three wells. Monitoring well 34CABA also detected an anomalously high concentration of nitrate (110 mg/L). This concentration exceeds the MCL of 50 mg/L. The source of these elements may be indicative of contaminant migration from the landfill as monitoring well 34CABA is located directly down-gradient within the Jamestown River valley. The contamination may also originate from the New Rockford sewage lagoons located northwest of the landfill in the James River valley. Nitrate migration from the lagoons may be possible due to the sand and gravel deposits in the river valley. The pH measurements indicated the ground water is

slightly acidic at wells 34CABA (6.72) and 34CBA (6.8) (Appendix E). The natural pH of the ground water, in the area of the landfill, is near 7.0. The lower pH detections do not appear to be due to contaminant migration from the landfill.

The trace element analyses indicated a selenium concentration of 6 µg/L in well 34CABA. This concentration is significantly higher than the other three wells but is slightly lower than the MCL of 10 µg/L. The source of the elevated selenium may be due to natural concentrations and/or contaminant migration from the landfill.

The results of the VOC analysis, from well 34CABA, are shown in Appendix F. The VOC analysis indicated three compounds above the detection limits. These compounds are chloroform (3.61 µg/L), bromodichloromethane (0.85 µg/L), and dichloromethane (1.04 µg/L). It is inconclusive whether the source of this VOC compound is the result of laboratory contamination<sup>†</sup> or migration from the landfill or sewage lagoons.

## CONCLUSIONS

The New Rockford landfill is located on the southwestern edge of the James River floodplain. Heavy rainfall during

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<sup>†</sup> Beginning in September, 1994 the NDSHCL changed their analytical procedures that lowered detection limits for VOC concentrations by one to two orders of magnitude.

the summers of 1993 and 1994 resulted in large areas of wet ground and standing water on the floodplain.

The geologic materials at the landfill consist of glacial till interbedded with layers of sand and gravel. The sand and gravel layers appear to be outwash deposits formed during the recession of the Late Wisconsinan ice sheet from the area. It is not known whether they are laterally extensive enough to provide routes for leachate migration to the New Rockford aquifer.

Ground water occurs at relatively shallow depths beneath the landfill. The sand and gravel aquifer underlying the landfill appears to be confined beneath a 10-foot layer of till. The direction of ground-water flow is east-northeast, toward the James River.

Chemical analyses of ground water showed evidence of contamination in monitoring well 34CABA, which is located at the northeast corner of the landfill. Water samples from this well contained high concentrations of chloride (280 mg/l), and nitrate (110 mg/l). This well also detected an elevated concentration of selenium compared with the other three monitoring wells. The source of these elements may originate from the landfill or the sewage lagoons located northwest of the landfill.

The VOC analysis was also taken from well 34CABA. This analysis detected traces of chloroform, dichloromethane, and bromodichloromethane. The VOC detections are inconclusive

because of new analytical procedures which lowered the detection limits for these compounds.

Regional aquifers include both glacial and bedrock lithologies. The New Rockford aquifer occupies a buried glacial valley which is located south of the landfill at a depth of about 100 feet below the surface. Undifferentiated glacial aquifers are present in isolated sand and gravel deposits. Bedrock aquifers occur in the Dakota and Pierre Formations.

The New Rockford aquifer may be susceptible to contaminant migration from the landfill. The bedrock aquifers should not be affected by the landfill because of their depth and the occurrence of intervening clays characterized by low transmitting capacity. Contaminant migration from the landfill may affect the shallow ground water and surface water in the James River floodplain.

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APPENDIX A

WATER QUALITY STANDARDS  
AND  
CONTAMINANT LEVELS

**Water Quality Standards  
and  
Contaminant Levels**

**Field Parameters**

appearance	color/odor
pH	6-9 (optimum)
specific conductance	-----
temperature	-----

<b><u>Constituent</u></b>	<b><u>MCL (µg/L)</u></b>
Arsenic	50
Cadmium	10
Lead	50
Molybdenum	100
Mercury	2
Selenium	10
Strontium	*

\*EPA has not set an MCL for strontium. The median concentration for most U.S. water supplies is 100 µg/L (Hem, 1989).

	<b><u>SMCL (mg/L)</u></b>
Chloride	250
Iron	>0.3
Nitrate	50
Sodium	20-170
Sulfate	300-1000
Total Dissolved Solids	>1000

	<b><u>Recommended Concentration Limits (mg/L)</u></b>
Bicarbonate	150-200
Calcium	25-50
Carbonate	150-200
Magnesium	25-50
Hardness	>121 (hard to very hard)

APPENDIX B

SAMPLING PROCEDURE FOR  
VOLATILE ORGANIC COMPOUNDS

## SAMPLING PROCEDURE FOR 40ML AMBER BOTTLES

### Sample Collection for Volatile Organic Compounds

by  
North Dakota Department of Health  
and Consolidated Laboratories

1. Three samples must be collected in the 40ml bottles that are provided by the lab. One is the sample and the others are duplicates.
2. A blank will be sent along. Do Not open this blank and turn it in with the other three samples.
3. Adjust the flow so that no air bubbles pass through the sample as the bottle is being filled. No air should be trapped in the sample when the bottle is sealed. Make sure that you do not wash the ascorbic acid out of the bottle when taking the sample.
4. The meniscus of the water is the curved upper surface of the liquid. The meniscus should be convex (as shown) so that when the cover to the bottle is put on, no air bubbles will be allowed in the sample.

convex meniscus



5. Add the small vial of concentrated HCL to the bottle.
6. Screw the cover on with the white Teflon side down. Shake vigorously, turn the bottle upside down, and tap gently to check if air bubbles are in the sample.
7. If air bubbles are present, take the cover off the bottle and add more water. Continue this process until there are no air bubbles in the sample.
8. The sample must be iced after collection and delivered to the laboratory as soon as possible.
9. The 40 ml bottles contain ascorbic acid as a preservative and care must be taken not to wash it out of the bottles. The concentrated acid must be added after collection as an additional preservative.

APPENDIX C

LITHOLOGIC LOGS  
OF WELLS AND TEST HOLES

149-066-34BCD

NDSWC

Date Completed:	9/29/94	Purpose:	Observation Well
L.S. Elevation (ft):		Well Type:	2" PVC
Depth Drilled (ft):	14	Aquifer:	Undefined
Screened Interval (ft):	4-14	Source:	
		Owner:	New Rockford

Lithologic Log

Unit	Description	Depth (ft)
TOPSOIL		0-2
SILT	Sandy, yellowish brown.	2-5
SAND	Fine grained, silty, yellowish brown.	5-9
SAND	Fine to medium grained, silty, yellowish brown.	9-12
CLAY	Sandy and gravelly, yellowish brown.	12-14

149-066-34CABA

NDSWC

Date Completed:	9/29/94	Purpose:	Observation Well
L.S. Elevation (ft):		Well Type:	2" PVC
Depth Drilled (ft):	20	Aquifer:	Undefined
Screened Interval (ft):	10-20	Source:	
		Owner:	New Rockford

Lithologic Log

Unit	Description	Depth (ft)
TOPSOIL		0-2
CLAY	Sandy with a trace of gravel, gray, till.	2-5
SAND	Coarse grained with a trace of gravel and clay.	5-7
CLAY	Sandy and gravelly, dark yellowish brown, till, boulder at 12 feet.	7-15
CLAY	SAndy and gravelly, gray.	15-20

149-066-34CAED

NDSWC

Date Completed: 9/29/94  
L.S. Elevation (ft):  
Depth Drilled (ft): 30  
Screened Interval (ft): 20-30

Purpose: Observation Well  
Well Type: 2" PVC  
Aquifer: Undefined  
Source:  
Owner: New Rockford

Lithologic Log

Unit	Description	Depth (ft)
TOPSOIL		0-2
CLAY	Sandy with a trace of gravel, yellowish brown, till.	2-15
CLAY	Sandy and gravelly, dark yellowish brown.	15-25
GRAVEL	Medium to coarse grained, boulders at 25 feet.	25-30

149-066-34CBA

NDSWC

Date Completed:	9/29/94	Purpose:	Observation Well
L.S. Elevation (ft):		Well Type:	2" PVC
Depth Drilled (ft):	43	Aquifer:	Undefined
Screened Interval (ft):	32-42	Source:	
		Owner:	New Rockford

Lithologic Log

Unit	Description	Depth (ft)
SAND	Fine grained, silty, yellowish brown, till.	0-3
SAND	Fine grained, clayey with a trace of gravel, yellowish brown.	3-6
SAND	Fine grained, yellowish brown.	6-15
SAND	Fine grained, silty, clayey, yellowish brown.	15-23
SAND	Meddium grained, clayey with a trace of gravel, dark yellowish brown.	23-27
CLAY	Sandy with a trace of gravel, gray, till.	27-35
GRAVEL	Medium grained with sand and clay, boulder at 40 feet.	35-43

APPENDIX D

WATER-LEVEL TABLES

New Rockford Landfill Water Levels  
10/07/94 to 11/04/94

**149-066-34BCD** MP Elev (msl, ft)=-1517.74  
Undefined Aquifer SI (ft.)=4-14

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
10/07/94	3.05	1514.69	10/25/94	3.17	1514.57
10/13/94	3.41	1514.33	10/28/94	3.06	1514.68
10/21/94	3.05	1514.69	11/04/94	3.78	1513.96

**149-066-34CABA** MP Elev (msl, ft)=-1514.59  
Undefined Aquifer SI (ft.)=10-20

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
10/07/94	2.48	1512.11	10/25/94	2.75	1511.84
10/13/94	3.00	1511.59	10/28/94	2.60	1511.99
10/21/94	2.50	1512.09	11/04/94	2.94	1511.65

**149-066-34CAED** MP Elev (msl, ft)=-1521.41  
Undefined Aquifer SI (ft.)=20-30

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
10/07/94	8.70	1512.71	10/25/94	7.46	1513.95
10/13/94	8.22	1513.19	10/28/94	7.28	1514.13
10/21/94	7.47	1513.94	11/04/94	7.66	1513.75

**149-066-34CBA** MP Elev (msl, ft)=-1535.23  
Undefined Aquifer SI (ft.)=32-42

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
10/07/94	10.77	1524.46	10/25/94	9.80	1525.43
10/13/94	10.26	1524.97	10/28/94	9.57	1525.66
10/21/94	9.72	1525.51	11/04/94	9.67	1525.56

APPENDIX E

MAJOR ION AND TRACE-ELEMENT  
CONCENTRATIONS

## New Rockford Water Quality Major Ions

Location	Screened Interval (ft)	Date Sampled	(milligrams per liter)															Hardness as CaCO <sub>3</sub>	as NCH	% Na	SAR	Spec Cond (µmho)	Temp (°C)	pH
			SiO <sub>2</sub>	Fe	Mn	Ca	Mg	Na	K	HCO <sub>3</sub>	CO <sub>3</sub>	SO <sub>4</sub>	Cl	F	NO <sub>3</sub>	B	TDS							
149-066-34BCD	4-14	11/01/94	22	0.03	0.06	160	210	210	3.1	996	0	650	170	0.5	42	2.7	1960	1300	450	27	2.5	2270	8.2	7.01
149-066-34CABA	10-20	10/25/94	25	0.05	0.09	330	260	480	23	418	0	2100	280	0.8	110	0.26	3820	1900	1600	35	4.8	3850	10.5	6.72
149-066-34CABD	20-30	10/25/94	25	0.04	1.2	200	100	360	26	314	0	1300	110	0.7	0	0.26	2280	910	650	45	5.2	2760	10.6	7.01
149-066-34CBA	32-42	10/25/94	28	0.06	2.3	330	130	550	46	545	0	2000	88	0.4	84	1	3530	1400	910	46	6.4	3790	10.9	6.8

## Trace Element Analyses

Location	Date Sampled	Selenium		Lead		Cadmium (micrograms per liter)		Mercury (micrograms per liter)		Arsenic		Molybdenum		Strontium	
		µg/L	ppm	µg/L	ppm	µg/L	ppm	µg/L	ppm	µg/L	ppm	µg/L	ppm	µg/L	ppm
149-066-34BCD	10/25/94	1	0.1	0	0	0	0	0	0	2	0.2	2	0.2	820	
149-066-34CABA	10/25/94	6	0.6	0	0	0	0	0	0	3	0.3	3	0.3	1800	
149-066-34CABD	10/25/94	0	0	0	0	0	0	0	0	2	0.2	9	0.9	1200	
149-066-34CBA	10/25/94	0	0	0	0	0	0	0.1	0.1	4	0.4	5	0.5	1200	

APPENDIX F

VOLATILE ORGANIC COMPOUNDS  
FOR WELL 149-066-34CABA

Volatile Organic Compounds  
and  
Minimum Concentrations

Concentrations are based only on detection limits. Anything over the detection limit indicates possible contamination.

Constituent	Chemical Analysis µg/L
Benzene	<0.5
Vinyl Chloride	<0.5
Carbon Tetrachloride	<0.5
1,2-Dichloroethane	<0.5
Trichloroethylene	<0.5
1,1-Dichloroethylene	<0.5
1,1,1-Trichloroethane	<0.5
para-Dichlorobenzene	<0.5
Acetone	<50
2-Butanone (MEK)	<50
2-Hexanone	<50
4-Methyl-2-pentanone	<50
Chloroform	3.61*
Bromodichloromethane	0.85*
Chlorodibromomethane	<0.5
Bromoform	<0.5
trans-1,2-Dichloroethylene	<0.5
Chlorobenzene	<0.5
m-Dichlorobenzene	<0.5
Dichloromethane	<0.5
cis-1,2-Dichloroethylene	<0.5
o-Dichlorobenzene	<0.5
Dibromomethane	<0.5
1,1-Dichloropropene	<0.5
Tetrachlorethylene	<0.5
Toluene	<0.5
Xylene (s)	<0.5
1,1-Dichloroethane	<0.5
1,2-Dichloropropane	<0.5
1,1,2,2-Tetrachloroethane	<0.5
Ethyl Benzene	<0.5
1,3-Dichloropropane	<0.5
Styrene	<0.5
Chloromethane	1.04*
Bromomethane	<0.5
1,2,3-Trichloropropane	<0.5
1,1,1,2-Tetrachloroethane	<0.5
Chloroethane	<0.5
1,1,2-Trichloroethane	<0.5

\* Constituent Detection

VOC Constituents cont.

2,2-Dichloropropane	<0.5
o-Chloroluene	<0.5
p-Chlorotoluene	<0.5
Bromobenzene	<0.5
1,3-Dichloropropene	<0.5
1,2,4-Trimethylbenzene	<0.5
1,2,4-Trichlorobenzene	<0.5
1,2,3-Trichlorobenzene	<0.5
n-Propylbenzene	<0.5
n-Butylbenzene	<0.5
Naphthalene	<0.5
Hexachlorobutadiene	<0.5
1,3,5-Trimethylbenzene	<0.5
p-Isopropyltoluene	<0.5
Isopropylbenzene	<0.5
Tert-butylbenzene	<0.5
Sec-butylbenzene	<0.5
Fluorotrichloromethane	<0.5
Dichlorodifluoromethane	<5
Bromochloromethane	<0.5
Allylchloride	<5
2,3-Dichloro-1-propane	<5
Tetrahydrofuran	<50
Pentachloroethane	<5
Trichlorotrifluoroethane	<5
Carbondisulfide	<5
Ether	<5
trans-1,3-Dichloropropene	<0.5

\* Constituent Detection