Site Suitability Review of the New England Landfill

by
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Prepared by the
North Dakota Geological Survey
and the
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ND Landfill Site Investigation No. 38

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OF THE
NEW ENGLAND LANDFILL

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Bismarck, North Dakota
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INTRODUCTION

Purpose

The North Dakota State Engineer and the North Dakota State Geologist were instructed by the 52nd 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 (NDSDHCL) 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 NDSDHCL for continued operation of solid-waste landfills. The New England solid-waste landfill is one of the landfills being evaluated.

Location of the New England Landfill

The New England solid-waste landfill is located about one-half mile west of the City of New England in the SE 1/4, SE 1/4, Section 32, Township 136 North, Range 97 West (Fig. 1). The landfill site encompasses approximately 10 acres.

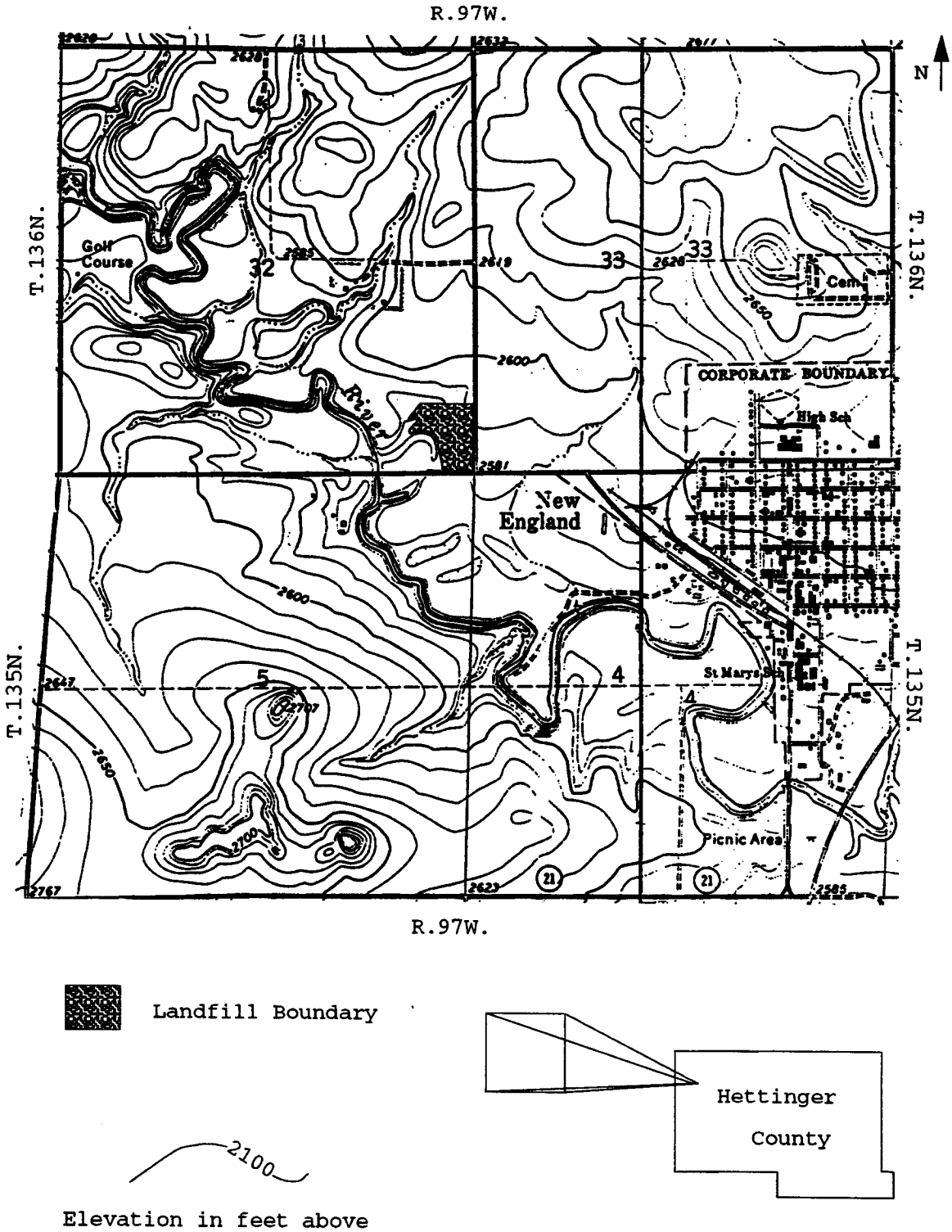

Figure 1. Location of the New England municipal landfill in the SE 1/4, Section 32, T.136N., R.97W.

Previous Site Investigations

No previous geological or hydrological investigations have been performed at the New England landfill.

Methods of Investigation

The New England 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.

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 forward rotary rig was used at the New England landfill due to the presence of lignite and sandstone at the site. 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

Six test holes were drilled at the New England landfill, and monitoring wells were installed in five of the test holes. 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 located around the active area of the landfill.

Wells were constructed following a standard design (Fig. 2) intended to comply with the construction regulations of the NDSDHCL 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. A two to three-foot bentonite plug was placed above the sand pack using one-half inch bentonite pellets. High-solids bentonite grout and/or neat cement was placed above the bentonite plug 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.

All monitoring wells were developed using a stainless steel bladder pump or a teflon bailer. Any drilling fluid

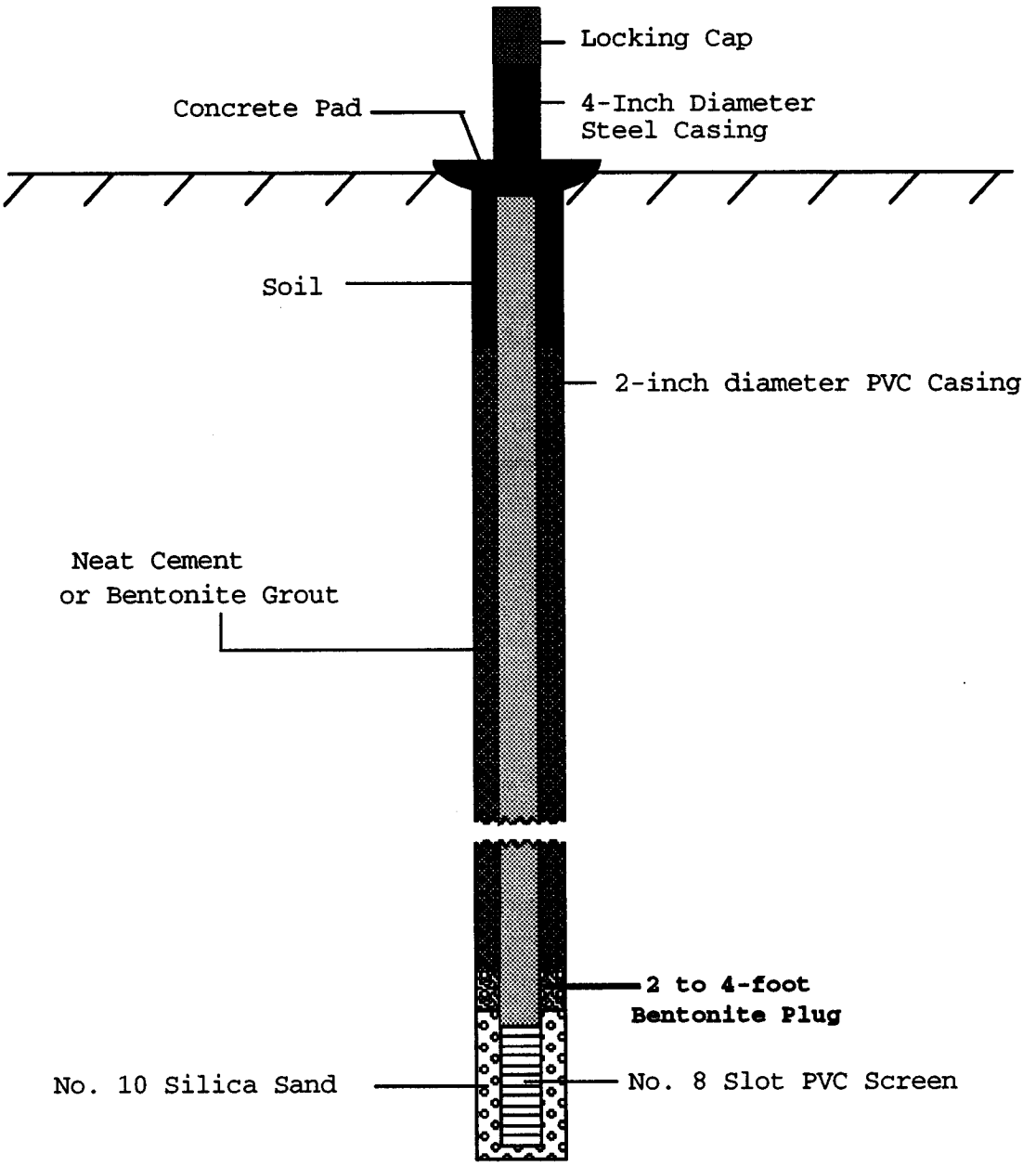

Figure 2. Construction design used for monitoring wells installed at the New England landfill.

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 NDSDHCL.

* 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.

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. 3). 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 136-097-32DDB would be located in the NW1/4, SE1/4, SE1/4, Section 32, Township 136 North, Range 97 West. Consecutive numbers are added following the three letters if more than one well is located in a 10-acre tract, e.g. 136-097-32DDB1 and 136-097-32DDB2.

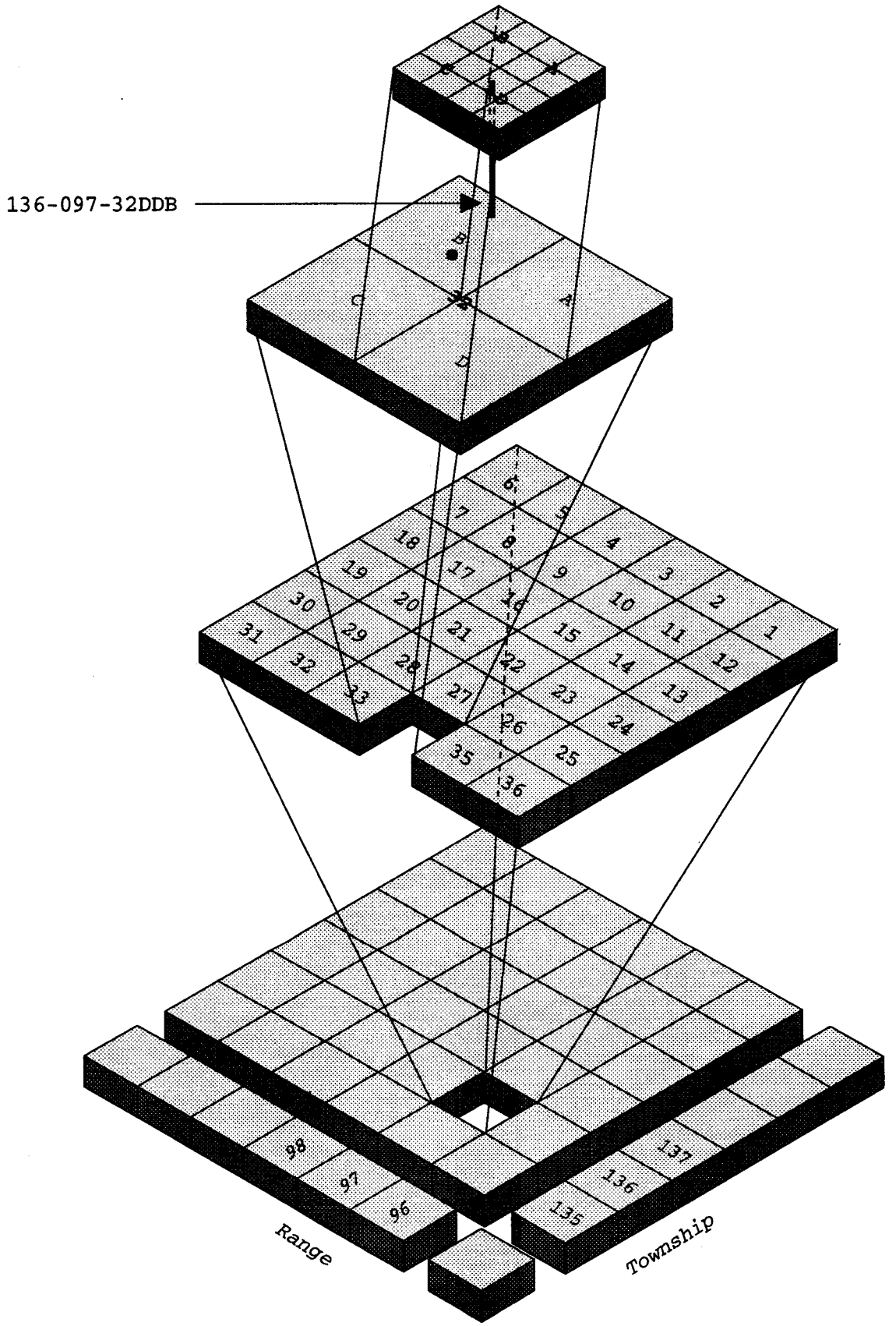

Figure 3. Location-numbering system.

GEOLOGY

The New England landfill is located on a terrace next to an abandoned oxbow of the Cannonball River (Fig. 4). The terrace is about 800 feet from the present bed of the river and between 20 and 30 feet higher than the river. In the past some refuse, consisting mainly of scrap metal and construction materials, was pushed over the bank and buried at the edge of the oxbow.

Test holes drilled around the perimeter of the landfill penetrated Quaternary alluvium overlying Paleocene bedrock of the Sentinel Butte Formation (Fig. 5, lithologic logs in Appendix C). The alluvium includes clay, sand, and gravel, whereas the Sentinel Butte Formation consists of sand, sandstone, clay, silt, and lignite.

The contact between the alluvium and bedrock is difficult to recognize in the subsurface because the bedrock sands and clays are typically poorly consolidated and similar in appearance to alluvial sand and clay. However, the alluvium appears to be about 10 feet thick on the north end of the landfill and 30 feet thick on the south end. This interpretation is based on several considerations. First, the deepest occurrence of gravel on the north end of the landfill is 8 feet in test holes 136-097-32DDA3 and 32DDB, whereas, on the south end of the site, gravel was recovered from depths of 26 feet (32DDDC) and 31 feet (32DDD). Second, a trench near the north end of the site revealed a sharp

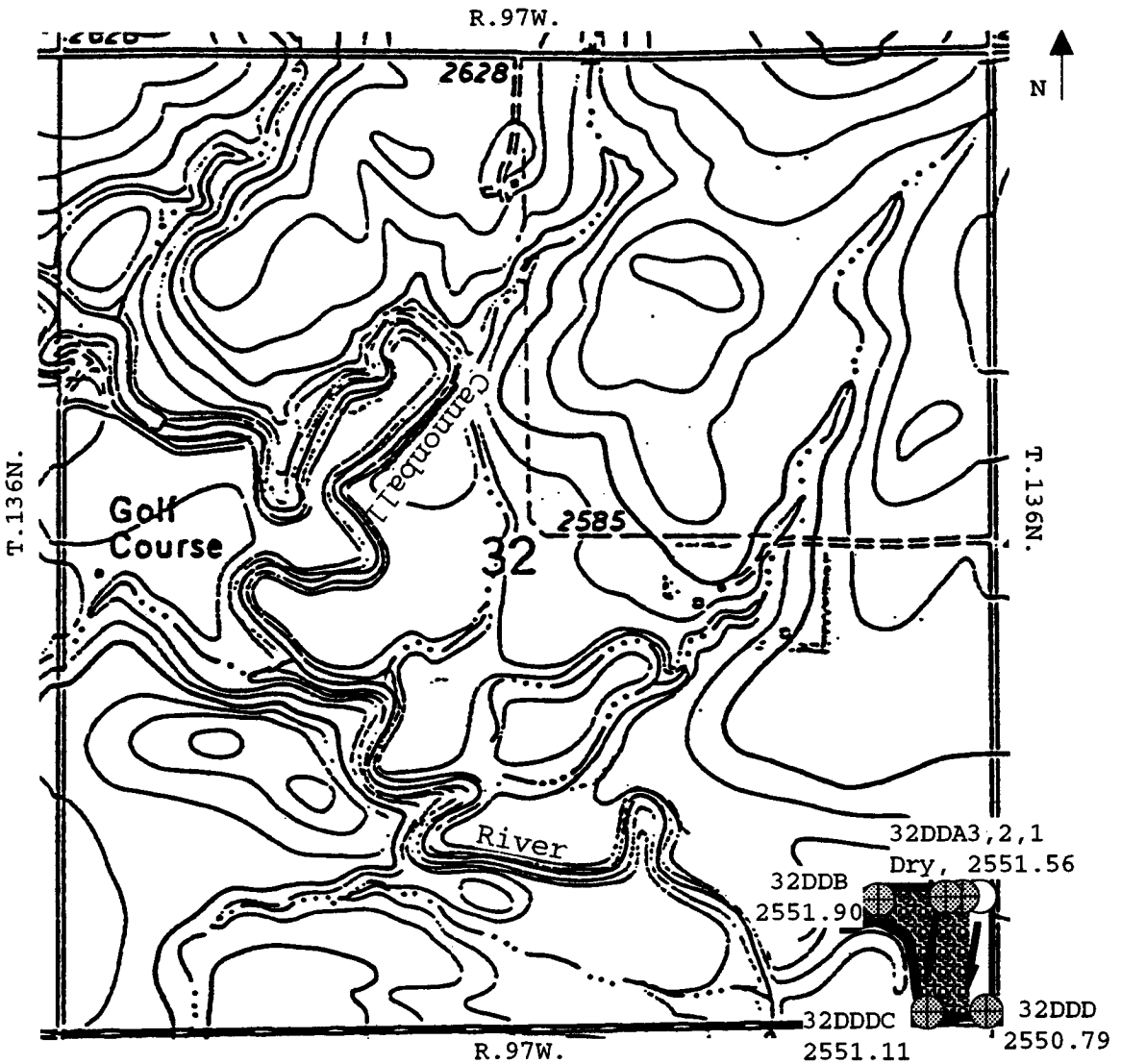

Figure 4. Location of monitoring wells and the direction of ground-water flow.

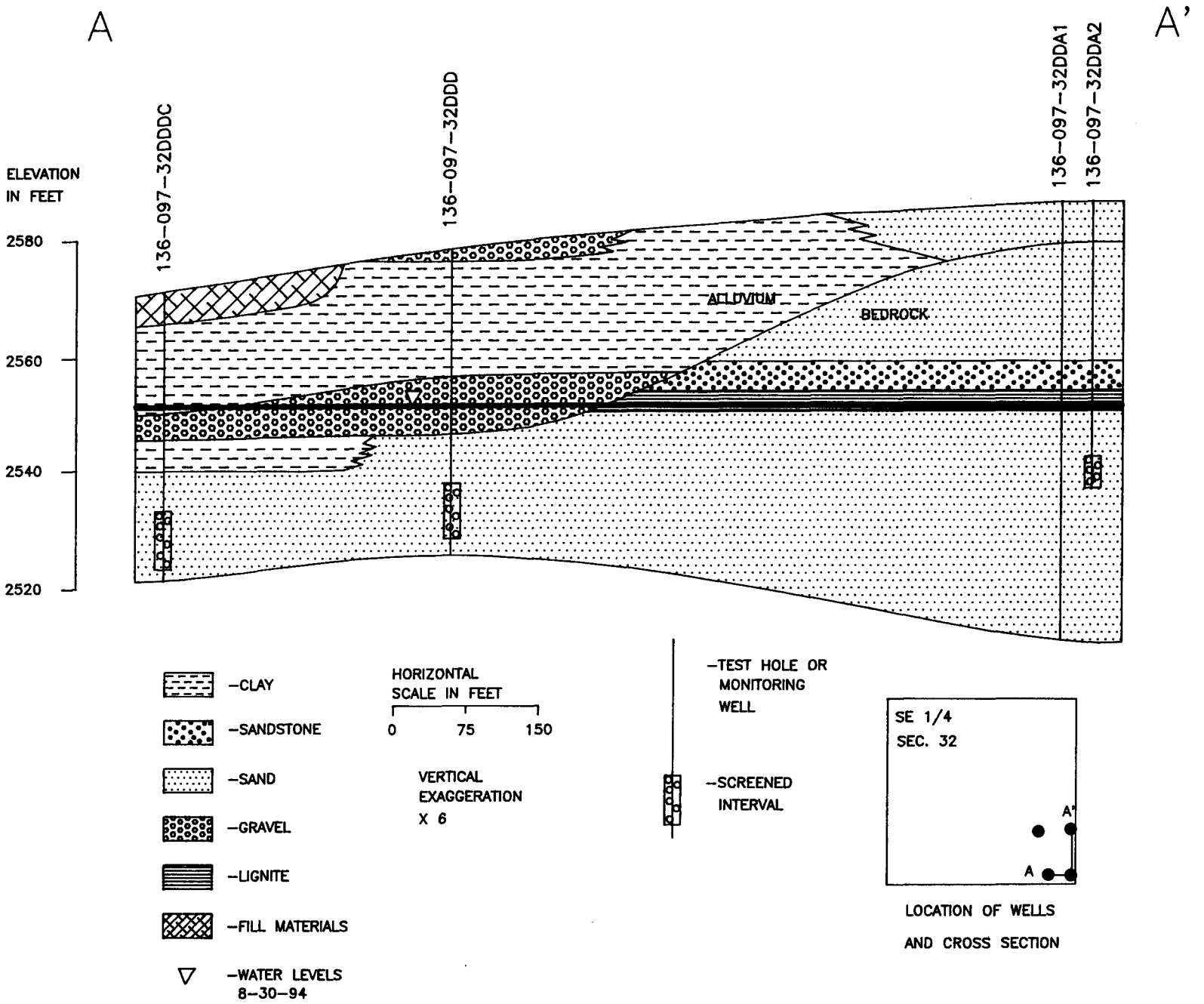

Figure 5. Geohydrologic section A–A' in the New England landfill.

lithologic and bedding change at a depth of about 10 feet. Third, the upper 30 feet of the test holes on the south end correlate well with each other, but poorly with the test holes on the north end.

On the north end of the landfill the shallower sediments (upper 25 to 30 feet) are predominantly sand, whereas on the south end a thick (20 feet or more) layer of clay is present near the surface. A layer of gravel underlies the clay. In all of the test holes a thick layer of fine to medium-grained bedrock sand is present at depths below 30 feet (Fig. 5).

HYDROLOGY

Surface-Water Hydrology

The New England landfill is located on the bank of an old meander scar of the Cannonball River (Fig. 1). A wetland is located in the area of the scar. The Cannonball River is located about 800 feet west of the landfill boundary. The wetland and the Cannonball River may be susceptible to contaminant migration because these features represent local discharge areas which may capture ground water from the landfill area. The wetland may also be susceptible to contamination during periods of surface runoff.

Regional Ground-Water Hydrology

The uppermost aquifer is located in the Sentinel Butte Formation. This unconfined aquifer occurs in layers of sandstone and lignite interbedded throughout the formation. The Sentinel Butte aquifer is the major water source for the northern and central parts of Hettinger County (Trapp, et al, 1975). The Sentinel Butte aquifer is characterized by a sodium-sulfate type water.

The Bullion Creek aquifer underlies the Sentinel Butte Formation and occurs in layers of sandstone and lignite. This aquifer is also hydraulically connected to the upper Ludlow aquifer system. The Bullion Creek/Upper Ludlow aquifer underlies Hettinger County and varies in thickness across the county. This aquifer is characterized by a sodium-bicarbonate type water (Trapp, et al, 1975).

The Upper Hell Creek and Lower Cannonball-Ludlow aquifer underlies the Bullion Creek aquifer system. This aquifer is located about 710 feet below land surface and underlies all of Hettinger County. This aquifer is characterized by a sodium-bicarbonate type water.

Local Ground-Water Hydrology

Figure 4 shows the location of five monitoring wells and one test hole installed at the New England landfill (Appendix

C). Four of the monitoring wells were screened within a sandstone layer of the Sentinel Butte Formation. Well 136-097-32DDA3 was screened in a layer of fluvial sands at a depth of about 25 feet. This well was dry during the study and was abandoned according to EPA regulations. At least four water-level measurements were taken over an eight-week period (Appendix D). Water-level measurements indicate the local ground-water flow is south-southwest toward the Cannonball River (Fig. 4).

Water Quality

Chemical analyses of water samples are shown in Appendix F. Well 32DDD detected elevated sulfate (2,200 mg/L), and chloride (850 mg/L) concentrations. The source of these concentrations was not determined. No other major ions exceeded the maximum contamination levels. The trace element analyses did not detect any elements above their MCL.

The VOC analysis, from well 32DDDC, is shown in Appendix G. The analysis detected concentrations of benzene (0.8 µg/L), dichloromethane (2.94 µg/L), toluene (2.22 µg/L), xylene (1.40 µg/L), and 1,2,4-trimethylbenzene (0.65 µg/L). It is inconclusive as to whether the source of dichloromethane is the result of laboratory contamination† or migration from the landfill.. Toluene, xylene, 1,2,4-

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

trimethylbenzene, and benzene are man-made compounds that are not associated with monitoring well construction and can be found in dry cleaning fluids, fumigants, gasoline, motor oil, insecticides, paint removers, spot removers, and various solvents. The detection of these VOC compounds indicates contaminant migration from the landfill into the underlying Sentinel Butte aquifer.

CONCLUSIONS

The New England landfill is located on a terrace next to an abandoned oxbow of the Cannonball River. The landfill is about 800 feet from the present bed of the river.

The upper 10 to 30 feet of material on the terrace is composed of alluvium, including clay, sand, and gravel. The alluvium overlies bedrock of the Sentinel Butte Formation. The Sentinel Butte Formation at the landfill is composed of sand interbedded with thin layers of sandstone, clay, and lignite.

The uppermost aquifer beneath the landfill occurs in a thick sand layer of the Sentinel Butte Formation. The Sentinel Butte aquifer is the main source of water for the surrounding area. Water-level measurements indicate that the direction of ground water flow is south-southwest toward the Cannonball River.

Chemical analyses of water samples revealed that well 32DDD contained elevated concentrations of sulfate and chloride. The source of these concentrations was not determined but may indicate contaminant migration from the landfill. This well is located in the southeast corner of the landfill. The trace element analyses did not detect any elements above their maximum contaminant levels.

The VOC analysis was taken from well 136-097-32DDDC, in the southwest corner of the landfill. This analysis detected traces of benzene, dichloromethane, toluene, xylene, and 1,2,4-trimethylbenzene. It is inconclusive as to whether the source of dichloromethane is the result of laboratory contamination or migration from the landfill. Toluene, xylene, 1,2,4-trimethylbenzene, and benzene are man-made compounds that are not associated with monitoring well construction and can be found in dry cleaning fluids, fumigants, gasoline, motor oil, insecticides, paint removers, spot removers, and various solvents. The detection of these VOC compounds indicates contaminant migration from the landfill into the underlying Sentinel Butte aquifer.

REFERENCES

Hem, J.D., 1989, Study and interpretation of the chemical characteristics of natural water: United States Geological Survey, Water-Supply Paper 2254, 263 p.

North Dakota Department of Health, 1986, Water well construction and water well pump installation: Article 33-18 of the North Dakota Administrative Code, 42 p.

Trapp, H., Jr., and Croft, M.G., Geology and ground-water resources of Hettinger and Stark Counties, North Dakota: North Dakota State Water Commission, County Ground-Water Studies 16, Part I, 51 p.

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	-----

Constituent	MCL (µg/L)
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).

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

	Recommended Concentration Limits (mg/L)
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

136-097-32DDA1
NDSWC

Date Completed:	5/17/94	Purpose:	Test Hole
L.S. Elevation (ft):	2586.94	Well Type:	
Depth Drilled (ft):	100	Source:	
		Owner:	New England

Lithologic Log

Unit	Description	Depth (ft)
TOPSOIL		0-1
SAND	fine grained, trace of gravel, moderate yellowish-brown, 10YR5/4.	1-9
SAND	fine grained, olive gray, 5Y4/1, (Sentinel Butte Formation).	9-30
SANDSTONE	medium grained, moderately cemented, pale yellowish-orange, 10YR6/6.	29-30
SANDSTONE	fine grained, well cemented, medium light gray, N6.	30-31
SANDSTONE	medium grained, moderately cemented, dark yellowish-brown, 10YR4/2.	31-36
LIGNITE		36-38
SAND	fine grained, silty, medium gray, N5.	38-42
SAND	fine to medium grained, medium dark gray, N4.	42-63
SAND	fine grained, silty, medium gray, N5.	63-76
LIGNITE		76-77
SAND	fine grained, medium gray, N5.	77-86

SILT	clayey, medium gray, N5.	86-91
SAND	fine grained, clayey, silty, medium gray, N5.	91-96
LIGNITE		96-100

136-097-32DDA2
NDSWC

Date Completed:	5/17/94	Purpose:	Observation Well
L.S. Elevation (ft):	2586.90	Well Type:	2" PVC
Depth Drilled (ft):	50	Aquifer:	Sentinel Butte
Screened Interval (ft):	45-50	Source:	
		Owner:	New England

Lithologic Log

Unit	Description	Depth (ft)
TOPSOIL		0-2
SAND	fine grained, moderate yellowish brown, 10YR5/4.	2-9
CLAY	sandy, dark yellowish orange, 10YR6/6, Sentinel Butte Formation.	9-12
CLAY	sandy, dark yellowish brown, 10YR4/2.	12-15
SAND	fine grained, moderate yellowish brown, 10YR4/2.	15-26
CLAY	silty, dark yellowish orange, 10YR6/6.	26-30
CLAY	sandy, dark yellowish orange, 10YR6/6.	30-34
SAND	fine grained, moderate yellowish brown, 10YR5/4.	34-37
SAND	fine to medium grained, medium grained, N5.	37-50

136-097-32DDA3
NDSWC

Date Completed:	5/17/94	Purpose:	Observation Well
L.S. Elevation (ft):	2586.90	Well Type:	2" PVC
Depth Drilled (ft):	27	Aquifer:	Sentinel Butte
Screened Interval (ft):	16-26	Source:	
		Owner:	New England

Lithologic Log

Unit	Description	Depth (ft)
TOPSOIL		0-1
SAND	fine grained, moderate yellowish brown, 10YR5/4.	1-6
GRAVEL	fine to medium grained.	6-8
SAND	fine grained, moderate yellowish brown, 10YR5/4, Sentinel Butte Formation.	8-26
CLAY	dark yellowish orange, 10YR6/6.	26-27

136-097-32DDB
NDSWC

Date Completed:	5/17/94	Purpose:	Observation Well
L.S. Elevation (ft):	2580.15	Well Type:	2" PVC
Depth Drilled (ft):	50	Aquifer:	Sentinel Butte
Screened Interval (ft):	45-50	Source:	
		Owner:	New England

Lithologic Log

Unit	Description	Depth (ft)
TOPSOIL		0-1
CLAY	sandy, dark yellowish brown, 10YR4/2.	1-4
SAND	fine grained, moderate yellowish brown, 10YR5/4.	4-6
GRAVEL	fine to medium grained.	6-8
CLAY	sandy, dark yellowish brown, 10YR4/2.	8-10
SAND	fine grained, moderate yellowish brown, 10YR5/4, Sentinel Butte Formation.	10-16
CLAY	sandy, moderate brown, 5YR3/4.	16-18
SAND	fine grained, moderate yellowish brown, 10YR5/4.	18-22
CLAY	sandy, dark yellowish orange, 10YR6/6.	22-23
SAND	fine grained, light olive gray, 5Y6/1.	23-30
SAND	fine to medium grained, medium gray, N5.	30-36
SAND	fine grained, medium gray, N5.	36-50

136-097-32DDD
NDSWC

Date Completed:	5/17/94	Purpose:	Observation Well
L.S. Elevation (ft):	2577.89	Well Type:	2" PVC
Depth Drilled (ft):	52	Aquifer:	Sentinel Butte
Screened Interval (ft):	38-48	Source:	
		Owner:	New England

Lithologic Log

Unit	Description	Depth (ft)
GRAVEL	medium grained.	0-2
CLAY	silty , dark yellowish brown, 10YR4/2.	2-12
CLAY	sandy, dark yellowish brown 10YR4/2.	12-22
GRAVEL	medium grained.	22-31
SAND	fine grained, medium gray, N5, Sentinel Butte Formation.	31-52

136-097-32DDDC
NDSWC

Date Completed:	5/17/94	Purpose:	Observation Well
L.S. Elevation (ft):	2571.64	Well Type:	2" PVC
Depth Drilled (ft):	50	Aquifer:	Sentinel Butte
Screened Interval (ft):	38-48	Source:	
		Owner:	New England

Lithologic Log

Unit	Description	Depth (ft)
CLAY	gravelly, dark yellowish brow, 10YR4/2, refuse.	0-10
CLAY	dark yellowish brown 10YR4/2.	10-23
GRAVEL	fine to medium grained.	23-26
CLAY	moderate yellowish brown, 10YR5/4, Sentinel Butte Formation.	26-31
SAND	fine grained, medium gray, N5.	31-50

APPENDIX D

WATER-LEVEL TABLES

New England Landfill Water Levels
6/13/94 to 8/30/94

136-097-32DDA2 MP Elev (msl,ft)=2588.89

Sentinel Butte Aquifer SI (ft.)=45-50

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
06/13/94	36.32	2552.57	08/18/94	37.40	2551.49
07/18/94	37.14	2551.75	08/30/94	37.59	2551.30
08/02/94	37.33	2551.56			

136-097-32DDA3 MP Elev (msl,ft)=2588.74

Sentinel Butte Aquifer SI (ft.)=16-26

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
07/18/94	Dry				

136-097-32DDB MP Elev (msl,ft)=2582.3

Sentinel Butte Aquifer SI (ft.)=45-50

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
06/13/94	29.06	2553.24	08/18/94	30.55	2551.75
07/18/94	31.04	2551.26	08/30/94	30.73	2551.57
08/02/94	30.40	2551.90			

136-097-32DDD MP Elev (msl,ft)=2579.75

Sentinel Butte Aquifer SI (ft.)=38-48

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
06/13/94	28.52	2551.23	08/18/94	29.08	2550.67
07/18/94	28.75	2551.00	08/30/94	29.24	2550.51
08/02/94	28.96	2550.79			

136-097-32DDDC MP Elev (msl,ft)=2573.45

Sentinel Butte Aquifer SI (ft.)=38-48

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
06/13/94	20.29	2553.16	08/18/94	22.54	2550.91
07/18/94	21.99	2551.46	08/30/94	22.72	2550.73
08/02/94	22.34	2551.11			

APPENDIX E

MAJOR ION AND TRACE-ELEMENT CONCENTRATIONS

New England Water Quality
Major Ions

Location	Screened Interval (ft)	Date Sampled	SiO_2	Fe	Mn	Ca	Mg	Na	K	HCO_3	CO_3	SO_4	Cl	F	NO_3	B	TDS	Hardness $CaCO_3$ as NCH	% Na	SAR	Spec Cond (µmho)	Temp (∞C)	pH
			←(milligrams per liter)→																				
136-097-32DDA2	45-50	06/13/94	16	0.07	1.1	110	56	130	11	589	0	320	16	0.4	4.6	0.22	955	510	23	35	2.5	1692	18	7.71
136-097-32DDB	45-50	06/13/94	13	0.28	0.6	72	26	170	8.2	444	0	300	14	0.4	1.1	0.23	825	290	0	55	4.3	1384	13	8.02
136-097-32DDD	38-48	06/13/94	15	0.29	1.7	270	120	850	18	761	0	2200	140	0.3	4.8	0.44	4000	1200	540	61	11	6000	17	7.8
136-097-32DDDC	38-48	06/13/94	14	0.86	0.43	190	58	96	19	436	0	580	13	0.4	34	3.7	1220	710	360	22	1.6	1942	11	7.46

Trace Element Analyses

Location	Date Sampled	Selenium	Lead	Cadmium	Mercury	Arsenic	Molybdenum	Strontium
		(micrograms per liter)						
136-097-32DDA2	6/13/94	0	3	0	0	0	2	740
136-097-32DDB	6/13/94	0	8	0	0	0	6	260
136-097-32DDD	6/13/92	1	1	0	0.1	1	3	1900
136-097-32DDDC	6/13/94	0	6	0	0	1	1	1200

APPENDIX F

VOLATILE ORGANIC COMPOUNDS FOR WELL 139-097-32DDDC

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	0.80*
Vinyl Chloride	<0.5
Carbon Tetrachloride	<0.5
1,2-Dichlorethane	<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	<0.5
Bromodichloromethane	<0.5
Chlorodibromomethane	<0.5
Bromoform	<0.5
trans1,2-Dichloroethylene	<0.5
Chlorobenzene	<0.5
m-Dichlorobenzene	<0.5
Dichloromethane	2.94*
cis-1,2-Dichloroethylene	<0.5
o-Dichlorobenzene	<0.5
Dibromomethane	<0.5
1,1-Dichloropropene	<0.5
Tetrachlorethylene	<0.5
Toluene	2.22*
Xylene(s)	1.40*
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	<0.5
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	0.65*
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
Carbondisufide	<5
Ether	<5
trans-1,3-Dichloropropene	<0.5

* Constituent Detection