

Site Suitability Review of the Bismarck Municipal Landfill

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

ND Landfill Site Investigation No. 18

SITE SUITABILITY REVIEW
OF THE
BISMARCK MUNICIPAL LANDFILL

By Phillip L. Greer, North Dakota Geological Survey,
and Jeffrey M. Olson, North Dakota State Water Commission

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Prepared by the NORTH DAKOTA GEOLOGICAL SURVEY
and the NORTH DAKOTA STATE WATER COMMISSION

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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 municipal 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. Additional studies may be necessary to meet the requirements of the NDS DHCL for continued operation of municipal solid waste landfills. The Bismarck municipal solid waste landfill is one of the landfills being evaluated.

Location of the Bismarck Landfill

The Bismarck solid waste landfill is located about one mile east of the City of Bismarck in section 25, Township 139 North, Range 80 West, and section 30, Township 139 North, Range 79 West (Fig. 1). The western portion of the landfill, in section 25, was closed in 1986. The landfill site covers approximately 487 acres. A residential area, called

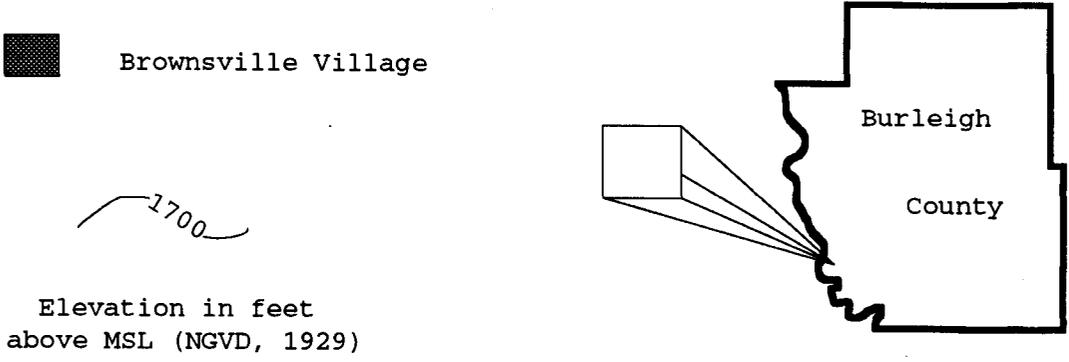
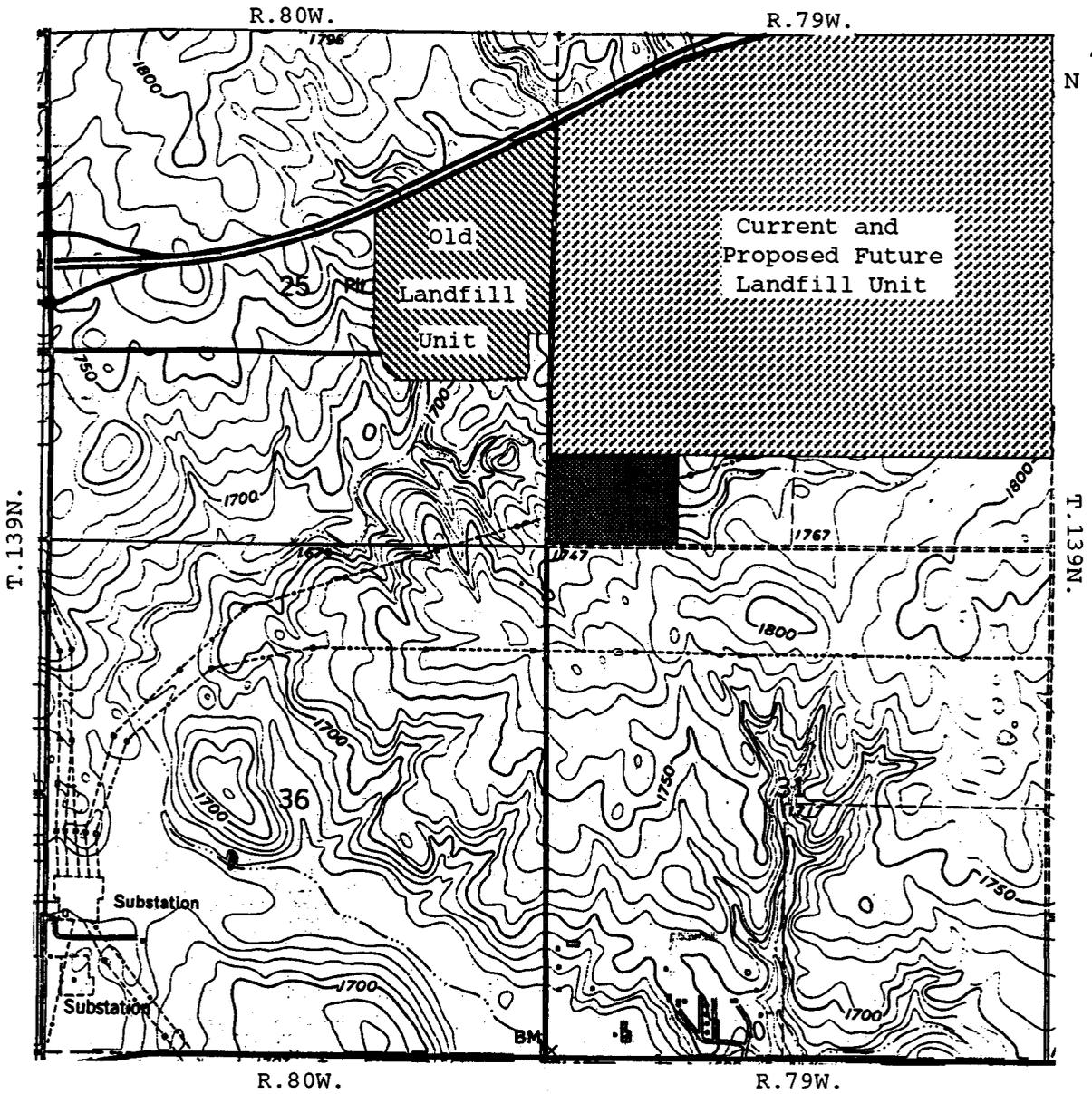


Figure 1. Location of the Bismarck landfill in the north half of section 30, T.1139 N., R.79 W.

Brownsville, is located south of the landfill in the SW 1/4, SW 1/4 of section 30.

Previous Site Investigations

Braun Intertec completed a hydrogeologic study of the Bismarck landfill in 1989 and 1990. Twenty-nine soil borings, 17 monitoring wells, and 5 temporary piezometers were completed for the study. In 1992, Braun drilled 8 more soil borings and installed 6 additional monitoring wells. Reports of the investigation were submitted to the City of Bismarck in 1990, 1991, and 1992.

Braun identified four stratigraphic units at the landfill: unit A - fluvial sand and gravel; unit B - fractured clay with silt; unit C - fine, silty sand; and unit D - clay with fine sand laminae. Unit A was found to occur only near intermittent streams, while the other units are widespread across the landfill.

Methods of Investigation

The Bismarck study was accomplished by means of: 1) test drilling; 2) construction and development of monitoring wells; 3) collecting and analyzing water samples; and 4) measuring water levels.

Test Drilling Procedure

The drilling procedure was based on the site's geology and depth to ground water, as determined by the preliminary evaluation. A hollow-stem auger was used at the Bismarck landfill because the sediments were poorly consolidated and the depth to groundwater was expected to be less than 70 feet. The lithologic descriptions were determined from the drilling returns.

Monitoring Well Construction and Development

Seven test holes were drilled at the Bismarck landfill and monitoring wells were installed in six of the test holes. Four of the monitoring wells were located on the north side of Brownsville. The other two were located in the north half of section 30 near the most recent waste disposal area. The depth and intake interval of each well was selected to monitor the water level at the top of the uppermost aquifer.

Wells were constructed following a standard design (Fig. 2) intended to comply with the construction regulations of the NDS DHCL 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

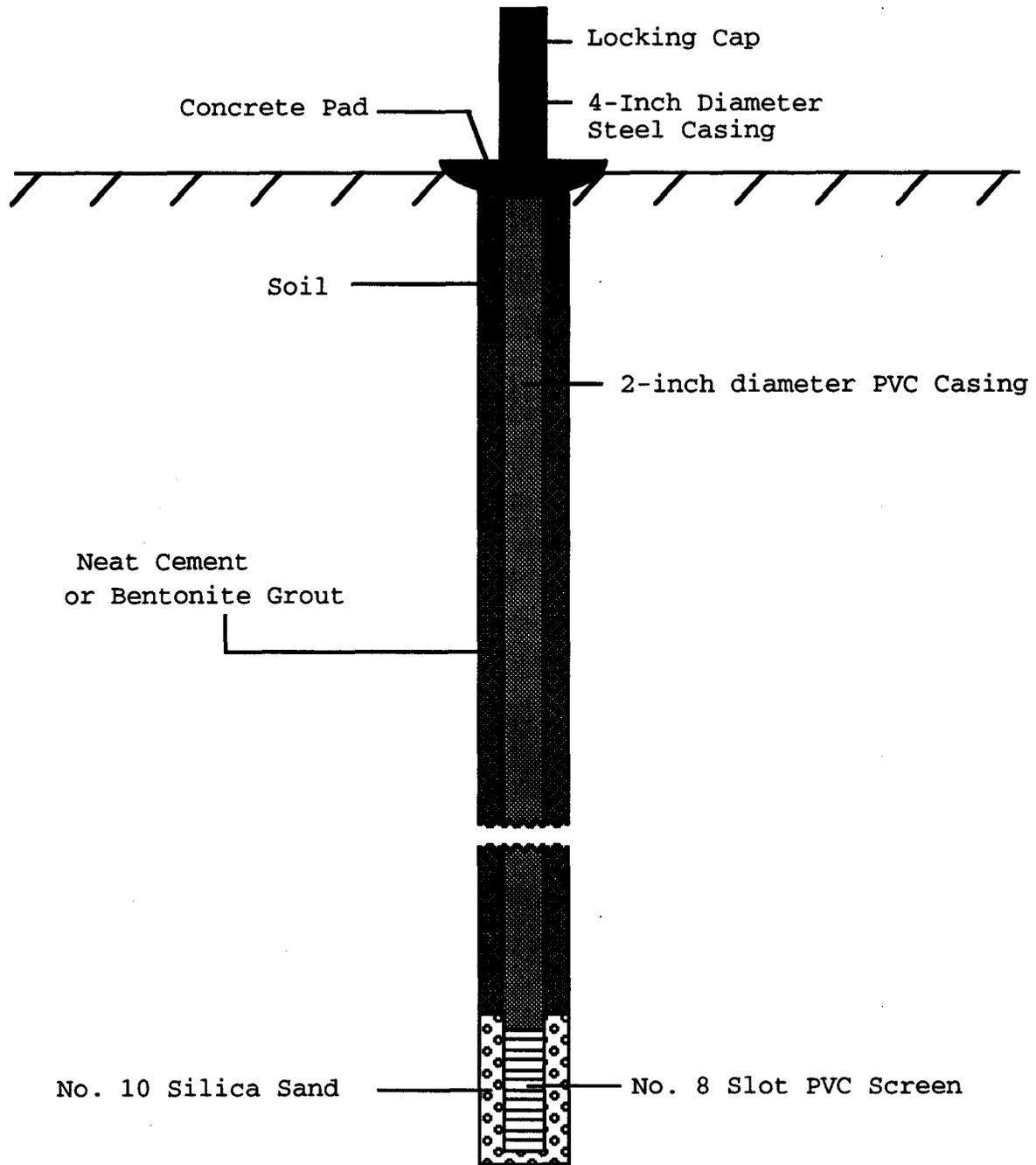


Figure 2. Construction design used for monitoring wells installed at the Bismarck landfill.

steel screws (no solvent weld cement was used). After the casing and screen were inserted 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.

All monitoring wells were developed using a stainless-steel bladder pump or a teflon bailer. Any drilling fluid and fine materials present in 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 and 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

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

time than the standard water quality sample. The procedure used for collecting the VOC sample is described in Appendix B. The sample was collected with a plastic throw-away bailer, kept chilled and was 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 analysis was performed by the NDSDHCL.

Water-Level Measurements

Water-level measurements were taken at least four times at about a two-week interval. 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

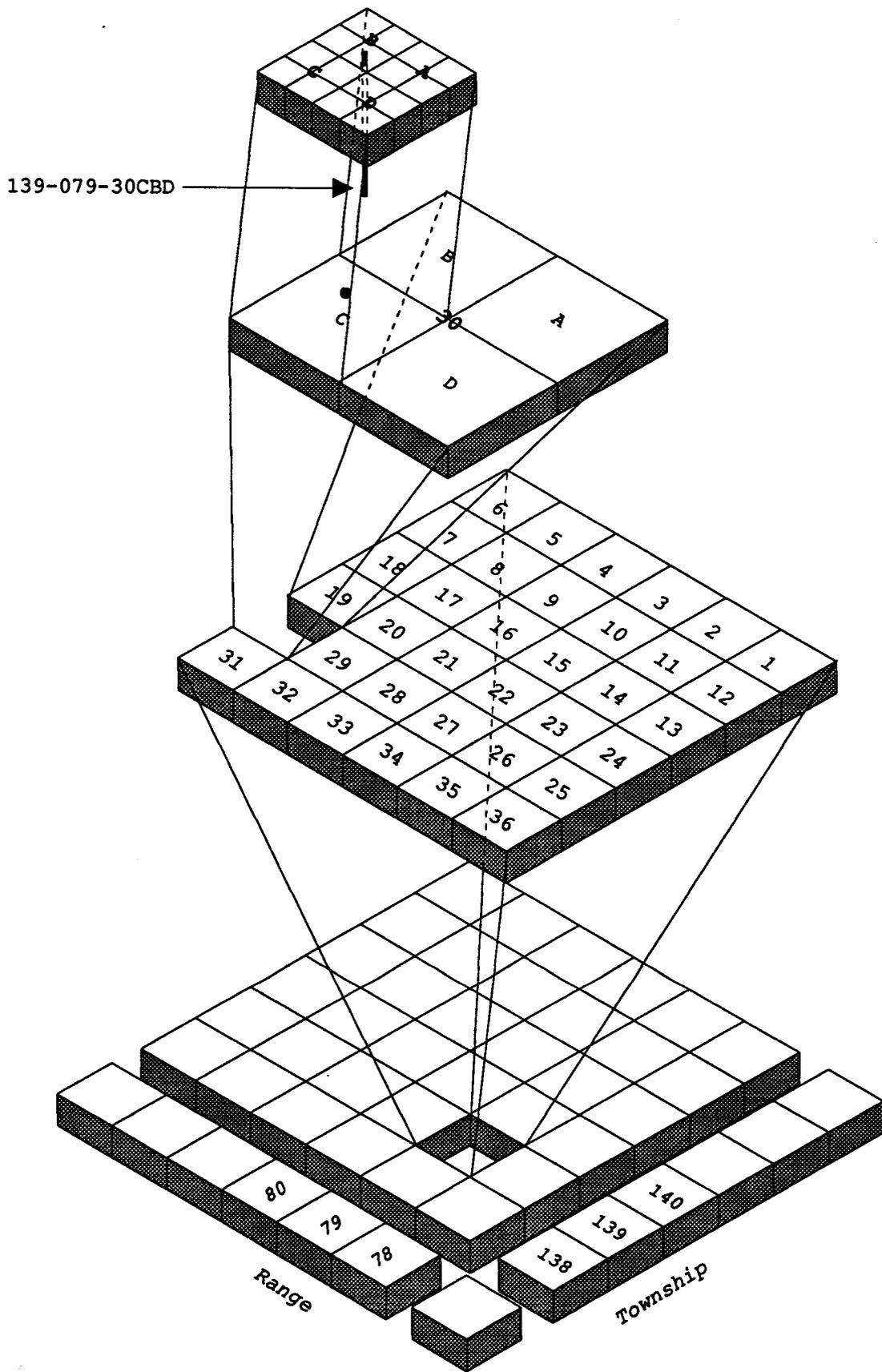


Figure 3. Location-numbering system for the Bismarck landfill.

section (40-acre tract), and quarter-quarter-quarter section (10-acre tract). Therefore, a well denoted by 139-079-30CBD would be located in the SE1/4, NW1/4, SW1/4, Section 30, Township 139 North, Range 79 West. Consecutive numbers are added following the three letters if more than one well is located in a 10-acre tract, e.g. 139-079-30CBD1 and 139-079-30CBD2.

GEOLOGY

Regional Geology

The Bismarck landfill is located in an area comprised of bedrock sediment overlain by a discontinuous layer of glacial till. Holocene alluvium occurs along present-day streams. The near-surface bedrock in the region is part of the Cannonball Formation (Paleocene). This marine sequence is composed of poorly consolidated sand, sandstone, silt, clay, and limestone (Kume and Hansen, 1965).

The Cannonball Formation is underlain by the Ludlow Formation (Paleocene) and the Hell Creek Formation (Cretaceous). The Ludlow Formation is composed of carbonaceous shale, lignite, and sandstone. The Hell Creek Formation is composed of shale, siltstone, and sandstone. The approximate thicknesses of the three formations in the Bismarck area are as follows: Cannonball - 300 feet, Ludlow - 20 feet, Hell Creek - 250 feet (Kume and Hansen, 1965).

Two meltwater channels occur in the area. The Lower Apple Creek aquifer occupies a meltwater channel about two miles south of the landfill. The outwash deposits in this channel range from 10 feet to 100 feet thick and consist of sand and gravel with interbedded silt and clay (Randich and Hatchett, 1966). The outwash is overlain by Holocene alluvium.

The Missouri River trench is about four miles southwest of the landfill. The combined thickness of alluvium and outwash in the trench is about 100 to 150 feet. The sediments are composed of sand and gravel with minor amounts of silt and clay (Kume and Hansen, 1965).

Local Geology

The Bismarck landfill is located in an area of moderate relief. An intermittent stream runs through the western part of the landfill in section 25 and the northwest corner of section 30 (Fig. 4). Surface elevations at the site range from 1700 feet to 1880 feet, with the higher elevations occurring in the east half of section 30.

Alluvium along the intermittent stream is composed of clay, silt, sand, and gravel. In monitoring well MW-L, located near the intermittent stream, layers of sand and gravel were reported between depths of 6 to 14 feet and again between depths of 49 to 54 feet (Braun, 1990).

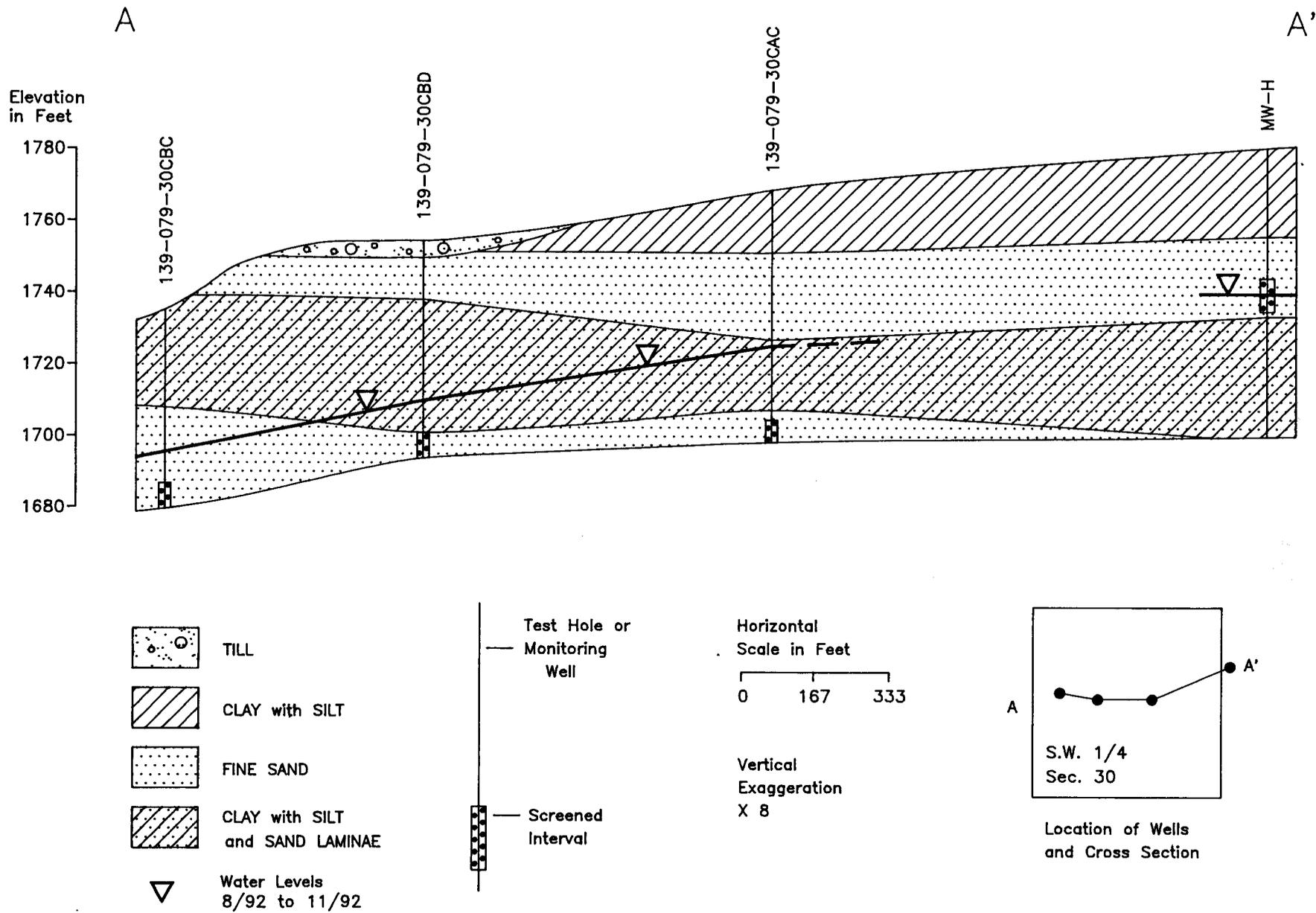


Figure 5. Geohydrologic section A-A' in the Bismarck landfill.

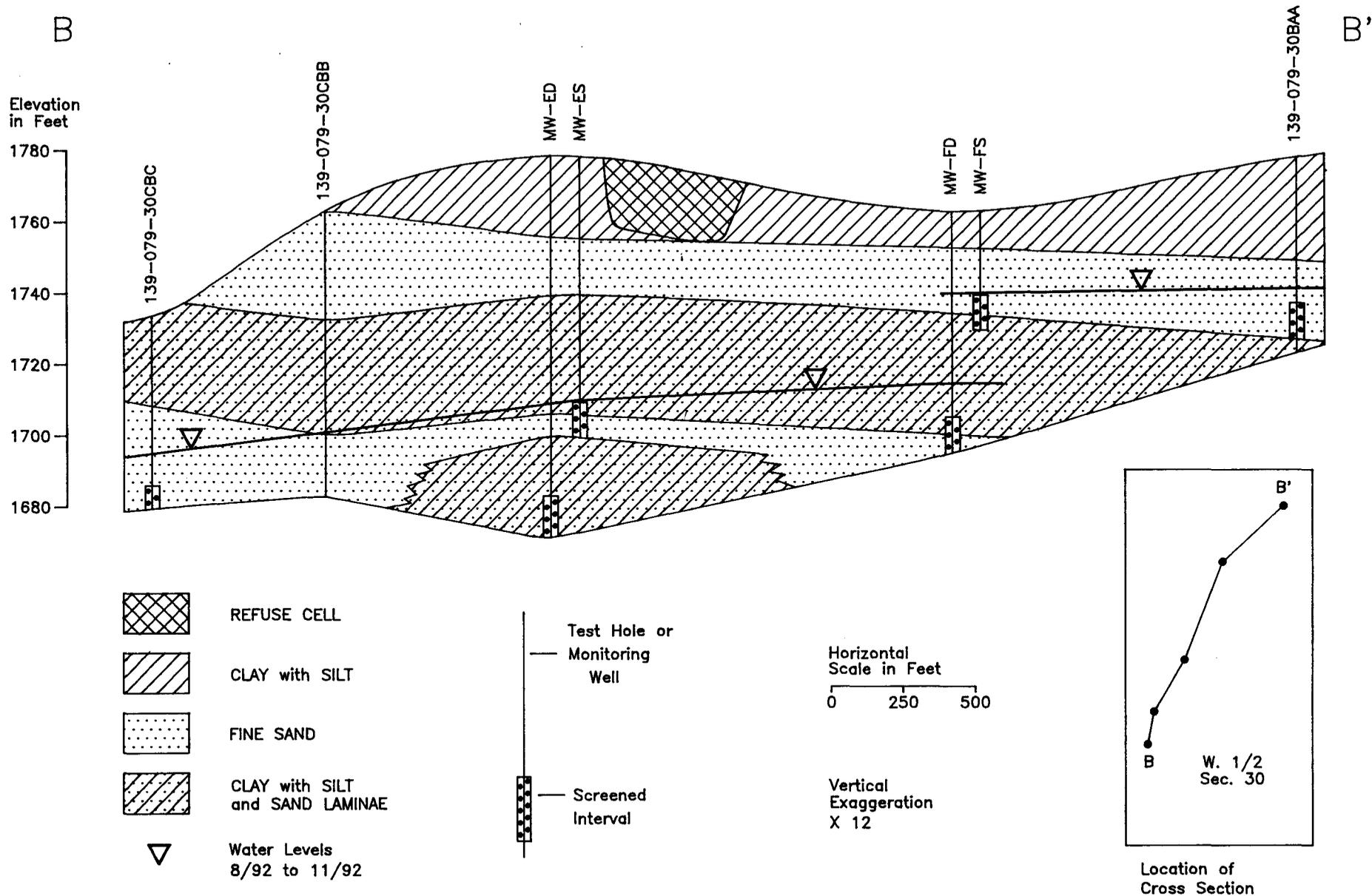


Figure 6. Geohydrologic section B-B' in the Bismarck landfill.

Away from the intermittent stream the landfill is situated within sediments of the Cannonball Formation, which are overlain by discontinuous bodies of glacial till. A veneer of glacial till was observed in the walls of a disposal trench (trench 91-2) and in several soil borings. However, the till has apparently been removed by erosion over much of the site.

The stratigraphic units in the Cannonball Formation are illustrated in Figures 5 and 6. The upper unit, designated unit B by Braun (1992), is a silty clay. This unit contains vertical fractures which are commonly filled with gypsum crystals. The thickness of this unit varies according to topography across the site. The maximum thickness is about 80 feet on the hill on the east side of section 30 (Braun, 1992).

The silty clay is underlain by a fine sand (unit C of Braun), which averages about 20 feet in thickness. The sand consistently occurs in soil borings between elevations of 1720 feet and 1760 feet, and it outcrops along the flanks of the intermittent stream valley. Limestone concretions were observed near the top of the sand in two disposal trenches which were open in the summer of 1991 (98-2 and 91-2). The concretions are lenticular in shape and average about 2 feet thick and 10 feet long. The concretions were also encountered in several of Braun's test holes (MW-I, P-8, P-9, ST-5, and ST-6).

The sand is underlain by another silty clay (unit D of Braun). This unit typically contains thin layers and laminae of fine sand.

The deeper NDGS/SWC test holes encountered another sand unit between the 1680-foot and 1700-foot elevations. Braun test holes D, E, and F also penetrated sand layers at about the same elevation, but test holes A and K did not. The thickness and lateral extent of this lower sand cannot be determined because drill-hole data is sparse below 1700 feet.

The deepest borings drilled by Braun penetrated black shale and lignite, identified as Ludlow Formation, at an elevation of about 1648 feet.

Water-well logs south of the landfill in Brownsville encountered several sand units. Exact elevations for these wells are not available, making correlations difficult. A survey of wells in Brownsville conducted by the City of Bismarck found that the depths of well screens ranged from 42 feet to 175 feet, corresponding to elevations between approximately 1550 feet and 1725 feet (Braun, 1990). The shallowest of these wells are probably screened in the lower Cannonball sand shown in Figures 5 and 6 (Fig. 5 is located just north of Brownsville). The deeper wells in Brownsville are probably screened in sands of the Hell Creek Formation.

Prior to 1986 refuse was buried in section 25 on either side of the intermittent stream. Refuse trenches were placed in the lower part of the Cannonball Formation, and trenches near the intermittent stream may have been placed partially

within alluvium. In 1986 operations were moved eastward to section 30, and the refuse was placed in the upper Cannonball sand and the overlying unit of silty clay. In 1992 the landfill plans were modified to prevent further burial of waste in the sand.

HYDROLOGY

Surface-Water Hydrology

Surface water in the area of the landfill consists of an intermittent stream that is located between the old and present sections of the landfill. This stream is usually dry except during spring runoff and periods of heavy precipitation. Dams located north of the landfill in the streambed may help control the amount of flow moving down the stream. This stream flows south into Apple Creek and then into the Missouri River.

Runoff from the landfill flows into this intermittent stream. This may cause contaminants to move from the landfill during heavy runoff periods. The streambed also may act as a local ground-water discharge area where the bedrock sand layers outcrop.

Regional Ground-Water Hydrology

The Dakota Formation ranges from 2,800 to 3,200 feet below land surface in Burleigh County (Randich, 1966). The Dakota Group aquifers are characterized by a sodium-sulfate type water. This aquifer system should not be affected by the landfill due to its depth and the intervening low conductivity shale of the Cannonball and Ludlow Formations.

The Hell Creek Formation is located about 140 feet below land surface near the landfill (Randich, 1966). The Hell Creek aquifer is characterized by a sodium-bicarbonate and sodium-bicarbonate-sulfate type water. Chloride is also found in varying concentrations throughout the Hell Creek aquifer.

The Cannonball Formation is the uppermost aquifer beneath the Bismarck landfill. Recharge to the Cannonball aquifer is by precipitation and lateral flow from adjacent glacial and bedrock aquifers. This aquifer is characterized by a sodium-sulfate-bicarbonate type water. This aquifer may be susceptible to contamination from the landfill due to its shallow depth and and relatively large hydraulic conductivity.

The Bismarck and Lower Apple Creek aquifers of glaciofluvial origin are located within five miles of the Bismarck landfill. The Bismarck aquifer is located southwest of the landfill and consists predominantly of mixed sand and gravel originating from a terrace or previous Missouri River

channel (Randich, 1966). Recharge to the Bismarck aquifer is predominantly from precipitation. Lateral flow from the Lower Apple Creek aquifer, bedrock aquifers, and the Missouri River also recharge the Bismarck aquifer. The Bismarck aquifer is characterized by a sodium-calcium-bicarbonate to a sodium-bicarbonate-sulfate type water. The Bismarck aquifer appears to be hydraulically connected to the Cannonball and Hell Creek aquifers.

The Lower Apple Creek aquifer is located south of the landfill and occurs from about 40 to 110 feet below land surface. The aquifer is comprised mainly of mixed sand and gravel with interbedded silts and clays (Randich, 1966). Recharge to the Lower Apple Creek aquifer is mainly by precipitation and seepage from Apple Creek, the McKenzie and Soo Channel aquifers, and from local bedrock aquifers. Discharge from the Lower Apple Creek aquifer is by pumpage and lateral flow into the Bismarck aquifer. The Lower Apple Creek aquifer is characterized by a sodium-bicarbonate type water. The Lower Apple Creek aquifer appears to be hydraulically connected to the Cannonball and Hell Creek aquifers that underlie the Bismarck landfill.

Local Ground-Water Hydrology

A conceptual model of the local ground-water hydrology is developed using data from 23 monitoring wells from previous investigations (Braun, 1991) and five supplementary

monitoring wells and one soil boring (Fig. 4). The five supplementary monitoring wells and test hole were drilled within the boundaries of the present landfill unit. All 28 monitoring wells are screened in the Cannonball Formation.

Four water-level measurements were taken over a five-week period from the five supplemental wells (Appendix D). Water-level data from an ongoing monitoring program by Braun Intertec (Appendix E) was also used in this site evaluation. Water levels indicate ground-water flow to the west-southwest below the present landfill unit and to the south-southwest below the intermittent stream. The direction of ground-water flow under the old landfill unit is to the south-southeast toward the intermittent stream.

Braun (1991) indicates an unconfined sand aquifer about 25 feet below land surface that appears to underlie much of the present landfill unit. The water level in this aquifer is controlled by the intermittent stream channel along the west boundary of the present landfill site. This unconfined aquifer was not found in the supplemental wells installed along the southern boundary of the landfill.

A confined/unconfined sand aquifer occurs about 60 feet below land surface in the landfill study area. This sand aquifer occurs under unconfined conditions at the southwest corner of the landfill and confined under the eastern part of the landfill. This aquifer also appears to underlie much of the landfill. Locally, the direction of ground-water in this aquifer is west toward the intermittent stream channel. The

difference in water-level elevations between the upper and lower sand aquifers suggest that the two aquifers are not directly connected hydraulically in the landfill study area.

Water Quality

Chemical analyses of water samples are shown in Appendix F and G. Braun (1991) found the general ground-water chemistry under the present landfill unit to be a sodium-sulfate type water except in monitoring well MW-I where it was found to be a calcium-bicarbonate type water. Ground-water analyses taken after the 1991 report indicate no change in ground-water chemistry (Appendix G).

Ground-water analyses from supplemental wells 139-079-30BAA, 30BDA, and 30CBC indicate a sodium-sulfate type water. Monitoring well 30CAC indicated the ground-water is characterized by a mixed sodium-bicarbonate-sulfate type water and monitoring well 30CBD indicated a mixed calcium-sodium-bicarbonate type water.

Supplemental monitoring wells 30BAA and 30BDA are screened in the upper-unconfined sand aquifer whereas monitoring wells 30CBC, 30CBD, and 30CAC are screened in the lower-confined/unconfined sand aquifer. The ground-water chemistry of the upper sand aquifer determined from the supplemental monitoring wells is consistent with the results of Braun (1991).

Braun monitoring wells MW-K, MW-BS, MW-BD, MW-CS, and MW-CD are located in the old landfill unit (Fig. 4). Chemical analyses from well MW-CS indicated a chloride concentration of 140 mg/L. This concentration is lower than the SMCL of 250 mg/L, but higher than the concentrations from the surrounding wells. Data from Braun (1991) indicates that this concentration has been increasing over the past three years. This trend may indicate leachate migration from the old landfill unit.

Anomalously high pH values were measured in wells 139-079-30CBC (pH=11.04), 139-079-30CBD (9.03), and 139-079-30BDA (8.97). The normal pH range for ground water in the Cannonball Formation should be between 7.0 and 8.5. Wells 30CBC and 30CBD are located down-gradient from the landfill along the southern property line and well 30BDA is located in the middle of the landfill. The source of the elevated pH may be due to leachate migration from the landfill or influences related to well construction. Braun Intertec sampled well 30BDA (MW-R) in November, 1992 and June, 1993 and measured the pH at 8.5 and 10.5 respectively. This well should be periodically monitored to determine the cause of the pH fluctuation. Monitoring wells 30CBC and 30CBD located along the southern boundary also should be monitored periodically to determine the cause of the elevated pH.

An arsenic concentration of 32 µg/L was detected in well 139-079-30BDA. This concentration is lower than the MCL of 50 µg/L, but higher than the surrounding monitoring-well

data. This well is located in the middle of the landfill. The elevated arsenic concentration may be due to leachate migration from the landfill. Well 139-079-30CAC indicated 337 $\mu\text{g}/\text{L}$ of molybdenum, which is over three times higher than the MCL of 100 $\mu\text{g}/\text{L}$. This well is located down-gradient at the southwest corner of the property line. The elevated molybdenum concentration may also be due to leachate migration from the landfill.

VOC analysis from well 139-079-30BDA is shown in Appendix H. There were no VOC detections from this well.

CONCLUSIONS

The Bismarck landfill is located in an area of bedrock overlain by a thin, discontinuous layer of glacial till. A small amount of alluvium occurs along an intermittent stream within the landfill site. The Cannonball Formation is the uppermost bedrock formation and is underlain by the Ludlow and Hell Creek Formations.

Four stratigraphic units have been identified in the Cannonball Formation at the landfill. The upper unit consists of a fractured, silty clay of variable thickness. This unit is thickest in the east half of section 30. The underlying sand is about 20 feet thick and is laterally continuous except in the area of the intermittent stream where it has been removed by erosion. The sand is underlain by another unit of silty clay. The fourth

unit in the Cannonball is a sand that occurs below about 1710 feet.

Area water supplies are derived from bedrock and glaciofluvial aquifers. The main bedrock aquifers consist of sands in the Cannonball, Hell Creek, and Dakota Formations. The nearest glaciofluvial aquifers are the Lower Apple Creek aquifer, located two miles south of the landfill, and the Bismarck aquifer, located four miles southwest of the landfill.

Within the landfill the upper Cannonball sand is partially saturated, whereas the lower Cannonball sand contains water under both confined and unconfined conditions. The direction of groundwater flow in these aquifers is west-southwest toward the intermittent stream. Near the intermittent stream the flow direction changes to south-southwest.

South of the landfill in Brownsville, a number of residences obtain domestic water from wells. Some of the wells are screened in the lower Cannonball sand, while others are screened in sands of the Hell Creek Formation. Contamination of these water supplies is possible because the wells are located down-gradient from the landfill.

Water quality analyses indicated an elevated concentration of chloride in monitoring well MW-CS. Although the concentration is below the SMCL, it may be caused by leachate migration from the old landfill unit.

Anomalously high pH measurements were detected in three of the supplemental monitoring wells. Later analyses from well 30BDA indicated that the pH measurements have fluctuated

over the past year from 8.5 to 10.5. The cause of the pH fluctuation has not been determined.

An elevated arsenic concentration of 32 $\mu\text{g/L}$ was detected in monitoring well 30BDA. Although the concentration is below the SMCL, it may be caused by leachate migration from the landfill. Monitoring well 30CAC detected a molybdenum concentration of 337 $\mu\text{g/L}$, which is three times higher than the MCL. The elevated molybdenum concentration may also be caused by leachate migration from the present landfill unit. No VOC's were detected from any of the monitoring wells.

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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 | ----- |

| <u>Constituent</u> | <u>MCL (µg/L)</u> |
|---------------------------|--------------------------|
| 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).

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

| | <u>Recommended Concentration Limits (mg/L)</u> |
|-------------|---|
| 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. Scew 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

139-079-30BAA

NDSWC

Date Completed: 9/11/92 Well Type: P2
 Depth Drilled (ft): 56 Source of Data:
 Screened Interval (ft): 38-48 Principal Aquifer : Undefined
 Casing size (in) & Type: 2 in L.S. Elevation (ft) 1778.66
 Owner: Bismarck

| Unit | Description | Lithologic Log | Depth (ft) |
|---------|--|----------------|------------|
| TOPSOIL | | | 0-1 |
| CLAY | Medium gray with dark yellowish orange streaks (Cannonball Formation). | | 1-6 |
| CLAY | Medium gray N5. | | 6-11 |
| CLAY | Sandy, dark yellowish brown 10YR4/2. | | 11-14 |
| CLAY | Silty with a trace of sand, moderate yellowish brown 10YR5/4, thin sandstone at 18 feet. | | 14-19 |
| CLAY | Silty with a trace of sand, moderate yellowish brown 10YR5/4. | | 19-24 |
| CLAY | Dark yellowish brown 10YR4/2 | | 24-27 |
| CLAY | Silty, sandy, dark yellowish brown 10YR4/2. | | 27-29 |
| SAND | Fine grained, silty, dark yellowish brown 10YR4/2. | | 29-31 |
| SAND | Fine grained, moderate yellowish brown 10YR5/4. | | 31-41 |
| SAND | Fine grained, damp, moderate yellowish brown 10YR5/4. | | 41-46 |
| SAND | Fine grained, olive gray 5Y4/1. | | 46-49 |
| SAND | Fine grained, silty with a trace of clay, olive gray 5Y4/1. | | 49-52 |
| CLAY | Silty with a trace of sand, dark gray N3. | | 52-56 |

139-079-30BDA

NDSWC

Date Completed: 9/14/92 Well Type: P2
 Depth Drilled (ft): 41 Source of Data:
 Screened Interval (ft): 36-41 Principal Aquifer : Undefined
 Casing size (in) & Type: 2 in L.S. Elevation (ft) 1769.6
 Owner: Bismarck

| Unit | Description | Lithologic Log | Depth (ft) |
|---------|--|----------------|------------|
| TOPSOIL | | | 0-1 |
| CLAY | Calcite mottle streaking, dark yellowish brown 10YR4/2 (till). | | 1-5 |
| CLAY | Silty with a trace of sand and pebbles, dark yellowish brown 10YR4/2 (till). | | 5-8 |
| SAND | Fine grained, silty, moderate yellowish brown 10YR 5/4 (Cannonball Formation). | | 8-13 |
| SAND | Fine grained, moderate yellowish brown 10YR5/4. | | 13-26 |
| SAND | Fine grained, damp, olive gray 5Y4/1. | | 26-32 |
| SAND | Fine grained, with interbedded clay, medium dark gray N4. | | 32-38 |
| CLAY | Sandy, medium dark gray N4. | | 38-41 |

139-079-30CAC

NDSWC

Date Completed: 9/10/92 Well Type: P2
 Depth Drilled (ft): 70 Source of Data:
 Screened Interval (ft): 65-70 Principal Aquifer : Undefined
 Casing size (in) & Type: 2 in L.S. Elevation (ft) 1767.52
 Owner: Bismarck

| Unit | Description | Lithologic Log | Depth (ft) |
|---------|--|----------------|------------|
| TOPSOIL | | | 0-2 |
| SILT | Trace of sand and clay, moderate yellowish brown 10YR5/4 (Cannonball Formation). | | 2-6 |
| SILT | Sandy, moderate yellowish brown 10YR5/4. | | 6-10 |
| CLAY | Silty with a trace of fine sand, dark yellowish brown 10YR4/2. | | 10-16 |
| SAND | Fine grained, trace of silt, moderate yellowish brown 10YR5/4. | | 16-20 |
| SILT | Sandy with a trace of clay, moderate yellowish brown 10YR5/4. | | 20-23 |
| SAND | Fine grained, trace of silt, moderate yellowish brown 10YR5/4. | | 23-33 |
| SAND | Fine grained, trace of silt, damp, moderate yellowish brown 10YR5/4. | | 33-41 |
| SILT | Clayey with fine sand, olive gray 5Y4/1. | | 41-45 |
| CLAY | Silty with a trace of fine sand, olive gray 5Y4/1. | | 45-49 |
| CLAY | Silty, dark greenish gray 5GY4/1. | | 49-57 |
| CLAY | Silty, medium dark gray N4. | | 57-60 |
| SAND | Fine grained, silty with a trace of clay, medium dark gray N4. | | 60-64 |
| SILT | Sandy with a trace of clay, medium dark gray N4. | | 64-70 |

139-079-30CEB

NDSWC

| | | | |
|---------------------|---------|-----------------|-----------|
| Date Completed: | 9/9/92 | Purpose: | Test Hole |
| Depth Drilled (ft): | 78 | Source of Data: | |
| L.S. Elevation (ft) | 1760.07 | Owner: Bismarck | |

| Unit | Description | Lithologic Log | Depth (ft) |
|-----------|--|----------------|------------|
| TOPSOIL | Cored to 70 feet, 70 to 78 feet described by cuttings (unable to core). | | 0-1 |
| SAND | Fine grained, silty with a trace of clay, moderate yellowish brown 10YR5/4 with spots of calcite (Cannonball Formation). | | 1-5 |
| SAND | Fine grained, silty with a trace of clay, moderate yellowish brown 10YR5/4. | | 5-8 |
| SANDSTONE | Fine grained, well cemented, light gray N6 | | 8-10 |
| SAND | Fine grained, silty, moderate yellowish brown 10YR5/4. | | 10-17 |
| SAND | Fine grained, moderate yellowish brown 10YR5/4. | | 17-25 |
| SAND | Fine grained, moderate yellowish brown 10YR5/4 with dark yellowish orange 10YR6/6 mottles. | | 25-27 |
| CLAY | Silty, sandy, numerous burrows filled with silty sand, abundant gypsum crystals, dark yellowish brown 10YR5/4 with orange stains on fractures. | | 27-33 |
| CLAY | Silty with a trace of sand, gypsum crystals, dark yellowish brown 10YR4/2 with orange stain on fractures. | | 33-44 |
| CLAY | Trace of silt, gypsum crystals, dark yellowish brown 10YR4/2 with orange on fractures. | | 44-48 |
| CLAY | grayish black N2 | | 48-53 |
| CLAY | Trace of silt and sand, grayish black N2. | | 53-58 |
| CLAY | Silty , sandy, grayish black N2. | | 58-60 |
| SAND | Fine grained, silty, olive gray 5Y4/1 with a few layers and irregular pockets of grayish black silty clay. | | 60-70 |

SAND

Fine grained, silty, grayish green 10G4/2.

70-78

139-079-30CBC

NDSWC

| | | | |
|--------------------------|----------|---------------------|-----------|
| Date Completed: | 9/11/92 | Well Type: | P2 |
| Depth Drilled (ft): | 55 | Source of Data: | |
| Screened Interval (ft): | 48-53 | Principal Aquifer : | Undefined |
| Casing size (in) & Type: | 2 in | L.S. Elevation (ft) | 1733.8 |
| Owner: | Bismarck | | |

| Unit | Description | Lithologic Log | Depth (ft) |
|---------|--|----------------|------------|
| TOPSOIL | | | 0-4 |
| CLAY | Silty, dark yellowish brown 10YR4/2 (Cannonball Formation). | | 4-7 |
| CLAY | Fine sand and silt, dark yellowish brown 10YR4/2 with dark yellowish orange 10YR6/6 mottles. | | 7-16 |
| CLAY | Silty, stiff, dark yellowish orange 10YR6/6. | | 16-26 |
| CLAY | Trace fine sand, dark yellowish brown 10YR4/2 | | 26-30 |
| SAND | Fine grained, clayey, dark yellowish orange 10YR6/6. | | 30-38 |
| SAND | Fine grained, clay, olive gray 5Y3/2. | | 38-50 |
| SAND | Fine grained, dark greenish gray 5GY4/1, saturated. | | 50-55 |

139-079-30CBD

NDSWC

| | | | |
|--------------------------|---------|---------------------|-----------|
| Date Completed: | 9/10/92 | Well Type: | P2 |
| Depth Drilled (ft): | 62 | Source of Data: | |
| Screened Interval (ft): | 57-62 | Principal Aquifer : | Undefined |
| Casing size (in) & Type: | 2 in | L.S. Elevation (ft) | 1755.21 |

Owner: Bismarck

| Unit | Description | Lithologic Log | Depth (ft) |
|---------|--|----------------|------------|
| TOPSOIL | | | 0-2 |
| CLAY | Intermixed gravel and very fine sand, rock at 3 feet, oxidized (till). | | 2-5 |
| SAND | Fine grained, moderate yellowish brown 10YR5/4 (Cannonball Formation). | | 5-17 |
| SAND | Clayey, dark yellowish brown 10YR4/2, moist. | | 17-21 |
| CLAY | Sandy, dark yellowish brown 10YR4/2. | | 21-27 |
| CLAY | Silty with very fine sand, olive gray 5Y4/1. | | 27-57 |
| SAND | Fine grained, clay, greenish black 5GY2/1. | | 57-60 |
| SAND | Fine grained, silty with a trace of clay, grayish green 10G4/2. | | 60-62 |

APPENDIX D

BRAUN LITHOLOGIES

LOG OF BORING



**PROJECT: NDG-006
HYDROGEOLOGIC INVESTIGATION**

Bismarck Sanitary Landfill

Bismarck, North Dakota

BORING: A

LOCATION:

See map: N. 425,839.0; E. 1,947,644.6

DATE: 10/30/89

SCALE: 1" = 4'

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------|---|-----|----|---|
| 1719.3 | 0.0 | | | | | |
| 1717.8 | 1.5 | ML | SANDY SILT, very fine- to coarse-grained, with roots, olive brown to light gray, moist. | | | |
| 1716.3 | 3.0 | CH | FAT CLAY, with very fine-grained SILTY SAND, dark olive brown to light gray, moist. (Shale) | | | |
| | | CH | FAT CLAY, with very fine-grained SILTY SAND and a trace of Gravel, dark olive brown to light gray, wet. (Shale) | | | |
| 1711.3 | 8.0 | CH | FAT CLAY, with layers of fine-grained SILTY SAND, dark gray, moist to wet. (Shale) | | | |
| 1701.3 | 18.0 | CH | FAT CLAY, with fine-grained SAND, very dark gray, moist. (Shale) | | | |
| 1696.3 | 23.0 | CH | FAT CLAY, with layers of fine-grained SILTY SAND, very dark gray, waterbearing. (Shale) | | | |
| 1690.8 | 28.5 | | END OF BORING | | | |
| | | | Water level down 14.5 feet with 28.5 feet of hollow-stem auger in the ground. | | | Monitoring well installed at 27.5 feet. |

LOG OF BORING



**PROJECT: NDG-006
HYDROGEOLOGIC INVESTIGATION**

Bismarck Sanitary Landfill

Bismarck, North Dakota

BORING: B

LOCATION:
See map: N. 424198.5; E. 1,946,121.9

DATE: 10/24/89 **SCALE: 1" = 4'**

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------|---|-----|----|----------------|
| 1732.8 | 0.0 | | | | | |
| 1730.8 | 2.0 | CL | SANDY LEAN CLAY, very fine- to coarse-grained, yellow to brown, dry. (Fill) | | | |
| | | | Landfill waste material. | | | |
| 1702.8 | 30.0 | | | | | |
| 1700.8 | 32.0 | CH | FAT CLAY, with very fine-grained SAND, olive brown, moist. (Shale) | 20 | | |

LOG OF BORING



| | |
|---|---|
| PROJECT: NDG-006 HYDROGEOLOGIC INVESTIGATION Bismarck Sanitary Landfill Bismarck, North Dakota | BORING: B (cont.) LOCATION: See map: N. 424198.5; E. 1,946,121.9 DATE: 10/24/89 SCALE: 1" = 4' |
|---|---|

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Note |
|--------|-------|-------------------|---|-----|----|---------------|
| | | CH | FAT CLAY, with very fine-grained, SAND, olive brown, moist. (Shale) | | | |
| 1694.8 | 38.0 | CH | FAT CLAY, with very fine-grained SAND, very dark gray, wet. (Shale) | | | |
| 1689.8 | 43.0 | CH | FAT CLAY, with layers of very fine-grained SILTY SAND, very dark gray, waterbearing. (Shale) | | | |
| 1674.8 | 58.0 | CH | FAT CLAY, with very fine-grained SAND, very dark gray, wet. (Shale) | | | |
| 1668.8 | 64.0 | CH | FAT CLAY, with very fine-grained SAND, very dark gray, wet. (Shale) | | | |

LOG OF BORING



| | |
|---|---|
| PROJECT: NDG-006 HYDROGEOLOGIC INVESTIGATION Bismarck Sanitary Landfill Bismarck, North Dakota | BORING: B (cont.) LOCATION: See map: N. 424198.5; E. 1,946,121.9 DATE: 10/24/89 SCALE: 1" = 4' |
|---|---|

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--|-------|-------------------|---|-----|----|----------------|
| 1664.8 | 68.0 | CH | FAT CLAY, with very fine-grained SAND, very dark gray, wet. (Shale) | | | |
| 1657.8 | 75.0 | SP SM | POORLY GRADED SAND with SILT, fine-grained, brownish gray, wet. (Sandstone) | | | |
| 1648.3 | 84.5 | SP SM | POORLY GRADED SAND with SILT, fine-grained, very dark gray, waterbearing. (Sandstone) | | | |
| 1646.3 | 86.5 | CH | FAT CLAY, with lignite fragments and a layer of lignite, very dark brownish gray, moist. (Shale) | | | |
| END OF BORING Water level down 49 feet 1 day after completion of boring. Monitoring well B South (deep) installed at 85.5 feet. Monitoring well B North (shallow) installed in adjacent borehole at 55 feet. | | | | | | |

LOG OF BORING



| | |
|---|---|
| PROJECT: NDG-006 HYDROGEOLOGIC INVESTIGATION Bismarck Sanitary Landfill Bismarck, North Dakota | BORING: C LOCATION: See map: N. 423,385.8; E. 1,946,271.2 DATE: 10/4/89 SCALE: 1" = 4' |
|---|---|

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------|--|-----|----|----------------|
| 1689.5 | 0.0 | CH | FAT CLAY, with roots, olive brown, damp, rather stiff. | 9 | | |
| 1686.5 | 3.0 | CH | FAT CLAY, with a trace of Gravel, dark olive brown, moist to wet, rather soft to rather stiff. | 9 | | |
| 1678.5 | 11.0 | CH | FAT CLAY, with very fine-grained SAND and a trace of Gravel, brown, waterbearing, rather soft to rather stiff. | 7 | | |
| 1673.5 | 16.0 | | END OF BORING Water level down 4.5 feet with 16 feet of hollow-stem auger in the ground. Monitoring well installed at 16 feet. | | | |

LOG OF BORING

BRAUN
INTERTEC

| | |
|--|--|
| PROJECT: CFEX-91-0006 BISMARCK SOLID WASTE MANAGEMENT FACILITY BISMARCK, NORTH DAKOTA | BORING: MW-CD LOCATION: See Plate 3. |
| DATE: 6/1/92 SCALE: 1" = 4' | |

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. 1689.0 | Depth 0.0 | ASTM Symbol | Description of Materials (ASTM D 2488) | BPF | WL | Tests or Notes |
|-----------------|--------------|----------------|--|-----|----|----------------|
| | | SC | <p>CLAY clay is the dominant constituent for the entire soil boring. There are zones that will contain abundant fine sand or silt; these generally alternate with no apparent regularity.</p> | | | |

LOG OF BORING

BRAUN
INTERTEC

| | |
|---|--|
| PROJECT: CFE-91-0006 BISMARCK SOLID WASTE MANAGEMENT FACILITY BISMARCK, NORTH DAKOTA | BORING: MW-CD (cont.) LOCATION: See Plate 3. |
| DATE: 6/1/92 SCALE: 1" = 4' | |

| | Elev. | Depth | ASTM Symbol | Description of Materials (ASTM D 2488) | BPF | WL | Tests or Notes |
|--|-------|-------|-------------|--|-----|----|----------------|
| (See Report and Standard Plates for evaluation and descriptive terminology.) | | | | abundant sand with the clay from about 38 to 43.3' predominantly clay with some silt and sand for remainder of boring | | | |

LOG OF BORING

BRAUN
INTERTEC

| | |
|--|--|
| PROJECT: CFEX-91-0006 BISMARCK SOLID WASTE MANAGEMENT FACILITY BISMARCK, NORTH DAKOTA | BORING: MW-CD (cont.) LOCATION: See Plate 3. |
| DATE: 6/1/92 | SCALE: 1" = 4' |

| | Elev. | Depth | ASTM Symbol | Description of Materials (ASTM D 2488) | BPF | WL | Tests or Notes |
|--|--------|-------|-------------------|--|-----|----|----------------|
| (See Report and Standard Plates for evaluation and descriptive terminology.) | 1618.0 | 71.0 | [Hatched Pattern] | | | | |
| | | | | END OF BORING | | | |

LOG OF BORING



| | |
|---|---|
| PROJECT: NDG-006 HYDROGEOLOGIC INVESTIGATION Bismarck Sanitary Landfill Bismarck, North Dakota | BORING: D |
| | LOCATION: See map: N. 423,339.9; E. 1,947,559.2 |
| | DATE: 10/2/89 SCALE: 1" = 4' |

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------|--|-----|----|----------------|
| 1733.3 | 0.0 | ML | SANDY SILT, fine-grained, olive brown, dry to damp, stiff to very stiff. | 14 | | |
| | | | | 16 | | |
| 1729.3 | 4.0 | CH | FAT CLAY, with fine-grained SAND, yellowish brown, damp, stiff to very stiff. (Shale) | 13 | | |
| | | | | 17 | | |
| | | | | 19 | | |
| | | | | 13 | | |
| | | | | 16 | | |
| 1716.3 | 17.0 | SP SM | POORLY GRADED SAND with SILT, fine-grained, yellowish brown, damp to moist, medium dense to dense. (Sandstone) | 18 | | |
| | | | | 18 | | |
| | | | | 38 | | |
| | | | | 48 | | |
| 1701.3 | 32.0 | | | | | |

PROJECT: NDG-006
HYDROGEOLOGIC INVESTIGATION

Bismarck Sanitary Landfill
Bismarck, North Dakota

BORING: **D** (cont.)

LOCATION:
See map: N. 423,339.9; E. 1,947,559.2

DATE: 10/2/89 SCALE: 1" = 4'

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------|--|-----|----|----------------|
| 1692.3 | 41.0 | SP SM | POORLY GRADED SAND with SILT, fine-grained, yellowish brown, damp to moist, medium dense to dense. (Sandstone) | 52 | | |
| 1683.3 | 50.0 | SC SM | SILTY CLAYEY SAND, fine-grained, very dark gray, moist, dense. (Sandstone) | 49 | | |
| | | | | 37 | | |
| | | | | 63 | | |
| 1669.3 | 64.0 | SP SM | POORLY GRADED SAND with SILT, fine-grained, dark gray, wet to waterbearing, dense to very dense. (Sandstone) | 74 | | |

LOG OF BORING



| | |
|---|---|
| PROJECT: NDG-006 HYDROGEOLOGIC INVESTIGATION Bismarck Sanitary Landfill Bismarck, North Dakota | BORING: D (cont.) LOCATION: See map: N. 423,339.9; E. 1,947,559.2 DATE: 10/2/89 SCALE: 1" = 4' |
|---|---|

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------|--|-----|----|----------------|
| | | SP SM | POORLY GRADED SAND with SILT, fine-grained, dark gray, wet to waterbearing, dense to very dense. (Sandstone) | 84 | | |
| 1658.8 | 74.5 | | | 78 | | |
| | | CH | FAT CLAY, with very fine-grained SAND, lignite, very dark gray, moist, hard. (Shale) | 100 | | |
| | | | | 70 | | |
| 1647.8 | 85.5 | | | 78 | | |
| | | CH | FAT CLAY, with very fine-grained SAND, and layers of lignite and plant fibers, gray to brownish black, moist, hard. (Shale) | 77 | | |
| | | | | 84 | | |
| 1637.3 | 96.0 | | | 62 | | |

(See Report and Standard Plates for evaluation and descriptive terminology.)

LOG OF BORING



PROJECT: NDG-006
 HYDROGEOLOGIC INVESTIGATION
 Bismarck Sanitary Landfill
 Bismarck, North Dakota

BORING: D (cont.)
 LOCATION:
 See map: N. 423,339.9; E. 1,947,559.2

DATE: 10/2/89 SCALE: 1" = 4'

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------|---|-----|----|---|
| | | CH | FAT CLAY, with lignite fragments, very dark gray, moist, hard. (Shale) | | | |
| | | | | 60 | | |
| | | | | 63 | | |
| | | | | 76 | | |
| | | | | 90 | | |
| 1612.8 | 120.5 | | | 88 | | |
| | | | END OF BORING Water level down 39.5 feet with 120.5 feet of hollow-stem auger in the ground. Monitoring well D North (deep) installed at 120 feet.* Monitoring well D South (shallow) installed in adjacent borehole at 47.5 feet. | | | *Monitoring well D North was subsequently abandoned due to the presence of a bentonite plug within the riser. D North replacement well installed in adjacent borehole at 76 feet. |

PROJECT: NDG-006
 HYDROGEOLOGIC INVESTIGATION
 Bismarck Sanitary Landfill
 Bismarck, North Dakota

BORING:
 LOCATION:
 See map: 1
 DATE: 10/

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF |
|--------|-------|-------------------|--|-----|
| 1777.5 | 0.0 | | | |
| 1776.0 | 1.5 | ML | SILT, with roots, yellowish brown, dry. (Topsoil) | |
| 1774.5 | 3.0 | CH | FAT CLAY, with roots and layers of SILTY SAND, yellowish brown, dry. (Shale) | |
| | | CH | FAT CLAY, with very fine-grained SAND and layers of gypsum, dark yellowish brown, damp. (Shale) | |
| 1757.5 | 20.0 | | | |
| | | SP SM | POORLY GRADED SAND with SILT, fine-grained, light brown, damp, with trace fossils. (Sandstone) | |
| 1745.5 | 32.0 | | | |

LOG OF BORING



| | |
|---|--|
| PROJECT: NDG-006 HYDROGEOLOGIC INVESTIGATION Bismarck Sanitary Landfill Bismarck, North Dakota | BORING: E (cont.) LOCATION: See map: N. 424,589.3; E. 1,948,373.3 DATE: 10/31/89 SCALE: 1" = 4' |
|---|--|

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------|--|-----|----|----------------|
| 1741.5 | 36.0 | SP SM | POORLY GRADED SAND with SILT, fine-grained, light brown, damp, with trace fossils. (Sandstone) | | | |
| 1739.5 | 38.0 | SP SM | POORLY GRADED SAND with SILT, fine-grained, brown, damp, with trace fossils. (Sandstone) | | | |
| 1724.5 | 53.0 | CH | FAT CLAY, with very fine-grained SAND and layers of gypsum, brownish gray, damp, fractures. (Shale) | | | |
| 1713.5 | 64.0 | CH | FAT CLAY, with very fine-grained SAND and layers of gypsum, very dark gray, moist, fractures. (Shale) | | | |

(See Report and Standard Plates for evaluation and descriptive terminology.)

| | |
|---|--|
| PROJECT: NDG-006 HYDROGEOLOGIC INVESTIGATION Bismarck Sanitary Landfill Bismarck, North Dakota | BORING: E (cont.) LOCATION: See map: N. 424,589.3; E. 1,948,373.3 DATE: 10/31/89 SCALE: 1" = 4' |
|---|--|

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------|---|-----|----|----------------|
| 1704.5 | 73.0 | CH | FAT CLAY, with very fine-grained SAND, very dark gray, moist. (Shale) | | | |
| 1699.5 | 78.0 | SP SM | POORLY GRADED SAND with SILT, fine-grained, very dark gray, wet to waterbearing. (Sandstone) | | | |
| 1681.5 | 96.0 | CH | FAT CLAY, with very fine-grained SAND, very dark gray, damp. (Shale) | | | |

LOG OF BORING



| | |
|---|--|
| PROJECT: NDG-006 HYDROGEOLOGIC INVESTIGATION Bismarck Sanitary Landfill Bismarck, North Dakota | BORING: E (cont.) LOCATION: See map: N. 424,589.3; E. 1,948,373.3 DATE: 10/31/89 SCALE: 1" = 4' |
|---|--|

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------|--|-----|----|----------------|
| | | CH | FAT CLAY, with very fine-grained SAND, very dark gray, damp. (Shale) | | | |
| 1670.5 | 107.0 | | | | | |
| | | | END OF BORING Water level down 73 feet with 107 feet of hollow-stem auger in the ground. Monitoring well E South (deep) installed at 107 feet. Monitoring well E North (shallow) installed in adjacent borehole at 78 feet. | | | |

LOG OF BORING



| | |
|---|--|
| PROJECT: NDG-006 HYDROGEOLOGIC INVESTIGATION Bismarck Sanitary Landfill Bismarck, North Dakota | BORING: F LOCATION: See map: N. 425,991.9; E. 1,948,980.3 DATE: 10/20/89 SCALE: 1" = 4' |
|---|--|

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------------|--|-----|----|----------------|
| 1762.4 | 0.0 | ML | SANDY SILT, fine-grained, brown, damp. | | | |
| 1759.4 | 3.0 | CH | FAT CLAY, very fine-grained, brown, damp. (Shale) | | | |
| 1754.4 | 8.0 | SP SM | POORLY GRADED SAND with SILT, fine-grained, dark yellowish brown, damp, with trace fossils. (Sandstone) | | | |
| 1741.4 | 21.0 | SP SM | POORLY GRADED SAND with SILT, fine-grained, brownish gray, wet, with trace fossils. (Sandstone) | | | |
| 1734.4 | 28.0 | CH | FAT CLAY, with very fine-grained SAND, very dark gray, moist. (Shale) | | | |
| 1730.4 | 32.0 | | | | | |

(See Report and Standard Plates for evaluation and descriptive terminology.)

LOG OF BORING



| | |
|---|--|
| PROJECT: NDG-006 HYDROGEOLOGIC INVESTIGATION Bismarck Sanitary Landfill Bismarck, North Dakota | BORING: F (cont.) LOCATION: See map: N. 425,991.9; E. 1,948,980.3 DATE: 10/20/89 SCALE: 1" = 4' |
|---|--|

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------|---|-----|----|----------------|
| | | CH | FAT CLAY, with very fine-grained SAND, very dark gray, moist. (Shale) | | | |
| 1698.4 | 64.0 | | | | | |

LOG OF BORING



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|---|--|
| PROJECT: NDG-006 HYDROGEOLOGIC INVESTIGATION Bismarck Sanitary Landfill Bismarck, North Dakota | BORING: F (cont.) LOCATION: See map: N. 425,991.9; E. 1,948,980.3 DATE: 10/20/89 SCALE: 1" = 4' |
|---|--|

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------|--|-----|----|----------------|
| 1695.4 | 67.0 | SP SM | POORLY GRADED SAND with SILT, fine-grained, very dark gray, waterbearing. (Sandstone) | | | |
| | | | END OF BORING Water level down 50 feet with 67 feet of hollow-stem auger in the ground. Monitoring well installed at 67 feet. | | | |

LOG OF BORING



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|---|--|
| PROJECT: NDG-006 HYDROGEOLOGIC INVESTIGATION Bismarck Sanitary Landfill Bismarck, North Dakota | BORING: G LOCATION: See map: N. 424,593.0; E. 1,949,256.1 DATE: 10/30/89 SCALE: 1" = 4' |
|---|--|

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------|--|-----|----|----------------|
| 1764.1 | 0.0 | ML | SANDY SILT, very fine- to coarse-grained, with roots, brown, dry. (Topsoil) | | | |
| 1762.6 | 1.5 | CH | FAT CLAY, with very fine-grained SAND, yellowish brown, dry. (Shale) | | | |
| 1756.1 | 8.0 | CH | FAT CLAY, with very fine-grained SAND, olive brown, damp. (Shale) | | | |
| 1752.6 | 11.5 | SP SM | POORLY GRADED SAND with SILT, fine-grained, brown, damp, with trace fossils. (Sandstone) | | | |
| 1751.1 | 13.0 | SP SM | POORLY GRADED SAND with SILT, fine-grained, tan, damp, with trace fossils. (Sandstone) | | | |
| 1746.1 | 18.0 | SP SM | POORLY GRADED SAND with SILT, fine-grained, brown, moist, with trace fossils. (Sandstone) | | | |
| 1741.1 | 23.0 | SP SM | POORLY GRADED SAND with SILT, fine-grained, very dark gray, waterbearing, with trace fossils. (Sandstone) | | | |
| 1732.1 | 32.0 | SP SM | | | | |

(See Report and Standard Plates for evaluation and descriptive terminology.)

LOG OF BORING



PROJECT: NDG-006
HYDROGEOLOGIC INVESTIGATION
Bismarck Sanitary Landfill
Bismarck, North Dakota

BORING: G (cont.)
LOCATION:
 See map: N. 424,593.0; E. 1,949,256.1
DATE: 10/30/89 **SCALE: 1" = 4'**

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------|--|-----|----|----------------|
| 1730.6 | 33.5 | CH | <p>FAT CLAY, with very fine-grained SAND, very dark gray, moist. (Shale)</p> <p>END OF BORING</p> <p>Water level down 24 feet with 33 feet of hollow-stem auger in the ground.</p> <p>Monitoring well installed at 33.5 feet.</p> | | | |

LOG OF BORING



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|---|--|
| PROJECT: NDG-006 HYDROGEOLOGIC INVESTIGATION Bismarck Sanitary Landfill Bismarck, North Dakota | BORING: H LOCATION: See map: N. 423,703.7; E. 1,950,254.3 DATE: 10/22/89 SCALE: 1" = 4' |
|---|--|

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------------|---|-----|----|----------------|
| 1782.5 | 0.0 | ML | SILT, with roots, dark brown, damp. (Topsoil) | | | |
| 1779.5 | 3.0 | CH | FAT CLAY, with very fine-grained SILTY SAND and a trace of gypsum, dark brown, damp. (Shale) | | | |
| 1774.5 | 8.0 | CH | FAT CLAY, with very fine-grained SAND and layers of gypsum, grayish brown, moist. (Shale) | | | |
| 1758.0 | 24.5 | SP SM | POORLY GRADED SAND with SILT, fine-grained, light brown, damp, with trace fossils. (Sandstone) | | | |
| 1750.5 | 32.0 | | | | | |

(See Report and Standard Plates for evaluation and descriptive terminology.)

LOG OF BORING



| | |
|---|--|
| PROJECT: NDG-006 HYDROGEOLOGIC INVESTIGATION Bismarck Sanitary Landfill Bismarck, North Dakota | BORING: H (cont.) LOCATION: See map: N. 423,703.7; E. 1,950,254.3 DATE: 10/22/89 SCALE: 1" = 4' |
|---|--|

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------|--|-----|----|----------------|
| 1744.5 | 38.0 | SP SM | POORLY GRADED SAND with SILT, fine-grained, light brown, damp, with trace fossils. (Sandstone) | | | |
| 1739.5 | 43.0 | SP SM | POORLY GRADED SAND with SILT, fine-grained, grayish brown, wet, with trace fossils. (Sandstone) | | | |
| 1734.0 | 48.5 | SP SM | POORLY GRADED SAND with SILT, fine-grained, very dark gray, waterbearing, with trace fossils. (Sandstone) | | | |
| 1719.5 | 63.0 | CH | FAT CLAY, with layers of very fine-grained SAND, dark gray, moist. (Shale) | | | |
| 1718.5 | 64.0 | CH | FAT CLAY, with very fine-grained SAND, | | | |

(See Report and Standard Plates for evaluation and descriptive terminology.)

LOG OF BORING



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|---|--|
| PROJECT: NDG-006 HYDROGEOLOGIC INVESTIGATION Bismarck Sanitary Landfill Bismarck, North Dakota | BORING: H (cont.) LOCATION: See map: N. 423,703.7; E. 1,950,254.3 DATE: 10/22/89 SCALE: 1" = 4' |
|---|--|

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------|--|-----|----|----------------|
| | | CH | dark gray, moist. (Shale) | | | |
| 1709.5 | 73.0 | CH | FAT CLAY, with very fine-grained SAND, dark gray, moist. (Shale) | | | |
| 1699.5 | 83.0 | CH | FAT CLAY, with layers of very fine-grained SAND, dark gray, moist. (Shale) | | | |
| | | CH | END OF BORING Water level down 42 feet immediately after withdrawal of auger. Boring then backfilled. Monitoring well installed at 47.5 feet in adjacent borehole. | | | |

LOG OF BORING



**PROJECT: NDG-006
HYDROGEOLOGIC INVESTIGATION**

Bismarck Sanitary Landfill

Bismarck, North Dakota

BORING: I

LOCATION:

See map: N. 424,505.0; E. 1,951,910.9

DATE: 10/21/89

SCALE: 1" = 4'

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------|--|-----|----|----------------|
| 1814.6 | 0.0 | | | | | |
| 1813.6 | 1.0 | ML | SANDY SILT, very fine- to coarse-grained, dark brown, dry. (Topsoil) | | | |
| 1811.6 | 3.0 | CH | | | | |
| 1810.6 | 4.0 | SP SM CH | FAT CLAY, fine- to coarse-grained, with a trace of Gravel, yellowish brown, dry. | | | |
| | | | SILTY SAND, very fine- to coarse-grained, yellowish brown, dry. | | | |
| 1806.6 | 8.0 | CH | FAT CLAY, with very fine- to coarse-grained SAND, yellowish brown, dry. FAT CLAY, with layers of gypsum, brown, moist. (Shale) | | | |
| 1796.6 | 18.0 | CH | FAT CLAY, with very fine-grained SILTY SAND and a trace of gypsum, olive brown, moist. (Shale) | | | |
| 1786.6 | 28.0 | CH | FAT CLAY, with very fine-grained SAND and a trace of gypsum, brownish gray and light gray, moist. (Shale) | | | |
| 1782.6 | 32.0 | CH | | | | |

LOG OF BORING



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| PROJECT: NDG-006 HYDROGEOLOGIC INVESTIGATION Bismarck Sanitary Landfill Bismarck, North Dakota | BORING: I (cont.) LOCATION: See map: N. 424,505.0; E. 1,951,910.9 DATE: 10/21/89 SCALE: 1" = 4' |
|---|--|

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------|--|-----|----|----------------|
| 1771.6 | 43.0 | CH | FAT CLAY, with very fine-grained SAND, brownish gray and light gray, moist. (Shale) | | | |
| 1766.6 | 48.0 | CH | FAT CLAY, with very fine-grained SAND, grayish brown, moist. (Shale) | | | |
| 1761.6 | 53.0 | CH | FAT CLAY, with very fine-grained SAND, very dark gray, moist. (Shale) | | | |
| 1753.6 | 61.0 | CH | FAT CLAY, with very fine-grained SAND, very dark gray, moist. (Shale) | | | |
| 1750.6 | 64.0 | CH | FAT CLAY, with very fine-grained SAND, dark brownish gray, moist. (Shale) | | | |

LOG OF BORING



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| PROJECT: NDG-006 HYDROGEOLOGIC INVESTIGATION Bismarck Sanitary Landfill Bismarck, North Dakota | BORING: 1 (cont.) LOCATION: See map: N. 424,505.0; E. 1,951,910.9 DATE: 10/21/89 SCALE: 1" = 4' |
|---|--|

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------|--|-----|----|----------------|
| 1748.6 | 66.0 | SP SM | POORLY GRADED SAND with SILT, fine-grained, dark gray, waterbearing. (Sandstone) | | | |
| 1746.6 | 68.0 | | LIMESTONE, dark gray, massive. | | | |
| | | SP SM | POORLY GRADED SAND with SILT, very fine-grained, dark gray, wet to waterbearing. (Sandstone) | | | |
| 1736.6 | 78.0 | | END OF BORING | | | |
| | | | Water level down 63.5 feet 1 day after completion of boring. | | | |
| | | | Monitoring well installed at 75 feet. | | | |

LOG OF BORING



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|---|--|
| PROJECT: NDG-006 HYDROGEOLOGIC INVESTIGATION Bismarck Sanitary Landfill Bismarck, North Dakota | BORING: J LOCATION: See map: N. 426,872.7; E. 1,951,254.8 DATE: 10/18/89 SCALE: 1" = 4' |
|---|--|

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------|---|-----|----|----------------|
| 1826.3 | 0.0 | | | | | |
| 1825.3 | 1.0 | ML CH | SILT, with fine- to coarse-grained SAND, with roots, dark brown, dry. (Topsoil) | | | |
| | | | FAT CLAY, with very fine- to coarse-grained SAND, with roots and a trace of Gravel, olive brown and light gray, dry. (Shale) | | | |
| 1818.3 | 8.0 | | | | | |
| | | SP SM | POORLY GRADED SAND with SILT, fine-grained, yellowish brown, dry. (Sandstone) | | | |
| 1815.3 | 11.0 | | | | | |
| | | CH | FAT CLAY, with very fine-grained SAND and a trace of gypsum, yellowish brown, damp. (Shale) | | | |
| 1808.3 | 18.0 | | | | | |
| | | CH | FAT CLAY, with very fine-grained SAND and layers of gypsum, dark olive brown, damp, fractures. (Shale) | | | |
| 1798.3 | 28.0 | | | | | |
| | | CH | FAT CLAY, with very fine-grained SAND and layers of gypsum, dark brownish gray, moist, fractures. (Shale) | | | |
| 1794.3 | 32.0 | | | | | |

LOG OF BORING



PROJECT: NDG-006
HYDROGEOLOGIC INVESTIGATION
Bismarck Sanitary Landfill
Bismarck, North Dakota

BORING: J (cont.)
LOCATION:
 See map: N. 426,872.7; E. 1,951,254.8
DATE: 10/18/89 **SCALE: 1" = 4'**

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------|--|-----|----|----------------|
| | | CH | FAT CLAY, with very fine-grained SAND and layers of gypsum, dark brownish gray, moist, fractures. (Shale) | | | |
| 1783.3 | 43.0 | CH | FAT CLAY, with very fine-grained SAND and a trace of gypsum, very dark gray, moist, fractures. (Shale) | | | |
| 1768.3 | 58.0 | CH | FAT CLAY, with very fine-grained SILTY SAND, dark gray, moist. (Shale) | | | |
| 1762.3 | 64.0 | | | | | |

LOG OF BORING



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|---|--|
| PROJECT: NDG-006 HYDROGEOLOGIC INVESTIGATION Bismarck Sanitary Landfill Bismarck, North Dakota | BORING: J (cont.) LOCATION: See map: N. 426,872.7; E. 1,951,254.8 DATE: 10/18/89 SCALE: 1" = 4' |
|---|--|

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------|--|-----|----|----------------|
| | | CH | FAT CLAY, very fine-grained SILTY SAND, dark gray, moist. (Shale) | | | |
| 1743.3 | 83.0 | | | | | |
| | | SP SM | POORLY GRADED SAND with SILT, fine-grained, dark gray, waterbearing. (Sandstone) | | | |
| 1736.3 | 90.0 | | | | | |
| | | | END OF BORING Water level down 81.5 feet with 90 feet of hollow-stem auger in the ground. Monitoring well installed at 90 feet. | | | |

LOG OF BORING



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|---|---|
| PROJECT: NDG-006 HYDROGEOLOGIC INVESTIGATION Bismarck Sanitary Landfill Bismarck, North Dakota | BORING: K LOCATION: See map: N. 425,306.7; E. 1,946,080.8 DATE: 10/5/89 SCALE: 1" = 4' |
|---|---|

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------|--|-----|--|----------------|
| 1749.6 | 0.0 | CH | FAT CLAY, with very fine-grained SAND and a trace of Gravel, dark olive brown, damp. (Shale) | | | |
| 1746.6 | 3.0 | CH | FAT CLAY, with very fine-grained SAND, olive brown and light gray, moist, stiff. (Shale) | | 13 | |
| 1742.6 | 7.0 | CH | FAT CLAY, with very fine-grained SAND, dark grayish brown, moist, rather stiff to very stiff. (Shale) | | 17 12 16 19 22 30 25 | |
| 1717.6 | 32.0 | | | | | |

LOG OF BORING



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|---|---|
| PROJECT: NDG-006 HYDROGEOLOGIC INVESTIGATION Bismarck Sanitary Landfill Bismarck, North Dakota | BORING: K (cont.) LOCATION: See map: N. 425,306.7; E. 1,946,080.8 DATE: 10/5/89 SCALE: 1" = 4' |
|---|---|

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------|---|-----|----|----------------|
| 1713.6 | 36.0 | CH | FAT CLAY, with very fine-grained SAND, dark grayish brown, moist, rather stiff to very stiff. (Shale) | 23 | | |
| | | CH | FAT CLAY, with very fine-grained SAND, very dark gray, moist to wet, very stiff. (Shale) | 22 | | |
| | | | | 25 | | |
| | | | | 26 | | |
| | | | | 23 | | |
| | | | | 23 | | |

LOG OF BORING



| | |
|---|---|
| PROJECT: NDG-006 HYDROGEOLOGIC INVESTIGATION Bismarck Sanitary Landfill Bismarck, North Dakota | BORING: K (cont.) LOCATION: See map: N. 425,306.7; E. 1,946,080.8 DATE: 10/5/89 SCALE: 1" = 4' |
|---|---|

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM D2487 Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------------|---|-----|----|----------------|
| | | CH | FAT CLAY, with very fine-grained SAND, very dark gray, moist to wet, very stiff to hard. (Shale) | 21 | | |
| | | | | 26 | | |
| | | | | 30 | | |
| | | | | 27 | | |
| | | | | 22 | | |
| 1663.6 | 86.0 | | END OF BORING Water level down 62 feet immediately after withdrawal of auger. Monitoring well installed at 85 feet. | | | |

LOG OF BORING



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| PROJECT: NDG-006 HYDROGEOLOGIC INVESTIGATION Bismarek Sanitary Landfill Bismarek, North Dakota | BORING: MW-M LOCATION: See map: N. 423,635.0; E. 1,948,931.8 DATE: 9/13/90 SCALE: 1" = 4' |
|---|--|

| | Elev. | Depth | ASTM Symbol | Description of Materials (ASTM D2488) | BPF | WL | Tests or Notes |
|--|--------|-------|-------------|---|-----|----|----------------|
| (See Report and Standard Plates for evaluation and descriptive terminology.) | 1756.1 | 0.0 | ML | <u>SANDY SILT</u> , with roots, dark brown, dry. (Topsoil) | | | |
| | 1749.1 | 7.0 | SP SM | <u>POORLY GRADED SAND</u> with SILT, fine-grained, light yellowish brown, dry, with trace fossils. (Sandstone) | | | |
| | 1743.1 | 13.0 | SP SM | <u>POORLY GRADED SAND</u> , fine-grained, grayish brown, moist, with trace fossils. (Sandstone) | | | |
| | 1738.1 | 18.0 | SP SM | <u>POORLY GRADED SAND</u> with SILT, fine-grained, dark gray, wet to waterbearing, with trace fossils. (Sandstone) | | | |
| | 1731.1 | 25.0 | CH | <u>FAT CLAY</u> with very fine-grained SAND, very dark gray, moist. (Shale) | | | |
| | 1730.1 | 26.0 | | END OF BORING. Boring down to 26 feet. Monitoring well installed at 25 feet. | | | |

LOG OF BORING

BRAUN
INTERTEC

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| PROJECT: CFEX-91-0006 BISMARCK SOLID WASTE MANAGEMENT FACILITY BISMARCK, NORTH DAKOTA | BORING: MW-N LOCATION: See Plate 3. |
| DATE: 5/19/92 | SCALE: 1" = 4' |

| Elev. | Depth | ASTM Symbol | Description of Materials (ASTM D 2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------|--|-----|----|----------------|
| 1773.1 | 0.0 | CL |  <p>CLAY with silt and trace of sand, dark olive gray (5Y3/2), abundant gypsum crystallizations.</p> | | | |
| 1756.1 | 17.0 | SP |  <p>SAND light olive gray, fine grained, little silt, dry.</p> <p>iron staining evident</p> <p>damp to moist</p> | | | |
| 1741.6 | 31.5 | | | | | |

(See Report and Standard Plates for evaluation and descriptive terminology.)

LOG OF BORING

BRAUN
INTERTEC

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|--|--|
| PROJECT: CFEX-91-0006 BISMARCK SOLID WASTE MANAGEMENT FACILITY BISMARCK, NORTH DAKOTA | BORING: MW-N (cont.) LOCATION: See Plate 3. DATE: 5/19/92 SCALE: 1" = 4' |
|--|--|

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM Symbol | Description of Materials (ASTM D 2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------|---|-----|----|----------------|
| 1737.1 | 36.0 | SP | SAND fine to medium grained, dark greenish gray (5BG4/1), waterbearing. | | | |
| 1731.6 | 41.5 | SC | SANDY CLAY clay with some sand from above, dark greenish gray, sand appears in burrows (bioturbation). | | | |
| 1729.1 | 44.0 | SC | SANDY CLAY same as above, but appears to contain more clay and less fine sand, very dark gray (5Y3/1), water not as abundant as above. | | | |
| | | | END OF BORING | | | |

LOG OF BORING

BRAUN
INTERTEC

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| PROJECT: CFEX-91-0006 BISMARCK SOLID WASTE MANAGEMENT FACILITY BISMARCK, NORTH DAKOTA | BORING: MW-0 LOCATION: See Plate 3. <hr/> DATE: 5/26/92 SCALE: 1" = 4' |
|--|---|

| | Elev. | Depth | ASTM Symbol | Description of Materials (ASTM D 2488) | BPF | WL | Tests or Notes |
|--|--------|-------|-------------|---|-----|----|----------------|
| (See Report and Standard Plates for evaluation and descriptive terminology.) | 1776.5 | 0.0 | CL | CLAY very dark grayisg brown (10YR3/2), some silt, some iron staining present. | | | |
| | 1770.5 | 6.0 | CL | gradational contact CLAY light olive brown (2.5Y5/3), some silt, dry, abundant iron staining, crumbly, horizontal bedding planes present. | | | |
| | 1762.5 | 14.0 | SP | SAND fine grained with silt, light olive brown (2.5Y5/6), grades to pale olive (5Y6/3), damp. moist, iron staining present | | | |

LOG OF BORING

BRAUN
INTERTEC

| | |
|--|---|
| PROJECT: CFEX-91-0006 BISMARCK SOLID WASTE MANAGEMENT FACILITY BISMARCK, NORTH DAKOTA | BORING: MW-O (cont.) LOCATION: See Plate 3. <hr/> DATE: 5/26/92 SCALE: 1" = 4' |
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(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM Symbol | Description of Materials (ASTM D 2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------|--|-----|----|----------------|
| 1743.5 | 33.0 | SP | sharp contact .M=SP SAND fine grained, dark greenish gray (5BG4/1), moist to wet. | | | |
| 1741.5 | 35.0 | SC | SANDY CLAY sand from above mixed with clay, bioturbation possible, dark greenish gray (5GY4/1 to 5G4/1). waterbearing | | | |
| | | | same clay, very dark gray (5Y3/1) | | | |
| 1727.5 | 49.0 | | END OF BORING | | | |

LOG OF BORING

BRAUN
INTERTEC

| | |
|--|---|
| PROJECT: CFEX-91-0006 BISMARCK SOLID WASTE MANAGEMENT FACILITY BISMARCK, NORTH DAKOTA | BORING: MW-P LOCATION: See Plate 3. |
| DATE: 5/27/92 SCALE: 1" = 4' | |

| | Elev. | Depth | ASTM Symbol | Description of Materials (ASTM D 2488) | BPF | WL | Tests or Notes |
|--|--------|-------|-------------|---|-----|----|----------------|
| (See Report and Standard Plates for evaluation and descriptive terminology.) | 1797.1 | 0.0 | CL | <p>CLAY with silt, dark grayish brown (2.5Y4/2), abundant gypsum crystals present along fracture planes, dry.</p> <p>abundant iron staining, less gypsum, dry to damp</p> <p>grades to olive gray (5Y4/2)</p> <p>some horizontal bedding of alternating silt and clay laminae</p> <p>some very fine sand laminae present</p> | | | |

LOG OF BORING

BRAUN
INTERTEC

| | |
|--|---|
| PROJECT: CFEX-91-0006 BISMARCK SOLID WASTE MANAGEMENT FACILITY BISMARCK, NORTH DAKOTA | BORING: MW-P (cont.) LOCATION: See Plate 3. DATE: 5/27/92 SCALE: 1" = 4' |
|--|---|

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM Symbol | Description of Materials (ASTM D 2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------|--|-----|----|----------------|
| 1758.1 | 39.0 | | | | | |
| 1744.1 | 53.0 | SP | SAND fine grained, friable, not cemented, yellowish brown (10YR5/8) to light olive gray (5Y6/2), dry, some silt, waterbearing at 50' | | | |
| 1737.6 | 59.5 | SP | SAND waterbearing, fine grained, dark greenish gray (5BG4/1), some silt. | | | |
| 1734.1 | 63.0 | SC | SANDY CLAY sand-filled burrows (indication of bioturbation), very dark gray (5Y3/1). | | | |
| | | | END OF BORING | | | |

LOG OF BORING

BRAUN
INTERTEC

| | |
|--|---|
| PROJECT: CFEX-91-0006 BISMARCK SOLID WASTE MANAGEMENT FACILITY BISMARCK, NORTH DAKOTA | BORING: MW-Q LOCATION: See Plate 3. <hr/> DATE: 5/28/92 SCALE: 1" = 4' |
|--|---|

| | Elev. | Depth | ASTM Symbol | Description of Materials (ASTM D 2488) | BPF | WL | Tests or Notes |
|--|--------|-------|-------------|---|-----|----|----------------|
| (See Report and Standard Plates for evaluation and descriptive terminology.) | 1824.7 | 0.0 | CL | CLAY with silt, brown (10YR5/3) gypsum crystals and iron staining present, dry. | | | |
| | | | | same as above, but grades to dark grayish brown (2.5Y4/2), dry to damp | | | |

LOG OF BORING

BRAUN
INTERTEC

| | |
|---|--|
| PROJECT: CFE-91-0006 BISMARCK SOLID WASTE MANAGEMENT FACILITY BISMARCK, NORTH DAKOTA | BORING: MW-Q (cont.) |
| | LOCATION: See Plate 3. |
| | DATE: 5/28/92 SCALE: 1" = 4' |

| Elev. | Depth | ASTM Symbol | Description of Materials (ASTM D 2488) | BPF | WL | Tests | or | Notes |
|--------|-------|-------------|---|-----|----|-------|----|-------|
| | | | | | | | | |
| | | | very hard or dense material, therefore sampling switched from continuous to split-spoon | | | | | |
| 1735.7 | 89.0 | SP | SAND dark greenish gray (5BG4/1), very stiff | | | | | |

(See Report and Standard Plates for evaluation and descriptive terminology.)

LOG OF BORING

BRAUN
INTERTEC

| | |
|---|---|
| PROJECT: CFX-91-0006 BISMARCK SOLID WASTE MANAGEMENT FACILITY BISMARCK, NORTH DAKOTA | BORING: MW-Q (cont.) LOCATION: See Plate 3. <hr/> DATE: 5/28/92 SCALE: 1" = 4' |
|---|---|

(See Report and Standard Plates for evaluation and descriptive terminology.)

| Elev. | Depth | ASTM Symbol | Description of Materials (ASTM D 2488) | BPF | WL | Tests or Notes |
|--------|-------|-------------|--|-----|----|----------------|
| 1723.2 | 101.5 | | | | | |
| 1720.7 | 104.0 | | CLAY with sand-filled bioturbation. | | | |
| | | | END OF BORING | | | |

APPENDIX E
WATER-LEVEL TABLES

Bismarck Water Levels
11/06/92 to 12/21/92

| 139-079-30BDA Undefined Aquifer | | | LS Elev (msl, ft)=1769.6 SI (ft.)=36-41 | | |
|------------------------------------|---------------------|-------------------|--|---------------------|-------------------|
| Date | Depth to Water (ft) | WL Elev (msl, ft) | Date | Depth to Water (ft) | WL Elev (msl, ft) |
| 11/06/92 | 26.61 | 1742.99 | 12/07/92 | 26.90 | 1742.70 |
| 11/13/92 | 27.02 | 1742.58 | 12/21/92 | 26.76 | 1742.84 |
| 11/23/92 | 26.92 | 1742.68 | | | |

| 139-079-30CAC Undefined Aquifer | | | LS Elev (msl, ft)=1767.52 SI (ft.)=65-70 | | |
|------------------------------------|---------------------|-------------------|---|---------------------|-------------------|
| Date | Depth to Water (ft) | WL Elev (msl, ft) | Date | Depth to Water (ft) | WL Elev (msl, ft) |
| 11/13/92 | 30.96 | 1736.56 | 12/07/92 | 32.86 | 1734.66 |
| 11/16/92 | 51.21 | 1716.31 | 12/21/92 | 31.14 | 1736.38 |
| 11/23/92 | 41.56 | 1725.96 | | | |

| 139-079-30CBC Undefined Aquifer | | | LS Elev (msl, ft)=1733.8 SI (ft.)=48-53 | | |
|------------------------------------|---------------------|-------------------|--|---------------------|-------------------|
| Date | Depth to Water (ft) | WL Elev (msl, ft) | Date | Depth to Water (ft) | WL Elev (msl, ft) |
| 11/13/92 | 38.76 | 1695.04 | 12/07/92 | 38.66 | 1695.14 |
| 11/23/92 | 38.54 | 1695.26 | 12/21/92 | 38.55 | 1695.25 |

| 139-079-30CBD Undefined Aquifer | | | LS Elev (msl, ft)=1755.21 SI (ft.)=57-62 | | |
|------------------------------------|---------------------|-------------------|---|---------------------|-------------------|
| Date | Depth to Water (ft) | WL Elev (msl, ft) | Date | Depth to Water (ft) | WL Elev (msl, ft) |
| 11/13/92 | 44.53 | 1710.68 | 12/07/92 | 43.69 | 1711.52 |
| 11/23/92 | 43.58 | 1711.63 | 12/21/92 | 43.62 | 1711.59 |

| 139-079-30BAA Undefined Aquifer | | | LS Elev (msl, ft)=1778.66 SI (ft.)=38-48 | | |
|------------------------------------|---------------------|-------------------|---|---------------------|-------------------|
| Date | Depth to Water (ft) | WL Elev (msl, ft) | Date | Depth to Water (ft) | WL Elev (msl, ft) |
| 10/30/92 | 36.52 | 1742.14 | 12/07/92 | 36.62 | 1742.04 |
| 11/23/92 | 36.62 | 1742.04 | 12/21/92 | 36.66 | 1742.00 |

APPENDIX F

MAJOR ION AND TRACE-ELEMENT
CONCENTRATIONS

Bismarck Landfill Water Quality Major Ion Analyses

| Location | Screened Interval (ft) | Date Sampled | (milligrams per liter) | | | | | | | | | | | | | | | | | Spec | | | | |
|---------------|------------------------|--------------|------------------------|------|------|----|----|------|-----|------------------|-----------------|-----------------|-----|-----|-----------------|------|------|-------------------------------|--------|------|-----|-------------|-----------|-------|
| | | | SiO ₂ | Fe | Mn | Ca | Mg | Na | K | HCO ₃ | CO ₃ | SO ₄ | Cl | F | NO ₃ | B | TDS | Hardness as CaCO ₃ | as NCH | % Na | SAR | Cond (μmho) | Temp (°C) | pH |
| 139-079-30BAA | 38-48 | 10/30/92 | 15 | 0.04 | 1.5 | 85 | 40 | 1100 | 8 | 1430 | 0 | 1700 | 8 | 0.4 | 5.4 | 2.3 | 3670 | 380 | 0 | 86 | 25 | 4700 | 6 | 7.89 |
| 139-079-30BDA | 36-41 | 11/13/92 | 16 | 0.19 | 0.02 | 14 | 2 | 480 | 4.2 | 421 | 47 | 690 | 16 | 1.1 | 6.9 | 1.5 | 1490 | 43 | 0 | 96 | 32 | 2140 | 0.8 | 8.97 |
| 139-079-30CAC | 65-70 | 11/16/92 | 9.1 | 0.13 | 0.06 | 21 | 13 | 180 | 4.2 | 236 | 0 | 280 | 18 | 0.7 | 5.4 | 0.63 | 648 | 110 | 0 | 78 | 7.5 | 985 | 7 | 8.22 |
| 139-079-30CBC | 48-53 | 11/13/92 | 1.5 | 0.01 | 0.01 | 63 | 18 | 90 | 13 | 51 | 17 | 360 | 5 | 0.2 | 0 | 0.09 | 593 | 230 | 160 | 44 | 2.6 | 975 | 4 | 11.04 |
| 139-079-30CBD | 57-62 | 11/13/92 | 20 | 0.01 | 0.13 | 60 | 38 | 60 | 6.2 | 328 | 0 | 130 | 5.1 | 0.3 | 5 | 0.28 | 487 | 310 | 37 | 29 | 1.5 | 742 | 4 | 9.03 |

Trace Element Analyses

| Location | Date Sampled | Selenium | Lead | Cadmium | Mercury | Arsenic | Molybdenum | Strontium |
|---------------|--------------|------------------------|------|---------|---------|---------|------------|-----------|
| | | (micrograms per liter) | | | | | | |
| 139-079-30BAA | 10/30/92 | 0 | 1 | 0 | 0 | 0 | 4 | 1200 |
| 139-079-30BDA | 10/30/92 | 1 | 2 | 0 | 0 | 32 | 35 | 320 |
| 139-079-30CAC | 10/30/92 | 1 | 0 | 0 | 0 | 6 | 337 | 440 |
| 139-079-30CBC | 10/30/92 | 0 | 0 | 0 | - | 0 | 16 | 890 |
| 139-079-30CBD | 10/30/92 | 0 | 0 | 0 | 0 | 1 | 6 | 640 |

APPENDIX G

BRAUN INTERTEC MAJOR ION
AND TRACE-ELEMENT CONCENTRATIONS

City of Bismarck

PROJECT: CFE-91-0006
COLLECTED: Braun Intertec
RECEIVED: 25-JUN-92

| PARAMETER | Braun Intertec ID: Client ID: Matrix: Collect Date: | 92-1365-01 MW-J Liquid 22-JUN-92 | 92-1365-02 MW-I Liquid 22-JUN-92 | 92-1365-03 MW-Q Liquid 23-JUN-92 | 92-1365-04 MW-P Liquid 23-JUN-92 |
|---------------------------------------|--|---|---|---|---|
| 1,3-Dichlorobenzene | | <1.5 ug/L | <1.5 ug/L | <1.5 ug/L | <1.5 ug/L |
| 1,4-Dichlorobenzene | | <0.2 ug/L | <0.2 ug/L | <0.2 ug/L | <0.2 ug/L |
| 1,2-Dichlorobenzene | | <0.2 ug/L | <0.2 ug/L | <0.2 ug/L | <0.2 ug/L |
| Dichlorofluoromethane | | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L |
| Ethyl Ether | | <1.0 ug/L | <1.0 ug/L | <1.0 ug/L | <1.0 ug/L |
| Trichlorotrifluoroethane | | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L |
| Acetone | | <50 ug/L | <50 ug/L | <50 ug/L | <50 ug/L |
| Allyl Chloride (3-Chloropropylene) | | <1.0 ug/L | <1.0 ug/L | <1.0 ug/L | <1.0 ug/L |
| Methyl Ethyl Ketone | | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L |
| Tetrahydrofuran | | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L |
| Methyl Isobutyl Ketone | | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L |
| Alkalinity, Total | | 860 mg/L | 460 mg/L | 1100 mg/L | 820 mg/L |
| Bicarbonate Alkalinity | | 530 mg/L | 460 mg/L | 1100 mg/L | 820 mg/L |
| Carbonate Alkalinity | | 330 mg/L | <4 mg/L | <4 mg/L | <4 mg/L |
| Appearance | | a | b | c | d |
| Cation/Anion Balance | | +5.3 % | -2.6 % | +0.4 % | +1.1 % |
| Chloride | | 14 mg/L | 1.9 mg/L | 6.5 mg/L | 3.3 mg/L |
| Chemical Oxygen Demand | | 36 mg/L | 61 mg/L | 36 mg/L | <25 mg/L |
| Fluoride | | 0.55 mg/L | 0.20 mg/L | 0.51 mg/L | 0.14 mg/L |
| Hardness as CaCO ₃ , Total | | 54 mgEq/L | 630 mgEq/L | 290 mgEq/L | 1200 mgEq/L |
| pH | | 9.5 Units | 6.8 Units | 7.8 Units | 6.8 Units |
| Specific Conductance | | 3900 umhos/cm | 1100 umhos/cm | 4800 umhos/cm | 2800 umhos/cm |
| Total Dissolved Solids | | 3000 mg/L | 830 mg/L | 3800 mg/L | 2400 mg/L |
| Temperature * | | 9.0 Deg. C | 9.0 Deg. C | 9.0 Deg. C | 9.0 Deg. C |
| Total Organic Carbon | | 9.0 mg/L | 2.0 mg/L | 3.4 mg/L | 2.2 mg/L |
| Total Suspended Solids | | 95 mg/L | 690 mg/L | 91 mg/L | 610 mg/L |
| Arsenic, Total | | 12 ug/L | 2 ug/L | 6 ug/L | <2 ug/L |
| Beryllium, Total | | <0.2 ug/L | 0.2 ug/L | 0.2 ug/L | <0.2 ug/L |
| Cadmium, Total | | <0.2 ug/L | 1.1 ug/L | <0.2 ug/L | <0.2 ug/L |
| Cobalt, Total | | 59 ug/L | 8.0 ug/L | 96 ug/L | 21 ug/L |
| Chromium, Total | | 7.7 ug/L | 6.6 ug/L | 18 ug/L | 8.8 ug/L |
| Lead, Total | | <2 ug/L | 6 ug/L | 14 ug/L | <2 ug/L |
| Thallium, Total | | 77 ug/L | 4.0 ug/L | 100 ug/L | 17 ug/L |
| Vanadium, Total | | 3.0 ug/L | 26 ug/L | 18 ug/L | 27 ug/L |
| Barium, Total | | 0.05 mg/L | 0.58 mg/L | 0.09 mg/L | 0.07 mg/L |
| Silver, Total | | 0.01 mg/L | <0.01 mg/L | 0.02 mg/L | <0.01 mg/L |
| Calcium, Total | | 17 mg/L | 120 mg/L | 47 mg/L | 200 mg/L |
| Copper, Total | | <0.01 mg/L | 0.02 mg/L | 0.01 mg/L | 0.01 mg/L |
| Iron, Total | | 0.70 mg/L | 32 mg/L | 5.8 mg/L | 6.7 mg/L |
| Magnesium, Total | | 2.8 mg/L | 80 mg/L | 41 mg/L | 170 mg/L |
| Manganese, Total | | 0.05 mg/L | 2.3 mg/L | 0.30 mg/L | 0.87 mg/L |

a = Light precipitate, lightly cloudy, brownish.

b = Brown precipitate, brownish, very cloudy.

c = Precipitate, lightly cloudy, gray-brown.

d = Precipitate, lightly cloudy, gray-brown.

* = Temperature as received by laboratory.

< = less than: compound not detected at or above indicated detection limit

- = Analysis not required

Quality control data reviewed: W20

City of Bismarck

PROJECT: CFEX-91-0006
 COLLECTED: Braun Intertec
 RECEIVED: 25-JUN-92

| PARAMETER | Braun Intertec ID: | 92-1365-01 | 92-1365-02 | 92-1365-03 | 92-1365-04 | |
|-------------------------|--------------------|------------|------------|------------|------------|------|
| | Client ID: | MW-J | MW-I | MW-Q | MW-P | |
| | Matrix: | Liquid | Liquid | Liquid | Liquid | |
| | Collect Date: | 22-JUN-92 | 22-JUN-92 | 23-JUN-92 | 23-JUN-92 | |
| Nickel, Total | <0.02 | mg/L | <0.02 | mg/L | <0.02 | mg/L |
| Potassium, Total | 8.7 | mg/L | 8.8 | mg/L | 8.2 | mg/L |
| Sodium, Total | 930 | mg/L | 62 | mg/L | 1300 | mg/L |
| Zinc, Total | 0.02 | mg/L | 0.07 | mg/L | 0.03 | mg/L |
| Antimony, Total | <6 | ug/L | <6 | ug/L | <6 | ug/L |
| Selenium, Total | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L |
| Mercury, Total | <0.4 | ug/L | <0.4 | ug/L | <0.4 | ug/L |
| Ammonia as N | 2.8 | mg/L | 1.0 | mg/L | 2.0 | mg/L |
| Nitrate + Nitrite, as N | <0.02 | mg/L | <0.02 | mg/L | 1.5 | mg/L |
| Sulfate | 1400 | mg/L | 270 | mg/L | 2000 | mg/L |
| Total Phosphorus, as P | 0.27 | mg/L | 0.55 | mg/L | 0.22 | mg/L |

< = less than: compound not detected at or above indicated detection limit
 - = Analysis not required

Quality control data reviewed: LRO

City of Bismarck
Braun Intertec Environmental
913 S. 18th Street
Bismarck, ND 58502

PROJECT: CFEX-91-0006
COLLECTED: Braun Intertec
RECEIVED: 25-JUN-92

| PARAMETER | Braun Intertec ID: Client ID: Matrix: Collect Date: | 92-1365-05 MW-FS Liquid 23-JUN-92 | 92-1365-06 MW-FD Liquid 23-JUN-92 | 92-1365-07 MW-A Liquid 23-JUN-92 | 92-1365-08 MW-G Liquid 24-JUN-92 |
|---------------------------------------|--|--|--|---|---|
| 1,3-Dichlorobenzene | | <1.5 ug/L | <1.5 ug/L | <1.5 ug/L | <1.5 ug/L |
| 1,4-Dichlorobenzene | | <0.2 ug/L | <0.2 ug/L | <0.2 ug/L | <0.2 ug/L |
| 1,2-Dichlorobenzene | | <0.2 ug/L | <0.2 ug/L | <0.2 ug/L | <0.2 ug/L |
| Dichlorofluoromethane | | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L |
| Ethyl Ether | | <1.0 ug/L | <1.0 ug/L | <1.0 ug/L | <1.0 ug/L |
| Trichlorotrifluoroethane | | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L |
| Acetone | | <50 ug/L | <50 ug/L | <50 ug/L | <50 ug/L |
| Allyl Chloride (3-Chloropropylene) | | <1.0 ug/L | <1.0 ug/L | <1.0 ug/L | <1.0 ug/L |
| Methyl Ethyl Ketone | | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L |
| Tetrahydrofuran | | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L |
| Methyl Isobutyl Ketone | | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L |
| Alkalinity, Total | | 570 mg/L | 780 mg/L | 860 mg/L | 290 mg/L |
| Bicarbonate Alkalinity | | 570 mg/L | 710 mg/L | 860 mg/L | 290 mg/L |
| Carbonate Alkalinity | | <4 mg/L | 72 mg/L | <4 mg/L | <4 mg/L |
| Appearance | | e | f | g | h |
| Cation/Anion Balance | | +1.1 % | -2.5 % | -0.08 % | +1.3 % |
| Chloride | | 97 mg/L | 6.1 mg/L | 26 mg/L | 13 mg/L |
| Chemical Oxygen Demand | | <25 mg/L | <25 mg/L | <25 mg/L | 39 mg/L |
| Fluoride | | 0.23 mg/L | 0.88 mg/L | 0.93 mg/L | 0.46 mg/L |
| Hardness as CaCO ₃ , Total | | 350 mgEq/L | 100 mgEq/L | 240 mgEq/L | 220 mgEq/L |
| pH | | 7.5 Units | 8.6 Units | 8.0 Units | 7.6 Units |
| Specific Conductance | | 2600 umhos/cm | 3800 umhos/cm | 4700 umhos/cm | 1600 umhos/cm |
| Total Dissolved Solids | | 1900 mg/L | 2900 mg/L | 3800 mg/L | 1200 mg/L |
| Temperature * | | 9.0 Deg. C | 8.0 Deg. C | 10 Deg. C | 10 Deg. C |
| Total Organic Carbon | | 5.1 mg/L | 5.2 mg/L | 5.9 mg/L | 3.0 mg/L |
| Total Suspended Solids | | 70 mg/L | 8 mg/L | 50 mg/L | 400 mg/L |
| Arsenic, Total | | <2 ug/L | 11 ug/L | <2 ug/L | <2 ug/L |
| Beryllium, Total | | <0.2 ug/L | <0.2 ug/L | <0.2 ug/L | <0.2 ug/L |
| Cadmium, Total | | <0.2 ug/L | <0.2 ug/L | 0.2 ug/L | <0.2 ug/L |
| Cobalt, Total | | 31 ug/L | 77 ug/L | 100 ug/L | 16 ug/L |
| Chromium, Total | | 6.3 ug/L | 9.8 ug/L | 17 ug/L | 10 ug/L |
| Lead, Total | | 3 ug/L | 9 ug/L | 12 ug/L | 3 ug/L |
| Thallium, Total | | 40 ug/L | 75 ug/L | 110 ug/L | 20 ug/L |
| Vanadium, Total | | 8.0 ug/L | <2.0 ug/L | 11 ug/L | 18 ug/L |
| Barium, Total | | 0.05 mg/L | 0.04 mg/L | 0.04 mg/L | 0.14 mg/L |
| Silver, Total | | <0.01 mg/L | 0.01 mg/L | 0.01 mg/L | <0.01 mg/L |
| Calcium, Total | | 63 mg/L | 27 mg/L | 58 mg/L | 48 mg/L |
| Copper, Total | | 0.01 mg/L | <0.01 mg/L | <0.01 mg/L | 0.02 mg/L |
| Iron, Total | | 2.0 mg/L | 0.70 mg/L | 2.1 mg/L | 11 mg/L |
| Magnesium, Total | | 48 mg/L | 8.7 mg/L | 24 mg/L | 25 mg/L |
| Manganese, Total | | 0.07 mg/L | 0.15 mg/L | 0.07 mg/L | 0.33 mg/L |

e = Precipitate, lightly cloudy, light gray.
f = No precipitate, lightly cloudy, light tan.
g = Light precipitate, lightly cloudy, light gray.
h = Brown precipitate, lightly cloudy, gray.
* = Temperature as received by laboratory.

< = less than: compound not detected at or above indicated detection limit
- = Analysis not required

Quality control data reviewed: UPO

City of Bismarck

PROJECT: CFEX-91-0006
COLLECTED: Braun Intertec
RECEIVED: 25-JUN-92

| PARAMETER | Braun Intertec ID: | 92-1365-05 | 92-1365-06 | 92-1365-07 | 92-1365-08 | | | |
|-------------------------|--------------------|------------|------------|------------|------------|------|-------|------|
| | Client ID: | MW-FS | MW-FD | MW-A | MW-G | | | |
| | Matrix: | Liquid | Liquid | Liquid | Liquid | | | |
| | Collect Date: | 23-JUN-92 | 23-JUN-92 | 23-JUN-92 | 24-JUN-92 | | | |
| Nickel, Total | <0.02 | mg/L | <0.02 | mg/L | <0.02 | mg/L | <0.02 | mg/L |
| Potassium, Total | 6.1 | mg/L | 4.2 | mg/L | 5.7 | mg/L | 6.7 | mg/L |
| Sodium, Total | 570 | mg/L | 1100 | mg/L | 1300 | mg/L | 330 | mg/L |
| Zinc, Total | 0.02 | mg/L | 0.02 | mg/L | 0.02 | mg/L | 0.05 | mg/L |
| Antimony, Total | <6 | ug/L | 49 | ug/L | <6 | ug/L | <6 | ug/L |
| Selenium, Total | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L |
| Mercury, Total | <0.4 | ug/L | <0.4 | ug/L | <0.4 | ug/L | <0.4 | ug/L |
| Ammonia as N | 0.03 | mg/L | 2.2 | mg/L | 1.9 | mg/L | 0.03 | mg/L |
| Nitrate + Nitrite, as N | 16 | mg/L | <0.02 | mg/L | <0.02 | mg/L | 3.5 | mg/L |
| Sulfate | 840 | mg/L | 1500 | mg/L | 2100 | mg/L | 630 | mg/L |
| Total Phosphorus, as P | 0.06 | mg/L | 0.15 | mg/L | 0.20 | mg/L | 0.29 | mg/L |

< = less than: compound not detected at or above indicated detection limit
- = Analysis not required

Quality control data reviewed: URO

City of Bismarck

PROJECT: CFE-91-0006
COLLECTED: Braun Intertec
RECEIVED: 25-JUN-92

| PARAMETER | Braun Intertec ID: | 92-1365-09 | 92-1365-10 | 92-1365-11 |
|------------------------------|--------------------|------------|------------|------------|
| | Client ID: | MW-M | MW-H | Duplicate |
| | Matrix: | Liquid | Liquid | Liquid |
| | Collect Date: | 24-JUN-92 | 24-JUN-92 | |
| 2,3-Dichloro-1-propene | <10 | ug/L | <10 | ug/L |
| 2-Chloroethyl Vinyl Ether | <10 | ug/L | <10 | ug/L |
| Dichloroacetomitrile | <20 | ug/L | <20 | ug/L |
| Pentachloroethane | <10 | ug/L | <10 | ug/L |
| Acrylonitrile | <10 | ug/L | <10 | ug/L |
| Carbon Disulfide | <10 | ug/L | <10 | ug/L |
| trans-1,4-Dichloro-2-butene | <10 | ug/L | <10 | ug/L |
| Methyl Butyl Ketone | <10 | ug/L | <10 | ug/L |
| Methyl Iodide | <10 | ug/L | <10 | ug/L |
| Vinyl Acetate | <10 | ug/L | <10 | ug/L |
| Dichlorodifluoromethane | <5.0 | ug/L | <5.0 | ug/L |
| Chloromethane | <5.0 | ug/L | <5.0 | ug/L |
| Vinyl Chloride | <1.0 | ug/L | <1.0 | ug/L |
| Bromomethane | <5.0 | ug/L | <5.0 | ug/L |
| Chloroethane | <1.0 | ug/L | <1.0 | ug/L |
| Trichlorofluoromethane | <1.0 | ug/L | <1.0 | ug/L |
| 1,1-Dichloroethylene | <1.0 | ug/L | <1.0 | ug/L |
| Methylene Chloride | <5.0 | ug/L | <5.0 | ug/L |
| trans-1,2-Dichloroethylene | <0.2 | ug/L | <0.2 | ug/L |
| 1,1-Dichloroethane | <1.0 | ug/L | <1.0 | ug/L |
| cis-1,2-Dichloroethylene | <0.2 | ug/L | <0.2 | ug/L |
| Chloroform | <1.5 | ug/L | <1.5 | ug/L |
| 1,1,1-Trichloroethane | <2.0 | ug/L | <2.0 | ug/L |
| Carbon Tetrachloride | <1.7 | ug/L | <1.7 | ug/L |
| 1,2-Dichloroethane | <0.3 | ug/L | <0.3 | ug/L |
| Benzene | <1.0 | ug/L | <1.0 | ug/L |
| 1,1,2-Trichloroethylene | <0.5 | ug/L | <0.5 | ug/L |
| Bromodichloromethane | <0.3 | ug/L | <0.3 | ug/L |
| Dibromomethane | <5.0 | ug/L | <5.0 | ug/L |
| cis-1,3-Dichloro-1-Propene | <0.5 | ug/L | <0.5 | ug/L |
| Toluene | <1.0 | ug/L | <1.0 | ug/L |
| trans-1,3-Dichloro-1-propene | <0.5 | ug/L | <0.5 | ug/L |
| 1,1,2-Trichloroethane | <1.2 | ug/L | <1.2 | ug/L |
| 1,3-Dichloropropane | <1.0 | ug/L | <1.0 | ug/L |
| Tetrachloroethylene | <1.0 | ug/L | <1.0 | ug/L |
| Chlorodibromomethane | <2.5 | ug/L | <2.5 | ug/L |
| Chlorobenzene | <1.0 | ug/L | <1.0 | ug/L |
| 1,1,1,2-Tetrachloroethane | <0.5 | ug/L | <0.5 | ug/L |
| Ethyl Benzene | <1.0 | ug/L | <1.0 | ug/L |
| m,p-Xylene | <1.0 | ug/L | <1.0 | ug/L |
| o-Xylene | <1.0 | ug/L | <1.0 | ug/L |
| Bromoform | <0.5 | ug/L | <0.5 | ug/L |
| Cumene | <1.0 | ug/L | <1.0 | ug/L |
| 1,1,2,2-Tetrachloroethane | <1.2 | ug/L | <1.2 | ug/L |
| 1,2,3-Trichloropropane | <1.0 | ug/L | <1.0 | ug/L |
| Bromochloromethane | <1.0 | ug/L | <1.0 | ug/L |
| 1,2-Dibromo-3-Chloropropane | <10 | ug/L | <10 | ug/L |
| 1,2-Dibromoethane | <0.2 | ug/L | <0.2 | ug/L |
| Styrene | <1.0 | ug/L | <1.0 | ug/L |

< = less than; compound not detected at or above indicated detection limit
- = Analysis not required

Quality control data reviewed: UCC

City of Bismarck

PROJECT: CFEX-91-0006
COLLECTED: Braun Intertec
RECEIVED: 25-JUN-92

| PARAMETER | Braun Intertec ID: 92-1365-09 | | 92-1365-10 | | 92-1365-11 | |
|---------------------------------------|-------------------------------|-----------|------------|-----------|------------|----------|
| | Client ID: MW-M | Liquid | MW-H | Liquid | Duplicate | Liquid |
| | Matrix: | 24-JUN-92 | 24-JUN-92 | 24-JUN-92 | | |
| | Collect Date: | | | | | |
| 1,3-Dichlorobenzene | <1.5 | ug/L | <1.5 | ug/L | <1.5 | ug/L |
| 1,4-Dichlorobenzene | <0.2 | ug/L | <0.2 | ug/L | <0.2 | ug/L |
| 1,2-Dichlorobenzene | <0.2 | ug/L | <0.2 | ug/L | <0.2 | ug/L |
| Dichlorofluoromethane | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L |
| Ethyl Ether | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| Trichlorotrifluoroethane | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L |
| Acetone | <50 | ug/L | <50 | ug/L | <50 | ug/L |
| Allyl Chloride (3-Chloropropylene) | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| Methyl Ethyl Ketone | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L |
| Tetrahydrofuran | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L |
| Methyl Isobutyl Ketone | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L |
| Alkalinity, Total | 160 | mg/L | 190 | mg/L | 460 | mg/L |
| Bicarbonate Alkalinity | 160 | mg/L | 190 | mg/L | 460 | mg/L |
| Carbonate Alkalinity | <4 | mg/L | <4 | mg/L | <4 | mg/L |
| Appearance | i | | j | | k | |
| Cation/Anion Balance | -18 | % | -13 | % | -11 | % |
| Chloride | 4.8 | mg/L | 2.4 | mg/L | 1.8 | mg/L |
| Chemical Oxygen Demand | 44 | mg/L | 58 | mg/L | 98 | mg/L |
| Fluoride | 0.34 | mg/L | 0.26 | mg/L | 0.18 | mg/L |
| Hardness as CaCO ₃ , Total | 190 | mgEq/L | 120 | mgEq/L | 640 | mgEq/L |
| pH | 7.6 | Units | 7.5 | Units | 6.8 | Units |
| Specific Conductance | 400 | umhos/cm | 400 | umhos/cm | 1100 | umhos/cm |
| Total Dissolved Solids | 230 | mg/L | 290 | mg/L | 760 | mg/L |
| Temperature * | 9.0 | Deg. C | 9.0 | Deg. C | 10 | Deg. C |
| Total Organic Carbon | 1.4 | mg/L | 1.4 | mg/L | 1.4 | mg/L |
| Total Suspended Solids | 710 | mg/L | 370 | mg/L | 890 | mg/L |
| Arsenic, Total | 4 | ug/L | 2 | ug/L | 2 | ug/L |
| Beryllium, Total | <0.2 | ug/L | 0.4 | ug/L | <0.2 | ug/L |
| Cadmium, Total | <0.2 | ug/L | <0.2 | ug/L | 0.8 | ug/L |
| Cobalt, Total | 7.0 | ug/L | 10 | ug/L | 8.0 | ug/L |
| Chromium, Total | 4.5 | ug/L | 5.0 | ug/L | 5.2 | ug/L |
| Lead, Total | 4 | ug/L | 2 | ug/L | 4 | ug/L |
| Thallium, Total | 2.0 | ug/L | 2.0 | ug/L | 4.0 | ug/L |
| Vanadium, Total | 13 | ug/L | 9.0 | ug/L | 23 | ug/L |
| Barium, Total | 0.28 | mg/L | 0.22 | mg/L | 0.47 | mg/L |
| Silver, Total | <0.01 | mg/L | <0.01 | mg/L | <0.01 | mg/L |
| Calcium, Total | 40 | mg/L | 24 | mg/L | 120 | mg/L |
| Copper, Total | 0.02 | mg/L | 0.02 | mg/L | 0.02 | mg/L |
| Iron, Total | 21 | mg/L | 18 | mg/L | 28 | mg/L |
| Magnesium, Total | 23 | mg/L | 14 | mg/L | 83 | mg/L |
| Manganese, Total | 0.44 | mg/L | 0.31 | mg/L | 2.2 | mg/L |

i = Brown precipitate, cloudy, light brown.
j = Brown precipitate, cloudy, light brown.
k = Brown precipitate, very cloudy, brownish.
* = Temperature as received by laboratory.

< = less than: compound not detected at or above indicated detection limit
- = Analysis not required

Quality control data reviewed: WRO

City of Bismarck

PROJECT: CFEX-91-0006
COLLECTED: Braun Intertec
RECEIVED: 29-JUN-92

| PARAMETER | Braun Intertec ID: 92-1404-01 | | 92-1404-02 | | 92-1404-03 | | 92-1404-04 | |
|------------------------------|-------------------------------|-----------|------------|-----------|------------|-----------|------------|-----------|
| | Client ID: MW-DD | Liquid | MS-DS | Liquid | MW-CD | Liquid | MW-CS | Liquid |
| | Collect Date: 24-JUN-92 | 24-JUN-92 | 24-JUN-92 | 24-JUN-92 | 24-JUN-92 | 24-JUN-92 | 24-JUN-92 | 24-JUN-92 |
| 2,3-Dichloro-1-propene | <10 | ug/L | <10 | ug/L | <10 | ug/L | <10 | ug/L |
| 2-Chloroethyl Vinyl Ether | <10 | ug/L | <10 | ug/L | <10 | ug/L | <10 | ug/L |
| Dichloroacetonitrile | <20 | ug/L | <20 | ug/L | <20 | ug/L | <20 | ug/L |
| Pentachloroethane | <10 | ug/L | <10 | ug/L | <10 | ug/L | <10 | ug/L |
| Acrylonitrile | <10 | ug/L | <10 | ug/L | <10 | ug/L | <10 | ug/L |
| Carbon Disulfide | <10 | ug/L | <10 | ug/L | <10 | ug/L | <10 | ug/L |
| Methyl Butyl Ketone | <10 | ug/L | <10 | ug/L | <10 | ug/L | <10 | ug/L |
| trans-1,4-Dichloro-2-butene | <10 | ug/L | <10 | ug/L | <10 | ug/L | <10 | ug/L |
| Methyl Iodide | <10 | ug/L | <10 | ug/L | <10 | ug/L | <10 | ug/L |
| Vinyl Acetate | <10 | ug/L | <10 | ug/L | <10 | ug/L | <10 | ug/L |
| Dichlorodifluoromethane | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L |
| Chloromethane | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L |
| Vinyl Chloride | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| Bromomethane | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L |
| Chloroethane | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| Trichlorofluoromethane | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| 1,1-Dichloroethylene | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| Methylene Chloride | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L |
| trans-1,2-Dichloroethylene | <0.2 | ug/L | <0.2 | ug/L | <0.2 | ug/L | <0.2 | ug/L |
| 1,1-Dichloroethane | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| cis-1,2-Dichloroethylene | <0.2 | ug/L | <0.2 | ug/L | <0.2 | ug/L | <0.2 | ug/L |
| Chloroform | <1.5 | ug/L | <1.5 | ug/L | <1.5 | ug/L | <1.5 | ug/L |
| 1,1,1-Trichloroethane | <2.0 | ug/L | <2.0 | ug/L | <2.0 | ug/L | <2.0 | ug/L |
| Carbon Tetrachloride | <1.7 | ug/L | <1.7 | ug/L | <1.7 | ug/L | <1.7 | ug/L |
| 1,2-Dichloroethane | <0.3 | ug/L | <0.3 | ug/L | <0.3 | ug/L | <0.3 | ug/L |
| Benzene | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| 1,1,2-Trichloroethylene | <0.5 | ug/L | <0.5 | ug/L | <0.5 | ug/L | <0.5 | ug/L |
| Bromodichloromethane | <0.3 | ug/L | <0.3 | ug/L | <0.3 | ug/L | <0.3 | ug/L |
| Dibromomethane | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L |
| cis-1,3-Dichloro-1-Propene | <0.5 | ug/L | <0.5 | ug/L | <0.5 | ug/L | <0.5 | ug/L |
| Toluene | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| trans-1,3-Dichloro-1-propene | <0.5 | ug/L | <0.5 | ug/L | <0.5 | ug/L | <0.5 | ug/L |
| 1,1,2-Trichloroethane | <1.2 | ug/L | <1.2 | ug/L | <1.2 | ug/L | <1.2 | ug/L |
| 1,3-Dichloropropane | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| Tetrachloroethylene | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| Chlorodibromomethane | <2.5 | ug/L | <2.5 | ug/L | <2.5 | ug/L | <2.5 | ug/L |
| Chlorobenzene | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| 1,1,1,2-Tetrachloroethane | <0.5 | ug/L | <0.5 | ug/L | <0.5 | ug/L | <0.5 | ug/L |
| Ethyl Benzene | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| m,p-Xylene | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| o-Xylene | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| Bromoform | <0.5 | ug/L | <0.5 | ug/L | <0.5 | ug/L | <0.5 | ug/L |
| Cumene | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| 1,1,2,2-Tetrachloroethane | <1.2 | ug/L | <1.2 | ug/L | <1.2 | ug/L | <1.2 | ug/L |
| 1,2,3-Trichloropropane | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| Bromochloromethane | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| 1,2-Dibromo-3-chloropropane | <0.2 | ug/L | <0.2 | ug/L | <0.2 | ug/L | <0.2 | ug/L |
| 1,2-Dibromoethane | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| Styrene | <10 | ug/L | <10 | ug/L | <10 | ug/L | <10 | ug/L |

< = less than: compound not detected at or above indicated detection limit

- = Analysis not required

Quality control data reviewed: UPO

City of Bismarck

PROJECT: CFEX-91-0006
COLLECTED: Braun Intertec
RECEIVED: 29-JUN-92

| PARAMETER | Braun Intertec ID: 92-1404-01 | | 92-1404-02 | | 92-1404-03 | | 92-1404-04 | |
|------------------------------------|-------------------------------|-----------|------------|-----------|------------|-----------|------------|----------|
| | Client ID: | MW-DD | MS-DS | MW-CD | MW-CS | MW-CD | MW-CS | |
| | Matrix: | Liquid | Liquid | Liquid | Liquid | Liquid | Liquid | |
| | Collect Date: | 24-JUN-92 | 24-JUN-92 | 24-JUN-92 | 24-JUN-92 | 24-JUN-92 | 24-JUN-92 | |
| 1,3-Dichlorobenzene | <1.5 | ug/L | <1.5 | ug/L | <1.5 | ug/L | <1.5 | ug/L |
| 1,4-Dichlorobenzene | <0.2 | ug/L | <0.2 | ug/L | <0.2 | ug/L | <0.2 | ug/L |
| 1,2-Dichlorobenzene | <0.2 | ug/L | <0.2 | ug/L | <0.2 | ug/L | <0.2 | ug/L |
| Dichlorofluoromethane | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L |
| Ethyl Ether | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| Trichlorotrifluoroethane | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L |
| Acetone | <50 | ug/L | <50 | ug/L | <50 | ug/L | <50 | ug/L |
| Allyl Chloride (3-Chloropropylene) | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| Methyl Tertiary Butyl Ether | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| Methyl Ethyl Ketone | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L |
| Tetrahydrofuran | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L |
| Methyl Isobutyl Ketone | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L |
| Alkalinity, Total | 620 | mg/L | 390 | mg/L | 730 | mg/L | 1100 | mg/L |
| Bicarbonate Alkalinity | 620 | mg/L | 390 | mg/L | 730 | mg/L | 1100 | mg/L |
| Carbonate Alkalinity | <4.0 | mg/L | <4.0 | mg/L | <4.0 | mg/L | <4.0 | mg/L |
| Appearance | a | | b | | c | | d | |
| Cation/Anion Balance | 4.4 | % | 2.7 | % | 2.5 | % | -1.3 | % |
| Chloride | 9.0 | mg/L | 5.5 | mg/L | 12 | mg/L | 140 | mg/L |
| Chemical Oxygen Demand | <25 | mg/L | <25 | mg/L | <25 | mg/L | 44 | mg/L |
| Fluoride | 0.61 | mg/L | 0.16 | mg/L | 0.94 | mg/L | 0.26 | mg/L |
| Hardness as CaCO3, Total | 260 | mgEq/L | 450 | mgEq/L | 220 | mgEq/L | 2200 | mgEq/L |
| pH | 7.5 | Units | 7.3 | Units | 7.8 | Units | 7.0 | Units |
| Specific Conductance | 2600 | umhos/cm | 1100 | umhos/cm | 2400 | umhos/cm | 6600 | umhos/cm |
| Total Dissolved Solids | 1900 | mg/L | 730 | mg/L | 1800 | mg/L | 6500 | mg/L |
| Temperature * | 13 | Deg. C | 13 | Deg. C | 13 | Deg. C | 12 | Deg. C |
| Total Organic Carbon | 1.7 | mg/L | 1.7 | mg/L | 6.7 | mg/L | 15 | mg/L |
| Total Suspended Solids | 8 | mg/L | 630 | mg/L | 200 | mg/L | 550 | mg/L |
| Antimony, Total | <6.0 | mg/L | <6.0 | mg/L | <6.0 | mg/L | <6.0 | mg/L |
| Arsenic, Total | <2.0 | ug/L | 3.0 | ug/L | 8.0 | ug/L | 7.0 | ug/L |
| Barium, Total | 0.03 | mg/L | 0.35 | mg/L | 0.12 | mg/L | 0.26 | mg/L |
| Beryllium, Total | <0.2 | ug/L | 0.6 | ug/L | 0.4 | ug/L | 0.8 | ug/L |
| Cadmium, Total | <0.2 | ug/L | <0.2 | ug/L | <0.2 | ug/L | 0.3 | ug/L |
| Calcium, Total | 55 | mg/L | 83 | mg/L | 50 | mg/L | 360 | mg/L |
| Chromium, Total | 5.2 | ug/L | 3.7 | ug/L | 6.4 | ug/L | 22 | ug/L |
| Cobalt, Total | 39 | ug/L | 10 | ug/L | 31 | ug/L | 99 | ug/L |
| Copper, Total | <0.01 | mg/L | 0.03 | mg/L | 0.02 | mg/L | 0.05 | mg/L |
| Iron, Total | 0.5 | mg/L | 24 | mg/L | 8.0 | mg/L | 25 | mg/L |
| Lead, Total | 4 | ug/L | 5 | ug/L | 6 | ug/L | 8 | ug/L |
| Magnesium, Total | 30 | mg/L | 58 | mg/L | 23 | mg/L | 310 | mg/L |
| Manganese, Total | 0.29 | mg/L | 0.84 | mg/L | 0.40 | mg/L | 1.0 | mg/L |
| Mercury, Total | <0.4 | ug/L | <0.4 | ug/L | <0.4 | ug/L | <0.4 | ug/L |
| Nickel, Total | <0.02 | mg/L | 0.04 | mg/L | <0.02 | mg/L | 0.03 | mg/L |

a = No precipitate, clear, light gray, slight odor.

b = Heavy dark brown precipitate, light tan and brown in color, very cloudy, slight odor.

c = Light precipitate, cloudy, brown, slight odor.

d = Light precipitate, cloudy, brown, slight odor.

* Temperature was taken upon receipt in the laboratory.

< = less than: compound not detected at or above indicated detection limit

- = Analysis not required

Quality control data reviewed: URO

City of Bismarck

PROJECT: CFEX-91-0006
COLLECTED: Braun Intertec
RECEIVED: 29-JUN-92

| PARAMETER | Braun Intertec ID: 92-1404-01 | | 92-1404-02 | | 92-1404-03 | | 92-1404-04 | |
|-------------------------|-------------------------------|-----------|------------|-----------|------------|---------|------------|--------|
| | Client ID: | MW-DD | MS-DS | MW-CD | MW-CS | Matrix: | Liquid | Liquid |
| | Collect Date: | 24-JUN-92 | 24-JUN-92 | 24-JUN-92 | 24-JUN-92 | | | |
| Potassium, Total | 5.6 | mg/L | 7.9 | mg/L | 6.8 | mg/L | 5.7 | mg/L |
| Selenium, Total | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L |
| Silver, Total | <0.01 | mg/L | <0.01 | mg/L | <0.01 | mg/L | 0.02 | mg/L |
| Sodium, Total | 580 | mg/L | 120 | mg/L | 560 | mg/L | 1300 | mg/L |
| Thallium, Total | 40 | ug/L | 6.0 | ug/L | 34 | ug/L | 68 | ug/L |
| Vanadium, Total | 6.0 | ug/L | 22 | ug/L | 13 | ug/L | 64 | ug/L |
| Zinc, Total | <0.02 | mg/L | 0.14 | mg/L | 0.05 | mg/L | 0.09 | mg/L |
| Ammonia as N | 1.4 | mg/L | 0.17 | mg/L | 1.6 | mg/L | 0.06 | mg/L |
| Nitrate + Nitrite, as N | <0.02 | mg/L | <0.02 | mg/L | 0.04 | mg/L | 0.11 | mg/L |
| Sulfate | 1000 | mg/L | 350 | mg/L | 740 | mg/L | 3400 | mg/L |
| Total Phosphorus, as P | 0.03 | mg/L | 0.17 | mg/L | 1.1 | mg/L | 0.66 | mg/L |

< = less than: compound not detected at or above indicated detection limit
- = Analysis not required

Quality control data reviewed: URO

City of Bismarck

PROJECT: CFEX-91-0006
COLLECTED: Braun Intertec
RECEIVED: 29-JUN-92

| PARAMETER | Braun Intertec ID: 92-1404-05 | | 92-1404-06 | | 92-1404-07 | | 92-1404-08 | |
|------------------------------|-------------------------------|-----------|------------|-----------|------------|---------|------------|--------|
| | Client ID: | MS-OS | MW-N | MW-ED | MW-ES | Matrix: | Liquid | Liquid |
| | Collect Date: | 25-JUN-92 | 25-JUN-92 | 25-JUN-92 | 25-JUN-92 | | | |
| 2,3-Dichloro-1-propene | <10 | ug/L | <10 | ug/L | <10 | ug/L | <10 | ug/L |
| 2-Chloroethyl Vinyl Ether | <10 | ug/L | <10 | ug/L | <10 | ug/L | <10 | ug/L |
| Dichloroacetonitrile | <20 | ug/L | <20 | ug/L | <20 | ug/L | <20 | ug/L |
| Pentachloroethane | <10 | ug/L | <10 | ug/L | <10 | ug/L | <10 | ug/L |
| Acrylonitrile | <10 | ug/L | <10 | ug/L | <10 | ug/L | <10 | ug/L |
| Carbon Disulfide | <10 | ug/L | <10 | ug/L | <10 | ug/L | <10 | ug/L |
| Methyl Butyl Ketone | <10 | ug/L | <10 | ug/L | <10 | ug/L | <10 | ug/L |
| trans-1,4-Dichloro-2-butene | <10 | ug/L | <10 | ug/L | <10 | ug/L | <10 | ug/L |
| Methyl Iodide | <10 | ug/L | <10 | ug/L | <10 | ug/L | <10 | ug/L |
| Vinyl Acetate | <10 | ug/L | <10 | ug/L | <10 | ug/L | <10 | ug/L |
| Dichlorodifluoromethane | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L |
| Chloromethane | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L |
| Vinyl Chloride | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| Bromomethane | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L |
| Chloroethane | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| Trichlorofluoromethane | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| 1,1-Dichloroethylene | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| Methylene Chloride | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L |
| trans-1,2-Dichloroethylene | <0.2 | ug/L | <0.2 | ug/L | <0.2 | ug/L | <0.2 | ug/L |
| 1,1-Dichloroethane | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| cis-1,2-Dichloroethylene | <0.2 | ug/L | <0.2 | ug/L | <0.2 | ug/L | <0.2 | ug/L |
| Chloroform | <1.5 | ug/L | <1.5 | ug/L | <1.5 | ug/L | <1.5 | ug/L |
| 1,1,1-Trichloroethane | <2.0 | ug/L | <2.0 | ug/L | <2.0 | ug/L | <2.0 | ug/L |
| Carbon Tetrachloride | <1.7 | ug/L | <1.7 | ug/L | <1.7 | ug/L | <1.7 | ug/L |
| 1,2-Dichloroethane | <0.3 | ug/L | <0.3 | ug/L | <0.3 | ug/L | <0.3 | ug/L |
| Benzene | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| 1,1,2-Trichloroethylene | <0.5 | ug/L | <0.5 | ug/L | <0.5 | ug/L | <0.5 | ug/L |
| Bromodichloromethane | <0.3 | ug/L | <0.3 | ug/L | <0.3 | ug/L | <0.3 | ug/L |
| Dibromomethane | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L |
| cis-1,3-Dichloro-1-Propene | <0.5 | ug/L | <0.5 | ug/L | <0.5 | ug/L | <0.5 | ug/L |
| Toluene | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| trans-1,3-Dichloro-1-propene | <0.5 | ug/L | <0.5 | ug/L | <0.5 | ug/L | <0.5 | ug/L |
| 1,1,2-Trichloroethane | <1.2 | ug/L | <1.2 | ug/L | <1.2 | ug/L | <1.2 | ug/L |
| 1,3-Dichloropropane | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| Tetrachloroethylene | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| Chlorodibromomethane | <2.5 | ug/L | <2.5 | ug/L | <2.5 | ug/L | <2.5 | ug/L |
| Chlorobenzene | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| 1,1,1,2-Tetrachloroethane | <0.5 | ug/L | <0.5 | ug/L | <0.5 | ug/L | <0.5 | ug/L |
| Ethyl Benzene | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| m,p-Xylene | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| o-Xylene | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| Bromoform | <0.5 | ug/L | <0.5 | ug/L | <0.5 | ug/L | <0.5 | ug/L |
| Cumene | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| 1,1,2,2-Tetrachloroethane | <1.2 | ug/L | <1.2 | ug/L | <1.2 | ug/L | <1.2 | ug/L |
| 1,2,3-Trichloropropane | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| Bromochloromethane | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| 1,2-Dibromo-3-chloropropane | <0.2 | ug/L | <0.2 | ug/L | <0.2 | ug/L | <0.2 | ug/L |
| 1,2-Dibromoethane | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L | <1.0 | ug/L |
| Styrene | <10 | ug/L | <10 | ug/L | <10 | ug/L | <10 | ug/L |

< = less than: compound not detected at or above indicated detection limit
 - = Analysis not required

Quality control data reviewed: URC

City of Bismarck

PROJECT: CFEX-91-0006
COLLECTED: Braun Intertec
RECEIVED: 29-JUN-92

| PARAMETER | Braun Intertec ID: Client ID: Matrix: Collect Date: | 92-1404-05 MS-OS Liquid 25-JUN-92 | 92-1404-06 MW-N Liquid 25-JUN-92 | 92-1404-07 MW-ED Liquid 25-JUN-92 | 92-1404-08 MW-ES Liquid 25-JUN-92 |
|---------------------------------------|--|--|---|--|--|
| 1,3-Dichlorobenzene | <1.5 ug/L | <1.5 ug/L | <1.5 ug/L | <1.5 ug/L | <1.5 ug/L |
| 1,4-Dichlorobenzene | <0.2 ug/L | <0.2 ug/L | <0.2 ug/L | <0.2 ug/L | <0.2 ug/L |
| 1,2-Dichlorobenzene | <0.2 ug/L | <0.2 ug/L | <0.2 ug/L | <0.2 ug/L | <0.2 ug/L |
| Dichlorofluoromethane | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L |
| Ethyl Ether | <1.0 ug/L | <1.0 ug/L | <1.0 ug/L | <1.0 ug/L | <1.0 ug/L |
| Trichlorotrifluoroethane | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L |
| Acetone | <50 ug/L | <50 ug/L | <50 ug/L | <50 ug/L | <50 ug/L |
| Allyl Chloride (3-Chloropropylene) | <1.0 ug/L | <1.0 ug/L | <1.0 ug/L | <1.0 ug/L | <1.0 ug/L |
| Methyl Tertiary Butyl Ether | <1.0 ug/L | <1.0 ug/L | <1.0 ug/L | <1.0 ug/L | <1.0 ug/L |
| Methyl Ethyl Ketone | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L |
| Tetrahydrofuran | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L |
| Methyl Isobutyl Ketone | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L | <5.0 ug/L |
| Alkalinity, Total | 770 mg/L | 1000 mg/L | 850 mg/L | 870 mg/L | |
| Bicarbonate Alkalinity | 770 mg/L | 1000 mg/L | 810 mg/L | 870 mg/L | |
| Carbonate Alkalinity | <4.0 mg/L | <4.0 mg/L | 40 mg/L | <4.0 mg/L | |
| Appearance | e | f | g | h | |
| Cation/Anion Balance | 3.6 % | 1.2 % | 0.35 % | -1.8 % | |
| Chloride | 3.9 mg/L | 5.6 mg/L | 41 mg/L | 15 mg/L | |
| Chemical Oxygen Demand | <25 mg/L | <25 mg/L | <25 mg/L | <25 mg/L | |
| Fluoride | 0.21 mg/L | 0.30 mg/L | 1.2 mg/L | 0.21 mg/L | |
| Hardness as CaCO ₃ , Total | 280 mgEq/L | 240 mgEq/L | 280 mgEq/L | 1100 mgEq/L | |
| pH | 7.3 Units | 7.3 Units | 8.4 Units | 6.9 Units | |
| Specific Conductance | 3600 umhos/cm | 3500 umhos/cm | 3200 umhos/cm | 6800 umhos/cm | |
| Total Dissolved Solids | 2800 mg/L | 2700 mg/L | 2400 mg/L | 6000 mg/L | |
| Temperature * | 13 Deg. C | 13 Deg. C | 13 Deg. C | 13 Deg. C | |
| Total Organic Carbon | 1.8 mg/L | 2.1 mg/L | 5.4 mg/L | 3.4 mg/L | |
| Total Suspended Solids | 120 mg/L | 110 mg/L | 270 mg/L | 290 mg/L | |
| Antimony, Total | <6.0 mg/L | <6.0 mg/L | <6.0 mg/L | <6.0 mg/L | |
| Arsenic, Total | 3 ug/L | 7 ug/L | 12 ug/L | <2 ug/L | |
| Barium, Total | 0.07 mg/L | 0.09 mg/L | 0.21 mg/L | 0.09 mg/L | |
| Beryllium, Total | <0.2 ug/L | <0.2 ug/L | 0.9 ug/L | 0.6 ug/L | |
| Cadmium, Total | <0.2 ug/L | <0.2 ug/L | <0.2 ug/L | 0.2 ug/L | |
| Calcium, Total | 68 mg/L | 58 mg/L | 92 mg/L | 220 mg/L | |
| Chromium, Total | 7.8 ug/L | 37 ug/L | 32 ug/L | 38 ug/L | |
| Cobalt, Total | 63 ug/L | 48 ug/L | 39 ug/L | 100 ug/L | |
| Copper, Total | 0.02 mg/L | 0.01 mg/L | 0.03 mg/L | 0.02 mg/L | |
| Iron, Total | 2.9 mg/L | 3.6 mg/L | 15 mg/L | 8.0 mg/L | |
| Lead, Total | 5 ug/L | 5 ug/L | 5 ug/L | <2 ug/L | |
| Magnesium, Total | 27 mg/L | 23 mg/L | 13 mg/L | 130 mg/L | |
| Manganese, Total | 0.25 mg/L | 0.9 mg/L | 0.45 mg/L | 0.5 mg/L | |
| Mercury, Total | <0.4 ug/L | <0.4 ug/L | <0.4 ug/L | <0.4 ug/L | |
| Nickel, Total | <0.02 mg/L | <0.02 mg/L | 0.02 mg/L | <0.02 mg/L | |

e = Very light precipitate, slightly cloudy, gray-brown, slight odor.

f = Very light precipitate, slightly cloudy, gray-brown, slight odor.

g = Light precipitate, cloudy, yellow-gray, slight odor.

h = Precipitate, cloudy, yellow-brown, slight odor.

α = See discussion.

* Temperature was taken upon receipt in the laboratory.

< = less than: compound not detected at or above indicated detection limit

- = Analysis not required

Quality control data reviewed: URO

City of Bismarck

PROJECT: CFEX-91-0006
COLLECTED: Braun Intertec
RECEIVED: 29-JUN-92

| | | | | |
|--------------------|------------|------------|------------|------------|
| Braun Intertec ID: | 92-1404-05 | 92-1404-06 | 92-1404-07 | 92-1404-08 |
| Client ID: | MS-OS | MW-N | MW-ED | MW-ES |
| Matrix: | Liquid | Liquid | Liquid | Liquid |
| Collect Date: | 25-JUN-92 | 25-JUN-92 | 25-JUN-92 | 25-JUN-92 |

PARAMETER

| | | | | | | | | |
|-------------------------|-------|---------|-------|------|-------|------|------|------|
| Potassium, Total | 6.8 | mg/L | 6.9 | mg/L | 5.5 | mg/L | 11 | mg/L |
| Selenium, Total | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L | <5.0 | ug/L |
| Silver, Total | 0.01 | mg/L | 0.01 | mg/L | 0.01 | mg/L | 0.02 | mg/L |
| Sodium, Total | 880 | mg/L | 890 | mg/L | 840 | mg/L | 1600 | mg/L |
| Thallium, Total | 70 | ug/L kk | 60 | ug/L | 55 | ug/L | 120 | ug/L |
| Vanadium, Total | 8.0 | ug/L | 19 | ug/L | 36 | ug/L | 37 | ug/L |
| Zinc, Total | 0.04 | mg/L | 0.05 | mg/L | 0.1 | mg/L | 0.06 | mg/L |
| Ammonia as N | 0.24 | mg/L | 0.64 | mg/L | 1.0 | mg/L | 1.4 | mg/L |
| Nitrate + Nitrite, as N | <0.02 | mg/L | <0.02 | mg/L | <0.02 | mg/L | 0.20 | mg/L |
| Sulfate | 1500 | mg/L | 1200 | mg/L | 1100 | mg/L | 3400 | mg/L |
| Total Phosphorus, as P | 0.32 | mg/L | 0.12 | mg/L | 0.50 | mg/L | 0.27 | mg/L |

kk = See discussion.

< = less than: compound not detected at or above indicated detection limit
- = Analysis not required

Quality control data reviewed: _____

UKo

City of Bismarck

PROJECT: CFEY-91-0006
COLLECTED: Braun Intertec
RECEIVED: 01-JUL-92Braun Intertec ID: 92-1434-05
Client ID: MW-L
Matrix: Liquid
Collect Date: 29-JUN-92

PARAMETER

| | | |
|------------------------------|------|------|
| Dichlorodifluoromethane | <5.0 | ug/L |
| Chloromethane | <5.0 | ug/L |
| Vinyl Chloride | <1.0 | ug/L |
| Bromomethane | <5.0 | ug/L |
| Chloroethane | <1.0 | ug/L |
| Trichlorofluoromethane | <1.0 | ug/L |
| 1,1-Dichloroethylene | <1.0 | ug/L |
| Methylene Chloride | <5.0 | ug/L |
| trans-1,2-Dichloroethylene | <0.2 | ug/L |
| 1,1-Dichloroethane | <1.0 | ug/L |
| cis-1,2-Dichloroethylene | <0.2 | ug/L |
| Chloroform | <1.5 | ug/L |
| Bromochloromethane | <1.0 | ug/L |
| 1,1,1-Trichloroethane | <2.0 | ug/L |
| Carbon Tetrachloride | <1.7 | ug/L |
| 1,2-Dichloroethane | <0.3 | ug/L |
| Benzene | <1.0 | ug/L |
| 1,1,2-Trichloroethylene | <0.5 | ug/L |
| Bromodichloromethane | <0.3 | ug/L |
| Dibromomethane | <5.0 | ug/L |
| cis-1,3-Dichloro-1-Propene | <0.5 | ug/L |
| Toluene | <1.0 | ug/L |
| trans-1,3-Dichloro-1-propene | <0.5 | ug/L |
| 1,1,2-Trichloroethane | <1.2 | ug/L |
| 1,3-Dichloropropane | <1.0 | ug/L |
| Tetrachloroethylene | <1.0 | ug/L |
| Chlorodibromomethane | <2.5 | ug/L |
| 1,2-Dibromoethane | <0.2 | ug/L |
| Chlorobenzene | <1.0 | ug/L |
| 1,1,1,2-Tetrachloroethane | <0.5 | ug/L |
| Ethyl Benzene | <1.0 | ug/L |
| m,p-Xylene | <1.0 | ug/L |
| o-Xylene | <1.0 | ug/L |
| Styrene | <1.0 | ug/L |
| Bromoform | <0.5 | ug/L |
| Isopropylbenzene (Cumene) | <1.0 | ug/L |
| 1,1,2,2-Tetrachloroethane | <1.2 | ug/L |
| 1,2,3-Trichloropropane | <1.0 | ug/L |

< = less than: compound not detected at or above indicated detection limit
- = Analysis not required

Quality control data reviewed: _____

URC

City of Bismarck

PROJECT: CFEX-91-0006
 COLLECTED: Braun Intertec
 RECEIVED: 01-JUL-92

Braun Intertec ID: 92-1434-05
 Client ID: MW-L
 Matrix: Liquid
 Collect Date: 29-JUN-92

PARAMETER

| | | |
|------------------------------------|-------|----------|
| 1,3-Dichlorobenzene | <1.5 | ug/L |
| 1,4-Dichlorobenzene | <0.2 | ug/L |
| 1,2,4-Trimethylbenzene | <1.0 | ug/L |
| 1,2-Dichlorobenzene | <0.2 | ug/L |
| 1,2-Dibromo-3-Chloropropane | <10 | ug/L |
| Dichlorofluoromethane | <5.0 | ug/L |
| Ethyl Ether | <1.0 | ug/L |
| Trichlorotrifluoroethane | <5.0 | ug/L |
| Acetone | <50 | ug/L |
| Allyl Chloride (3-Chloropropylene) | <1.0 | ug/L |
| Methyl Ethyl Ketone | <5.0 | ug/L |
| Tetrahydrofuran | <5.0 | ug/L |
| Methyl Isobutyl Ketone | <5.0 | ug/L |
| Acrylonitrile | <10 | ug/L |
| Carbon Disulfide | <10 | ug/L |
| trans-1,4-Dichloro-2-Butene | <10 | ug/L |
| Methyl Butyl Ketone | <10 | ug/L |
| Methyl Iodide | <10 | ug/L |
| Vinyl Acetate | <10 | ug/L |
| Alkalinity, Total | 1300 | mg/L |
| Bicarbonate Alkalinity | 1300 | mg/L |
| Carbonate Alkalinity | <4 | mg/L |
| Appearance | d | |
| Cation/Anion Balance | -4.1 | % |
| Chloride | 84 | mg/L |
| Chemical Oxygen Demand | 57 | mg/L |
| Fluoride | 0.49 | mg/L |
| Ammonia as N | 0.15 | mg/L |
| Nitrate + Nitrite, as N | <0.02 | mg/L |
| pH | 7.2 | Units |
| Specific Conductance | 7700 | umhos/cm |
| Sulfate | 3200 | mg/L |

d = Heavy precipitate, heavy turbidity, yellow-brown, odorless.

< = less than: compound not detected at or above indicated detection limit
 - = Analysis not required

Quality control data reviewed: _____

URC

City of Bismarck

PROJECT: CFEX-91-0006
COLLECTED: Braun Intertec
RECEIVED: 01-JUL-92Braun Intertec ID: 92-1434-05
Client ID: MW-L
Matrix: Liquid
Collect Date: 29-JUN-92

PARAMETER

| | | |
|------------------------|--------|--------|
| Total Dissolved Solids | 330 | mg/L |
| Total Suspended Solids | 810 | mg/L |
| Total Phosphorus | 0.68 | mg/L |
| Temperature * | 13 | Deg. C |
| Total Organic Carbon | 15 | mg/L |
| Chromium, Total | 10 | ug/L |
| Silver, Total | 0.02 | mg/L |
| Arsenic, Total | 20 | ug/L |
| Beryllium, Total | 0.4 | ug/L |
| Cadmium, Total | <0.4 | ug/L |
| Cobalt, Total | 110 | ug/L |
| Lead, Total | 15 | ug/L |
| Thallium, Total | 100 kk | ug/L |
| Vanadium, Total | 27 | ug/L |
| Mercury, Total | <0.4 | ug/L |
| Barium, Total | 0.42 | mg/L |
| Calcium, Total | 360 | mg/L |
| Copper, Total | 0.04 | mg/L |
| Iron, Total | 30 | mg/L |
| Magnesium, Total | 320 | mg/L |
| Manganese, Total | 1.6 | mg/L |
| Nickel, Total | 0.04 | mg/L |
| Potassium, Total | 11 | mg/L |
| Sodium, Total | 1600 | mg/L |
| Zinc, Total | 0.11 | mg/L |
| Antimony | <6.0 | ug/L |
| Selenium, Total | <5.0 | ug/L |

kk = See discussion.

* = Temperature on receipt in laboratory.

< = less than: compound not detected at or above indicated detection limit
- = Analysis not requiredQuality control data reviewed: URO

APPENDIX H

VOLATILE ORGANIC COMPOUNDS
FOR WELL 139-079-30CBD

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 | <2 |
| Vinyl Chloride | <1 |
| Carbon Tetrachloride | <2 |
| 1,2-Dichloroethane | <2 |
| Trichloroethylene | <2 |
| 1,1-Dichloroethylene | <2 |
| 1,1,1-Trichloroethane | <2 |
| para-Dichlorobenzene | <2 |
| Acetone | <50 |
| 2-Butanone (MEK) | <50 |
| 2-Hexanone | <50 |
| 4-Methyl-2-pentanone | <50 |
| Chloroform | <5 |
| Bromodichloromethane | <5 |
| Chlorodibromomethane | <5 |
| Bromoform | <5 |
| trans-1,2-Dichloroethylene | <2 |
| Chlorobenzene | <2 |
| m-Dichlorobenzene | <5 |
| Dichloromethane | <5 |
| cis-1,2-Dichloroethylene | <2 |
| o-Dichlorobenzene | <2 |
| Dibromomethane | <5 |
| 1,1-Dichloropropene | <5 |
| Tetrachlorethylene | <2 |
| Toluene | <2 |
| Xylene (s) | <2 |
| 1,1-Dichloroethane | <5 |
| 1,2-Dichloropropane | <2 |
| 1,1,2,2-Tetrachloroethane | <5 |
| Ethyl Benzene | <2 |
| 1,3-Dichloropropane | <5 |
| Styrene | <2 |
| Chloromethane | <5 |
| Bromomethane | <5 |
| 1,2,3-Trichloropropane | <5 |
| 1,1,1,2-Tetrachloroethane | <5 |
| Chloroethane | <5 |
| 1,1,2-Trichloroethane | <5 |

* Constituent Detection

VOC Constituents cont.

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

* Constituent Detection