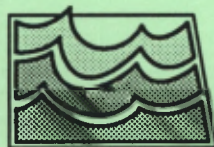


# Site Suitability Review of the Osnabrock Municipal Landfill

by  
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and  
Phillip L. Greer  
North Dakota Geological Survey



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



**ND Landfill Site Investigation No. 26**

SITE SUITABILITY REVIEW  
OF THE  
OSNABROCK MUNICIPAL LANDFILL

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North Dakota Landfill Site Investigation 26

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

Bismarck, North Dakota  
1994

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## INTRODUCTION

### Purpose

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

### Location of the Osnabrock landfill

The Osnabrock solid waste landfill is located one mile west of the City of Osnabrock in Township 160 North, Range 58 West, SW 1/4, SW 1/4 Section 17 (Fig. 1). The landfill site encompasses approximately 3 acres.

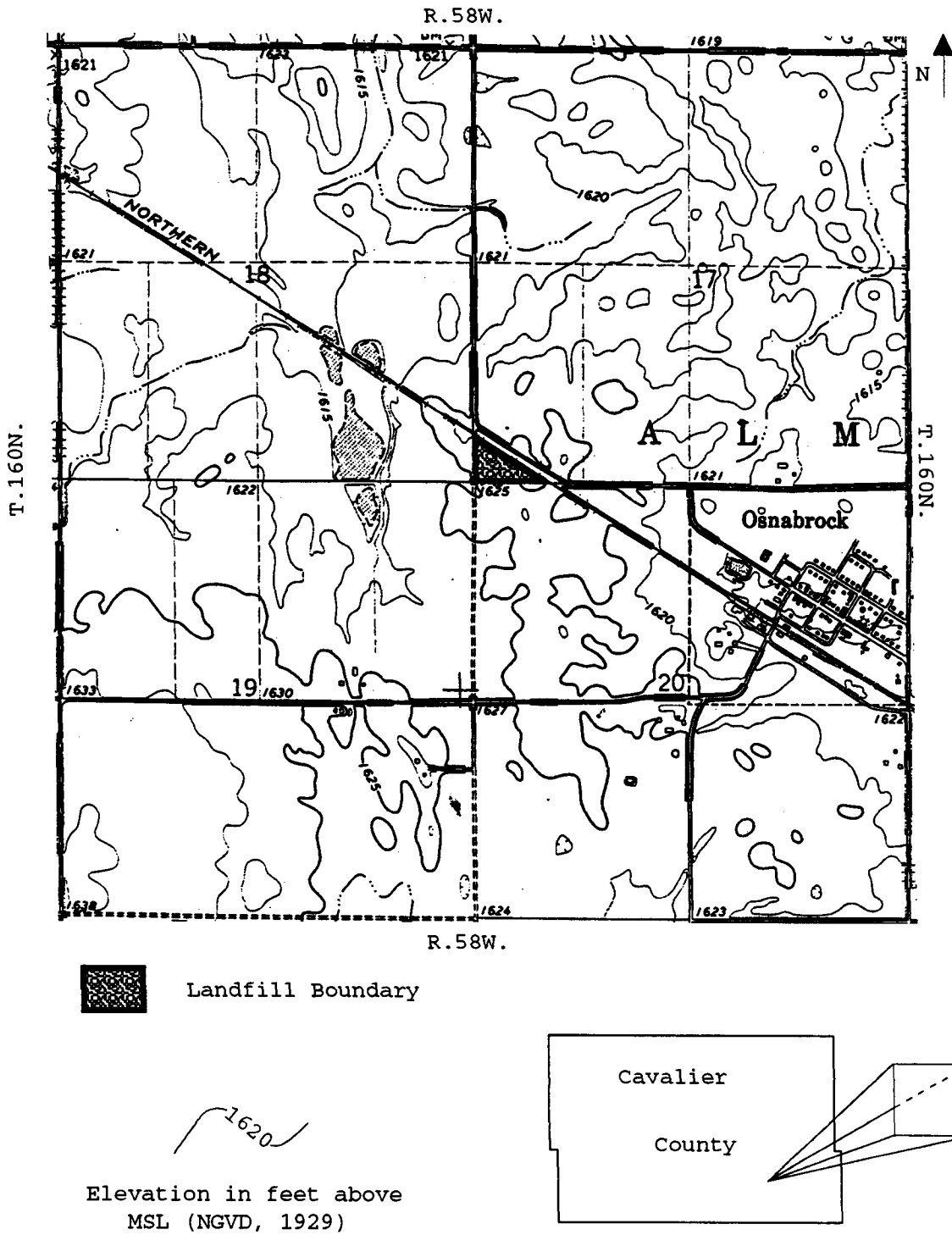


Figure 1. Location of the Osnabrock Municipal landfill in the SW 1/4, SW 1/4 of section 17, T160N, R58W.

## Previous Site Investigations

There were no previous hydrogeologic studies completed at this site.

## Methods of Investigation

The Osnabrock study was accomplished by means of: 1) drilling test holes; 2) constructing and developing monitoring wells; 3) collecting and analyzing water samples; and 4) measuring water levels.

### Test-Drilling Procedure

The drilling method at the Osnabrock landfill 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 Osnabrock landfill because the sediments were poorly consolidated and because the depth to the water table was expected to be less than 70 feet. The lithologic descriptions were determined from the drill cuttings.

### Monitoring Well Construction and Development

Three test holes were drilled at the Osnabrock landfill, and monitoring wells were installed in all of them. The



number of wells installed at the Osnabrock landfill was based on the geologic and topographic characteristics of the site. The depth and intake interval of each well was selected to monitor the water level at the top of the uppermost aquifer. The wells were located within the active area of the landfill.

Wells were constructed following a standard design (Fig. 2) intended to comply with the construction regulations of the NDSDHCL and the North Dakota Board of Water Well Contractors (North Dakota Department of Health, 1986). The wells were constructed using a 2-inch diameter, SDR21, polyvinyl chloride (PVC) well casing and a PVC screen, either 5 or 10 feet long, with a slot-opening size of 0.012 or 0.013 inches. The screen was fastened to the casing with stainless steel screws (no solvent weld cement was used). After the casing and screen were installed into the drill hole, the annulus around the screen was filled with No. 10 (grain-size diameter) silica sand to a height of two feet above the top of the screen. 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

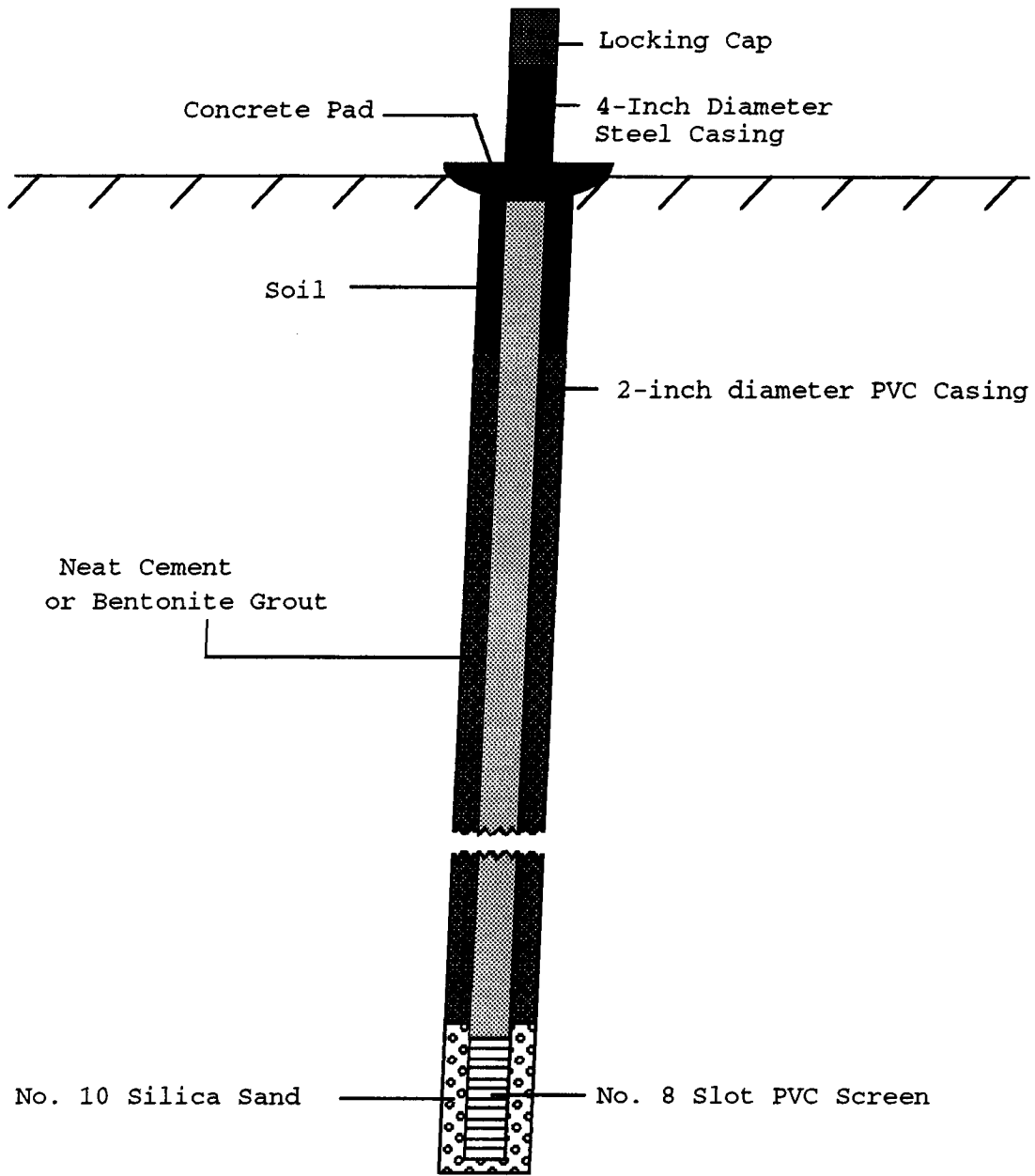


Figure 2. Construction design used for monitoring wells installed at the Osnabrock landfill.

and fine materials present near the well were removed to insure movement of formation water through the screen.

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

### Collecting and Analyzing Water Samples

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

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

were collected in high density polyethylene plastic bottles as follows:

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

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

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

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

## Water-Level Measurements

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

## Location-Numbering System

The system for denoting the location of a test hole or observation well is based on the federal system of rectangular surveys of public land. The first and second numbers indicate Township north and Range west of the 5th Principle Meridian and baseline (Fig. 3). The third number indicates the section. The letters A, B, C, and D designate, respectively, the northeast, northwest, southwest, and southeast quarter section (160-acre tract), quarter-quarter section (40-acre tract), and quarter-quarter-quarter section (10-acre tract). Therefore, a well denoted by 160-058-17CCC would be located in the SW1/4, SW1/4, SW1/4, Section 17, Township 160 North, Range 58 West. Consecutive numbers are added following the three letters if more than one well is located in a 10-acre tract, e.g. 160-058-17CCC1 and 160-058-17CCC2.

160-058-17CCC

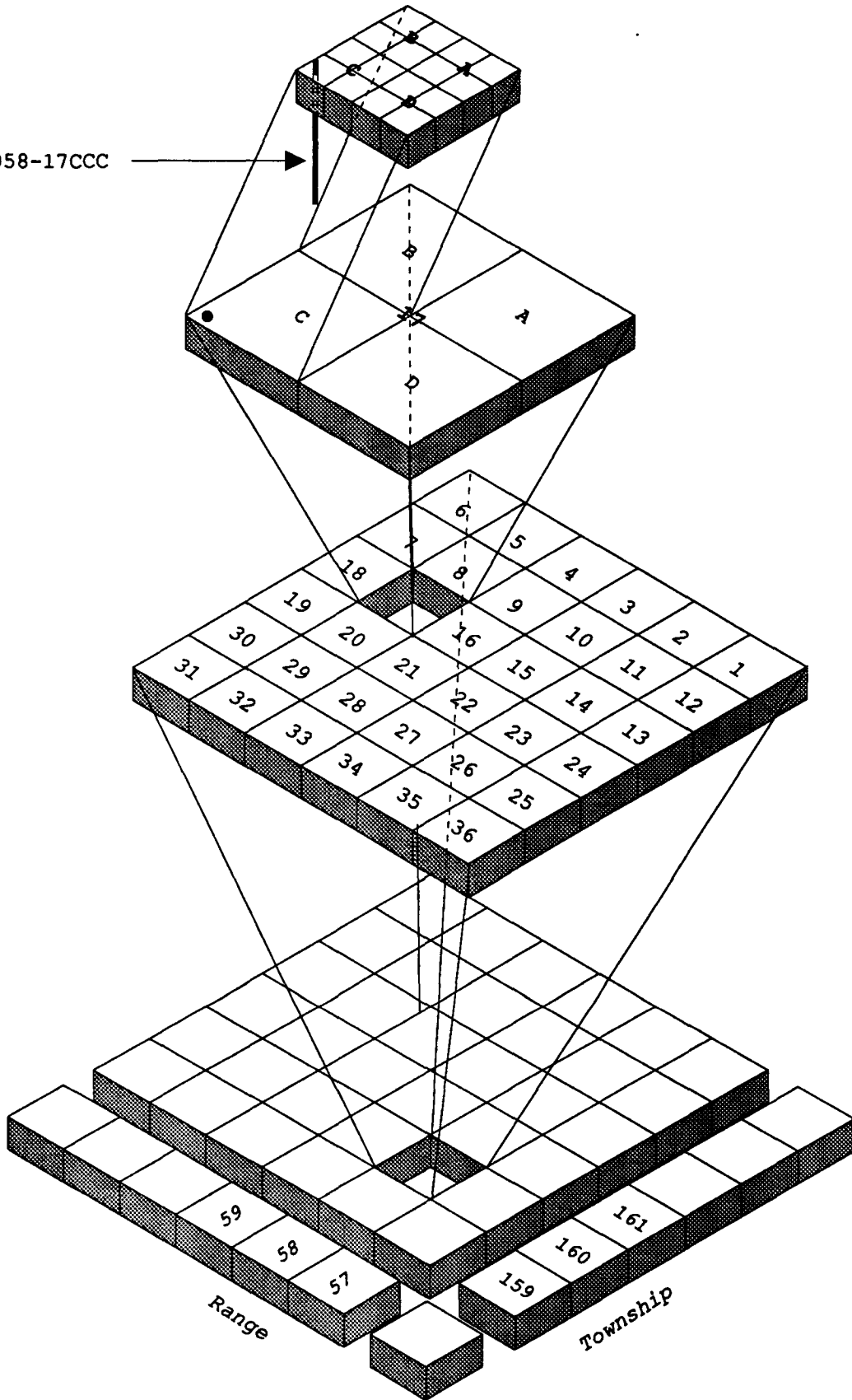


Figure 3. Location-numbering system at the Osnabrock landfill.

## GEOLOGY

The Osnabrock landfill is located in an area of glacial sediments with a nearly flat to gently undulating topography (Arndt, 1975). Local relief is generally 5 to 10 feet. Drainage is partially integrated, and surface depressions are common.

A small meltwater channel occurs about one-fourth mile west of the landfill (Arndt, 1975). The channel is now occupied by two intermittent streams.

The thickness of glacial sediments is extremely variable, ranging from a few feet to more than 150 feet within a one-mile radius of the landfill (Arndt, 1975). The glacial sediments consist of sandy clay till with minor amounts of stratified clay, sand, and gravel. The glacial sediments are underlain by the Cretaceous Pierre Formation, which is composed of hard, gray, siliceous shale, soft, black shale, clay, and bentonite (Arndt, 1975).

Within the landfill the glacial sediments range from 13 to 19 feet thick (lithologic logs in Appendix C). Except for a 2-foot-thick layer of sand in test hole 160-058-17CCC, the glacial material is composed of till (Fig. 4). The upper 10 to 12 feet of the Pierre Formation underlying the landfill is composed of hard, siliceous shale. Below this layer the Pierre Formation is composed of soft shale and clay interbedded with thin layers of hard shale.

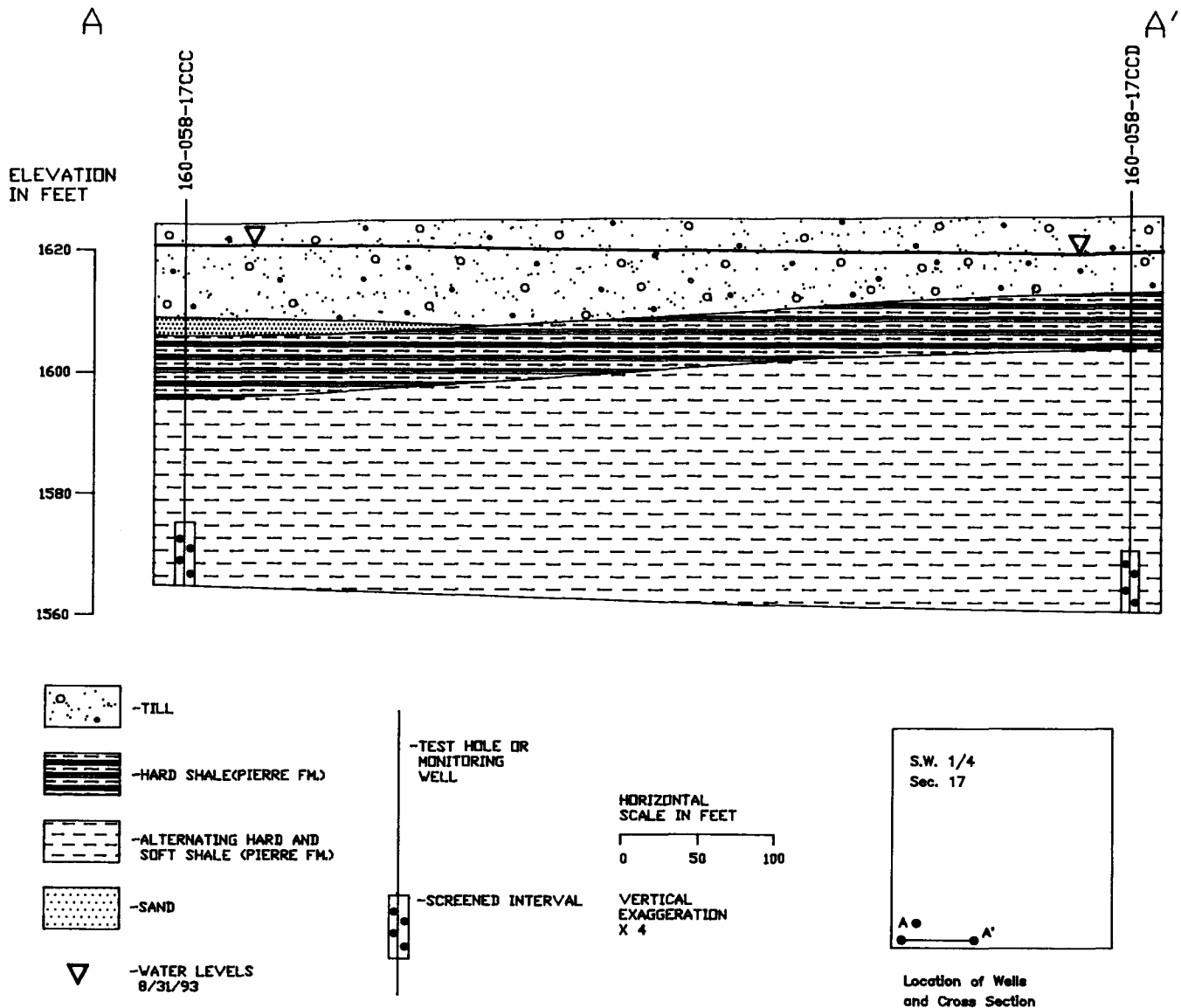


Figure 4. Geohydrologic section A-A' in the Os nabrock Landfill.



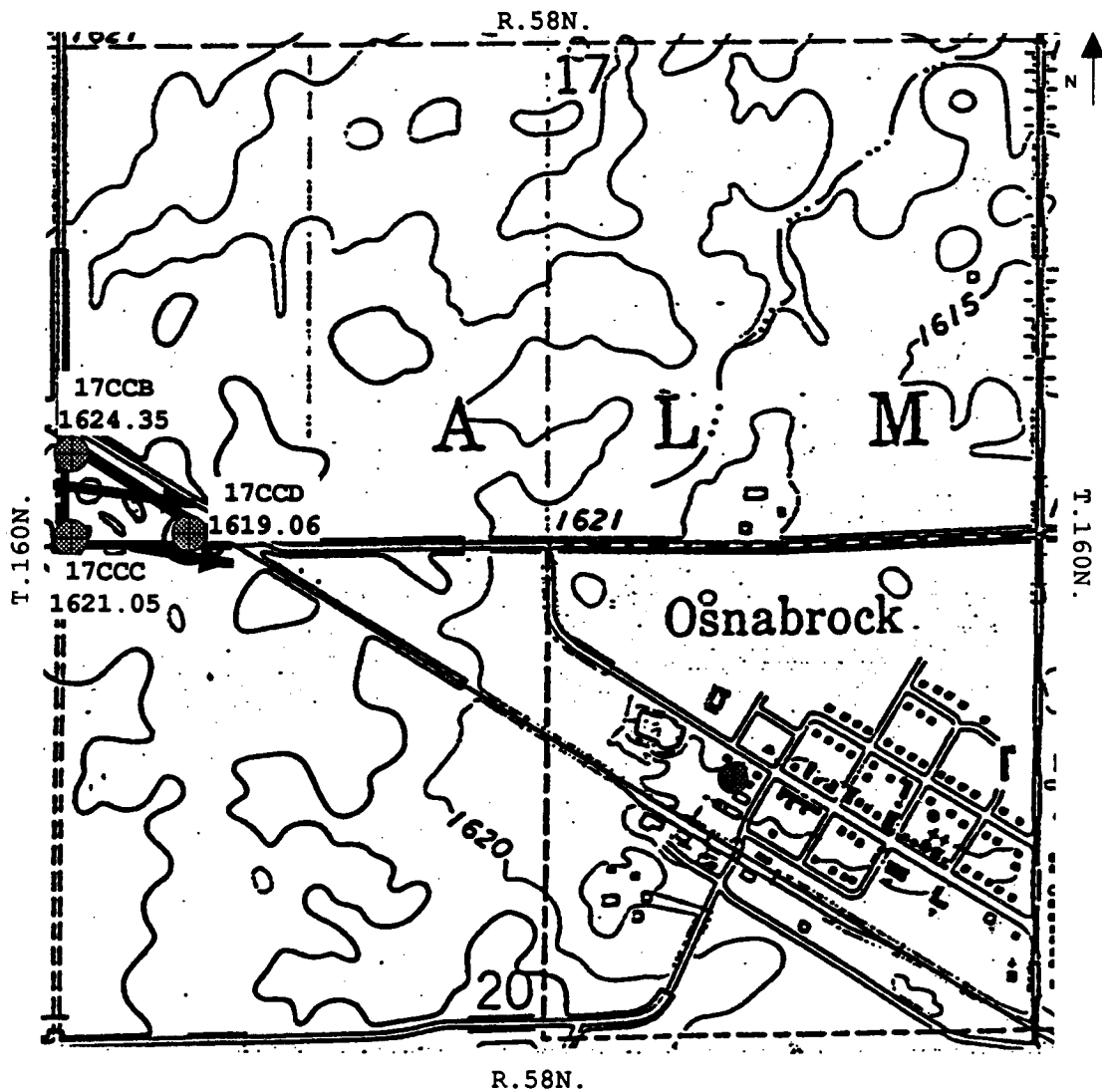
## HYDROLOGY

### Surface-Water Hydrology

Surface water appears to flow away from the Osnabrock landfill area. Surface-water runoff from the landfill does not appear to be significant because of the relatively flat topography. The North Branch Park River originates about one-half mile north of the landfill and flows to the north (Fig. 1). An intermittent stream exists about one-half mile west of the landfill (Fig. 1). This stream flows to the northeast and discharges into a wetland located about one-quarter mile west of the landfill. The North Branch Park River and the intermittent stream do not appear to be susceptible to contaminant migration from the landfill.

Numerous wetlands exist throughout the study area. These wetlands occupy depressions associated with low hydraulic conductivity surface material. Temporary wetlands may appear after periods of high precipitation. Wetlands adjacent to the landfill may receive contaminated runoff from the landfill.

A man-made pond is located at the east end of the refuse cells. This pond also may receive refuse runoff and local ground-water discharge from the landfill area.



- Monitoring Well
- Osnabrock City Well
- Landfill Boundary
- Direction of Ground-Water Flow

Elevation in feet above MSL (NGVD, 1929)

Well Number and Water-Level Elevations 8/31/93

Figure 5. Location of monitoring wells at the Osnabrock Municipal landfill.

## Regional Ground-Water Hydrology

Cretaceous formations and undifferentiated Pleistocene sands and gravels are regional aquifers that occur in the study area. The Dakota aquifer occurs at a depth of 600 to 700 feet. This aquifer is characterized by a sodium-chloride type water (Hutchinson, 1977). This aquifer should not be affected by the landfill.

The Pierre Formation underlies the glacial drift and is a source of ground water in areas of extensive fracturing. The City of Osnabrock obtains its water supply from the Pierre aquifer. The Pierre aquifer is characterized by a sodium-sulfate type water in the upper regions of the aquifer and by a sodium-chloride type water in the lower regions (Hutchinson, 1977).

Undifferentiated sand and gravel aquifers are found throughout the region. These aquifers are not extensive and small quantities of water are usually found with slow recharge potential. The water chemistry of these aquifers is variable.

## Local Ground-Water Hydrology

Three monitoring wells were installed within the boundaries of the landfill (Fig. 5). The well screens were placed near the top of the uppermost aquifer which appears to be the Pierre aquifer.

Four water-level measurements were taken from these wells over an eight-week period. These water levels indicate the ground-water flow direction to be to the east-southeast (Fig. 5). Locally, the direction of ground-water flow may be influenced by the draw down of the municipal wells located at the west end of the City of Osnabrock. This well is at a depth of about 90 feet and screened in the Pierre aquifer. This water supply may be susceptible to contaminant migration from the landfill.

#### Water Quality

Chemical analyses of water samples are shown in Appendix E. An anomalously high chloride concentration (1000 mg/L) was detected in well 160-058-17CCC. This concentration is four times the SMCL (250 mg/L) and at least 50 times higher than the rest of the water samples. This concentration also coincides with a sodium concentration of 1000 mg/L which is above the SMCL of 170 mg/L. Chloride and sodium concentrations of this magnitude are not typical for the Pierre aquifer. This well is located at the southwest corner of the site and is adjacent to the western edge of the refuse cells. These concentrations may indicate contaminant migration from the landfill. Well 160-058-17CCD detected an iron concentration of 1.3 mg/L which is greater than the SMCL of 0.3 mg/L. The source of this concentration was not

determined. Trace element concentrations are within the range of values typical of the Pierre aquifer.

Results of the VOC analysis, from well 160-058-17CCB, are shown in Appendix F. The analysis did not detect any VOC compounds.

### CONCLUSIONS

The Osnabrock landfill is located in an area of glacial sediments with a nearly flat to gently undulating topography. The thickness of the glacial sediments is variable and consists of sandy clay till with minor amounts of stratified clay, sand, and gravel. Glacial sediments within the landfill boundary range from 13 to 19 feet thick.

The Pierre Formation directly underlies the glacial till and is composed of hard, siliceous shale, soft, black shale, and bentonitic clay. The Pierre Formation is the uppermost aquifer beneath the landfill. This aquifer is present in areas of extensive fracturing. The direction of ground-water flow is to the east-southeast. The City of Osnabrock municipal well is located one-half mile southeast of the landfill and is screened in the Pierre aquifer. This well may be influencing the direction of local ground-water flow and may also be susceptible to leachate migration from the landfill. There are no known glacial aquifers in the area of the landfill.

Water quality analyses indicated anomalously high chloride and sodium concentrations in well 17CCC. This well is located adjacent to the buried refuse along the western boundary of the landfill and the concentrations may be due to contaminant migration from the landfill. An elevated iron concentration was detected in well 17CCD. The source of this concentration was not determined. No trace elements or VOC compounds were detected from the water analyses.

## REFERENCES

- Arndt, B.M., 1975, Geology of Cavalier and Pembina Counties: North Dakota Geological Survey, Bulletin 62, North Dakota State Water Commission, County Groundwater Studies 20, Part I, 68 p.
- Hem, J.D., 1989, Study and interpretation of the chemical characteristics of natural water: United States Geological Survey Water-Supply Paper 2254, 263 p.
- Hutchinson, R.D., 1977, Ground-water resources of Cavalier and Pembina Counties: North Dakota Geological Survey, Bulletin 62, North Dakota State Water Commission, County Groundwater Studies 20, Part III, 68 p.
- North Dakota Department of Health, 1986, Water well construction and well pump installation: Article 33-18 of the North Dakota Administrative Code.

APPENDIX A

WATER QUALITY STANDARDS  
AND  
CONTAMINANT LEVELS



**Water Quality Standards  
and  
Contaminant Levels**

**Field Parameters**

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

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

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

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

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

APPENDIX B

SAMPLING PROCEDURE FOR  
VOLATILE ORGANIC COMPOUNDS

## SAMPLING PROCEDURE FOR 40ML AMBER BOTTLES

### Sample Collection for Volatile Organic Compounds

by  
North Dakota Department of Health  
and Consolidated Laboratories

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

convex meniscus



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

APPENDIX C

LITHOLOGIC LOGS  
OF WELLS AND TEST HOLES

160-058-17CCB

NDSWC

Date Completed:	6/22/93	Purpose:	Observation Well
L.S. Elevation (ft):	1625.91	Well Type:	2" PVC
Depth Drilled (ft):	40	Aquifer:	UND
Screened Interval (ft):	30-40	Source:	
		Owner:	City of Osnabrook

Lithologic Log

Unit	Description	Depth (ft)
TOPSOIL		0-2
SILT	sandy, pale yellowish brown 10YR6/2, moist.	2-5
CLAY	sandy, moderate yellowish brown 10YR 5/4, moist (till).	5-10
CLAY	sandy, trace gravel, olive gray 5Y 4/1, dry (till).	10-15
SHALE	dark gray N3, dry (Pierre Formation).	15-27
SHALE	Clay, dark gray N3, wet.	27-29
SHALE	Same as above except dry.	29-32
SHALE	Same as above except wet.	32-35
SHALE	Same as above except dry.	35-37
SHALE	Same as above except wet	37-40

160-058-17000

NDSWC

Date Completed:	6/22/93	Purpose:	Observation Well
L.S. Elevation (ft):	1625.23	Well Type:	2" PVC
Depth Drilled (ft):	60	Aquifer:	UND
Screened Interval (ft):	50-60	Source:	
		Owner:	City of Osnabrook

Lithologic Log

Unit	Description	Depth (ft)
TOPSOIL		0-2
CLAY	sandy, trace gravel, moderate yellowish brown 10YR5/4 (till) moist.	2-8
CLAY	sandy, trace gravel, moderate yellowish brown 10YR5/4 (till), dry.	8-14
CLAY	sandy, gravelly with shale clasts, moderate yellowish brown 10YR5/4.	14-17
SAND	medium grained, moderate yellowish brown 10YR5/4.	17-19
SHALE	medium dark gray N4. (Pierre Formation).	19-30
SHALE	Clay, dark gray N3.	30-43
SHALE	Clay, medium dark gray N4.	43-60

160-058-17CCD

NDSWC

Date Completed:	6/22/93	Purpose:	Observation Well
L.S. Elevation (ft):	1625.74	Well Type:	2" PVC
Depth Drilled (ft):	65	Aquifer:	UND
Screened Interval (ft):	55-65	Source:	
		Owner:	City of Osnabrook

Lithologic Log

Unit	Description	Depth (ft)
TOPSOIL		0-4
CLAY	sandy, moderate yellowish brown (moist) 10YR5/4 (till).	4-6
SAND	clayey, moderate yellowish brown 10YR5/4 (till).	6-8
CLAY	sandy, moderate yellowish brown 10YR5/4, trace gravel (till).	8-13
SHALE	clay, medium dark gray N4. (Pierre Formation).	13-23
CLAY	with pieces of shale, medium dark gray N4.	23-65

APPENDIX D

WATER-LEVEL TABLES



Osnabrook Water Levels  
7/20/93 to 9/15/93

160-058-17CCB			IS Elev (msl,ft)=1625.91		
UND Aquifer			SI (ft.)=30-40		
Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
07/20/93	1.89	1624.02	08/31/93	1.56	1624.35
08/18/93	1.55	1624.36	09/15/93	1.62	1624.29

160-058-17CCC			IS Elev (msl,ft)=1625.23		
UND Aquifer			SI (ft.)=50-60		
Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
07/20/93	5.31	1619.92	08/31/93	4.18	1621.05
08/18/93	4.41	1620.82	09/15/93	3.84	1621.39

160-058-17CCD			IS Elev (msl,ft)=1625.74		
UND Aquifer			SI (ft.)=55-65		
Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
07/20/93	6.63	1619.11	08/18/93	7.02	1618.72
07/21/93	7.67	1618.07	08/31/93	6.68	1619.06
07/22/93	9.42	1616.32	09/15/93	6.42	1619.32

APPENDIX E

MAJOR ION AND TRACE-ELEMENT  
CONCENTRATIONS

## Osnabrook Water Quality Major Ion Analyses

Location	Screened Interval (ft)	Date Sampled	(milligrams per liter)																			Spec		
			SiO <sub>2</sub>	Fe	Mn	Ca	Mg	Na	K	HCO <sub>3</sub>	CO <sub>3</sub>	SO <sub>4</sub>	Cl	F	NO <sub>3</sub>	B	TDS	Hardness as CaCO <sub>3</sub>	as NCH	% Na	SAR	Cond (µmho)	Temp (°C)	pH
160-058-17CCB	30-40	07/20/93	30	0.02	0.1	9	3	430	7	756	4	320	42	0.7	7	3.3	1230	35	0	96	32	1773	11	8.18
160-058-17CCC	50-60	07/20/93	28	0.1	0.25	33	10	1000	19	926	0	180	1000	0.4	16	0.32	2740	120	0	94	40	4620	14	8.15
160-058-17CCD	55-65	07/22/93	56	1.3	0.06	9.5	2	260	7.4	506	49	140	7.5	0.7	6.3	2.3	791	32	0	93	20	1095	10	8.97

## Trace Element Analyses

Location	Date Sampled	(micrograms per liter)						
		Selenium	Lead	Cadmium	Mercury	Arsenic	Molybdenum	Strontium
160-058-17CCB	07/20/93	0	0	0	0.1	3	9	180
160-058-17CCC	07/20/93	0	0	0	0	3	12	540
160-058-17CCD	07/20/93	0	2	0	0	4	14	160

APPENDIX F

VOLATILE ORGANIC COMPOUNDS  
FOR WELL 160-058-17CCB

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
trans1,2-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