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ERP - E
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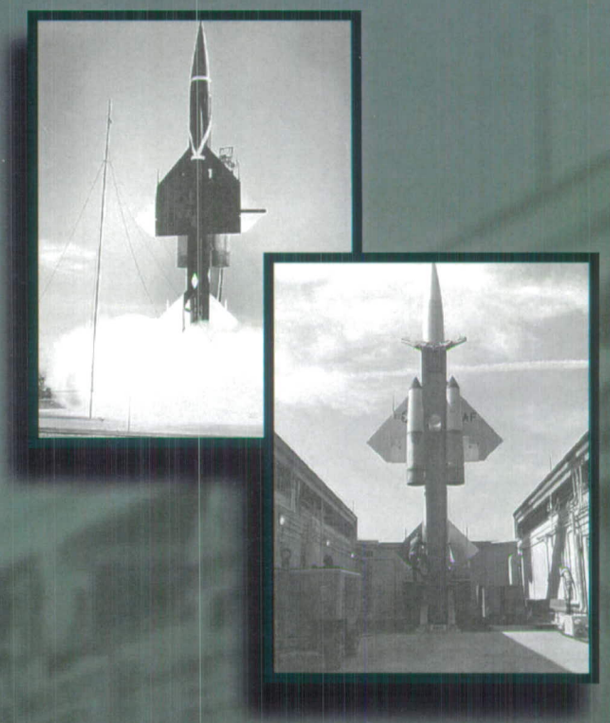
Focused RCRA Facility Investigation and Corrective Measures Study

Installation Restoration Program Site 5
Niagara Falls Air Reserve Station
Niagara Falls, New York

February 2000



Prepared for:
United States Department of the Air Force,
Air Force Reserve Command,
914th Airlift Wing

914TH AIRLIFT WING

ecology and environment, inc.
International Specialists in the Environment

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Focused RCRA Facility Investigation and Corrective Measures Study Niagara Falls Air Reserve Station Niagara Falls, New York

Contract Number F30617-94-D-0008

February 2000

Prepared for:

UNITED STATES DEPARTMENT OF THE AIR FORCE
AIR FORCE RESERVE COMMAND
914TH AIRLIFT WING

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Introduction

USAF
United States Department of the Air Force

AW
Airlift Wing

AFRC
United States Air Force Reserve Command

E & E
Ecology and Environment, Inc.

IRP
Installation Restoration Program

NFARS
Niagara Falls Air Reserve Station

RCRA
Resource Conservation and Recovery Act

RFI/CMS
RCRA Facility Investigation and Corrective Measures Study

NYSDEC
New York State Department of Environmental Conservation

SWMUs
solid waste management units

NYANG
New York Air National Guard

The United States Department of the Air Force (USAF), 914th Airlift Wing (AW) of the United States Air Force Reserve Command (AFRC), has retained Ecology and Environment, Inc., (E & E) under Contract No. F30617-94-D-0008 to perform Architect-Engineering Services (Environmental) — including Title I (Design Services), Title II (Supervision and Inspection Services), and other Architect-Engineering Services — in support of the United States Department of Defense Installation Restoration Program (IRP) at the Niagara Falls Air Reserve Station (NFARS) in Niagara County, New York.

This Focused Resource Conservation and Recovery Act (RCRA) Facility Investigation and Corrective Measures Study (RFI/CMS) is part of an ongoing phased investigation for IRP Site 5. Specifically, this report completes the requirements of 914th AW project No. RVKQ 99-0697. The Focused RFI/CMS was conducted in accordance with the requirements of a New York State Department of Environmental Conservation (NYSDEC) Part 373 hazardous waste storage permit, which requires corrective action programs for all solid waste management units (SWMUs).

AFRC is responsible for the implementation of the IRP. The 914th AW, as the host unit of NFARS, is responsible for administering corrective actions under Module III of the NYSDEC Part 373 permit, including the investigation and remediation of contamination resulting from tenant organization activities, specifically those of the New York Air National Guard (NYANG).

Work on this project was performed in accordance with E & E's work plan dated June 28, 1999. This report summarizes all work performed to date at Site 5 and specifically presents and evaluates the data collected under project No. RVKQ 99-0697 for June through October 1999. To minimize repetition, previous reports are referenced where appropriate.

1.1 Project Objectives

The objectives of the phased investigation were to provide a methodical and logical approach to the identification, quantification, and development of feasible remedies for environmental problems caused by hazardous materials use or disposal at IRP Site 5. RFI activities performed to date were designed to identify contaminant source areas, to delineate the vertical and horizontal extent of contamination in all media, and to identify potential related public health hazards.

The specific objectives of this Focused RFI/CMS project were to determine the following:

BOMARC
Boeing/Michigan
Aeronautical Research
Center

- The location and condition of the former Boeing/Michigan Aeronautical Research Center (BOMARC) missile pit launcher drainage system, if present;
- Whether the launcher pit drainage system contains contaminants and whether it functions as a potential contaminant transport pathway;
- The nature and extent of subsurface soil contamination in the source area;
- The extent and physical characteristics of the water-bearing sand zone encountered during previous phases of the investigation;
- The potential risks to human health associated with the groundwater contamination; and
- The potential response actions necessary to address the groundwater contamination.

Another objective was to further define the contaminant distribution in the groundwater.

1.2 Site Description and Operational History

NFARS is located in Niagara County, approximately 15 miles north of the city of Buffalo and 6 miles east of the city of Niagara Falls (see Figure 1-1). The base covers approximately 547 acres in the towns of Wheatfield to the east and Niagara to the west. NFARS was established *as Niagara Falls Air Force Reserve Facility* in November 1942. Numerous host and tenant organizations of the Air Force Reserve and NYANG have occupied the base to

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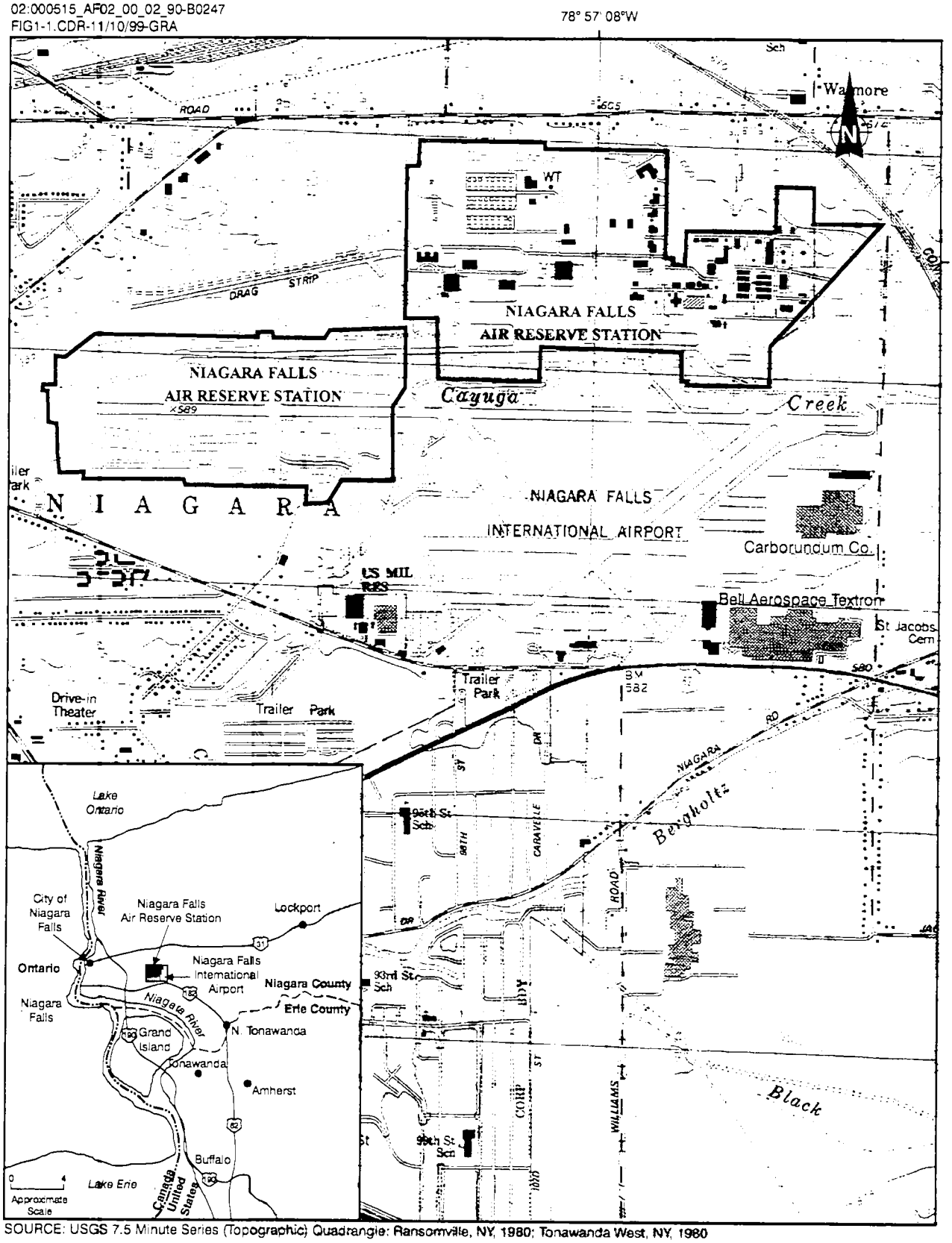
FIG1-1.CDR-11/10/99-GRA



SOURCE: USGS 7.5 Minute Series (Topographic) Quadrangle: Ransomville, NY, 1980; Tonawanda West, NY, 1980

SCALE 1:24,000

0 ½ 1 Mile

0 .5 1 Kilometer

Figure 1-1 REGIONAL LOCATION MAP

accomplish various USAF missions. For a history of base operations, refer to the 914th AW Management Action Plan (HQ AFRC/CEVV 1998).

The North American Defense Command Defense System IM-99B (a.k.a. XF-99, F-99, IM-99A, CIM-10A, and CIM-10A) BOMARC missile was deployed in the northwestern portion of the base (at what is now Site 5) in 1959. The 35th Air Defense Missile Squadron was activated to maintain the BOMARC missile complex. BOMARC missiles were surface-launched, pilotless interceptor missiles designed to destroy enemy aircraft. The *B* designation represented a Thiokol solid-fuel rocket motor, and *A* designated a liquid-fueled engine. The missile reportedly was 47 feet long and had an 18-foot wingspan. The warhead consisted of 1,000 pounds of high explosives, which could be detonated by a fuse activated from a ground control center. Alternatively, a nuclear warhead could be carried, but nuclear devices reportedly were not used at NFARS. Forty-eight BOMARC missiles were housed at NFARS in above-grade launcher shelters approximately 60 feet long by 22 feet wide and spaced approximately 65 feet apart.

The 35th Air Defense Missile Squadron and missiles were deactivated in the late 1960s, and the NYANG 107th Tactical Fighter Group became the tenant organization occupying the western portion of the base. USAF completed phase-out of the BOMARC's air defense mission in October 1972. After several intervening changes, the 107th now is designated as the *107th Air Refueling Wing (ARW)* and maintains 10 KC-135R refuelers. The area encompassed by Site 5 is used by the 107th ARW for vehicle maintenance (Building 920) and as a petroleum, oil, and lubricant (POL) storage area for temporary storage of JP-8 jet fuel.

ARW
Air Refueling Wing

POL
petroleum, oil, and lubricant

Remnants of the abandoned launcher shelters consist of approximately 36-foot-long, 22-foot-wide, 1-foot-thick reinforced concrete slabs that formerly formed the floors of the launcher rooms. Adjacent to each slab is an approximately 24-foot-long by 22-foot-wide launcher pit, which served as a sump and blast pit. This pit consisted of 13-inch-thick reinforced concrete walls and a 25-inch-thick reinforced concrete floor (including sub-slabs). Launcher pit floors originally were installed 6 feet to 6.5 feet below (Boeing Airplane Company 1961a, 1961b, 1963).

After the missiles were decommissioned, the walls, the roof, and some of the associated mechanics were pushed into the launcher pits. Based on observations made during previous test pit

excavations, other debris also was dumped into at least some of the launcher pits before burial with soil (E & E 1999a).

1.3 Previous Investigations

Site 5 initially was investigated in relation to the NYANG Hazardous Waste Storage Yard, which was located on one of the former BOMARC missile launcher floor slabs near the center of the complex. NYANG used the concrete pad for drum storage from 1978 to 1983. Only low levels of contaminants were found in this area; however, investigation continued with the discovery of volatile organic compounds (VOCs) in groundwater downgradient, and to the south and southeast, of the former Hazardous Waste Storage Yard.

VOCs
volatile organic compounds

SAIC
Science Applications International Corp.

RI/FS
Remedial Investigation/Feasibility Study

BNA
base/neutral and acid extractable organic compounds

1.3.1 1983 Phase I Records Search

The Phase I records search reported visual evidence of minor spills at the site, leading from the concrete pad used for drum storage toward a nearby ditch (Engineering-Science 1983). The Phase I report concludes that the site had sufficient potential for environmental contamination and recommends additional investigation.

1.3.2 1986 Phase II

The concrete pad at Site 5 was cleaned in 1983 in accordance with a NYSDEC-approved closure plan developed in order to close the storage area in accordance with New York Interim Status Standards for Owners and Operators of Hazardous Waste Facilities. What remained of the pad was buried in topsoil in late 1995.

Four overburden groundwater monitoring wells (MW5-1 through MW5-4) were installed and sampled in 1984. Analytical results indicated the presence of oil and grease, total organic carbon, purgeable organic carbon, total organic halides, and lead (Science Applications International Corp. [SAIC] 1986).

1.3.3 1991 IRP Remedial Investigation/Feasibility Study (RI/FS)

During the IRP RI/FS, two additional wells were installed (MW5-5 and MW5-1D), four groundwater samples were collected (from the new wells and from MW5-2 and MW5-4), and one soil sample was collected from a boring installed during the investigation. The groundwater samples were analyzed for VOCs, base/neutral and acid extractable organic compounds (BNA), metals, and general analytical parameters. Several metals were detected above appropriate standards in the groundwater samples. Only copper was detected at a concentration above background levels in the soil sample (SAIC 1991).

TCE
trichloroethene

µg/L
micrograms per liter

EPA
United States Environmental Protection Agency

DCE
Dichloroethene

1.3.4 1992 Additional RI/FS

The same wells sampled in 1989 were sampled again in an additional RI/FS conducted in late 1992. The results of the additional RI/FS indicated low levels of toluene and trichloroethene (TCE) in one of the overburden wells. TCE also was detected in bedrock well MW5-1D at a concentration of 380 micrograms per liter (µg/L; E & E 1992). No other VOCs or total petroleum hydrocarbons were detected. Several metals exceeded Class GA NYSDEC standards and guidance values in three overburden wells. NYSDEC and United States Environmental Protection Agency (EPA) reviewed the sample results in 1993, and NYSDEC requested additional semiannual groundwater sampling for at least two years.

During a well inspection and maintenance project conducted in 1993, two wells were abandoned and replaced because of frost damage (E & E 1993).

1.3.5 1995-97 Installation-Wide Groundwater Monitoring Project

The Installation-Wide Groundwater Monitoring Project began in September 1994. Biannual groundwater sampling began in March 1995 and continued through September 1999. Numerous wells and Geoprobe boreholes were installed throughout the course of the investigation in order to delineate the extent of VOC contamination. In 1995, two new shallow bedrock wells (MW5-2D and MW5-3D) were installed and one bedrock well was replaced with a properly constructed shallow bedrock well (MW5-1DA). In 1996, one replacement well (MW5-5A) was installed because of frost damage to the original well. Analytical results from groundwater sampling in 1995 and 1996 indicated no or low levels of VOCs in the tested wells, except for TCE and cis-1,2-dichloroethene (DCE) in MW5-1DA. The monitoring wells between the suspected source area (NYANG Hazardous Waste Storage Yard) and MW5-1DA were free of VOC contamination. This suggested the presence of an alternative source of the observed VOC contamination.

During 1997, two shallow bedrock wells (MW5-4D and MW5-5D) were installed downgradient of existing well MW5-1DA to assist in determining the lateral extent of groundwater contamination. The TCE concentration detected in MW5-5D in September 1997 was significantly higher than that detected in any other well at the site. This high concentration indicated that a source other than the drum storage pad was likely.

1.3.6 1998 Focused RFI

The focused investigation was performed to identify potential sources of groundwater contamination at the site and to delineate the vertical and horizontal extent of the groundwater contamination. This focused investigation was initiated because of the high concentrations of VOCs detected in well MW5-5D. Because Site 5 contains 48 abandoned underground BOMARC missile launcher pits, the source of the organic contaminants detected in the groundwater was suspected to be the launcher pits. Therefore, a phased investigation of the 48 missile launcher pits was performed (E & E 1999a).

The investigation included backhoe excavation of five BOMARC missile launcher pits; Geoprobe borehole sampling and temporary well installation; installation of permanent monitoring wells; collection of water level measurements; and groundwater, subsurface soil, and surface soil sampling.

The backhoe investigation included excavation of a portion of five abandoned BOMARC missile launcher pits in the vicinity and upgradient of monitoring well MW5-5D, which was the most contaminated well at Site 5. A large amount of reinforced concrete, believed to be the remains of the launcher shelter walls, was found in the excavated launcher pits. No drums or other obvious indicators of waste disposal were encountered. A soil sample was collected from each pit and analyzed for VOCs. One sample also was analyzed for polychlorinated biphenyls (PCBs) because of the presence of an oil sheen and buried electrical equipment. The only compound detected above the NYSDEC recommended soil cleanup objectives was the PCB Aroclor 1254 in one of the samples. A low concentration of benzene, ethylbenzene, toluene, and xylene isomers (BETX) was detected in each sample.

PCBs
polychlorinated biphenyls

BETX
benzene, ethylbenzene, toluene, and xylene isomers

Sixty-eight Geoprobe boreholes and temporary wells were installed in May and July 1998 to characterize and delineate the lateral extent of groundwater contamination in the vicinity of MW5-5D and in all of the BOMARC missile launcher pits. Subsurface soil samples also were collected during the Geoprobe borehole installation. All samples were analyzed for VOCs, and some of the samples also were analyzed for PCBs. At least one VOC was detected in 12 of 17 subsurface soil samples. However, the only exceedance of NYSDEC soil cleanup objectives was TCE in two samples (GP5-03 and GP5-06). Low concentrations of PCBs were detected in six of the soil samples.

Groundwater samples were collected from all 68 temporary wells. At least one VOC was detected above NYSDEC Class GA groundwater standards in 29 of the groundwater samples. Various compounds detected at concentrations above NYSDEC Class GA groundwater standards include TCE; cis-1,2-DCE; trans-1,2-DCE; benzene; chloroform; 1,1-DCE; ethylbenzene; toluene; vinyl chloride; xylenes; and methyl tert-butyl ether. PCBs were detected in one sample at a concentration exceeding the NYSDEC standard. Two TCE and 1,2-DCE plumes were delineated at Site 5. The larger and more clearly defined plume is centered approximately 150 feet northwest of Building 902 and extends to the east and south (E & E 1999a). The second plume is somewhat elongated in shape from southwest to northeast and extends from the northeast portion of Site 5 toward Building 202.

Based on the results of the missile launcher pit excavations and Geoprobe sampling, four additional groundwater monitoring wells were installed at Site 5 — three wells completed in the shallow bedrock water-bearing zone (MW5-6D, MW5-7D, and MW5-8D) and another completed in the deep bedrock zone (MW5-1E). Subsurface soil samples were collected from three of these well borings. TCE was detected above the NYSDEC soil cleanup objective in MW5-1E.

Groundwater samples were collected from all Site 5 wells in 1998. The newly installed wells were sampled for VOCs, BNA, PCBs, and/or metals. TCE and cis-1,2-DCE have been consistently present since well installation. Consistently high TCE concentrations were detected in MW5-5D, and although they were less than the maximum solubility of TCE in water (1,100,000 µg/L) by an order of magnitude, the concentrations suggested that denser-than-water nonaqueous phase liquid (DNAPL) is present and that a source other than the drum storage pad is present at the site. All detected metals were below Class GA standards.

DNAPL
denser-than-water, non-aqueous phase liquid

One composite surface soil sample (SS5-1) was collected from a drainage ditch that cuts across a launcher pit in which PCBs were detected in the subsurface. Aroclor 1260 was detected at a concentration below the NYSDEC surface soil cleanup objective.

1.4 Environmental Setting

1.4.1 Physiography and Topography

The site lies on the Lake Tonawanda plain within the Erie-Ontario lowland topographic province, which is characterized by generally flat terrain within the lake basin and beach ridges and moraines forming areas of low relief (Johnston 1964). The ground surface at

AMSL
above mean sea level

USGS
United States Geological Survey

F
Fahrenheit

NOAA
National Oceanic and Atmospheric Administration

and near NFARS reflects this trend, resulting in topography that slopes gradually from approximately 600 feet above mean sea level (AMSL) along the northern site boundary to 585 feet AMSL along the southern site boundary. Cayuga Creek, which flows along the southern site boundary, has an approximate bed elevation of 572 feet AMSL at its lowest point (United States Geological Survey [USGS] 1980a, 1980b).

1.4.2 Climate

Meteorological conditions, including temperature and precipitation, are influenced by Lakes Ontario and Erie. The annual mean maximum temperature for the area is 56° Fahrenheit (F), and the annual mean minimum temperature is 40°F (National Oceanic and Atmospheric Administration [NOAA] 1992).

The annual average precipitation (including snowfall), which varies throughout the region, is 38.1 inches of rainfall equivalent in Buffalo and 34.1 inches in the Niagara regional district of Ontario, Canada (NOAA 1992).

1.4.3 Land Use

The base is located within an area of varied land use, including industrial, residential, agricultural/rural, and commercial.

1.4.4 Surface Hydrology

Surface water drainage at the base is controlled by a system of open ditches and underground storm drains that discharge into Cayuga Creek. Cayuga Creek enters the northeastern side of the base from the north and flows along the eastern and southern boundaries, eventually joining the Little River, which in turn flows into the Niagara River. An unnamed tributary fed by a nearby quarry and several on-site drainage ditches flows southward across the base, eventually joining Cayuga Creek. In a downgradient direction, the nearest surface water body to Site 5 is Cayuga Creek, which is approximately 0.4 mile south.

1.4.5 Geology

Overburden thickness at NFARS has been found to range from approximately 3 feet near Cayuga Creek to nearly 18 feet at Site 5. Except for fill material and topsoil, the unconsolidated deposits consist of three types of materials from the top down — reworked topsoil/fill, lacustrine deposits, and glacial till. In certain locations, including Site 5, a distinct and apparently laterally confined uniform sand layer exists between the lacustrine deposits and till.

The bedrock situated immediately beneath the relatively thin cover of overburden is Middle Silurian Lockport Dolostone, which consists mainly of gray to brownish gray, fine- to coarse-grained dolostone. Regionally, the Lockport Dolostone consists of four formations. In the base vicinity, the uppermost unit (Guelph Formation) is not present, nor is the top 10 feet to 20 feet of the underlying Eramosa Formation (Brett et al. 1995). Investigations to date at Site 5 have focused on the top 44 feet of bedrock. Brett et al. (1995) describe the Eramosa (Dolomite) Formation as a biostromal, bituminous, medium- to massive-bedded dolomite divided into six informal units (A through F). Unit F, Unit E, and a portion of Unit D are likely absent from the base. Unit D consists of upper and lower nonfossiliferous dolomites separated by a massive bed locally packed with coral. The underlying Unit C is a biostromal interval characterized by up to 5-foot-thick stromatolites and associated corals. The rock is massive, thickly bedded dolomite with abundant vugs, which typically are lined with sphalerite, galena, fluorite, calcite, or dolomite (Brett et al. 1995).

Observations made during well drilling activities at the installation indicated that the top 10 feet of the Lockport Dolostone generally is fractured more than below, and contains mainly horizontal bedding plane fractures but also some vertical fracturing (joints and stress relief fractures). Also, fracture concentrations vary greatly between locations. Other features of the Lockport Dolostone observed at the installation include fossil algal and coral structures; stylolites; vugs; and secondary mineralization of dolomite, gypsum, calcite, sphalerite, and fluorite. For a more complete description of the Lockport Dolostone at NFARS, refer to E & E's *Stratigraphy Assessment Report* (E & E 1999b).

1.4.6 Regional Hydrogeology

At the base, horizontal groundwater flow in the overburden has been observed to flow to the east, southeast, south, or southwest, varying from site to site and depending on the proximity to Cayuga Creek and other surface drainages.

Bedrock groundwater flows through horizontal bedding planes, vertical fractures, and joints within the Lockport Dolostone. The most permeable zone is the upper 5 feet to 15 feet of more heavily fractured and weathered bedrock. The generalized regional groundwater flow direction in the bedrock aquifer is to the south-southwest. Water elevation measurements taken at the base for previous projects indicated that the shallow bedrock groundwater flow direction varies locally and seasonally on a site-by-site basis but has a primary component to the south (E & E 1999a).

Several manmade and natural hydrogeologic controls affect deep groundwater flow in the region and beneath the installation. As a consequence of the regional hydrologic setting, there is a limit (135 feet) to the downward migration of dissolved contaminants under the base. Only a discharge of DNAPL could migrate deeper into the bedrock. Dissolved contaminants at the base that enter deeply enough into the bedrock to pass under Cayuga Creek south of the base would turn west and discharge to the drains of the New York Power Authority power project conduits, and therefore would enter the Niagara gorge. However, this has not been observed at Site 5 or at any other site at the base.

2 Field Investigation and Analytical Results

2.1 BOMARC Storm and Subsurface Drain Investigation

In order to determine the location and condition of the abandoned storm sewer lines related to the former BOMARC missile launcher system, E & E performed a sewer survey at Site 5. This survey consisted of a records and manhole search, a video inspection of the storm drain system, and manhole sampling.

2.1.1 Records Search and Manhole Identification

E & E performed a search of all available records, drawings, and maps to identify the locations of the missile launcher drainage system. This included drawings provided by 914th AW/Civil and Environmental Engineering and the 107th ARW (Boeing Airplane Company 1961a, 1961b, 1963; Seelye et al. 1961, 1963; Woolpert Consultants 1989; Enterprise Engineering, Inc. 1993). A field search also was performed to identify all visible manholes related to the drainage system.

The purpose of this portion of the investigation was to identify a source of the groundwater contamination. Previous investigations assessed the groundwater quality adjacent to each of the former BOMARC shelters and determined that the contaminant plume was located mainly within the southernmost two rows of the shelters (E & E 1999a). Therefore, this phase of the investigation focused on these two rows (see Figure 2-1, Rows 5 and 6).

An as-built drawing of the BOMARC launcher shelter complex (Seelye et al. 1961) depicts the initial four (northern) rows of shelters constructed at the site (28 shelters) and the related subsurface drainage system. Another as-built drawing (Seelye et al. 1963) shows the complete BOMARC complex after construction of 20 additional shelters. However, this drawing does not include any drainage lines. Therefore, a composite drawing (see Figure 2-1)

was made with the assumption that the drainage system layout used in the first phase of shelter construction also was used for the second phase of construction.

A field inspection then was performed to locate manholes associated with the BOMARC subsurface drainage system. A metal detector (inductive-type magnetic locator) was used to search for potentially buried manholes at locations where they were expected to exist but were not visible. Manholes labeled *MH5-1*, *MH5-2*, *MH5-3*, and *MH5-5* in Figure 2-1 were located, and three were sampled (see Section 2.1.3). Manhole MW5-4 was not evident on the surface but was located later during the video inspection (see Section 2.1.2). An attempt also was made to locate additional manholes along the lateral line west of MH5-2. Several magnetic anomalies were identified near the western terminus of the drainage system (near shelter A6) using the metal detector. However, no manholes were located upon excavation. The manhole located north of former shelter D6 was not located and is presumed to have been removed when the 107th ARW POL yard was constructed.

Upon inspection of manholes MH5-1, MH5-2, and MH5-3, a significant amount of debris (concrete, brick, gravel, and sediment) was observed in each. The north-south trunk line consists of 8-inch clay sectional pipe. In each manhole, the top portion of this pipe was broken to allow water from 6-inch, east-west lateral lines to join the flow. The lateral lines also were constructed of sectional clay pipe. A small amount of flowing water was observed in each manhole. Based on the measurements summarized in Table 2-1, the slope of the north-south trunk line was determined to be 0.26%. In addition, the subsurface drain lines were above the groundwater table at the time of inspection. However, groundwater levels in overburden wells at the site have been observed to fluctuate seasonally by 5 feet to 8 feet. Therefore, it is anticipated that groundwater rises to or above the elevation of the storm drain lines seasonally.

Table 2-1 Manhole Survey Data, Installation Restoration Program Site 5

Manhole ID	Rim Elevation	Invert Elevation
MH5-1	597.32	588.7
MH5-2	595.38	588.4
MH5-3	595.72	589.2
Utility manhole	595.34	586.3

Notes: Elevations are in feet above mean sea level.
See Figure 2-1 for manhole locations.

Key: ID = Identification.

In addition to the storm drain system manholes, a utility manhole located approximately 25 feet north of MH5-2 was investigated. The utility manhole was approximately 9 feet deep with a soft bottom due to accumulation of sediment. The sediment was black with a strong sulfur odor from anaerobic decay of organic matter. When sampled, the sediment released hydrocarbons resulting in a small sheen on the water. The utility manhole contained approximately 6 feet of standing water. It was identified as a utility manhole because it did not coincide with known storm drain lines and it contained an electrical outlet and conduit. Drawings indicate that the BOMARC shelters and outdoor lighting for the complex were serviced by an underground electrical system.

2.1.2 Storm Drain Video Inspection

On July 21, 1999, American Pipe Services, Inc., of Kenmore, New York, performed a video inspection of the abandoned storm drains that once serviced the former bunkers at IRP Site 5. On site were a camera truck; a jetter truck (to clean clogged pipe runs); and a tank truck for collection and disposal of the water, if necessary. An E & E engineer performed contractor oversight. The logs of the video inspection are provided in Appendix A.

Previous searches for the storm drainage system identified the location of three stormwater manholes of interest. The first is located in the parking lot north of Building 920 (MH5-1). MH5-2 is located approximately 82 feet north of MH5-1 and just south of an open drainage ditch. MH5-3 is located approximately 110 feet north of MH5-2 in an area of tall grass (see Figure 2-1).

lf
linear feet

The first video inspection interval was from MH5-2 south to MH5-1 for a distance of 80.7 linear feet (lf). The 8-inch vitreous clay pipe contained no blockages or lateral connections, and pressure washing this pipe run was unnecessary. However, there are various locations where the pipe has sagged and collects water.

The second inspection interval was from MH5-2 north to MH5-3. This interval also is an 8-inch vitreous clay pipe with joints every 3 lf to 4 lf. One lateral connection corroded and stained with mineral deposits was found 22.8 lf north of MH5-2. The video inspection continued north toward MH5-3 for a total distance of 91.2 lf, where it stopped because of debris accumulation. At this point, the camera was moved to MH5-3 and the inspection resumed southward for a distance of 22.9 lf, where it was terminated because of debris. No additional lateral connections were detected.

The next video inspection interval was from MH5-3 north to MH5-4. Although sections of the 8-inch clay pipe contained large amounts of water, the video inspection continued until MH5-4 was found 88.4 lf north of MH5-3. Finding MH5-4 intact was unexpected because it had not been located during surface surveys.

The next video inspection interval was from MH5-1 south toward Building 920. This 8-inch clay line also was filled with water. A section of broken pipe was detected 44.8 lf south of MH5-1, and a section of cracked pipe was detected 135.4 lf south of MH5-1. Debris in the pipe stopped the camera at 157.8 lf, just 5 feet south of MH5-5. The top of MH5-5 was found in the parking lot south of Building 920, and the drain pipe continues southeast beyond MH5-5.

After the video inspections of all of the 8-inch pipe runs, the camera was reconfigured to fit into the 6-inch lateral pipes running west and east from MH5-2. First, traveling west, the camera found the pipe to be deteriorating and full of debris. On the first attempt, the camera traveled only 8 lf west before getting stuck in debris. The line was pressure cleaned with the jetter truck, and a second video inspection run was attempted. The camera detected lateral connections (to the north and south) 32 lf, 118 lf, and 206 lf west of MH5-2. The camera traveled a total distance of 280.5 lf west from MH5-2 before being stopped by debris. After the line was pressure washed two more times, the camera was unable to obtain additional footage because the jetter caused more debris to block the pipe run. It is suspected that this additional debris originated from the abandoned manhole west of MH5-2. This abandoned manhole probably was filled with debris (mainly crushed rock) and left connected to the pipe.

After the amount of debris in the 6-inch concrete pipe running from MH5-2 east was noted, American Pipe Services, Inc., personnel decided to clean the line twice before attempting video inspection. Even after the line was cleaned, the camera reached a distance of only 8 lf east because an offset joint prevented it from traveling further. The pipe was deteriorating and contained water.

All equipment used in the sewer survey task was decontaminated using high-pressure steam/hot water before removal from the site. Based on the analytical results of the water and sediment samples previously collected from the manholes (see Section 2.1.3), decontamination was able to be performed directly over manhole MH5-2.

2.1.3 Manhole Sampling

On June 16, 1999, water and sediment samples were collected from three of the manholes identified as part of the former BOMARC drainage system (MH5-1, MH5-2, and MH5-3) and from the utility manhole MH5-UM. Analytical methods identified in the work plan (E & E 1999d) were developed based on the assumption that a significant volume of water and sediment from each manhole would require off-site disposal during the investigation. However, because of the lack of accumulated sediment and water in the three sewer manholes and the relatively small amount of sediment found in manhole MH5-UM, the corresponding samples were analyzed for VOCs by EPA Method 8260B for characterization purposes only. Because there was a significant amount of water in manhole MH5-UM, a water sample was analyzed for additional parameters (Method 8260B VOCs, Method 8270C BNA, Method 9040B pH, and Method 6010B metals). These parameters were selected for characterization of the water and in accordance with the base's Industrial Waste Discharge Permit issued by Niagara County Sewer District #1 to assess disposal options should the 914th AW opt to abandon this utility manhole in the future.

On July 21, 1999, an additional water sample (MH5-1-W2) was collected from MH5-1 during the sewer video inspection discussed above. Because of debris blocking the lateral line west of MH5-2, water was jetted from MH5-2 to clean the pipes of the debris and allow the camera to continue inspection. However, the blocked section was not opened and the water back-flushed through MH5-2 to manhole MH5-1. More water than what initially was jetted in apparently might have returned. The jetting possibly cleared a portion of the blockage that had trapped additional water. Whether the storm sewer system was still operational and where it discharged were unclear, so water sample MH5-1-W2 was collected to identify any contaminants flushed through the line. This sample also was analyzed for Method 8260B VOCs.

ASC
Analytical Services
Center

All analyses were performed by E & E's Analytical Services Center (ASC) in Lancaster, New York. Laboratory data reports are provided in Appendix B (report Nos. 9906048 and 9907132). Positive analytical results for the storm drain water and sediment samples are summarized in Tables 2-2 and 2-3, respectively.

To provide a framework for comparison, the water sample results were compared to NYSDEC (1998) Class C water standards because the sewer system drains into Cayuga Creek, which is

Table 2-2 Storm Sewer Manhole Water Analytical Results, IRP Site 5, Niagara Falls ARS

Sample ID: / Sample Date:	NYSDEC Class C Fresh Water Standards [a]	MH5-1-W2 7/21/99	MH5-1-WO 6/16/99	MH5-2-WO 6/16/99	MH5-3-WO 6/16/99	MH5-UM-WO 6/16/99
Volatiles by Method 8260B (µg/L)						
Acetone	—	3.6 J	ND	ND	ND	ND
Bromodichloromethane	—	2.7 J	ND	ND	ND	ND
Chloroform	—	4.9 J	ND	ND	ND	ND
Dibromochloromethane	—	1.4 J	ND	ND	ND	ND
Trichloroethene	40	12	3.5 J	4.5 J	ND	ND
Semivolatiles by Method 8270C (µg/L)						
Bis(2-ethylhexyl)phthalate	0.6	NA	NA	NA	NA	5.9 J
Di-n-butyl phthalate	—	NA	NA	NA	NA	4 J
Fluoranthene	—	NA	NA	NA	NA	5.5 J
pH by Method 9040B (s.u.)						
pH	>6.5 and <8.5	NA	NA	NA	NA	6.9
Metals by ICP Method 6010B (µg/L)						
Lead	31[b]	NA	NA	NA	NA	5.41
Zinc	453[b]	NA	NA	NA	NA	785

Note: Shaded values exceed NYSDEC Class C freshwater standard.

[a] NYSDEC 1998.

[b] Class C freshwater class standard type A(C) for protection of fish propagation. The water standard was calculated using an average water hardness of 740 parts per million.

Key:

ARS = Air Reserve Station.
ICP = Inductively coupled plasma.
ID = Identification.
IRP = Installation Restoration Program.
J = Estimated value.
µg/L = Micrograms per liter.
NA = Not analyzed.
ND = Not detected.
NYSDEC = New York State Department of Environmental Conservation.
s.u. = Standard units.
— = Standard or guidance value not available.

Table 2-3 Storm Sewer Manhole Sediment Analytical Results, IRP Site 5, Niagara Falls ARS

Sample ID: / Sample Date:	NYSDEC Soil Cleanup Criteria [a]	MH5-1-SO 6/16/99	MH5-2-SO 6/16/99	MH5-3-SO 6/16/99	MH5-UM-SO 6/16/99
Volatiles by Method 8260B (µg/kg)					
Acetone	200	32.1	47.1	125	134
Carbon disulfide	300	ND	ND	ND	13 J
Trichloroethene	1,500	ND	2.1 J	ND	ND
Pecent moisture	—	50.60	34.00	30.10	63.60

Note: Shaded values exceed soil cleanup objective.

[a] NYSDEC 1994.

Key:

— = No criteria available.
ARS = Air Reserve Station.
ID = Identification.
IRP = Installation Restoration Program.
J = Estimated value.
µg/kg = Micrograms per kilogram.
ND = Not detected.
NYSDEC = New York State Department of Environmental Conservation.

designated as Class C. For screening purposes, the results of the sediment samples collected from the manholes were compared to NYSDEC (1994) soil cleanup objectives. Based on the mode of deposition, these samples are referred to as sediments; however, it is inappropriate to compare their analytical results to NYSDEC sediment screening criteria because these criteria were developed for protection of aquatic life in open channels.

TCE was detected in three of the water samples at concentrations below the NYSDEC surface water standard (see Table 2-2). No VOCs were detected in manholes MH5-3 and MH5-UM. In the second sample from MH5-1 collected during jetting, acetone, bromodichloromethane, chloroform, and dibromochloromethane were detected in addition to TCE. Acetone is a suspected laboratory artifact. The presence of the trihalomethanes is likely a result of using municipal water during jetting because they are common constituents of chlorinated water supplies. Bis(2-ethylhexyl)phthalate, a common laboratory artifact, was detected in sample MH5-UM-WO at a concentration above the Class C standard. Fluoranthene, di-n-butylphthalate, lead, and zinc also were detected in this sample, with zinc exceeding the Class C standard. Three VOCs (acetone, carbon disulfide, and TCE) were detected in the sediment samples at concentrations below the NYSDEC soil cleanup objectives (see Table 2-3).

COC
contaminant of concern

Regarding characterization of the water and sediment, only TCE has been identified as a site-related contaminant of concern (COC). The remaining compounds are naturally occurring materials, ubiquitous anthropogenic substances, or laboratory artifacts.

2.2 Geoprobe Investigation

The Geoprobe investigation at Site 5 was divided into three subtasks as described below, in order to accomplish specific project objectives. E & E's subcontractor, SJB Services, Inc., of Hamburg, New York, performed Geoprobe borehole and well installation. Forty-four Geoprobe boreholes were drilled during this phase of the investigation in July 1999. Twenty-five groundwater samples and 38 subsurface soil samples were collected from these boreholes for chemical analysis. Additionally, six soil samples were collected for geotechnical analyses. Rationale, sample descriptions, and analytical results are presented in the appropriate sections below.

2.2.1 Former BOMARC Bunker Geoprobe Wells

Sixteen temporary wells (GP5-A5 through GP5- H6) were installed in former BOMARC launcher pits from July 19 to 21, 1999, in

order to investigate the bunkers as a possible source of the VOCs found in groundwater samples. Previous investigation (E & E 1999a) determined that the contaminant plume was centered near former BOMARC shelters F5 and F6 (see Figure 2-1 for former shelter locations). However, test pitting revealed no apparent source. Therefore, each launcher pit along the southernmost two rows was investigated to determine whether it was a possible TCE source.

Temporary wells were installed within the sump of each launcher pit by driving temporary steel casing with an expendable drive point to refusal. Several attempts were made at some of the locations because of lack of water in the borehole or refusal at shallow depths. In these cases, the unsuccessful boreholes were abandoned, relocated a few feet away, and redrilled. At launcher pits A5 and C5, refusal was encountered numerous times and the sample point had to be located outside (south) of the firing pit (see Figure 2-1). The average depth of the successfully drilled boreholes was 7 feet below ground surface (BGS). When refusal was reached, a temporary well was installed in each boring. Well construction involved insertion of a 1-inch inner diameter (ID) Schedule 40 polyvinyl chloride (PVC) well casing. Portions of the wells were screened with a 5-foot-long well screen with 0.010-inch slots.

BGS
below ground surface

ID
inner diameter

PVC
polyvinyl chloride

HDPE
high-density polyethylene

Following installation of the temporary wells, the water level was measured and a grab overburden groundwater sample was collected using a dedicated bottom-filling, high-density polyethylene (HDPE) bailer. The annulus around the temporary well was sealed at the surface using bentonite, plastic sheeting, or other suitable material. After sufficient time for the wells to equilibrate, one complete round of water elevation measurements was taken on July 27, 1999, for groundwater mapping purposes (see Section 2.4). The temporary wells were decommissioned by removal of the PVC screen and riser, and grouting of the borehole from the bottom to grade with a mixture of Portland cement and bentonite. A summary of the location and construction information for these temporary wells is provided in Table 2-4.

As soon as sufficient recharge occurred, groundwater samples were collected as discrete grab samples from 15 of the 16 temporary wells. Temporary well GP5-C5 was dry, so no water sample was collected from it. The groundwater samples were analyzed for VOCs by Method 8260B.

Table 2-4 Geoprobe Borehole/Temporary Well Construction Summary — July 1999, IRP Site 5, Niagara Falls ARS

Geoprobe No.	Ground Elevation (feet AMSL)	Location		Depth Drilled (feet BGS)	Date Drilled
		Northing	Easting		
Subsurface Soil Borings					
GP5-69	596.12	1135935	402623.6	15	7/19/99
GP5-70	594.92	1135909	402593.5	13.4	7/19/99
GP5-71	594.99	1135914	402639.1	9	7/19/99
GP5-72	597.66	1135884	402639.1	16.7	7/19/99
GP5-73	597.72	1135885	402613.3	15.7	7/19/99
GP5-74	596.85	1135930	402574.2	14.7	7/19/99
GP5-80	597.36	1135884	402569.1	14	7/20/99
GP5-81	595.16	1135929	402665.4	7.3	7/21/99
GP5-82	596.97	1135893	402686.8	13	7/21/99
GP5-83	597.76	1135855	402641.7	15	7/21/99
GP5-84	598.01	1135935	402549.8	17.5	7/21/99
GP5-85	598.09	1135963	402571	17.5	7/21/99
GP5-86	597.44	1135954	402605.4	15.7	7/21/99
GP5-89	595.99	1136031	402884.9	11.1	7/22/99
GP5-93	597.44	1136003	402623.5	15.8	7/23/99
GP5-94	598.83	1135958	402537	17.01	7/23/99
GP5-95	596.8	1135957	402651.8	16	7/23/99
GP5-96	595.59	1135927	402700	12.9	7/23/99
Sand Lens Temporary Wells					
GP5-75	597.47	1135884	402730.9	13.7	7/20/99
GP5-76	595.93	1135952	402728.3	13.4	7/20/99
GP5-77	596.25	1135961	402815.9	14	7/20/99
GP5-78	596.74	1135718	402624.5	14.5	7/20/99
GP5-79	597.33	1135782	402567.8	14	7/20/99
GP5-87	593.73	1135522	402491.7	6.7	7/22/99
GP5-88	591.5	1135631	402913.2	9.5	7/22/99
GP5-90	596.46	1136034	402734.3	14.5	7/22/99
GP5-91	597.51	1136036	402642.2	15	7/22/99
GP5-92	597.54	1135972	402615.2	14.9	7/22/99
BOMARC Bunker Temporary Wells					
GP5-A5	599.01	1135936	402146.6	8.3	7/22/99
GP5-A6	600.23	1135871	402154.8	7.7	7/22/99
GP5-B5	599.47	1135951	402234.2	6.5	7/21/99
GP5-B6	599.06	1135875	402243.9	6.8	7/22/99
GP5-C5	598.11	1135935	402318.8	9	7/21/99
GP5-C6	599.31	1135865	402321.6	7	7/21/99
GP5-D5	598.53	1135965	402420.6	7	7/21/99
GP5-D6	599.56	1135879	402408.1	7.4	7/21/99
GP5-E5	597.56	1135955	402489.5	6.5	7/21/99
GP5-E6	597.7	1135860	402511.1	7.5	7/21/99
GP5-F5	597.63	1135952	402589.8	7.5	7/21/99
GP5-F6	597.25	1135878	402587.1	6	7/19/99
GP5-G5	596.99	1135953	402670	6.5	7/20/99
GP5-G6	597.54	1135879	402671.4	5.8	7/19/99
GP5-H5	596.95	1135958	402774.7	6.5	7/20/99
GP5-H6	597.46	1135882	402767	approx. 6	7/20/99

Key:

AMSL = Above mean sea level.
approx. = Approximately.
ARS = Air Reserve Station.
BGS = Below ground surface.
BOMARC = Boeing/Michigan Aeronautical Research Center.
IRP = Installation Restoration Program.

A summary of the positive analytical results for the groundwater samples from the BOMARC bunkers is presented in Table 2-5. Laboratory data reports are provided in Appendix B (laboratory report Nos. 9907118, 9907131, 9907142, and 9907173). The groundwater analytical results were compared to NYSDEC (1998) Class GA groundwater standards. Three VOCs (benzene; chlorobenzene; and cis-1,2-DCE) were detected in the groundwater samples, with at least one of these compounds detected in five of the 15 samples. Benzene was detected above its NYSDEC Class GA groundwater standard in three samples (GP5-D5, GP5-D6, and GP5-E6), and chlorobenzene was detected above its standard in one of these samples (GP5-E6). No VOCs were detected in 10 of the bunker groundwater samples.

In general, VOC concentrations were low in all bunker samples compared to those detected in groundwater in the main plume area. Additionally, no TCE, which is the main component of the contaminant plume being investigated, was detected in any of the samples. Therefore, the former BOMARC launcher pits apparently are not the source of contamination.

2.2.2 Delineation of Subsurface Soil Contamination

From July 19 to 23, 1999, 18 soil borings (GP5-69 through GP5-74, GP5-80 through GP5-86, GP5-89, and GP5-93 through GP5-96) were drilled in order to delineate the horizontal and vertical extent of subsurface soil contamination in the main plume are a northwest of Building 920. Continuous soil cores were collected at each location using a Geoprobe Macro-Core sampler equipped with an acetate sleeve. The soil cores were logged and screened for organic vapors with a flame ionization detector (FID) by an E & E geologist. Geoprobe borehole logs are provided in Appendix D. A summary of the elevations, locations, and depths sampled for the boreholes is provided in Table 2-4.

FID
flame ionization detector

Samples were collected for geotechnical testing and VOC analysis. Table 2-6 provides a summary of the subsurface soil samples collected for chemical analysis during Geoprobe borehole installation. Sample selection was based on visual observation, relative depth, lithology, location, and FID readings. Samples were collected from each of the identified overburden units (lacustrine clay, sand, and glacial till). Thirty-eight soil samples were submitted to E & E's ASC for Method 8021B VOC analysis. A rapid-turnaround, screening-level analysis was employed so that VOC screening results from the soil samples collected one day could be used to preliminarily define the limits of contamination and select

Table 2-5 Groundwater Analytical Results for Former BOMARC Bunker Samples, IRP Site 5, Niagara Falls ARS

Sample ID: / Sample Date:	NYSDEC Class GA Groundwater Standards [a]	GP5-A5-WO 7/27/99	GP5-A6-WO 7/22/99	GP5-B5-WO 7/22/99	GP5-B6-WO 7/22/99	GP5-C6-WO 7/22/99
Volatiles by Method 8260B (µg/L)						
Benzene	1	ND	ND	ND	ND	ND
Chlorobenzene	5	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	5	ND	ND	ND	ND	ND

Table 2-5 Groundwater Analytical Results for Former BOMARC Bunker Samples, IRP Site 5, Niagara Falls ARS

Sample ID: / Sample Date:	NYSDEC Class GA Groundwater Standards [a]	GP5-D5-WO 7/22/99	GP5-D6-WO 7/21/99	GP5-E5-WO 7/21/99	GP5-E6-WO 7/21/99	GP5-F5-WO 7/21/99
Volatiles by Method 8260B (µg/L)						
Benzene	1	2.6 J	6.83	ND	3.4 J	ND
Chlorobenzene	5	ND	4.7 J	ND	27.9	ND
cis-1,2-Dichloroethene	5	ND	0.85 J	ND	ND	1.2 J

Table 2-5 Groundwater Analytical Results for Former BOMARC Bunker Samples, IRP Site 5, Niagara Falls ARS

Sample ID: / Sample Date:	NYSDEC Class GA Groundwater Standards [a]	GP5-F6-WO 7/20/99	GP5-G5-WO 7/21/99	GP5-G6-WO 7/20/99	GP5-H5-WO 7/21/99	GP5-H6-WO 7/20/99
Volatiles by Method 8260B (µg/L)						
Benzene	1	ND	ND	ND	0.6 J	ND
Chlorobenzene	5	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	5	ND	ND	ND	ND	ND

Note: Shaded values exceed groundwater standard.

[a] NYSDEC 1998.

Key:

ARS = Air Reserve Station.

BOMARC = Boeing/Michigan Aeronautical Research Center.

ID = Identification.

IRP = Installation Restoration Program.

J = Estimated value.

µg/L = Micrograms per liter.

ND = Not detected.

NYSDEC = New York State Department of Environmental Conservation.

Table 2-6 Geoprobe Subsurface Soil Sample Collection Summary — July 1999

Geoprobe Location	Soil Sample No.	Sample Date	Sample Depth (feet BGS)	FID Reading (ppm)	Analysis	Sample Description
GP5-69	GP5-69A-SO	7/19/99	9.5-11	10	VOCs	Clay: red/brown, tight, moist, some greenish sandy layers.
GP5-69	GP5-69B-SO	7/19/99	11.8-12.3	8	VOCs	Sand: orange/brown with silt/clay and trace gravel, saturated.
GP5-70	GP5-70C-SO	7/19/99	10.8-11.3	2	VOCs	Till: red/brown gravel with fine sand and silt, wet.
GP5-71	GP5-71B-SO	7/19/99	6-6.5	10	VOCs	Fine-grained sand: brown, saturated.
GP5-72	GP5-72B-SO	7/19/99	10.7-11.1	0	VOCs	Sand: red/brown, moderately tight, nonplastic, saturated.
GP5-72	GP5-72C-SO	7/19/99	16-16.7	0	VOCs	Till: red/brown till with sand/clay matrix surrounded by subangular gravel, wet.
GP5-73	GP5-73A-SO	7/19/99	9-9.6	0	VOCs	Clay: red/brown with some greenish sandy laminations, tight, slightly moist.
GP5-73	GP5-73C-SO	7/19/99	12-13	5	VOCs	Till: red/brown till with sand/clay matrix surrounded by subangular gravel, wet.
GP5-74	GP5-74C-SO	7/19/99	14.3-14.5	2	VOCs	Till: red/brown till with sand/clay matrix surrounded by subangular gravel, wet.
GP5-80	GP5-80A-SO	7/21/99	4.9-5.1	0	VOCs	Clay: red/brown, tight, moist, some orange mottling.
GP5-80	GP5-80B-SO	7/21/99	10.3-10.8	0	VOCs	Sand: red and clayey, well-sorted, wet.
GP5-80	GP5-80C-SO	7/21/99	11.3-11.8	0	VOCs	Till: red/brown with sandy clay matrix and coarse gravel.
GP5-81	GP5-81A-SO	7/21/99	7-7.3	0	VOCs	Clay: red/brown with gray mottling, tight, moist.
GP5-82	GP5-82A-SO	7/21/99	8-8.7	NA	VOCs	Clay: brown, plastic, moist
GP5-82	GP5-82B-SO	7/21/99	9-9.4	NA	VOCs	Sand: red/brown fine clayey sand, wet.
GP5-82	GP5-82C-SO	7/21/99	12.5-13	NA	VOCs	Till: red/brown clayey fine sand with coarse pebble size gravel, wet, loose.
GP5-83	GP5-83A-SO	7/21/99	11.3-11.8	0	VOCs	Clay: red brown with orange and gray laminations, tight, moist.
GP5-83	GP5-83C-SO	7/21/99	14.5-15	0	VOCs	Till: red/brown clayey sand with pebble- to cobble-size gravel, wet.
GP5-84	GP5-84A-SO	7/21/99	2-5.3	0	VOCs	Clay: red/brown with trace gravel, some laminations, moist.
GP5-84	GP5-84B-SO	7/21/99	11.7-12	0	VOCs	Sandy clay: plastic, some gray layers.

Table 2-6 Geoprobe Subsurface Soil Sample Collection Summary — July 1999

Geoprobe Location	Soil Sample No.	Sample Date	Sample Depth (feet BGS)	FID Reading (ppm)	Analysis	Sample Description
GP5-84	GP5-84C-SO	7/21/99	14-14.5	0	VOCs	Till: red/brown clayey sand with pebble- to cobble-size gravel, wet.
GP5-85	GP5-85A-SO	7/21/99	5.3-5.8	0	VOCs	Clay: red with some gravel, some sandy layers, tight, moist.
GP5-85	GP5-85A-SO DUP	7/21/99	5.3-5.8	0	VOCs	Clay: red with some gravel, some sandy layers, tight, moist.
GP5-85	GP5-85C-SO	7/21/99	12.8-13.3	NA	VOCs	Till: red with sandy clay matrix and limestone gravel, wet.
GP5-86	GP5-86A-SO	7/21/99	13.2-13.7	0	VOCs	Clay: red, brown sandy laminations.
GP5-86	GP5-86B-SO	7/21/99	13.9-14.1	2	VOCs	Sand: fine, brown with clay, saturated.
GP5-86	GP5-86C-SO	7/21/99	15-15.7	NA	VOCs	Till: red with sandy clay matrix and limestone gravel, wet.
GP5-93	GP5-93A-SO	7/23/99	9-9.3	0	VOCs	Clay: red/brown, tight, hard, trace gravel and sand, moist.
GP5-93	GP5-93B-SO	7/23/99	10-12	0	VOCs	Sand: brown, fine to medium, wet.
GP5-93	GP5-93C-SO	7/23/99	14.7-15.7	NA	VOCs	Till: red sandy clay with pebble- to cobble-size limestone gravel.
GP5-94	GP5-94A-SO	7/23/99	5.5-6	1.5	VOCs	Clay: red with some gray mottling and laminations, hard, tight, moist.
GP5-94	GP5-94C-SO	7/23/99	16-16.5	0	VOCs	Till: red with sandy clay matrix and limestone gravel, wet.
GP5-95	GP5-95A-SO	7/23/99	9-10	0	VOCs	Clay: red, sandy laminations, wet.
GP5-95	GP5-95B-SO	7/23/99	11.7-13.2	0	VOCs	Sand: brown, fine, clayey, wet.
GP5-95	GP5-95C-SO	7/23/99	14-16	NA	VOCs	Till: red, sandy clay matrix with limestone gravel.
GP5-96	GP5-96A-SO	7/23/99	4-7	NA	VOCs	Clay: red orange clay with some sand and gravel, tight, slightly plastic, moist.
GP5-96	GP5-96B-SO	7/23/99	7.8-9.5	0.5	VOCs	Sand: brown, silty, wet.
GP5-96	GP5-96C-SO	7/23/99	10-12	0	VOCs	Till: red sandy clay with limestone gravel, wet.

Key:

BGS	=	Below ground surface.
FID	=	Flame ionization detector.
NA	=	Not available.
ppm	=	Parts per million.
VOCs	=	Volatile organic compounds.

GC
gas chromatography

MS
mass spectrometry

TAGM
Technical and Administrative Guidance Memorandum

µg/kg
micrograms per kilogram

subsequent borehole locations the following day. Method 8021B describes the procedure for VOC analysis by gas chromatography (GC), while Method 8260B uses GC/mass spectrometry (MS). The same list of compounds can be identified using both methods, but identification is more certain using Method 8260B because GC/MS uses mass spectra in addition to retention time on the GC. The GC method is more sensitive, allowing lower quantitation limits. However, GC/MS provides the ability to tentatively identify nontarget compounds based on the mass spectra. When used for screening purposes, samples run under Method 8021B usually are not reanalyzed at secondary dilutions if target compound concentrations exceed the calibrated range.

Table 2-7 provides a summary of positive analytical data for the Geoprobe subsurface soil samples. Laboratory data reports are provided in Appendix B (laboratory Nos. 9907105,.9907130, and 9907151). The subsurface soil analytical results were compared to NYSDEC (1994) Technical and Administrative Guidance Memorandum (TAGM) 4046 soil cleanup objectives. At least one VOC was detected in 23 of the 38 subsurface soil samples, with 20 samples having at least one VOC detected above NYSDEC soil cleanup criteria. TCE was detected in 21 samples: 10 from the till layer, six from the sand layer, and five from the clay layer. Eighteen of these 21 samples contained TCE at concentrations exceeding the recommended cleanup objective of 700 micrograms per kilogram (μg/kg). cis-1,2-DCE was detected in four samples, all of which were collected from the till layer. Two of these four samples contained cis-1,2-DCE at concentrations above the NYSDEC standard. Bromoform and bromomethane were detected in one sample each at concentrations exceeding their criteria. Other detected VOCs included ethylbenzene, toluene, and total xylenes. In general, the frequency of positive VOC results increases with depth, with the clay and sand layers having the same number of VOCs detected above NYSDEC criteria. Additional discussion and corresponding illustrations pertaining to these analytical results are provided in Section 3.

Two samples from each of the three overburden layers (clay, sand, and till) were submitted to GZA GeoEnvironmental in Buffalo, New York, for geotechnical analysis in order to confirm the field identifications and provide data regarding grain size distribution of each unit. Geotechnical results are provided in Appendix E. The samples from the clay layer were classified as brown or dark brown lean clay. Samples collected from the sand lens were classified as light brown silty sand or sandy silt. Finally, the till samples were classified as brown sandy silty clay (see Appendix E). Because of

Table 2-7 Analytical Results for Subsurface Soil Samples, IRP Site 5, Niagara Falls ARS

Sample ID: / Sample Date:	NYSDEC Soil Cleanup Criteria [a]	GP5-69A-SO-071999	GP5-69B-SO-071999	GP5-70C-SO-071999	GP5-71B-SO-071999	GP5-72B-SO-071999
Volatiles by Method 8021B (µg/kg)						
Bromoform	60	ND	ND	ND	ND	ND
Bromomethane	5	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	300	ND	ND	ND	ND	ND
Ethylbenzene	5,500	ND	ND	ND	ND	ND
Toluene	1,500	ND	ND	ND	ND	ND
Trichloroethene	700	14,700 N	25,900 N	17,500 N	24,700 N	1,670 N
Xylenes, total	1,200	ND	ND	ND	ND	ND

Table 2-7 Analytical Results for Subsurface Soil Samples, IRP Site 5, Niagara Falls ARS

Sample ID: / Sample Date:	NYSDEC Soil Cleanup Criteria [a]	GP5-72C-SO-071999	GP5-73A-SO-071999	GP5-73C-SO-071999	GP5-74C-SO-071999	GP5-80A-SO-072199
Volatiles by Method 8021B (µg/kg)						
Bromoform	60	ND	ND	ND	ND	ND
Bromomethane	5	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	300	ND	ND	ND	ND	ND
Ethylbenzene	5,500	ND	ND	ND	ND	ND
Toluene	1,500	ND	ND	ND	ND	ND
Trichloroethene	700	7,150 N	ND	203 N	28,500 N	ND
Xylenes, total	1,200	ND	ND	ND	ND	ND

Table 2-7 Analytical Results for Subsurface Soil Samples, IRP Site 5, Niagara Falls ARS

Sample ID: / Sample Date:	NYSDEC Soil Cleanup Criteria [a]	GP5-80B-SO-072199	GP5-80C-SO-072199	GP5-81A-SO-072199	GP5-82A-SO-072199	GP5-82B-SO-072199
Volatiles by Method 8021B (µg/kg)						
Bromoform	60	ND	ND	ND	ND	ND
Bromomethane	5	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	300	ND	738 N	ND	ND	ND
Ethylbenzene	5,500	135 N	ND	ND	ND	ND
Toluene	1,500	278 N	ND	ND	ND	ND
Trichloroethene	700	ND	ND	9,230 N	ND	ND
Xylenes, total	1,200	872 N	ND	ND	ND	ND

Table 2-7 Analytical Results for Subsurface Soil Samples, IRP Site 5, Niagara Falls ARS

Sample ID: / Sample Date:	NYSDEC Soil Cleanup Criteria [a]	GP5-82C-SO-072199	GP5-83A-SO-072199	GP5-83C-SO-072199	GP5-84A-SO-072199	GP5-84B-SO-072199
Volatiles by Method 8021B (µg/kg)						
Bromoform	60	ND	ND	ND	ND	ND
Bromomethane	5	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	300	67 J	ND	ND	ND	ND
Ethylbenzene	5,500	ND	ND	ND	ND	ND
Toluene	1,500	ND	ND	ND	ND	ND
Trichloroethene	700	2,570 N	ND	ND	ND	5,110 N
Xylenes, total	**1,200**	**ND**	**ND**	**ND**	**ND**	**ND**

Table 2-7 Analytical Results for Subsurface Soil Samples, IRP Site 5, Niagara Falls ARS

Sample ID: / Sample Date:	NYSDEC Soil Cleanup Criteria [a]	GP5-84C-SO-072199	GP5-85A-SO-072199	GP5-85A-SO-072199 DUP	GP5-85C-SO-072199	GP5-86A-SO-072199
Volatiles by Method 8021B (µg/kg)						
Bromoform	60	ND	ND	ND	ND	ND
Bromomethane	5	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	300	303 N	ND	ND	ND	ND
Ethylbenzene	5,500	ND	ND	ND	ND	ND
Toluene	1,500	ND	ND	ND	ND	ND
Trichloroethene	700	601 N	ND	ND	4,550 N	87,800 N
Xylenes, total	1,200	ND	ND	ND	ND	ND

Table 2-7 Analytical Results for Subsurface Soil Samples, IRP Site 5, Niagara Falls ARS

Sample ID: / Sample Date:	NYSDEC Soil Cleanup Criteria [a]	GP5-86B-SO-072199	GP5-86C-SO-072199	GP5-93A-SO-072399	GP5-93B-SO-072399	GP5-93C-SO-072399
Volatiles by Method 8021B (µg/kg)						
Bromoform	60	ND	ND	ND	ND	ND
Bromomethane	5	ND	3,920 N	ND	ND	ND
cis-1,2-Dichloroethene	300	ND	ND	ND	ND	ND
Ethylbenzene	5,500	ND	ND	ND	ND	ND
Toluene	1,500	ND	ND	ND	ND	ND
Trichloroethene	700	42,100 N	38,400 N	726 N	ND	ND
Xylenes, total	**1,200**	**ND**	**ND**	**ND**	**ND**	**ND**

Table 2-7 Analytical Results for Subsurface Soil Samples, IRP Site 5, Niagara Falls ARS

Sample ID: / Sample Date:	NYSDEC Soil Cleanup Criteria [a]	GP5-94A-SO-072399	GP5-94C-SO-072399	GP5-95A-SO-072399	GP5-95B-SO-072399	GP5-95C-SO-072399
Volatiles by Method 8021B (µg/kg)						
Bromoform	60	ND	ND	172 N	ND	ND
Bromomethane	5	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	300	ND	ND	ND	ND	203 N
Ethylbenzene	5,500	ND	ND	ND	ND	ND
Toluene	1,500	ND	ND	ND	ND	ND
Trichloroethene	700	ND	ND	951 N	1,510	2,280 N
Xylenes, total	1,200	ND	ND	ND	ND	ND

Table 2-7 Analytical Results for Subsurface Soil Samples, IRP Site 5, Niagara Falls ARS

Sample ID: Sample Date:	NYSDEC Soil Cleanup Criteria [a]	GP5-96A-SO-072399	GP5-96B-SO-072399	GP5-96C-SO-072399
Volatiles by Method 8021B (µg/kg)				
Bromoform	60	ND	ND	ND
Bromomethane	5	ND	ND	ND
cis-1,2-Dichloroethene	300	ND	ND	ND
Ethylbenzene	5,500	ND	ND	ND
Toluene	1,500	ND	ND	ND
Trichloroethene	700	ND	ND	200 N
Xylenes, total	1,200	ND	ND	ND

Note 1: These results are based on a screenining level VOC analysis.

Note 2: Shaded values exceed soil cleanup objective.

[a] NYSDEC 1994.

Key:

ARS = Air Reserve Station.

ID = Identification.

IRP = Installation Restoration Program.

J = Estimated value.

µg/kg = Micrograms per kilogram.

N = Not confirmed on second column.

ND = Not detected.

NYSDEC = New York State Department of Environmental Conservation.

the sampling methods employed, the grain size distribution of the till is skewed toward the fine-grained material. Gravel and cobbles are not retrieved easily with Macro-Core or split-spoon samplers. Therefore, a more accurate description of the till unit may be sandy silty clay with gravel. In addition to grain size analyses, Atterberg limits were determined for each sample. These limits define the liquid limit, plastic limit, and plasticity index of soil and aid in classification of the soil samples. The clay samples exhibited medium plasticity, and the till samples exhibited low plasticity.

2.2.3 Delineation of the Sand Lens

Ten temporary wells (GP5-75 through GP5-79, GP5-87, GP5-88, and GP5-90 through GP5-92) were installed from July 20 to 22, 1999, to more accurately delineate the sand lens identified during previous investigations (E & E 1999a). Continuous soil cores were collected at each location using a Geoprobe Macro-Core sampler equipped with an acetate sleeve. The soil cores were logged and screened for organic vapors with an FID by an E & E geologist. Soil cores were collected until refusal was encountered, which generally occurred in the gravelly till at an average depth of 13 feet BGS. Groundwater was encountered at depths ranging from 4.7 feet to 9.7 feet BGS (see Table 2-8).

When refusal was reached, a temporary well was installed in each boring. Well construction involved installation of a 1-inch ID Schedule 40 PVC well casing and 5-foot-long well screen with 0.010-inch slots. Following installation of each temporary well, the water level was measured and an overburden groundwater sample was collected using a dedicated bottom-filling HDPE bailer. After sufficient time for the wells to equilibrate, one complete round of water elevation measurements was taken on July 27, 1999, for groundwater mapping purposes (see Section 3.2). The temporary wells were decommissioned by removing the PVC screen and casing and filling the borehole with a mixture of Portland cement and bentonite. A summary of the location and construction of these temporary wells is provided in Table 2-4. Geoprobe borehole logs are provided in Appendix D.

Groundwater samples were collected from each temporary well, except for GP5-87, which was dry. Samples were collected without purging and as soon as sufficient recharge had occurred after installation. Samples were submitted for Method 8021B VOC rapid-turnaround screening analysis. The borehole/well locations were sampled over two days; therefore, VOC screening results from the groundwater samples collected the first day were used to

Table 2-8 Groundwater Elevation Summary for Temporary Geoprobe Wells and Permanent Monitoring Wells, IRP Site 5, Niagara Falls ARS

Well/ Geoprobe ID	Reference Elevation[a]	7/27/99 Water Level Elevation (ft AMSL)	8/31/99 Water Level Elevation (ft AMSL)	9/9/99 Water Level Elevation (ft AMSL)
Sand Lens Temporary Wells				
GP5-75	597.47	587.76	587.26	—
GP5-76	595.93	587.98	586.4	—
GP5-77	596.25	588.11	589.59	—
GP5-78	596.74	587.51	585.88	—
GP5-79	597.33	590.43	586.76	—
GP5-87	593.73	588.8	Dry	—
GP5-88	591.5	586.82	585.39	—
GP5-90	596.46	588.26	586.89	—
GP5-91	597.51	588.15	586.81	—
GP5-92	597.54	587.91	586.18	—
BOMARC Bunker Temporary Wells				
GP5-A5	599.01	591.39	Dry	—
GP5-A6	600.23	594.99	595.02	—
GP5-B5	599.47	594.27	594.15	—
GP5-B6	599.06	594.81	594.68	—
GP5-C5	598.11	Dry	Dry	—
GP5-C6	599.31	594.3	594.17	—
GP5-D5	598.53	593.6	593.39	—
GP5-D6	599.56	594.28	594.28	—
GP5-E5	597.56	592.93	592.84	—
GP5-E6	597.7	592.61	592.42	—
GP5-F5	597.63	592.97	592.79	—
GP5-F6	597.25	593.57	593.41	—
GP5-G5	596.99	592.87	592.71	—
GP5-G6	597.54	593.17	593.18	—
GP5-H5	596.95	593.01	592.59	—
GP5-H6	597.46	593	592.94	—
Monitoring Wells				
MW5-1A	600.42	587.34	—	585.97
MW5-1DA	600.07	586.37	—	585.97
MW5-1E	596.39	582.14	—	580.71
MW5-2D	600.8	586.52	—	585.96
MW5-3D	600.5	586.32	—	585.8
MW5-4	599.42	586.43	—	585.88

Table 2-8 Groundwater Elevation Summary for Temporary Geoprobe Wells and Permanent Monitoring Wells, IRP Site 5, Niagara Falls ARS

Well/ Geoprobe ID	Reference Elevation[a]	7/27/99 Water Level Elevation (ft AMSL)	8/31/99 Water Level Elevation (ft AMSL)	9/9/99 Water Level Elevation (ft AMSL)
MW5-4D	597.34	586.36	—	590.09
MW5-5A	600.8	586.33	—	585.94
MW5-5D	597.12	586.57	—	586.19
MW5-6	596.42	—	—	586.86
MW5-6D	594.94	587.62	—	586.92
MW5-7	596.46	—	—	586.8
MW5-7D	595.14	587.65	—	586.94
MW5-8	594.25	—	—	585.24
MW5-8D	592.68	586.2	—	585.39

[a] Reference elevation for Geoprobe wells is feet below ground surface, and reference elevation for monitoring wells is feet from top of inner casing.

Key:

AMSL = Above mean sea level.
ARS = Air Reserve Station.
BOMARC = Boeing/Michigan Aeronautical Research Center.
ft = Feet.
GP = Geoprobe temporary well.
ID = Identification.
IRP = Installation Restoration Program.
MW = Monitoring well.
— = Elevation not available (water level not measured or well not installed at time of measurement).

select subsequent borehole locations. Table 2-9 summarizes the positive analytical results, and Appendix B contains the laboratory data reports (laboratory report Nos. 9907117, 9907141, and 9907151).

The groundwater analytical results were compared to NYSDEC Class GA groundwater standards. VOCs were present in six of the nine samples, with at least one VOC detected above NYSDEC Class GA groundwater standards in each sample. With five VOCs detected above NYSDEC standards, the sample collected from GP5-78-WO was the most contaminated sample analyzed. TCE exceeded its standard in four of the five samples in which it was detected. cis-1,2-DCE and benzene concentrations exceeded their standards in all samples in which they were detected. Other VOCs detected above NYSDEC standards included bromoform, ethylbenzene, toluene, and total xylenes. MTBE also was found in one sample. Additional discussion and corresponding illustrations pertaining to these analytical results are provided in Section 3.

2.3 Overburden Monitoring Wells

2.3.1 Well Installation

Based on the distribution of the TCE plume and the pattern of groundwater flow delineated during the Geoprobe investigation, three new overburden monitoring wells were installed in order to study the extent of the contaminant plume further and to provide long-term groundwater monitoring locations. The new monitoring wells (MW5-6, MW5-7, and MW5-8) were drilled by advancing 4.25-inch ID hollow-stem augers to the top of bedrock. Continuous split-spoon samples were collected from the MW5-7 and MW5-8 borings. However, because of its proximity to wells MW5-5D and MW5-1E, continuous sampling at MW5-6 started at 8 feet BGS. For the top 8 feet of boring MW5-6, well logs from MW5-1E or MW5-5D are applicable. Each borehole was logged by a field geologist and screened for organic vapors with an FID.

The wells were constructed with 4 feet of a 2-inch ID Schedule 40 PVC screen with 0.010-inch slots. In wells MW5-7 and MW5-8, the screen was installed at the bottom of the borehole because a layer of native till remained at the bottom after augering. In well MW5-6, the screen was installed on top of a 0.5-foot-thick bentonite seal. A threaded PVC plug was fitted on the bottom of the screen, and a flush-joint, threaded PVC riser was installed above the screen. The well screen was surrounded by a chemically inert, fine-grained silica sand filter pack (Morie No. 0 sand). A

Table 2-9 Groundwater Analytical Results for Sand Lens Geoprobe Wells, IRP Site 5, Niagara Falls ARS

Sample ID: Sample Date:	NYSDEC Class GA Groundwater Standards[a]	GP5-75-WO 7/20/99	GP5-76-WO 7/20/99	GP5-77-WO 7/20/99	GP5-78-WO 7/20/99	GP5-79-WO 7/20/99
Volatiles by Method 8021B (µg/L)						
Benzene	1	ND	1.54	ND	ND	ND
Bromoform	5	5.17	ND	ND	ND	ND
cis-1,2-Dichloroethene	5	130	ND	ND	1,080	26.7
Ethylbenzene	5	ND	ND	ND	670	ND
Methyl tert-butyl ether	10[b]	ND	ND	ND	ND	1.9
Toluene	5	ND	3	ND	482	1.04
Trichloroethene	5	24.3	4.9	ND	192	77.7
Xylenes, total	5	ND	2.97	ND	3,690	ND

Table 2-9 Groundwater Analytical Results for Sand Lens Geoprobe Wells, IRP Site 5, Niagara Falls ARS

Sample ID: / Sample Date:	NYSDEC Class GA Groundwater Standards[a]	GP5-88-WO 7/22/99	GP5-90-WO 7/22/99	GP5-91-WO 7/22/99	GP5-92-WO 7/23/99
Volatiles by Method 8021B (µg/L)					
Benzene	1	1.18	ND	ND	ND
Bromoform	5	ND	ND	ND	ND
cis-1,2-Dichloroethene	5	ND	ND	ND	ND
Ethylbenzene	5	ND	ND	ND	ND
Methyl tert-butyl ether	10[b]	ND	ND	ND	ND
Toluene	5	1.83	ND	ND	ND
Trichloroethene	**5**	**ND**	**ND**	**ND**	**4,660 N**
Xylenes, total	**5**	**ND**	**ND**	**ND**	**ND**

Note 1: These results are based on a screening level VOC analysis.

Note 2: Shaded values exceed groundwater standard.

[a] NYSDEC 1998.

[b] Guidance value.

Key:

ARS = Air Reserve Station.
GA =
ID = Identification.
IRP = Installation Restoration Program.
µg/L = Micrograms per liter.
N = Not confirmed on second column.
ND = Not detected.
NYSDEC = New York State Department of Environmental Conservation.

2-foot-thick bentonite seal was installed above the filter pack to provide protection from infiltration from above. The remainder of the well annulus was filled to grade with grout. Grout consisted of Portland cement (Type I/II) with approximately 5% bentonite by weight. The wells were completed with locked, watertight well caps; a flush-mount protective cover; and a concrete drainage pad. All wells were secured with padlocks that were keyed alike. A summary of the locations and construction of these permanent wells is provided in Table 2-10. Well boring logs are provided in Appendix F.

2.3.2 Well Development

Following completion of the drilling program, the three new monitoring wells were developed by surging and evacuation in accordance with Section 4.6.5 of E & E's 1995 work plan. Well development was performed to stabilize the filter packs, remove fine-grained particles from the wells, and generally restore natural groundwater flow in the vicinity of the wells. The wells were surged with a stainless steel bailer, and water was removed from each well using either a bailer or pump. Development continued until water quality parameters, including temperature, specific conductance, and turbidity, stabilized. During development, the pH probe was inoperative; therefore, stability of pH was checked before groundwater sampling. A summary of the development method used, the volume of water removed, and the final water quality parameters for each well is provided in Table 2-11. Well development water was containerized, sampled, and disposed of as described in Appendix C.

2.3.3 Aquifer Testing

On October 20, 1999, E & E performed aquifer tests on the three new wells at Site 5 using the rising-head slug test method. The purpose of the slug tests was to determine the horizontal hydraulic conductivity (K value) of the aquifer immediately adjacent to the sand filter pack of each well. These data will be useful in characterizing the groundwater flow dynamics across the site.

The rising-head slug tests involved removing a known volume of water from the well. Data collection was initiated at the time of slug removal, and water level measurements were taken at predetermined time intervals on a logarithmic scale as the water level rose to its initial static level. Water level response data were collected using an In-Situ, Inc., Hermit 2000 data logger and pressure transducer system. The tests were completed when the water level returned to at least 95% of its initial static level, or when no significant change in head was recorded over 0.5 hour.

Table 2-10 Monitoring Well Construction Summary — September 1999
IRP Site 5, Niagara Falls ARS

Well No.	Location		Completion Date	Depth to Bedrock (feet BGS)	Total Depth Drilled (feet BGS)	Screen Interval (feet BGS)	Sand Pack Interval (feet BGS)	Bentonite Interval (feet BGS)	Inner Casing Stickup (feet)	Ground Elevation (feet AMSL)	Top of Inner Casing Elevation (feet AMSL)
	Northing	Easting									
MW5-6	1,135,903.84	402,597.90	9/2/99	15.5	15	9.5 - 13.5	7.0 - 14.5	5-7	-0.22	596.64	596.42
MW5-7	1,135,901.15	402,787.80	9/2/99	13.5	13.5	8.5 - 12.8	6.0 - 13.4	4-6	-0.17	596.63	596.46
MW5-8	1,135,671.96	402,559.08	9/2/99	12.2	11.3	6.7 - 10.7	5.0 - 11.2	3-5	-0.3	594.55	594.25

Key:

AMSL = Above mean sea level.
ARS = Air Reserve Station.
BGS = Below ground surface.
IRP = Installation Restoration Program.

Table 2-11 Monitoring Well Development Summary—September 1999, IRP Site 5, Niagara Falls ARS

Well No.	Development Date	Development Method	Volume Removed (gallons)	Number of Well Volumes Removed	Temperature (°F)	pH (s.u.)	Conductivity (µS/cm)	Turbidity (NTU)
MW5-6	9/8/99	Hand PVC pump/bailer evacuate and surge	12	24	71.8	7.16[a]	1,217	>1,000
MW5-7	9/8/99	Stainless steel bailer surge/ evacuate	5	10	69.9	7.07[a]	1,738	>1,000
MW5-8	9/8/99	Stainless steel bailer surge/ evacuate	1.5	3.8	73.9	7.32[a]	1,260	488

[a]pH meter malfunctioned.

Key:

ARS = Air Reserve Station.
°F = Degrees Fahrenheit.
IRP = Installation Restoration Program.
µS/cm = MicroSiemens per centimeter.
MW = Monitoring well.
NTU = Nephelometric turbidity units.
PVC = Polyvinyl chloride.
s.u. = Standard units.

All instrumentation introduced into the well was decontaminated thoroughly before use.

Data collected during slug testing was downloaded to a computer using the Data Transfer package by In-Situ, Inc. The data then were processed and interpreted using AQTESOLV (HydroSOLVE, Inc. 1998). The interpretation method of Bouwer and Rice (1976) was used for all wells.

Table 2-12 provides a summary of the aquifer test results, and Appendix G presents the graphs from which the conductivities and transmissivities were derived.

cm/s
centimeters per second

The three overburden wells tested (MW5-6, MW5-7, and MW5-8) exhibited hydraulic conductivities that ranged from 1.3×10^{-4} to 2×10^{-2} centimeters per second (cm/s). The conductivities for wells MW5-7 and MW5-8 were consistent with those calculated for other wells constructed in the till. The hydraulic conductivity calculated for well MW5-6 was two orders of magnitude higher and is considered representative of the sand lens.

2.3.4 Groundwater Sampling

Eleven existing monitoring wells, including the three new overburden wells discussed above, were sampled for VOCs in September 1999 as part of the Installation-Wide Groundwater Monitoring Project (RVKQ 99-0658). Sample collection,

Table 2-12 Aquifer Testing Results — October 20, 1999
IRP Site 5, Niagara Falls ARS

Well No.	Well Type	Slug Test Method	Hydraulic Conductivity (ft/min)	Hydraulic Conductivity (cm/s)	Transmissivity (cm^2/s)
MW5-6	Overburden	Rising head	3.87E-02	1.97E-02	5.99E-01
MW5-7	Overburden	Rising head	4.19E-04	2.13E-04	3.89E-02
MW5-8	Overburden	Rising head	2.51E-04	1.28E-04	2.33E-02

Key:

ARS = Air Reserve Station.
cm/s = Centimeters per second.
cm^2/s = Centimeters squared per second.
ft/min = Feet per minute.
IRP = Installation Restoration Program.

handling, containerization, preservation, and custody procedures, as well as decontamination, were performed in accordance with the regulator-approved work plan (E & E 1995) and work plan amendment (E & E 1999e). A detailed discussion of these procedures can be found in these documents. All analyses were performed by E & E's ASC in accordance with Method 8260B.

Groundwater samples from the three new monitoring wells were collected no sooner than one week after well development. All samples were collected after the wells were purged of at least three static volumes of water, or until dry, using a stainless steel bailer, or, in the case of large-volume wells, a PVC hand-operated pump. Samples were collected with stainless steel bailers immediately after purging or as soon as sufficient well recharge occurred. At the time of sample collection, readings of pH, temperature, specific conductance (conductivity), and turbidity were recorded.

A summary of the positive groundwater sample analytical results is provided in Table 2-13. The results were compared to NYSDEC Class GA groundwater standards. The analytical results for compounds that exceeded these standards are shaded on the table for ease of review. Laboratory data packs for all sample results, including quantitation limits for analytes not detected, are presented in Appendix B. Groundwater sample results are included in laboratory report Nos. 9909144 and 9909155.

VOCs were detected in eight of the 11 wells sampled, and at least one VOC was detected at a concentration exceeding its standard in four wells. As in previous rounds of sampling, well MW5-5D contained the highest concentration of VOCs. Five compounds (1,1-DCE; cis-1,2-DCE; trans-1,2-DCE; TCE; and vinyl chloride) were detected above their standards in well MW5-5D. Three VOCs (cis-1,2-DCE; trans-1,2-DCE; and TCE) exceeded their standards in well MW5-1DA. One VOC (cis-1,2-DCE) exceeded its standard in well MW5-4D (see Table 2-13).

Groundwater samples from new monitoring wells MW5-7 and MW5-8 contained only low levels of TCE and cis-1,2-DCE, respectively. However, the sample collected from new well MW5-6 contained four VOCs (1,1-DCE; trans-1,2-DCE; TCE; and vinyl chloride) at concentrations exceeding NYSDEC Class GA groundwater standards. These high levels are consistent with past and current high levels of VOCs detected in nearby well MW5-5D. This similarity in type and level of contaminants suggests an association between the overburden and shallow bedrock water-bearing zones. Similar to previous sampling rounds, groundwater samples

Table 2-13 Groundwater Analytical Results for Monitoring Wells, September 1999, Niagara Falls ARS

Well ID: / Sample Date:	NYSDEC Class GA Groundwater Standards [a]	MW5-1DA 09-17-99	MW5-1E 09-16-99	MW5-4D 09-17-99	MW5-5A 09-17-99	MW5-5D 09-17-99	MW5-5D[b] 09-17-99
Volatiles µg/L (Method 8260B)							
1,1-Dichloroethene	5	4.45 J	ND	ND	ND	7.79	9.10
cis-1,2 Dichloroethene	5	6,140	ND	84.4	1.81 J	3,360	3210
trans-1,2 Dichloroethene	5	10.1	ND	ND	ND	19.1	21.9
Trichloroethene	5	10,100	ND	1.32 J	ND	31,600	29700
Vinyl Chloride	2	ND	ND	ND	ND	2.06 J	3.14 J

Table 2-13 Groundwater Analytical Results for Monitoring Wells, September 1999, Niagara Falls ARS

Well ID: / Sample Date:	NYSDEC Class GA Groundwater Standards [a]	MW5-6 09-17-99	MW5-6D 09-17-99	MW5-7 09-17-99	MW5-7D 09-17-99	MW5-8 09-17-99	MW5-8D 09-17-99
Volatiles µg/L (Method 8260B)							
1,1-Dichloroethene	5	6.11	ND	ND	ND	ND	ND
cis-1,2 Dichloroethene	5	1,900	ND	ND	ND	1.96 J	2.51 J
trans-1,2 Dichloroethene	5	12.8	ND	ND	ND	ND	ND
Trichloroethene	5	26,100	ND	3.85 J	ND	ND	ND
Vinyl Chloride	2	4.7 J	ND	ND	ND	ND	ND

[a] NYSDEC 1998.

Note: Shaded values exceed groundwater standards.

Key:

J = Estimated value.
µg/L = Micrograms per liter.
ND = Not detected.
NYSDEC = New York State Department of Environmental Conservation.

from the rest of the wells (MW5-1E, MW5-5A, MW5-6D, MW5-7D, and MW5-8D) contained no or very low levels of VOCs. The absence of VOCs in well MW5-1E, which is located in the source area adjacent to wells MW5-6 and MW5-5D, suggests that a downward limit to contaminant migration is present in the bedrock.

2.4 Water Level Measurements

After installation of the temporary Geoprobe wells, water level measurements were taken from all Geoprobe monitoring wells on July 27 and August 31, 1999 (see Table 2-8). Additionally, as part of the Installation-Wide Groundwater Monitoring Project, water level elevations were taken from all existing monitoring wells, including those at Site 5, on September 9, 1999 (see Table 2-8). Based on these groundwater level measurements, overburden and shallow bedrock groundwater contour maps were constructed (see Section 3.2).

Groundwater level measurements were collected using an electronic water level indicator graduated to 0.01 foot. The probe of the instrument was lowered slowly until the indicator alarm sounded. The probe then was pulled above the water surface, and the measurement was repeated. The depth to water was measured from a marked reference point on the top of the inner well casing. After use, any part of the water level indicator that was submerged was decontaminated by triple rinsing with deionized water.

During the measurement of groundwater levels, wells with flush-mount covers and airtight caps were opened to allow the water in the well to equilibrate before the measurement of the static water level.

2.5 Surveying

Elevations of the ground level at each new well and at each Geoprobe borehole, as well as the elevation of the inner casing at each new well, were obtained and referenced to the National Geodetic Vertical Datum 1929 (mean sea level).

The horizontal locations of all points were surveyed using the Global Positioning System. All locations were tied into the New York State plane coordinates (West Zone) NAD27 datum. Existing bedrock wells were used as reference points. The locations and elevations of these existing wells were based on previous surveying performed by E & E and McIntosh & McIntosh, P.C. (1997). All survey information is based on data provided by AFRC (McIntosh 1963; McIntosh & McIntosh 1976; Mooreman and Taylor 1986).

Survey results were entered into the IRP Well Maintenance System Database and used to generate maps depicting groundwater contours (see Section 3.2). Elevation and location data for the Geoprobe boreholes and the new wells are included in Tables 2-4 and 2-10.

2.6 Decontamination and Investigation-Derived Waste

All sampling tools were decontaminated before and after use according to E & E's Focused RFI work plan (E & E 1999d) and generic work plan for IRP sites (E & E 1995). Dedicated equipment, such as Geoprobe acetate sleeves, expendable drive points, and bailers, did not require decontamination. Decontamination of drilling equipment and other large items consisted of:

- Removal of foreign matter, followed by
- High-pressure steam cleaning.

Nondedicated sampling equipment was decontaminated as follows:

- Initially cleaning equipment of all foreign matter;
- Scrubbing equipment with brushes in a laboratory-grade detergent solution;
- Rinsing equipment with deionized water;
- Rinsing equipment with 10% nitric acid solution (only when sampling for metals);
- Triple-rinsing equipment with deionized water; and
- Allowing equipment to air dry.

IDW
investigation-derived
waste

E & E contained, labeled, and sampled investigation-derived waste (IDW) generated during the field investigation, including soil cuttings, well development water, decontamination water, well purge water, and personnel protective clothing, as appropriate. All solid waste, including well construction materials and protective clothing used during nonhazardous sampling, was segregated and disposed of off site by E & E. All remaining wastes were contained in United States Department of Transportation-approved steel drums and sampled for characterization. An inventory of IDW generated,

IDW sample analytical results, and IDW disposal status are provided in Appendix C.

2.7 Quality Assurance/Quality Control Results

QA
quality assurance

QC
quality control

This section summarizes the quality assurance (QA)/quality control (QC) procedures used and results for the samples collected and analyzed at Site 5 in June and July 1999. The QA/QC of groundwater data for Site 5 from September 1999 is discussed in the final 1999 Installation-Wide Groundwater Monitoring Report (E & E 2000). All procedures were consistent with the EPA QA/QC requirements as described in SW-846, Third Edition, Update III, revised 1997. All analytical data have been reviewed for compliance with precision, accuracy, representativeness, completeness, and comparability parameters based on EPA's *National Functional Guidelines for Organic Data Review* (EPA 1999) and *National Functional Guidelines for Inorganic Data Review* (EPA 1994). A complete QA/QC review memorandum is included at the beginning of the analytical data provided in Appendix B.

QA/QC concerns that may affect data usability are presented below, along with appropriate data qualifiers and discussion of potential impacts. Results and quantitation limits are considered to be estimated values when flagged *J* or *UJ*, respectively. Any *J* qualifier not explained in the data review memorandum (see Appendix B) indicates that the level detected is below the quantitation limit but above the method detection limit.

2.7.1 Field Quality Control Samples

Field Blanks

Field QC samples are used to check the cleanliness and effectiveness of field handling methods. These samples are analyzed in the laboratory as regular samples, the purpose being to assess the sampling and transport procedures as possible sources of sample contamination and to document overall sampling and analytical precision. Field QC samples collected during the June and July 1999 sampling events include the following:

- Trip blanks, collected at the rate of one per shipping container holding samples for VOC analysis (one per day), are used to assess the overall level of contamination except that which is due to ambient field conditions, especially during sample transport and storage; and

- Field duplicates, collected at the rate of one per 20 field samples, are used to assess the consistency and precision of the overall sampling and analytical system.

Contamination was not detected in any trip blanks. A trip blank was not included in one shipment affecting one sample. Because nothing was detected in the associated sample, there is no impact on data usability.

Field Duplicates

Groundwater field duplicate sets were collected for VOC analysis from wells GP5-77-WO and GP5-H6-WO, and one soil field duplicate sample was collected from GP5-72C-SO. Acceptable precision was achieved for all sample analyses performed, except for the soil sample. Because the sample was analyzed using a screening method and screening results are inherently considered estimated values, no data qualification is required.

2.7.2 Laboratory Quality Control Samples

The purpose of laboratory QC samples is to assess the accuracy and precision of the analytical methods and to determine any sample contamination from laboratory procedures such as digestion and extraction. Laboratory QC samples consisted of method blanks, matrix spike (MS)/matrix spike duplicates (MSDs), laboratory control samples (LCSs), surrogates for all organic methods, and internal standards for all GC/MS organic methods.

MS
matrix spike

MSDs
matrix spike duplicates

LCSs
laboratory control samples

The frequency of laboratory QC samples was as follows:

- One method blank per batch;
- One MS/MSD set per batch or per 20 samples, whichever was greater;
- One LCS for each analytical batch;
- Surrogate standards added to each sample before purging or extraction for organics; and
- Internal standards added to each sample before instrumental analysis for GC/MS organic methods.

Method Blanks

No contamination was detected in the VOC method blanks associated with the groundwater and soil samples. No method blanks had detectable concentrations of target compounds.

Laboratory Spikes

Laboratory spikes were analyzed at the required frequency. Precision and accuracy measurements were generally within acceptance criteria established for the LCS. The results did not indicate significant matrix problems, so no data qualification is required.

Laboratory Control Samples

All LCS analyses were within control limits and were performed at the required frequency.

Surrogate and Internal Standards

Surrogate spike recoveries were within laboratory QC criteria for all samples except for five Geoprobe groundwater samples. No data qualification is required because the surrogate recoveries were just below limits while other surrogate recoveries were within limits. In addition, the data are used for screening purposes only.

Additional Quality Control Measures

The pH analysis of sample MH5-D-WO was completed one day beyond holding times. The positive result was flagged *J* as estimated.

3 Data Evaluation and Conclusions

3.1 Site Geology

The unconsolidated deposits (overburden) and uppermost portion of the underlying bedrock units were investigated during the Focused RFI. Geologic data collected during the RFI are consistent with those previously collected (E & E 1999a) and are described briefly below.

3.1.1 Bedrock

Depth to bedrock at NFARS has been found to range from approximately 3 feet near Cayuga Creek to nearly 18 feet at Site 5. The bedrock comprises the Middle Silurian Lockport Dolostone, which consists mainly of gray to brownish gray, fine- to coarse-grained dolostone. The Lockport Dolostone consists of four formations. In the vicinity of the base, the uppermost unit (Guelph Formation) is not present, nor is the top 10 feet to 20 feet of the underlying Eramosa Formation (Brett et al. 1995). Investigations at the site have focused on the top 43 feet of bedrock. Brett et al. (1995) describe the Eramosa Formation as a biostromal, bituminous, medium- to massive-bedded dolomite divided into six informal units (A through F). Unit F, Unit E, and a portion of Unit D are likely absent from the base. Unit D consists of upper and lower nonfossiliferous dolomites separated by a massive bed locally packed with coral. The underlying Unit C is a biostromal interval characterized by up to 5-foot-thick stromatolites and associated corals. The rock is massive, thickly bedded dolomite with abundant vugs, which typically are lined with sphalerite, galena, fluorite, calcite, or dolomite (Brett et al. 1995). Additional descriptions of the Lockport Dolostone and stratigraphic columns are presented in Section 4.5 of E & E 1996b; Zenger 1965; and Brett et al. 1995.

3.1.2 Overburden

Except for fill material and topsoil, the unconsolidated deposits (overburden) at NFARS consist of three types of materials (from the top down)—fluvial deposits, lacustrine deposits, and glacial

till. Fluvial deposits are generally absent from Site 5 or have been reworked. These deposits are confined to areas near Cayuga Creek. RFI drilling activities at Site 5 encountered a distinct and apparently laterally discontinuous sand layer between the lacustrine deposits and till. This layer and other hydrogeologic findings particular to Site 5 are described below.

Each of the 96 Geoprobe borings installed during the various phases of the RFI were sampled and logged continuously from ground surface to the depth of refusal. The geologic data collected during the Geoprobe drilling have provided a better understanding of the subsurface conditions at and near Site 5.

In general, the overburden stratigraphy encountered is consistent with previous models. The overburden at Site 5 comprises four main layers. From top to bottom, they are topsoil and/or fill material; glaciolacustrine clays with stratified silt and sand; well-sorted, fine-grained silty sand; and glacial till comprising an unstratified mix of clay- to cobble-size particles. These units are depicted in Figure 3-1. The topsoil/fill layer is generally thin, has been reworked, is uncontaminated, and therefore is not considered important to this investigation. The upper clay layer thickness at Site 5 was found to range from approximately 3 feet at GP5-72 to approximately 13 feet at GP5-92. Based on geotechnical analysis and geotechnical borehole logs, the clay layer was described as brown, low to medium plastic clay, with gray sandy laminations and orange mottling. Occasionally, traces of sand and gravel also were encountered in the clay layer.

The silty sand is generally present at the base of the glaciolacustrine clay layer, directly above and in contact with the underlying glacial till. It occurs in discontinuous lenses varying in thickness from 0 feet to 3.5 feet. These sand lenses are described as light brown, well-sorted, low-plasticity silty sand or sandy silt that very sporadically contains traces of clay or gravel.

The till layer thickness at Site 5 was found to range from less than 0.5 foot at GP5-92 to approximately 7.5 feet at MW5-1DA. The till layer is described as a brown, low-plasticity, sandy silty clay matrix with subangular to subrounded limestone gravel and pebbles.

Two geologic cross-sections (A-A' and B-B') were prepared using the data from the Geoprobe and monitoring well borings (see Figure 3-1). These two cross-sections detail the overburden stratigraphy at Site 5 from west to east and north to south.

Figure 3-1 depicts the thickness and extent of the sand lenses and their relationship to the underlying till. While laterally discontinuous, a primary sand lens was identified, with the thickest area located north and northwest of Building 920.. As discussed below, the primary groundwater contaminant plume generally coincides with the extent of this sand lens. As depicted in Figure 3-1, two small sand lenses are also present and located in the northwest and west portions of the 107th ARW POL storage yard. However, no significant groundwater contamination has been associated with these lenses. Therefore, the focus of this investigation remains on the large lens near Building 920. The total area of the primary sand lens is less than 6 acres and appears to be laterally confined on all sides. Confinement of the sand lens has not been defined fully on the east and southeast sides (see Section 3.3 and Figure 3-1). However, the sand is observed to be thinning in that direction, and, more importantly, the contaminant plume is confined to the east and southeast (see Figure 3-4). Confinement of the contaminant plume within the sand may be due to a relative hydraulic conductivity decrease to the east within the sand. Alternatively, Figure 3-1 indicates that the elevation of the sand lens tends to increase to the east and may occur above the water table in places. This would serve to laterally confine the contaminants because they are distributed primarily below the water table.

3.2 Site Hydrogeology

As part of the Installation-Wide Groundwater Monitoring Project, water level elevations were measured at each monitoring well at Site 5, and at nearby monitoring wells at Site 8, on September 9, 1999. The water level and survey data were used to calculate groundwater elevations above mean sea level (AMSL), and maps of the local overburden and bedrock groundwater flow patterns were prepared (see Figures 3-2 and 3-3).

E & E has taken groundwater and surface water elevation measurements at least semiannually since 1995. Detailed discussions and contour maps of previous groundwater flow patterns observed at Site 5 can be found in E & E 1996b, 1997, 1998, and 1999a. Overburden groundwater flow directions at Site 5 have shown great variability. This variability is believed to be a result of the very small magnitude of horizontal gradient at the site, which is impacted more by the effects of seasonal variations. Water level fluctuations in nearby overburden well MW5-1A (see Figure 2-1) are monitored monthly for another project, and seasonal variations of 5 feet to 8 feet have been observed in this well.

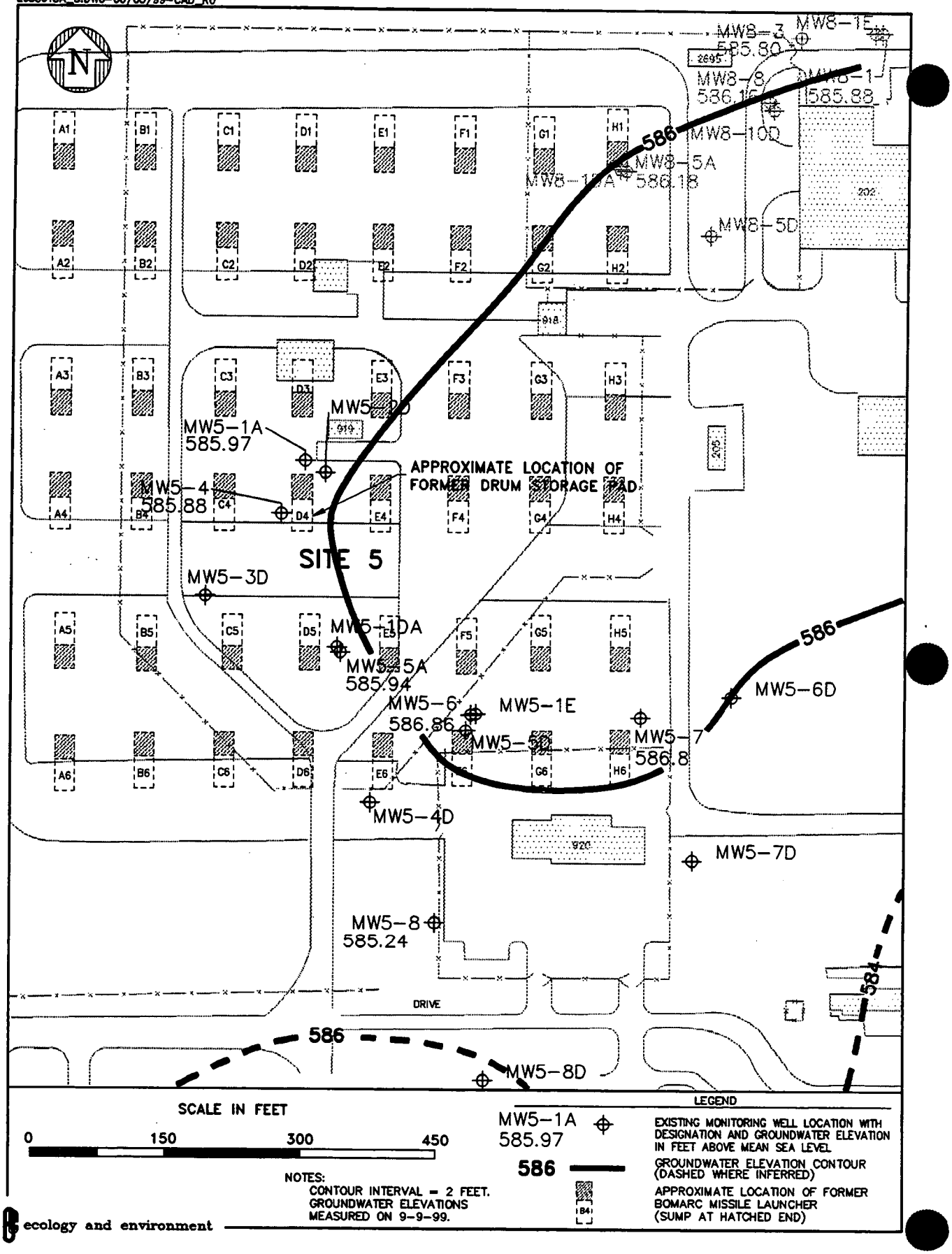


Figure 3-2
SEPTEMBER 1999 OVERBURDEN GROUNDWATER CONTOUR MAP
IRP SITE 5
NIAGARA FALLS ARS

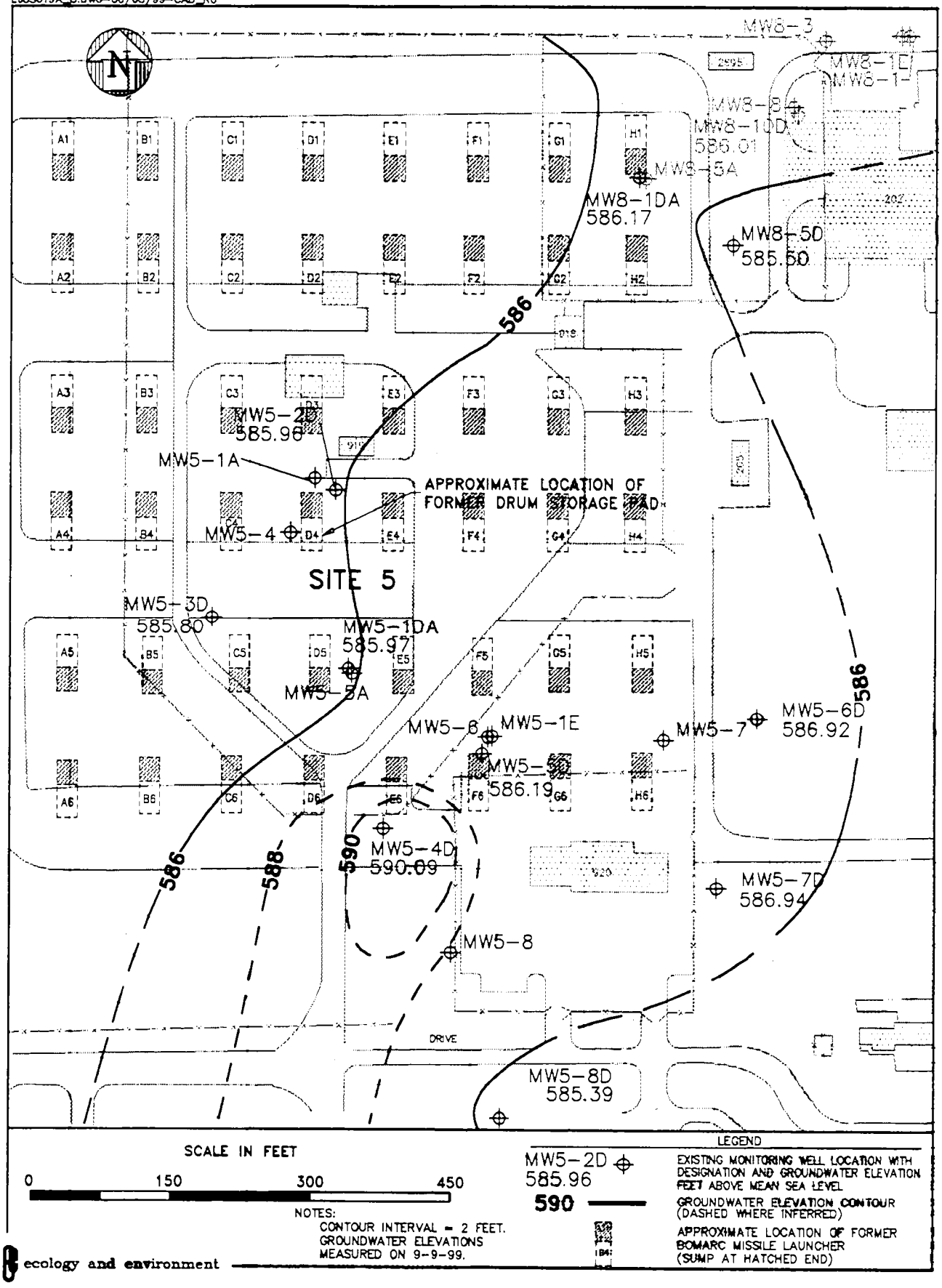


Figure 3-3
SEPTEMBER 1999 SHALLOW BEDROCK GROUNDWATER CONTOUR MAP
IRP SITE 5
NIAGARA FALLS ARS

The predominant direction of groundwater flow at the site generally fluctuates from east to south; however, components of groundwater flow to the southwest and west also have been observed. In September 1999 (see Figure 3-2), a predominant flow direction could not be discerned readily. The overall contour pattern is "saddle-shaped" and somewhat radial, with discharge predominantly to the southeast. Discharge to the southeast is consistent with extension of the sand lens in this direction. The magnitude of the horizontal hydraulic gradient is very small (0.7% from MW5-6 to MW5-8) compared to that of other locations at NFARS, but is similar to those calculated previously at Site 5.

Previously mapped shallow bedrock groundwater elevations at this site consistently have shown a general pattern of flow to the east and southeast, similar to that of the overburden groundwater. Radial flow outward from various locations of the site and components of flow to the southwest and northeast also have been observed. In September 1999, a flow divide oriented north-south crossed Site 5 (see Figure 3-3). Groundwater flows to the east and west, away from this divide. The relatively high groundwater mound measured at MW5-4D necessitates the depiction of this divide; i.e., there is a radial flow pattern away from MW5-4D and the magnitude of the horizontal hydraulic gradient varies locally. Because of the variability in the gradient and direction of flow, a sitewide estimate of the hydraulic gradient is impossible. However, the magnitude of the horizontal gradient measured from MW5-3D to MW5-5D in September 1998 was 0.2%, which was consistent with previous measurements.

One deep bedrock well was installed at Site 5 (MW5-1E) to characterize the vertical extent of contaminant migration. Although no component of horizontal groundwater flow can be determined from just one well, there is evidence of a downward vertical gradient at the site. Calculations of vertical gradients at well triplet MW5-6/MW5-5D/MW5-1E in the source area of the plume were performed based on the water level measurements recorded in September 1999. A downward vertical hydraulic gradient of 5.4% was calculated between the overburden and shallow bedrock zones. Between the shallow and deep bedrock zones, a downward gradient of 23% was determined. Overburden well MW5-6 was not installed in March 1999; however, at that time, a downward hydraulic gradient of 28% was calculated between the shallow and deep bedrock zones. So, while seasonal variations in groundwater levels occur, the effect on hydraulic gradients at depth is limited. Seasonal water level fluctuations are expected to have a greater impact

on gradients in the overburden because this unit is affected more directly by meteoric recharge.

As discussed in Section 3.3, contaminant concentrations are similar in the source area in the overburden and shallow bedrock zones, indicating downward migration of contaminants in the direction of groundwater flow. However, consistent absence of contamination in the deep bedrock zone indicates that although a strong downward gradient exists, a downward limit to the extent of contamination also exists. The limiting factor is likely an aquiclude of competent rock. In the well boring for MW5-1E, the Lockport Dolostone was observed to become considerably more competent with depth. The top 15 feet of bedrock contained numerous horizontal fractures, many of which exhibited weathering and dissolution, and rubble zones. Below the top 15 feet, fracture spacing was greater and very little to no dissolution along the fractures was noted.

Slug test results for all of the monitoring wells at Site 5 were compiled, and geometric means were calculated (E & E 2000). The highest mean hydraulic conductivity at the site (approximately 3.5×10^{-3} cm/s) was found in the shallow bedrock wells. The maximum hydraulic conductivity (1.8×10^{-2} cm/s) at Site 5 was found in shallow bedrock well MW5-8D. Because the permeability of the bedrock is controlled almost exclusively by secondary porosity features, the hydraulic conductivity of the bedrock wells is directly proportional to the amount and degree of fracturing encountered during well drilling. The median value determined for the shallow bedrock wells is nearly an order of magnitude less than the median of observed values reported by Yager (1993) as part of a USGS hydrologic model. This indicates that the degree of weathering and fracturing is variable throughout the region and that variations in hydraulic conductivity are likely a function of well location and depth, both of which affect the number and size of fractures encountered. Previous studies by USGS and E & E indicate that groundwater in the Lockport Dolostone moves mainly along horizontal fractures formed along bedding planes and formation contacts in the weathered bedrock zone (top 10 feet to 25 feet regionally, and 15 feet at Site 5). These horizontal fractures are intersected periodically by high-angle fractures formed along joints and stress relief fractures. However, the vertical fractures are less numerous than the horizontal fractures, resulting in a 70:1 anisotropy ratio of horizontal to vertical hydraulic conductivities (Yager 1993).

Hydraulic conductivity for overburden wells ranged from 3.8×10^{-5} cm/s to 2.0×10^{-2} cm/s. The wide range of hydraulic conductivities

observed at the site is likely a function of well location and depth, both of which affect the presence and thickness of the sand lens encountered in the well boring. Because of the relatively high hydraulic conductivity of the sand unit compared to that of the overlying clay and underlying clay-rich till, the sand lens is the predominant water-bearing zone in the overburden.

Water levels measured in July 1999 are depicted on the cross-sections in Figure 2-1. At that time, water within each former BOMARC launcher pit was perched above the water table. The lower portion of the lacustrine clay, the entire sand lens, and all of the till were saturated. Based on water level fluctuations previously observed in overburden wells at the site, it is anticipated that during seasons of high recharge, the groundwater table intersects the bottom of the launcher pits and their associated storm drains.

Based on relative hydraulic conductivities and porosity, the most easily extractable groundwater at the site is in the sand lens. Despite the greater hydraulic conductivity, the volume of contaminated water in the bedrock considered practically recoverable is small compared to that of the sand. This conclusion is based on the estimated porosity of the fracture system. The porosity of fractured bedrock is highly variable and can range from 0% to 20% (Freeze and Cherry 1979). Based on the competent nature of the bedrock encountered and the fracture spacing observed, a porosity of 0.5% has been assumed for the bedrock. The relatively high hydraulic conductivity but low porosity of the bedrock suggest that some of the fractures are large enough to provide easy pathways for groundwater flow and that this flow is limited to just a few fractures. Efforts to remove groundwater from the formation simply would remove large amounts of water from these few fractures, bypassing the potentially significant contaminant mass remaining within the smaller, discontinuous fractures and vugs, and rock mass. The porosity of the sand is estimated to be 30% and, more importantly, is likely to have a more uniform distribution of hydraulic conductivity. Therefore, removal of groundwater from this layer will be more uniform and complete. The porosity of the clay and till units is likely higher than that of the sand (approximately 40%). However, because of the low hydraulic conductivity (K) of the clay-rich units, actual well yields (discharge) would be orders of magnitude lower than that of the sand. Specific applications of this information are provided in Section 4.3.

3.3 Contaminant Distribution

To gain a better understanding of the magnitude and distribution of contamination, and the potential migration pathways that exist,

analytical data collected from the various phases of investigation were compiled and evaluated. Figures 3-4 to 3-6 depict a variety of information for TCE; cis-1,2-DCE; and benzene, toluene, ethylbenzene, and total xylenes (BTEX). These compounds were selected for mapping because they were the most often detected and had the highest relative concentrations at the site. Each illustration is a composite of sample results for each medium in which contamination was detected.

BTEX
benzene, toluene, ethylbenzene, and total xylenes

3.3.1 Groundwater

The blue contour lines on the main portion of Figures 3-4 to 3-6 depict contaminant concentrations in samples of overburden groundwater. The most recent analytical result for each sample location, including Geoprobe temporary wells (depicted in red) and permanent overburden monitoring wells (depicted in green), was used. Similar contaminant plume contour maps for the shallow and deep bedrock zones could not be generated because of the limited number of sample location points and complexities involved with depicting flow in fractured rock. Therefore, to provide some information regarding contaminant concentrations in these zones, bedrock monitoring wells and the most recent sample results for each contaminant are presented in purple in Figures 3-4 to 3-6. Shallow bedrock wells, including MW5-5D, are presented in light purple, while deep bedrock wells, including MW5-1E, are presented in dark purple. Based on the relatively similar contaminant concentrations detected in the bedrock and overburden wells, the TCE and cis-1,2-DCE plume boundaries in these aquifers also appear to be similar, except to the northwest. In shallow bedrock well MW5-1DA, relatively high concentrations of TCE and cis-1,2-DCE are present, compared to those detected in adjacent overburden well MW5-5A. This disparity likely results from anisotropic contaminant distribution in the fractures of the Lockport Dolostone.

As discussed previously, an aquiclude exists between the shallow and deep bedrock water-bearing zones. This is demonstrated by the fact that a strong downward hydraulic gradient exists between these zones, yet MW5-1E has been consistently free of organic contamination (see Figures 3-4 and 3-5).

TCE was the most commonly detected compound at the site. The maximum concentration in overburden groundwater was at GP5-03 (170,000 µg/L). This value is 15% of the maximum solubility of TCE in water (1,100,000 µg/L; Pankow and Cherry 1996), suggesting the presence of DNAPL in this area (referred to herein as the *source area*). The maximum concentration of TCE in bedrock

groundwater was detected in MW5-5D (31,600 µg/L). Both locations are situated between former BOMARC launchers F5 and F6 (see Figure 3-4). Low concentrations of TCE and cis-1,2-DCE were detected at other locations throughout the investigation area, but are insignificant compared to the primary plume.

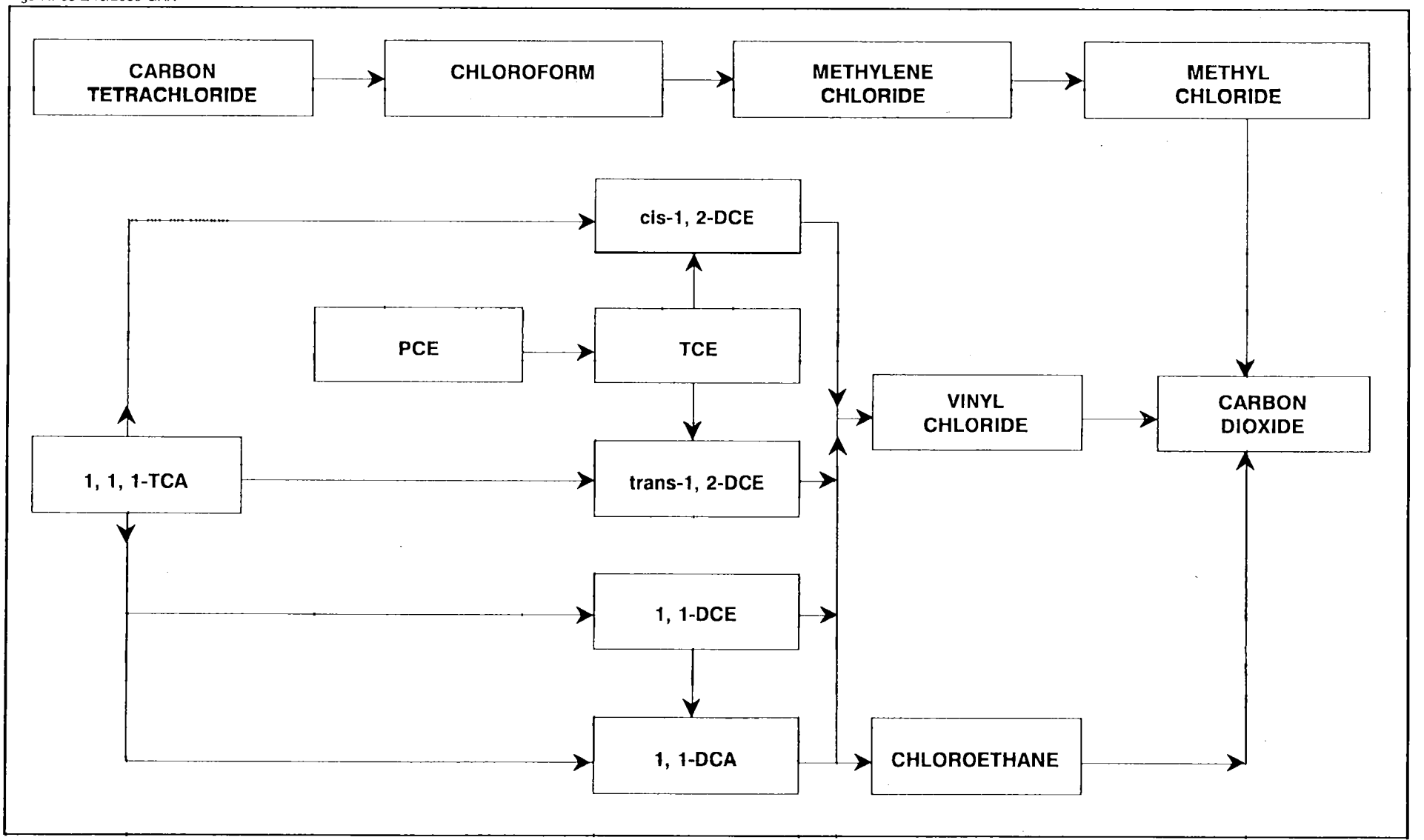
The primary TCE plume is well-defined on every side; whereas nondetect levels of cis-1,2-DCE and BTEX have not been identified to the south. However, the southernmost detections of these contaminants are below NYSDEC Class GA standards. Therefore, the plumes are considered fully defined laterally.

The TCE and cis-1,2-DCE concentration maps for overburden groundwater are similar except that the cis-1,2-DCE plume is larger in areal extent and exhibits lower concentrations. This observation is consistent with the natural process of biodegradation of TCE and the associated degradation kinetics; i.e., TCE is reductively dechlorinated to by-products such as cis-1,2-DCE (see Figure 3-7). However, the transformation is not immediate. Because of the time lag involved and the dynamics of groundwater flow, the natural degradation of TCE to cis-1,2-DCE generally results in a plume relationship similar to that observed at the site.

Figures 3-4 and 3-5 show two plumes. The larger, more clearly defined plume is of much higher concentration and is centered south of former BOMARC launcher F5. This primary contaminant plume extends to the east, west, and south. The second plume is less well-defined and of lower concentration than the first plume. It is somewhat elongated in shape from southwest to northeast and extends from the northeast portion of Site 5 into Site 8.

The distribution of BTEX is not defined as clearly as that of TCE or cis-1,2-DCE, and concentrations are generally lower. BTEX was detected in the overburden groundwater in three areas at Site 5, as depicted in Figure 3-6. Very low BTEX concentrations were detected in two small areas, one in the northwest and the other in the northeast of the 107th ARW POL storage yard. The third area is much larger in extent, has higher concentrations, and correlates to some degree with the primary TCE and cis-1,2-DCE plumes. However, the maximum concentration of total BTEX does not correlate with that of TCE and cis-1,2-DCE and was detected southwest of Building 920 (location GP5-78). Therefore, the source of BTEX contamination is likely not the same as that of the TCE and may include multiple locations.

02:000515_EJ09_00_08_90-B0298
Fig3-7.P65-2/10/2000-GRA



SOURCE: Ecology and Environment 1996; Adapted from Smith and Dragun 1984.

Figure 3-7 TRANSFORMATION REACTIONS FOR VARIOUS CHLORINATED ORGANICS IN SOIL-GROUNDWATER SYSTEMS

3.3.2 Subsurface Soil

On the right-hand side of each of Figures 3-4 to 3-6 are insets containing three-dimensional depictions of TCE; total 1,2-DCE; and BTEX concentrations, respectively, detected in each of the three overburden units. Each contour map represents a different lithologic unit, not depth. For example, the high TCE concentration detected in the lacustrine clay at location GP5-86 was in a sample collected at a depth below 13 feet. Other neighboring samples from the lacustrine clay were collected at various depths throughout the unit, some from as shallow as 2 feet. Each of the three-dimensional soil contaminant maps is contoured on the same scale. This makes it easy to see that TCE concentrations were as much as two orders of magnitude higher than total 1,2-DCE or BTEX concentrations in the soil samples. TCE was detected at relatively high concentrations in all three units, whereas total 1,2-DCE was detected only in the till unit and BTEX was detected only in the sand lens.

All three diagrams depict contamination spreading beyond the study area. For example, TCE appears to extend to the northwest in the sand and to the southeast in the till. This is a remnant of the statistical method utilized to calculate the contour lines caused when sufficient nondetects are not present within a reasonable distance in those directions. Therefore, the actual extent of contamination is expected to be smaller than the conservative estimates depicted.

3.3.3 Trend Analysis

In order to determine whether a significant trend in observed contaminant levels is occurring, the nonparametric Mann-Kendall test for trend was utilized. This test is applicable to VOC levels in groundwater samples detected over time because the data need not conform to any particular distribution. The test uses the relative magnitudes of the data to calculate the Mann-Kendall statistic, S. Comparison to tabulated values of S for given data counts, n, indicates whether the calculated value of S is significant. The 90^{th} percentile was selected as the significance level. Therefore, the probability of the calculated value of S equaling or exceeding the null hypothesis of no trend must be less than 0.10 to imply significance.

At Site 5, the only wells in which TCE has been detected repeatedly are MW5-1DA and MW5-5D. The remaining wells have been consistently clean, or very few positive TCE detections have occurred. In addition, cis-1,2-DCE has been detected repeatedly in MW5-4D and MW5-5D. Therefore, the Mann-Kendall test was applied for TCE and cis-1,2-DCE concentrations in these three

wells. The results of the trend analysis are summarized in Table 3-1. These results indicate no statistically significant increasing or decreasing trends in the observed contaminant levels. Based on this analysis, it appears that the contaminant distribution is near a steady state and that no significant migration is occurring.

Table 3-1 Contaminant Trend Analysis Summary

Well ID	Number of Sample Events (n)	Number of Positive Detections	Mann-Kendall Statistic (S)	Probability of Exceeding No Trend[a]	Trend
Trichloroethene					
MW5-1DA	9	9	-12	0.130	No trend
MW5-5D	5	5	-4	0.242	No trend
cis-1,2-Dichloroethene					
MW5-4D	5	5	2	0.408	No trend
MW5-5D	5	5	+4	0.242	No trend

[a]Gilbert 1987.

Key:

ID = Identification.

3.4 Contaminant Source

Site 5 originally was investigated as an SWMU related to the use of a concrete pad for hazardous waste drum storage. The location of the drum storage pad was former BOMARC shelter D4. Monitoring wells installed in the vicinity of this pad suggested that no significant source of contamination exists. Groundwater contamination was first identified approximately 150 feet south of the storage pad, in well MW5-1DA. Subsequent investigation determined that the source area of the primary groundwater contaminant plume is centered south of former shelter F5. In 1998, several BOMARC launcher pits in that area were investigated. No source was identified visually or analytically in five launcher pits excavated near the source area. Therefore, in 1999, water samples were collected from each launcher pit in the south two rows and the associated storm drain system was investigated. The purpose was to determine whether an upstream launcher pit was the source, with contamination migrating along the drain lines. No significant contamination was detected in any of the launcher pits or storm drains.

Because the launcher pits have been eliminated as potential sources of groundwater contamination, the source apparently was a surface spill in the vicinity of former shelter F5. The current mass of TCE was estimated to determine the size of the spill resulting in the plume identified at Site 5. The mass of TCE in the soil and groundwater was calculated by integrating TCE concentrations

over the area of the plume using Surfer Version 7.00. The result was multiplied by the estimated average thickness of contamination in each unit. A similar approach was taken to calculate the mass of TCE present in the groundwater, except that the resulting mass is also a function of porosity. Conversion factors for the dry density of the overburden (50 kilograms per cubic feet) and density of TCE (1.46 kilograms per liter) were used where appropriate. Table 3-2 summarizes the TCE mass calculations. Based on this information, the current volume of TCE in the subsurface is estimated to be 13 gallons and the original spill was probably between 15 gallons and 20 gallons.

Table 3-2 TCE Mass Estimates

Unit	Integrated Areal Concentration	Thickness (ft)	Porosity	TCE Mass (kg)
Soil	($\mu g \times ft^2/kg$)			
Lacustrine clay	2.01×10^7	9.3	—	9.74
Sand lens	2.53×10^8	1.1	—	13.9
Glacial till	1.37×10^8	3.0	—	20.2
Groundwater	($\mu g \times ft^2/L$)			
Overburden	3.74×10^8	7.0	0.30	22.2
Bedrock	9.10×10^8	15	0.005	3.90
Total				69.9 kg or 13 gal

Key:

ft = Feet.
ft^2/kg = Square feet per kilogram.
ft^2/L = Square feet per liter.
gal = Gallons.
kg = Kilograms.
TCE = Trichloroethene.

3.5 Risk Evaluation

3.5.1 Human Health Risk Evaluation

This risk evaluation for IRP Site 5 supplements the preliminary risk evaluation performed for the 1999 groundwater sampling rounds of the Installation-Wide Groundwater Monitoring Project (E & E 2000). The evaluation of the Site 5 groundwater data in that report concludes that the minor exposures of workers or visitors to groundwater contaminants under current conditions would not pose any significant health risks. The evaluation also concludes that if groundwater were used as a drinking water source, it would pose unacceptably high cancer risks mainly due to high levels of TCE, and potentially could cause adverse noncarcinogenic health effects due to cis-1,2-DCE contamination. However, groundwater is not used at the site or surrounding vicinity and is

not anticipated to be used in the future. Therefore, no risk to human health is anticipated.

This evaluation focuses on the soil data from sampling conducted in 1998 and 1999. Sixty-four soil samples were collected: five test pit samples in May 1998; 17 Geoprobe subsurface samples, three subsurface well boring samples, and one composite surface soil sample in July 1998; and 38 Geoprobe subsurface samples in July 1999. All of the samples were analyzed for VOCs. Some of the 1998 samples also were analyzed for PCBs.

Exposure Setting and Potential Exposure Pathways

Section 5.5.1 of the Final 1999 Sampling/Monitoring Report (E & E 2000) describes the general exposure setting at NFARS and discusses the lack of a plausible exposure pathway for contaminants in groundwater. Site 5 is in the northwest section of the base in what is now an active POL storage area for NYANG. Facility workers are the only individuals expected to enter the site under normal conditions. Unless soil were excavated for some reason, possibly future construction or maintenance activities, workers would not be expected to come into direct contact with contamination in subsurface soils.

Risk-Based Screening Criteria

It is unlikely that subsurface soil contamination at IRP Site 5 poses any significant human health risk given its inaccessibility and the low likelihood of regular long-term exposure for site workers or any other receptors. However, for the purpose of discussion in this risk evaluation, contaminant concentrations detected in soil were compared to applicable New York State regulatory criteria and to conservative (health-protective) risk-based criteria.

The recommended soil cleanup objectives published by NYSDEC's Division of Hazardous Waste Remediation in TAGM 4046 (NYSDEC 1994) were developed as preliminary goals for Superfund sites, with the intention of eliminating all significant threats to human health and/or the environment. The recommended soil cleanup objectives for organic chemicals are either risk-based concentrations (RBCs; most based on protection of groundwater assuming use as drinking water, the rest based on incidental ingestion of soil by residents) or the detection limits in soil. The TAGM 4046 soil cleanup objectives are inappropriate for evaluating potential site-related risks because they are based on exposure assumptions that do not apply to this site (i.e., groundwater use or residential soil contact, almost daily for 30 years.)

RBCs
risk-based concentrations

EPA, Region III, RBCs for commercial/industrial soils (EPA 1999b) are based on potential worker exposures by incidental ingestion. The RBCs are calculated using EPA's standard default values for reasonable maximum exposure. A 70-kilogram worker is assumed to ingest 50 milligrams of soil per day, 250 days per year, for 25 years. The target risk for each RBC is either an upper-bound excess lifetime cancer risk of 1×10^{-6} (the lower end of the range regarded as acceptable by EPA) or a non-cancer hazard quotient of 1.0 (EPA's benchmark for noncarcinogenic effects). The RBC for each chemical represents a level of long-term exposure that would not pose a significant risk to a site worker.

Risk-Based Screening

Table 3-3 summarizes the results from the 64 samples collected at IRP Site 5. For each chemical detected, the table lists the frequency of detection, the minimum and maximum concentrations detected, and the location and depth of the maximum concentration, along with comparisons to the screening criteria described above.

TCE concentrations in 21 soil samples were greater than the TAGM-4046-recommended soil cleanup objective, which is based on protection of groundwater. The maximum reported TCE concentration was 125 times greater than the TAGM value. The highest reported soil TCE concentrations were located below the water table and near the highest concentrations of groundwater contamination. TCE concentrations did not exceed the industrial soil RBC, indicating that even if the contaminated soil were accessible to workers, it would not pose a significant health risk.

PCB Aroclor 1254 was detected in one sample at 74,000 milligrams per kilogram, approximately seven times greater than the TAGM-4046-recommended soil cleanup criteria, which are based on groundwater protection, and 25 times greater than the industrial soil RBC for PCBs. The estimated risk to workers, even if exposure were to occur daily, would fall within the 10^{-6}-to-10^{-4} range considered acceptable by EPA. PCB concentrations detected in other samples (identified as Aroclor 1260) were substantially lower and well below the TAGM value and the RBC.

3.5.2 Ecological Risk Evaluation

An ecological risk evaluation was performed as part of the Installation-Wide Groundwater Monitoring Project (E & E 2000) to assess potential ecological risks at the installation. This assessment was based on 1999 sampling data and previous site investigations.

As part of the ecological risk evaluation, an ecological characterization was conducted. Based on field surveys, three ecological habitats were identified at the installation: the Buildings Area, the Runway/Taxiway Area, and Cayuga Creek and its tributaries. Site 5 was identified as part of the Buildings Area. The area consists of paved roads, parking lots, buildings, and maintained lawns and is used regularly by base personnel. This area is not considered of ecological importance because it is suitable habitat for only a few individuals of common wildlife species, such as the house sparrow (Passer domesticus), that are accustomed to human activity and disturbance. Consequently, the Buildings Area was not considered an ecosystem of concern and any IRP sites therein, including Site 5, were not considered further in the ecological evaluation.

3.5.3 Risk Summary

Based on the lack of credible exposure pathways, the groundwater and subsurface soil contamination found at IRP Site 5 is unlikely to pose any risk to human health. Comparison to industrial soil RBCs indicated that even if regular exposure to the soil contamination did occur, it would be unlikely to pose a significant health risk to site workers. TCE concentrations in some site soils were elevated above TAGM levels established for groundwater protection, and groundwater at the site is highly contaminated with TCE and other chlorinated hydrocarbons. However, as long as the groundwater is not used, the potential exposures and health risks from this contamination are negligible.

Ecological risks are considered negligible in the highly developed portions of the base, including Site 5. Impacts to surface water are not anticipated because Cayuga Creek is approximately 0.5 mile south of the site, the groundwater contamination is laterally confined, and no groundwater discharges to local tributary streams.

3.6 Summary of Conclusions

Because of the lower concentrations, the presence of cis-1,2-DCE and BTEX in the overburden groundwater at the site is less significant than the presence of TCE. Additionally, TCE is the source material for the cis-1,2-DCE. Therefore, future discussions and the selection of corrective actions will focus on the area defined by TCE contamination. While the source of the BTEX likely differs from that of the TCE and cis-1,2-DCE, the contaminant plumes generally coincide. Therefore, corrective actions performed at Site 5 will address all contaminants simultaneously.

The mass of contaminants in the overburden groundwater is distributed among the clay, sand, and till layers. However, because of

its relatively high hydraulic conductivity compared to that of the overlying and underlying clay-rich strata, and its coincidental location to the contaminant source area, the sand lens serves as the primary means of transport for overburden groundwater contamination at Site 5. However, because of the discontinuous nature and limited lateral extent of the sand lens, the low hydraulic gradient of the groundwater, and the low hydraulic conductivity of the surrounding water-bearing zones, migration of these contaminants is limited and unlikely to reach sensitive environmental or human receptors. This is supported further by the trend analysis, which indicated that no significant change in contaminant distribution is occurring.

Contaminated groundwater considered practically recoverable is confined to the sand lens, based on the relatively high hydraulic conductivity of the sand and the low porosity and complex flow patterns associated with the bedrock.

The concentrations of TCE detected in the source area suggest the presence of DNAPL below the water table. Based on current concentrations, the original TCE spill was estimated to be between 15 gallons and 20 gallons. The source was likely a surface spill because evidence of source material was not identified in the former BOMARC launcher pits. Furthermore, the existing BOMARC storm drain lines do not appear to serve as significant conduits of contaminated groundwater migration. However, at times of high water table elevation, some contamination is discharged along the storm drain.

4

IRP Site 5 Focused Corrective Measures Study

4.1 Corrective Measures Study Purpose and Objectives

The purpose of the Focused Corrective Measures Study was to identify and evaluate a corrective measure for the site. Per Module III of the Hazardous Waste Management Permit for the base, the corrective measure is to attain the following standards:

- Be protective of human health and the environment;
- Attain media-specific standards;
- Control the source of release in order to reduce or eliminate further releases of hazardous waste to the maximum extent practicable; and
- Meet all applicable waste management requirements.

CAOs
corrective action objectives

A streamlined approach was undertaken to arrive at a corrective measure for IRP Site 5 in a timely and cost-efficient manner. The streamlined approach involved establishment of corrective action objectives (CAOs), an abbreviated review of potential corrective measure technologies, and development and evaluation of a corrective measure for the site. During the evaluation process, it was demonstrated how the corrective measure attains the above standards.

4.2 Establishment of IRP Site 5 Corrective Action Objectives

Contamination was detected in subsurface soils and groundwater at the site. A completed exposure pathway does not exist for these contaminants; therefore, actual risk to human health or the environment was eliminated. The risk evaluation described in Section 3.5 conservatively included unlikely exposure scenarios, including direct impacts on the surface water quality of Cayuga Creek and

groundwater from the site being used as a drinking water source. These scenarios are unlikely because the base is supplied with municipal drinking water and the formation within which the contamination is present does not provide sufficient yield to be used as a drinking water source. In addition, there appears to be relatively little migration of contaminants from the suspected source area. Therefore, the potential for Site 5 contaminants to reach other sensitive receptors outside the immediate Site 5 area, including Cayuga Creek, is remote. However, attaining media-specific standards as required by the Hazardous Waste Management Permit will further ensure that contaminants at Site 5 will not result in an unacceptable risk.

SCGs
standards, criteria, and guidance values

CAOs were established for soil and groundwater by comparing observed concentrations to existing New York state standards, criteria, and guidance values (SCGs). This comparison was done as part of the risk evaluation described in Section 3.5. COCs for IRP Site 5 were identified as those with maximum concentrations exceeding respective SCGs or RBCs. CAOs were developed for all COCs identified during the risk screening evaluation.

Soils

COCs identified for Site 5 soils include TCE and PCB Aroclor 1254. TCE was detected in 21 of 64 samples above the NYSDEC (1994) generic cleanup objective of 700 µg/kg developed in TAGM 4046. Aroclor 1254 was reported above NYSDEC TAGM 4046 in one of 21 samples tested for PCBs. This sample was collected from debris located in a concrete-lined bunker. Because this sample was collected from fill material above the water table, this result is not considered indicative of subsurface conditions or a larger PCB contamination problem. Therefore, this PCB was not used to drive the corrective measure.

No metals testing in soils was completed per the approved RFI work plan. Based on site history and metals concentrations in groundwater, metals contaminants in site soils are not considered to be a concern.

Groundwater

NYSDEC Class GA groundwater standards were used as the basis of the identified CAOs. COCs in IRP Site 5 groundwater and corresponding CAOs are summarized in Table 4-1. These standards are appropriate for waters used as drinking water.

Table 4-1 Corrective Action Objectives for IRP Site 5 Groundwater

Contaminant of Concern	Corrective Action Objective (µg/L)	Frequency of Exceeding CAO	Maximum Concentration (µg/L)
Benzene	1	5/41	6.83
Toluene	5	1/41	482
Ethylbenzene	5	1/41	670
Xylenes (total)	5	1/41	3,690
Bromoform	5	1/41	5.2
Chlorobenzene	5	1/41	27.9
1,1-Dichloroethene	5	4/41	11
cis-1,2-Dichloroethene	5	9/41	6,140
trans-1,2-Dichloroethene	5	5/41	10.1
Trichloroethene	5	9/41	56,000
Vinyl chloride	2	3/41	4.7

Key:

CAO = Corrective action objective.
IRP = Installation Restoration Program.
µg/L = Micrograms per liter (parts per billion).

4.3 Area and Volume of IRP Site 5 Contaminated Media

The spatial distribution of the various COCs at IRP Site 5 tends to be generally similar. The highest concentrations of each were found northwest of Building 920 near the southeast corner of BOMARC Launcher F5, within the suspected source area. Lower concentrations were found moving away from this area toward the south and east. Concentrations to the north and west dropped off quickly. Based on the distribution, migration, and relative concentrations of the COCs, TCE was selected to estimate areas and volumes of contaminated media. In addition, TCE often degrades more slowly than other COCs detected at Site 5, thereby providing a more conservative estimate of contaminated media areas and volumes. Other locations west and south of the main TCE plume exhibited relatively low concentrations of BETX; TCE; and cis-1,2-DCE in groundwater. The concentrations were typically below 10 µg/L and are suspected to be unrelated to the main source area. These concentrations are very near the CAOs for these compounds and were not addressed directly in the development and evaluation of the corrective measure for the site.

Soils

As described in Section 3.1, three distinct soil layers exist at Site 5: upper clay, sand, and lower glacial till. The spatial distribution of TCE within each layer is shown in Figure 3-4. Table 4-2

summarizes the area and volume of soils with TCE concentrations exceeding the CAO of 700 µg/kg. Area calculations were based on the interpolated extent of the contamination. The positive planar area of each soil unit with TCE concentrations exceeding 700 µg/kg was calculated using the Surfer Surface Mapping System (Golden Software 1999). Calculations were based on the data presented in Figure 3-4. To perform the volume calculations, each layer was assumed to have a uniform thickness based on data obtained from well and Geoprobe boring logs and the information summarized in Figure 3-1. This uniform thickness then was multiplied by the area to yield a volume.

Table 4-2 Estimated Volume of Contaminated Soils

Soil Unit	Average Thickness (ft)	Arial Extent (ft^2)	Volume (yd^3)
Lacustrine clay	9.3	15,500	5,300
Sand	1.1	25,200	1,030
Glacial till	3	19,100	2,100

Key:

ft = Feet.
ft^2 = Square feet.
yd^3 = Cubic yards.

Overburden Groundwater

Contaminated overburden groundwater exists in all three soil units. Estimated volumes of the contaminated overburden groundwater are presented in Table 4-3. The volumes were calculated in a manner similar to that described above. The positive planar area of the plume was calculated using Surfer. This was multiplied by the saturated thickness of the soil unit and by an assumed porosity. A porosity of 30% was used for all three units. Groundwater volume calculations were repeated for plume areas containing concentrations exceeding 5 µg/L, 100 µg/L, and 1,000 µg/L.

gpm
gallon per minute

Based on the site hydrogeology (see Section 3.2), only groundwater within the sand layer is considered recoverable in a practical manner. For example, a recovery well screened across the sand layer will yield about 0.2 gallon per minute (gpm) at steady state, with an estimated 140-foot hydraulic radius, if a drawdown of 1 foot is maintained. A well screened in the clay or till layer, maintaining the same 1-foot drawdown, will yield about 0.002 gpm with an estimated hydraulic radius of 10 feet. Therefore, attempts to remove overburden groundwater from the sand layer may have some success in reducing the overall contaminant mass present at the site in

Table 4-3 Estimated Volume of Contaminated Groundwater

	Planar Area (ft^2)	Estimated Saturated Thickness (ft)	Volume (gal)
Total Overburden Groundwater			
Exceeding 5 µg/L	79,700	6	1,070,000
Exceeding 100 µg/L	48,800	6	657,000
Exceeding 1,000 µg/L	15,100	6	203,000
Sand Layer Groundwater			
Exceeding 5 µg/L	79,700	1.1	197,000
Exceeding 100 µg/L	48,800	1.1	120,000
Exceeding 1,000 µg/L	15,100	1.1	37,300

Key:

ft = Feet.
ft^2 = Square feet.
gal = Gallons.
µg/L = Micrograms per liter.

a reasonable amount of time. However, attempts to recover contaminant mass from the other soil units would be much more difficult, take much more time, and be much more costly.

Bedrock Groundwater

The volume of contaminated groundwater existing within the bedrock is more difficult to predict. Contaminated groundwater within the Lockport Dolostone that is practically recoverable is limited to the large fractures in which groundwater easily flows (secondary porosity features). Comparatively, a relatively small amount has diffused into the surrounding rock mass (primary porosity) and small fractures and vugs, and is not considered practically recoverable. The fracture space volume or secondary porosity in a competent rock such as the Lockport Dolostone is highly variable, ranging from 0% to 20%. Given the competent nature of the rock observed at the site, especially at depth, a secondary porosity value of 0.5% was used for estimating the amount of available contaminated groundwater. Assuming a contaminated zone thickness of 15 feet, the estimated volume of recoverable bedrock groundwater (present within the fracture spaces) with TCE concentrations above 5 µg/L is approximately 222,000 gallons. Only two bedrock groundwater wells were found to contain TCE concentrations exceeding 5 µg/L. The relatively large volume of contaminated bedrock groundwater is a result of widely spaced data points. The actual amount of contaminated bedrock groundwater is believed to be lower than the above estimate.

4.4 Screening of Potential Corrective Measure Technologies

This section provides a review of several potential corrective measure technologies. A narrative is provided for each technology considered, including a brief discussion of the technology, comments regarding its potential effectiveness, implementability issues, estimated cost, and a conclusion as to whether the technology is applicable at Site 5. The considered technologies include only those commonly employed to treat the media and contaminants present at Site 5.

4.4.1 Soil/Fill Corrective Measure Technologies

Corrective measure technologies for contaminated soil/fill are used to contain, treat, or remove and dispose of the contaminated media. These technologies are presented below.

Capping

In general, capping isolates contamination from contact with potential receptors, surface runoff, and infiltration. By isolating contaminated soil from surface water runoff, the potential for contaminants being transported off site is minimized. By reducing the rate of infiltration and thus the rate of recharge, the potential for contaminant migration via groundwater is reduced. Capping techniques utilize materials such as synthetic membranes, clay, asphalt, concrete, and chemical sealants.

Contaminants within surface soils have not been identified as a risk concern for IRP Site 5. Therefore, implementation of a capping technology to reduce direct-contact exposure or surface water runoff would serve no additional significant purpose in reducing risks associated with the site. In addition, the existing upper portion of the lacustrine clay layer already provides a barrier from infiltration. Therefore, capping technology will not be an effective technology for Site 5 and will not be considered further.

Excavation and Treatment/Disposal

Excavation is used widely for removing surface and subsurface contaminated soils. Conventional heavy-construction equipment generally is used for excavation, removal, and hauling of contaminated soils. Excavation typically is followed by land disposal or treatment. Excavation usually is adopted to remove contaminant "hot spots" within the unsaturated zone, and other corrective measures (e.g., in situ treatment) are used for the less-contaminated soils and soils below the groundwater table.

Following removal, excavated soils must be treated and/or disposed of off site.

Off-Site Disposal: Off-site disposal of contaminated materials and soil involves hauling excavated material to a commercial disposal facility. The type of facility chosen depends on whether material is classified as hazardous waste under RCRA and New York State's hazardous waste regulations. Hazardous waste may be disposed of only at a RCRA-permitted hazardous/solid waste facility. Before land disposal, most hazardous wastes must meet specific treatment standards codified in 40 Code of Federal Regulations (CFR) 268.

CFR
Code of Federal Regulations

MCLs
maximum contaminant levels

Ex Situ Treatment: On-site and off-site treatment of contaminated soils includes techniques falling into three major categories:

- Thermal treatment,
- Physical/chemical treatment, and
- Biological treatment.

Most commonly, soils contaminated with the types of chemicals observed at Site 5 are treated using thermal desorption. Thermal desorption is a treatment technology that uses low to medium temperatures to transfer volatile and semi-volatile organic contaminants from a solid matrix into a gas stream, using heat and mechanical agitation. The organic compounds transferred into the gas stream then are subjected to further treatment (e.g., carbon adsorption or high-temperature incineration).

Maximum contaminant levels (MCLs) in the soil exist approximately 10 feet BGS and below the water table. The upper clay layer, especially that above the water table, is believed to be relatively uncontaminated. Implementation of excavation at Site 5 would require construction of staging facilities for processing and characterizing excavated material for treatment and/or disposal. Uncontaminated soils from the upper clay layer would have to be removed and staged before excavation of the contaminated soils. Some mixing between uncontaminated and contaminated soils, resulting in additional treatment costs, would be inevitable. In order to remove the area of highest contamination, significant dewatering may be required, followed by treatment and disposal of the excavation-derived water.

Although some contaminant mass would be removed by excavation, backfilled material placed below the water table would be recontaminated by the groundwater. Based on the above factors, excavation followed by treatment and disposal is not considered an effective corrective measure for Site 5 and will not be considered further.

In Situ Treatment

Many technologies that employ physical-chemical or biological means to immobilize or remove waste constituents in the subsurface environment have been developed. In situ treatment technologies are discussed below.

Soil Flushing

Soil flushing is an in situ technology in which organic constituents such as those present at Site 5 are desorbed from subsurface soils by means of an extraction process using a suitable extractant. The process essentially consists of injecting an aqueous solution into the area of contamination. The contaminant elutriant then is pumped to the surface for removal, recirculation, or on-site treatment and reinjection. During elutriation, sorbed contaminants are mobilized into solution because of solubility, formation of an emulsion, or chemical reaction with the flushing solution. Therefore, an in situ soil-flushing system includes a network of aqueous solution injection and extraction wells.

Soil-flushing technology is not applied often at sites with suspected DNAPL because of the possibility of mobilizing the DNAPL. Because maximum concentrations reported in groundwater at the site suggest the potential presence of DNAPL, soil-flushing technology is not considered viable and will not be considered further.

In Situ Bioremediation

In situ bioremediation refers to the breakdown of organic compounds by action of microorganisms in the subsurface environment. In situ bioremediation is initiated by the addition of water enriched with nutrients and/or hydrogen into the subsurface. Occasionally, naturally occurring microorganisms are augmented by specialized contaminant-specific microorganisms to accelerate the restoration process. The most difficult aspect of implementing these in situ techniques is ensuring delivery of nutrients and/or other amendments to contaminated areas. In situ bioremediation involves designing an amendment injection system that will allow for the availability of nutrients, hydrogen, and/or other amendments in zones of contamination. The extent and rate of bioremediation are controlled by contaminant mass-transfer rates, which

are controlled by the efficiency of the injection and extraction systems and the characteristics of the soil media. Environmental factors such as soil pH and water alkalinity also control the extent and rate of in situ bioremediation.

In situ bioremediation may be viable for Site 5 provided that an adequate delivery strategy can be developed.

Soil Vapor Extraction and Bioventing

SVE
soil vapor extraction

Soil vapor extraction (SVE), also referred to as *vacuum extraction*, is an in situ technique used to remove volatile and semivolatile organics from the vadose (unsaturated) soil zone. The basic components of the system include extraction wells, monitoring wells, and high-vacuum pumps. The system operates by applying a vacuum through the extraction wells. The induced vacuum causes airflow in the interstitial pores, volatilizing and stripping the organics from the soil matrix into the air stream. The extracted air stream then is treated typically by using activated carbon. Several other geometries for SVE (e.g., trenches and horizontal drilling) are also available. In general, SVE is applicable for volatile organic contaminants only. In addition, the subsurface must be sufficiently permeable to permit the vapor extraction wells to draw air through all of the contaminated domain at a reasonable rate.

Bioventing essentially is in situ bioremediation in the vadose zone. Bioventing is similar to SVE; however, bioventing uses low-airflow rates to provide only enough oxygen to sustain microbial activity. Oxygen most commonly is supplied through direct air injection. Two basic criteria must be satisfied for successful bioventing. First, air must be able to pass through the soil in sufficient quantities to maintain aerobic conditions. Soil grain size and soil moisture significantly influence soil gas permeability. Second, hydrocarbon-degrading microorganisms must be present in concentrations large enough to obtain reasonable biodegradation rates. Besides the presence of bacterial populations, soil pH, moisture, basic nutrients (nitrogen and phosphorus), and temperature impact microbial activity.

Most of the contamination at Site 5 exists within saturated soils. In addition, the upper clay layer likely would not have adequate permeability to allow bioventing or vapor extraction. Therefore, SVE and bioventing will not be considered further for Site 5.

4.4.2 Groundwater Corrective Measure Technologies

Corrective measure technologies for groundwater involve one of the following four options:

- Active treatment of the plume;
- Containment of the plume;
- Diversion of groundwater to mitigate the further contamination of "clean" groundwater; or
- Prevention of leachate formation by lowering the groundwater table beneath a source of contamination.

Based on these corrective action options, groundwater corrective measure technologies generally are classified in the following groups:

- Subsurface containment;
- Extraction followed by on- and/or off-site treatment of groundwater; and
- In situ treatment.

Groundwater corrective measure technologies are presented below.

4.4.2.1 Subsurface Containment

Subsurface containment is a technology that adopts hydraulic barriers in the subsurface environment to intercept the groundwater flow. Hydraulic barriers divert groundwater so that it does not contact waste materials and become contaminated, and/or mitigate off-site contaminant migration. Subsurface containment includes the following technology types:

- Slurry walls,
- Liner panel walls,
- Jet grouting, and
- Sheet piling.

As described within the RFI, significant migration does not appear to be occurring. Hydraulic gradients at the site are relatively low indicating little groundwater flow through the contaminated areas. Therefore, the effectiveness of containment technologies at Site 5 would be minimal and they are not considered further.

4.4.2.2 Groundwater Extraction and On- or Off-Site Treatment

Groundwater extraction involves active manipulation and management of groundwater in order to contain or remove a plume or to adjust groundwater levels in order to prevent formation of a plume. Groundwater extraction can be achieved by using extraction wells, subsurface drains installed in excavated trenches, or horizontal boreholes.

Potential groundwater treatment can be accomplished either on or off site using one of the following four general approaches:

- On-site treatment using mobile treatment systems;
- On-site construction and operation of treatment systems;
- Pretreatment followed by discharge to a publicly owned treatment works (POTW) facility; and
- Transportation of collected groundwater to an off-site treatment facility.

POTW
publicly owned treatment works

Most commonly, on-site treatment systems for the contaminant types and flow rates expected at Site 5 include air stripping and/or carbon adsorption.

Carbon adsorption is a phase-transfer technology in which dissolved organic contaminants are transferred from the aqueous phase to the solid carbon phase. Carbon adsorption can be effective for removal of various dissolved organic compounds (including chlorinated aliphatic hydrocarbons and aromatic hydrocarbons such as benzene, ethylbenzene, toluene, and xylenes). Carbon adsorption applied to groundwater treatment generally utilizes carbon columns. In column applications, adsorption involves the passage of contaminated water through a bed of activated carbon, which selectively adsorbs the hazardous constituent onto the carbon. When the activated carbon is used to its maximum adsorptive capacity (i.e., spent), it is replaced and the spent carbon is disposed of, destroyed, or regenerated.

Air stripping is also a phase-transfer process, in which volatile organic contaminants are transferred to the vapor phase by pumping the contaminated groundwater through an air stripping tower. The organic-laden vapor or air stream from the tower then is treated typically using carbon adsorption or vented to the atmosphere, depending on contaminant concentrations. Besides an air stripping

tower, shallow-tray air strippers, diffused aeration, and jet stripping also are used for air stripping operations. Air stripping may be used as a pretreatment step followed by carbon adsorption or off-site disposal.

Off-site disposal of collected groundwater involves discharging to the local POTW via the existing base sewer system. This is done at other base IRP sites. A discharge permit modification would be required for a permanent discharge. Based on the expected concentrations within the collected groundwater, obtaining a permit for discharge of Site 5 groundwater is not expected to pose a problem. If necessary, pretreatment, including air stripping or carbon adsorption, could be done before discharge to POTW.

The effectiveness of the technology depends on the placement of the extraction system. Within the overburden groundwater, the extraction system should be placed in the sand layer to maximize collection effectiveness. Within the bedrock groundwater, it is more difficult to determine the appropriate extraction system placement. Flow within the bedrock depends on the distribution and connectivity of the fracture system. Locating a collection system would require performance and analysis of a pump test to optimize extraction locations.

It is anticipated that a significant portion of the contamination present in the sand layer could be removed using groundwater extraction within a relatively short time. As discussed above, significantly fewer portions of the contaminant mass located within the clay, till, and bedrock units are considered practically recoverable using traditional groundwater extraction technologies. Therefore, limited groundwater extraction from the sand layer and on- or off-site treatment are considered viable for Site 5.

4.4.2.3 In Situ Treatment

In situ treatment allows groundwater to be treated without being brought to the surface. It employs a combination of biological, physical, and chemical technologies.

Bioremediation

As discussed above, bioremediation refers to destruction techniques directed toward stimulating intrinsic microbial populations to grow and use the contaminants as a food and energy source by creating a favorable environment for the microorganisms. Generally, biological remediation of chlorinated compounds is accomplished by delivering a combination of hydrogen, nutrients, and/or co-metabolites to the subsurface and maintaining the groundwater

pH and temperature within the optimum range. Occasionally, intrinsic microbial populations may be supplemented by microbial cultures that have been specially bred for degradation of a particular variety of contaminants.

Co-metabolism and nitrate enhancement are two relatively new in situ biological treatment technologies. Co-metabolism has been used to biodegrade chlorinated chemical species such as TCE and vinyl chloride. This technology is one form of secondary substrate transformation in which enzymes produced for primary substrate oxidation are capable of degrading the secondary substrate, even though the secondary substrate does not provide sufficient energy to sustain the microbial population. Using co-metabolism, methanotrophic bacteria utilize the injected dissolved methane and oxygen as a primary substrate, and co-metabolize chlorinated compounds (e.g., TCE and vinyl chloride).

Nitrate enhancement relies on the greater solubility of nitrate in water compared to that of oxygen. Solubilized nitrate is circulated through groundwater contamination zones to provide electron acceptors for biological activity and to enhance the rate of anaerobic biodegradation by naturally occurring microbes. Toluene, ethylbenzene, and xylene compounds are known to degrade under aerobic conditions and under anaerobic conditions. However, the rate of aerobic biodegradation often is limited by the inability to provide sufficient oxygen to the contaminated zones as a result of the low water solubility of oxygen (maximum 9.3 milligrams per liter [mg/L] at standard temperature and pressure). Nitrates, on the other hand, have very high solubility and can be delivered efficiently to the subsurface environment.

mg/L
milligrams per liter

HRCs
hydrogen-releasing compounds

Hydrogen-releasing compounds (HRCs) may be used to ensure an adequate supply of electron donors. A hydrogen-releasing product developed and marketed by Regenesis provides lactic acid as a source of energy and hydrogen. The HRC product is pumped under pressure into the plume using direct push technology on a grid throughout the plume. As the product breaks down, lactic acid and hydrogen are produced and diffuse into the contaminated zone.

In situ bioremediation systems for groundwater corrective measures consist of supplying the above-described key elements to the subsurface environment, and monitoring the subsurface environment for process control. The rate at which microorganisms degrade contaminants is influenced by the specific contaminant types, concentrations, temperature, oxygen concentration, nutrient supply,

pH, the availability of contaminants to the microorganisms, and microbial growth inhibitors (e.g., mercury).

As discussed above for in situ bioremediation of soils, impediments to in situ bioremediation of groundwater include lack of an adequate delivery mechanism. In situ bioremediation may be viable for Site 5 provided an adequate delivery strategy can be developed.

Air Sparging

Air sparging, an in situ technology, uses compressed air delivered to the subsurface environment at one or more air injection wells. Air bubbles emanating from one or more injection wells traverse horizontally and vertically through the soil and water column, creating an in situ air stripper that removes contaminants from the groundwater by volatilization. The air injection well may or may not be coupled with an air extraction well positioned in the vadose zone. The air extraction well serves as a recovery well to capture volatilized contaminants. Because contaminants are removed by volatilization mechanisms, air sparging is applicable for chlorinated and aromatic VOCs. In a modification to the air sparging technology, steam may be used to replace the compressed air. By using steam, higher temperatures that enhance volatilization rates can be achieved, making some semivolatile compounds amenable to this technology.

Air sparging is not considered viable at Site 5 because of the presence of low-permeability clay within the unsaturated zone.

Passive Treatment Walls

Passive treatment walls use trenches filled with reactive permeable media to serve as an in situ reactor. These walls allow passive passage of groundwater while prohibiting movement of contaminants by employing agents such as chelators, sorbents, catalysts, or microbes. In the passive treatment wall, contaminants are destroyed, transformed chemically to a less mobile form, or retained in a concentrated form by the barrier material.

Because of the low hydraulic gradient, the unpredictable nature of the groundwater flow direction, and the low groundwater flow rate, implementation of this technology at Site 5 would be difficult. In addition, this technology generally is not considered applicable to bedrock groundwater because of difficulties in excavating a trench in bedrock. Therefore, this technology is not considered viable for Site 5 and will not be considered further.

4.5 Development and Evaluation of Corrective Measure

The developed corrective measure combines elements of several of the above technologies considered viable at Site 5. The corrective measure combines groundwater extraction to remove contaminant mass from within the source area with in situ bioremediation of soil and groundwater. The following factors were considered in development of the measure:

- Risks posed to human health and the environment by contaminants in the subsurface are minimal;
- TCE concentrations within the suspected source area suggest presence of DNAPL. Therefore, the primary source of contamination is likely below the water table;
- Significant migration of contaminants has not occurred and is not expected to occur within the near future;
- The spatial distribution of contamination appears to coincide with the sand layer, and the hydraulic properties of the sand lens suggest that this layer provides the primary path of contaminant migration;
- Most contaminant mass considered practically recoverable is limited to that located within the sand layer; and
- Degradation of contaminants is naturally occurring as demonstrated by the presence of TCE daughter products such as cis-1,2-DCE; trans-1,2-DCE; and vinyl chloride.

4.5.1 Description of the Corrective Measure

The corrective measure developed for Site 5 includes two main components: limited source removal followed by in situ bioremediation. The limited source removal will include groundwater extraction from the sand layer. Because of the limited extent of the sand layer and low hydraulic conductivity of the adjacent clay and till layers, it is anticipated that a significant mass of the contaminants within the sand layer can be removed during a short-term pumping event. It is expected that a significant portion of the contaminant mass considered recoverable can be removed by short-term pumping and that plume concentrations may be reduced to a point more amenable to bio-remediation.

In situ biological remediation will be accomplished by enhancing the biodegradation believed to be occurring already. A biological

activity evaluation will be completed to identify how the degradation process may be enhanced and how best to achieve the enhancement. The most difficult aspect of this corrective measure is ensuring adequate delivery of amendments throughout the plume. For purposes of this CMS, two alternative delivery strategies were developed. The first involves use of a limited number of injection wells combined with pumping from the source area during a second short-term pumping event. This will pull amendments through the plume to the source area. The effectiveness of this delivery strategy will be assessed through groundwater fate and transport modeling following the biological activity evaluation and initial short-term pumping event. If it is determined that this methodology cannot be accomplished within a reasonable time frame, a more active method, involving injection of amendments on a grid using direct push technology, will be considered. The actual implemented amendment delivery strategy will be based on results of the biological activity evaluation.

Other activities to be completed as part of the corrective measure include abandonment of the existing storm sewer pipe. Abandonment will be done by excavating the pipe and adjacent bedding. The pipe will be broken and the excavation extended until the underlying natural material is encountered. The excavation will be filled to a depth above the bedding with a cement bentonite grout or concrete. Abandonment of the sewer pipe in this manner will help ensure that the sewer pipe and its bedding are not providing a preferential pathway for migration of contaminants.

Below is a summary of the major components of the corrective measure.

Initial Biological Activity Evaluation

A biological activity evaluation will be completed to assess current natural biodegradation and the availability of nutrients required to maintain biological activity at an acceptable rate. This evaluation will consist of the following:

- Collection of groundwater samples from monitoring wells at the site; and

- Testing of the groundwater samples for pH, temperature, specific conductance, turbidity, ferrous and ferric iron, manganese, alkalinity, oxidation/reduction potential, VOCs, anions (chloride, nitrate, nitrite, phosphate, and sulfate), dissolved organic carbon, and dissolved gases (hydrogen, oxygen, nitrogen, carbon dioxide, methane, ethane, and ethene).

Sampling will be performed in accordance with EPA protocols for low-flow well purging and sampling.

The data will be evaluated and used in conjunction with a groundwater flow model discussed below to develop a strategy for enhancing biological activity, if necessary.

First Pumping Event

Short-term groundwater extraction will be performed in order to reduce the contaminant mass in the source area and to collect hydraulic data to be incorporated into a three-dimensional groundwater flow model. The key components of the pumping event are as follows:

- Two 20,000-gallon tanks will be mobilized to the site;
- Up to four extraction wells will be installed within the sand layer. The wells will be positioned within the area of highest groundwater contamination;
- Water will be collected from the wells and discharged to the tanks. Estimated well yields are on the order of 0.5 gpm. Pumping will last for about 20 days, removing 40,000 gallons. This is approximately the pore volume of groundwater estimated to have a TCE concentration greater than 1,000 µg/L;
- During the short-term pumping event, water levels will be measured continuously at all appropriate site wells and up to four new monitoring wells (piezometers) to better define hydrogeologic properties of the overburden and bedrock at the site; and
- Following the pumping event, extracted groundwater stored in the tanks will be characterized and undergo treatment as necessary before discharge to the sanitary sewer.

need permits

Groundwater Model Development

A three-dimensional groundwater flow and contaminant transport model of the site will be constructed utilizing information gathered during the RFI and previous investigations. Hydraulic data collected during the first pumping event will be analyzed and incorporated into the model. Information gathered during the biological activity evaluation will be used in conjunction with the groundwater flow model to develop a strategy for delivering amendments to the plume area and enhancing the biological activity. This strategy

will include the types of amendments required (e.g., nutrients, seed, and bacteria) and the method of delivery to the plume area (injection points). Transport modeling will be completed to determine the effectiveness of various delivery strategies.

Delivery Strategy Alternative 1: Second Pumping Event

A second pumping event similar to the first will be completed after allowing the sand layer to recharge and concentrations to re-equilibrate, resulting in a further reduction of contaminant mass within the sand layer. During the pumping event, biological amendments (e.g., nutrients, seed, and bacteria) will be added at selected locations within the plume. These amendments will be drawn toward the source area where the dewatering is occurring. Up to four additional wells may be installed to facilitate adequate delivery to all portions of the plume.

Delivery Strategy Alternative 2: Direct Injection

Groundwater amendments will be injected on grid locations over the area of the plume. The injection will be accomplished using direct push technology (Geoprobe) to drive a probe to the top of bedrock. Biological amendments then will be forced under pressure into the subsurface. Calculations will be performed to determine the optimum injection point spacing and the required volume of amendments per injection point. For purposes of this CMS, it is estimated that injection points at 10-foot intervals would be required over a plume area of approximately 1 acre and that a proprietary slow-release hydrogen amendment will be injected.

Biological Activity Monitoring

Following the second pumping event/direct injection and biological activity enhancement, a monitoring program will be implemented. Quarterly monitoring for two years is recommended to assess contaminant degradation, uptake of amendments, and overall changes in the groundwater chemistry and quality. If necessary, additional pumping/injection events may be completed during the monitoring period to further enhance biodegradation, replenish amendments, etc.

4.5.2 Evaluation of Corrective Measure

This section includes an evaluation of the developed corrective measure based on technical, environmental, human health, and institutional concerns. The final portion of this section includes an estimate of the costs associated with this alternative.

4.5.2.1 Technical Concerns

Technical concerns encompass technical effectiveness, reliability, implementability, and safety issues.

Effectiveness

The effectiveness of the short-term pumping events in removing a significant portion of the contaminant mass will not be known until implementation of the first event. Groundwater extraction will result in a reduction of contaminant mass within the subsurface at the site. Whether this is significant with respect to the total contaminant mass will not be known until completion of the pumping event. However, the pumping process will be designed to remove groundwater with the highest contaminant concentrations. This not only will reduce risks posed by the groundwater, but also reduce the potential for further migration.

Research conducted in aerobic and anaerobic biodegradation has shown that chlorinated organics such as TCE; cis-1,2-DCE; and vinyl chloride, as well as aromatic compounds such as benzene, toluene, ethylbenzene, and xylenes, are biodegradable in groundwater. Various organic compounds are transformed biologically by indigenous microorganisms to stable, nontoxic end products such as carbon dioxide and water. Intermediate products in the degradation of TCE include cis-1,2-DCE and vinyl chloride. Because vinyl chloride reportedly was never used as a raw product on base (SAIC 1991) and cis-1,2-DCE was not commercially available in significant quantities, the presence of these compounds in site groundwater further supports that biodegradation is naturally occurring. Because high levels of vinyl chloride are not found throughout the installation, this compound apparently is not being degraded further to the nontoxic end products ethene and chloride.

The corrective measure includes an assessment of these naturally occurring processes and will address the need for amendments to enhance the degradation. Published literature supports that degradation can be enhanced by the addition of amendments. However, the effectiveness of this technology is limited by the ability to deliver the amendments to all portions of the plume. Complex hydrogeology often results in a short-circuiting of injection and extraction wells. The corrective measure includes detailed study and modeling of the site hydrodynamics to develop a strategy to deliver amendments.

Reliability

The corrective measure combines technologies that remove contaminant mass from the subsurface. Therefore, long-term

reliability is not an issue. Once the contaminated mass is removed, it will not return. During implementation of the corrective measure, injection of amendments will be done in conjunction with pumping events to minimize the potential of forcing contaminants farther away from the source area. Extensive monitoring will take place after amendment addition to evaluate the degradation processes and associated contaminant reductions.

Implementability

The corrective measure is relatively simple to implement. Pumping will be temporary; therefore, no construction or installation of permanent utilities is required, minimizing initial capital costs. There are no pumps to be maintained or serviced. Pumping events will be performed during warm periods, so freeze protection of equipment will not be necessary. Collected water will be discharged to the sanitary sewer following treatment as necessary. This is being done at other sites on base and is not expected to pose a problem.

Safety

The corrective measure does not involve construction (other than well installation), so potential for construction-related accidents is minimal. Significant volumes of contaminated media will not be exposed as to create an air-related health concern to the community. In addition, the corrective measure includes no trucking of hazardous waste off site.

4.5.2.2 Environmental Concerns

There appears to be a completed pathway for environmental exposure to site contaminants. The activities to be completed as part of the corrective measure are not expected to induce significant migration of contaminants, nor will they uncover contaminants. Therefore, expansion or completion of exposure pathways to sensitive environmental receptors is not anticipated, so the corrective action has no significant environmental concerns.

4.5.2.3 Human Health Concerns

Site groundwater exceeds NYSDEC Class GA groundwater standards for waters with a best possible use as drinking water. On-site groundwater is not used as a potable water supply, nor is it expected to be used in the future because of the availability of publicly supplied water and the low yield of the formations within which the contaminated groundwater is located. However, the corrective measure will offer no additional protection of human health at Site 5 until Class GA criteria are achieved. It is impossible to predict when this will occur until the corrective

measure is implemented. However, because contaminant mass will be reduced through groundwater extraction, risks to human health based on potential consumption of groundwater are expected to be mitigated to some extent immediately after implementation.

4.5.2.4 Institutional Concerns

Contaminant concentrations in groundwater and soils will continue to exceed criteria until biologically degraded. It will be impossible to predict the time required to achieve the CAOs until the corrective measure is implemented. However, removal of groundwater with the highest levels of contamination will reduce the potential for further spread of contamination. Other institutional concerns related to this alternative include compliance with local requirements for discharge to the sanitary sewer system. This type of discharge has been implemented before at the base and is not expected to pose a problem. Should it be required, carbon treatment is included in the cost estimate as a pretreatment measure.

4.5.2.5 Cost

Costs associated with implementation of the corrective measure, including capital and labor expended over the first two years, are estimated to range from $309,000 to $405,000. This cost estimate includes storm sewer abandonment, the first pumping event, initial biological activity evaluation, and eight subsequent quarterly monitoring events. In addition, the low end of the range includes amendment delivery strategy one (single injection of a relatively low-cost amendment). The high end of the range includes amendment delivery strategy two (multipoint injection of relatively high-cost slow-release amendment). Operations and maintenance costs associated with the corrective measure include quarterly monitoring and reporting. Costs for an additional 10 years of quarterly monitoring of four wells are estimated to be $53,000 annually. The estimated present worth of this 10-year monitoring period after an initial three-year startup is $353,500. Therefore, the estimated total present worth is $662,500 to $758,500 over the next 13 years.

5

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A

Sewer Video Inspection Logs

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PROJECT	NIAGARA FALLS AIR RESERVE STATION			PURCHASE ORDER #	
ENGINEER	ECOLOGY AND ENVIRONMENT			PROJECT #	151
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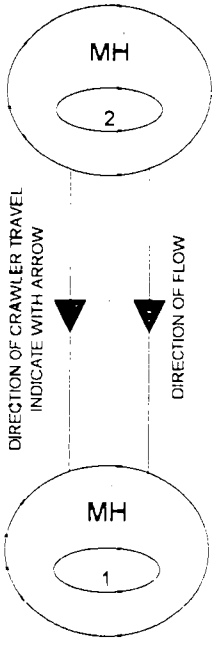

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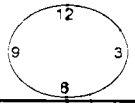

SPECIAL CONDITIONS

DOWNSTREAM FROM MH #2 TO MH #1

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			INSPECTION COMPLETE

ABBREVIATIONS

L-LEAK
O-OBSTRUCTION
R-ROOTS
SR-SEVERE ROOTS
RC-ROOTS IN CONNECTION
BJ-BAD JOINT
JL-JOINT LEAK
OJ-OFFSET JOINT
BP-BROKEN PIPE
CP-CRACKED PIPE
SP-SAG IN LINE
CR-CRUSHED PIPE
V-WYE
T-TAP/LATERAL
PT-PROTRUDING TAP
IA-INACTIVE CONNECTION
MD-MINERAL DEPOSIT
ED-EXCESSIVE DEBRIS

SHEET 1 OF 8

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ENGINEER	ECOLOGY AND ENVIRONMENT	PROJECT #	151
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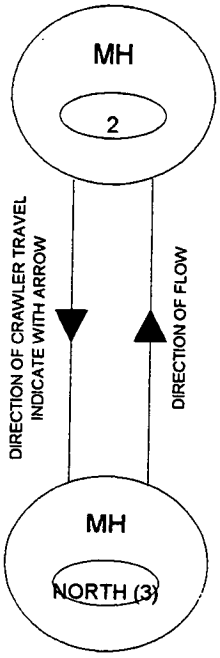

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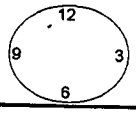

SPECIAL CONDITIONS

UPSTREAM FROM MH #2 TO NORTH INLET AT MH #3

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			INSPECTION TERMINATED

ABBREVIATIONS

L-LEAK
O-OBSTRUCTION
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OJ-OFFSET JOINT
BP-BROKEN PIPE
CP-CRACKED PIPE
SP-SAG IN LINE
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Y-WYE
T-TAP/LATERAL
PT-PROTRUDING TAP
IA-INACTIVE CONNECTION
MD-MINERAL DEPOSIT
ED-EXCESSIVE DEBRIS

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SEP 0 8 '99
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ENGINEER	ECOLOGY AND ENVIRONMENT			PROJECT #	151
LOCATION				CONTR. SUPT.	
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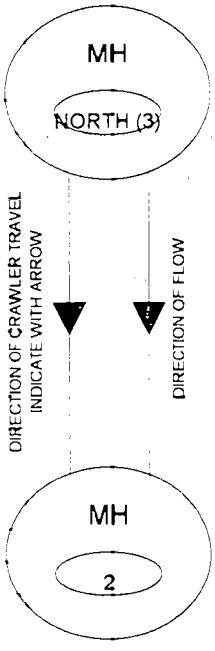

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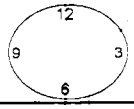

SPECIAL CONDITIONS

DOWNSTREAM FROM NORTH INLET AT MH #3 TO MH #2

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			INSPECTION COMPLETE

ABBREVIATIONS

L-LEAK
O-OBSTRUCTION
R-ROOTS
SR-SEVERE ROOTS
RC-ROOTS IN CONNECTION
BJ-BAD JOINT
JL-JOINT LEAK
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BP-BROKEN PIPE
CP-CRACKED PIPE
SP-SAG IN LINE
CR-CRUSHED PIPE
Y-WYE
T-TAP/LATERAL
PT-PROTRUDING TAP
IA-INACTIVE CONNECTION
MD-MINERAL DEPOSIT
ED-EXCESSIVE DEBRIS

RECEIVED BUFF

ECOLOGY

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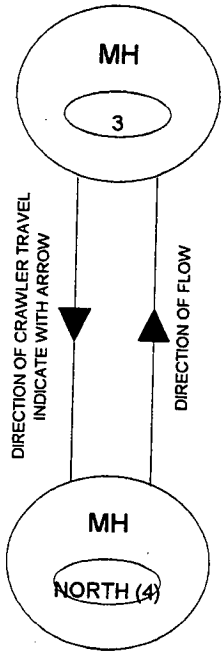
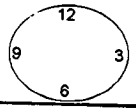
ENGINEER	ECOLOGY AND ENVIRONMENT	PROJECT #	151
LOCATION		CONTR. SUPT.	
FROM MH #	3	TO MH # NORTH (4)	INSPECTOR GF
SECTION LENGTH	88.4'		DATE/TIME 7/21/99
PIPE: SIZE	8"	TYPE	VIDEO TAPE # 1
MATERIAL	VTP	SPACING	[S - 0:15.47] [F - 0:19.02]



CLOCK



SPECIAL CONDITIONS

UPSTREAM FROM MH #3 TO MH #4

FEET	REFERENCE OBSERVATIONS		REMARKS
88.40		FI	END OF SECTION AT MH #4
			INSPECTION COMPLETE

ABBREVIATIONS

- L-LEAK
- O-OBSTRUCTION
- R-ROOTS
- SR-SEVERE ROOTS
- RC-ROOTS IN CONNECTION
- BJ-BAD JOINT
- JL-JOINT LEAK
- OJ-OFFSET JOINT
- BP-BROKEN PIPE
- CP-CRACKED PIPE
- SP-SAG IN LINE
- CR-CRUSHED PIPE
- Y-WYE
- T-TAP/LATERAL
- PT-PROTRUDING TAP
- IA-INACTIVE CONNECTION
- MD-MINERAL DEPOSIT
- ED-EXCESSIVE DEBRIS

RECEIVED BUFFALO
SEP 03
ECOLOGY & ENVIRONMENT, INC.

SHEET 4 OF 8

TECHNICIAN SIGNATURE

AMERICAN PIPE SERVICES, INC.

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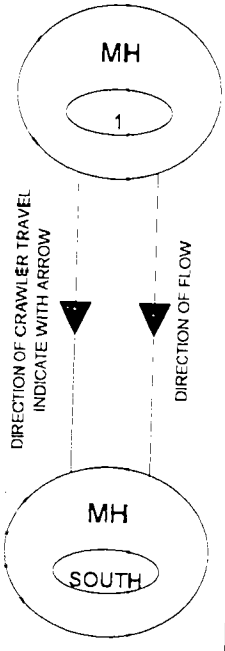
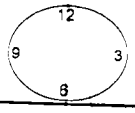
CCTV VIDEO INSPECTION LOG

PROJECT	NIAGARA FALLS AIR RESERVE STATION	PURCHASE ORDER #	
ENGINEER	ECOLOGY AND ENVIRONMENT	PROJECT #	151
LOCATION		CONTR. SUPT.	
FROM MH #	1	TO MH # SOUTH	INSPECTOR GF
SECTION LENGTH	162.8'		DATE/TIME 7/21/99
PIPE: SIZE	8"	TYPE	VIDEO TAPE # 1
MATERIAL	VTP	SPACING	[S - 0:19.02] [F - 0:28.46]



CLOCK



SPECIAL CONDITIONS

DOWNSTREAM FROM MH #1 TO SOUTH

FEET	REFERENCE OBSERVATIONS		REMARKS
44.80	12 O/C	BP	
135.40		CP	
157.80			
162.80		FI	END OF SECTION AT SOUTH
			INSPECTION COMPLETE

ABBREVIATIONS

L-LEAK
O-OBSTRUCTION
R-ROOTS
SR-SEVERE ROOTS
RC-ROOTS IN CONNECTION
BJ-BAD JOINT
JL-JOINT LEAK
OJ-OFFSET JOINT
BP-BROKEN PIPE
CP-CRACKED PIPE
SP-SAG IN LINE
CR-CRUSHED PIPE
Y-WYE
T-TAP/LATERAL
PT-PROTRUDING TAP
IA-INACTIVE CONNECTION
MD-MINERAL DEPOSIT
ED-EXCESSIVE DEBRIS

SHEET 5 OF 8

TECHNICIAN SIGNATURE

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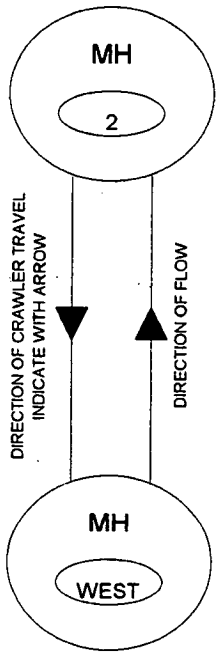
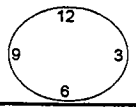
CCTV VIDEO INSPECTION LOG

PROJECT	NIAGARA FALLS AIR RESERVE STATION	PURCHASE ORDER #	
ENGINEER	ECOLOGY AND ENVIRONMENT	PROJECT #	151
LOCATION		CONTR. SUPT.	
FROM MH #	2 TO MH # WEST	INSPECTOR	GF
SECTION LENGTH	278.9'	DATE/TIME	7/21/99
PIPE: SIZE	8" TYPE	VIDEO TAPE #	1
MATERIAL	RCP SPACING	[S - 0:28.46]	[F - 0:40.26]



CLOCK



SPECIAL CONDITIONS

UPSTREAM FROM MH #2 TO WEST

FEET	REFERENCE	OBSERVATIONS	REMARKS
117.80	9 O/C	T	ACTIVE
118.00	3 O/C	T	ACTIVE
205.70	3 O/C	T	ACTIVE
205.80	9 O/C	T	ACTIVE
278.90		ED	UNABLE TO PASS
			INSPECTION TERMINATED

ABBREVIATIONS

L-LEAK
O-OBSTRUCTION
R-ROOTS
SR-SEVERE ROOTS
RC-ROOTS IN CONNECTION
BJ-BAD JOINT
JL-JOINT LEAK
OJ-OFFSET JOINT
BP-BROKEN PIPE
CP-CRACKED PIPE
SP-SAG IN LINE
CR-CRUSHED PIPE
Y-WYE
T-TAP/LATERAL
PT-PROTRUDING TAP
IA-INACTIVE CONNECTION
MD-MINERAL DEPOSIT
ED-EXCESSIVE DEBRIS

TECHNICIAN SIGNATURE

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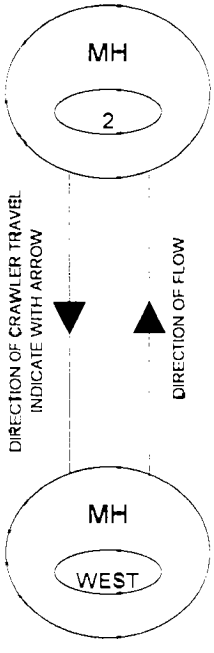
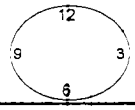
(716) 874-3476

PACP'S CCTV VIDEO INSPECTION LOG

PROJECT	NIAGARA FALLS AIR RESERVE STATION			PURCHASE ORDER #	
ENGINEER	ECOLOGY AND ENVIRONMENT			PROJECT #	151
LOCATION				CONTR. SUPT.	
FROM MH #	2	TO MH #	WEST	INSPECTOR	GF
SECTION LENGTH	278.9'			DATE/TIME	7/21/99
PIPE: SIZE	8"	TYPE		VIDEO TAPE #	1
MATERIAL	RCP	SPACING		[S - 0:40.26]	[F - 0:50.37]



CLOCK



SPECIAL CONDITIONS

UPSTREAM FROM MH #2 TO WEST

FEET	REFERENCE	OBSERVATIONS		REMARKS
32.00	9 O/C	T		ACTIVE
32.00	3 O/C	T		ACTIVE
117.30	9 O/C	T		ACTIVE
117.40	3 O/C	T		ACTIVE
134.20		ED		UNABLE TO PASS
				INSPECTION TERMINATED

ABBREVIATIONS

L-LEAK
O-OBSTRUCTION
R-ROOTS
SR-SEVERE ROOTS
RC-ROOTS IN CONNECTION
BJ-BAD JOINT
JL-JOINT LEAK
OJ-OFFSET JOINT
BP-BROKEN PIPE
CP-CRACKED PIPE
SP-SAG IN LINE
CR-CRUSHED PIPE
Y-WYE
T-TAP/LATERAL
PT-PROTRUDING TAP
IA-INACTIVE CONNECTION
MD-MINERAL DEPOSIT
ED-EXCESSIVE DEBRIS

TECHNICIAN SIGNATURE

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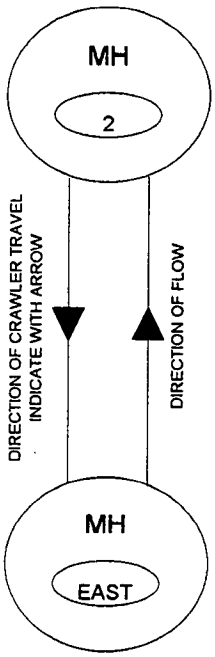
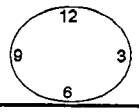
CCTV VIDEO INSPECTION LOG

PROJECT	NIAGARA FALLS AIR RESERVE STATION			PURCHASE ORDER #	
ENGINEER	ECOLOGY AND ENVIRONMENT			PROJECT #	151
LOCATION				CONTR. SUPT.	
FROM MH #	2	TO MH #	EAST	INSPECTOR	GF
SECTION LENGTH	11.0'			DATE/TIME	7/21/99
PIPE: SIZE	6"	TYPE		VIDEO TAPE #	1
MATERIAL	RCP	SPACING		[S - 0:50.37]	[F - 0:55.34]



CLOCK



SPECIAL CONDITIONS

UPSTREAM FROM MH #2 TO EAST

FEET	REFERENCE	OBSERVATIONS	REMARKS
11.00		OJ	UNABLE TO PASS
			INSPECTION TERMINATED

ABBREVIATIONS

L-LEAK
O-OBSTRUCTION
R-ROOTS
SR-SEVERE ROOTS
RC-ROOTS IN CONNECTION
BJ-BAD JOINT
JL-JOINT LEAK
OJ-OFFSET JOINT
BP-BROKEN PIPE
CP-CRACKED PIPE
SP-SAG IN LINE
CR-CRUSHED PIPE
Y-WYE
T-TAP/LATERAL
PT-PROTRUDING TAP
IA-INACTIVE CONNECTION
MD-MINERAL DEPOSIT
ED-EXCESSIVE DEBRIS

SHEET 8 OF 8

TECHNICIAN SIGNATURE

B

Analytical Results

Laboratory Reports to be provided in Final Report.

Memorandum

To: File 000515.EJ09

From: Rick Watt, Project Manager RWW

Date: 01/24/00

Re: Sample Identifiers

Subsequent to collection of sediment and water samples from four manholes located at Site 5 in the vicinity of Building 920, sample identifiers were altered. The table below correlates the sample identifiers applied in the field notes, laboratory reports, and data review memorandum included in Appendix B of the Focussed RFI/CMS report with the report location identifiers used in Section 2.1, Tables 2-1 and 2-2, and Figure 2-1 of the report.

Field Sample ID	Laboratory Report Number	Report Location ID
MH5-A-WO-061699	9906048	MH5-1
MH5-B-WO-061699	9906048	MH5-2
MH5-C-WO-061699	9906048	MH5-3
MH5-D-WO-061699	9906048	Utility Manhole (UM) 25 feet northeast of MH5-2
MH5-A-SO-061699	9906048	MH5-1
MH5-B-SO-061699	9906048	MH5-2
MH5-C-SO-061699	9906048	MH5-3
MH5-D-SO-061699	9906048	Utility Manhole (UM) 25 feet northeast of MH5-2
MH5-1-W2-072199	9907132	MH5-1

DATA REVIEW MEMORANDUM

DATE: August 16, 1999

TO: Richard Watt, Project Manager, E & E, Buffalo

FROM: Marcia Meredith Galloway, QA Officer E & E, Buffalo

SUBJ: Data Review
Niagara Falls International Airport - Air Reserve Station (IAP-ARS)

REFERENCE:

ASC Work Order	Project ID
9906048	000515EJ09000270
9907105	000515EJ09000370
9907117	000515EJ09000370
9907118	000515EJ09000370
9907130	000515EJ09000370
9907131	000515EJ09000370
9907132	000515EJ09000270
9907141	000515EJ09000370
9907142	000515EJ09000370
9907151	000515EJ09000370
9907173	000515EJ09000370

I. SAMPLE IDENTIFICATION

For the sampling activities at Niagara Falls IAP-ARS, Ecology and Environment, Inc. (E & E) collected the samples listed on the following table. The samples were analyzed for methods listed below. Trip blanks were provided with each shipment and analyzed for volatiles. All samples were sent to E & E's Analytical Services Center (ASC) for analysis.

Matrix	Client Sample ID	Lab Sample ID	Collection Date	Method
Groundwater	GP5-75-WO-072099	9907117-01A	7/20/99	SW8021B
Groundwater	GP5-76-WO-072099	9907117-02A	7/20/99	SW8021B
Groundwater	GP5-77-WD-072099	9907117-05A	7/20/99	SW8021B
Groundwater	GP5-77-WO-072099	9907117-04A	7/20/99	SW8021B
Groundwater	GP5-78-WO-072099	9907117-07A	7/20/99	SW8021B
Groundwater	GP5-79-WO-072099	9907117-06A	7/20/99	SW8021B
Groundwater	GP5-88-WO-072299	9907141-02A	7/22/99	SW8021B
Groundwater	GP5-90-WO-072299	9907141-03A	7/22/99	SW8021B
Groundwater	GP5-91-WO-072299	9907141-01A	7/22/99	SW8021B

Matrix	Client Sample ID	Lab Sample ID	Collection Date	Method
Groundwater	GP5-92-WO-072399	9907151-02A	7/23/99	SW8021B
Groundwater	GP5-A5-WO-072799	9907173-01A	7/27/99	SW8260B
Groundwater	GP5-A6-WO-072299	9907142-05A	7/22/99	SW8260B
Groundwater	GP5-B5-WO-072299	9907142-06A	7/22/99	SW8260B
Groundwater	GP5-B6-WO-072299	9907142-04A	7/22/99	SW8260B
Groundwater	GP5-C6-WO-072299	9907142-03A	7/22/99	SW8260B
Groundwater	GP5-D5-WO-072299	9907142-02A	7/22/99	SW8260B
Groundwater	GP5-D6-WO-072199	9907131-05A	7/21/99	SW8260B
Groundwater	GP5-E5-WO-072199	9907131-06A	7/21/99	SW8260B
Groundwater	GP5-E6-WO-072199	9907131-04A	7/21/99	SW8260B
Groundwater	GP5-F5-WO-072199	9907131-03A	7/21/99	SW8260B
Groundwater	GP5-F6-WO-072099	9907118-01A	7/20/99	SW8260B
Groundwater	GP5-G5-WO-072199	9907131-01A	7/21/99	SW8260B
Groundwater	GP5-G6-WO-072099	9907118-02A	7/20/99	SW8260B
Groundwater	GP5-H5-WO-072199	9907131-02A	7/21/99	SW8260B
Groundwater	GP5-H6-WD-072099	9907118-04A	7/20/99	SW8260B
Groundwater	GP5-H6-WO-072099	9907118-03A	7/20/99	SW8260B
Groundwater	MH5-1-W2-072199	9907132-01A	7/21/99	SW8260B
Groundwater	MH5-A-WO-061699	9906048-01A	6/16/99	SW8260B
Groundwater	MH5-B-WO-061699	9906048-03A	6/16/99	SW8260B
Groundwater	MH5-C-WO-061699	9906048-05A	6/16/99	SW8260B
Groundwater	MH5-D-WO0061699	9906048-07A	6/16/99	SW8260B
Groundwater	MH5-D-WO0061699	9906048-07B	6/16/99	SW8270C
Groundwater	MH5-D-WO0061699	9906048-07B	6/16/99	SW9040B
Groundwater	MH5-D-WO0061699	9906048-07C	6/16/99	SW6010B
Sediment	MH5-A-SO-061699	9906048-02A	6/16/99	SW8260B
Sediment	MH5-B-SO-061699	9906048-04A	6/16/99	SW8260B
Sediment	MH5-C-SO-061699	9906048-06A	6/16/99	SW8260B
Sediment	MH5-D-SO-061699	9906048-08A	6/16/99	SW8260B
Soil	GP5-69A-SO-071999	9907105-01A	7/19/99	SW8021B
Soil	GP5-69B-SO-071999	9907105-02A	7/19/99	SW8021B
Soil	GP5-70C-SO-071999	9907105-03A	7/19/99	SW8021B
Soil	GP5-71B-SO-071999	9907105-04A	7/19/99	SW8021B
Soil	GP5-72B-SO-071999	9907105-05A	7/19/99	SW8021B
Soil	GP5-72C-SD-071999	9907105-10A	7/19/99	SW8021B
Soil	GP5-72C-SO-071999	9907105-06A	7/19/99	SW8021B
Soil	GP5-73A-SO-071999	9907105-07A	7/19/99	SW8021B
Soil	GP5-73C-SO-071999	9907105-09A	7/19/99	SW8021B
Soil	GP5-74C-SO-071999	9907105-08A	7/19/99	SW8021B
Soil	GP5-80A-SO-072199	9907130-22A	7/21/99	SW8021B
Soil	GP5-80B-SO-072199	9907130-23A	7/21/99	SW8021B
Soil	GP5-80C-SO-072199	9907130-24A	7/21/99	SW8021B
Soil	GP5-81A-SO-072199	9907130-21A	7/21/99	SW8021B
Soil	GP5-82A-SO-072199	9907130-18A	7/21/99	SW8021B
Soil	GP5-82B-SO-072199	9907130-19A	7/21/99	SW8021B
Soil	GP5-82C-SO-072199	9907130-20A	7/21/99	SW8021B

Matrix	Client Sample ID	Lab Sample ID	Collection Date	Method
Soil	GP5-83A-SO-072199	9907130-16A	7/21/99	SW8021B
Soil	GP5-83C-SO-072199	9907130-17A	7/21/99	SW8021B
Soil	GP5-84A-SO-072199	9907130-13A	7/21/99	SW8021B
Soil	GP5-84B-SO-072199	9907130-14A	7/21/99	SW8021B
Soil	GP5-84C-SO-072199	9907130-15A	7/21/99	SW8021B
Soil	GP5-85A-SO-072199	9907130-11A	7/21/99	SW8021B
Soil	GP5-85A-SO-072199	9907130-25A	7/21/99	SW8021B
Soil	GP5-85C-SO-072199	9907130-12A	7/21/99	SW8021B
Soil	GP5-86A-SO-072199	9907130-08A	7/21/99	SW8021B
Soil	GP5-86B-SO-072199	9907130-09A	7/21/99	SW8021B
Soil	GP5-86C-SO-072199	9907130-10A	7/21/99	SW8021B
Soil	GP5-93A-SO-072399	9907151-03A	7/23/99	SW8021B
Soil	GP5-93B-SO-072399	9907151-04A	7/23/99	SW8021B
Soil	GP5-93C-SO-072399	9907151-05A	7/23/99	SW8021B
Soil	GP5-94A-SO-072399	9907151-06A	7/23/99	SW8021B
Soil	GP5-94C-SO-072399	9907151-07A	7/23/99	SW8021B
Soil	GP5-95A-SO-072399	9907151-08A	7/23/99	SW8021B
Soil	GP5-95B-SO-072399	9907151-09A	7/23/99	SW8021B
Soil	GP5-95C-SO-072399	9907151-10A	7/23/99	SW8021B
Soil	GP5-96A-SO-072399	9907151-11A	7/23/99	SW8021B
Soil	GP5-96B-SO-072399	9907151-12A	7/23/99	SW8021B
Soil	GP5-96C-SO-072399	9907151-13A	7/23/99	SW8021B
Trip Blank	MH-WT-061699	9906048-09A	6/16/99	SW8260B
Trip Blank	WT-071999	9907105-11A	7/19/99	SW8021B
Trip Blank	WT-072099	9907117-03A	7/20/99	SW8021B
Trip Blank	WT-072199	9907131-07A	7/21/99	SW8260B
Trip Blank	WT-072299	9907142-01A	7/22/99	SW8260B
Trip Blank	WT-072399	9907151-01A	7/23/99	SW8021B

Data were reviewed for field and laboratory precision, accuracy, and completeness in accordance with procedures and quality control (QC) limits, the current laboratory Quality Assurance Manual (QAM) and current standard operating procedures (SOPs).

Laboratory data qualifiers for compound identification and quantitation were accepted, no additional data review qualifiers were added. Definitions of all data qualifiers are given in the report.

II. SAMPLE PROCEDURES

All samples were collected as specified in the work plan and documented on the chain-of-custody (COC) and in field notebooks. Samples were analyzed as specified on the COC. Samples were packaged, shipped and received as specified in the work plan. All samples must be received cold 4 (+/-2) °C and in good condition as documented on the Cooler Receipt Form.

REVIEW RESULTS:

All sample procedures were followed except that a cooler was received on July 27, 1999 at 6:20 PM, but the cooler was not placed in cold storage immediately. The cooler was opened the next morning and was at 16 degrees. The shipment also did not include a trip blank. The only affected sample was GP5-A5–WO-072799. Field staff verified that the sample was properly iced on delivery. Therefore, the temperature would have increased gradually over the evening and the sample would not have been warm for very long. The sample was all non-detect, which was consistent with expectations based on historical data. Therefore, there does not appear to be any impact on data use.

III. LABORATORY DATA

1.0 HOLDING TIMES

Holding times are established and monitored to ensure analytical results accurately represent analyte concentrations in a sample at the time of collection. Exceeding the holding time for a sample generally results in a loss of the analyte due to a variety of mechanisms, such as deposition on the sample container walls or precipitation.

REVIEW RESULTS:

All holding times were met except for the pH analysis of sample MH5-D-WO. The analysis was completed one day beyond holding times. The positive result is flagged "J" as estimated.

2.0 BLANKS

Laboratory blank samples are analyzed and evaluated to determine the existence and magnitude of possible contamination. Generally, if analyte concentrations exceeding the LDL for a given metal are detected in a laboratory blank, then it is likely that the analyte is present as a contaminant from some phase of the extraction or analytical procedure and associated low level sample concentrations may be biased high.

REVIEW RESULTS:

No blank contamination was detected above the LDL for both method and trip blanks. Method blanks were performed at the required frequency. One trip blank was not collected as noted above.

3.0 MATRIX SPIKE AND MATRIX SPIKE DUPLICATE ANALYSIS

The matrix spike and matrix spike duplicate (MS/MSD) analyses are intended to provide information about the affects that the sample matrix exerts on the digestion/extraction and measurement methodology. MS recovery values that do not meet laboratory QC criteria may indicate that sample analyte results are being attenuated in the analysis procedure. The potential sample bias may be estimated by noting the degree to which the MS concentration was elevated or lowered in the spike analysis. However, this bias should serve only as approximations; sample-specific problems may be the cause of the discrepancy, particularly in soil samples. Recoveries of a post-digestion spike or a laboratory control sample (LCS) are used to verify that the analytical methodology is acceptable and that MS recoveries are due to matrix effects. A MSD analysis is analyzed to evaluate the precision of the sample results. Precision is measured as the relative percent difference (RPD) between analytical results for duplicate samples. The laboratory's failure to produce similar results for MSD samples may indicate that the samples were non-homogeneous (particularly in soil samples), or that method defects may exist in the laboratory's techniques.

REVIEW RESULTS:

The MS/MSD sample analyses were performed at the required frequency. The recovery and RPD results were generally within QC criteria established for the LCS and no significant matrix effects were indicted. The LCS recoveries were within control limits. Therefore, no data qualification or corrective action is required.

4.0 LABORATORY CONTROL SAMPLE ANALYSIS

The LCS is analyzed to monitor of the efficiency of the digestion/extraction procedure and analytical instrument operation. The ability of the laboratory to successfully analyze a LCS demonstrates that there are no analytical problems related to the digestion/sample preparation procedures and/or instrument operations.

REVIEW RESULTS:

All LCS analyses were within control limits and performed at the required frequency.

5.0 SURROGATE SPIKE RECOVERY

Laboratory performance for individual samples is established by means of surrogate spiking activities. Samples are spiked with surrogate compounds prior to preparation and analysis. Unusually low or high surrogate recovery values may indicate some deficiency in the analytical

system or that some matrix effects exist, resulting in low or high sample results for target compounds.

REVIEW RESULTS:

All surrogate spike recoveries for all samples were within laboratory QC criteria except for the following geoprobe screening samples. No corrective action is required because the surrogates are just below limits, other surrogate recoveries are within limits, and the samples are used for screening purposes only.

Client Sample ID	Analyte	REC	Low Limit	High Limit	Qual
GP5-82C-SO-072199	1,4-Dichlorobutane	61.63%	62	129	None
GP5-83C-SO-072199	1,4-Dichlorobutane	60.94%	62	129	None
GP5-93B-SO-072399	1,4-Dichlorobutane	61.24%	62	129	None
GP5-95B-SO-072399	1,4-Dichlorobutane	57.01%	62	129	None
GP5-96A-SO-072399	1,4-Dichlorobutane	60.40%	62	129	None

IV. FIELD DUPLICATE SAMPLE RESULTS

Field duplicate samples were collected and analyzed as an indication of overall precision for both field and laboratory. The results are expected to have more variability than laboratory duplicates, which measure only laboratory precision. It is expected also that soil field duplicates will exhibit greater variance than water field duplicates due to the difficulties associated with collecting identical field samples. The QC criteria used to assess field duplicate samples for this project were limits of 70% RPD for soils and 40% RPD for waters, or twice the general laboratory duplicate criteria. If both compounds were below the laboratory PQL or one of the compounds was present as a non-detect, then the compounds are generally not qualified for to field duplicate precision. There are no guidelines regarding data qualification based on poor field duplicate precision. Professional judgement was used to determine whether or not to qualify results.

REVIEW RESULTS:

Two field duplicate sets were collected for groundwater samples and one field duplicate set was collected for soils. The laboratory misinterpreted the COC record and analyzed an additional sample in duplicate. Acceptable precision was generated for all of the analyses performed on the field duplicates except for the one soil sample used for screening. All samples for screening methods are considered estimated values and no data qualification is required.

Comparison of Field Duplicates for Soil Samples				
Field Duplicate Pair	Parameter	Original Result (ug/L)	Duplicate Result (ug/L)	RPD
GP5-72C-SO/SD-071999	Trichloroethene	7150	1950	114%

Notes : NC = Not calculated.

ND = Less than detection limit.

V. COMPOUND IDENTIFICATION AND QUANTITATION

Compound identities are assigned by comparing sample compound retention times to retention times from known (standard) compounds. For Method 8260B, positive results are confirmed based on identification of an acceptable mass spectrum. Compounds detected below PQLs in samples should be considered estimated and are qualified "J". For Method 8021B, the results are confirmed based on comparison of a standard retention time and analysis of the sample on a second column. Results for samples used for screening purposes may not be confirmed. If the results are not confirmed, they are qualified "N".

REVIEW RESULTS:

All compound identification and quantitation criteria were achieved.

C

Investigation Derived Waste Report

ecology and environment, inc.

International Specialists in the Environment

BUFFALO CORPORATE CENTER
368 Pleasant View Drive, Lancaster, New York 14086
Tel: 716/684-8060, Fax: 716/684-0844

January 18, 2000

Barbara J. Mansfield
Operational Contracting Office
914th AW/LGC
2720 Kirkbridge Drive
Niagara Falls, New York 14304-5001

Re: Investigation-Derived Waste
Project Numbers 99-0697 and 99-0658
Contract Number. F30617-94-D-0008

Dear Ms. Mansfield:

Investigation-derived waste (IDW) was generated between July 19, 1999 and September 17, 1999 during performance of the Site 5 RFI/CMS (RVKQ 99-0697) and 1999 Groundwater Monitoring (RVKQ 99-0658) projects. Some of this waste has been disposed of within the specifications of the Niagara County Sewer District No. 1 Industrial Waste Discharge Permit, and some waste remains. Enclosed is an inventory of the IDW (Table 1) and IDW analytical results from water (Table 2) and soil samples (Table 3) collected from the remaining waste. Ecology and Environment, Inc. (E & E) seeks approval to dispose of additional wastewater on site and dispose of waste soil either on site or off site if a suitable on-site location can not be identified.

IDW previously disposed of includes well purge water generated during groundwater sampling at Sites 3, 10, and 13 (Table 1). Based on the analytical results of the wells sampled and the volume of well purge water generated at these sites, the total mass of volatile organic compounds (VOCs) discharged at each site was calculated. For Sites 3, 10, and 13, the resulting VOC masses were 2.9×10^{-6}, 0.04, and 6.5×10^{-5} pounds, respectively. These contaminant masses are well within the daily discharge limits of the Niagara County Sewer District No. 1 Industrial Waste Discharge Permit.

Approximately 231 gallons of well purge water was disposed of directly on the ground near the wells purged (Table 1). These wells were previously determined to be "clean" and the well purge water was not containerized in accordance with the NYSDEC-approved work plan.

A composite sample from two drums of IDW wastewater generated at Sites 5, 7, and 8 was analyzed for VOCs, metals, and pH (see Table 2). Based on the analytical results and the volume of wastewater contained in drums DM99-8 and DM99-9, the mass of contaminants within the purgewater was calculated. When added to the average daily discharge of permitted contaminants at Sites 3, 10, and 13, the resulting mass, if discharged in one day, is within the limits of the Niagara County Sewer District No. 1 Industrial Waste Discharge Permit. Therefore, E & E seeks approval to dump the drummed purgewater from Sites 5, 7, and 8 into the sanitary sewer lift station at Building 731.

IDW soil was generated during the installation of geoprobe wells and monitoring wells at Site 5 (Table 1). A composite sample of these soils was analyzed for TCLP VOCs, TCLP metals, pH, and reactivity (see Table 3). All parameters were found to be within acceptable regulatory levels. Therefore, E & E seeks approval to dispose of the soil at a suitable on-site location chosen by the installation Remedial Project Manager (RPM), Mr. Gerry Hromowyk. If no suitable on-site location is identified, E & E will arrange for appropriate disposal of the soil at an off-site landfill as non-regulated, non-hazardous waste.

For your reference, attached to this letter are the original laboratory reports, or appropriate portions thereof, pertaining to the IDW sample analyses summarized in Tables 2 and 3.

If you have any questions please call me at 684-8060.

Sincerely,

Richard M. Watt

Richard M. Watt, P.G.
Project Manager

Attachments

cc: G. Hromowyk (914th AW/CEV)
T. Grady (E & E)

Ref No.: 000515.EJ08.00.03.00
000515.EJ09.00.06

Table 1 1999 Investigation-Derived Waste Inventory, Niagara Falls ARS

Drum/ Container ID Number	Date Generated	Waste Source	Contents	Approximate Volume	Sample ID	Disposal Method
DM99-1	3/24/99	MW3-1A (4.5 gal), MW3-3DA (8.3 gal), MW3-4DA (6.5 gal)	Well purge water	19 gal	IDW-3-WO-032599	Pumped into sewer at Building 731 lift station on 3/26/99.
DM99-2	3/26/99	MW5-1DA (9 gal), MW5-4D (9.4 gal), MW5-5D (10 gal), MW5-8D (8 gal)	Well purge water	36 gal	IDW-5-WO-032699	Pumped into sewer at Building 731 lift station on 5/27/99.
DM99-3	**3/23-3/24/99**	**MW10-1DA (60 gal), MW10-2 (3 gal), MW10-2E (10 gal), MW10-3 (4 gal), MW10-4 (2.7 gal), MW10-4D (9 gal), MW10-4E (18 gal), MW10-6 (4 gal), MW10-7 (3.5 gal), MW10-9D (10.2 gal)**	**Well purge water**	**124 gal**	**IDW-10-WO-032499**	**Pumped into sewer at Building 731 lift station on 3/26/99.**
DM99-4	3/25/99	MW13-1E (15 gal), MW13-3 (1 gal), MW13-4D (3 gal), MW13-5 (1.5 gal), MW13-5 D (2.5 gal)	Well purge water	23 gal	IDW-13-WO-032599	Pumped into sewer at Building 731 lift station on 3/26/99.
DM99-5	9/1-9/2/99	MW5-6 installation	Soil (0-15 ft)	0.27 yd^3	DM99-A-SO-091099	
DM99-6	9/2/99	MW5-7 installation	Soil (0-13.4 ft)	0.27 yd^3	DM99-A-SO-091099	
DM99-7	9/2/99	MW5-8 installation	Soil (0-11.2 ft)	0.27 yd^3	DM99-A-SO-091099	
DM99-8	9/1-9/17/99	MW5-1DA (7 gal), MW5-6 (12 gal), MW5-7 (7 gal), MW5-8 (1.5 gal), MW5-8D (6 gal), decon (20 gal)	Decon water from well installation, well development water, well purge water	54 gal	DM99-B-WO-091799	
DM99-9	9/13-9/17/99	MW5-4D (9 gal), MW5-5D (8 gal), MW5-6 (2 gal), MW5-8 (1 gal), MW7-1D (2.5 gal), MW8-1 (2 gal), MW8-3DA (6 gal), MW8-10D (6 gal)	Well purge water	37 gal	DM99-B-WO-091799	
DM99-10	7/19-7/23/99	Site 5 geoprobe wells	Soil (0-15 ft)	0.3 yd^3	DM99-A-SO-091099	

Drum/ Container ID Number	Date Generated	Waste Source	Contents	Approximate Volume	Sample ID	Disposal Method
Not drummed	9/13/99	MW3-1A (3 gal), MW3-3DA (8 gal), MW3-4DA (7 gal)	Well purge water	18 gal	---	Dumped into PW3-3A
Not drummed	9/15-9/17/99	MW10-1DA (38 gal), MW10-2E (9 gal), MW10-3 (1gal), MW10-4 (0.13 gal), MW10-4D (7 gal), MW10-4E (17 gal), MW10-6 (0.5 gal), MW10-7 (0.25 gal), MW10-9D (9 gal), MW10-10D (7 gal)	Well purge water	89 gal	---	Dumped into PW10-1
Not drummed	9/16/99	MW13-1E (13 gal), MW13-3 (0.5 gal), MW13-4 (0.5 gal), MW13-4D (2 gal), MW13-5D (0.13 gal)	Well purge water	16 gal	---	Dumped into PW13-1
Not drummed	9/13-9/17/99	MW1-1DA (6 gal), MW3-1E (21 gal), MW3-5D (95 gal), MW7-3D (5 gal), MW5-1E (20 gal), MW5-5A (3 gal), MW5-6D (8 gal), MW5-7D (7 gal), MW10-1EA (15 gal), MW10-1F (25 gal), MW10-3D (9 gal), MW10-3E (17 gal)	Well purge water	231 gal	---	Dumped on ground at individual well locations

Key:

gal = Gallons.
MW = Monitoring well.
yd^3 = Cubic yards.

Table 2 Investigation-Derived Waste Analytical Results for Water Sample DM99B-WO-091799, Niagara Falls ARS

Analyte	Contaminant Concentration (µg/L)	Contaminant Mass (pounds)	Average Daily Discharge for Sites 3, 10 & 13 (pounds/day)[a]	Total Discharge Limits for Sites 3, 10, & 13 (pounds/day)[b]
VOCs (µg/L) (Method 8260B)				
Benzene	ND	-	0	0.1
Carbon disulfide	ND	-	0	0.1
Carbon tetrachloride	ND	-	0.0000390	0.15
Chloroform	ND	-	0.0001900	0.1
cis-1,2-Dichloroethene	**616**	**0.000466**	**0.008655**	**0.081**
Methylene chloride	**ND**	**-**	**0**	**0.012**
trans-1,2-Dichloroethene	**2.98 J**	**0.000002**	**0**	**NS**
Trichloroethene	**3660**	**0.002770**	**0.00099**	**0.256**
Vinyl chloride	ND	-	0.002317	0.13
Priority Pollutant Metals (µg/L) (Method 6010B)				
Arsenic	91.3	0.000692	0	0.1
Cadmium	44.5	0.000337	0	0.1
Chromium	361	0.002734	0	NS
Copper	606	0.000459	0	0.2
Lead	1100	0.000832	0.0001543	0.3
Nickel	318	0.000241	0	0.3
Zinc	85,000	0.064328	0.038737	0.3
pH (s.u.)	8.7[c]	-	NS	NS

[a] From 1999 Quarterly Performance Monitoring Reports by E & E.

[b] Niagara County Sewer District No. 1, Industrial Discharge Permit.

[c] Performed in field with Hydac pH meter calibrated to stand buffer solutions. Within limits (>2 or <12) specified in 6 NYCRR 371.

Key: J = Analyte detected below reporting limits. ND = Not detected.
NS = No limit specified. s.u. = Standard units.
µg/L = Micrograms per liter.

Table 3 Investigation-Derived Waste Analytical Results for Soil
Niagara Falls ARS

Sample ID: / Sample Date:	DM99-A-SO 9/10/99	Regulatory Level[a]
Analyte (units)		
TCLP VOCs (mg/L) (Method 8260B)		
1,1-Dichloroethene	ND	0.7
1,2-Dichloroethane	ND	0.5
2-Butanone	ND	200
Benzene	ND	0.5
Carbon tetrachloride	ND	0.5
Chlorobenzene	ND	100.0
Chloroform	ND	6.0
Tetrachloroethene	ND	0.73
Trichloroethene	ND	0.5
Vinyl chloride	ND	0.2
TCLP Metals (mg/L) (Method 6010B/7470A)		
Arsenic	ND	5.0
Barium	0.570	100
Cadmium	ND	1.0
Chromium	ND	5.0
Lead	ND	5.0
Mercury	ND	0.2
Selenium	ND	1.0
Silver	ND	5.0
pH (s.u.) (Method 9045C)	6.5	>2 or <12
Reactivity (mg/Kg) (Method 9012A-7.3.3/9034-7.3.4)		
Cyanide	ND	250
Sulfide	ND	500

[a] 6 NYCRR 371

Key:

mg/Kg = Milligrams per kilogram.
mg/L = Milligrams per liter.
ND = Not detected.
s.u. = Standard units.
TCLP = Toxicity Characteristic Leaching Procedure.
VOC = Volatile Organic Compound

Ecology and Environment, Inc.
Analytical Services Center
4493 Walden Avenue
Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

September 29, 1999

Mr. Rick Watt
Ecology & Environment, Inc.
368 Pleasant View Dr.
Lancaster, NY 14086

RE: Niagara Falls Air Reserve Station – 000515.EJ09.00.03.70
Work Order No.: **9909100**

Dear Mr. Watt,

Ecology and Environment, Inc. received 1 sample on Friday, September 10, 1999 for the analyses presented in the following report.

E & E will retain the samples addressed in this report for 30 days, unless otherwise instructed by the client. If additional storage is requested, the storage fee is $1.00 per sample container per month, to accrue until the client authorizes sample destruction.

Sincerely,

Barbara Krajewski
Project Manager

CC: Lab File

Ecology and Environment, Inc.
Analytical Services Center
Lancaster, New York 14086
Phone: (716) 685-8080

Laboratory Results

NYS ELAP ID#: 10486

CLIENT: E and E Buffalo Office
Project: Niagara Falls Air Reserve Station
Lab Order: 9909100

CASE NARRATIVE

WET CHEMISTRY

Low spike recovery for the reactive cyanide and sulfide laboratory control samples are typical of these methods.

CHAIN OF CUSTODY RECORD

ASC analytical services center

Ecology and Environment, Inc., Analytical Services Center
4493 Walden Avenue, Lancaster, New York, 14086, Tel: 716/685-8080, Fax 716/685-0852
Where Scientific Excellence and Efficiency Meet

Cooler No: 1
Lab: ASC

PROJECT No:	SITE NAME:	LOCATION: (Include State)
000515. EJ09.00. 03.70	NIAGARA FALLS ARS	NY

CLIENT: 914th AW, AFRC

PROJECT MANAGER: RWATT

OFFICE No:

FIELD TEAM LEADER: RWATT

PHONE No:

SAMPLERS: (PRINT) J. MAUS

CONTAINER TYPE AND PRESERVATIVE

REQUESTED ANALYSIS

DATE	TIME	SAMPLE ID	SAMPLE MATRIX	CHECK FOR MS/MSD	SAMPLE TYPE	No. OF CONTAINERS	TCLP VOCs	TCLP METALS	pH	REACTIVITY CN SULFIDE				OVA/HNU READINGS (PPM)	BEGINNING DEPTH (FEET BGS)	ENDING DEPTH (FEET BGS)	REMARKS
9-10-99	1110	DM99-A-SO-091099	SB		0	3	x	x	x	x							

TURNAROUND TIME
24-HOUR ☐ RUSH
48-HOUR ☐
1-WEEK ☐
STANDARD ☒
RUSH _____ days
OTHER _____

(FOR LAB USE ONLY)
Lab Job No:
Report type:
Batch QC:
Yes No

Relinquished By: (Signature)	Date/Time:	Received By: (Signature)	Date/Time:	Ship Via:	Date:
				E&E	9-10-99
Relinquished By: (Signature)	Date/Time:	Received By: (Signature)	Date/Time:	BL/Airbill Number:	
			9/10/99 12:15	N/A	

Temperature Blank Info.
Enclosed: (Yes) No

(FOR LAB USE ONLY)
Date: _____ Time: _____
Temperature: _____ °C

Distribution: White - Lab original Yellow - Field team leader

2

Ecology and Environment, Inc. Analytical Services Center

Cooler Receipt Form

PACKAGE RECEIPT #: 4551 NUMBER OF COOLERS: 1 cooler DATE RECEIVED: 9/10/99

E & E PROJECT #: _____ PROJECT OR SITE NAME: Niagara Falls ARS

A. Preliminary Examination Phase

CIRCLE ONE

1. Did coolers come with airbill or packing slip? _____ YES (NO) NA

   Enter carrier here and print airbill # below: *(Circle One)* FedEx Airborne (Client) Other

2. Did cooler(s) have custody seals? _____ YES (NO) NA

   If YES, how many and where? _____

3. Were custody seals unbroken and intact on receipt? _____ YES NO* (NA)

4. Were custody seals dated and signed? _____ YES NO (NA)

   If YES, enter date: _____ Name: _____

5. Sign here to acknowledge receipt of cooler (s): Jen Wart

   Date cooler(s) opened: 9/10/99 C-O-C numbers: _____

   Cooler(s) opened by (print): Jennifer Wart Signature: Jen Wart

6. Were the C-O-C forms received? _____ (YES) NO* NA

7. Was the project identifiable from the C-O-C form? _____ (YES) NO* NA

   If YES, enter the project number and name in the heading above.

Please record Temperature Blank or Cooler Temperature for Each Cooler. Range (2 - 6°C)*

AIRBILL #	TEMP. °C	AIRBILL #	TEMP. °C	AIRBILL #	TEMP. °C
✓	3.5°C				

Thermometer # 142 Correction Factor 0 * If No or Temperature Outside of Acceptable Range, a CAF must be filed. CAF # _____

B. Unpacking Phase

8. Was enough packing material used in cooler(s)? _____ (YES) NO NA

   Type of material: ☐ Vermiculite ☐ Bubble Wrap ☑ Other

9. If required, was enough ice used? _____ (YES) NO NA

   If YES, type of ice used: ☑ Wet ☐ Dry ☐ Blue ☐ Other

10. Was a temperature blank included inside cooler(s)? _____ (YES) NO NA

    If YES, indicate temperature blank temperature in table above. If NO, indicate cooler temperature in table above.

11. Were all containers sealed in separate plastic bags? _____ YES (NO) NA

12. Did all containers arrive unbroken and in good condition? _____ (YES) NO* NA

C. Login Phase

Samples Logged In By (print): KYLE MEAD Signature: Kyle Mead Date: 9/10/99

13. Were all container labels complete (e.g. date, time preserv)? _____ (YES) NO* NA

14. Were all C-O-C forms filled out properly in ink and signed? _____ (YES) NO* NA

15. Did the C-O-C form agree with containers received? _____ (YES) NO* NA

16. Were the correct containers used for the tests requested? _____ (YES) NO* NA

17. Were the correct preservatives listed on the sample labels? _____ (YES) NO* NA

18. Was a sufficient sample volume sent for the tests requested? _____ (YES) NO* NA

19. Were all volatile samples received without head space? _____ (YES) NO* NA

Ecology and Environment, Inc.

Analytical Services Center

Lancaster, New York 14086

Phone: (716) 685-8080

Laboratory Results

NYS ELAP ID#: 10486

Lab Order: 9909100

Client: E and E Buffalo Office

Project: Niagara Falls Air Reserve Station

DATES REPORT

Sample ID	Client Sample ID	Collection Date	Matrix	Test Name	TCLP Date	Prep Date	Analysis Date
9909100-01A	DM99-A-SO-091099	09/10/1999 11:10:00 AM	Soil	TCLP VOCs by Method 8260B		09/13/1999	09/17/1999
9909100-01B				TCLP Mercury by Method 7470A		09/13/1999	09/15/1999
				TCLP Metals by ICP Method 6010B		09/14/1999	09/15/1999
9909100-01C				pH by Method EPA 9045C		09/13/1999	09/13/1999
				Reactive Cyanide by Method 9012A-7.3.3		09/20/1999	09/20/1999
				Reactive Sulfide by Method 9034-7.3.4		09/20/1999	09/20/1999

Ecology and Environment, Inc.

Analytical Services Center

4493 Walden Avenue

Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 104[redacted]

Phone: (716) 685-80[redacted]

CLIENT: E and E Buffalo Office
Client Sample ID: DM99-A-SO-091099
Lab Order: 9909100
Alt. Client ID:
Project: Niagara Falls Air Reserve Station
Collection Date: 9/10/99 11:10:00 AM
Lab ID: 9909100-01A **Sample Type:** SAMP **Matrix:** SOIL **% Moist:**

Analyte	Result	Q	Limit	Units	DF	Date Analyzed	Run Batch ID	Analyst
TCLP VOLATILE ORGANIC COMPOUNDS BY METHOD 8260B								
1_1311_8260B_L								
1,1-Dichloroethene	ND		0.05	mg/L	10	9/17/99 12:24:00 AM	JAKE_990916B	DWW
1,2-Dichloroethane	ND		0.05	mg/L	10			
2-Butanone	ND		0.1	mg/L	10			
Benzene	ND		0.05	mg/L	10			
Carbon tetrachloride	ND		0.05	mg/L	10			
Chlorobenzene	ND		0.05	mg/L	10			
Chloroform	ND		0.05	mg/L	10			
Tetrachloroethene	ND		0.05	mg/L	10			
Trichloroethene	ND		0.05	mg/L	10			
Vinyl chloride	ND		0.1	mg/L	10			
Surr: 1,2-Dichloroethane-d4	108.0		72-114	%REC	10			
Surr: 4-Bromofluorobenzene	98.9		88-120	%REC	10			
Surr: Toluene-d8	98.0		79-119	%REC	10			

Definitions:

ND - Not Detected at the Reporting Limit
J - Analyte detected below Reporting limits
B - Analyte detected in the associated Method Blank
H - Value exceeds Maximum Contaminant Level
* - Recovery outside limits
R - RPD outside recovery limits
E - Value above quantitation range
Surr - Denotes Surrogate Compound
M -Matrix Spike recovery outside limits
Q - Qualifier
Limit - Reporting Limit

Ecology and Environment, Inc.
Analytical Services Center
4493 Walden Avenue
Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909100
Project: Niagara Falls Air Reserve Station

QC SUMMARY REPORT
Method Blank

TCLP VOCs by Method 8260B Test Code: *1_1311_8260B_L* Units: **mg/L**

Sample ID: **BLK 1312-154-2**

Run Batch ID: **JAKE_990916B** SeqNo: **66007** Analysis Date: **9/16/99 7:07:00 PM** Prep Batch ID: **199900866** Prep Date:

	Analyte	Result	RL	Spike Value	Orig Result	%REC	LowLimit	HighLimit	%RPD	RPDLimit [1]	Qual
A	1,1-Dichloroethene	ND	0.005								
A	1,2-Dichloroethane	ND	0.005								
A	2-Butanone	ND	0.01								
A	Benzene	ND	0.005								
A	Carbon tetrachloride	ND	0.005								
A	Chlorobenzene	ND	0.005								
A	Chloroform	ND	0.005								
A	Tetrachloroethene	ND	0.005								
A	Trichloroethene	ND	0.005								
A	Vinyl chloride	ND	0.01								
S	1,2-Dichloroethane-d4	0.04923		0.05		98%	72	114			
S	4-Bromofluorobenzene	0.04807		0.05		96%	88	120			
S	Toluene-d8	0.05033		0.05		101%	79	119			

Definitions: ND - Not Detected at the Reporting Limit; * - LCS Recovery outside limits; M - Matrix Spike Recovery outside limits; RL -Reporting Limit

J - Analyte detected below reporting limits; B - Analyte detected in the associated Method Blank; R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable)

1 - Represents RSD Limit for Quad Analysis

Ecology and Environment, Inc.
Analytical Services Center
4493 Walden Avenue
Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909100
Project: Niagara Falls Air Reserve Station

QC SUMMARY REPORT
Method Blank

TCLP VOCs by Method 8260B Test Code: *1_1311_8260B_L* Units: **mg/L**

Sample ID: **ZHE-199900866**

Run Batch ID: **JAKE_990916B** SeqNo: **66008** Analysis Date: **9/16/99 9:06:00 PM** Prep Batch ID: **199900866** Prep Date: **9/13/99**

	Analyte	Result	RL	Spike Value	Orig Result	%REC	LowLimit	HighLimit	%RPD	RPDLimit [1]	Qual
A	1,1-Dichloroethene	ND	0.05								
A	1,2-Dichloroethane	ND	0.05								
A	2-Butanone	ND	0.1								
A	Benzene	ND	0.05								
A	Carbon tetrachloride	ND	0.05								
A	Chlorobenzene	ND	0.05								
A	Chloroform	ND	0.05								
A	Tetrachloroethene	ND	0.05								
A	Trichloroethene	ND	0.05								
A	Vinyl chloride	ND	0.1								
S	1,2-Dichloroethane-d4	0.4738		0.5		95%	72	114			
S	4-Bromofluorobenzene	0.4777		0.5		96%	88	120			
S	Toluene-d8	0.592		0.5		118%	79	119			

Definitions: ND - Not Detected at the Reporting Limit; * - LCS Recovery outside limits; M - Matrix Spike Recovery outside limits; RL -Reporting Limit

J - Analyte detected below reporting limits; B - Analyte detected in the associated Method Blank; R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable)

J 1 - Represents RSD Limit for Quad Analysis

Ecology and Environment, Inc.
Analytical Services Center
4493 Walden Avenue
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Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909100
Project: Niagara Falls Air Reserve Station

QC SUMMARY REPORT
Laboratory Control Spike - generic

TCLP VOCs by Method 8260B Test Code: *1_1311_8260B_L* Units: **mg/L**

Sample ID: **LCS 1312-154-1**

Run Batch ID: **JAKE_990916B** SeqNo: **66010** Analysis Date: **9/16/99 5:46:00 PM** Prep Batch ID: **199900866** Prep Date:

Analyte		Result	RL	Spike Value	Orig Result	%REC	LowLimit	HighLimit	%RPD	RPDLimit [1]	Qual
A	1,1-Dichloroethene	0.0537	0.005	0.05	0	107%	61	135			
A	1,2-Dichloroethane	0.05472	0.005	0.05	0	109%	80	134			
A	2-Butanone	0.04207	0.01	0.05	0	84%	46	169			
A	Benzene	0.05034	0.005	0.05	0	101%	82	131			
A	Carbon tetrachloride	0.05665	0.005	0.05	0	113%	81	132			
A	Chlorobenzene	0.049	0.005	0.05	0	98%	77	128			
A	Chloroform	0.0525	0.005	0.05	0	105%	81	130			
A	Tetrachloroethene	0.05132	0.005	0.05	0	103%	76	127			
A	Trichloroethene	0.05046	0.005	0.05	0	101%	82	120			
A	Vinyl chloride	0.0494	0.01	0.05	0	99%	43	159			
S	1,2-Dichloroethane-d4	0.05512		0.05	0	110%	82	124			
S	4-Bromofluorobenzene	0.04907		0.05	0	98%	87	115			
S	Toluene-d8	0.0495		0.05	0	99%	85	115			

Definitions: ND - Not Detected at the Reporting Limit; * - LCS Recovery outside limits; M - Matrix Spike Recovery outside limits; RL - Reporting Limit

J - Analyte detected below reporting limits; B - Analyte detected in the associated Method Blank; R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable)

1 - Represents RSD Limit for Quad Analysis

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Laboratory Results

NYS ELAP ID#: 10486

Phone: (716) 685-80[illegible]

CLIENT: E and E Buffalo Office
Client Sample ID: DM99-A-SO-091099
Lab Order: 9909100
Alt. Client ID:
Project: Niagara Falls Air Reserve Station
Collection Date: 9/10/99 11:10:00 AM
Lab ID: 9909100-01B **Sample Type:** SAMP
Matrix: SOIL **% Moist:**

Analyte	Result	Q	Limit	Units	DF	Date Analyzed	Run Batch ID	Analyst
TCLP METALS ANALYSIS BY METHOD 6010B 1_1311_6010B_L								
Arsenic	ND		0.3	mg/L	1	9/15/99 2:32:06 PM	OPTIMA_990915C	SHT
Barium	0.570		0.06	mg/L	1			
Cadmium	ND		0.015	mg/L	1			
Chromium	ND		0.03	mg/L	1			
Lead	ND		0.15	mg/L	1			
Selenium	ND		0.3	mg/L	1			
Silver	ND		0.03	mg/L	1			

Definitions:

ND - Not Detected at the Reporting Limit
J - Analyte detected below Reporting limits
B - Analyte detected in the associated Method Blank
H - Value exceeds Maximum Contaminant Level
* - Recovery outside limits
R - RPD outside recovery limits
E - Value above quantitation range
Surr - Denotes Surrogate Compound
M -Matrix Spike recovery outside limits
Q - Qualifier
Limit - Reporting Limit

LIMS Version #: 3.1.1.0Dev - 9/15/99 12:00:00 PM

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NYS ELAP ID#: 10486
Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909100
Project: Niagara Falls Air Reserve Station

QC SUMMARY REPORT
Method Blank

TCLP Metals by ICP Method 6010B Test Code: *1_1311_6010B_L* Units: **mg/L**

Sample ID: **MB-199900878**

Run Batch ID: **OPTIMA_990915C** SeqNo: **63234** Analysis Date **9/15/99 1:28:44 PM** Prep Batch ID: **199900878** Prep Date: **9/14/99**

	Analyte	Result	RL	Spike Value	Orig Result	%REC	LowLimit	HighLimit	%RPD	RPDLimit [1]	Qual
A	Arsenic	ND	0.3								
A	Barium	ND	0.06								
A	Cadmium	ND	0.015								
A	Chromium	ND	0.03								
A	Lead	ND	0.15								
A	Selenium	ND	0.3								
A	Silver	ND	0.03								

Definitions: ND - Not Detected at the Reporting Limit; * - LCS Recovery outside limits; M - Matrix Spike Recovery outside limits; RL -Reporting Limit; J - Analyte detected below reporting limits; B - Analyte detected in the associated Method Blank; R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable); 1 - Represents RSD Limit for Quad Analysis

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Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909100
Project: Niagara Falls Air Reserve Station

QC SUMMARY REPORT
Laboratory Control Spike - generic

TCLP Metals by ICP Method 6010B Test Code: *1_1311_6010B_L* Units: **mg/L**

Sample ID: **LCS-199900878**

Run Batch ID: **OPTIMA_990915C** SeqNo: **63235** Analysis Date **9/15/99 1:32:10 PM** Prep Batch ID: **199900878** Prep Date: **9/14/99**

	Analyte	Result	RL	Spike Value	Orig Result	%REC	LowLimit	HighLimit	%RPD	RPDLimit [1]	Qual
A	Arsenic	1.102	0.3	1	0	110%	85	115			
A	Barium	1.114	0.06	1	0	111%	85	115			
A	Cadmium	1.108	0.015	1	0	111%	85	115			
A	Chromium	1.099	0.03	1	0	110%	85	115			
A	Lead	1.11	0.15	1	0	111%	85	115			
A	Selenium	1.073	0.3	1	0	107%	85	115			
A	Silver	0.05264	0.03	0.05	0	105%	85	115			

Definitions: ND - Not Detected at the Reporting Limit
J - Analyte detected below reporting limits
1 - Represents RSD Limit for Quad Analysis
* - LCS Recovery outside limits
B - Analyte detected in the associated Method Blank
M - Matrix Spike Recovery outside limits
RL -Reporting Limit
R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable)

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Laboratory Results

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Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909100
Project: Niagara Falls Air Reserve Station

QC SUMMARY REPORT
Sample Matrix Spike

TCLP Metals by ICP Method 6010B Test Code: *1_1311_6010B_L* Units: mg/L
Sample ID: **9909075-03AS**
Run Batch ID: **OPTIMA_990915C** SeqNo: **63250** Analysis Date **9/15/99 2:21:05 PM** Prep Batch ID: **199900878** Prep Date: **9/14/99**

Analyte		Result	PQL	SPK Added	Orig Result	%REC	%RPD
A	Barium	46.53	0.6	50	0.2277	93%	

TCLP Metals by ICP Method 6010B Test Code: *1_1311_6010B_L* Units: mg/L
Sample ID: **9909075-03AS**
Run Batch ID: **OPTIMA_990915C** SeqNo: **63246** Analysis Date **9/15/99 2:10:41 PM** Prep Batch ID: **199900878** Prep Date: **9/14/99**

Analyte		Result	PQL	SPK Added	Orig Result	%REC	%RPD
A	Arsenic	4.718	0.3	5	0	94%	
A	Cadmium	0.8266	0.015	1	0	83%	
A	Chromium	4.294	0.03	5	0	86%	
A	Lead	4.083	0.15	5	0	82%	
A	Selenium	4.957	0.3	5	0	99%	
A	Silver	0.9787	0.03	1	0	98%	

TCLP Metals by ICP Method 6010B Test Code: *1_1311_6010B_L* Units: mg/L
Sample ID: **9909075-03AS1**
Run Batch ID: **OPTIMA_990915C** SeqNo: **63251** Analysis Date **9/15/99 2:24:43 PM** Prep Batch ID: **199900878** Prep Date: **9/14/99**

Analyte		Result	PQL	SPK Added	Orig Result	%REC	%RPD
A	Barium	51	0.6	50	0.2277	102%	9.2%

Qualifiers: ND - Not Detected at the Reporting Limit (PQL); S - Spike Recovery outside accepted recovery limits; R - RPD outside accepted recovery limits; J - Analyte detected below quantitation limits (MDL<*<PQL); B - Analyte detected in the associated Method Blank

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Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909100
Project: Niagara Falls Air Reserve Station

QC SUMMARY REPORT

Sample Matrix Spike Duplicate

TCLP Metals by ICP Method 6010B Test Code: ***1_1311_6010B_L*** Units: **mg/L**

Sample ID: **9909075-03AS1**

Run Batch ID: **OPTIMA_990915C** SeqNo: **63247** Analysis Date **9/15/99 2:13:50 PM** Prep Batch ID: **199900878** Prep Date: **9/14/99**

Analyte		Result	PQL	SPK Added	Orig Result	%REC	%RPD
A	Arsenic	5.019	0.3	5	0	100%	6.2%
A	Cadmium	0.9065	0.015	1	0	91%	9.2%
A	Chromium	4.679	0.03	5	0	94%	8.6%
A	Lead	4.387	0.15	5	0	88%	7.2%
A	Selenium	5.307	0.3	5	0	106%	6.8%
A	Silver	1.059	0.03	1	0	106%	7.9%

Qualifiers: ND - Not Detected at the Reporting Limit (PQL)
J - Analyte detected below quantitation limits (MDL<*<PQL)
S - Spike Recovery outside accepted recovery limits
B - Analyte detected in the associated Method Blank
R - RPD outside accepted recovery limits

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[redacted]caster, New York 14086
NYS ELAP ID#: 10486
Phone: (716) 685-8080

Laboratory Results

CLIENT:	E and E Buffalo Office	Client Sample ID:	DM99-A-SO-091099
Lab Order:	9909100	Alt. Client ID:	
Project:	Niagara Falls Air Reserve Station	Collection Date:	9/10/99 11:10:00 AM
Lab ID:	9909100-01B Sample Type: SAMP	Matrix:	SOIL % Moist:

Analyte	Result	Q	Limit	Units	DF	Date Analyzed	Run Batch ID	Analyst
TCLP MERCURY ANALYSIS IN WATER BY METHOD 7470A 1_1311_7470A_L								
Mercury	ND		0.02	mg/L	1	9/15/99 10:33:54 AM	LEEMAN_990915A	PAR

Definitions:
ND - Not Detected at the Reporting Limit
J - Analyte detected below Reporting limits
B - Analyte detected in the associated Method Blank
H - Value exceeds Maximum Contaminant Level
* - Recovery outside limits
R - RPD outside recovery limits
E - Value above quantitation range
Surr - Denotes Surrogate Compound
M -Matrix Spike recovery outside limits
Q - Qualifier
Limit - Reporting Limit

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Laboratory Results

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Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909100
Project: Niagara Falls Air Reserve Station

QC SUMMARY REPORT
Method Blank

TCLP Mercury by Method 7470A Test Code: *1_1311_7470A_L* Units: mg/L

Sample ID: **Ck6PBW**

Run Batch ID: **LEEMAN_990915A** SeqNo: **63012** Analysis Date **9/15/99 10:27:44 AM** Prep Batch ID: **990914290** Prep Date: **9/15/99**

Analyte		Result	RL	Spike Value	Orig Result	%REC	LowLimit	HighLimit	%RPD	RPDLimit [1]	Qual
A	Mercury	ND	0.02								

Definitions: ND - Not Detected at the Reporting Limit; * - LCS Recovery outside limits; M - Matrix Spike Recovery outside limits; RL -Reporting Limit
J - Analyte detected below reporting limits; B - Analyte detected in the associated Method Blank; R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable)
1 - Represents RSD Limit for Quad Analysis

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Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909100
Project: Niagara Falls Air Reserve Station

QC SUMMARY REPORT
Method Blank

TCLP Mercury by Method 7470A Test Code: *1_1311_7470A_L* Units: **mg/L**

Sample ID: **TCLP-2**

Run Batch ID: **LEEMAN_990915A** SeqNo: **63020** Analysis Date **9/15/99 10:36:36 AM** Prep Batch ID: **990914290** Prep Date: **9/15/99**

Analyte	Result	RL	Spike Value	Orig Result	%REC	LowLimit	HighLimit	%RPD	RPDLimit [1]	Qual
A Mercury	ND	0.02								

Definitions: ND - Not Detected at the Reporting Limit; * - LCS Recovery outside limits; M - Matrix Spike Recovery outside limits; RL -Reporting Limit

J - Analyte detected below reporting limits; B - Analyte detected in the associated Method Blank; R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable)

1 - Represents RSD Limit for Quad Analysis

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Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909100
Project: Niagara Falls Air Reserve Station

QC SUMMARY REPORT
Laboratory Control Spike - generic

TCLP Mercury by Method 7470A Test Code: *1_1311_7470A_L* Units: mg/L

Sample ID: **Ck3LCSW**

Run Batch ID: **LEEMAN_990915A** SeqNo: **63013** Analysis Date **9/15/99 10:29:56 AM** Prep Batch ID: **990914290** Prep Date: **9/15/99**

Analyte		Result	RL	Spike Value	Orig Result	%REC	LowLimit	HighLimit	%RPD	RPDLimit [1]	Qual
A	Mercury	2.009	0.02	2	0	100%	80	120			

Definitions: ND - Not Detected at the Reporting Limit; * - LCS Recovery outside limits; M - Matrix Spike Recovery outside limits; RL -Reporting Limit

J - Analyte detected below reporting limits; B - Analyte detected in the associated Method Blank

1 - Represents RSD Limit for Quad Analysis

R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable)

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Analytical Services Center

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Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486

Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909100
Project: Niagara Falls Air Reserve Station

QC SUMMARY REPORT

Sample Matrix Spike

TCLP Mercury by Method 7470A Test Code: *1_1311_7470A_L* Units: **mg/L**

Sample ID: **9909100-01BS**

Run Batch ID: **LEEMAN_990915A** SeqNo: **63018** Analysis Date: **09/15/1999 10:34:47 A** Prep Batch ID: **990914290** Prep Date: **09/15/1999**

Analyte		Result	PQL	SPK Added	Orig Result	%REC	%RPD
A	Mercury	0.8283	0.02	1	0	83%	

TCLP Mercury by Method 7470A Test Code: *1_1311_7470A_L* Units: **mg/L**

Sample ID: **9909100-01BS1**

Run Batch ID: **LEEMAN_990915A** SeqNo: **63019** Analysis Date: **09/15/1999 10:35:42 A** Prep Batch ID: **990914290** Prep Date: **09/15/1999**

Analyte		Result	PQL	SPK Added	Orig Result	%REC	%RPD
A	Mercury	0.8345	0.02	1	0	83%	0.7%

Qualifiers: ND - Not Detected at the Reporting Limit (PQL); S - Spike Recovery outside accepted recovery limits; R - RPD outside accepted recovery limits

J - Analyte detected below quantitation limits (MDL<*<PQL); B - Analyte detected in the associated Method Blank

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Laboratory Results

NYS ELAP ID#: 10486

Phone: (716) 685-80[illegible]

CLIENT: E and E Buffalo Office
Lab Order: 9909100
Project: Niagara Falls Air Reserve Station
Lab ID: 9909100-01C **Sample Type:** SAMP

Client Sample ID: DM99-A-SO-091099
Alt. Client ID:
Collection Date: 9/10/99 11:10:00 AM
Matrix: SOIL **% Moist:**

Analyte	Result	Q	Limit	Units	DF	Date Analyzed	Run Batch ID	Analyst
REACTIVE CYANIDE, BY METHOD 9012A-7.3.3 1_9012A-7.3.3_RCN_S								
Reactive Cyanide	ND		0.05	mg/Kg	1	9/20/99	LACHAT_AE_990920A	CMO

Definitions:

ND - Not Detected at the Reporting Limit
J - Analyte detected below Reporting limits
B - Analyte detected in the associated Method Blank
H - Value exceeds Maximum Contaminant Level
* - Recovery outside limits
R - RPD outside recovery limits
E - Value above quantitation range
Surr - Denotes Surrogate Compound
M -Matrix Spike recovery outside limits
Q - Qualifier
Limit - Reporting Limit

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CLIENT: E and E Buffalo Office
Work Order: 9909100
Project: Niagara Falls Air Reserve Station

QC SUMMARY REPORT

Method Blank

Reactive Cyanide by Method 9012A-7.3.3 Test Code: *1_9012A-7.3.3_RCN_S* Units: **mg/Kg**

Sample ID: **MBlank**

Run Batch ID: **LACHAT_AE_990920A** SeqNo: **68972** Analysis Date: **9/20/99** Prep Batch ID: **990920130R** Prep Date: **9/20/99**

Analyte		Result	RL	Spike Value	Orig Result	%REC	LowLimit	HighLimit	%RPD	RPDLimit [1]	Qual
A	Reactive Cyanide	ND	0.05								

Definitions: ND - Not Detected at the Reporting Limit
J - Analyte detected below reporting limits
1 - Represents RSD Limit for Quad Analysis
* - LCS Recovery outside limits
B - Analyte detected in the associated Method Blank
M - Matrix Spike Recovery outside limits
RL -Reporting Limit
R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable)

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Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909100
Project: Niagara Falls Air Reserve Station

QC SUMMARY REPORT
Laboratory Control Spike - generic

Reactive Cyanide by Method 9012A-7.3.3 Test Code: ***1_9012A-7.3.3_RCN_S*** Units: **mg/Kg**

Sample ID: **LCS**

Run Batch ID: **LACHAT_AE_990920A** SeqNo: **68973** Analysis Date: **9/20/99** Prep Batch ID: **990920130R** Prep Date: **9/20/99**

Analyte		Result	RL	Spike Value	Orig Result	%REC	LowLimit	HighLimit	%RPD	RPDLimit [1]	Qual
A	Reactive Cyanide	4.22	0.05	898.6	0	0%	1	125			*

Definitions: ND - Not Detected at the Reporting Limit; * - LCS Recovery outside limits; M - Matrix Spike Recovery outside limits; RL -Reporting Limit

J - Analyte detected below reporting limits; B - Analyte detected in the associated Method Blank; R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable)

1 - Represents RSD Limit for Quad Analysis

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Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909100
Project: Niagara Falls Air Reserve Station

QC SUMMARY REPORT
Sample Duplicate

Reactive Cyanide by Method 9012A-7.3.3 Test Code: *1_9012A-7.3.3_RCN_S* Units: **mg/Kg**

Sample ID: **9909100-01C**

Run Batch ID: **LACHAT_AE_990920A** SeqNo: **68975** Analysis Date: **9/20/99** Prep Batch ID: **990920130R** Prep Date: **9/20/99**

Analyte		Result	RL	Spike Value	Orig Result	%REC	LowLimit	HighLimit	%RPD	RPDLimit [1]	Qual
A	Reactive Cyanide	ND	0.05	0	0	0%	0	0	0.0%	35	

Definitions: ND - Not Detected at the Reporting Limit; * - LCS Recovery outside limits; M - Matrix Spike Recovery outside limits; RL -Reporting Limit

J - Analyte detected below reporting limits; B - Analyte detected in the associated Method Blank; R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable)

1 - Represents RSD Limit for Quad Analysis

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Laboratory Results

NYS ELAP ID#: 1048[redacted]

Phone: (716) 685-80[redacted]

CLIENT:	E and E Buffalo Office	**Client Sample ID:**	DM99-A-SO-091099
Lab Order:	9909100	**Alt. Client ID:**	
Project:	Niagara Falls Air Reserve Station	**Collection Date:**	9/10/99 11:10:00 AM
Lab ID:	9909100-01C **Sample Type:** SAMP	**Matrix:**	SOIL **% Moist:**

Analyte	Result	Q	Limit	Units	DF	Date Analyzed	Run Batch ID	Analyst
REACTIVE SULFIDE BY METHOD 9034-7.3.4								
1_9034-7.3.4_RS_S								
Reactive Sulfide	ND		170	mg/Kg	1	9/20/99	WC_990920A	CMO

Definitions:	ND - Not Detected at the Reporting Limit	* - Recovery outside limits	M -Matrix Spike recovery outside limits
	J - Analyte detected below Reporting limits	R - RPD outside recovery limits	Q - Qualifier
	B - Analyte detected in the associated Method Blank	E - Value above quantitation range	Limit - Reporting Limit
	H - Value exceeds Maximum Contaminant Level	Surr - Denotes Surrogate Compound	

LIMS Version #: 3.1.1.0Dev - 9/28/99 2:00:00 PM

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CLIENT: E and E Buffalo Office
Work Order: 9909100
Project: Niagara Falls Air Reserve Station

QC SUMMARY REPORT
Method Blank

Reactive Sulfide by Method 9034-7.3.4 Test Code: *1_9034-7.3.4_RS_S* Units: **mg/Kg**

Sample ID: **MBlank**

Run Batch ID: **WC_990920A** SeqNo: **69924** Analysis Date: **9/20/99** Prep Batch ID: **990920131R** Prep Date: **9/20/99**

Analyte		Result	RL	Spike Value	Orig Result	%REC	LowLimit	HighLimit	%RPD	RPDLimit [1]	Qual
A	Reactive Sulfide	ND	170								

Definitions: ND - Not Detected at the Reporting Limit
J - Analyte detected below reporting limits
1 - Represents RSD Limit for Quad Analysis
* - LCS Recovery outside limits
B - Analyte detected in the associated Method Blank
M - Matrix Spike Recovery outside limits
RL -Reporting Limit
R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable)

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Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909100
Project: Niagara Falls Air Reserve Station

QC SUMMARY REPORT
Laboratory Control Spike - generic

Reactive Sulfide by Method 9034-7.3.4 Test Code: *1_9034-7.3.4_RS_S* Units: **mg/Kg**

Sample ID: **LCS**

Run Batch ID: **WC_990920A** SeqNo: **69925** Analysis Date: **9/20/99** Prep Batch ID: **990920131R** Prep Date: **9/20/99**

Analyte		Result	RL	Spike Value	Orig Result	%REC	LowLimit	HighLimit	%RPD	RPDLimit [1]	Qual
A	Reactive Sulfide	92	170	448	0	21%	1	125			J

Definitions:
ND - Not Detected at the Reporting Limit
J - Analyte detected below reporting limits
1 - Represents RSD Limit for Quad Analysis
* - LCS Recovery outside limits
B - Analyte detected in the associated Method Blank
M - Matrix Spike Recovery outside limits
RL -Reporting Limit
R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable)

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Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909100
Project: Niagara Falls Air Reserve Station

QC SUMMARY REPORT

Sample Duplicate

Reactive Sulfide by Method 9034-7.3.4 Test Code: *1_9034-7.3.4_RS_S* Units: **mg/Kg**

Sample ID: **9909100-01C**

Run Batch ID: **WC_990920A** SeqNo: **69927** Analysis Date: **9/20/99** Prep Batch ID: **990920131R** Prep Date: **9/20/99**

Analyte		Result	RL	Spike Value	Orig Result	%REC	LowLimit	HighLimit	%RPD	RPDLimit [1]	Qual
A	Reactive Sulfide	ND	170	0	0	0%	0	0	0.0%	35	

Definitions: ND - Not Detected at the Reporting Limit * - LCS Recovery outside limits M - Matrix Spike Recovery outside limits RL -Reporting Limit

J - Analyte detected below reporting limits B - Analyte detected in the associated Method Blank R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable)

1 - Represents RSD Limit for Quad Analysis

Ecology and Environment, Inc.

Analytical Services Center
4493 Walden Avenue
Lancaster, New York 14086-

Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-808

CLIENT:	E and E Buffalo Office	**Client Sample ID:**	DM99-A-SO-091099
Lab Order:	9909100	**Alt. Client ID:**	
Project:	Niagara Falls Air Reserve Station	**Collection Date:**	9/10/99 11:10:00 AM
Lab ID:	9909100-01C **Sample Type:** SAMP	**Matrix:**	SOIL **% Moist:**

Analyte	Result	Q	Limit	Units	DF	Date Analyzed	Run Batch ID	Analyst
PH BY METHOD EPA 9045C								
1_9045C_PH_S								
pH	6.5		0.1	S.U.	1	9/13/99	WC_PH_990913A	CMO

Definitions:	ND - Not Detected at the Reporting Limit	* - Recovery outside limits	M -Matrix Spike recovery outside limits
	J - Analyte detected below Reporting limits	R - RPD outside recovery limits	Q - Qualifier
	B - Analyte detected in the associated Method Blank	E - Value above quantitation range	Limit - Reporting Limit
	H - Value exceeds Maximum Contaminant Level	Surr - Denotes Surrogate Compound	

LIMS Version #: 3.1.1.0Dev - 9/28/99 2:00:00 PM

Ecology and Environment, Inc.

Analytical Services Center
4493 Walden Avenue
Lancaster, New York 14086-

Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909100
Project: Niagara Falls Air Reserve Station

QC SUMMARY REPORT
Sample Duplicate

pH by Method EPA 9045C Test Code: *1_9045C_pH_S* Units: **S.U.**

Sample ID: **9909100-01C**

Run Batch ID: **WC_PH_990913A** SeqNo: **61700** Analysis Date: **9/13/99** Prep Batch ID: **990913131R** Prep Date: **9/13/99**

Analyte		Result	RL	Spike Value	Orig Result	%REC	LowLimit	HighLimit	%RPD	RPDLimit [1]	Qual
A	pH	6.52	0.1	0	6.51	0%	0	0	0.2%	35	

Definitions:
ND - Not Detected at the Reporting Limit
J - Analyte detected below reporting limits
1 - Represents RSD Limit for Quad Analysis
* - LCS Recovery outside limits
B - Analyte detected in the associated Method Blank
M - Matrix Spike Recovery outside limits
RL -Reporting Limit
R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable)

Ecology and Environment, Inc.
Analytical Services Center
4493 Walden Avenue
Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

October 13, 1999

Mr. Rick Watt
E and E Buffalo Office
368 Pleasant View Dr.
Lancaster, NY 14086

RE: Niagara Falls ARS
Work Order No.: **9909155**

Dear Mr. Rick Watt,

Ecology and Environment, Inc. received 14 samples on Friday, September 17, 1999 for the analyses presented in the following report.

You will receive an invoice under separate cover.

E & E will retain the samples addressed in this report for 30 days, unless otherwise instructed by the client. If additional storage is requested, the storage fee is $1.00 per sample container per month, to accrue until the client authorizes sample destruction.

Sincerely,

Barbara Krajewski

Barbara Krajewski
Project Manager

CC:
Enclosures as note

Ecology and Environment, Inc.
Analytical Services Center
Lancaster, New York 14086
Phone: (716) 685-8080

Laboratory Results

NYS ELAP ID#: 10486

CLIENT: E and E Buffalo Office
Project: Niagara Falls ARS
Lab Order: 9909155

CASE NARRATIVE

NARRATIVE

Laboratory sample 9909155-03A (MW5-1DA-WO-091799) was over the calibration range for cis-1,2-dichloroetheneand trichloroethene. The sample was re-analyzed at a 100X..dilution and reported.

Laboratory sample 9909155-06A (MW5-5D-WO-091799) was over the calibration range for cis-1,2-dichloroetheneand trichloroethene. The sample was re-analyzed at a 200X..dilution and reported.

Laboratory sample 9909155-07A (MW5-5D-WD-091799) was over the calibration range for cis-1,2-dichloroetheneand trichloroethene. The sample was re-analyzed at a 200X..dilution and reported.

Laboratory sample 9909155-08A (MW5-6-WO-091799) was over the calibration range for thrichloroethene. The sample was re-analyzed at a 200X dilution and reported.

Laboratory sample 9909155-14A (DM99-B-WO-091799) were over the calibration range for cis-1,2-dichloroetheneand trichloroethene. The sample was re-analyzed at a 20X..dilution and reported.

CHAIN OF CUSTODY RECORD

ASC Analytical Services Center

Ecology and Environment, Inc., Analytical Services Center
4493 Walden Avenue, Lancaster, New York, 14086, Tel: 716/685-8080, Fax 716/685-0852
Where Scientific Excellence and Efficiency Meet

Cooler No: 1
Lab: ASC

PROJECT No:	SITE NAME:	LOCATION: (Include State)
SIS. EJDF. 00.0370	Niagara Falls ARS	

CLIENT: 914TH AW, AFRC

PROJECT MANAGER: R. Watt

OFFICE No:

FIELD TEAM LEADER: R. Watt

PHONE No:

SAMPLERS: (PRINT) R. Watt, J. Mayo

CONTAINER TYPE AND PRESERVATIVE: 40-ml vial; 1-L poly HNO3

REQUESTED ANALYSIS: 8260B VOCs; 6010B Metals As, Cd, Cr, Cu, Pb, Ni, Zn

TURNAROUND TIME: 24-HOUR; 48-HOUR; 1-WEEK; STANDARD (ASL); RUSH _____ days; OTHER _____

(FOR LAB USE ONLY)
Lab Job No:
Report type:
Batch QC: Yes No

DATE	TIME	SAMPLE ID	SAMPLE MATRIX	CHECK FOR MS/MSD	SAMPLE TYPE	No. OF CONTAINERS	8260B VOCs	6010B Metals As, Cd, Cr, Cu, Pb, Ni, Zn	OVA/HNU READINGS (PPM)	BEGINNING DEPTH (FEET BGS)	ENDING DEPTH (FEET BGS)	REMARKS
9-17-99	1035	MW5-7D-WO-091799	GW		0	2	X					
	1328	MW5-8-WO-091799			0	2	X					
	0954	MW5-8D-WO-091799			0	2	X					
	1430	DM99-B-WO-091799			0	3	X	X				

Relinquished By: (Signature)	Date/Time:	Received By: (Signature)	Date/Time:	Ship Via:	Date:
				E&E	9-17-99
Relinquished By: (Signature)	Date/Time:	Received By: (Signature)	Date/Time:	BL/Airbill Number:	
	9-17-99 1645		9/17/99 16:45	N/A	

Temperature Blank Info. Enclosed: Yes No

(FOR LAB USE ONLY)
Date: _____ Time: _____
Temperature: _____ °C

Distribution: White - Lab original Yellow - Field team leader

0881297

Ecology and Environment, Inc. Analytical Services Center

Cooler Receipt Form

PACKAGE RECEIPT #: 4595 NUMBER OF COOLERS: 1-Cooler DATE RECEIVED: 9/17/99

E & E PROJECT #: _____ PROJECT OR SITE NAME: Niagara Falls ARS

A. Preliminary Examination Phase

CIRCLE ONE

1. Did coolers come with airbill or packing slip? E+E — YES (NO) NA

   Enter carrier here and print airbill # below: *(Circle One)* FedEx Airborne Client (Other)

2. Did cooler(s) have custody seals? — YES (NO) NA

   If YES, how many and where? _____

3. Were custody seals unbroken and intact on receipt? — YES NO* (NA)

4. Were custody seals dated and signed? — YES NO (NA)

   If YES, enter date: _____ Name: _____

5. Sign here to acknowledge receipt of cooler (s): Kyle Mead

   Date cooler(s) opened: 9/17/99 C-O-C numbers: _____

   Cooler(s) opened by (print): KYLE MEAD Signature: Kyle Mead

6. Were the C-O-C forms received? — (YES) NO* NA

7. Was the project identifiable from the C-O-C form? — (YES) NO* NA

   If YES, enter the project number and name in the heading above.

Please record Temperature Blank or Cooler Temperature for Each Cooler. Range (2 - 6°C)*

AIRBILL #	TEMP. °C	AIRBILL #	TEMP. °C	AIRBILL #	TEMP. °C
	5.5				

Thermometer # 142 Correction Factor 0° * If No or Temperature Outside of Acceptable Range, a CAF must be filed. CAF # _____

B. Unpacking Phase

8. Was enough packing material used in cooler(s)? — (YES) NO NA

   Type of material: ☐ Vermiculite ☐ Bubble Wrap (Other)

9. If required, was enough ice used? — (YES) NO NA

   If YES, type of ice used: (Wet) ☐ Dry ☐ Blue ☐ Other

10. Was a temperature blank included inside cooler(s)? — (YES) NO NA

    If YES, indicate temperature blank temperature in table above. If NO, indicate cooler temperature in table above.

11. Were all containers sealed in separate plastic bags? — (YES) NO NA

12. Did all containers arrive unbroken and in good condition? — (YES) NO* NA

C. Login Phase

Samples Logged in By (print): KYLE MEAD Signature: Kyle Mead Date: 9/17/99

13. Were all container labels complete (e.g. date, time, preserv.)? — (YES) NO* NA

14. Were all C-O-C forms filled out properly in ink and signed? — (YES) NO* NA

15. Did the C-O-C form agree with containers received? — (YES) NO* NA

16. Were the correct containers used for the tests requested? — (YES) NO* NA

17. Were the correct preservatives listed on the sample labels? — (YES) NO* NA

18. Was a sufficient sample volume sent for the tests requested? — (YES) NO* NA

19. Were all volatile samples received without head space? — (YES) NO* NA

To be included with all lab data and with each workplan

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE IDENTIFICATION AND ANALYTICAL REQUIREMENT SUMMARY

Customer Sample Code	Laboratory Sample Code	Analytical Requirements					
		*VOA GC/MS Method #	*BNA GC/MS Method #	*VOA GC Method #	*Pest PCBs Method #	*Metals	*Other
WR-091799	9909155-01	8260B					
WS-091799	02						
MWS-1DA-WD-091799	03						
MWS-4D-WD-091799	04						
MWS-5A-WD-091799	05						
MWS-5D-WD-091799	06						
MWS-5D-WD-091799	07						
MWS-6-WD-091799	08						
MWS-6D-WD-091799	09						
MWS-7-WD-091799	10						
MWS-7D-WD-091799	11						
MWS-8-WD-091799	12						
MWS-8D-WD-091799	13						
DMGG-B-WD-091799	14A						
DMGG-B-WD-091799	14B					6010B	

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE PREPARATION AND ANALYSIS SUMMARY
VOLATILE (VOA)
ANALYSES

Laboratory Sample ID	Matrix	Date Collected	Date Rec'd at Lab	Date Extracted	Date Analyzed
9909155-01	water	9/17/99	9/17/99		9/21/99
02	"	"	"		9/22/99
03	"	"	"		"
04	"	"	"		9/24/99
05	"	"	"		"
06	"	"	"		9/22/99
07	"	"	"		"
08	"	"	"		"
09	"	"	"		9/23/99
10	"	"	"		"
11	"	"	"		"
12	"	"	"		"
13	"	"	"		"
14A	"	"	"		9/22/99
14B	"	"	"	9/21/99	9/23/99

Ecology and Environment, Inc.
Analytical Services Center
[redacted]3 Walden Avenue
Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Client Sample ID: DM99-B-WO-091799
Lab Order: 9909155
Alt. Client ID:
Project: Niagara Falls ARS
Collection Date: 9/17/99 2:30:00 PM
Lab ID: 9909155-14B Sample Type: SAMP
Matrix: GROUNDWATER % Moist:

Analyte	Result	Q	Limit	Units	DF	Date Analyzed	Run Batch ID	Analyst
PRIORITY POLLUANT METALS ANALYSIS BY METHOD 6010B								
1_6010B_PPM_W								
Arsenic	91.3		10.0	µg/L	1	9/23/99 12:55:12 AM	OPTIMA_990922C	SHT
Cadmium	44.5		5.00	µg/L	1			
Chromium	361		10.0	µg/L	1			
Copper	606	B	20.0	µg/L	1			
Lead	1100		5.00	µg/L	1			
Nickel	318	B	20.0	µg/L	1			
Zinc	85000	E	500	µg/L	50	9/23/99 7:38:12 PM	OPTIMA_990923D	

MMG
12/10/99

Definitions:
ND - Not Detected at the Reporting Limit
J - Analyte detected below Reporting limits
B - Analyte detected in the associated Method Blank
H - Value exceeds Maximum Contaminant Level
* - Recovery outside limits
R - RPD outside recovery limits
E - Value above quantitation range
Surr - Denotes Surrogate Compound
M -Matrix Spike recovery outside limits
Q - Qualifier
Limit - Reporting Limit

LIMS Version #: 3.1.1.0Dev - 9/22/99 4:00:00 PM

Ecology and Environment, Inc.
Analytical Services Center
4493 Walden Avenue
Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909155
Project: Niagara Falls ARS

QC SUMMARY REPORT
Laboratory Control Spike - generic

Metals, Priority Pollutant by ICP Method 6010B Test Code: *1_6010B_PPM_W* Units: µg/L

Sample ID: **lcs-199900933**

Run Batch ID: **OPTIMA_990922C** SeqNo: **70284** Analysis Date **9/23/99 12:03:21 AM** Prep Batch ID: **199900933** Prep Date: **9/21/99**

Analyte		Result	RL	Spike Value	Orig Result	%REC	LowLimit	HighLimit	%RPD	RPDLimit [1]	Qual
A	Arsenic	973.7	10	1000	0	97%	85	115			
A	Cadmium	980.8	5	1000	0	98%	85	115			
A	Chromium	969.5	10	1000	0	97%	85	115			
A	Copper	986	20	1000	4.53	98%	85	115			B
A	Lead	949.7	5	1000	0	95%	85	115			
A	Nickel	979.8	20	1000	1.472	98%	85	115			B
A	Zinc	994.1	10	1000	6.666	99%	85	115			B

MMG 12/10/99

Definitions: ND - Not Detected at the Reporting Limit; * - LCS Recovery outside limits; M - Matrix Spike Recovery outside limits; RL -Reporting Limit
J - Analyte detected below reporting limits; B - Analyte detected in the associated Method Blank; R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable)
1 - Represents RSD Limit for Quad Analysis

Ecology and Environment, Inc.

Analytical Services Center
4493 Walden Avenue
Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909155
Project: Niagara Falls ARS

QC SUMMARY REPORT
Method Blank

Metals, Priority Pollutant by ICP Method 6010B Test Code: *1_6010B_PPM_W* Units: µg/L

Sample ID: **MB-199900933**

Run Batch ID: **OPTIMA_990922C** SeqNo: **70283** Analysis Date **9/22/99 11:59:33 PM** Prep Batch ID: **199900933** Prep Date: **9/21/99**

	Analyte	Result	RL	Spike Value	Orig Result	%REC	LowLimit	HighLimit	%RPD	RPDLimit [1]	Qual
A	Arsenic	ND	10								
A	Cadmium	ND	5								
A	Chromium	ND	10								
A	Copper	4.53	20								J
A	Lead	ND	5								
A	Nickel	1.472	20								J
A	Zinc	6.666	10								J

Definitions: ND - Not Detected at the Reporting Limit; * - LCS Recovery outside limits; M - Matrix Spike Recovery outside limits; RL -Reporting Limit

J - Analyte detected below reporting limits; B - Analyte detected in the associated Method Blank; R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable)

1 - Represents RSD Limit for Quad Analysis

Ecology and Environment, Inc.

Analytical Services Center

4493 Walden Avenue

Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10[redacted]

Phone: (716) 685-8[redacted]

CLIENT:	E and E Buffalo Office	**Client Sample ID:**	**DM99-B-WO-091799**
Lab Order:	9909155	**Alt. Client ID:**	
Project:	Niagara Falls ARS	**Collection Date:**	9/17/99 2:30:00 PM
Lab ID:	**9909155-14A** **Sample Type:** SAMP	**Matrix:**	GROUNDWATER **% Moist:**

Analyte	Result	Q	Limit	Units	DF	Date Analyzed	Run Batch ID	Analyst
VOLATILE ORGANIC COMPOUNDS BY METHOD 8260B								
1_8260B_5030B_W								
1,1,1-Trichloroethane	ND		5.00	µg/L	1	9/22/99 7:25:00 AM	CLYDE_II_990921C	TM
1,1,2,2-Tetrachloroethane	ND		5.00	µg/L	1			
1,1,2-Trichloroethane	ND		5.00	µg/L	1			
1,1-Dichloroethane	ND		5.00	µg/L	1			
1,1-Dichloroethene	ND		5.00	µg/L	1			
1,2-Dichlorobenzene	ND		5.00	µg/L	1			
1,2-Dichloroethane	ND		5.00	µg/L	1			
1,2-Dichloropropane	ND		5.00	µg/L	1			
1,3-Dichlorobenzene	ND		5.00	µg/L	1			
1,4-Dichlorobenzene	ND		5.00	µg/L	1			
2-Butanone	ND		10.0	µg/L	1			
2-Chloroethyl vinyl ether	ND		10.0	µg/L	1			
2-Hexanone	ND		10.0	µg/L	1			
4-Methyl-2-pentanone	ND		10.0	µg/L	1			
Acetone	ND		10.0	µg/L	1			
Benzene	ND		5.00	µg/L	1			
Bromodichloromethane	ND		5.00	µg/L	1			
Bromoform	ND		5.00	µg/L	1			
Bromomethane	ND		10.0	µg/L	1			
Carbon disulfide	ND		5.00	µg/L	1			
Carbon tetrachloride	ND		5.00	µg/L	1			
Chlorobenzene	ND		5.00	µg/L	1			
Chloroethane	ND		10.0	µg/L	1			
Chloroform	ND		5.00	µg/L	1			
Chloromethane	ND		10.0	µg/L	1			
cis-1,2-Dichloroethene	616		100	µg/L	20	9/24/99 4:55:00 PM	FRED_990924B	DWW
cis-1,3-Dichloropropene	ND		5.00	µg/L	1	9/22/99 7:25:00 AM	CLYDE_II_990921C	TM
Dibromochloromethane	ND		5.00	µg/L	1			
Ethylbenzene	ND		5.00	µg/L	1			
m,p-Xylene	ND		5.00	µg/L	1			
Methylene chloride	ND		5.00	µg/L	1			
o-Xylene	ND		5.00	µg/L	1			
Styrene	ND		5.00	µg/L	1			
Tetrachloroethene	ND		5.00	µg/L	1			
Toluene	ND		5.00	µg/L	1			

Definitions:

ND - Not Detected at the Reporting Limit
J - Analyte detected below Reporting limits
B - Analyte detected in the associated Method Blank
H - Value exceeds Maximum Contaminant Level
* - Recovery outside limits
R - RPD outside recovery limits
E - Value above quantitation range
Surr - Denotes Surrogate Compound
M -Matrix Spike recovery outside limits
Q - Qualifier
Limit - Reporting Limit

Ecology and Environment, Inc.
Analytical Services Center
[redacted] Walden Avenue
Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

CLIENT:	E and E Buffalo Office	**Client Sample ID:**	**DM99-B-WO-091799**
Lab Order:	9909155	**Alt. Client ID:**	
Project:	Niagara Falls ARS	**Collection Date:**	9/17/99 2:30:00 PM
Lab ID:	**9909155-14A** **Sample Type:** SAMP	**Matrix:**	GROUNDWATER **% Moist:**

Analyte	Result	Q	Limit	Units	DF	Date Analyzed	Run Batch ID	Analyst
VOLATILE ORGANIC COMPOUNDS BY METHOD 8260B								
1_8260B_5030B_W								
trans-1,2-Dichloroethene	2.98	J	5.00	µg/L	1			
trans-1,3-Dichloropropene	ND		5.00	µg/L	1			
Trichloroethene	3660		100	µg/L	20	9/24/99 4:55:00 PM	FRED_990924B	DWW
Trichlorofluoromethane	ND		5.00	µg/L	1	9/22/99 7:25:00 AM	CLYDE_II_990921C	TM
Vinyl acetate	ND		10.0	µg/L	1			
Vinyl chloride	ND		10.0	µg/L	1			
Surr: 1,2-Dichloroethane-d4	100.7		82-124	%REC	1			
Surr: 4-Bromofluorobenzene	96.4		87-115	%REC	1			
Surr: Dibromofluoromethane	106.8		89-119	%REC	1			
Surr: Toluene-d8	110.2		85-115	%REC	1			

Definitions:
ND - Not Detected at the Reporting Limit
J - Analyte detected below Reporting limits
B - Analyte detected in the associated Method Blank
H - Value exceeds Maximum Contaminant Level
* - Recovery outside limits
R - RPD outside recovery limits
E - Value above quantitation range
Surr - Denotes Surrogate Compound
M -Matrix Spike recovery outside limits
Q - Qualifier
Limit - Reporting Limit

LIMS Version #: 3.1.1.0Dev - 10/6/99 2:00:00 PM

Ecology and Environment Inc.

Data file : /var/chem/CLYDE_II.i/990921432r.b/C4616.d
Lab Smp Id:
Inj Date : 22-SEP-1999 07:25
Operator : USER4 REG. GRP. Inst ID: CLYDE_II.i
Smp Info : 9909155-14A
Misc Info : [990921432r]{c8bw23},1_8260B_5030B_W,SAMP,TM,5ML
Comment : Instrument 5995A (CLYDE_II.i)
Method : /var/chem/CLYDE_II.i/990921432r.b/c8bw23.m
Meth Date : 24-Sep-1999 15:34 glynds Quant Type: ISTD
Cal Date : 24-AUG-1999 23:52 Cal File: C4111.d
Als bottle: 1
Dil Factor: 1.00000
Integrator: HP RTE Compound Sublist: tcl.sub
Target Version: 3.50
Processing Host: chemsrv

- NO TENTATIVELY IDENTIFIED COMPOUNDS -

Data File : HP RTE MS C4616.d, Ion 57.00

Integrator: HP RTE Integrator

Number of peaks found: 4

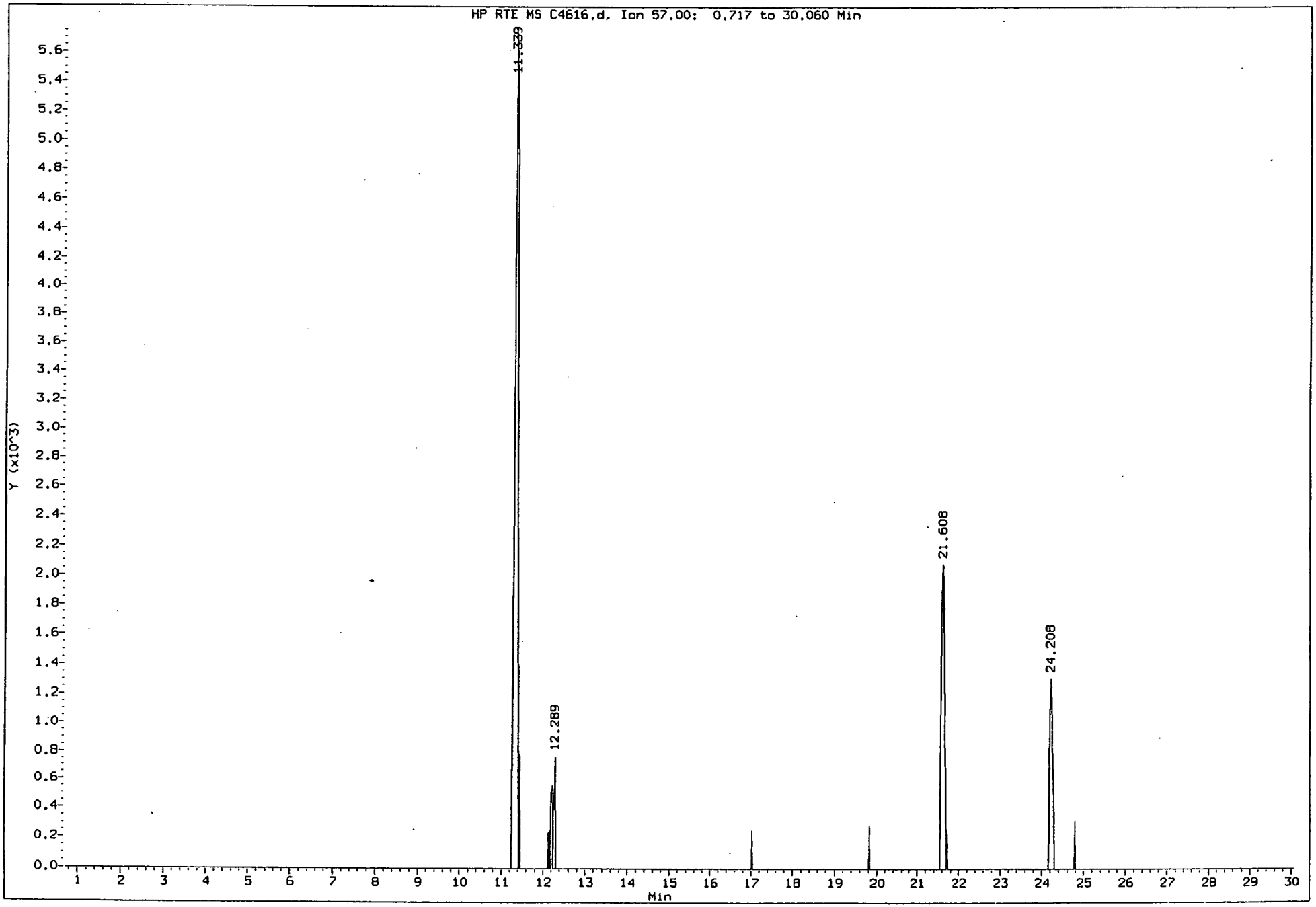
Time	Start Time	End Time	Area	Area%	Height	Height%	Peak Type
11.339	11.242	11.419	33166	63.88	5777	58.08	**
12.289	12.241	12.305	1690	3.26	771	7.75	**
21.608	21.544	21.689	10706	20.62	2084	20.95	**
24.208	24.160	24.289	6353	12.24	1315	13.22	**

51915

$\frac{51915}{835045} \times 50 = 3.1 \text{ ug/L}$

DLY
10/11/99

Data File: /var/chem/CLYDE_II.i/990921432r.b/C4616.d
Injection Date: 22-SEP-1999 07:25



Ecology and Environment Inc.

Data file : /var/chem/7001F.i/990924461r.b/F2578.d
Lab Smp Id:
Inj Date : 24-SEP-1999 16:55
Operator : USER4 REG. GRP. Inst ID: 7001F.i
Smp Info : 99009155-14A
Misc Info : [990924461r]{f8bw17},,SAMP,TR,5ml
Comment : Instrument 5970 (fred.i)
Method : /var/chem/7001F.i/990924461r.b/f8bw17.m
Meth Date : 24-Sep-1999 10:10 dwilly Quant Type: ISTD
Cal Date : 22-SEP-1999 17:02 Cal File: F2514.d
Als bottle: 1
Dil Factor: 20.00000
Integrator: HP RTE Compound Sublist: all.sub
Target Version: 3.40
Processing Host: chemsrv

- NO TENTATIVELY IDENTIFIED COMPOUNDS -

Data File : HP RTE MS F2578.d, Ion 57.00

Integrator: HP RTE Integrator

Number of peaks found: 3

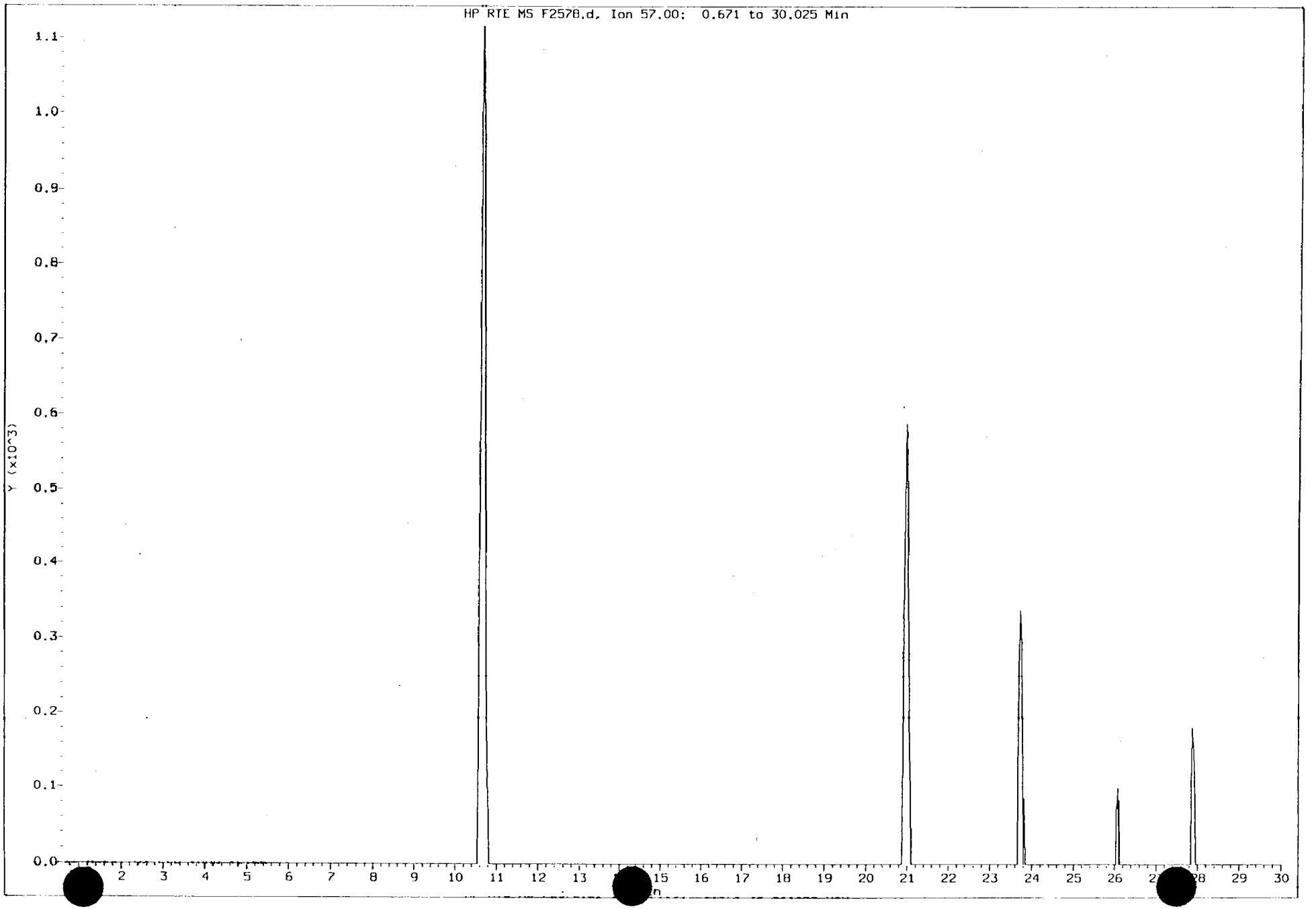
Time	Start Time	End Time	Area	Area%	Height	Height%	Peak Type
10.674	10.534	10.814	8597	59.62	1117	54.67	**
20.981	20.876	21.098	4013	27.83	588	28.78	**
23.730	23.660	23.800	1810	12.55	338	16.54	**

14420

$$\frac{14420}{227095} \times 50 = 3.24\%$$

DNS
10/12/99

Data File: /var/chem/7001F.i/990924461r.b/F2578.d
Injection Date: 24-SEP-1999 16:55



Ecology and Environment, Inc.
Analytical Services Center
4493 Walden Avenue
Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909155
Project: Niagara Falls ARS

QC SUMMARY REPORT
Sample Matrix Spike

VOCs by GCMS Method 8260B Test Code: *1_8260B_5030B_W* Units: µg/L

Sample ID: **9909155-05A**

Run Batch ID: **FRED_990924B** SeqNo: **73497** Analysis Date: **9/24/99 6:39:00 PM** Prep Batch ID: **R3028** Prep Date:

	Analyte	Result	RL	Spike Value	Orig Result	%REC	LowLimit	HighLimit	%RPD	RPDLimit [1]	Qual
A	1,1-Dichloroethene	47.13	5	50	0	94%	61	135			
A	Benzene	46.7	5	50	0	93%	82	131			
A	Chlorobenzene	48.48	5	50	0	97%	77	128			
A	Toluene	48.07	5	50	0	96%	80	125			
A	Trichloroethene	46.82	5	50	0	94%	82	120			
S	1,2-Dichloroethane-d4	48.4		50	0	97%	82	124			
S	4-Bromofluorobenzene	48.34		50	0	97%	87	115			
S	Dibromofluoromethane	48.19		50	0	96%	89	119			
S	Toluene-d8	49.16		50	0	98%	85	115			

Definitions: ND - Not Detected at the Reporting Limit; * - LCS Recovery outside limits; M - Matrix Spike Recovery outside limits; RL -Reporting Limit
J - Analyte detected below reporting limits; B - Analyte detected in the associated Method Blank; R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable)
1 - Represents RSD Limit for Quad Analysis

Ecology and Environment, Inc.

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4493 Walden Avenue
Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909155
Project: Niagara Falls ARS

QC SUMMARY REPORT

Sample Matrix Spike Duplicate

VOCs by GCMS Method 8260B Test Code: *1_8260B_5030B_W* Units: µg/L

Sample ID: **9909155-05A**

Run Batch ID: **FRED_990924B** SeqNo: **73511** Analysis Date: **9/24/99 7:14:00 PM** Prep Batch ID: **R3028** Prep Date:

Analyte		Result	RL	Spike Value	Orig Result	%REC	LowLimit	HighLimit	%RPD	RPDLimit [1]	Qual
A	1,1-Dichloroethene	48.72	5	50	0	97%	61	135	3.3%	20	
A	Benzene	47.57	5	50	0	95%	82	131	1.8%	20	
A	Chlorobenzene	47.32	5	50	0	95%	77	128	2.4%	20	
A	Toluene	47.62	5	50	0	95%	80	125	0.9%	20	
A	Trichloroethene	47.26	5	50	0	95%	82	120	0.9%	20	
S	1,2-Dichloroethane-d4	48.62		50	0	97%	82	124	0.0%	0	
S	4-Bromofluorobenzene	48.27		50	0	97%	87	115	0.0%	0	
S	Dibromofluoromethane	48.12		50	0	96%	89	119	0.0%	0	
S	Toluene-d8	48.54		50	0	97%	85	115	0.0%	0	

Definitions: ND - Not Detected at the Reporting Limit; * - LCS Recovery outside limits; M - Matrix Spike Recovery outside limits; RL -Reporting Limit

J - Analyte detected below reporting limits; B - Analyte detected in the associated Method Blank; R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable)

1 - Represents RSD Limit for Quad Analysis

S
J

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4493 Walden Avenue
Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909155
Project: Niagara Falls ARS

QC SUMMARY REPORT
Laboratory Control Spike - generic

VOCs by GCMS Method 8260B Test Code: *1_8260B_5030B_W* Units: µg/L

Sample ID: **LCS 1520-63-1**

Run Batch ID: **CLYDE_II_990921C** SeqNo: **71141** Analysis Date: **9/21/99 9:12:00 PM** Prep Batch ID: **R2917** Prep Date:

	Analyte	Result	RL	Spike Value	Orig Result	%REC	LowLimit	HighLimit	%RPD	RPDLimit [1]	Qual
A	1,1-Dichloroethene	54.12	5	50	0	108%	61	135			
A	Benzene	49.65	5	50	0	99%	82	131			
A	Chlorobenzene	50.39	5	50	0	101%	77	128			
A	Toluene	50	5	50	0	100%	80	125			
A	Trichloroethene	48.3	5	50	0	97%	82	120			
S	1,2-Dichloroethane-d4	47.41		50	0	95%	82	124			
S	4-Bromofluorobenzene	49.22		50	0	98%	87	115			
S	Dibromofluoromethane	52.99		50	0	106%	89	119			
S	Toluene-d8	55.74		50	0	111%	85	115			

Definitions: ND - Not Detected at the Reporting Limit; * - LCS Recovery outside limits; M - Matrix Spike Recovery outside limits; RL -Reporting Limit; J - Analyte detected below reporting limits; B - Analyte detected in the associated Method Blank; R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable); 1 - Represents RSD Limit for Quad Analysis

Ecology and Environment, Inc.

Analytical Services Center

4493 Walden Avenue

Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486

Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909155
Project: Niagara Falls ARS

QC SUMMARY REPORT
Laboratory Control Spike - generic

VOCs by GCMS Method 8260B Test Code: *1_8260B_5030B_W* Units: µg/L

Sample ID: **LCS 1523-52-1**

Run Batch ID: **FRED_990924B** SeqNo: **73496** Analysis Date: **9/24/99 9:37:00 AM** Prep Batch ID: **R3028** Prep Date:

	Analyte	Result	RL	Spike Value	Orig Result	%REC	LowLimit	HighLimit	%RPD	RPDLimit [1]	Qual
A	1,1-Dichloroethene	46.4	5	50	0	93%	61	135			
A	Benzene	44.45	5	50	0	89%	82	131			
A	Chlorobenzene	45.17	5	50	0	90%	77	128			
A	Toluene	45.63	5	50	0	91%	80	125			
A	Trichloroethene	42.98	5	50	0	86%	82	120			
S	1,2-Dichloroethane-d4	47.56		50	0	95%	82	124			
S	4-Bromofluorobenzene	48.36		50	0	97%	87	115			
S	Dibromofluoromethane	47.69		50	0	95%	89	119			
S	Toluene-d8	48.52		50	0	97%	85	115			

Definitions: ND - Not Detected at the Reporting Limit; * - LCS Recovery outside limits; M - Matrix Spike Recovery outside limits; RL -Reporting Limit; J - Analyte detected below reporting limits; B - Analyte detected in the associated Method Blank; R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable); 1 - Represents RSD Limit for Quad Analysis

Ecology and Environment, Inc.
Analytical Services Center
4493 Walden Avenue
Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909155
Project: Niagara Falls ARS

QC SUMMARY REPORT
Laboratory Control Spike Duplicate

VOCs by GCMS Method 8260B Test Code: *1_8260B_5030B_W* Units: µg/L

Sample ID: **LCSD 1520-63-2**

Run Batch ID: **CLYDE_II_990921C** SeqNo: **71168** Analysis Date: **9/21/99 9:48:00 PM** Prep Batch ID: **R2917** Prep Date:

	Analyte	Result	RL	Spike Value	Orig Result	%REC	LowLimit	HighLimit	%RPD	RPDLimit [1]	Qual
A	1,1-Dichloroethene	51.36	5	50	0	103%	61	135	5.2%	20	
A	Benzene	48.66	5	50	0	97%	82	131	2.0%	20	
A	Chlorobenzene	48.59	5	50	0	97%	77	128	3.6%	20	
A	Toluene	48.66	5	50	0	97%	80	125	2.7%	20	
A	Trichloroethene	47.44	5	50	0	95%	82	120	1.8%	20	
S	1,2-Dichloroethane-d4	50.58		50	0	101%	82	124	0.0%	0	
S	4-Bromofluorobenzene	53.12		50	0	106%	87	115	0.0%	0	
S	Dibromofluoromethane	52.56		50	0	105%	89	119	0.0%	0	
S	Toluene-d8	55.4		50	0	111%	85	115	0.0%	0	

Definitions: ND - Not Detected at the Reporting Limit; * - LCS Recovery outside limits; M - Matrix Spike Recovery outside limits; RL -Reporting Limit
J - Analyte detected below reporting limits; B - Analyte detected in the associated Method Blank; R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable)
1 - Represents RSD Limit for Quad Analysis

Ecology and Environment, Inc.

Analytical Services Center
4493 Walden Avenue
Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909155
Project: Niagara Falls ARS

QC SUMMARY REPORT
Method Blank

VOCs by GCMS Method 8260B Test Code: *1_8260B_5030B_W* Units: µg/L

Sample ID: **BLK 1520-63-2**

Run Batch ID: **CLYDE_II_990921C** SeqNo: **71167** Analysis Date: **9/21/99 11:19:00 PM** Prep Batch ID: **R2917** Prep Date:

	Analyte	Result	RL	Spike Value	Orig Result	%REC	LowLimit	HighLimit	%RPD	RPDLimit [1]	Qual
A	1,1,1-Trichloroethane	ND	5								
A	1,1,2,2-Tetrachloroethane	ND	5								
A	1,1,2-Trichloroethane	ND	5								
A	1,1-Dichloroethane	ND	5								
A	1,1-Dichloroethene	ND	5								
A	1,2-Dichlorobenzene	ND	5								
A	1,2-Dichloroethane	ND	5								
A	1,2-Dichloropropane	ND	5								
A	1,3-Dichlorobenzene	ND	5								
A	1,4-Dichlorobenzene	ND	5								
A	2-Butanone	ND	10								
A	2-Chloroethyl vinyl ether	ND	10								
A	2-Hexanone	ND	10								
A	4-Methyl-2-pentanone	ND	10								
A	Acetone	ND	10								
A	Benzene	ND	5								
A	Bromodichloromethane	ND	5								
A	Bromoform	ND	5								
A	Bromomethane	ND	10								
A	Carbon disulfide	ND	5								
A	Carbon tetrachloride	ND	5								
A	Chlorobenzene	ND	5								

Definitions: ND - Not Detected at the Reporting Limit; * - LCS Recovery outside limits; M - Matrix Spike Recovery outside limits; RL -Reporting Limit
J - Analyte detected below reporting limits; B - Analyte detected in the associated Method Blank; R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable)
1 - Represents RSD Limit for Quad Analysis

Ecology and Environment, Inc.

Analytical Services Center
4493 Walden Avenue
Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909155
Project: Niagara Falls ARS

QC SUMMARY REPORT
Method Blank

A	Chloroethane	ND	10				
A	Chloroform	ND	5				
A	Chloromethane	ND	10				
A	cis-1,2-Dichloroethene	ND	5				
A	cis-1,3-Dichloropropene	ND	5				
A	Dibromochloromethane	ND	5				
A	Ethylbenzene	ND	5				
A	m,p-Xylene	ND	5				
A	Methylene chloride	ND	5				
A	o-Xylene	ND	5				
A	Styrene	ND	5				
A	Tetrachloroethene	ND	5				
A	Toluene	ND	5				
A	trans-1,2-Dichloroethene	ND	5				
A	trans-1,3-Dichloropropene	ND	5				
A	Trichloroethene	ND	5				
A	Trichlorofluoromethane	ND	5				
A	Vinyl acetate	ND	10				
A	Vinyl chloride	ND	10				
S	1,2-Dichloroethane-d4	47.96		50	96%	82	124
S	4-Bromofluorobenzene	49.15		50	98%	87	115
S	Dibromofluoromethane	49.02		50	98%	89	119
S	Toluene-d8	54.94		50	110%	85	115

Definitions: ND - Not Detected at the Reporting Limit
J - Analyte detected below reporting limits
1 - Represents RSD Limit for Quad Analysis
* - LCS Recovery outside limits
B - Analyte detected in the associated Method Blank
M - Matrix Spike Recovery outside limits
RL -Reporting Limit
R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable)

Ecology and Environment Inc.

Data file : /var/chem/CLYDE_II.i/990921432r.b/C4603.d
Lab Smp Id:
Inj Date : 21-SEP-1999 23:19
Operator : USER4 REG. GRP. Inst ID: CLYDE_II.i
Smp Info : BLK 1520-63-2
Misc Info : [990921432r]{c8bw23},,MBLK,TM,5ml
Comment : Instrument 5995A (CLYDE_II.i)
Method : /var/chem/CLYDE_II.i/990921432r.b/c8bw23.m
Meth Date : 24-Sep-1999 15:34 glynds Quant Type: ISTD
Cal Date : 24-AUG-1999 23:52 Cal File: C4111.d
Als bottle: 1
Dil Factor: 1.00000
Integrator: HP RTE Compound Sublist: tcl.sub
Target Version: 3.50
Processing Host: chemsrv

- NO TENTATIVELY IDENTIFIED COMPOUNDS -

Data File : HP RTE MS C4603.d, Ion 57.00

Integrator: HP RTE Integrator

Number of peaks found: 3

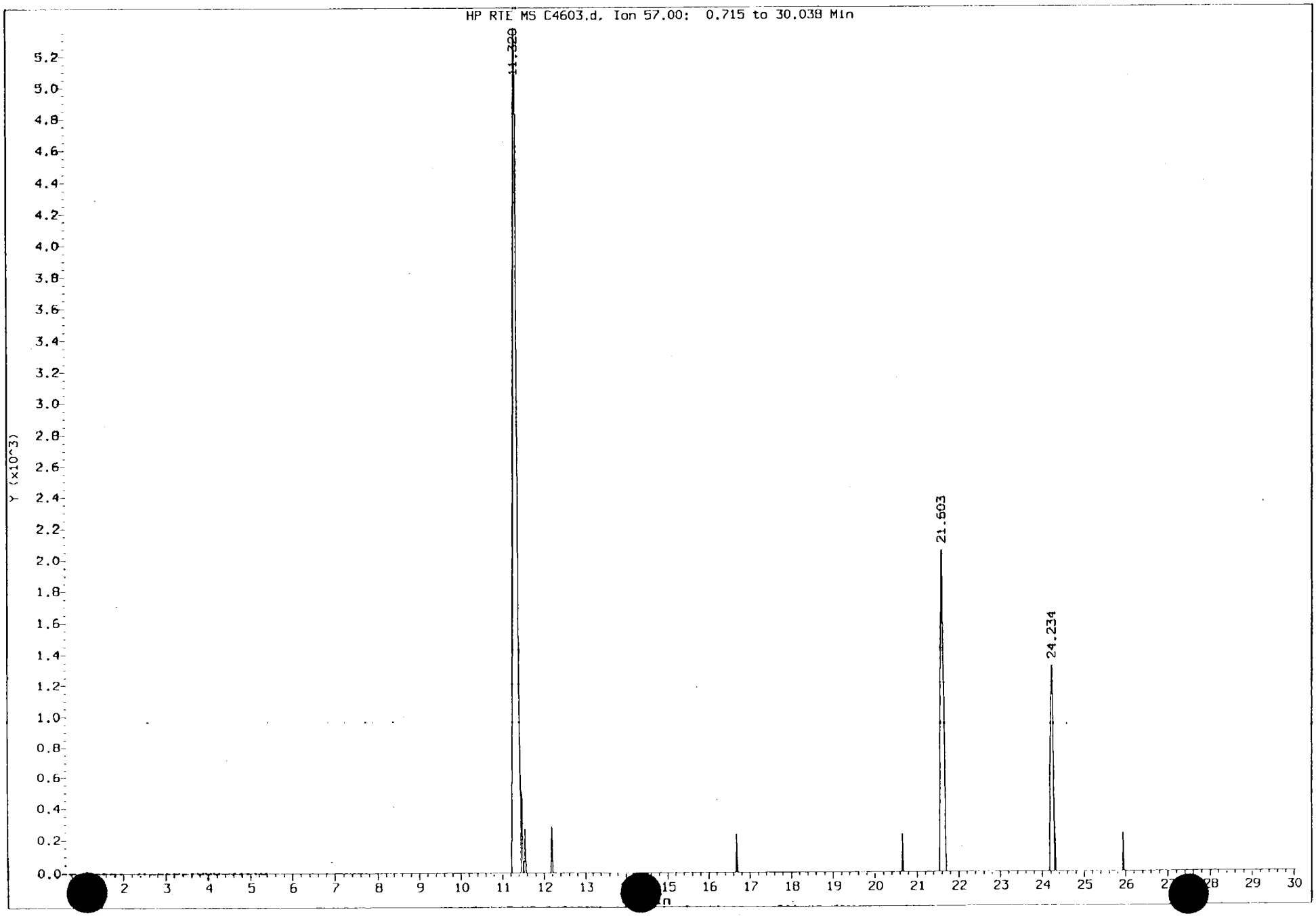
Time	Start Time	End Time	Area	Area%	Height	Height%	Peak Type
11.320	11.223	11.449	35036	69.03	5370	61.41	**
21.603	21.538	21.699	10222	20.14	2055	23.50	**
24.234	24.169	24.282	5495	10.83	1319	15.08	**

50753

$$\frac{50753}{846829} \times 50 = 3.0 \text{ ug/L}$$

DWS
10/11/99

Data File: /var/chem/CLYDE_II.i/990921432r.b/C4603.d
Injection Date: 21-SEP-1999 23:19



Ecology and Environment, Inc.

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Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486
Phone: (716) 685-8080

CLIENT: E and E Buffalo Office
Work Order: 9909155
Project: Niagara Falls ARS

QC SUMMARY REPORT
Method Blank

VOCs by GCMS Method 8260B Test Code: *1_8260B_5030B_W* Units: µg/L

Sample ID: **BLK 1523-52-2**

Run Batch ID: **FRED_990924B** SeqNo: **73510** Analysis Date: **9/24/99 10:47:00 AM** Prep Batch ID: **R3028** Prep Date:

	Analyte	Result	RL	Spike Value	Orig Result	%REC	LowLimit	HighLimit	%RPD	RPDLimit [1]	Qual
A	1,1,1-Trichloroethane	ND	5								
A	1,1,2,2-Tetrachloroethane	ND	5								
A	1,1,2-Trichloroethane	ND	5								
A	1,1-Dichloroethane	ND	5								
A	1,1-Dichloroethene	ND	5								
A	1,2-Dichlorobenzene	ND	5								
A	1,2-Dichloroethane	ND	5								
A	1,2-Dichloropropane	ND	5								
A	1,3-Dichlorobenzene	ND	5								
A	1,4-Dichlorobenzene	ND	5								
A	2-Butanone	ND	10								
A	2-Chloroethyl vinyl ether	ND	10								
A	2-Hexanone	ND	10								
A	4-Methyl-2-pentanone	ND	10								
A	Acetone	ND	10								
A	Benzene	ND	5								
A	Bromodichloromethane	ND	5								
A	Bromoform	ND	5								
A	Bromomethane	ND	10								
A	Carbon disulfide	ND	5								
A	Carbon tetrachloride	ND	5								
A	Chlorobenzene	ND	5								

Definitions: ND - Not Detected at the Reporting Limit
J - Analyte detected below reporting limits
1 - Represents RSD Limit for Quad Analysis
* - LCS Recovery outside limits
B - Analyte detected in the associated Method Blank
M - Matrix Spike Recovery outside limits
RL -Reporting Limit
R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable)

Ecology and Environment, Inc.

Analytical Services Center

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Lancaster, New York 14086

Laboratory Results

NYS ELAP ID#: 10486

Phone: (716) 685-8080

CLIENT: E and E Buffalo Office

Work Order: 9909155

Project: Niagara Falls ARS

QC SUMMARY REPORT

Method Blank

A	Chloroethane	ND	10				
A	Chloroform	ND	5				
A	Chloromethane	ND	10				
A	cis-1,2-Dichloroethene	ND	5				
A	cis-1,3-Dichloropropene	ND	5				
A	Dibromochloromethane	ND	5				
A	Ethylbenzene	ND	5				
A	m,p-Xylene	ND	5				
A	Methylene chloride	ND	5				
A	o-Xylene	ND	5				
A	Styrene	ND	5				
A	Tetrachloroethene	ND	5				
A	Toluene	ND	5				
A	trans-1,2-Dichloroethene	ND	5				
A	trans-1,3-Dichloropropene	ND	5				
A	Trichloroethene	ND	5				
A	Trichlorofluoromethane	ND	5				
A	Vinyl acetate	ND	10				
A	Vinyl chloride	ND	10				
S	1,2-Dichloroethane-d4	47.25		50	95%	82	124
S	4-Bromofluorobenzene	48.48		50	97%	87	115
S	Dibromofluoromethane	47.72		50	95%	89	119
S	Toluene-d8	48.89		50	98%	85	115

Definitions: ND - Not Detected at the Reporting Limit; * - LCS Recovery outside limits; M - Matrix Spike Recovery outside limits; RL -Reporting Limit

J - Analyte detected below reporting limits; B - Analyte detected in the associated Method Blank; R - RPD outside recovery limits (for Samp/Duplicates < 5X RL Difference <2X RL is Acceptable)

1 - Represents RSD Limit for Quad Analysis

Ecology and Environment Inc.

Data file : /var/chem/7001F.i/990924461r.b/F2568.d
Lab Smp Id:
Inj Date : 24-SEP-1999 10:47
Operator : USER4 REG. GRP. Inst ID: 7001F.i
Smp Info : BLK 1523-52-2
Misc Info : [990924461r]{f8bw17},,MBLK,DWW,5ml
Comment : Instrument 5970 (fred.i)
Method : /var/chem/7001F.i/990924461r.b/f8bw17.m
Meth Date : 24-Sep-1999 10:10 dwilly Quant Type: ISTD
Cal Date : 22-SEP-1999 17:02 Cal File: F2514.d
Als bottle: 1
Dil Factor: 1.00000
Integrator: HP RTE Compound Sublist: all.sub
Target Version: 3.40
Processing Host: chemsrv

- NO TENTATIVELY IDENTIFIED COMPOUNDS -

Data File : HP RTE MS F2568.d, Ion 57.00

Integrator: HP RTE Integrator

Number of peaks found: 3

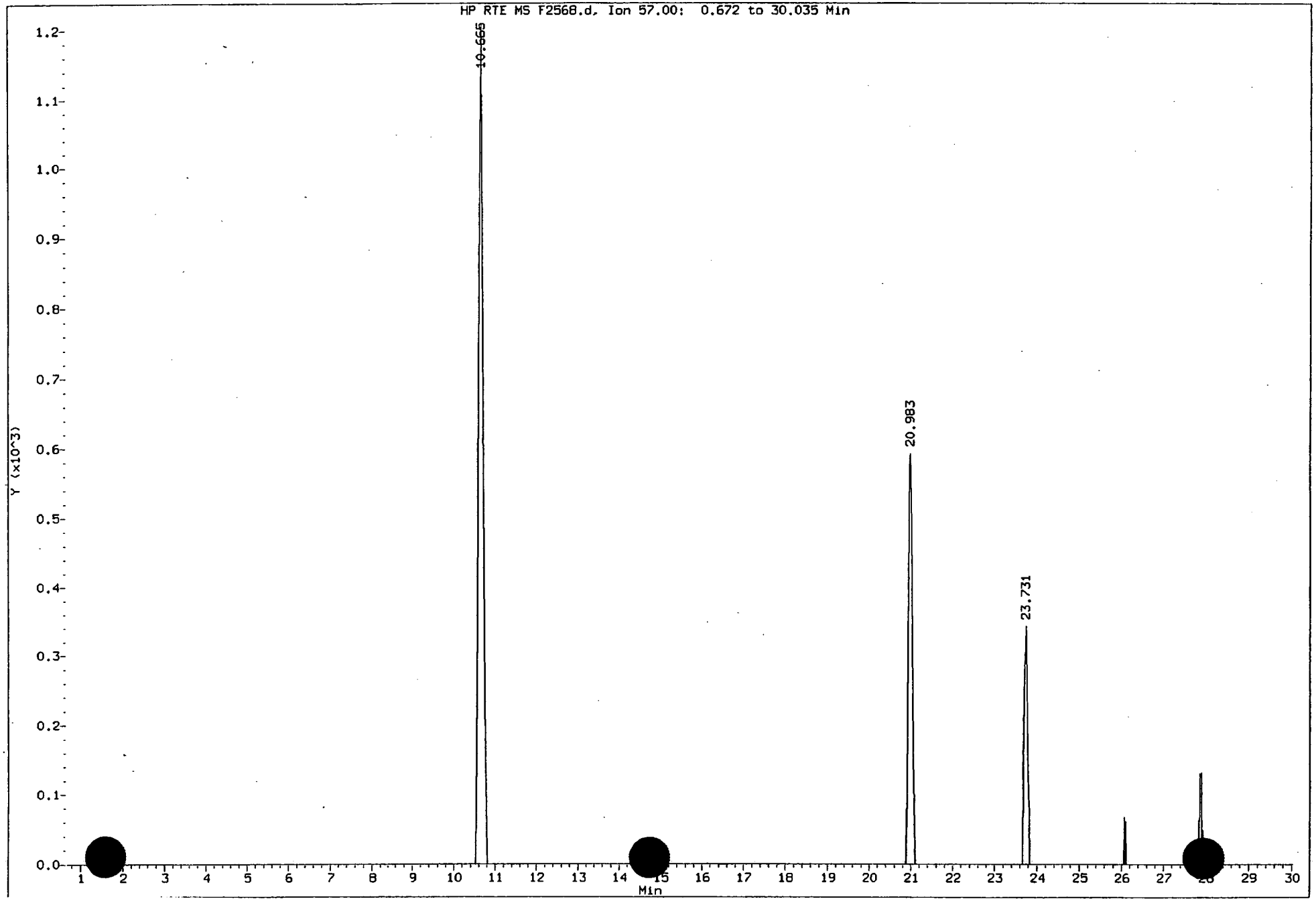
Time	Start Time	End Time	Area	Area%	Height	Height%	Peak Type
10.665	10.525	10.805	9093	61.01	1210	56.57	**
20.983	20.901	21.099	3906	26.21	590	27.58	**
23.731	23.661	23.825	1906	12.79	339	15.85	**

14905

$\frac{14905}{245348} \times 50 = 3.0 \text{ ug/L}$

DWJ
10/12/99

Data File: /var/chem/7001F.i/990924461r.b/F2568.d
Injection Date: 24-SEP-1999 10:47



D

Geoprobe Boring Logs (GP5-69 to GP5-96)

DRILLING LOG OF BOREHOLE NO. GP5-69

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY

Boring Location: N 1135934.976 E 402623.637

Total Depth Drilled (feet BGS): 15

Total Depth Measured (feet BGS): 15

Ground Elevation (feet above MSL): 596.12

Date Installed: 7/19/1999

Drilling Company: SJB

Driller/Geologist: A. Jakubczak / Julie Barclay

Groundwater Depth (feet BGS)	Date	Time
▽		
▼		

ELEVATION	DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
gs elevation 596.12			ground surface (gs)						
595	1		CLAY/SILT: Brown red clay/silt with some gravel, hard, crumbly, some black and red mottling, dry.			1040			
	2						2.2	0	
	2.2		CLAY: Brown/red clay.						
	3		At 2.2'-6.2': Brown/red clay with trace fine gravel and sand, hard, tight, slight orange/red mottling, dry-moist.			1047			
	4								
	5						4	0	
590	6		At 6.2'-11': Brown/red clay, tight, some green sandy layers, moist.						
	7					1052			
	8								
	9		At 9.2': Wet.				4	10	
	10								7/19/99 (1052) - Collected soil (clay) sample GP5-69A-SO-071999.
585	11								
	11.8					1110			
	12		12.3 SAND: Orange/brown sand, with silt and clay, and trace gravel, wet.						7/19/99 (1110) - Collected soil (sand) sample GP5-69B-SO-071999.
	13		TILL: Red/brown till, coarse subangular to subrounded gravel, faceted with silt and fine sand matrix, wet.				4	0	
	14								
	15.0								
	15								Refusal at 15 ft BGS.
580	16								
	17								
	18								
	19								

DRILLING LOG OF BOREHOLE NO. GP5-70

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY
Boring Location: N 1135909.416 E 402593.507
Date Installed: 7/19/1999
Drilling Company: SJB
Driller/Geologist: A. Jakubczak / Julie Barclay

Total Depth Drilled (feet BGS): 13.4
Total Depth Measured (feet BGS): 13.4
Ground Elevation (feet above MSL): 594.92

Groundwater Depth (feet BGS)	Date	Time
▽		
▼		

ELEVATION / DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
gs elevation 594.92		*ground surface (gs)*						
1		SAND AND GRAVEL: Brown sand and gravel. At 0'-0.6': Organic, loose, dry.			1137	2.1	0	
1.9								
2		CLAY: Brown/red clay. At 1.9'-2.1': Brown/red clay with slight mottling, hard, crumbly, dry.			1143			
3								
4		At 2.1'-6.1': Brown/red tight clay, with trace sand and gravel, hard, crumbly, dry.				2.0	0	
590 5								
6		At 6.1'-9.5': Brown/red clay with some grayish laminations, moist becoming wet at 8.9'.			1149			
7								
8						2.0	0	
9								
9.5								
585 10		NO RECOVERY						
10.1								
11		TILL: Red/brown till, coarse subangular to subrounded faceted gravel, with red/brown silt and fine sand, wet.			1152			
12						3.3	2	7/19/99 (1152) - Collected soil (till) sample GP5-70C-SO-071999.
13								
13.4								
14								Refusal at 13.4 ft BGS.
580 15								
16								
17								
18								
19								

DRILLING LOG OF BOREHOLE NO. GP5-71

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY

Boring Location: N 1135914.196 E 402639.087

Date Installed: 7/19/1999

Drilling Company: SJB

Driller/Geologist: A. Jakubczak / Julie Barclay

Total Depth Drilled (feet BGS): 9

Total Depth Measured (feet BGS): 9

Ground Elevation (feet above MSL): 594.99

Groundwater Depth (feet BGS)	Date	Time
▽		
▼		

ELEVATION	DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
gs elevation 594.99			ground surface (gs)						
	1		CLAY/SILT: Brown orange silt and clay with fine sand and trace gravel, hard, crumbly, dry.			1257	2	0	
	2		2.0						
	3		CLAY: Brown/red clay, trace fine gravel and sand, tight, dry becoming moist at 5' BGS.			1301			
	4						2	2	
590	5								
	6		6.0						
			SAND: Brown, fine-grained sand, saturated.			1304			7/19/99 (1304) - Collected soil (sand) sample GP5-71B-SO-071999.
	7		7.5						
	8		TILL: Red/brown till, sand and clay matrix with subrounded to subangular gravel, wet.				3	10	
	9		9.0						Refusal at 9 ft BGS.
585	10								
	11								
	12								
	13								
	14								
580	15								
	16								
	17								
	18								
	19								

DRILLING LOG OF BOREHOLE NO. GP5-72

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY

Boring Location: N 1135884.196 E 402639.087

Date Installed: 7/19/1999

Drilling Company: SJB

Driller/Geologist: A. Jakubczak / Julie Barclay

Total Depth Drilled (feet BGS): 16.7

Total Depth Measured (feet BGS):

Ground Elevation (feet above MSL): 597.66

Groundwater Depth (feet BGS)	Date	Time
▽		
▼		

ELEVATION / DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
gs elevation 597.66		*ground surface (gs)*						
		0.6 TOPSOIL: Brown silt and sand with organics, hard, dry.			1320			
1		FILL: Brown silt, sand, and gravel with tight clay, dry.				2.2	0	
2		At 1.9'-2.2': Asphalt layer.						
595		2.6						
3		CLAY: Orange/red clay with some mottling, tight, moist.			1325			
4		At 3.6'-3.7': Dark brown sand layer.				4.0	0	
5		At 4.0'-4.3': Dark brown sand layer.						
6								
7					1333			
590								
8						4.0	0	
9		9.5						
10		SAND: Red/brown sand, fine to medium grained, well sorted, moderately tight, wet.						
11					1345			7/19/99 (1345) - Collected soil (sand) sample GP5-72B-SO-071999.
12		12.1				3.3	0	
585		TILL: Red/brown till, sand and clay matrix with subrounded to subangular gravel, wet.						
13								
14								
15						2.5	0	
16		16.7						7/19/99 (1345) - Collected soil (till) samples GP5-72C-SO-071999 and GP5-72C-SD-071999. Refusal at 16.7 ft BGS.
17								
580								
18								
19								

DRILLING LOG OF BOREHOLE NO. GP5-73

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY

Boring Location: N 1135884.606 E 402613.317

Date Installed: 7/19/1999

Drilling Company: SJB

Driller/Geologist: A. Jakubczak / Julie Barclay

Total Depth Drilled (feet BGS): 15.7

Total Depth Measured (feet BGS):

Ground Elevation (feet above MSL): 597.72

Groundwater Depth (feet BGS)	Date	Time
▽		
▼		

gs elevation 597.72

ELEVATION / DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
		ground surface (gs)						
1		FILL: Brown sand and gravel, loose, poorly sorted, pieces of brick and asphalt, dry. At 0' - 0.5': topsoil.			1410	2.2	0	
2		2.2						
595 3		CLAY: Red/brown clay with some greenish and sandy laminations, tight, slightly moist.			1414			
4						4	0	
5								
6								
590 7								
8						4	0	
9								
10								7/19/99 (1419) - Collected soil (clay) sample GP5-73A-SO-071999 (MS/MSD).
		10.7			1419			
11		SAND: Brown well sorted sand, fine to medium grained, wet.						
		11.5						
12		TILL: Red/brown till, sand and clay matrix with subrounded to subangular gravel, wet.				4	0	7/19/99 (1426) - Collected soil (till) sample GP5-73C-SO-071999.
585 13								
14								
15					1426	1.5	5	
		15.7						
16								Refusal at 15.7 ft BGS.
17								
580 18								
19								

DRILLING LOG OF BOREHOLE NO. GP5-74

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY
Boring Location: N 1135929.886 E 402574.197
Date Installed: 7/19/1999
Drilling Company: SJB
Driller/Geologist: A. Jakubczak / Julie Barclay

Total Depth Drilled (feet BGS): 14.7
Total Depth Measured (feet BGS):
Ground Elevation (feet above MSL): 596.85

Groundwater Depth (feet BGS)	Date	Time
▽		
▼		

ELEVATION / DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
gs elevation 596.85		*ground surface (gs)*						
1		TOPSOIL AND FILL: Brown sand and gravel, with some silt and clay, loose, dry.			1425	1.9	0	
595 2		1.9 NO RECOVERY 2.5						
3		CLAY: Orange/brown clay with trace sand and gravel, some mottling, tight, moist.			1434	2	0	
4 5 6								
590 7		At 7.5' - 11.5': Some fine, brown sandy laminations, moist.			1305	4	0	
8 9 10								
11		At 11.5': Wet.				3	2	
585 12								
13		13.5						
14		14.3 SAND: Red and gray well sorted sand with some clay, fine to medium grained, wet.						
15		TILL: Red/brown till, sand and clay matrix with subrounded to subangular gravel, wet. 15.7				1.2		7/19/99 (1426) - Collected soil (till) sample GP5-74C-SO-071999.
16								Refusal at 15.7 ft BGS.
580 17								
18 19								

515.EJ09.00.07

DRILLING LOG OF BOREHOLE NO. GP5-75

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY

Boring Location: N 1135884.406 E 402730.947

Total Depth Drilled (feet BGS): 13.7

Total Depth Measured (feet BGS):

Ground Elevation (feet above MSL): 597.47

Date Installed: 7/19/1999

Drilling Company: SJB

Driller/Geologist: A. Jakubczak / Julie Barclay

Groundwater Depth (feet BGS)	Date	Time
9.71 ▽	7/27/1999	
10.21	8/31/1999	
▼		

gs elevation 597.47

ELEVATION	DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
			ground surface (gs)						
	0.7		TOPSOIL: Brown sand and gravel, organic, dry.			0928			
	1		FILL: Angular gravel, asphalt, some brown sand and gravel (mostly limestone), loose, dry.				2.2	0	
	2								
595	2.4		CLAY: Red/brown clay with some gray mottling, tight, plastic, moist.			0933			
	3								
	4						4	0	
	5								
	6		At 6.4' - 10.4': Laminations and several root filled vertical fractures.						
	7					0936			
590	8						4	0	
	9								
▽	10								
	10.4		SAND: Brown well sorted sand, wet.			0947			7/20/99 (1150)-Collected groundwater sample GP5-75-WO-072099.
	11								
	12						3.5	0	
585	12.1		TILL: Red/brown till, sand and clay with subrounded to subangular gravel, wet.						
	13								
	13.7								Refusal at 13.7 ft BGS.
	14								
	15								
	16								
	17								
580	18								
	19								

DRILLING LOG OF BOREHOLE NO. GP5-76

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY

Boring Location: N 1135952.386 E 402728.347

Date Installed: 7/19/1999

Drilling Company: SJB

Driller/Geologist: A. Jakubczak / Julie Barclay

Total Depth Drilled (feet BGS): 13.4

Total Depth Measured (feet BGS):

Ground Elevation (feet above MSL): 595.93

Groundwater Depth (feet BGS)	Date	Time
7.95 ▽	7/27/1999	
9.53	8/31/1999	
▼		

ELEVATION / DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
gs elevation 595.93		*ground surface (gs)*						
595 / 1		FILL: Brownish red clay and silt with gravel, very hard, crumbly, dry.			0954	2.8	0	
2								
2.8								
3		CLAY: Orange/brown clay with gray mottling, tight, hard, dry.			0959			
4						4	0	
590 / 5								
6								
7					1006			
7.8								
▽ 8		SAND: Brown well sorted sand with gravel, saturated.				4	5	7/20/99 (1200)-Collected groundwater sample GP5-76-WO-072099.
9.0								
9		TILL: Angular limestone gravel with brown silt and clay, wet.						
10								
585 / 11					1013			
12						2.6	5	
13								
13.4								Refusal at 13.4 ft BGS.
14								
15								
580 / 16								
17								
18								
19								

DRILLING LOG OF BOREHOLE NO. GP5-77

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY

Boring Location: N 1135960.676 E 402815.947

Total Depth Drilled (feet BGS): 14

Total Depth Measured (feet BGS):

Ground Elevation (feet above MSL): 596.25

Date Installed: 7/20/1999

Drilling Company: SJB

Driller/Geologist: A. Jakubczak / Julie Barclay

Groundwater Depth (feet BGS)		Date	Time
8.14	▽	7/27/1999	14
6.66		8/31/1999	66
	▼		

ELEVATION	DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
gs elevation 596.25			ground surface (gs)						
595	1		FILL: Brown/red clay with some subangular to subrounded gravel (fine to pebble size), hard, crumbly, dry. At 0'-0.6': Topsoil.			1105	2.4	0	
	2		2.4						
	3		CLAY: Red/brown clay with trace gravel, tight, hard, slightly plastic, slightly moist.			1110			
	4						4	0	
	5								
590	6		At 6.4': Becoming moist.						7/20/99 (1110) - Collected geotechnical soil (clay) sample GP5-77A-SO.
	7					1115			
	8 ▽						4	0	
	9								
	10		At 10.4': Wet.						7/20/99 (1330)-Collected groundwater samples GP5-77-WO-072099 and GP5-WD-072099.
585	11		10.9 SAND: Brown well sorted fine to medium grained sand, saturated.			1223			
	12		11.9 TILL: Red clayey sand with some gravel, wet.				3.6	0	
	13								
	14		14.0						Refusal at 14 ft BGS.
	15								
580	16								
	17								
	18								
	19								

DRILLING LOG OF BOREHOLE NO. GP5-78

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY
Boring Location: N 1135717.926 E 402624.467
Date Installed: 7/20/1999
Drilling Company: SJB
Driller/Geologist: A. Jakubczak / Julie Barclay

Total Depth Drilled (feet BGS): 14.5
Total Depth Measured (feet BGS):
Ground Elevation (feet above MSL): 596.74

Groundwater Depth (feet BGS)	Date	Time
9.23 ▽	7/27/1999	
10.86	8/31/1999	
▼		

ELEVATION / DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
gs elevation 596.74		*ground surface (gs)*						
		0.3 ASPHALT			1336	1.4	0	
1		FILL: Brown sand and silt with angular limestone gravel (fine						
		1.4 to pebble size), loose, dry.						
595 2		CLAY: Red/brown clay, tight, slightly plastic, trace rounded gravel.			1340			
3		At 3.4': Cobble.				4	0	
4		At 4.4' - 4.7': Black staining.						
5		At 5.4' - 8.8': Laminations, moist.						
6					1346			
590 7						4	0	
8		8.8						
▽ 9		9.4 CLAY: Sandy red clay with subangular to subrounded gravel, some orange sandy layers.						
10		SAND: Brown/red well sorted fine to medium grained sand, saturated.			1353	2	0	7/20/99 (1616)-Collected groundwater sample GP5-78-WO-072099.
11		11.2						
585 12		TILL: Red till with a clay matrix and subrounded limestone clasts of pebble to cobble size.			1400			
13						3.1	0	7/20/99 - Collected geotechnical soil (sand) sample GP5-78B-SO.
14		14.5						
15								Refusal at 14.5 ft BGS.
16								
580 17								
18 19								

DRILLING LOG OF BOREHOLE NO. GP5-79

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY

Boring Location: N 1135781.666 E 402567.777

Total Depth Drilled (feet BGS): 14

Total Depth Measured (feet BGS):

Ground Elevation (feet above MSL): 597.33

Date Installed: 7/20/1999

Drilling Company: SJB

Driller/Geologist: A. Jakubczak / Julie Barclay & V. Angelaki

Groundwater Depth (feet BGS)	Date	Time
6.9 ▽	7/27/1999	
10.57	8/31/1999	
▼		

ELEVATION / DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
gs elevation 597.33		*ground surface (gs)*						
1		TOPSOIL: Brown sand and gravel, organic, dry.			1430	1.4		
1.4		NO RECOVERY						
2.0		CLAY: Red/brown clay, tight, plastic, hard, dry.						
595 2								
3								
4						3.29		
5								
5.3		NO RECOVERY						
6.0		CLAY: Red clay, tight, hard, yellow and gray mottling, dry.						
▽ 7								
590 8						3.4		
		At 9.4': Big cobble.						
9.4		NO RECOVERY						
10.0		TILL: Red, sandy silty gravel. Wet at 11'.						
10								
11								
585 12						4		
13								
14.0								7/20/99 (1554)-Collected groundwater sample GP5-79-WO-072099. Refusal at 14 ft BGS.
14								
15								
16								
580 17								
18								
19								

DRILLING LOG OF BOREHOLE NO. GP5-80

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY
Boring Location: N 1135883.536 E 402569.117
Date Installed: 7/21/1999
Drilling Company: SJB
Driller/Geologist: A. Jakubczak / Julie Barclay

Total Depth Drilled (feet BGS): 14
Total Depth Measured (feet BGS):
Ground Elevation (feet above MSL): 597.36

Groundwater Depth (feet BGS)	Date	Time
▽		
▼		

gs elevation 597.36

ELEVATION / DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
		ground surface (gs)						
		0.9 TOPSOIL: Brown clay with some sand and gravel, hard, organic, crumbly, dry.			0840			
1		1.4 FILL: Gray/brown sand and gravel, loose, dry.				2.3	0	
		1.8 ASPHALT						
595 2		2.3 CLAY: Red/brown clay with some orange mottling, tight, very slightly plastic, moist.			0845			
3		NO RECOVERY						
4						2.7	0	
5								7/21/99 (0850) - Collected soil (clay) sample GP5-80A-SO-072199.
6		6.3						
7		CLAY: Red/brown clay with some orange mottling, tight, very slightly plastic, moist.			0850			
590 8						3.5	0	
9		Wet at 9.5'.						
10		9.8						
		10.3 NO RECOVERY						
		10.9 SAND: Red clayey fine sand, well sorted, wet.			0855			7/21/99 (0855) - Collected soil (sand) sample GP5-80B-SO-072199.
11		TILL: Red/brown till with a sandy clay matrix and subrounded coarse limestone gravel.						
585 12						3.7	0	
13								7/21/99 (0855) - Collected soil (till) sample GP5-80C-SO-072199.
		14.0						
14								Refusal at 14 ft BGS.
15								
16								
580 17								
18								
19								

DRILLING LOG OF BOREHOLE NO. GP5-81

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY

Boring Location: N 1135929.246 E 402665.407

Total Depth Drilled (feet BGS): 7.3

Total Depth Measured (feet BGS):

Ground Elevation (feet above MSL): 595.16

Date Installed: 7/21/1999

Drilling Company: SJB

Driller/Geologist: A. Jakubczak / Julie Barclay

Groundwater Depth (feet BGS)	Date	Time
▽		
▼		

ELEVATION	DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
gs elevation 595.16			ground surface (gs)						
595			0.6 TOPSOIL: Brown sand and gravel, orgainic, dry.			0909			
	1		CLAY: Brown clay with sand and gravel, hard, crumbly, dry.				2.4	0	
	2		2.4						
			3.1 NO RECOVERY			0912			
	3		CLAY: Red/brown clay with gray mottling, tight, moist.						
	4						3.3	0	
590	5								
	6								
						0929	0.9		
	7		7.3						7/21/99 (0929) - Collected soil (clay) sample GP5-81A-SO-072199. Refusal at 7.3 ft BGS.
	8								
	9								
585	10								
	11								
	12								
	13								
	14								
580	15								
	16								
	17								
	18								
	19								

DRILLING LOG OF BOREHOLE NO. GP5-82

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY

Boring Location: N 1135893.176 E 402686.837

Date Installed: 7/21/1999

Drilling Company: SJB

Driller/Geologist: A. Jakubczak / Julie Barclay & V. Angelaki

Total Depth Drilled (feet BGS): 13

Total Depth Measured (feet BGS):

Ground Elevation (feet above MSL): 596.97

Groundwater Depth (feet BGS)	Date	Time
▽		
▼		

ELEVATION / DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
gs elevation 596.97		*ground surface (gs)*						
1		TOPSOIL: Brown sand and gravel, dry.			0940	2		
1.8								
595 2		CLAY:			0947			
3		At 1.8'-2.0': Brown clay, dry.						
4		At 2.0'-5.2': Brown/red hard brittle clay with some angular gravel, dry.				3.2		
5								
6		At 5.2'-6.0': Brown plastic clay, moist.						
590 7		At 6.0'-9.0': Brown/red clay with orange and gray laminations, trace gravel, moist.			0950			
8						4		7/21/99 (0950) - Collected soil (clay) sample GP5-82A-SO-072199.
9.0								
9		SAND: Brown/red fine clayey sand, wet.						7/21/99 (0950) - Collected soil (sand) sample GP5-82B-SO-072199.
10.0								
10		TILL: Red/brown till, clayey fine sand with coarse to pebble size gravel (subrounded to subangular), loose, wet.			1002			
11						3		
585 12								
13.0								7/21/99 (1002) - Collected soil (till) sample GP5-82C-SO-072199. Refusal at 13 ft BGS.
13								
14								
15								
16								
580 17								
18								
19								

DRILLING LOG OF BOREHOLE NO. GP5-83

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY

Boring Location: N 1135855.396, E 402641.727

Total Depth Drilled (feet BGS): 15

Total Depth Measured (feet BGS):

Ground Elevation (feet above MSL): 597.76

Date Installed: 7/21/1999

Drilling Company: SJB

Driller/Geologist: A. Jakubczak / Julie Barclay

Groundwater Depth (feet BGS)	Date	Time
▽		
▼		

gs elevation 597.76

ELEVATION	DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
			ground surface (gs)						
	1		ASPHALT/FILL: Brown sand and angular limestone gravel, dry, loose.			1018			
			1.2 NO RECOVERY				1.2	1	
595	3		3.3 CLAY: Red/brown clay with trace gravel, laminations, tight, moist.			1021			
	4								
	5						3	0	
	6		6.3 NO RECOVERY						
	7		7.3						
590	8		CLAY: Red/brown clay with orange and gray laminations, tight, some sandier orange layers with depth, moist.			1025			
	9						2.9	0	
	10		10.2 NO RECOVERY						
	11		11.3						
	12		CLAY: Red/brown clay, orange and gray laminations, tight, moist. Wet at 12.3'.			1040			7/21/99 (1025) - Collected soil (clay) sample GP5-83A-SO-072199.
585	13		13.3						
	14		TILL: Red/brown clayey sand with angular limestone gravel (pebble to cobble size), wet. Possibly 1-2" of sand between clay and till, very wet.				3.7	0	
	15		15.0						7/21/99 (1040) - Collected soil (till) sample GP5-83C-SO-072199. Refusal at 15 ft BGS.
	16								
	17								
580	18								
	19								

DRILLING LOG OF BOREHOLE NO. GP5-84

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY

Boring Location: N 1135934.546 E 402549.757

Date Installed: 7/21/1999

Drilling Company: SJB

Driller/Geologist: A. Jakubczak / Julie Barclay

Total Depth Drilled (feet BGS): 17.5

Total Depth Measured (feet BGS):

Ground Elevation (feet above MSL): 598.01

Groundwater Depth (feet BGS)	Date	Time
▽		
▼		

ELEVATION / DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
gs elevation 598.01		*ground surface (gs)*						
1		FILL: Brown sand and angular gravel, loose, crumbly, dry.			1118	2	0	
1.1		CLAY: Red/brown clay with trace gravel (cobble to pebble size) and some laminations, hard, dry and becoming moist at 2'.						
2								
595 3					1121			7/21/99 (1121) - Collected soil (clay) sample GP5-84A-SO-072199.
4						3.3	0	
5								
5.3		NO RECOVERY						
6.0								
6		CLAY: Red/brown clay with trace gravel and laminations, hard, moist.			1126			
7								
590 8						3.4	0	7/21/99 (1126) - Collected geotechnical soil (clay) sample GP5-84A-SO.
9								
9.4		NO RECOVERY						
10.0								
10		CLAY: Red/brown clay with trace gravel and laminations, hard, moist.			1129			
11								
11.4		SAND: Red sandy clay, some gray layers, plastic, wet.				4	0	7/21/99 (1129) - Collected soil (sandy clay) sample GP5-84B-SO-072199.
12								
12.7		TILL: Red/brown clayey sand with angular limestone gravel, wet.						
585 13								
14					1136			7/21/99 (1136) - Collected soil (till) sample GP5-84C-SO-072199.
15								
16						3.5	0	
17								7/21/99 (1136) - Collected geotechnical soil (till) sample GP5-84C-SO.
17.5								Refusal at 17.5 ft BGS.
580 18								
19								

515.EJ09.00.07

DRILLING LOG OF BOREHOLE NO. GP5-85

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY

Boring Location: N 1135963.276 E 402570.987

Total Depth Drilled (feet BGS): 17.5

Total Depth Measured (feet BGS):

Ground Elevation (feet above MSL): 598.09

Date Installed: 7/21/1999

Drilling Company: SJB

Driller/Geologist: A. Jakubczak / Julie Barclay

Groundwater Depth (feet BGS)	Date	Time
▽		
▼		

ELEVATION	DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
gs elevation 598.09			*ground surface (gs)*						
			0.6 TOPSOIL: Brown sand/silt/gravel, loose, organic, dry.			1235			
	1		CLAY: Brown/red clay with some gravel. At 0.6'-2.2': Hard, crumbly, dry.				2.2	0	
	2		At 2.2'-6.2': Tight with some fine sandy layers, moist.			1239			
595	3								
	4						4	0	
	5								
	6		At 6.2'-10.2': Laminated, tight, moist.						7/21/99 (1241) - Collected soil (clay) samples GP5-85A-SO-072199 and GP5-85A-SD-072199.
	7					1241			
590	8						4	0	
	9								
	10		10.2						
			NO RECOVERY			1250			
	11								
	12		12.2				2		
585	13		TILL: Red till with a sandy matrix and subangular to subrounded limestone gravel (fine to pebble size), wet.						7/21/99 (1250) - Collected soil (till) sample GP5-85C-SO-072199
	14								
	15					1252			
	16						3.3	2	
	17		17.5						
580	18								Refusal at 17.5 ft BGS.
	19								

515.EJ09.00.07

DRILLING LOG OF BOREHOLE NO. GP5-86

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY

Boring Location: N 1135954.336 E 402605.407

Date Installed: 7/21/1999

Drilling Company: SJB

Driller/Geologist: A. Jakubczak / Julie Barclay

Total Depth Drilled (feet BGS): 15.7

Total Depth Measured (feet BGS):

Ground Elevation (feet above MSL): 597.44

Groundwater Depth (feet BGS)	Date	Time
▽		
▼		

ELEVATION / DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
gs elevation 597.44		*ground surface (gs)*						
		0.5 TOPSOIL: Brown sand and gravel, loose, organic, dry.			1300			
1		FILL: Brown sand and gravel, loose, dry.				2.4	0	
		1.4 CLAY: Brown/orange clay with sand and gravel, hard,						
2		2.4 crumbly, dry.						
595		CLAY: Red clay with some gravel, tight, moist.			1302			
3								
4						3.3	0	
5								
		5.7						
6		6.4 NO RECOVERY						
		CLAY: Red tight clay with some gravel, brown/orange sandy			1308			
7		layers, laminated, moist.						
590								
8						3.3	2	
9		At 9.6': 1/2" thick brown coarse grained sand layer.						
		9.7						
10		10.4 NO RECOVERY						
		CLAY: Red tight clay with some gravel, brown/orange sandy			1320			
11		layers, laminated, wet.						
12								
585						4		
13								
		13.9						
14		14.1 SAND: Brown fine sand with clay, saturated.						7/21/99 (1320) - Collected soil (clay) sample GP5-86A-SO-072199.
15		TILL: Red till with a sandy matrix and subangular to subrounded limestone gravel, wet.				1.3		7/21/99 (1320) - Collected soil (sand) sample GP5-86B-SO-072199.
		15.7						7/21/99 (1320) - Collected soil (till) sample GP5-86C-SO-072199.
16								Refusal at 15.7 ft BGS.
17								
580								
18								
19								

515.EJ09.00.07

DRILLING LOG OF BOREHOLE NO. GP5-87

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY

Boring Location: N 1135522.106 E 402491.657

Date Installed: 7/22/1999

Drilling Company: SJB

Driller/Geologist: A. Jakubczak / Julie Barclay

Total Depth Drilled (feet BGS): 6.7

Total Depth Measured (feet BGS): 6.67

Ground Elevation (feet above MSL): 593.73

Groundwater Depth (feet BGS)	Date	Time
4.93 ▽	7/27/1999	
dry	8/31/1999	
▼		

ELEVATION	DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
gs elevation 593.73			ground surface (gs)						
	1		CLAY: Brown/red clay, organic at top 0.4', orange mottling with depth, trace gravel, very slightly plastic, moist.			1018	2	0	
	2		2.0						
	3		CLAY: Orange/brown clay with gray and orange mottling throughout, very slightly plastic, hard, tight, moist.			1021			
590	4						4	0	
▽	5								
	6		6.0						
			6.3 SAND: Brown, clayey, fine to medium grained sand, wet.			1025	0.7	0	
	7		6.7 TILL: Red till. Clayey red sand with coarse limestone gravel (subangular to subrounded clasts), wet.						Refusal at 6.7 ft BGS.
	8								
585	9								
	10								
	11								
	12								
	13								
580	14								
	15								
	16								
	17								
	18								
	19								

DRILLING LOG OF BOREHOLE NO. GP5-88

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY

Boring Location: N 1135630.856 E 402913.177

Date Installed: 7/22/1999

Drilling Company: SJB

Driller/Geologist: A. Jakubczak / Julie Barclay

Total Depth Drilled (feet BGS): 9.5

Total Depth Measured (feet BGS): 8.4

Ground Elevation (feet above MSL): 591.5

Groundwater Depth (feet BGS)	Date	Time
4.68 ▽	7/27/1999	
6.11	8/31/1999	
▼		

ELEVATION / DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
gs elevation 591.5		*ground surface (gs)*						
1		CLAY: Brown clay/silt with fine sand, loose, crumbly, dry.			1056			
590		1.0 CLAY: Orange/brown clay with some sand, hard, dry.				2	0	
2		2.0 NO RECOVERY (limestone fragment in shoe).			1059			
3								
4		4.0 CLAY: Red clay with gray mottling, tight, hard, dry to slightly moist.				2	0	
▽ 5		5.0 GRAVEL: Fragment of limestone gravel.						
		5.7 TILL: Red till with red sandy clayey matrix and subrounded limestone pebbles and gravel.			1101			
6		6.0 NO RECOVERY (rock in sampler)						
585		7.2 CLAY: Red clay with gray mottling, tight, hard.				2.8	10	
7		8.2 TILL: Red clayey sand with subangular limestone gravel.						OVA reading of 10 ppm in the till.
8		9.5						Refusal at 9.5 ft BGS.
9								
10								
11								
580								
12								
13								
14								
15								
16								
575								
17								
18								
19								

DRILLING LOG OF BOREHOLE NO. GP5-89

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY

Boring Location: N 1136030.806 E 402884.917

Total Depth Drilled (feet BGS): 11.1

Total Depth Measured (feet BGS):

Ground Elevation (feet above MSL): 595.99

Date Installed: 7/22/1999

Drilling Company: SJB

Driller/Geologist: A. Jakubczak / Julie Barclay

Groundwater Depth (feet BGS)	Date	Time
▽		
▼		

ELEVATION	DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
gs elevation 595.99			*ground surface (gs)*						
595	1		0.8 TOPSOIL: Brown silt and sand with clay, crumbly, organic, dry.			1120	2	0	
			CLAY: Orange/brown clay with some gravel, crumbly, hard, dry.						
	2		2.0 CLAY: Red clay, tight, hard, some orange and gray mottling, slightly moist.			1124			
	3								
	4						4	0	
	5								
590	6		6.0 CLAY: Red clay with some brownish sandy layers.			1126			
	7								
	8						4		
	9		9.0						
	10		9.5 SAND: Orange sand and brown mottled clay with fine to coarse gravel, moist. 10.0						7/22/99 - Collected geotechnical soil (sand) sample GP5-89B-SO.
585	11		SAND: Very fine grained orange/brown sand interlayered with red clay, moist. 11.1			1132	1.1		
			TILL: Brown fine grained clayey sand, well sorted, uniform, saturated.						Refusal at 11.1 ft BGS.
	12								
	13								
	14								
	15								
580	16								
	17								
	18								
	19								

DRILLING LOG OF BOREHOLE NO. GP5-90

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY
Boring Location: N 1136033.706 E 402734.277
Date Installed: 7/22/1999
Drilling Company: SJB
Driller/Geologist: A. Jakubczak / Julie Barclay

Total Depth Drilled (feet BGS): 14.5
Total Depth Measured (feet BGS): 11.28
Ground Elevation (feet above MSL): 596.46

Groundwater Depth (feet BGS)		Date	Time
8.2	▽	7/27/1999	
9.57		8/31/1999	
	▼		

ELEVATION / DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
gs elevation 596.46		*ground surface (gs)*						
595 / 1–2		FILL: Brown sand, silt and gravel with some clay, loose, dry, organic from 0' to 0.2'.			1341	2	1	
2.5		CLAY: Red clay tight, some gray mottling. At 3.5': Black staining. At 3.7'-4.8': Sandy clay with trace gravel.			1344	4	0	
590 / 6–7		At 6'-10': Brown sandy layers.			1347			
▽ 8–9						4		
10.0		SAND: Brown fine grained silty sand, well sorted, plastic, saturated.			1352			
585 / 11–12						4	1	
12.0		TILL: Till, red clay with sand matrix with limestone gravel and pebbles (subrounded facted clasts), wet.						
13–14								7/22/99 (1552) - Collected geotechnical soil (till) sample GP5-90C-SO.
14.5					1355	0.5		Refusal at 14.5 ft BGS.
580 / 15–19								

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DRILLING LOG OF BOREHOLE NO. GP5-91

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY

Boring Location: N 1136036.246 E 402642.157

Total Depth Drilled (feet BGS): 15

Total Depth Measured (feet BGS): 14.64

Ground Elevation (feet above MSL): 597.51

Date Installed: 7/22/1999

Drilling Company: SJB

Driller/Geologist: A. Jakubczak / Julie Barclay

Groundwater Depth (feet BGS)	Date	Time
9.36 ▽	7/27/1999	
10.7	8/31/1999	
▼		

ELEVATION / DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
gs elevation 597.51		*ground surface (gs)*						
1		FILL: Brown sand, silt and gravel (fine to pebble size), asphalt, loose, dry.			1425	2	0	
1.5								
2		2.0 CLAY: Brown/orange clay with gravel, hard, dry.						
595		NO RECOVERY			1427			
3		3.0 CLAY: Red clay.						
4		At 3'-6': Some gravel.				3	8	
5		At 3.6'-6.0': Black staining. At 4.3'-5.0': Sandy.						
6		At 6'-9': Gray and brown laminations, hard, tight, moist.			1431			
7								
590								
8						3	0	
9		9.0 NO RECOVERY						
▽								
10		10.0 CLAY: Red clay with gray and brown laminations, hard, tight, moist.			1435			
11								
1.4								
12		12.2 SAND: Brown clayey very fine grained sand, slightly plastic, wet.				2.7	15	
585		TILL: Till.						
13		At 14'-15': Coarse limestone, well sorted sand grading into coarse gravel and pebbles with clay, wet.						
14					1440			
15		15.0				1	0	Refusal at 15 ft BGS.
16								
17								
580								
18								
19								

DRILLING LOG OF BOREHOLE NO. GP5-92

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY

Boring Location: N 1135972.476 E 402615.157

Date Installed: 7/22/1999

Drilling Company: SJB

Driller/Geologist: A. Jakubczak / Julie Barclay

Total Depth Drilled (feet BGS): 14.9

Total Depth Measured (feet BGS): 14.9

Ground Elevation (feet above MSL): 597.54

Groundwater Depth (feet BGS)	Date	Time
9.63 ▽	7/27/1999	
11.36	8/31/1999	
▼		

ELEVATION / DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
gs elevation 597.54		*ground surface (gs)*						
		0.5 TOPSOIL: Brown sand and gravel, loose, organic, dry.						
1		FILL: Brown sand and gravel, loose, dry.						
		1.4						
2		CLAY: Brown/orange clay with sand and gravel, hard,						
595		2.4 crumbly, dry.						
		CLAY: Red clay with some gravel, tight, moist.						
3								
4								
5		5.7						
6		6.4 NO RECOVERY						
		CLAY: Red clay with some gravel, brown/orange sandy layers, laminated, tight, moist.						
7								
590								
8								
9								
▽								
10		At 9.6': Half-inch thick coarse brown sand layer.						
11								
12								
585								
13								
14		14.4						
		14.6 SAND: Brown fine sand with clay, saturated.						
15		14.9 TILL: Red till with a sandy matrix and subangular to subrounded limestone gravel (fine to pebble size), wet.						7/23/99 (0904)-Collected groundwater sample GP5-92-WO-072399. Refusal at 14.9 ft BGS.
16								
17								
580								
18								
19								

DRILLING LOG OF BOREHOLE NO. GP5-93

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY

Boring Location: N 1136002.906, E 402623.487

Date Installed: 7/23/1999

Drilling Company: SJB

Driller/Geologist: A. Jakubczak / Julie Barclay

Total Depth Drilled (feet BGS): 15.8

Total Depth Measured (feet BGS):

Ground Elevation (feet above MSL): 597.44

Groundwater Depth (feet BGS)	Date	Time
▽		
▼		

gs elevation 597.44

ELEVATION	DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
			ground surface (gs)						
	1		NOT SAMPLED.						
	2								
595	3								
	4		4.0						
			4.5 SAND: Red/brown medium grained sand, well sorted, moist.			0910			
	5		CLAY: Red/brown clay, tight, hard, trace sand and gravel, some light brown sandy layers throughout, some gray mottling, moist.				4	0	
	6								
	7								
590	8					0918			
	9								7/23/99 (0918) - Collected soil (clay) sample GP5-93A-SO-072399.
	10						4	0	7/23/99 (0918) - Collected soil (sand) sample GP5-93B-SO-072399.
			10.6						
	11		SAND: Brown fine to medium grained sand, well sorted, some silt, wet.						
	12					0930			
585	13								
	14						2.5		
			14.7						
	15		TILL: Red sandy clay with subangular limestone gravel (coarse to pebble or cobble size).						7/23/99 (0930) - Collected soil (till) sample GP5-93C-SO-072399.
			15.7						Refusal at 15.8 ft BGS.
	16								
	17								
580	18								
	19								

DRILLING LOG OF BOREHOLE NO. GP5-94

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY

Boring Location: N 1135957.756 E 402537.017

Date Installed: 7/23/1999

Drilling Company: SJB

Driller/Geologist: A. Jakubczak / Julie Barclay

Total Depth Drilled (feet BGS): 17.01

Total Depth Measured (feet BGS):

Ground Elevation (feet above MSL): 598.83

Groundwater Depth (feet BGS)	Date	Time
▽		
▼		

ELEVATION / DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
gs elevation 598.83		*ground surface (gs)*						
		NOT SAMPLED.						
595 / 4		4.0						
		CLAY: Red clay with gray mottling, gray laminations with depth, hard, tight, moist.			0958	4	15	7/23/99 (0958) - Collected soil (clay) sample GP5-94A-SO-072399.
		At 8'-12': Trace gravel.			1000	4	2	
590 / 9								
12		12.0						
		12.6 CLAY: Brown/red sandy clay, very plastic, wet.			1008			
		TILL: Red till, sandy clay matrix with limestone gravel (fine to pebble size) and some sand, wet.				2.7	0	
585 / 14								
16					1010	1		7/23/99 (1010) - Collected soil (till) sample GP5-94C-SO-072399. Refusal at 17.01 ft BGS.
17		17.0						
18 / 19								

515.EJ09.00.07

DRILLING LOG OF BOREHOLE NO. GP5-95

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY

Boring Location: N 1135956.566 E 402651.777

Date Installed: 7/23/1999

Drilling Company: SJB

Driller/Geologist: A. Jakubczak / Julie Barclay

Total Depth Drilled (feet BGS): 16

Total Depth Measured (feet BGS):

Ground Elevation (feet above MSL): 596.8

Groundwater Depth (feet BGS)	Date	Time
▽		
▼		

ELEVATION	DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
gs elevation 596.8			ground surface (gs)						
	1		NOT SAMPLED.						
595	2								
	3								
	4		4.0						
	5		CLAY: Red clay with trace sand and fine gravel, gray mottling, tight, hard, moist becoming wet at 9'.			1050	2	0	
	6		At 6.5'-9.5': Laminations and sandy layers.			1057			
590	7								
	8						3.5	0	
	9		9.5						7/23/99 (1057) - Collected soil (clay) sample GP5-95A-SO-072399.
	10		NO RECOVERY						
	11					1104			
	12		11.7 SAND: Brown well-sorted fine-grained clayey sand, wet.				0.9	0	7/23/99 (1104) - Collected soil (sand) sample GP5-95B-SO-072399.
585	13		13.2						
	14		TILL: Red till, sandy clay matrix with limestone gravel (fine to cobble size).			1115	2		7/23/99 (1115) - Collected soil (till) sample GP5-95C-SO-072399.
	15								
	16		16.0						Refusal at 16 ft BGS.
580	17								
	18								
	19								

DRILLING LOG OF BOREHOLE NO. GP5-96

Project/Location: Site 5 RFI-Niagara Falls ARS / Niagara Falls, NY

Boring Location: N 1135926.956 E 402700.047

Date Installed: 7/23/1999

Drilling Company: SJB

Driller/Geologist: A. Jakubczak / Julie Barclay

Total Depth Drilled (feet BGS): 12.9

Total Depth Measured (feet BGS):

Ground Elevation (feet above MSL): 595.59

Groundwater Depth (feet BGS)	Date	Time
7.06 ▽	7/27/1999	
▼		

ELEVATION / DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	PENETRATION TIMES	RECOVERY (feet)	OVA (ppm)	COMMENTS
gs elevation 595.59		*ground surface (gs)*						
595 / 1		NOT SAMPLED.						
2								
3								
4		4.0						
5		CLAY: Red/orange clay with some sand and gravel, tight, slightly plastic, moist.			1150			
590 / 6		Wet at 6.5'.				3.3	1	
▽ 7		7.0 / 7.3 SAND: Brown silty sand, wet.						
8		8.0 NO RECOVERY						7/23/99 (1150) - Collected soil (clay) sample GP5-96A-SO-072399.
9		SAND: Brown silty sand, wet.			1156			7/23/99 (1156) - Collected soil (sand) sample GP5-96B-SO-072399.
10		9.5 TILL: Red till, sandy clay matrix with limestone gravel, wet.				2.5	0.5	7/23/99 (1205) - Collected soil (till) sample GP5-96C-SO-072399.
585 / 11		10.5 NO RECOVERY						
12		12.0 TILL: Red till, sandy clay matrix with limestone gravel, wet.			1205	0.9	0	
13		12.9						Refusal at 12.9 ft BGS.
14								
15								
580 / 16								
17								
18 / 19								

515.EJ09.00.07

ecology and environment, inc.

E

Soil Classification and Geotechnical Testing Results

GZA
GeoEnvironmental
of New York

Engineers and
Scientists

November 17, 1999
File: 1300.55

Mr. Rick Watt
Ecology and Environment
368 Pleasantview Drive
Lancaster, NY 14806

Re: Geotechnical Laboratory Testing Services
Niagara Falls ARS Site
Niagara Falls, NY

364 Nagel Drive
Buffalo
New York 14225
716-685-2300
FAX 716-685-3629
http://www.gza.net

Dear Mr. Watt,

GZA GeoEnvironmental of New York (GZA) has completed testing six (6) samples collected by Ecology and Environment (E&E). The Samples were delivered to our Buffalo, New York office on July 23, 1999.

GZA has laboratory tested these samples as requested by E&E. The testing program included the following tests: Grain Size Analysis and Atterberg Limits.

Enclosed please find one copy of sheets entitled "Geotechnical Laboratory Test Procedures", "Geotechnical Laboratory Testing Data Summary", and "Legend for Geotechnical Laboratory Summary".

GZA appreciates the opportunity to be of service to E&E on this project. Please do not hesitate to contact us with any question or if you require any additional information.

Very truly yours,

GZA GEOENVIRONMENTAL OF NEW YORK

David J. Birch
Geotechnical Laboratory Supervisor

John J. Danzer, P.E.
Senior Project Manager

Enclosures

A Subsidiary of GZA
GeoEnvironmental
Technologies, Inc.

GEOTECHNICAL LABORATORY TEST PROCEDURES

NIAGARA FALLS ARS
NIAGARA FALLS, NY
File No. 1300.55
NOVEMBER 17, 1999

1. The following tests were conducted in general accordance with the noted ASTM test method:

DESIGNATION	TEST METHOD
ASTM D 422-63	Particle-Size Analysis of Soils
ASTM D 2216-92	Laboratory Determination of Water (Moisture) Content of Soil and Rock
ASTM D 2487-92	Classification of Soils for Engineering Purposes (Unified Classification System) (see Item 2)
ASTM D 4318-93	Liquid Limit, Plastic Limit, and Plasticity Index of Soils

2. Soil description for samples tested for particle-size analysis and Atterberg limits are based upon particle-size analysis results and determination of the liquid limit, plastic limit and plasticity index.

3. The test results are presented on the sheet entitled "PARTICLE-SIZE ANALYSIS" and "GEOTECHNICAL LABORATORY TESTING DATA SHEET".

GEOTECHNICAL LABORATORY TESTING DATA SUMMARY

PROJECT NAME: NIAGARA FALLS ARS
LOCATION: NIAGARA FALLS, NY
PROJECT NO. 1300.55

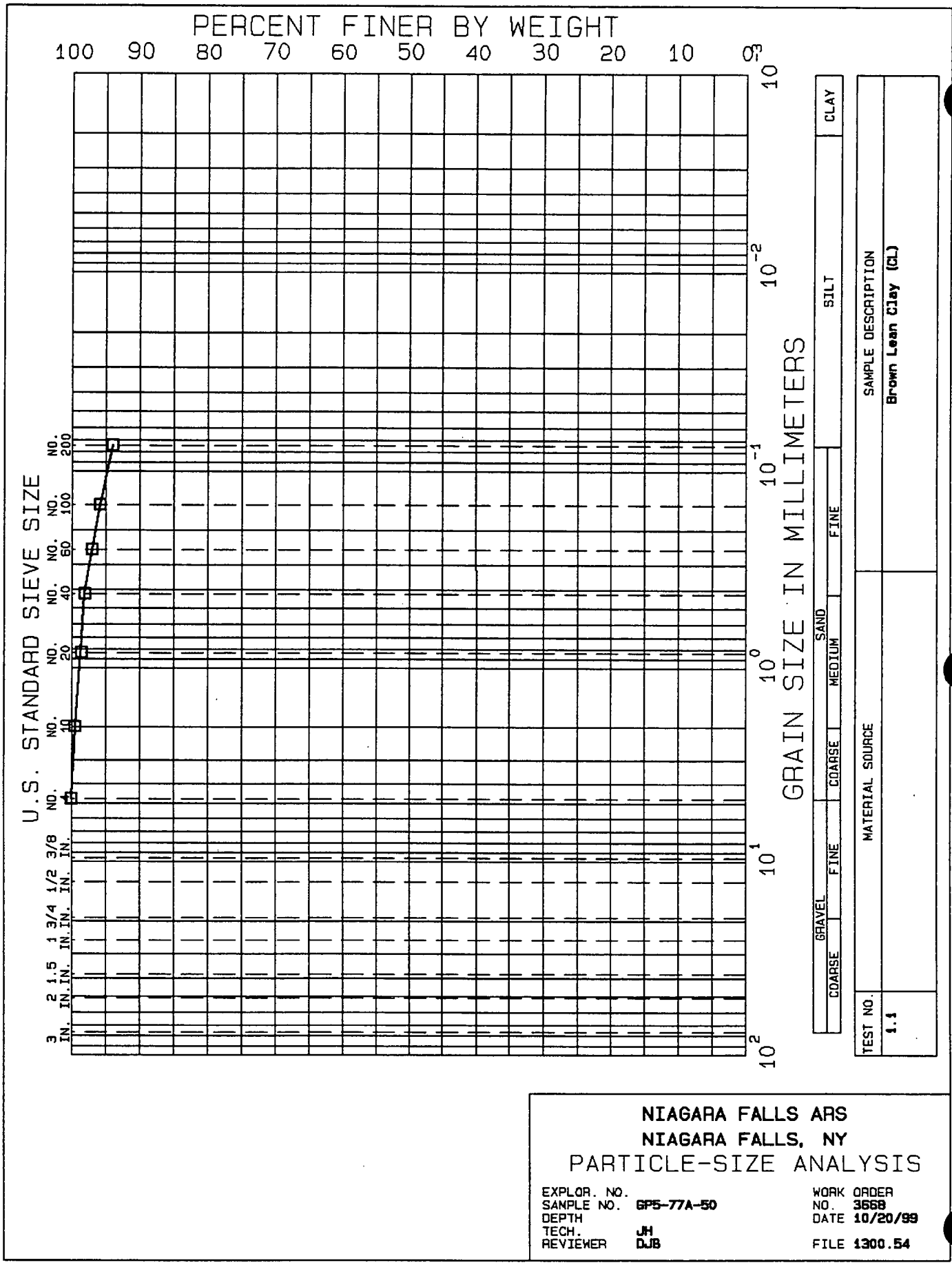
CLIENT: ECOLOGY AND ENVIRONMENT

MATERIAL SOURCE: UNKNOWN

DATE REPORTED: November 17, 1999

WORK ORDER NO. 3668

IDENTIFICATION			WATER CONTENT	ATTERBERG LIMITS			GRAIN SIZE ANALYSIS		MOISTURE-DENSITY RELATIONSHIP (Modified)		PERMEABILITY TEST					LABORATORY LOG AND SOIL DESCRIPTION
EXPLOR. NUMBER	SAMPLE NUMBER	DEPTH ft.	%	LL %	PL %	PI	SIEVE -200 %	HYD. -2μ %	MAX. DRY DENSITY pcf	OPT. WATER CONTENT %	PERME-ABILITY cm/sec.	TYPE OF TEST	$\bar{\sigma}_c$ psf	DRY UNIT WT pcf	WATER CONTENT %	
JARS	GP5-77 A-50	-	23.0	40	16	24	94									Brown Lean Clay (CL)
JARS	GP5-78 B-50	-	18.5	NP	NP	NP	56									Light Brown Sandy Silt (ML)
JARS	GP5-84 C-50	-	29.5	33	21	7	97									Brown Sandy Silty Clay (CL-ML)
JARS	GP5-84 A-50	-	18.0	28	17	12	47									Dark Brown Lean Clay (CL)
JARS	GP5-89 B-50	-	25.0	NP	NP	NP	47									Light Brown Silty Sand (SM)
JARS	GP5-90 C-50	-	25.5	28	17	6	63									Brown Sandy Silty Clay (CL-ML)

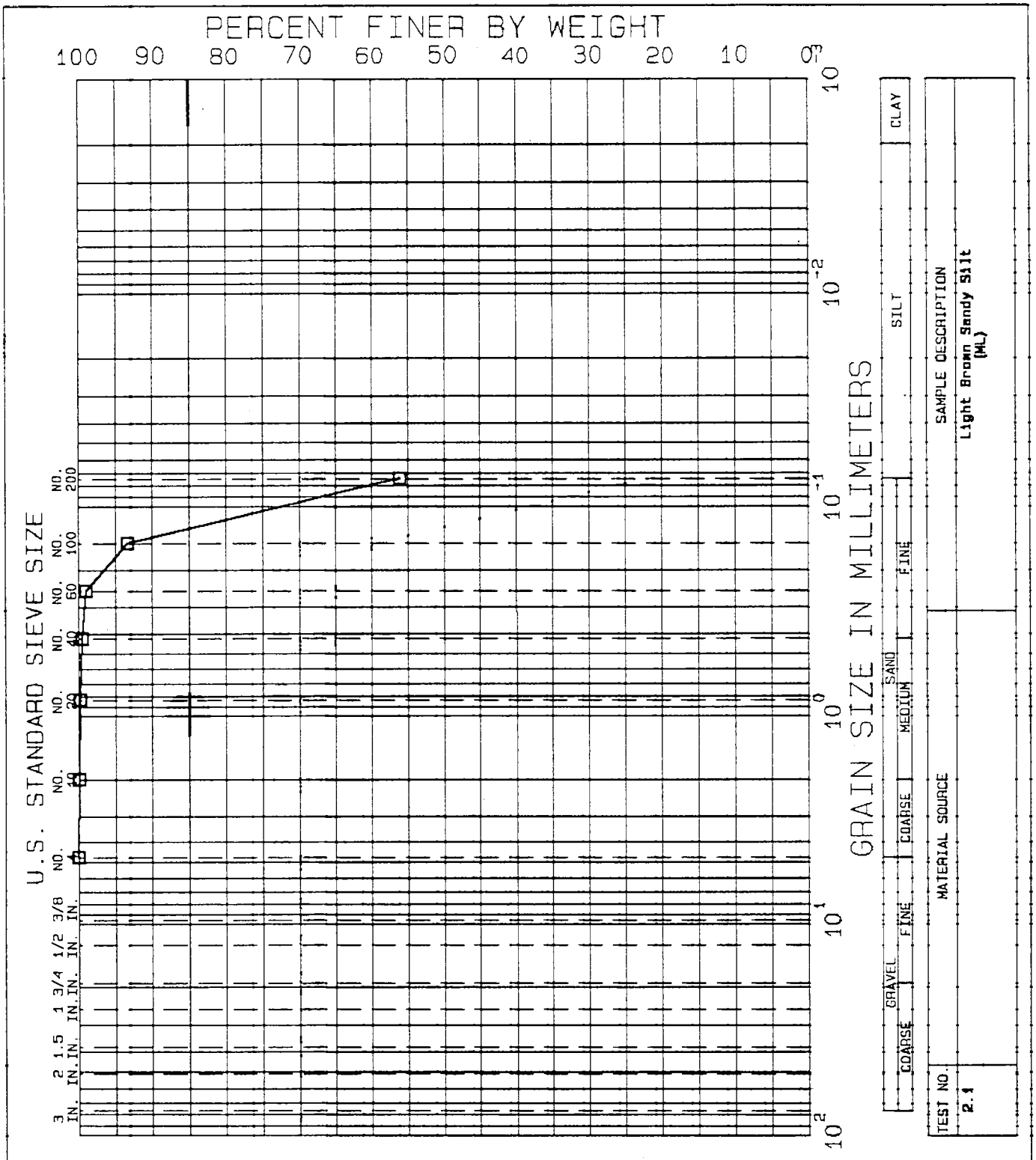


NIAGARA FALLS ARS
NIAGARA FALLS, NY

PARTICLE-SIZE ANALYSIS

EXPLOR. NO.		WORK ORDER NO.	3668
SAMPLE NO.	GP5-77A-50	DATE	10/20/99
DEPTH			
TECH.	JH		
REVIEWER	DJB	FILE	1300.54

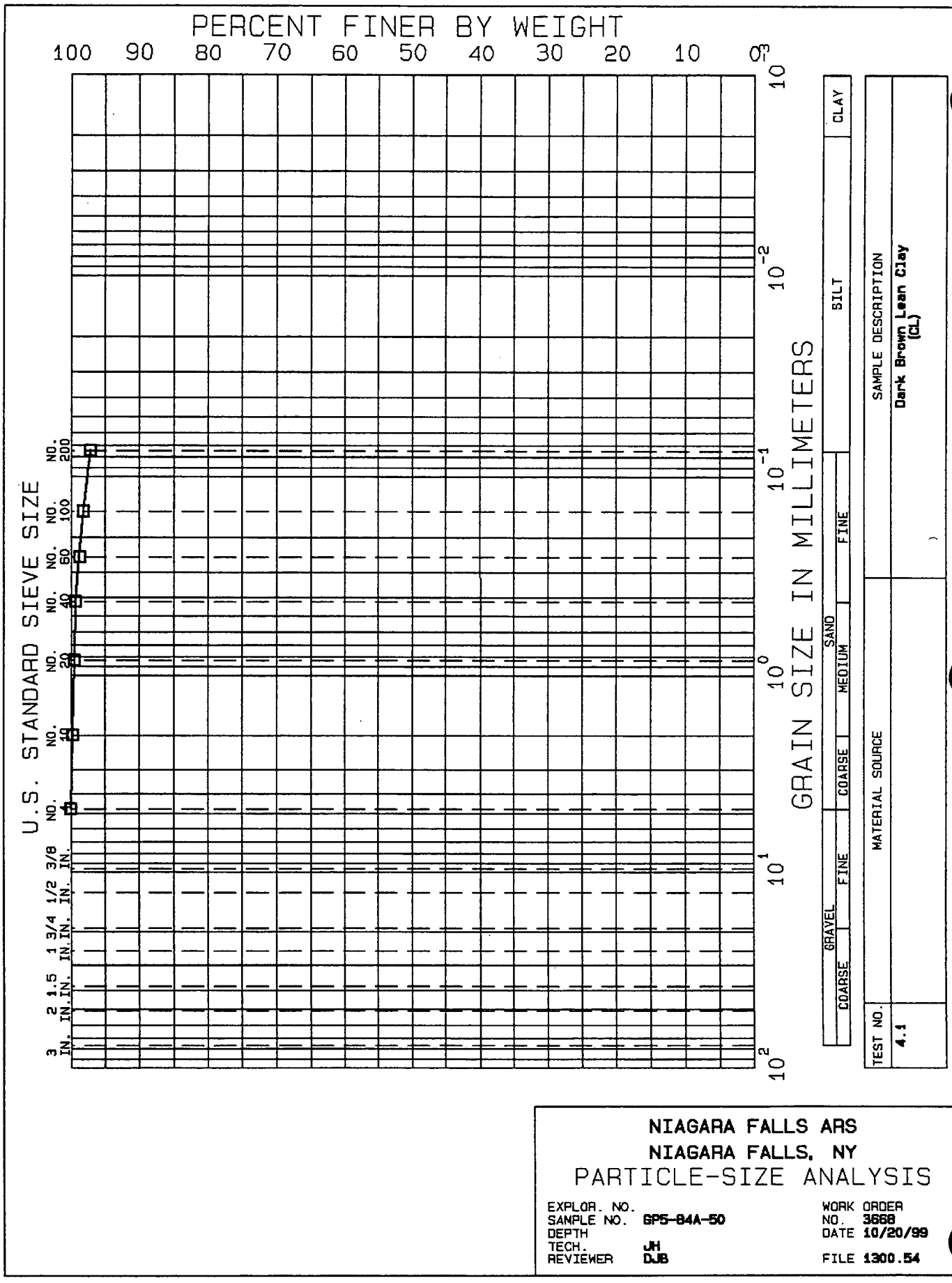
GZA GeoEnvironmental of New York
Engineers and Scientists



NIAGARA FALLS ARS
NIAGARA FALLS, NY

PARTICLE-SIZE ANALYSIS

EXPLOR. NO.		WORK ORDER NO.	3668
SAMPLE NO.	GP5-788-50	DATE	10/20/99
DEPTH			
TECH.	JH		
REVIEWER	DJB	FILE	1300.54

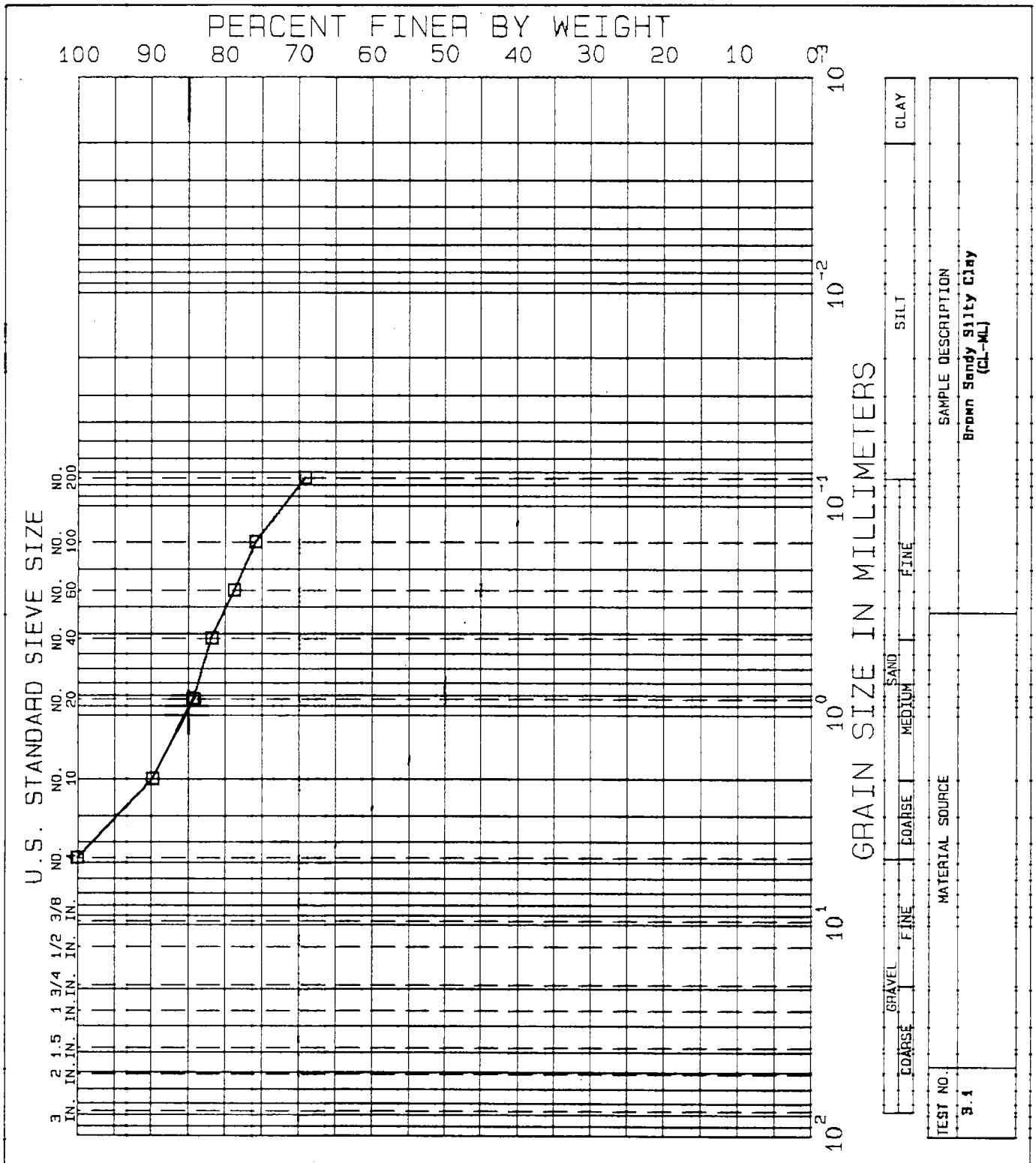


NIAGARA FALLS ARS
NIAGARA FALLS, NY

PARTICLE-SIZE ANALYSIS

EXPLOR. NO.		WORK ORDER NO.	3668
SAMPLE NO.	GP5-84A-50	DATE	10/20/99
DEPTH			
TECH.	JH		
REVIEWER	DJB	FILE	1300.54

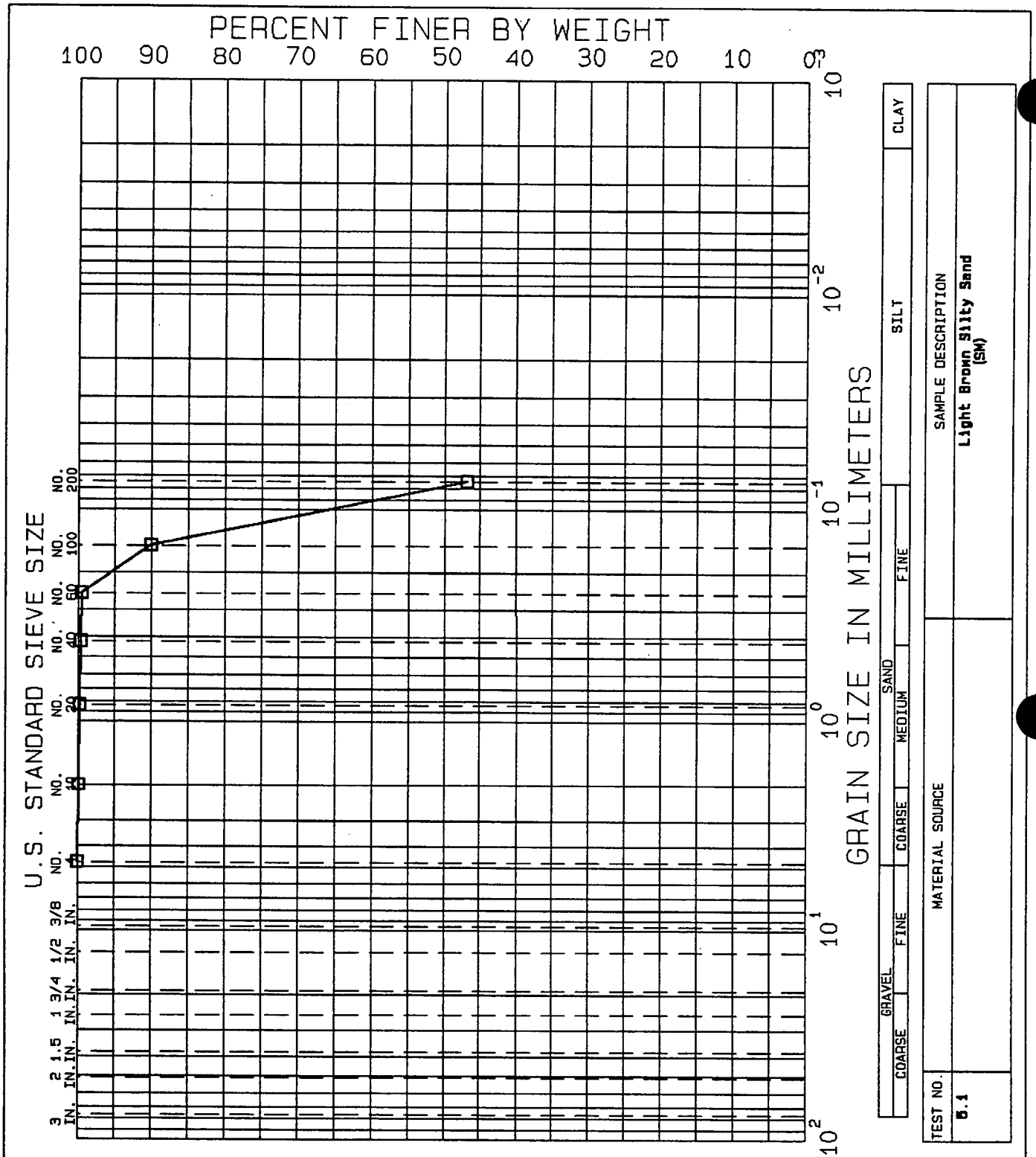
GZA GeoEnvironmental of New York
Engineers and Scientists



NIAGARA FALLS ARS
NIAGARA FALLS, NY
PARTICLE-SIZE ANALYSIS

EXPLOR. NO.		WORK ORDER NO.	3568
SAMPLE NO.	GP5-B4C-50	DATE	10/20/99
DEPTH			
TECH.	JH		
REVIEWER	DJB	FILE	1300.54

GZA GeoEnvironmental of New York
Engineers and Scientists

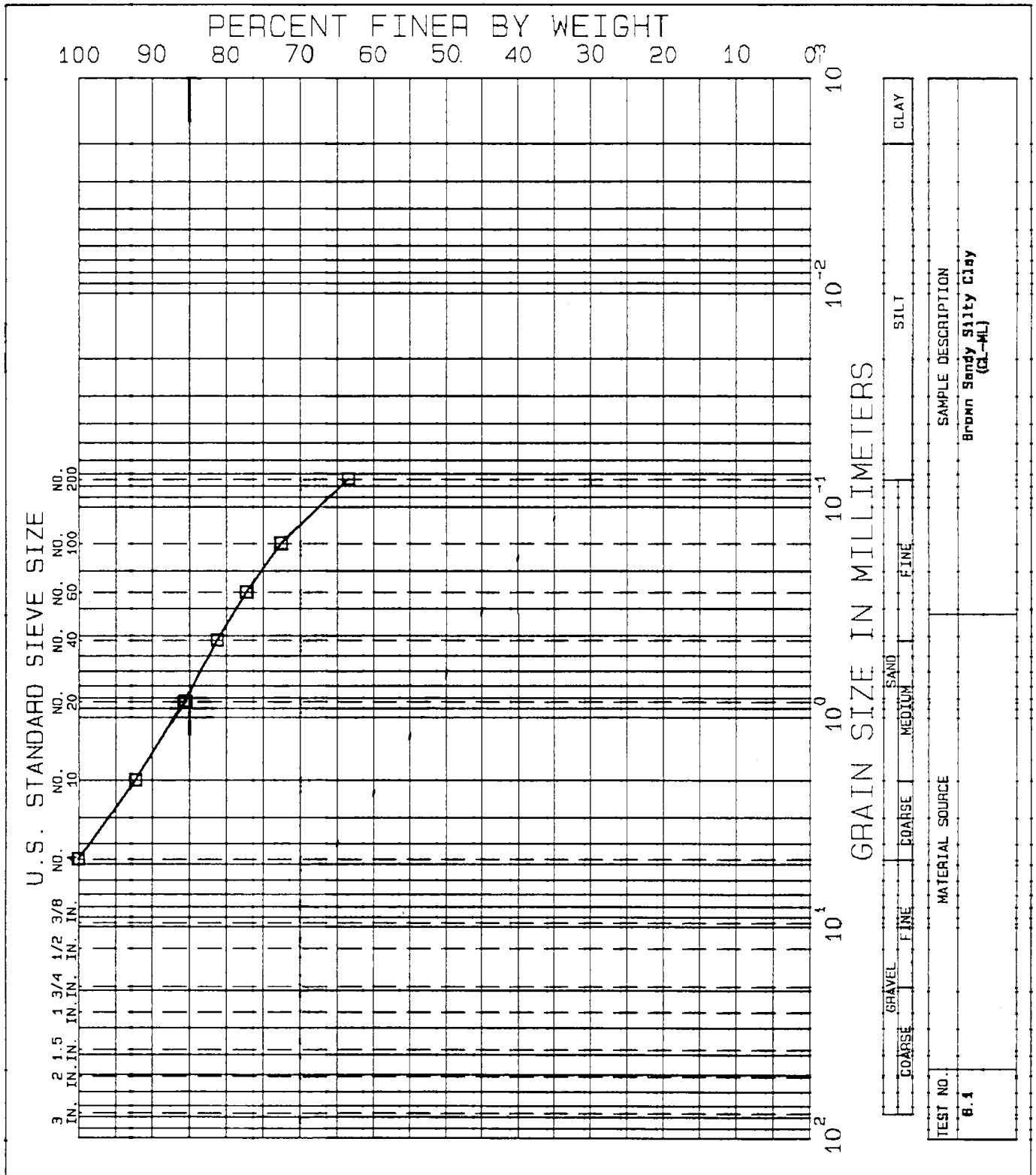


NIAGARA FALLS ARS
NIAGARA FALLS, NY

PARTICLE-SIZE ANALYSIS

EXPLOR. NO.		WORK ORDER NO.	3668
SAMPLE NO.	GP5-B9B-50	DATE	10/20/99
DEPTH			
TECH.	JH		
REVIEWER	DJB	FILE	1300.54

GZA GeoEnvironmental of New York
Engineers and Scientists



NIAGARA FALLS ARS
NIAGARA FALLS, NY
PARTICLE-SIZE ANALYSIS

EXPLOR. NO.		WORK ORDER NO.	3668
SAMPLE NO.	GP5-80C-50	DATE	10/20/99
DEPTH			
TECH.	JM		
REVIEWER	DJB	FILE	1300.54

PROJECT No:	SITE NAME:	LOCATION: (Include State)
000515.EJ09. 00.03.96	Niagara Falls ARS	NY

CLIENT: 914th AW USAFRC

PROJECT MANAGER: Rick Watt

OFFICE No:

FIELD TEAM LEADER: Rick Watt

PHONE No:

SAMPLERS: (PRINT) R. Watt

CONTAINER TYPE AND PRESERVATIVE

REQUESTED ANALYSIS

TURNAROUND TIME
- 24-HOUR ☐ RUSH
- 48-HOUR ☐ RUSH
- 1-WEEK ☐ RUSH
- STANDARD ☒
- RUSH _____ days
- OTHER _____

(FOR LAB USE ONLY)
Lab Job No:
Report type:
Batch QC: Yes No

DATE	TIME	SAMPLE ID	SAMPLE MATRIX	CHECK FOR MS/MSD	SAMPLE TYPE	No. OF CONTAINERS	USCS	Moisture Content				ppm TCE & cis DCE in Nearby groundwater	ppb TCE + cis DCE in Nearby Samples	OVA/HNU READINGS (PPM)	BEGINNING DEPTH (FEET BGS)	ENDING DEPTH (FEET BGS)	REMARKS
7-21-99		GP5-77A-SO	SB		0	1	x	x				20	-	0	7	8	Clay
7-21-99		GP5-78B-SO	SB		0	1	x	x				ND	-	0	12	13	Sand
7-21-99		GP5-84C-SO	SB		0	1	x	x				-	850	0	17	17.5	T.11
7-21-99		GP5-84A-SO	SB		0	1	x	x				-	ND	0	7	7.5	Clay
7-22-99		GP5-89B-SO	SB		0	2	x	x				-	-	0	9.5	10	Sand
7-22-99		GP5-90C-SO	SB		0	2	x	x				ND	-	1	13	14	& T.11

Relinquished By: (Signature)	Date/Time:	Received By: (Signature)	Date/Time:	Ship Via:	Date:
				E&E	7-23-99
Relinquished By: (Signature)	Date/Time: 7-23-99 1440	Received By: (Signature)	Date/Time: 7/23 1440	BL/Airbill Number: N/A	

Temperature Blank Info. Enclosed: Yes No N/A

(FOR LAB USE ONLY)
Date: _____ Time: _____
Temperature: _____ °C

Distribution: White - Lab original Yellow - Field team leader

0881297

F

Well Logs (MW5-6, MW5-7, MW5-8)

DRILLING LOG OF WELL NO. MW5-6

Project/Location: Niagara Falls ARS / Niagara Falls, NY
Boring Location: IRP SITE 5
Northing/Easting: 1135903.84 / 402597.9
Date Started - Finished: 9/1/99 - 9/2/99
Drilling Company: SJB
Driller/Geologist: D. Mathes / R. Watt

Total Depth of Hole (feet BGS): 15
Ground Elevation (feet AMSL): 596.64
Groundwater Depth After Drilling / Date: 9.56 feet BGS ▽ / 9/9/99
Top of Inner Casing (feet AMSL): 596.42

ELEVATION / DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	RQD (%)	PENETRATION TIMES	BLOW COUNT	RECOVERY (feet)	SAMPLE / HOLE	OVA (ppm)	COMMENTS
gs elevation 596.64		ground surface (gs)							
	Flush Mount; Portland Cement; Bentonite Seal; U.S. Silica No. 0; 2" PVC No. 10 Slot Screen	0.5 TOPSOIL: Silty clay with organics. CLAY: Red/brown clay with trace silt and trace gray molting, soft, slightly plastic, varved.						0	Well Construction Bentonite Seal: 5.0 - 7.0 ft BGS Sand Pack: 7.0 - 14.5 ft BGS Screen: 9.5 - 13.5 ft BGS Bentonite Plug: 14.5 - 15.0
595		8.0 CLAY: Reddish brown, silty clay with trace of very fine sand; moist.		1504	4 4 5 5	1.8		0	
		9.7 ▽ SAND: Light to medium brown layered fine sand; wet.			2				Wet at 9.7' BGS.
590		10.5 TILL: Reddish brown clayey sitly sand with gravel (subrounded to subangular chert and dolostone); wet. Stopped sampling at 12'.		1509	2 7 4 2	0.7		0	
585		15.5 LOCKPORT DOLOSTONE							Split spoon refusal at 15.5' BGS.
		16.5							

DRILLING LOG OF WELL NO. MW5-7

Project/Location: Niagara Falls ARS / Niagara Falls, NY
Boring Location: IRP SITE 5
Northing/Easting: 1135901.15 / 402787.8
Date Started - Finished: 9/2/99 - 9/2/99
Drilling Company: SJB
Driller/Geologist: D. Mathes / R. Watt

Total Depth of Hole (feet BGS): 13.4
Ground Elevation (feet AMSL): 596.63
Groundwater Depth After Drilling / Date: 9.66 feet BGS ▽ / 9/9/99
Top of Inner Casing (feet AMSL): 596.46

ELEVATION / DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	RQD (%)	PENETRATION TIMES	BLOW COUNT	RECOVERY (feet)	OVA (ppm) SAMPLE / HOLE	COMMENTS
gs elevation 596.63		ground surface (gs)						
595 / 1	Flush Mount; Portland Cement	TOPSOIL: Dark brown silty clay with sand and gravel, organic rich; dry.			8 12 10 9	1.7	0	Well Construction Bentonite Seal: 4.0 - 6.0 ft BGS Sand Pack: 6.0 - 13.4 ft BGS Screen: 8.8 - 12.8 ft BGS
1.8		SILTY CLAY: Dark brown layered silty clay, hard; very dry.			7 8 10 8	0.5	0	
2.5		NO RECOVERY						
4.0	Bentonite Seal	SILTY CLAY: Reddish brown silty clay with some gray mottling; dry.			5 3 3 5	0.8	0	
590 / 6.4	U.S. Silica No. 0	SAND: Reddish brown fine sand with silt, very well sorted; moist.			9 10 5 5	1.6	0	
7.5		TILL: Reddish brown sandy clay with some gray and yellowish-brown mottling; moist.			3 3 4 4	0.4	5	
9	2" PVC No. 10 Slot Screen							
10.5					9 15 17 8	0.8	1	
11.0		WEATHERED BEDROCK: Heavily weathered Lockport Dolostone in clayey sand matrix.						
585 / 12.0		NO RECOVERY			10 12 8	1.2	3	Wet at 12' BGS.
13.4		TILL: Reddish brown sandy clay with silt and gravel (angular to subrounded dolostone); wet.			27			Auger refusal at 13.5' BGS. Split spoon refusal at 14' BGS.
14 / 15 / 16 / 17								

DRILLING LOG OF WELL NO. MW5-8

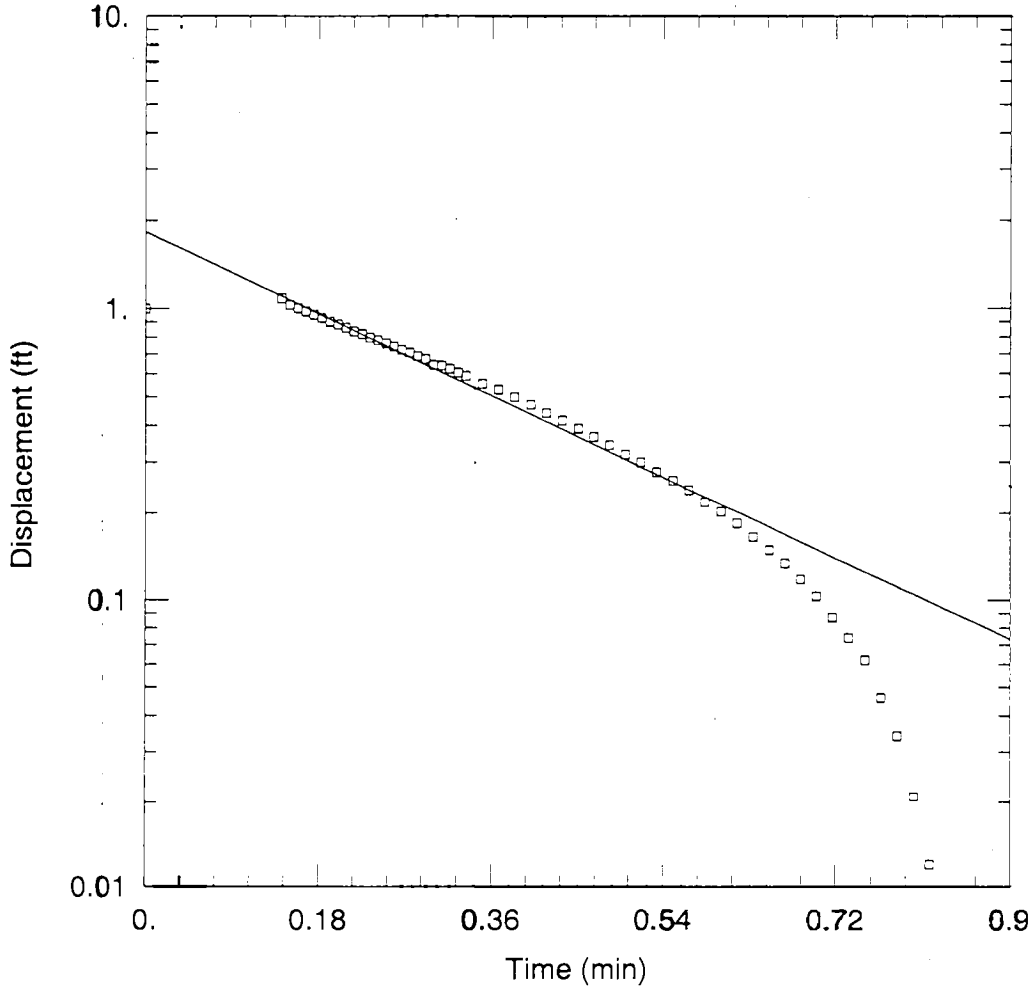
Project/Location: Niagara Falls ARS / Niagara Falls, NY
Boring Location: IRP SITE 5
Northing/Easting: 1135671.96 / 402559.08
Date Started - Finished: 9/2/99 - 9/2/99
Drilling Company: SJB
Driller/Geologist: D. Mathes / R. Watt

Total Depth of Hole (feet BGS): 11.2
Ground Elevation (feet AMSL): 594.55
Groundwater Depth After Drilling / Date: 9.01 feet BGS ▽ / 9/9/99
Top of Inner Casing (feet AMSL): 594.25

ELEVATION / DEPTH	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	RQD (%)	PENETRATION TIMES	BLOW COUNT	RECOVERY (feet)	OVA (ppm) SAMPLE / HOLE	COMMENTS
gs elevation 594.55		ground surface (gs)						
	Flush Mount; Portland Cement							Well Construction
		LOAM: Dark brown, hard silty sandy clay with organics; dry. 1.0		1313	4 4 7 10	0.9	0	Bentonite Seal: 3.0 - 5.0 ft BGS
		NO RECOVERY						Sand Pack: 5.0 - 11.2 ft BGS
								Screen: 6.7 - 10.7 ft BGS
				1315	7 5 8 5	0	0	OVA: 0.2 ppm in augers.
	Bentonite Seal	4.0						
590		CLAY: Reddish brown sandy clay with silt; dry. 4.4 / 4.8		1323	11 12 38 34	0.8	0.8	
	U.S. Silica No. 0	SAND: Reddish brown to yellowish brown fine-grained well-sorted sand; moist. 5.0 / 6.0						
		TILL: Reddish brown, sandy clay with silt and gravel; moist. 6.5		1326	15 9 7 5	1	1	
	2" PVC No. 10 Slot Screen	NO RECOVERY						
		WEATHERED BEDROCK: Weathered Lockport Dolostone.						
		TILL: Reddish brown, sandy clay with silt and gravel. Gravel is angular to subrounded dolostone and chert; moist. Wet below 8'.		1332	4 6 5 8	0.8	0	Wet at approximately 8' BGS.
585				1335	2 2 7 5	0.9	0	
		12.2		1336	50/0	0.1		Refusal at 12.2' BGS.
580								

G

Aquifer Testing Results



MW5-6 SLUG TEST 10/99

Data Set: A:\10-99S~1\MW5-6.AQT
Date: 12/04/99 Time: 09:31:43

PROJECT INFORMATION

Company: Ecology and Environment, Inc.
Client: 914th Airlift Wing
Project: 000515.EJ09
Test Location: Site 5
Test Well: MW5-6
Test Date: 10/21/99

AQUIFER DATA

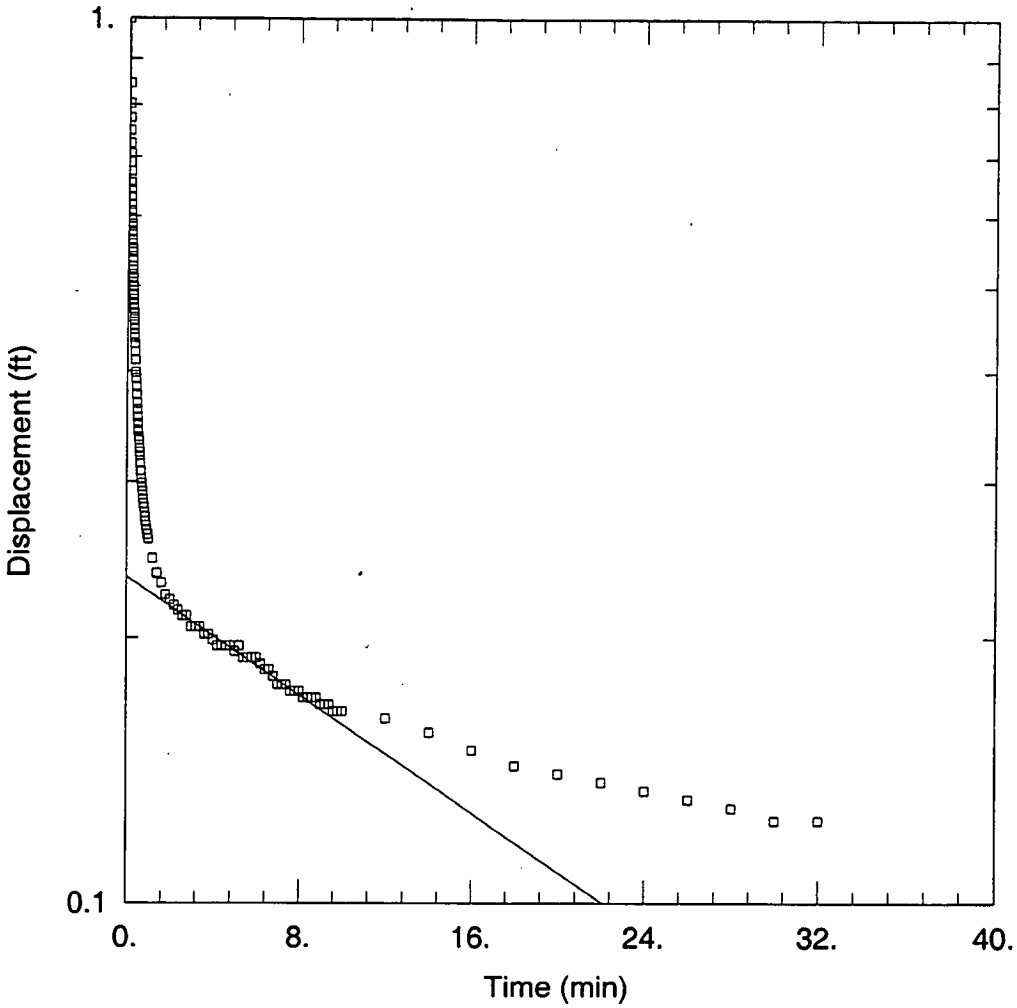
Saturated Thickness: 1. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Initial Displacement: 1. ft
Casing Radius: 0.083 ft
Screen Length: 5. ft
Water Column Height: 6. ft
Wellbore Radius: 0.35 ft
Gravel Pack Porosity: 0.4

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.01967 cm/sec
y0 = 1.825 ft



MW5-7 SLUG TEST 10/99

Data Set: A:\10-99S~1\MW5-7.AQT
Date: 12/04/99 Time: 09:31:52

PROJECT INFORMATION

Company: Ecology and Environment, Inc.
Client: 914th Airlift Wing
Project: 000515.EJ09
Test Location: Site 5
Test Well: MW5-7
Test Date: 10/21/99

AQUIFER DATA

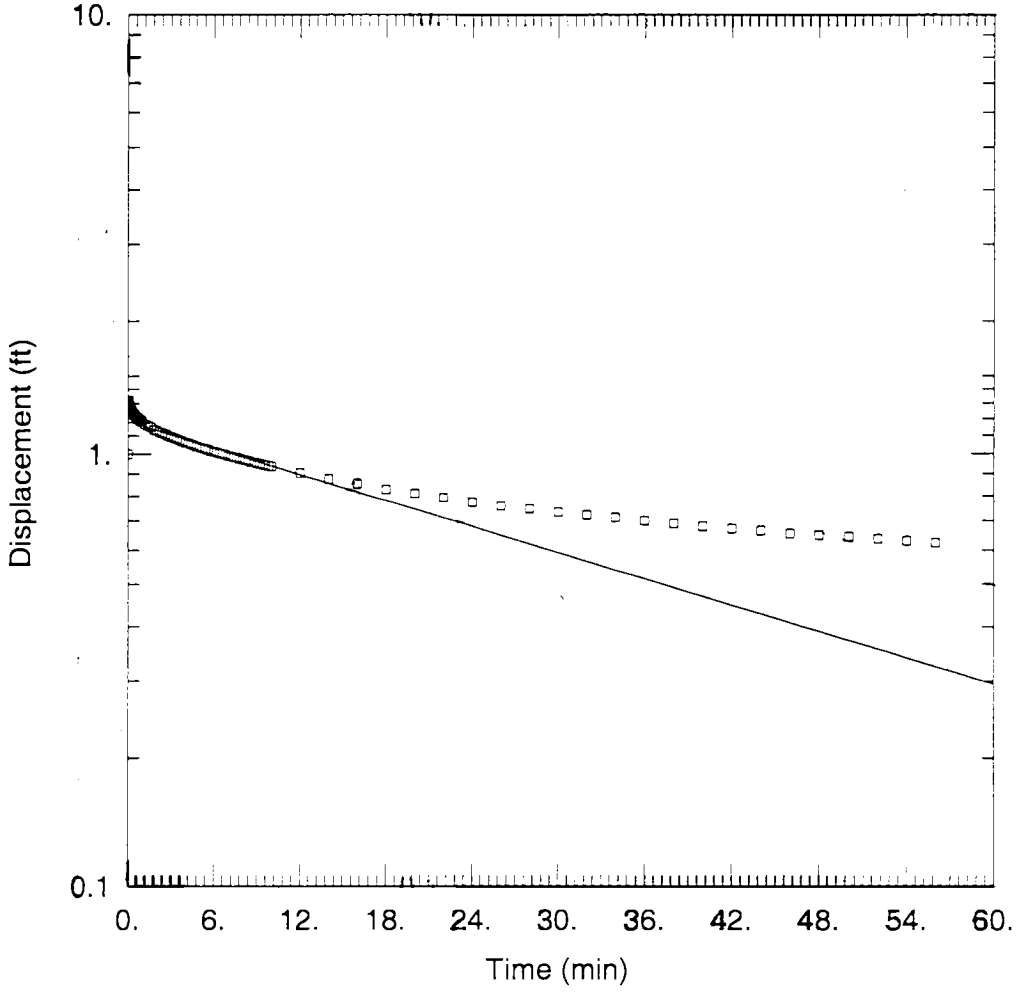
Saturated Thickness: 6. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Initial Displacement: 1. ft
Water Column Height: 6. ft
Casing Radius: 0.083 ft
Wellbore Radius: 0.35 ft
Screen Length: 5. ft
Gravel Pack Porosity: 0.4

SOLUTION

Aquifer Model: Unconfined
K = 0.0002129 cm/sec
Solution Method: Bouwer-Rice
y0 = 0.2348 ft



MW5-8 SLUG TEST 10/99

Data Set: A:\10-99S~1\MW5-8.AQT
Date: 12/04/99 Time: 09:32:02

PROJECT INFORMATION

Company: Ecology and Environment, Inc.
Client: 914th Airlift Wing
Project: 000515.EJ09
Test Location: Site 5
Test Well: MW5-8
Test Date: 10/21/99

AQUIFER DATA

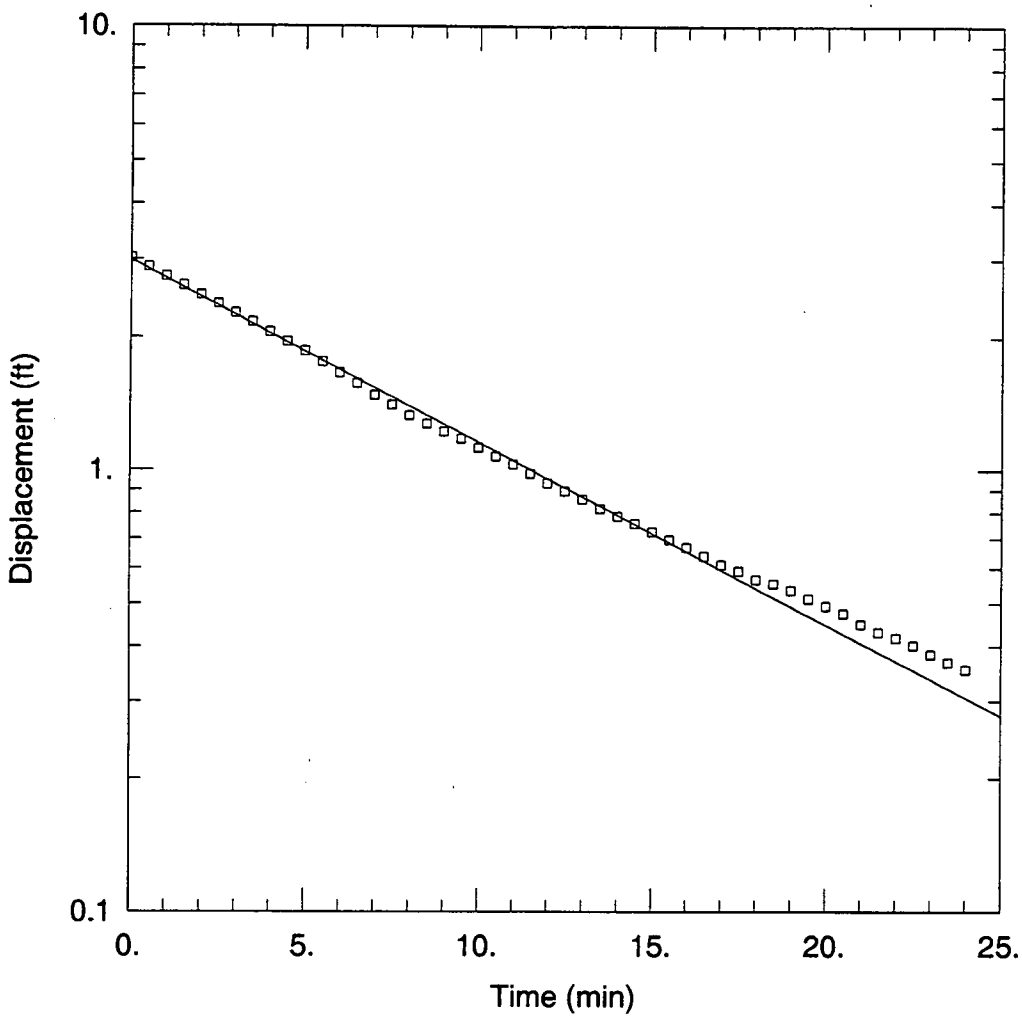
Saturated Thickness: 6. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Initial Displacement: 1. ft
Casing Radius: 0.083 ft
Screen Length: 5. ft
Water Column Height: 6. ft
Wellbore Radius: 0.35 ft
Gravel Pack Porosity: 0.4

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0001275 cm/sec
y0 = 1.186 ft



GP5-75 SLUG TEST

Data Set: Z:\NFARS\EJ09-S~1\SLUGTE~1\GP5-75.AQT
Date: 12/04/99 Time: 09:29:50

PROJECT INFORMATION

Company: Ecology and Environment, Inc.
Client: 914th Airlift Wing
Project: 000515.EJ09
Test Location: NFARS Site 5
Test Well: GP5-75
Test Date: 27 July 1999

AQUIFER DATA

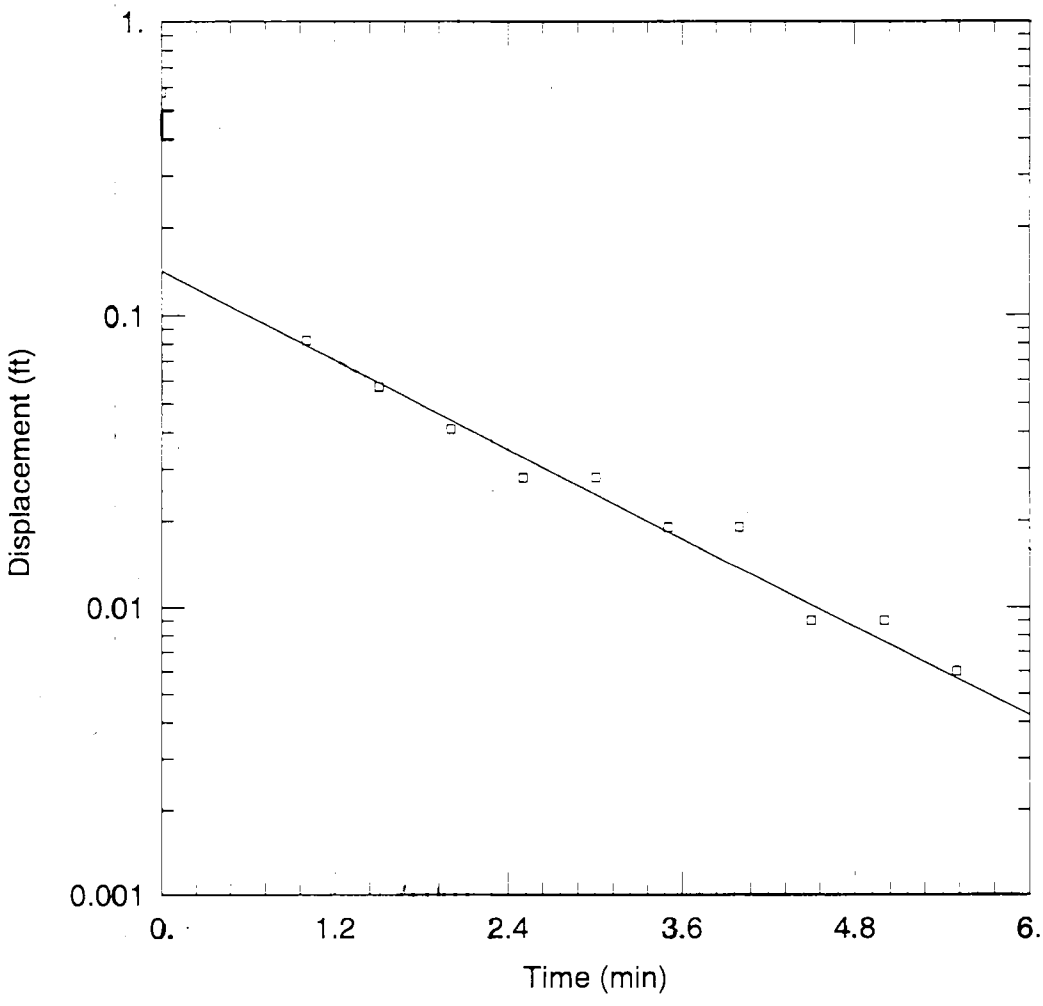
Saturated Thickness: 1.7 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Initial Displacement: 3.024 ft
Water Column Height: 1.7 ft
Casing Radius: 0.033 ft
Wellbore Radius: 0.104 ft
Screen Length: 5. ft
Gravel Pack Porosity: 1.

SOLUTION

Aquifer Model: Unconfined
K = 0.0001167 cm/sec
Solution Method: Bouwer-Rice
y0 = 2.991 ft



GP5-76 SLUG TEST

Data Set: Z:\NFARS\EJ09-S~1\SLUGTE~1\GP5-76.AQT
Date: 12/04/99 Time: 09:29:30

PROJECT INFORMATION

Company: Ecology and Environment, Inc.
Client: 914th Airlift Wing
Project: 000515.EJ09
Test Location: NFARS Site 5
Test Well: GP5-76
Test Date: 27 July 1999

AQUIFER DATA

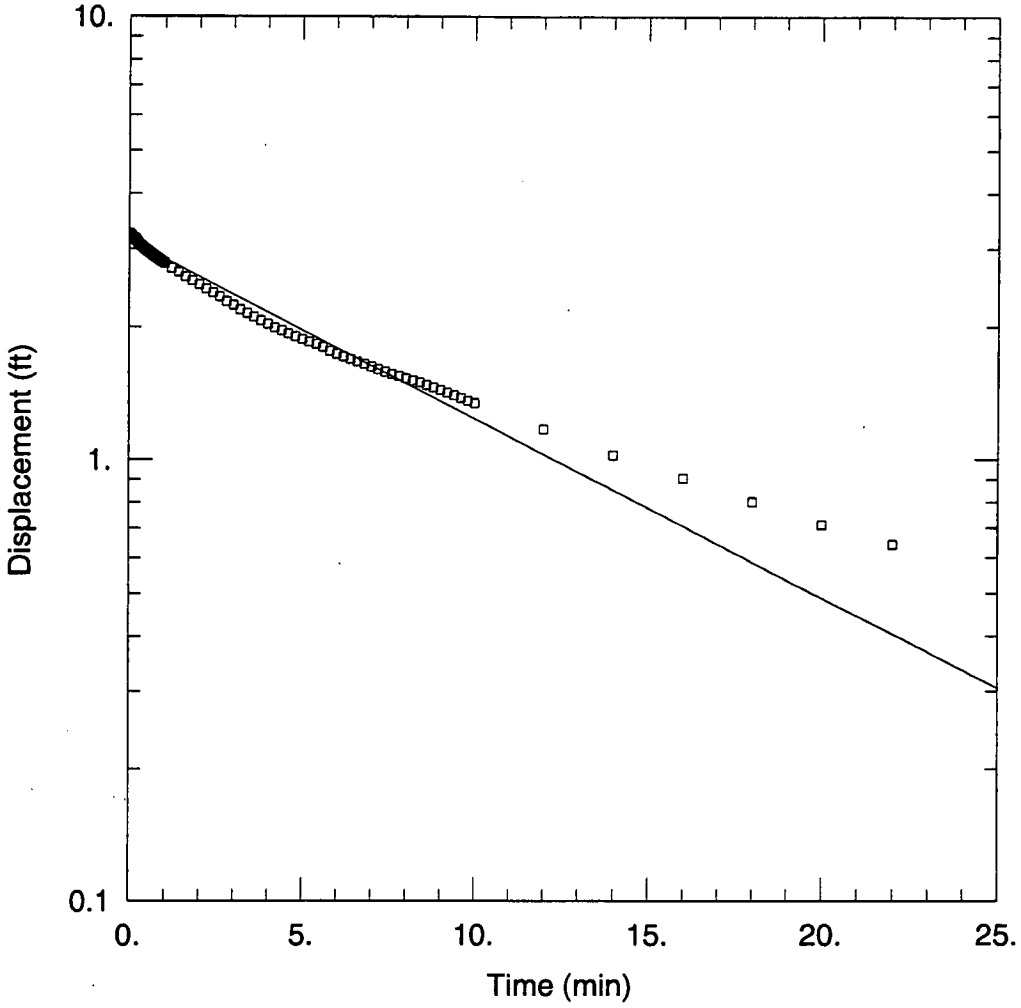
Saturated Thickness: 1.2 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Initial Displacement: 0.576 ft
Water Column Height: 1.2 ft
Casing Radius: 0.033 ft
Wellbore Radius: 0.104 ft
Screen Length: 5. ft
Gravel Pack Porosity: 1.

SOLUTION

Aquifer Model: Unconfined
K = 0.0006388 cm/sec
Solution Method: Bouwer-Rice
y0 = 0.1418 ft



GP5-78 SLUG TEST

Data Set: Z:\NFARS\EJ09-S~1\SLUGTE~1\GP5-78.AQT
Date: 12/04/99 Time: 09:29:10

PROJECT INFORMATION

Company: Ecology and Environment, Inc.
Client: 914th Airlift Wing
Project: 000515.EJ09
Test Location: NFARS Site 5
Test Well: GP5-78
Test Date: 27 July 1999

AQUIFER DATA

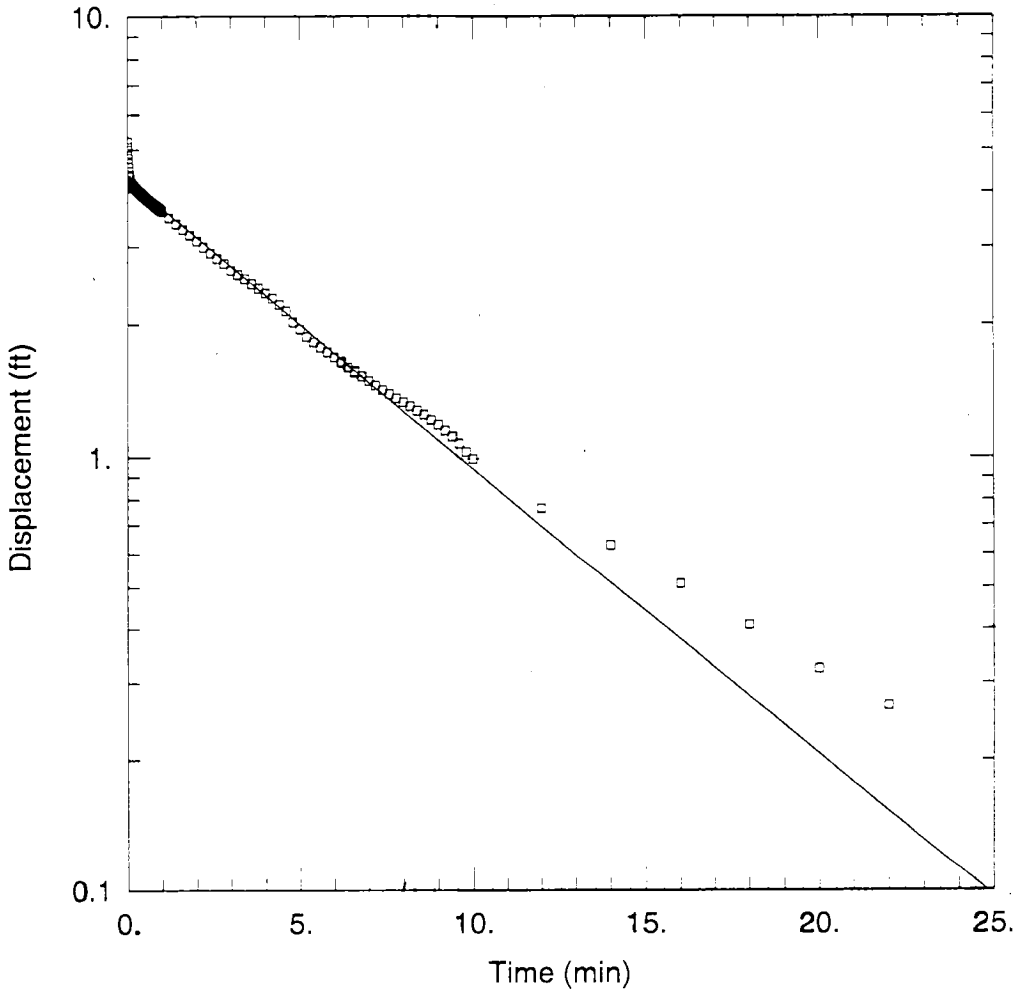
Saturated Thickness: 1.8 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Initial Displacement: 3.265 ft
Casing Radius: 0.033 ft
Screen Length: 5. ft
Water Column Height: 1.8 ft
Wellbore Radius: 0.104 ft
Gravel Pack Porosity: 1.

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0001164 cm/sec
y0 = 3.134 ft



GP5-90 SLUG TEST

Data Set: Z:\NFARS\EJ09-S~1\SLUGTE~1\GP5-90.AQT
Date: 12/04/99 Time: 09:28:42

PROJECT INFORMATION

Company: Ecology and Environment, Inc.
Client: 914th Airlift Wing
Project: 000515.EJ09
Test Location: NFARS Site 5
Test Well: GP5-90
Test Date: 27 July 1999

AQUIFER DATA

Saturated Thickness: 1.7 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Initial Displacement: 5.215 ft
Casing Radius: 0.033 ft
Screen Length: 5. ft
Water Column Height: 1.7 ft
Wellbore Radius: 0.104 ft
Gravel Pack Porosity: 1.

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.000186 cm/sec
y0 = 4.27 ft