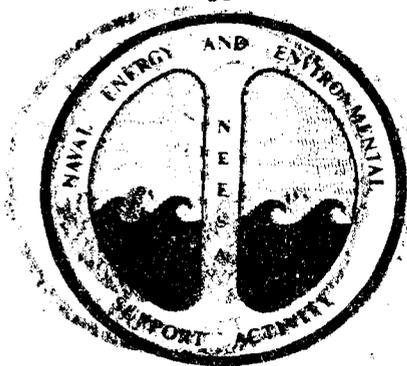


November 1991

**TECHNICAL MEMORANDUM
ON THE
REMEDIAL INVESTIGATION
VERIFICATION STEP
FOR THE
NAVAL TRAINING CENTER
GREAT LAKES, ILLINOIS**

**NEESA 21-011, VOLUME 2A
Main Report and Appendices A-F**



**NAVAL ENERGY AND ENVIRONMENTAL
SUPPORT ACTIVITY
Port Hueneme, California 93043**

NOT FOR PUBLIC RELEASE

November 7, 1991

Mr. Mitchell S. Goldberg
Martin Marietta Energy Systems, Inc.
Hazardous Waste Remedial Actions Program
Tri County Mall
831 Tri County Boulevard
Oliver Springs, Tennessee 37840

Re: Transmittal of Final Technical Memorandum
(TM) Remedial Investigation (RI) Verifica-
tion Step for the Naval Training Center
(NTC) Great Lakes, Illinois
General Order No. 89B-97383C
Task Order X-03

Dear Mr. Goldberg:

This letter transmits seven (7) bound copies and one (1) unbound, camera-ready copy of the Final TM for the above-referenced project. The Final TM incorporates comments on the Draft TM that were transmitted by and discussed with you on October 22, 1991.

For the most part, the comments on the Draft TM related to the fact that, because most of the analytical data for this project could not be validated (because of unavailability of complete data packages from the bankrupt laboratory), the data are not usable for their intended purpose. Thus, no conclusions can be drawn nor recommendations presented based on these data. This problem was handled by making the following revisions to the Draft TM:

- o Statements have been added in text and footnotes have been added to tables wherever unvalidated analytical data are presented to indicate that these data are not usable for their intended purpose. Furthermore, in each case, the reader is referred back to the discussion of data validation problems in Section 1.1 of the TM.
- o The preliminary risk evaluations for the study sites have been deleted.
- o Conclusions (Section 3.0 of the Draft TM) have been deleted.

Mr. Mitchell S. Goldberg
November 7, 1991
Page 2

The above changes resulted in many of the comments on the Draft TM being no longer relevant because they referred to now-deleted sections. Comments on the remaining sections were incorporated.

Please contact me if you have any questions or need additional information.

Sincerely,

DAMES & MOORE

A handwritten signature in cursive script, appearing to read "Steve Lemont".

Stephen Lemont
Project Manager

SL:mb

Enclosures

TECHNICAL MEMORANDUM ON THE
REMEDIAL INVESTIGATION VERIFICATION STEP
FOR THE
NAVAL TRAINING CENTER GREAT LAKES, ILLINOIS
NEESA 21-011, VOLUME 2A
MAIN REPORT AND APPENDICES A-F

November 1991

Submitted to:

Naval Energy and Environmental Support Activity
Environmental Protection Department
Port Hueneme, California 93043

Prepared by:

Dames & Moore
A Professional Limited Partnership
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NOTE

For reasons discussed in Section 1.1 in Volume 2A, with the exception of the pesticide/PCB data for Site 12 (Harbor Dredge Spoil Area), the data presented herein could not be validated under USEPA Level III and, therefore, are not usable for their intended purpose.

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LIST OF ACRONYMS AND ABBREVIATIONS

AAS	Atomic absorption spectroscopy
ACGIH	American Conference of Governmental Industrial Hygienists
ARAR	Applicable or relevant and appropriate requirement
AWQC	Ambient water quality criteria
BCF	Bioconcentration factor
BDL	Below detection limit
BNAs	Base-neutral and acid extractable organics
BO	Boring (from which soil samples are collected)
CAS	Chicago Aerial Survey
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
COT	Cleanup Objectives Team
CVAAS	Cold vapor atomic absorption spectroscopy
df	Dilution factor
DL	Detection limit
ECD	Electron capture detector
EP	Extraction procedure
ERB	Equipment rinsate blank
FAC	Freshwater acute criteria
FAO	Food and Agriculture Organization
FB	Field blank
FCC	Freshwater chronic criteria
FFTA	Fire Fighting Training Area
FFTU	Fire Fighting Training Unit
FR	Federal Register
GC	Gas chromatography
GC/ECD	Gas chromatography with electron capture detector
GC/MS	Gas chromatography/mass spectrometry
GFAAS	Graphite furnace atomic absorption spectroscopy
HAZWRAP	Hazardous Waste Remedial Actions Program
HSA	Hollow-stem auger
IAS	Initial Assessment Study
IC	Ion chromatography

LIST OF ACRONYMS AND ABBREVIATIONS (cont'd)

ICP	Inductively coupled plasma atomic emission spectroscopy
ID	Inside diameter
IEPA	Illinois Environmental Protection Agency
IGWQS	Illinois General Use Water Quality Standards
IPWSS	Illinois Public and Food Processing Water Supply Standards
IR	Infrared
IR	Installation Restoration
IRIS	Integrated Risk Information System
LHA	Lifetime health advisory
MB	Method blank
MCL	Maximum contaminant level
MCLG	Maximum contaminant level goal
msl	Mean sea level
MW	Monitoring Well
NA	Not available or not applicable
ND	Not detected
NEESA	Naval Energy and Environmental Support Activity
NORTHDIV	Northern Division, Naval Facilities Engineering Command
NPDES	National Pollutant Discharge Elimination System
NTC	Naval Training Center
OD	Outside diameter
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyls
PE	Preliminary evaluation
POL	Petroleum, oil, and lubricants
QA	Quality assurance
QC	Quality control
RI/FS	Remedial Investigation/Feasibility Study
RTC	Recruit Training Center
SCS	U.S. Soil Conservation Service
SDWA	Safe Drinking Water Act
SMCL	Secondary maximum contaminant level
STEL	Short-term exposure limit
TAL	Target analytic list

LIST OF ACRONYMS AND ABBREVIATIONS (cont'd)

TB	Trip blank
TIC	Tentatively identified compounds
TM	Technical Memorandum
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons
TSCA	Toxic Substances Control Act
TWA	Time weighted average
USDHHS	U.S. Department of Health and Human Services
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UST	Underground storage tank
VA	Veterans Administration
VOC	Volatile organic compounds
VSWP	Verification Step Work Plan
WB	Well boring (from which soil samples are collected)
WHO	World Health Organization

EXECUTIVE SUMMARY

ES.1 BACKGROUND

Dames & Moore has conducted the Verification Step of the Navy Installation Restoration (IR) Program Remedial Investigation/Feasibility Study (RI/FS) at the Naval Training Center (NTC), Great Lakes, Illinois. This Technical Memorandum (TM) reports the findings and conclusions of this study.

This document was originally intended to be the RI Verification Step Report for five study sites at NTC Great Lakes. However, because of problems encountered with the laboratory performing the sample analyses for this project, and the unavailability of sufficient data from this now bankrupt laboratory (metaTRACE, Inc., Earth City, Missouri) to conduct validation of nearly all of the sample analysis data, it was determined that this report would be issued as a TM only to document the work performed thus far. Also, it would not draw conclusions or present recommendations based on laboratory data, which could not be validated.

NTC Great Lakes is located in Shields Township, Lake County, Illinois, on the shore of Lake Michigan. Dedicated in 1911, NTC Great Lakes is the largest naval training center (1,650 acres) in the United States. It is bounded on the west by U.S. Route 41 (Skokie Highway), on the north by the City of North Chicago, and on the south by the Veterans Administration (VA) Hospital and Golf Course and the Shore Acres Country Club. Lake Michigan lies to the east.

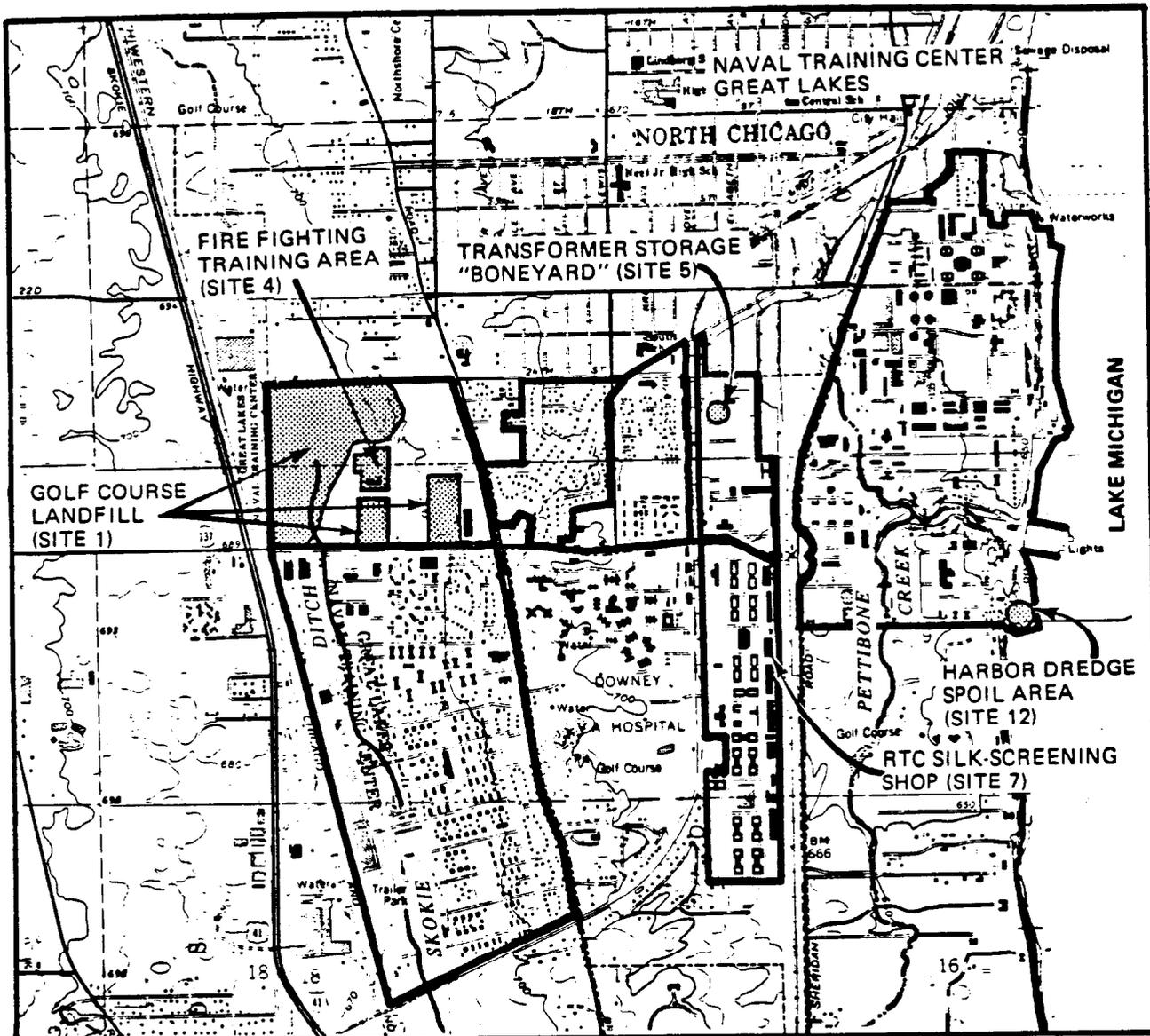
During the Initial Assessment Study (IAS) for NTC Great Lakes (Rogers, Golden & Halpern, 1986), seven sites were identified as requiring further study. The IAS determined that both surface water and shallow groundwater are potential contaminant migration pathways. The downward migration of contaminants into deeper aquifers used for drinking water is unlikely due to the presence of aquitards formed by the glacial till of the area. Runoff from the activity may enter either Skokie Ditch or Pettibone Creek. Furthermore, groundwater supplies much of the flow for Pettibone Creek and may supply water for intermittent flow in Skokie Ditch. Although neither of these streams is used as a source of potable or industrial water in the immediate vicinity of the activity, both streams do flow into other bodies of water that are used for these purposes. Pettibone Creek flows

directly into Lake Michigan, which is used extensively for sport fishing, while Skokie Ditch becomes the Skokie River, which eventually drains into both the Mississippi River and Lake Michigan. Lake Michigan is also used for drinking water.

The IAS concluded that, "while none of the sites poses an immediate threat to human health or the environment, seven sites warrant further investigation under the Navy IR program to assess potential long-term impacts." An RI/FS, involving sampling and monitoring of the seven sites, was recommended to "either confirm or refute the presence of the suspected contamination and to better define the extent of any problems that may exist."

Five of the seven sites are the subject of this TM. Each of these sites is briefly described below. The locations of these sites at NTC Great Lakes are shown in Figure ES-1.

- o Site 1, Golf Course Landfill--Underlying at least 50 acres of the present golf course, the landfill was operated as a trenching/burning operation between 1942 and 1967 for an estimated 1.5 million tons of material. Types of waste reportedly include domestic refuse; sewage sludge; petroleum, oil, and lubricants (POLs); solvents; coal ash; and materials contaminated by polychlorinated biphenyls (PCBs).
- o Site 4, Fire Fighting Training Area--The Fire Fighting Training Area (FFTA) consists of a 10-acre partially paved area, used since 1942 to stage fires for training exercises. Fuels used for fires include #2 fuel oil and gasoline. The site includes ditches that may receive runoff from the site and two oil/water separator lagoons. In addition--reportedly between 1942 and 1979--a portion of the site was used for storage of drums containing waste POLs and solvents, as well as oils and materials recovered from the training exercises.
- o Site 5, Transformer Storage "Boneyard"--This 2-acre site was reportedly used between 1945 and 1985, primarily for the storage of out-of-service transformers, including some filled with PCB-containing oil. Other stored items include lead-insulated cable, heavy equipment, and other miscellaneous scrap metal and materials.



**FIGURE ES-1
LOCATION OF STUDY SITES
AT NTC GREAT LAKES**



- o Site 7, RTC Silk-Screening Shop--The shop used a variety of materials, including paint, inks, water- and oil-based lacquers, enamels, mineral spirits, acetone, thinners, and photographic emulsions. Up until 1945, washwater from the finishing of silk screens, possibly contaminated with some of these products, was allowed to drain onto the ground outside the building via a small pipe draining the shop's washwater booth.
- o Site 12, Harbor Dredge Spoil Area--During harbor dredging activities in 1952 and 1970, dredge spoils were reportedly disposed of at this site along the shore of Lake Michigan. The sludge could have a high organic material concentration (though exposure to air could have resulted in oxidation and accelerated decomposition of the organics) and could potentially contain heavy metals, oils, pesticides, and PCBs from industries or other off-post activities upstream of NTC Great Lakes.

Regarding the remaining two sites, the investigation of the Mainside Transformer Storage Area (Site 6) is discussed in separate work plan and report documents (Dames & Moore, 1987b; 1989), and, at the Exchange Service Station (Site 8), remedial actions will be conducted by Northern Division (NORTHDIV), Naval Facilities Engineering Command.

ES.2 VERIFICATION STEP OBJECTIVES AND SCOPE OF WORK

The objective of this project was to conduct an RI Verification Step for the five subject sites at NTC Great Lakes. The original goal of the Verification Step, as specified by the U.S. Navy, was to collect sufficient quantitative environmental data to either (1) verify the presence of hazardous or toxic waste and supply planning for an expanded monitoring program (Characterization Step), or (2) recommend no further action where such materials are not found. However, due to the laboratory analysis/data validation problems identified above, no conclusions or recommendations are included in this TM.

Dames & Moore conducted a field investigation of the five study sites to characterize potential contamination of soil, groundwater, and/or surface water at these locations. The investigation included installation of groundwater monitoring wells; sampling of soil, groundwater, and surface water; and chemical analysis of these samples.

Major aspects of the RI Verification Step program at NTC Great Lakes are summarized in Table ES-1. This table shows the number of wells installed at each site and summarizes the sampling/analysis program by providing site-specific information on soil, groundwater, and surface water samples collected, and on analytical parameters for these samples. The table also provides information on the field quality control (QC) samples that were collected in association with the sampling program.

Fieldwork activities at NTC Great Lakes--the results of which are reported in this document--were conducted during the following time periods:

<u>Fieldwork Activity</u>	<u>Dates</u>
Initial site reconnaissance	December 1986
Monitoring well installation	November-December 1988
Soil sampling (all sites)	November-December 1988
Groundwater and surface water sampling (Round 1)	December 1988
Soil resampling (selected Site 4 locations)	March 1989
Groundwater and surface water sampling (Round 2)	March 1989
Site 12 soil sampling (third event)	August 1989

ES.3 VERIFICATION STEP FINDINGS

For reasons discussed in Section ES.1, the analytical data discussed in this section could not be validated under U.S. Environmental Protection Agency (USEPA) Level III and, therefore, are not considered usable for their intended purpose. Thus, the data assessment discussions presented below are highly speculative. This concern does not apply, however, to pesticide/PCB data (third sampling event) for Site 12, which are considered valid and usable based on data validation conducted by Martin Marietta Energy Systems, Inc., Hazardous Waste Remedial Actions Program (HAZWRAP).

ES.3.1 General (Installation-Wide)

- o Subsurface conditions encountered in well borings at Sites 1 and 4 indicate that these sites are underlain primarily by silty clay till interbedded with lenses of sandy or gravelly material. The coarser

TABLE ES-1

Summary of RI Verification Step
Field Investigation Program at
NTC Great Lakes, Illinois

Site No.	Site Name	Number of Wells Installed	Types of Samples Collected	Number of Sample Locations	Description/Frequency of Sampling	Total No. of Samples	Number of Associated Field QC Samples			Analytical Parameters
							Replicates	Field Blanks (Equipment Rinsate Blanks)	Other	
1	Golf Course Landfill	9	Groundwater Surface water	9 2	Two times--December 1988 and March 1989. Two times--December 1988 and March 1989.	18 4	1 (a) 1 (c)	1/1 (b)		Volatile organic compounds (VOCs), semi-volatile organic compounds (base-neutral and acid extractable organics--BNAs), priority pollutant metals, PCBs, oil and grease, chloride, total organic carbon (TOC).
4	Fire Fighting Training Area	4	Groundwater Surface water Soil	4 (d) 4 12	Two times--December 1988 and March 1989. Two times--December 1988 and March 1989. One time; two samples were collected--one each from depths of 1.5-3 feet and 3.5-5 feet--at each location.	8 8 24	1 (a) 1 (c) 1	1/1 (b) 1		VOCs, BNAs, oil and grease, lead
5	Transformer Storage "Boneyard"	0	Soil	27	One time; two samples were collected--one each from depths of 0.5-1 foot and 1.5-2 feet--at five of the locations; one sample was collected at a depth of 0.5-1 foot at each of the remaining 22 locations.	32	2	2		PCBs, oil and grease, lead
7	RTC Silk-Screening Shop	0	Soil	3	One time; two samples were collected--one each from depths of 0.5-1 foot and 1.5-2 feet--at each location.	6	1	1		VOCs, silver, chromium (total), cadmium, lead
12	Harbor Dredge Spoil Area	0	Soil/sludge	14	One time; three samples were collected--one each from depths of 0.5 to 2, 3.5-5, and 6.5-8 feet--at each location.	42	3	3		VOCs, priority pollutant metals, pesticides, PCBs
--	Trip blanks	--	--	--	--	--			5/1 (b)	VOCs
--	Drilling water (from tap in Bldg. 3304 at FFTA)	--	--	--	--	--			1 (c)	VOCs, BNAs, priority pollutant metals, pesticides, PCBs, oil and grease, chloride, TOC

ES-6

(a) Collected in Round 2.

(b) Round 1/Round 2.

(c) Collected in Round 1.

(d) One of these wells (MW4-1) also serves as a background well for the Golf Course Landfill (Site 1) and, therefore, was sampled for all analytes of concern at the landfill.

material typically occurs in thicknesses less than 5 feet and with limited areal extent. Similar conditions are expected to exist throughout the remainder of NTC Great Lakes.

- o Groundwater occurring in the thin sandy/gravelly lenses does not indicate connection of the lenses, even where they occur at approximately the same elevation with relatively small horizontal separation. Similarly, there does not appear to be a clear interconnection between shallower lenses and deeper ones. Downward migration of water and potential contaminants is expected to be very slow due to the low permeability of the clayey till as evidenced by its generally low moisture content.

ES.3.2 Site 1, Golf Course Landfill

- o Very limited contamination--in the form of drinking water standard exceedances for cadmium, mercury, silver, beryllium, and copper--was detected in the shallow groundwater. However, the single exceedances noted for these metals (except beryllium), though of potential concern, may not be statistically significant. With regard to beryllium, drinking water standard exceedances were detected in background wells at concentrations similar to downgradient wells, indicating that beryllium is naturally occurring and not the result of landfill contamination. Further, the fact that beryllium was detected only in Round 1 samples may indicate that these results are anomalous. There were also several detections of nickel above background, but none above the drinking water standard. No other contamination of concern was detected in groundwater.
- o Metals detected in the surface water of Skokie Ditch--some at concentrations exceeding surface water quality criteria--are copper, lead, mercury, and silver. Oil and grease was also detected. The oil and grease and lead may have been contributed by the National Pollutant Discharge Elimination System (NPDES) outfall from the FFTA lagoons, where these contaminants have also been found. The other metals may be derived from the landfill, given their presence in groundwater. However, the contaminant concentrations are low, and Skokie Ditch--

rather than being an aquatic environment--is a point of collection for on-post and off-post storm drainage industrial discharges.

ES.3.3 Site 4, Fire Fighting Training Area

- o Contamination of concern--consisting primarily of low-to-moderate concentrations of petroleum hydrocarbons (detected as VOCs, BNAs, and oil and grease) found in soils in some areas down to 5 feet, the greatest depth sampled--was detected throughout the site area, as would be expected at a site such as the FFTA where liquid fuels have been used extensively in training exercises. Leaks and spills have undoubtedly occurred in the course of fuel and fuel waste use, storage, and handling operations. Most of the contamination is concentrated in the vicinity of the former drum staging area and nearby shed, where soils are heavily stained and blackened.
- o Other soil contaminants include polyaromatic hydrocarbons (PAHs) and lead. However, these contaminants are of less concern. The PAHs are ubiquitous to developed sites where ash and cinders (of which PAHs are constituents) are frequently used for ground fill and stabilization. Also, the PAHs are mostly present below ground surface and are highly immobile. Lead is present at concentrations that are not extremely high, though elevated above apparent natural levels, in only a few isolated samples.
- o Shallow groundwater contamination by oil and grease may be present in the immediate vicinity of the site. However, this cannot be confirmed because the oil and grease was detected only in samples from the first sampling round, and neither volatile nor semivolatile petroleum hydrocarbons were detected in the wells during either sampling round. The source of such contamination could be surface operations that result in spills and infiltration of fuel products and/or potential (though unconfirmed) leaks from underground storage tanks (USTs) and the associated extensive underground network of piping at the site. No other contamination of concern was detected in groundwater.
- o Water in the lagoons at the site was found to contain moderate-to-high concentrations of oil and grease and semivolatile petroleum hydro-

carbons, and low concentrations of lead. However, this was not unexpected, because these lagoons are used for oil/water separation. This finding merely indicates that care needs to be taken in discharging water from the lagoons via the NPDES outfall to Skokie Ditch. Contamination also found in the site's runoff ditch was minimal.

ES.3.4 Site 5, Transformer Storage "Boneyard"

- o PCBs are present in site soils--generally restricted to the northeast corner of the site, some at concentrations in excess of potential Federal and State cleanup guidelines (10 parts per million (ppm)). The areal and vertical extent of contamination by PCBs and other constituents was not determined in the limited initial sampling program conducted.
- o Oil and grease and lead contamination is present and is more widespread throughout the site area sampled than is PCB contamination. The oil and grease contamination found is not unexpected for a storage yard of this type. Lead is present at concentrations well in excess of apparent natural concentrations.
- o Although groundwater was not investigated, contamination of shallow groundwater by surface constituents is possible, especially by lead--which is more mobile in the environment than PCBs. Impacts on surface water and on the environment are also unlikely.

ES.3.5 Site 7, RTC Silk-Screening Shop

- o The disposal of washwater onto soils outside the silk-screening shop appears to have resulted in some residual lead contamination. Lead contamination was detected above natural background levels in all three soil borings, though at its highest levels only in surficial samples at two of the borings.
- o Although groundwater and surface water were not investigated, impacts on these media are expected to be minimal or none. Any contaminants mobilized from the very small drainage area of the site and transported to Pettibone Creek via storm sewers along Ohio Street would be greatly diluted when mixed with runoff from other areas.

ES.3.6 Site 12, Harbor Dredge Spoil Area

- o Heavy metals--including antimony, cadmium, copper, lead, mercury, selenium, silver, and zinc--were detected in site soils at concentrations exceeding those representative of natural soils. Of these, lead and mercury are of greatest potential concern because lead is considered a probable carcinogen and mercury is considered toxic via oral and inhalation routes, and both metals were detected throughout the areal extent of the site and at depths to 8 feet (the greatest depth sampled). The distribution of the metals throughout the fill appears to indicate that they were constituents of the apparent lake dredgings at the time of their placement at the site.
- o The pesticides 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT were also detected throughout the site's areal extent, though only within the upper 5 feet and at concentrations that should pose little or no human health risks based on comparison with published toxicological parameters. It is believed that the DDT, which subsequently decomposed to DDD and DDE, was deposited on the surface of the dredgings following their placement--from such possible sources as onsite storage of contaminated soils and plant debris, onsite pesticide usage, and runoff from landscaped areas over the bluff.
- o The areal extent of contamination apparently encompasses the entire site area identified in the IAS. The vertical extent of contamination was not determined, however, because metals contamination was found at the greatest depth (i.e., 8 feet) sampled and probably extends below this depth.
- o Contamination of shallow groundwater and surface water is considered unlikely and/or of little concern. The metals appear immobile in the permeable site soils based on the lack of a trend of increasing concentration with depth. DDT and its byproducts are generally immobile in soils, as evidenced here by the observed trend of decreasing concentration with depth and general lack of pesticides below the 3.5- to 5-foot sample interval. Any contamination entering the lake would be greatly diluted and dispersed.

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

This document is the Technical Memorandum (TM) on the Verification Investigation Step for the Navy Installation Restoration (IR) Program Remedial Investigation/Feasibility Study (RI/FS) at five sites at the Naval Training Center (NTC), Great Lakes, Illinois. The subject sites of this report are:

- o Site 1, Golf Course Landfill
- o Site 4, Fire Fighting Training Area (FFTA)
- o Site 5, Transformer Storage "Boneyard"
- o Site 7, Recruit Training Center (RTC) Silk-Screening Shop
- o Site 12, Harbor Dredge Spoil Area.

This TM is Volume 2 in the series of documents related to the RI/FS at these five sites. Volume 1 is the Verification Step Work Plan (VSWP) for these sites (Dames & Moore, 1987a). This TM was originally intended to serve as the RI Verification Step Report for the five subject NTC Great Lakes sites. However, due to problems encountered with the laboratory data for this project and to subsequent difficulties in obtaining data for validation purposes from the laboratory (metaTRACE, Inc., Earth City, Missouri) (as outlined below), it was determined that this report would be issued as a TM only to document the work performed thus far and would not draw conclusions or present recommendations based on laboratory data, which could not be validated. Analytical data that cannot be validated under U.S. Environmental Protection Agency (USEPA) Level III are not considered usable for their intended purpose.

The laboratory data problems encountered in this project are as follows. These created a need to conduct validation of the laboratory data.

- o Anomalous pesticide analysis results were obtained for Site 12 soil samples that were ultimately resolved through resampling. (See Section 2.2.5.2.1 for a detailed discussion of this issue.*)

*As discussed in Section 2.2.5.2.1, the data for pesticides and polychlorinated biphenyls (PCBs) from the third sampling event at Site 12 are considered valid and usable for their intended purpose.

- o During preparation of the first revision of the RI Verification Step Report by Dames & Moore, a number of changes in sample analysis results were reported to Dames & Moore by the laboratory. The laboratory reported that these changes were caused solely by calculation errors and lack of proper subsequent review in the lab, not by incorrect analysis.

The need for data validation was further precipitated by a growing lack of confidence in metaTRACE's data based on their legal problems with the Government regarding alleged falsification of data. However, data validation was not possible because the new owners of the bankrupt laboratory were unable to locate and provide sufficient data to properly conduct the data validation.

During the Initial Assessment Study (IAS) for NTC Great Lakes (Rogers, Golden & Halpern, 1986), seven sites were identified as requiring further study. Site conditions determined from the IAS indicated a potential for contamination of groundwater, surface water, and/or soil as a result of past disposal, spills, or other site operations, as well as a potential for contaminant migration and for exposure by potential receptors. These sites included the five identified above and two others that have been handled separately.

The investigation of the Mainside Transformer Storage Area (Site 6) is discussed in separate work plan and report documents (Dames & Moore, 1987b; 1989). At the Exchange Service Station (Site 8), remedial actions will be conducted by Northern Division (NORTHDIV), Naval Facilities Engineering Command.

Based on the recommendations of the IAS, the Verification Step of the RI was conducted at the five subject sites. The objective of this investigation was to perform a field program--consisting of groundwater monitoring, well installation, and collection and chemical analysis of groundwater, surface water, and soil samples--to verify the presence of contaminants (if any) at the sites and to determine the approximate degree of contamination, if present.

The following introductory discussion provides background information on the Installation; a brief overview of the nature of suspected contamination problems identified during the IAS for the study sites, which led to the performance of the present investigation; a summary of the scope of the RI Verification Step program; and an outline of the organization of the remainder of the report. Detailed

information on site descriptions, fieldwork approaches, and study findings is presented in Section 2.0 for each site.

1.2 INSTALLATION BACKGROUND INFORMATION

The information presented in the sections that follow has been taken largely from the IAS for NTC Great Lakes. For information on installation history and present mission, the reader is referred to the VSWP for the subject study sites (Dames & Moore, 1987a).

1.2.1 Location

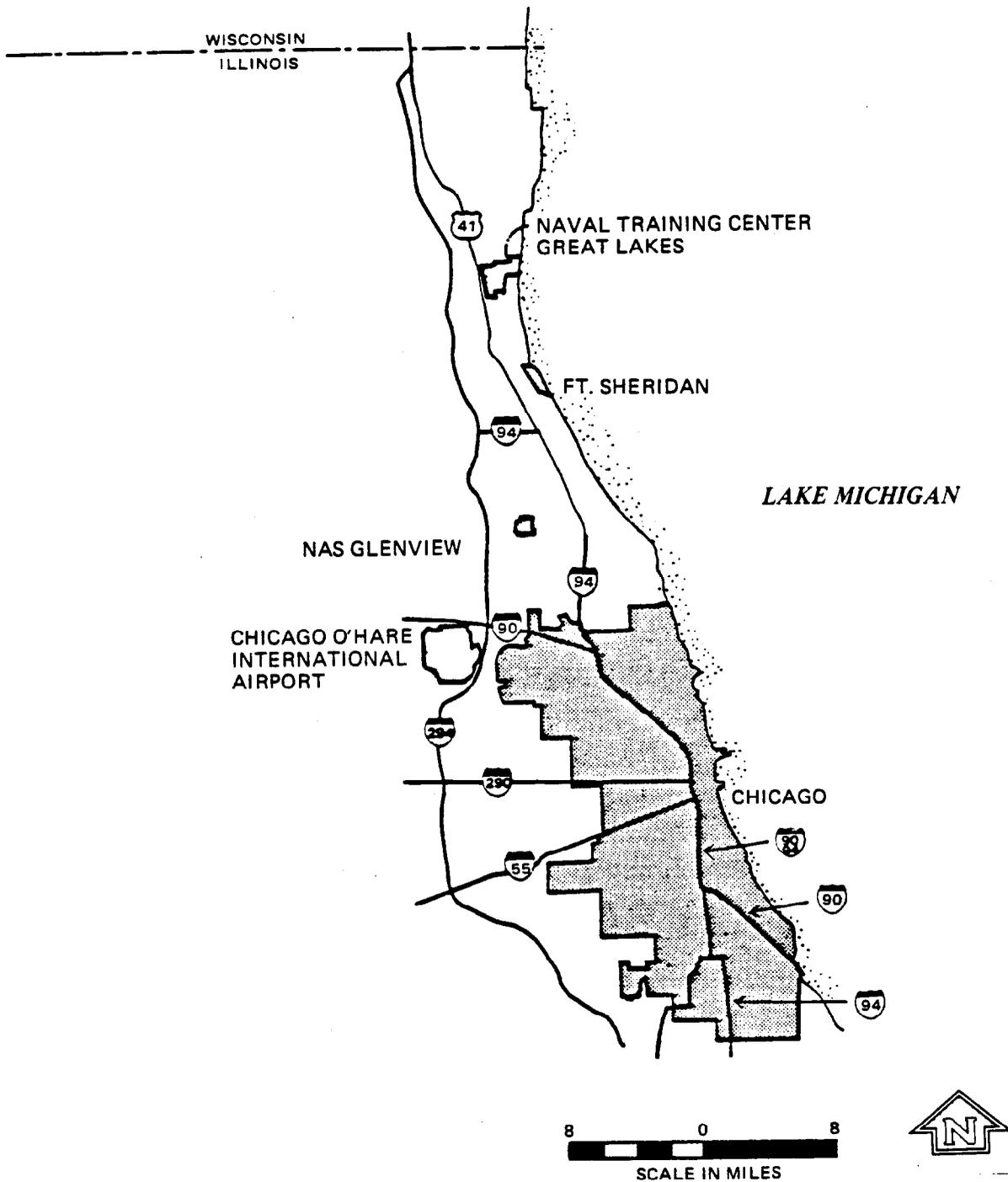
NTC Great Lakes is located in Shields Township, Lake County, Illinois, on the shore of Lake Michigan (see Figure 1-1). Dedicated in 1911, NTC Great Lakes is the largest naval training center (1,650 acres) in the United States. It is bounded on the west by U.S. Route 41 (Skokie Highway), on the north by the City of North Chicago, and on the south by the Veterans Administration (VA) Hospital and Golf Course and the Shore Acres Country Club. Lake Michigan lies to the east (see Figure 1-2). Figure 1-3 depicts the installation in larger scale. "Mainside" includes the area east of Sheridan Road, which includes the location of the original base. "Hospitalside" includes the area west of Sheridan Road, which includes the VA Hospital.

1.2.2 Topography, Geology, and Hydrology

The information presented in this section is largely derived from the IAS (Rogers, Golden & Halpern, 1986), which based its discussion on published reports and maps from the Illinois State Geological Survey, the U.S. Geological Survey (USGS, 1967), a soil survey from the Soil Conservation Service (SCS, 1970), aerial photographs (various sources and years; see Section 1.3.2), and observations made during the field investigation. No other information was available. Therefore, descriptions of site geology are supplemented by data obtained through the present field investigation.

1.2.2.1 Topography

NTC Great Lakes (Figure 1-3) is located in the Wheaton Morainal Country of the Great Lakes section of the Central Lowland physiographic province. This province is characterized by gently sloping and poorly drained areas, with many streams ending in depressions and marshes. The Installation is located on the



**FIGURE 1-1
GENERAL LOCATION MAP
NTC GREAT LAKES**



**REMEDIAL INVESTIGATION
FEASIBILITY STUDY
NAVAL TRAINING CENTER
Great Lakes, Illinois**

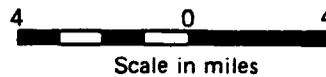
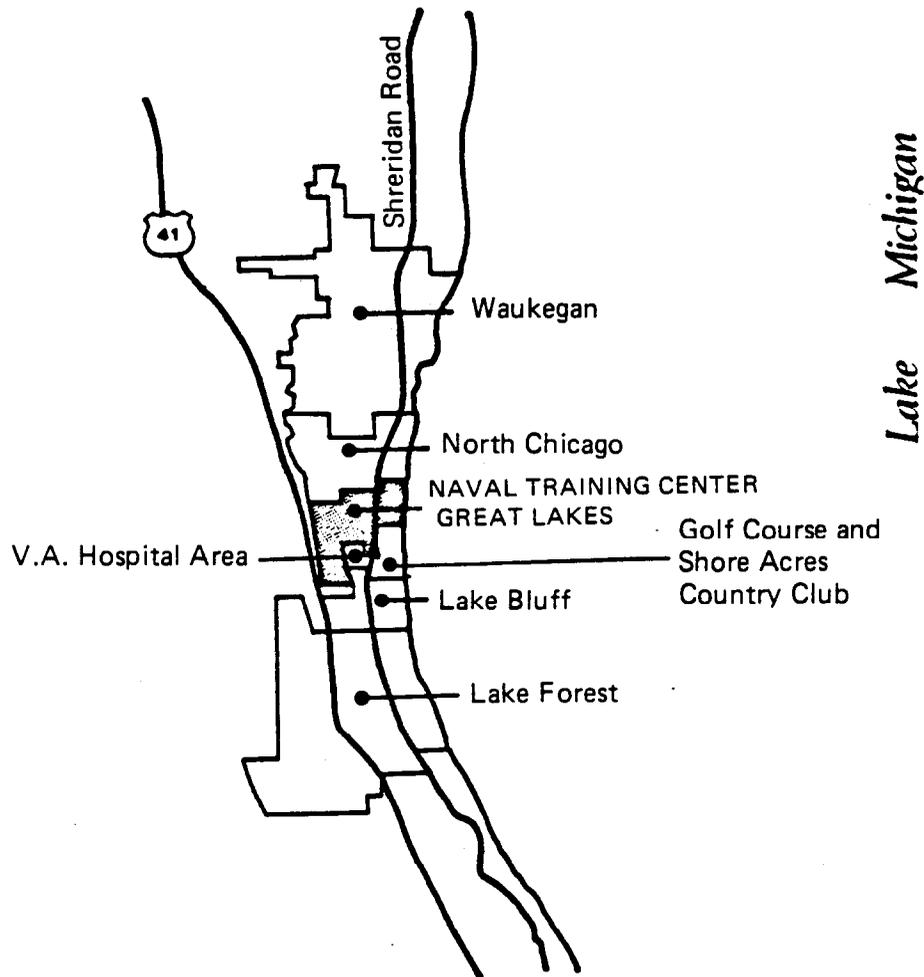


FIGURE 1-2
IMMEDIATE AREA SURROUNDING
NTC GREAT LAKES

1-5



**REMEDIAL INVESTIGATION/
 FEASIBILITY STUDY**
NAVAL TRAINING CENTER
 Great Lakes, Illinois

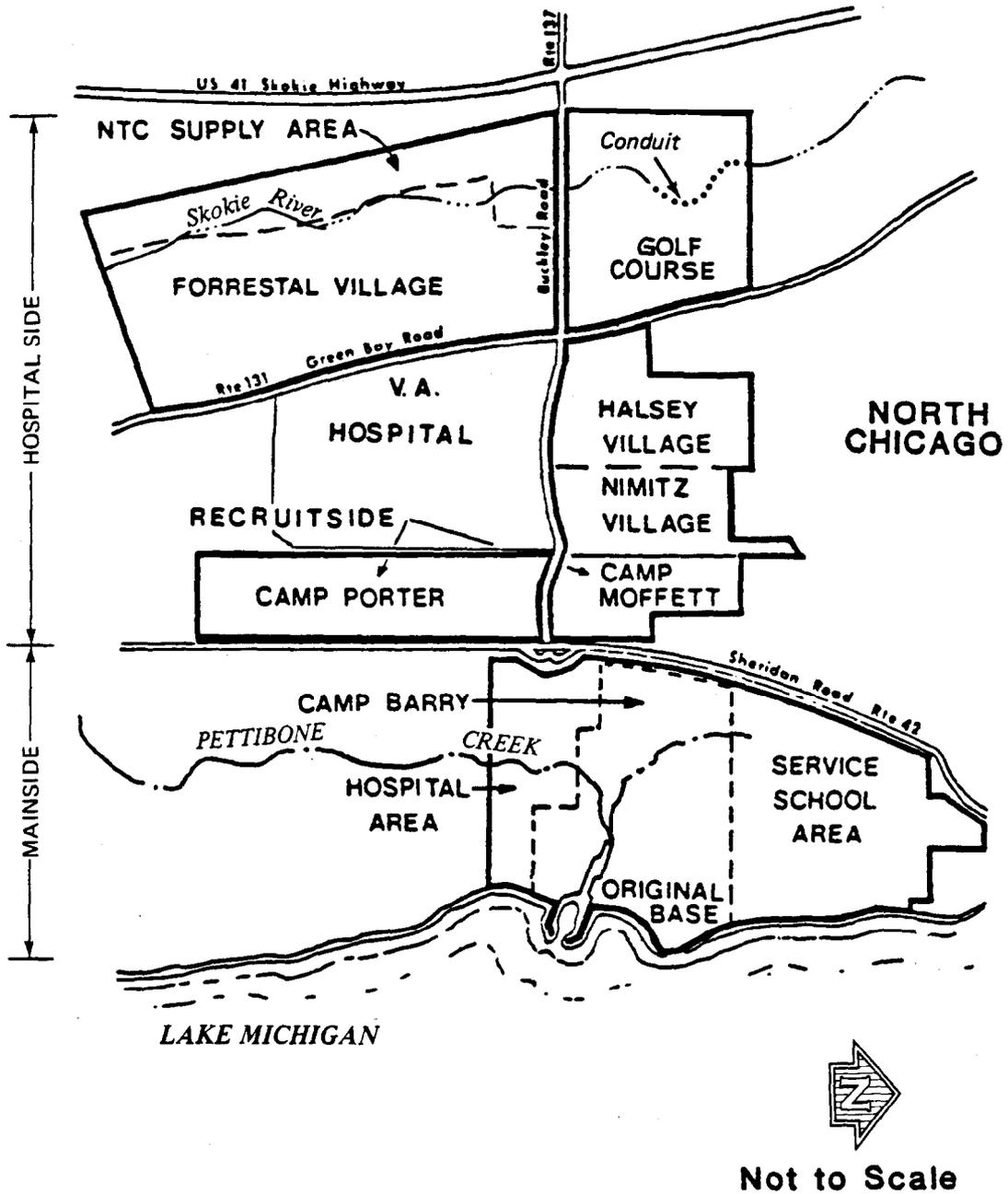


FIGURE 1-3
MAP OF NTC GREAT LAKES



REMEDIAL INVESTIGATIVE
FEASIBILITY STUDY
NAVAL TRAINING CENTER
Great Lakes, Illinois

Bluff-Ravine Complex, one of three topographic subcomplexes in this area. The Bluff-Ravine Complex is found within the narrow Lake Michigan watershed and is comprised of level tablelands that are typically bordered by steep lake-facing bluffs and a network of interior ravines. The lake bluffs and ravines found at NTC Great Lakes are highly susceptible to erosion, as is characteristic of this topographic complex.

Most of the facilities at NTC Great Lakes are located on uplands adjacent to Lake Michigan. The upland areas are typically nearly level-to-gently sloping, but are in places cut by steep-walled ravines that drain to Lake Michigan. Elevations range from approximately 580 feet along the Lake Michigan shoreline to a maximum of approximately 730 feet above mean sea level (msl) just northwest of the intersection of Green Bay and Buckley Roads near Bldg. 3400. Bluffs rise approximately 60 to 70 feet above Lake Michigan; elevations of the upland area between the bluffs and Sheridan Road generally range from 640 to 670 feet. Elevations for those portions of NTC Great Lakes west of Sheridan Road generally range from 650 to 710 feet.

Slopes generally are less than 5 percent on the upland surface, but exceed 50 percent in the steep-walled ravine cut by Pettibone Creek. The bluffs overlooking Lake Michigan rise nearly vertical to the upland surface.

1.2.2.2 Geology

NTC Great Lakes is located within the glaciated Central Lowlands and is underlain by Silurian age bedrock consisting of Niagran and Alexandrian limestone. Bedding is nearly horizontal-to-gently eastward dipping in the vicinity of NTC Great Lakes. The shape of the bedrock surface is not well defined, but is generally considered to be nearly horizontal with slight surface irregularities as a result of glaciation.

The bedrock surface is blanketed by glacial till that ranges from approximately 170 to 210 feet in thickness, based on reviews of several well logs from the Lake Bluff area. The predominant glacial deposit in the vicinity of NTC Great Lakes is the Wadsworth till member (clayey phase and sandy phase), an unsorted material consisting of elements ranging from clay to large boulders. The Wadsworth till member has been further subdivided into phases according to the size of the dominant particles. The clayey phase is predominant in the vicinity of

NTC Great Lakes, but both the sandy phase and clayey sand phase may be interbedded as well. Because this till is unsorted (i.e., it has not been exposed to the sorting action of water or wind), interstices between rocks in the till are filled with fine clay-sized particles.

The depositional patterns associated with the glacial till are highly variable; significant changes often occur over very short distances. In general, the till at NTC Great Lakes is highly clayey with thin--often less than 2 feet thick--irregular lenses of sand and silty sand occurring over limited areas. These small lenses or pockets of sandy material may have been placed during minor changes in the movement of the ice sheet (i.e., a brief thaw producing some fluvial deposition) or as a result of variations in the ice sheet itself (such as a small crevasse resulting in deposition of coarser material). Regardless of the source of these coarser deposits, the significance of their presence is that they are discontinuous and have only limited areal extent.

In addition to the localized deposits of coarse material within the till, the interface of the bedrock surface with the overlying till generally consists of from 1 to 15 feet of broken rock (limestone), gravel, and sand. This layer has been identified from local well logs and appears to be debris ground from the bedrock by the advancing ice.

The Soil Survey of Lake County, Illinois, indicates that surface soils of the Installation have been classified primarily into two groups--the Morley-Beecher-Hennepin association and Made Land (SCS, 1970). Made land is defined as areas of manmade cuts and fills, and areas covered by roads and buildings. Fill materials include a variety of soils and nonsoil materials that have not been distinguished. The Morley-Beecher-Hennepin association consists primarily of loams and silty loams that are characterized as nearly level-to-very steep in deep ravines, well drained-to-somewhat poorly drained, and having moderately slow-to-moderate permeability.

1.2.2.3 Hydrology

1.2.2.3.1 Groundwater

Groundwater occurs throughout the till, but due to the extremely low hydraulic conductivity of the clayey material, the till yields very little water and does not constitute an aquifer. The discontinuous lenses and strands of sandy

materials are potential sources of groundwater and have been reported to have been used for limited water supplies. However, due to their limited extent and irregular nature, the quantity of water available from these deposits is also limited and there is no indication that they provide more than minor water supplies.

Two distinct zones of coarse material were encountered during this investigation. The shallower zone had a potentiometric surface at a depth less than 10 feet below ground surface, while the deeper zone had a potentiometric surface at a depth between 15 and 30 feet. No other zones were encountered to the maximum depth explored--45 feet. The two zones encountered do not appear to be directly connected; due to the lenticular nature of their occurrence, deposits in the same zone do not appear to be directly connected. The intervening clay till appears to effectively isolate the various coarse deposits by restricting the rate at which water moves through the clay both horizontally and vertically. The potential for contaminant migration in the till is also very low because of the low hydraulic conductivity. It is unlikely that till deposits would constitute a pathway for exposure of a significant number of receptors due to limited use as a groundwater source.

Most wells in the area tap bedrock as the source of groundwater, with yields reported to reach 25 to 40 gallons per minute. Because of the consistent and higher yields available from bedrock, it is the preferred source of groundwater where such supplies are developed. In addition, the low conductivity of the till indicates that any potential contamination in shallow deposits is effectively isolated from the bedrock aquifer.

The coarse zone occurring at the till-bedrock interface may have limited use for irrigation water, but is not known to supply potable water.

1.2.2.3.2 Surface Water

NTC Great Lakes is located within two major drainage basins--the Lake Michigan north drainage basin and the North Branch Chicago River drainage basin. Areas east of Green Bay Road drain to Lake Michigan, in large part by Pettibone Creek; areas to the west of Green Bay Road drain to Skokie River, which is locally referred to as Skokie Ditch (see Figure 1-3). The IAS indicated that Skokie River drainage ultimately reaches the Mississippi River. Although this may occur via various canals and the DesPlaines River, it is more likely that flow discharges to

Lake Michigan at Chicago via the Chicago River. Despite the conflict regarding the discharge of Skokie River, the stream receives a major portion of its flow from urban runoff and storm drainage in the more than 20 miles it flows to Chicago. The water quality of both Skokie River and Pettibone Creek is reported to be poor because of urban runoff (Rogers, Golden & Halpern, 1986).

It is also important to note that, though the IAS indicated that Skokie River originates at NTC Great Lakes, it appears to exist upstream of the golf course and has been placed in a conduit under the northern portion of the golf course, as shown in Figure 1-3. The existence of the conduit was identified through review of published documents (USGS, 1967), because it was not clearly evident in the field nor was it identified by Installation personnel. Also, much of Skokie River south of Buckley Road, and apparently north of the golf course, has been channelized to improve stormwater flow. The presence of such drainage improvements typically indicates urban runoff and storm flow, which are generally characterized by poor water quality and a high potential for contaminant migration.

1.2.2.3.3 Groundwater-Surface Water Interaction

Due to the shallow depths of groundwater in coarse material in the till, it is likely that these deposits intersect Skokie River and Pettibone Creek and discharge to surface water via seeps or small springs, though no such discharges have been observed in the IAS or the present investigation. Recharge of groundwater by surface water is possible where a sand lense intersects surface water below the water surface, a situation that is not likely to commonly occur.

1.3 SUMMARY OF PROBLEMS LEADING TO REMEDIAL INVESTIGATION

Based on information from historical records, aerial photographs, field inspections, and personnel interviews, the IAS (Rogers, Golden & Halpern, 1986) identified a total of 14 potentially contaminated sites at NTC Great Lakes. Each of the sites was evaluated in the IAS with respect to contamination characteristics, migration pathways, and pollutant receptors.

The IAS determined that both surface water and shallow groundwater are potential contaminant migration pathways. As discussed in Section 1.1.4, the downward migration of contaminants into deeper aquifers used for drinking water is unlikely due to the presence of aquitards formed by the glacial till of the area. Runoff from the activity may enter either Skokie Ditch or Pettibone Creek.

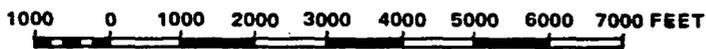
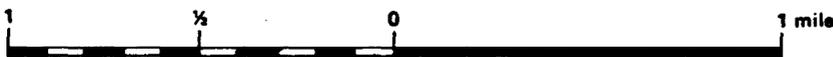
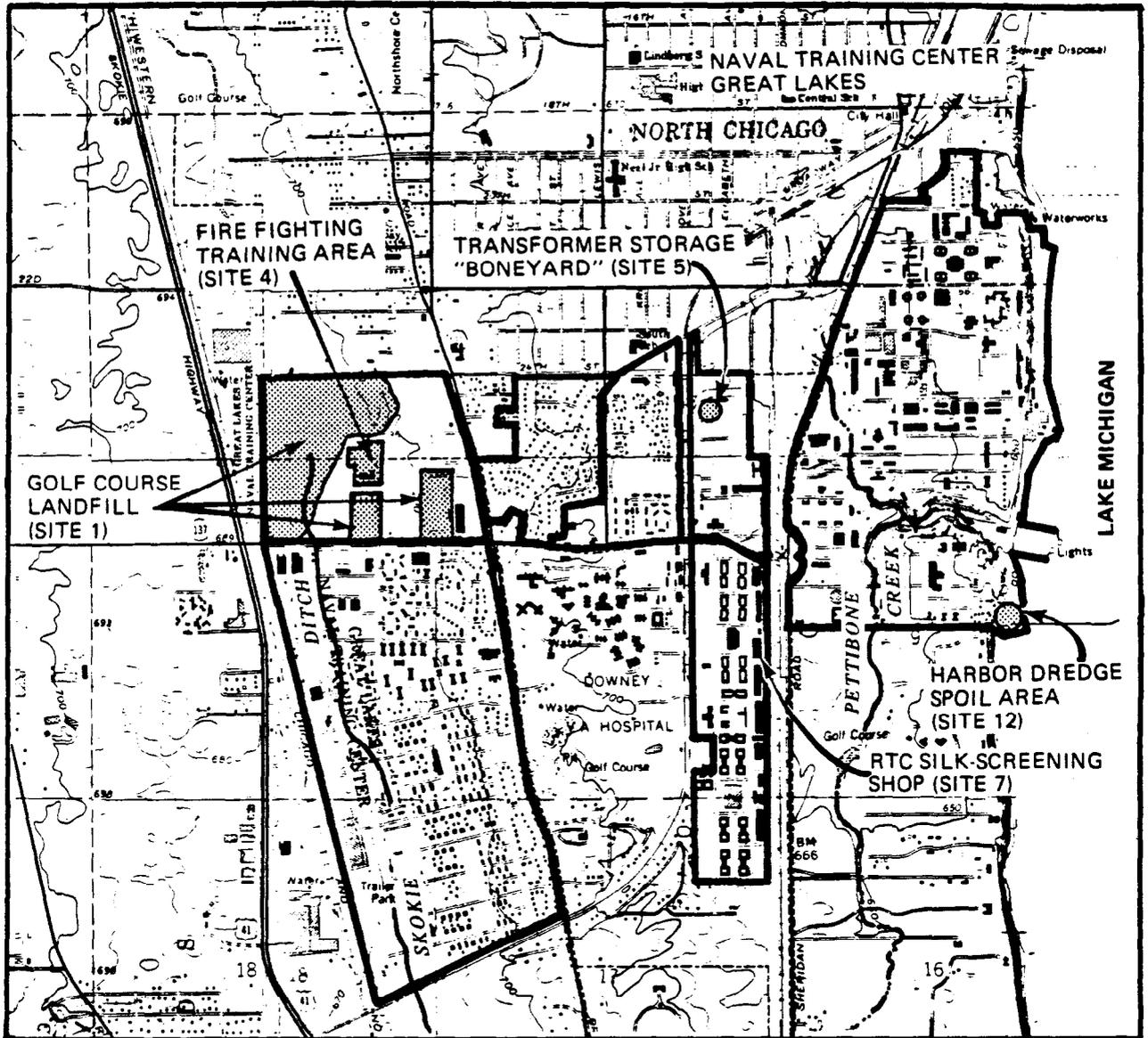
Furthermore, groundwater supplies much of the flow for Pettibone Creek and may supply water for intermittent flow in Skokie Ditch. Although neither of these streams is used as a source of potable or industrial water in the immediate vicinity of the activity, both streams do flow into other bodies of water that are used for these purposes. Pettibone Creek flows directly into Lake Michigan, which is used extensively for sport fishing; while Skokie Ditch becomes the Skokie River, which eventually drains into both the Mississippi River and Lake Michigan.* Lake Michigan is also used for drinking water.

The IAS concluded that, "while none of the sites poses an immediate threat to human health or the environment, seven sites warrant further investigation under the Navy IR program to assess potential long-term impacts." An RI/FS, involving sampling and monitoring of the seven sites, was recommended to "either confirm or refute the presence of the suspected contamination and to better define the extent of any problems that may exist."

As discussed earlier, five of the seven sites are the subject of this report. A brief description of each of these sites follows. Detailed descriptions of these sites and the nature and extent of problems leading to the present investigation are provided in Section 2.2 in association with the discussion of each site. The locations of these sites at NTC Great Lakes are shown in Figure 1-4.

- o Site 1, Golf Course Landfill--Underlying at least 50 acres of the present golf course, the landfill was operated as a trenching/burning operation between 1942 and 1967 for an estimated 1.5 million tons of material. Types of waste reportedly include domestic refuse; sewage sludge; petroleum, oil, and lubricants (POLs); solvents; coal ash; and materials contaminated by polychlorinated biphenyls (PCBs).
- o Site 4, Fire Fighting Training Area--The FFTA consists of a 10-acre partially paved area, used since 1942 to stage fires for training exercises. Fuels used for fires include #2 fuel oil and gasoline. The site includes ditches that may receive runoff from the site and two oil/water separator lagoons. In addition--reportedly between 1942 and

*The Skokie River drains to the North Chicago River, the North Branch of which enters Lake Michigan and the South Branch of which enters a system of ship canals that eventually drains to the Mississippi River.



**FIGURE 1-4
LOCATION OF STUDY SITES
AT NTC GREAT LAKES**



**REMEDIAL INVESTIGATION/
FEASIBILITY STUDY
NAVAL TRAINING CENTER
Great Lakes, Illinois**

1979--a portion of the site was used for storage of drums containing waste POLs and solvents, as well as oils and materials recovered from the training exercises.

- o Site 5, Transformer Storage "Boneyard"--This 2-acre site was reportedly used between 1945 and 1985, primarily for the storage of out-of-service transformers, including some filled with PCB-containing oil. Other stored items include lead-insulated cable, heavy equipment, and other miscellaneous scrap metal and materials.
- o Site 7, RTC Silk-Screening Shop--The shop used a variety of materials, including paint, inks, water- and oil-based lacquers, enamels, mineral spirits, acetone, thinners, and photographic emulsions. Up until 1945, washwater from the finishing of silk screens, possibly contaminated with some of these products, was allowed to drain onto the ground outside the building via a small pipe draining the shop's washwater booth.
- o Site 12, Harbor Dredge Spoil Area--During harbor dredging activities in 1952 and 1970, dredge spoils were reportedly disposed of at this site along the shore of Lake Michigan. The sludge could have a high organic material concentration (though exposure to air could have resulted in oxidation and accelerated decomposition of the organics) and could potentially contain heavy metals, oils, pesticides, and PCBs from industries or other off-post activities upstream of NTC Great Lakes.

The IAS indicated that contamination from these sites could possibly migrate in the environment, potentially resulting in human health or environmental impacts. Thus, an RI/FS was recommended.

1.4 RI VERIFICATION STEP PROGRAM OVERVIEW

This section provides an overview of the monitor well installation and soil, groundwater, and surface water sampling and analysis programs conducted at the study sites. Detailed descriptions of the site-specific field programs and rationales are provided in Section 2.2 in association with the discussion of each site. In addition, a detailed discussion of fieldwork methodologies and associated field quality assurance (QA) procedures employed in this investigation is presented in Appendix A. The Laboratory QA Plan was provided as part of the VSWP for this investigation (Dames & Moore, 1987a).

Fieldwork activities at NTC Great Lakes--the results of which are reported in this document--were conducted during the following time periods:

<u>Fieldwork Activity</u>	<u>Dates</u>
Initial site reconnaissance	December 1986
Monitoring well installation	November-December 1988
Soil sampling (all sites)	November-December 1988
Groundwater and surface water sampling (Round 1)	December 1988
Soil resampling (selected Site 4 locations)	March 1989
Groundwater and surface water sampling (Round 2)	March 1989
Site 12 soil sampling (third event)	August 1989

These activities are described and explained in sections that follow and/or in Section 2.0.

1.4.1 Study Objectives and Scope of Work

The objective of this project was to conduct an RI Verification Step for the five subject sites at NTC Great Lakes. The original goal of the Verification Step, as specified by the U.S. Navy, was to collect sufficient quantitative environmental data to either (1) verify the presence of hazardous or toxic waste and supply planning for an expanded monitoring program (Characterization Step), or (2) recommend no further action where such materials are not found. However, due to the laboratory analysis/data validation problems discussed earlier, no conclusions or recommendations are included in this TM.

The above-stated objective was accomplished by conducting field investigations of the five study sites to characterize potential contamination of soil, groundwater, and/or surface water at these locations. The investigation included installation of groundwater monitoring wells; sampling of soil, groundwater, and surface water; and chemical analysis of these samples. Details of the investigations are summarized in Section 2.2 of this report.

1.4.2 Site Reconnaissance and Records Review

To develop a technical approach to the RI Verification Step program, a site reconnaissance and records review were conducted. The initial site reconnaissance

of the sites to be addressed in this RI/FS was conducted on December 15-16, 1986. Histories of the various sites, services to be performed at each site, and current Installation activity were discussed. During the site visit, conditions at each of the sites were observed and recorded, including surface conditions, location and condition of structures and other physical facilities, evidence of past operations/facilities, visual identification of potentially contaminated areas, topography, condition of/lack of vegetation, location of existing wells and surface water, conditions that may impede site access, and other site-specific features.

In conjunction with and following the site reconnaissance, a review of pertinent documents and photographs was performed. These consisted primarily of the IAS document; the Naval Energy and Environmental Support Activity (NEESA) files containing IAS interview notes, maps, and a set of 1953 aerial photographs, as well as other pertinent documents; additional aerial photographs obtained by Dames & Moore covering the period 1946 to 1985; and additional geologic and hydrogeologic reports on the region and the site. In addition, this information was supplemented by telephone discussions with Installation personnel. Information from these sources was used to develop an RI Verification Step field investigation program that is consistent with facility history, operations, and conditions.

Historic aerial photography covering the five study sites was evaluated to detect changes in site conditions over the years and thereby locate potential contamination sources. The investigation involved the stereoscopic interpretation of individual aerial photographs acquired as follows:

<u>Source</u>	<u>Date</u>
USGS	July 1946
USGS	May 1953
Chicago Aerial Survey (CAS)	January 1963
CAS	March 1970
USGS	October 1972
CAS	April 1975
CAS	March 1981
SCS	April 1985

Also included was the monoscopic interpretation of USGS oblique aerial photographs taken in April 1958. For each year analyzed, the aerial photographic investigation determined the conditions at each site, including evidence of manmade changes and activity, particularly at the landfill, and the presence of features such as "flow stains" or drums that may indicate contamination sources.

1.4.3 Overview of RI Verification Step Field Program

This section presents an overview of the RI Verification Step field program at NTC Great Lakes. The first two major subsections (1.3.3.1 and 1.3.3.2) define the two major components of the program:

- o Hydrogeologic investigation--exploratory borings, monitoring well installation, water level measurements, and soil and groundwater sampling.
- o Surface water investigation--surface water sampling.

The third subsection (1.3.3.3) discusses methods used for the chemical analysis of the soil, groundwater, and surface water samples.

Major aspects of the RI Verification Step program at NTC Great Lakes are summarized in Table 1-1. This table shows the number of wells installed at each site and summarizes the sampling/analysis program by providing site-specific information on soil, groundwater, and surface water samples collected, and on analytical parameters for these samples. The table also provides information on the field quality control (QC) samples that were collected in association with the sampling program. (See Appendix A for further information on field QC samples.) Monitoring well and sampling locations for each site are illustrated in the individual site drawings and discussed in Section 2.2.

1.4.3.1 Hydrogeologic Investigation

1.4.3.1.1 Boring/Monitoring Well Installation

Tentative locations for a total of 13 exploratory borings/monitoring wells in the shallow water table water-bearing zone were selected for Sites 1 and 4 during VSWP preparation and marked by Dames & Moore prior to installation. These sites were believed to be the ones among those studied at which groundwater contamination was most likely to have occurred. These locations were chosen with two general purposes in mind:

- o Boreholes were located to provide additional information on subsurface soils, shallow groundwater conditions, and groundwater gradients so as to further the understanding of site hydrogeologic characteristics.

TABLE 1-1

Summary of RI Verification Step
Field Investigation Program at
NTC Great Lakes, Illinois^(a)

Site No.	Site Name	Number of Wells Installed	Types of Samples Collected	Number of Sample Locations	Description/Frequency of Sampling	Total No. of Samples	Number of Associated Field QC Samples			Analytical Parameters
							Replicates	Field Blanks (Equipment Rinsate Blanks)	Other	
1	Golf Course Landfill	9	Groundwater Surface water	9 2	Two times--December 1988 and March 1989. Two times--December 1988 and March 1989.	18 4	1 (b) 1 (d)	1/1 (c)		Volatile organic compounds (VOCs), semi-volatile organic compounds (base-neutral and acid extractable organics--BNAs), priority pollutant metals, PCBs, oil and grease, chloride, total organic carbon (TOC).
4	Fire Fighting Training Area	4	Groundwater Surface water Soil	4 (e) 4 12	Two times--December 1988 and March 1989. Two times--December 1988 and March 1989. One time; two samples were collected--one each from depths of 1.5-3 feet and 3.5-5 feet--at each location.	8 8 24	1 (b) 1 (d) 1	1/1 (c)	1	VOCs, BNAs, oil and grease, lead
5	Transformer Storage "Boneyard"	0	Soil	27	One time; two samples were collected--one each from depths of 0.5-1 foot and 1.5-2 feet--at five of the locations; one sample was collected at a depth of 0.5-1 foot at each of the remaining 22 locations.	32	2		2	PCBs, oil and grease, lead
7	RTC Silk-Screening Shop	0	Soil	3	One time; two samples were collected--one each from depths of 0.5-1 foot and 1.5-2 feet--at each location.	6	1		1	VOCs, silver, chromium (total), cadmium, lead
12	Harbor Dredge Spoil Area	0	Soil/sludge	14	One time; three samples were collected--one each from depths of 0.5 to 2, 3.5-5, and 6.5-8 feet--at each location.	42	3		3	VOCs, priority pollutant metals, pesticides, PCBs
--	Trip blanks	--	--	--	--	--			5/1 (c)	VOCs
--	Drilling water (from tap in Bldg. 3304 at FFTA)	--	--	--	--	--			1 (d)	VOCs, BNAs, priority pollutant metals, pesticides, PCBs, oil and grease, chloride, TOC

(a) Well and sample locations are shown in the individual site drawings in Section 2.2.

(b) Collected in Round 2.

(c) Round 1/Round 2.

(d) Collected in Round 1.

(e) One of these wells (MW4-1) also serves as a background well for the Golf Course Landfill (Site 1) and, therefore, was sampled for all analytes of concern at the landfill.

- o Boreholes were located so that wells installed therein would provide information on naturally occurring groundwater quality in the shallow water table aquifer upgradient of any potential contamination sources or on lateral migration of contaminants downgradient from any potential contamination sources.

The overall groundwater monitoring network included the 13 newly installed wells. There were no existing wells at the sites.

Groundwater monitoring well installation and subsequent sampling of the 13 wells during the Verification Step included areas where shallow groundwater quality degradation was believed possible because of site activities generally involving waste disposal at depth (e.g., the landfill) or considerable confirmed surface deposition of liquid wastes (e.g., the FFTA)--where preliminary assessment indicated groundwater as being a likely pathway for contaminant migration, shallow water-bearing sands were believed to be underlying the areas, and no existing monitoring wells were present in the vicinity. Areas where wells were not installed include sites where activities and resulting potential contamination appeared to be limited to the near surface and/or where potential contamination appeared to be nonexistent or of very limited severity. In some of these latter cases, recommendations for groundwater monitoring have been deferred pending the results of surface soil sampling.

Major aspects of the drilling program are summarized briefly below; additional details are presented in Appendix A. Soil boring and well installation were performed--under Dames & Moore supervision--by Fox Drilling, Inc., Itasca, Illinois, using a truck-mounted drill rig. The wells were installed over the period of November 7 through December 8, 1988. All wells were drilled using hollow-stem augers, which provided temporary casing to support surrounding soil during well installation. The wells were all constructed using Grade 304 stainless-steel casing and screen. The wells range in depth from 16 to 40 feet, and each has a 10-foot screen. Boring logs, well construction diagrams, and well development records are provided in Appendix B. The wells installed during this investigation were intended to penetrate the shallowest water-bearing zone, with the screen placed to straddle the water table as identified during drilling so as to allow for the detection of floating constituents (e.g., POLs).

1.4.3.1.2 Soil Sampling

Soil samples were collected from all well borings for visual examination. At Site 4, several samples were also collected from selected borings for chemical analysis; these samples were collected from depths corresponding to those planned for other soil samples at this site. In addition, shallow soil sampling programs were planned and implemented to examine residual contamination, if any, at various spill, storage, and disposal areas, where potential contaminant sources had been identified (i.e., Sites 5, 7, and 12). At both the FFTA and Harbor Dredge Spoil Area, sampling was performed by Fox Drilling, Inc. (under the supervision of Dames & Moore staff), using a truck-mounted drill rig. These borings were drilled using solid-stem augers because the borings were shallow--8 feet or less--and soil disturbance was minimized with the smaller augers. Soil sampling at Sites 5 and 7 was performed using a hand auger and/or a shovel, because the maximum depth of sampling was 2 feet. Additional information regarding sampling is provided in the site-by-site discussions (Section 2.2) and in Appendix A. A total of 105 soil samples were collected. Soil samples were collected on a one-time basis.

1.4.3.1.3 Groundwater Sampling

Groundwater samples were collected from the 13 newly installed wells (see Table 1-1). General considerations for selection of locations for the wells and the rationale for groundwater monitoring are discussed in Section 1.3.3.1.1. The newly installed wells were used at Sites 1 and 4 to comprise groundwater monitoring networks to characterize groundwater quality upgradient and downgradient of potential contamination sources. The wells were sampled twice during sampling events approximately 4 months apart.

1.4.3.2 Surface Water Investigation

The aspects of the surface water investigation summarized in Table 1-1 included surface water sampling at two locations in Skokie Ditch and in surface water bodies associated with the FFTA. No sediment samples were included during the RI Verification Step, because it was believed that the small number of these samples collected in association with surface water samples would be of limited usefulness during this initial effort, in which the primary concern was whether contaminants were present and migrating in surface water. Surface water samples were collected twice along with the groundwater samples.

Sampling points were selected to obtain representative ambient surface water quality characteristics; to determine the nature of pollution from potential contaminant sources; and/or to determine the fate and extent of migration of pollutants in surface water. General guidelines for determining surface water locations indicated that samples be collected downstream of potential contamination sources (upstream sampling was not conducted, because it would have required off-base sampling, which was not included in the scope of this investigation) to determine downstream water quality, the effects of dilution, possible contributions of other contamination sources, etc.

1.4.3.3 Chemical Analysis Program

This section discusses the laboratory methods employed in this investigation for the chemical analysis of groundwater, surface water, soil, and sludge (i.e., dredge spoils) samples collected at the five study sites. The analytical parameters for each study site were selected based on potential contaminants expected to be associated with known or suspected activities or occurrences at each site. The specific parameters selected and the rationale for selection in each case are discussed in association with the sampling program for each site (see Section 2.2). Chemical analyses for this project were performed by metaTRACE, Inc., Earth City, Missouri, under subcontract to Dames & Moore.

Information pertinent to the analytical methods for this investigation is summarized in Table 1-2. For each analytical parameter and sample matrix (i.e., water, soil/sludge), the table shows the analytical technique, USEPA method number, and analytical method detection limit (DL). DLs for VOCs and semivolatile organic compounds (i.e., BNAs) by gas chromatography/mass spectrometry (GC/MS) are presented in Tables 1-3 and 1-4, respectively. DLs for pesticides and PCBs by gas chromatography (GC) are provided in Table 1-5.

The DLs shown in Tables 1-2 through 1-5 are the lowest reportable DLs for the analytical methods used. During actual analyses, the DL for each constituent is calculated for each sample and can vary as a result of such factors as matrix interference effects, signal-to-noise ratio, moisture content, and extract dilution or concentration requirements during analysis. Thus, DLs for each sample can be and often are different and higher than the DLs shown in Tables 1-2 through 1-5, especially for soil/sludge samples. The actual, sample-specific DLs are tabulated along with the sample analysis results presented in Appendix G.

TABLE 1-2

Information on Chemical Analysis Methods
 RI Verification Step at NTC Great Lakes, Illinois

Analytical Parameter	Analytical Technique (a)	Water			Soil/Sludge	
		USEPA Method No. (b)	DL (c) (ug/l)		USEPA Method No. (b)	DL (c) (ug/g unless noted otherwise)
			Round 1	Round 2		
Priority pollutant metals:						
Antimony	ICP	200.7	10	55	6010	6
Arsenic	GFAAS	206.2	10	3	7060	1
Beryllium	ICP	200.7	5	5	6010	0.5
Cadmium	ICP	200.7	5	5	6010	0.5
Chromium (total)	ICP	200.7	10	8	6010	1
Copper	ICP	200.7	25	9	6010	2.5
Lead	ICP/GFAAS (d)	200.7/239.2	5	3	6010/7421	2.5
Mercury	CVAAS	245.1	0.2	0.2	7471	0.1
Nickel	ICP	200.7	15	26	6010	0.1
Selenium	GFAAS	270.2	5	2	7740	0.5
Silver	ICP	200.7	10	7	6010	1
Thallium	GFAAS	279.2	10	3	7841	1
Zinc	ICP	200.7	20	4	6010	2
VOCs	GC/MS (e)	8270/624 (f)	(g)	(g)	8270	(g)
Semivolatile organic compounds (BNAs)	GC/MS (e)	625	(h)	(h)	8270	(h)
Pesticides/PCBs	GC/ECD	608	(j)	(j)	8080	(j)
TOC	Combustion/oxidation	415.1	100	100	NA (k)	--
Oil and grease	Gravimetric/spectro- photometric, IR	413.1/413.2 (f)	5,000	20	413.1/413.2 (f,l)	0.6/2 (m)
Chloride	IC	300.0	250	250	NA	--

TABLE 1-2 (cont'd)

- (a) CVAAS = cold vapor atomic absorption spectroscopy.
 GC/ECD = gas chromatography with electron capture detector.
 GC/MS = gas chromatography/mass spectrometry.
 GFAAS = graphite furnace atomic absorption spectroscopy.
 IC = ion chromatography.
 ICP = inductively coupled plasma atomic emission spectroscopy.
 IR = infrared.

(b) USEPA analytical methods are described in the following references:

<u>USEPA Method No. Series</u>	<u>Citation</u>
200 through 400	USEPA, 1979
600	40 CFR 136
6000 through 8000	USEPA, 1986

- (c) DL = detection limit.
- (d) The AAS method was used if the metal could not be detected by ICP at a level at least two times the ICP DL. The DLs shown are for the AAS method.
- (e) Includes library search to detect nonpriority pollutant compounds.
- (f) Round 1/Round 2.
- (g) See Table 1-3.
- (h) See Table 1-4.
- (i) Where lower DLs are required for pesticides or PCBs than could be attained by GC/MS, in cases where compounds of this type were believed to be present or of concern, GC/ECD was employed rather than GC/MS.
- (j) See Table 1-5.
- (k) NA = not applicable.
- (l) Modified water methods were used for solid matrix analyses.
- (m) USEPA 413.1/USEPA 413.2. Note that for Method 413.1, the concentration of the DL is expressed in percent.

TABLE 1-3

Detection Limits for Volatile Organic
Compounds by GC/MS

Compound Name	Water Detection Limits ^a (ug/l)	Soil Detection Limits ^a (ug/g)
Acetone	10	0.010
2-Butanone	10	0.010
Vinyl acetate	10	0.010
2-Hexanone	10	0.010
4-Methyl-2-pentanone	10	0.010
Chloromethane	10	0.010
Bromomethane	10	0.010
Vinyl chloride	10	0.010
Chloroethane	10	0.010
Methylene chloride	5	0.005
1,1-Dichloroethene	5	0.005
1,1-Dichloroethane	5	0.005
1,2-Dichloroethene (total)	5	0.005
Chloroform	5	0.005
1,2-Dichloroethane	5	0.005
1,1,1-Trichloroethane	5	0.005
Carbon tetrachloride	5	0.005
Bromodichloromethane	5	0.005
1,2-Dichloropropane	5	0.005
cis-1,3-Dichloropropene	5	0.005
Trichloroethene	5	0.005
Dibromochloromethane	5	0.005
1,1,2-Trichloroethane	5	0.005
Benzene	5	0.005
trans-1,3-Dichloropropene	5	0.005
Bromoform	5	0.005
Tetrachloroethene	5	0.005
1,1,2,2-Tetrachloroethane	5	0.005
Toluene	5	0.005
Chlorobenzene	5	0.005
Ethylbenzene	5	0.005
Carbon disulfide	5	0.005
Styrene	5	0.005
Xylenes (total)	5	0.005

^aUnknown responses in the mass chromatogram that account for greater than 10 percent of the concentration of the nearest internal standard will be library searched to attempt identification and quantification.

TABLE 1-4

Detection Limits for Semivolatile Organic
Compounds by GC/MS

Compound Name	Water Detection Limits (ug/l)	Soil Detection Limits (ug/g)
Base-Neutrals		
Acenaphthene	10	0.33
1,2,4-Trichlorobenzene	10	0.33
Hexachlorobenzene	10	0.33
Hexachloroethane	10	0.33
Bis (2-chloroethyl) ether	10	0.33
2-Chloronaphthalene	10	0.33
1,2-Dichlorobenzene	10	0.33
1,3-Dichlorobenzene	10	0.33
1,4-Dichlorobenzene	10	0.33
3,3-Dichlorobenzidine	20	0.66
2,4-Dinitrotoluene	10	0.33
2,6-Dinitrotoluene	10	0.33
Fluoranthene	10	0.33
4-Chlorophenyl phenyl ether	10	0.33
4-Bromophenyl phenyl ether	10	0.33
Bis (2-chloroisopropyl) ether	10	0.33
Hexachlorobutadiene	10	0.33
Hexachlorocyclopentadiene	10	0.33
Isophorone	10	0.33
Naphthalene	10	0.33
Nitrobenzene	10	0.33
N-Nitroso-dipropylamine	10	0.33
Butyl benzyl phthalate	10	0.33
Di-n-butyl phthalate	10	0.33
Di-n-octyl phthalate	10	0.33
Diethyl phthalate	10	0.33
Dimethyl phthalate	10	0.33
Bis (2-chloroethoxy) methane	10	0.33
Benzo (a) anthracene	10	0.33
Benzo (b) fluoranthene	10	0.33
Chrysene	10	0.33
Acenaphthylene	10	0.33
Anthracene	10	0.33
Benzo (g,h,i) perylene	10	0.33
Fluorene	10	0.33
Phenanthrene	10	0.33
Dibenzo (a,h) anthracene	10	0.33
Benzyl alcohol	10	0.33
4-Chloroaniline	10	0.33
2-Methylnaphthalene	10	0.33

TABLE 1-4 (cont'd)

<u>Compound Name</u>	<u>Water Detection Limits EPA 625 (ug/l)</u>	<u>Soil Detection Limits EPA 8250 (ug/g)</u>
Base-Neutrals (cont'd)		
2-Nitroaniline	50	1.6
3-Nitroaniline	50	1.6
Dibenzofuran	10	0.33
4-Nitroaniline	50	1.6
Benzo (k) fluoranthene	10	0.33
N-nitrosodiphenylamine	10	0.33
Indeno (1,2,3-cd) pyrene	10	0.33
Pyrene	10	0.33
Bis (2-ethylhexyl) phthalate	10	0.33
Benzo (a) pyrene	10	0.33
Benzoic acid	50	1.6
Acid Extractables		
2,4,5-Trichlorophenol	50	1.6
2,4,6-Trichlorophenol	10	0.33
2-Chlorophenol	10	0.33
2-Nitrophenol	50	1.6
4-Nitrophenol	50	1.6
2,4-Dinitrophenol	50	1.6
2,4-Dichlorophenol	10	0.33
Pentachlorophenol	50	1.6
2,4-Dimethylphenol	10	0.33
Phenol	10	0.33
4-Chloro-3-methyl phenol	10	0.33
4,6-Dinitro-2-methyl phenol	50	1.6
2-Methylphenol	10	0.33
4-Methylphenol	10	0.33
Pesticides/PCBs and Library-Searched Compounds	(a)	(a)

^aPesticides, PCBs, and unknown responses in the mass chromatogram that account for greater than 10 percent of the concentration of the nearest internal standard will be library searched to attempt identification and quantification.

TABLE 1-5

Detection Limits for Pesticides and PCBs by GC/ECD

Compound Name	Water Detection Limits (ug/l)	Soil Detection Limits (ug/g)
Pesticides		
alpha-BHC	0.003	0.008
beta-BHC	0.003	0.008
delta-BHC	0.009	0.008
gamma-BHC (Lindane)	0.003	0.008
Heptachlor	0.003	0.008
Aldrin	0.004	0.008
Heptachlor epoxide	0.083	0.008
Endosulfan I	0.014	0.008
Dieldrin	0.002	0.016
4,4-DDE	0.004	0.016
Endrin	0.006	0.016
Endosulfan II	0.004	0.016
4,4-DDD	0.011	0.016
4,4-DDT	0.012	0.016
Endosulfan sulfate	0.066	0.016
alpha-Chlordane	0.014	0.008
gamma-Chlordane	0.014	0.008
Toxaphene	0.24	0.008
Methoxychlor	0.50	0.08
Endrin ketone	0.10	0.16
PCBs		
PCB-1016	0.07	0.08
PCB-1221	0.07	0.08
PCB-1232	0.07	0.08
PCB-1242	0.07	0.08
PCB-1248	0.07	0.08
PCB-1254	0.12	0.16
PCB-1260	0.12	0.16

These DLs for inorganic (metals, TOC, oil and grease, chloride) analyses of water and soil/sludge samples are calculated as follows:

Inorganics in water: $DL \times df$

Inorganics in soil/sludge: $\frac{DL}{D} \times df$

where: DL = the detection limit shown in Table 1-2

D = $\frac{100\% \text{ moisture}}{100}$ (i.e., the dry weight correction)

df = dilution factor.

For organic analyses (volatiles, semivolatiles, pesticides/PCBs), an additional correction has been applied by the laboratory to account for signal-to-noise ratio.

The analysis of metals was performed using inductively coupled plasma (ICP) atomic emission spectroscopy, with the exception of arsenic, selenium, and thallium--which were determined using graphite furnace atomic absorption spectroscopy (GFAAS); and mercury--which was determined using cold vapor atomic absorption spectroscopy (CVAAS). For lead analyses, GFAAS was used for samples in which the metal could not be detected by ICP at a level at least two times the ICP detection limit (see Table 1-2).

The analysis of volatile organics and semivolatile organics (BNAs, pesticides, and PCBs) employed GC/MS screening techniques. Priority pollutants (excluding pesticides/PCBs) were identified and quantified. In addition, pesticides, PCBs, and unknown responses in the mass chromatogram that accounted for greater than 10 percent of the concentration of the nearest internal standard were library searched to attempt identification and quantification.

Where lower DLs than those obtainable by GC/MS were desired for pesticides or PCBs (i.e., in cases where such compounds were believed to be present), pesticides or PCBs were determined by GC with an electron capture detector (ECD). A florasil cleanup procedure was conducted to attempt to eliminate interferences. In the RI Verification Step program specified herein, such analyses were conducted for pesticides in sludges at the Harbor Dredge Spoil Area, and for PCBs in samples collected at the Golf Course Landfill, Transformer Storage "Boneyard," and Harbor Dredge Spoil Area.

It was originally planned to analyze for oil and grease using the infrared (IR) spectrophotometric method (USEPA Method 413.2). This method allows for recovery of both heavy and light oil fractions. However, during the first round of sampling, the gravimetric method--USEPA 413.1, which analyzes for the heavy oil fraction only--was used instead. During the second round, USEPA 413.2 was used for the water samples and for some soil samples for which reanalyses were required due to missed holding times. Other samples for oil and grease were not recollected/reanalyzed, because sufficient information was believed to be available for these from VOC and BNA analyses such that satisfactory conclusions regarding petroleum-based contamination could be reached.

TOC was analyzed using the combustion/oxidation method (USEPA 415.1). Chloride was analyzed using ion chromatography (IC), USEPA Method 300.0.

1.5 REPORT ORGANIZATION

The remaining sections of this report present the following information:

- o Section 2.0--A detailed discussion of the RI Verification Step results for each study site, in terms of the site descriptions/histories and nature and extent of problems leading to this investigation; current field program approach and rationale; and Verification Step findings for the hydrogeologic (soils and groundwater) and surface water investigations conducted.
- o Section 3.0--References.

Also included are appendices that provide the following supplementary data:

<u>Appendix</u>	<u>Content</u>
A	Detailed field procedures and fieldwork QA
B	Geotechnical information (boring logs, well construction diagrams, well development records, and topographic survey data)
C	Blank sample analysis results (for method, field, and trip blanks)
D	Summary and evaluation of exceedances of maximum holding times

<u>Appendix</u>	<u>Content</u>
E	Listing of applicable standards/guidelines for groundwater and surface water
F	Information on concentrations of metals in surficial soils of the eastern United States
G	A tabulation of chemical analysis results including field and laboratory quality control (QC) data

Appendix G is bound as three separate volumes.

2.0 RI VERIFICATION STEP RESULTS

2.1 INTRODUCTION

The data analysis and resulting contamination assessment for each of the NTC Great Lakes study areas involve a synthesis of literature sources and other existing data, evaluation of geotechnical and analytical data, assessment of potential contaminant migration, and comparison of chemical concentrations with regulatory standards and guidelines (where available). This information and associated evaluations are presented in Section 2.2 on a site-by-site basis. The following information is presented for each site:

- o Nature and extent of problems leading to investigation--site location and history, types of contaminants and associated contamination problems known or suspected to be present, and possible human health or environmental concerns that lead to the present study.
- o RI Verification Step field program--the field investigation approach and rationale for gathering information to satisfy the RI Verification Step objectives stated in Section 1.3.1.
- o RI Verification Step findings--for the hydrogeologic (soils and groundwater) and surface water investigations, site descriptive information relevant to contaminant migration potential is first presented based on previously existing data on site topography, geology, and/or hydrology and on physical observations during the field program; and a contamination assessment is then presented to describe and assess observed contamination conditions based on sample analysis results, comparisons with probable background concentrations and applicable or relevant and appropriate requirements (ARARs, in the form of drinking water groundwater quality, or surface water standards and guidelines), and the potential for contaminant migration in the environment.
- o Summary--overall characterization of the site based on physical features, observed contamination, and contaminant migration potential.

This format allows for presentation of all site descriptive information, findings, and evaluations in one place to promote the understanding of conditions at each site.

The data analysis/discussion of results by site in Section 2.2 makes use of the geotechnical information and chemical analysis results presented in the appendices. In addition, the Section 2.2 discussions incorporate a number of other common features that, along with those above, will first be addressed here. These additional considerations include treatment of data from laboratory method blanks (MBs), field blanks (FBs)/equipment rinsate blanks (ERBs), and trip blanks (TBs); identification of samples collected during the RI Verification Step for which maximum holding times were exceeded; comparison of groundwater and surface water sample analysis results with applicable water quality criteria, and comparison of soil sample analysis results with soil action levels; and evaluation of soil results in light of natural levels of constituents in soils.

2.1.1 Geotechnical Information

Geotechnical information relevant to the RI Verification Step, collected during the field portion of the investigation, is presented in Appendix B. This information includes:

- o Logs of 18 borings* installed by Dames & Moore at NTC Great Lakes (Section B.1).
- o Well construction diagrams for 14 new wells** (Section B.2).
- o Well development records for 13 new wells (Section B.3).
- o Topographic survey data--locations and elevations of new wells (Section B.4).

This information is used to supplement other available data on site geology/geohydrology to characterize soils, geology, and groundwater conditions.

2.1.2 Chemical Analysis Results

A complete tabulation of analytical results is presented in Appendix G for samples collected during the RI Verification Step.

* Includes borings for the 13 new wells sampled in this investigation, one for a new well that went dry after completion and was replaced, and four others in which wells were not completed because no water was found.

** Includes diagrams for the 13 new wells sampled in this investigation and one for a new well that went dry after completion and was replaced.

Laboratory analytical results are reported by sample number (see Section 2.2) and are grouped by site (in Sections G.1 through G.5 for Sites 1, 4, 5, 7, and 12, respectively) and then by sample matrix (i.e., soil, groundwater, and surface water) within the section for each site, as applicable. Included are the tentatively identified compounds (TICs) from the GC/MS library searches for VOCs and BNAs. These sections also contain results for replicate samples (designated by an "X" following the sample number) and FBs (designated by a "Z" following the sample number) associated with particular samples collected at each site. In addition, Section G.6 contains results for other samples not associated with any particular site--for the TBs collected in Rounds 1 and 2 (Section G.6.1); for the drilling water sample (DW-1) (Section G.6.2); and for laboratory method blanks, spikes, and duplicates (Section G.6.3). Positive detections (i.e., results greater than or equal to DLs) have been extracted from these tables and are presented in tables of soil, groundwater, and surface water sample analysis results for each site contamination assessment in Section 2.2.

Measurements of pH and conductivity--made in the field in conjunction with groundwater and surface water sample collection--are tabulated in Section G.7. These measurements are used as needed in the Section 2.2 analyses.

2.1.3 Blank Sample Analysis Results

The RI Verification Step program included the preparation and analysis of blank samples--including laboratory MBs, FBs (ERBs), and TBs--as a check of laboratory and/or field QC. The results of the blank sample analyses are used to evaluate and qualify the analytical results for the environmental samples collected at NTC Great Lakes. The blank sample analyses results and their use in subsequent sample analyses are discussed below.

2.1.3.1 Laboratory Method Blanks

The RI Verification Step program required the laboratory to include an MB with each lot of samples analyzed by each method. For MBs, the entire sample preparation and analysis method is carried out on a standard water matrix without addition of target analytes to verify the absence (or presence) of sample contamination in the laboratory. Where such contamination is found in the blanks, it can be assumed that similar contamination in environmental samples may be the result of laboratory-introduced contamination. The various constituents detected

in laboratory MBs associated with the RI Verification Step sample analyses would arise from a number of sources, including air in the laboratory, impurities from reagents or glassware, or sample extraction byproducts (e.g., aldol condensation products), etc.

Data analysis in Section 2.2 compares sample analysis results with MB results. To assist in this evaluation, constituents detected in MBs from GC/MS analyses (including priority pollutants and TICs) are presented in tables in Appendix C, Section C.1, as follows:

<u>Table</u>	<u>Analysis</u>	<u>Sample Matrix</u>	<u>Sample Round</u>
C-1	VOC	Water	1
C-2	VOC	Water	2
C-3	VOC	Soil	--
C-4	BNA	Water	1
C-5	BNA	Water	2
C-6	BNA	Soil	--

These tables present results by lot/MB number and also provide the range of concentrations detected for each compound. All laboratory MB data are tabulated in Section G.6.3, Appendix G.

Positive detections are rarely found in MBs from analyses for constituents other than VOCs and BNAs. Such was the case for the analyses conducted for the RI Verification Step. There were a few detections that are of little significance in analyzing the sample analysis results for corresponding constituents.

According to USEPA's Functional Guidelines for Evaluating Organics Analyses under the Contract Laboratory Program (CLP) (USEPA, 1988a)--which discusses laboratory data validation requirements/procedures--it is required that positive detections in GC/MS sample analyses not be reported (i.e., that they be considered as not detected) if the concentration of the compound in the sample is less than or equal to 10 times the amount in the MBs for specified common laboratory contaminants (methylene chloride, acetone, toluene, 2-butanone, and common phthalate esters*) or less than or equal to five times the amount for other compounds. Under the USEPA CLP, sample analysis results are not corrected by subtracting blank values, nor were they corrected in this manner for analyses conducted under this RI Verification Step program.

*Common phthalate esters include bis(2-ethylhexyl) phthalate, diethyl phthalate, and di-n-octyl phthalate.

In the absence of other requirements, the CLP approach was chosen to evaluate the sample analysis results. Where detected, the "common" laboratory contaminants listed above are reported in Section 2.2 tables, but are not considered actual contamination if their concentrations are less than or equal to 10 times the levels found in MBs of corresponding sample matrices, as shown in Tables C-1 through C-6. For other organic compounds reported in GC/MS analyses, positive detections are not considered actual contamination if their concentrations are less than or equal to five times the levels found in MBs.

2.1.3.2 Field Blanks (Equipment Rinse Blanks)

In this program, FBs (ERBs) were prepared in the field by pouring distilled water over decontaminated sampling equipment and submitting this water for analysis. These blanks--also known as equipment rinse blanks--are used to evaluate the effectiveness of field equipment decontamination procedures. Although contaminants found in the FBs (ERBs) could be indicative of improper or inadequate equipment cleaning procedures, they could also be indicative of laboratory-introduced contamination and are thus compared with MB analysis results. Contaminants attributable to inadequate equipment cleaning would be taken into account in evaluating sample analysis results; the presence of such contaminants could indicate cross-contamination among sample locations.

Results for FBs (ERBs) for the RI Verification Step program are presented in Table C-7, Section C.2, Appendix C. As shown in this table, few contaminants were found in FBs (ERBs)--indicating adequate sampling equipment decontamination and no concern over possible cross-contamination. The low concentrations of constituents found are attributable to laboratory-introduced contamination (based on comparison with MB results) and possibly to impurities in the distilled water used for equipment rinsing.

2.1.3.3 Trip Blanks

TBs were included in this program to evaluate the possible introduction of VOCs into samples during sample transit. TB vials are filled in the lab and sent to the field with the sample bottles, then returned to the lab along with other samples for VOC analysis. VOCs introduced to samples by vehicle exhaust or other sources could be identified through TB analysis and thus discounted as actual site contamination. As with other samples, TB results could also reflect laboratory-introduced contamination as detected in MBs.

The TB analysis results for this investigation are presented in Table C-8, Section C.3, Appendix C. The results show that acetone and methylene chloride levels detected are probably laboratory artifacts, based on comparison with MB results. Chlorobenzene was also detected in the TB from the second round of samples, but at a very low estimated value below the DL.

2.1.4 Missed Holding Times

Maximum holding times for samples for each type of analysis are specified in Appendix A. Actual sample holding times have been compared to these maximum specified holding times, and exceedances of maximum holding times for some organic analyses are noted in a few instances. These exceedances are identified and evaluated in Table D-1, Appendix D. Other exceedances not shown in Table D-1 were noted for some soil samples, but these samples were recollected and then reanalyzed within the specified holding times.

According to USEPA's Functional Guidelines for Evaluating Organics Analyses under the CLP (USEPA, 1988a), if holding times are "grossly exceeded," the data reviewer must use professional judgment to determine the reliability of the data and the effects of additional storage on the sample results. Since holding times were only minimally exceeded for a few samples, the results have been determined to be useable for the purposes of this investigation, as discussed in Table D-1.

2.1.5 Comparison of Sample Analysis Results With Available Standards/Guidelines

As part of the contamination and preliminary risk assessments in Section 2.2, analytical results for groundwater and surface water samples are compared with available drinking water standards/guidelines and surface water quality criteria, respectively. Such standards/guidelines--which are considered to be potential chemical-specific ARARs for NTC Great Lakes--generally correspond to maximum exposure levels (for acute or chronic exposures) above which adverse toxic effects and/or aesthetic problems are considered probable. Comparison with such criteria is useful in assessing the severity of contaminant concentrations, because exceedances of such criteria can provide a generally accepted indication that contaminants may be present at levels of concern from a human health or environmental perspective. There are no such standards/guidelines for soils.

2.1.5.1 Groundwater

In this report, groundwater sample analysis results are compared with available standards and guidelines for public drinking water supplies. While it is recognized that the shallow monitoring wells sampled at NTC Great Lakes would not be used as drinking water sources, the quality of groundwater in these wells can be indicative of water quality in, or potential impacts on, shallow off-post groundwater. Impacts on deeper drinking water aquifers are not expected due to the presence of barriers to downward contaminant migration presented by the approximately 170 feet of underlying clay till. Table E-1, Appendix E, lists drinking water standards and guidelines for constituents detected in groundwater samples during the RI Verification Step. Where more than one criterion is available for each constituent, the table lists the criterion selected for comparison with sample analysis results in Section 2.2 (i.e., the potential ARAR). Explanations for criteria selection are also provided.

The following types of drinking water standards/guidelines are included in Table E-1:

- o Maximum Contaminant Levels (MCLs)--The final MCLs are the Federal, legally-enforceable standards issued as the National Primary Drinking Water Regulations (40 CFR 141) pursuant to the Safe Drinking Water Act (SDWA), Public Law 93-523. MCLs have also been proposed for a number of constituents. The MCLs are applicable to public drinking water systems and have been developed based on toxicological studies and on technology available. Thus, exceedances of these standards could result in health implications. The Illinois Environmental Protection Agency (IEPA) has adopted several of the Federal MCLs.
- o Secondary Maximum Contaminant Levels (SMCLs)--The final SMCLs are Federal guidelines that constitute the National Secondary Drinking Water Regulations (40 CFR 143) pursuant to Section 1412 of the SDWA. They are not federally enforceable. SMCLs have also been proposed for a number of constituents. These regulations control contaminants in public drinking water that primarily affect aesthetic qualities related to the public acceptance of drinking water. At considerably higher

concentrations of these contaminants, health implications may also exist as well as aesthetic degradation. The IEPA has adopted some of the Final SMCLs, including the SMCL for chloride (see Table E-1, Appendix E) as an Illinois Public and Food Processing Water Supply Standard (see below).

- o Maximum Contaminant Level Goals (MCLGs)--These are non-enforceable health goals for public drinking water supplies, which are set by USEPA, pursuant to the 1986 Amendments to the SDWA, at a level at which no known or anticipated adverse effects on the health of persons occur and which allow an adequate margin of safety. There are both final and proposed MCLGs for several chemicals.
- o Illinois Groundwater Quality Standards--Two separate types of quality standards can be applied to groundwater in Illinois under State regulations. Illinois General Use Water Quality Standards (IGWQS) (Title 35, Subtitle C, Subpart B) must be met in waters of the State for which there is no specific designation. Illinois Public and Food Processing Water Supply Standards (IPWSS) (Title 35, Subtitle C, Subpart C) are cumulative with the IGWQS and must be met for waters that will be withdrawn and used as a potable water supply. For the purpose of comparison with sample analysis results in this study, it has been assumed that both types of standards are potentially applicable at NTC Great Lakes. As indicated in Table E-1, the food processing standards are typically more stringent than the general use standards. Furthermore, for some chemical constituents, the food processing standards are identical to the Federal Primary and Secondary Drinking Water Regulations.
- o USEPA lifetime health advisories (LHAs)--The LHAs serve as informal technical guidance to assist Federal, state, and local officials responsible for protecting public health when contamination situations occur. The LHA exposure level is based on data describing noncarcinogenic endpoints of toxicity. They do not incorporate any potential carcinogenic risk from such exposure.
- o Ambient Water Quality Criteria (AWQC) adjusted for drinking water--These are health-based guidelines developed by adjusting the AWQCs

for freshwater aquatic environments to consider human health effects from consumption of contaminants in drinking water. (See discussion below on surface water criteria for more information.)

2.1.5.2 Surface Water

Surface water quality criteria for constituents detected in surface water samples during the RI Verification Step are listed in Table E-2, Appendix E. Surface water sample analysis results are compared to these criteria in Section 2.2. For the most part, these are the IGWQS (see Section 2.1.5.1) that, although the State of Illinois does not have any criteria specifically adopted for constituents in surface water, are applicable criteria and should be used as ARARs in this case (USEPA, 1988b). IGWQS, as listed in Table E-2, must be met in waters of the State for which there is no specific designation (IEPA, Title 35, Subtitle C, Chapter I, Part 302). Where there are no IGWQS, the Federal AWQC (see below) become relevant and appropriate (though not applicable according to USEPA guidance), but are used as potential ARARs in the absence of IGWQS.

AWQC were developed by USEPA in fulfillment of the requirement to protect and improve surface water quality, as described in Section 304(a) of the Clean Water Act. The intent is to promote sufficient surface water quality to maintain public health and welfare and aquatic life. This dual intent of the AWQC has frequently resulted in the establishment of more than one criterion for some chemicals. The applicability of the AWQC depends on the intended use of the surface water. At NTC Great Lakes, the intended use both on-post and off-post does not include human consumption of water, and no consumption of fish from potentially affected areas is expected; therefore, the AWQC potentially applicable to NTC Great Lakes surface water bodies sampled are the freshwater criteria for the protection of aquatic life. While it is recognized that not all surface water bodies sampled at NTC Great Lakes represent aquatic environments, it is believed that the AWQC are most generally applicable to all NTC Great Lakes surface water in the absence of other, more applicable standards (i.e., IGWQS).

The AWQC for the protection of freshwater aquatic life consist of both freshwater acute criteria (FAC) and freshwater chronic criteria (FCC). The FAC is larger than the FCC for a given chemical. The FAC, derived from acute toxicity data, is for short-term exposures at high concentrations. It corresponds to the

maximum allowable contaminant level to which freshwater aquatic life may be exposed, regardless of the exposure period. The FCC is derived from chronic toxicity data (i.e., relatively long-term exposures at low concentrations). It corresponds to the acceptable exposure concentration that may persist for a period of up to 24 hours.

2.1.5.3 Soil

There are no Federal or State standards for acceptable constituent levels in soils. Such criteria would, by necessity, vary greatly from site to site, based on a number of widely differing, highly site-specific factors affecting contaminant migration potential and the level of risk to human health and the environment. Thus, soil "cleanup criteria" are generally developed on a case-by-case basis. An exception is for PCBs, for which Federal and State cleanup criteria potentially applicable at NTC Great Lakes are discussed in Section 2.2.3.3.1.

In the context of these broad goals and areas of concern, Illinois has established what State contacts describe as a "quasi-formal" procedure for determining cleanup levels at specific sites. The procedure, which is not yet codified in a statute or regulation, involves assessment by a Cleanup Objectives Team (COT).

2.1.6 Comparison of Soil Sample Analysis Results With Natural Concentrations in Soils

In evaluating the significance of constituent concentrations in soils, groundwater, and surface water, it is useful to compare these levels to natural, background concentrations. For groundwater, such background data are available, on a site-specific basis, from results of background, upgradient samples of this medium. The RI Verification Step did not include analysis of background soil samples from NTC Great Lakes, so data specific to the base are not available. However, the U.S. Geological Survey (USGS) has compiled such data for certain metals for the conterminous United States (Shacklette and Boerngen, 1984). For metals analyzed in NTC Great Lakes soil samples, Table F-1, Appendix F, presents USGS data on concentrations of metals in surficial soils of the eastern United States; no smaller regional breakdown including sufficient samples was presented. The organic compounds analyzed in the RI Verification Step are not naturally occurring. The available USGS data are used in Section 2.2--in conjunction with

data from some 105 soil samples to assist in providing an indication of "typical" constituent concentrations in NTC Great Lakes soils--to evaluate the significance of metals detected in soils, especially with regard to whether such detections may represent contamination.

Table F-1 presents the observed range of concentrations for all samples included in the USGS study, and the estimated arithmetic mean and geometric mean concentrations and the geometric deviation for these samples. The geometric mean is considered to be the more proper measure of central tendency because of the tendency of elements in natural materials to have lognormal frequency distributions. The arithmetic mean is estimated from the geometric mean.

In lognormal distributions, the geometric deviation measures the magnitude of scatter around the mean, and this deviation may be used to estimate the range of variation expected for the metals concentrations in Table F-1. Statistically, approximately 95 percent of the samples for each metal should fall between M/D^2 and MXD^2 , where M is the geometric mean and D is the geometric deviation (Shacklette and Boerngen, 1984). Using this approach, very low and very high results (i.e., outliers) can be eliminated to provide a more accurate representation of metals concentration ranges at the 95-percent confidence level. These ranges have been calculated and are shown in the last column of Table F-1. The "estimated ranges" are compared with soil sample analysis results for metals in Section 2.2 to determine if the occurrence of metals appears to represent site contamination.

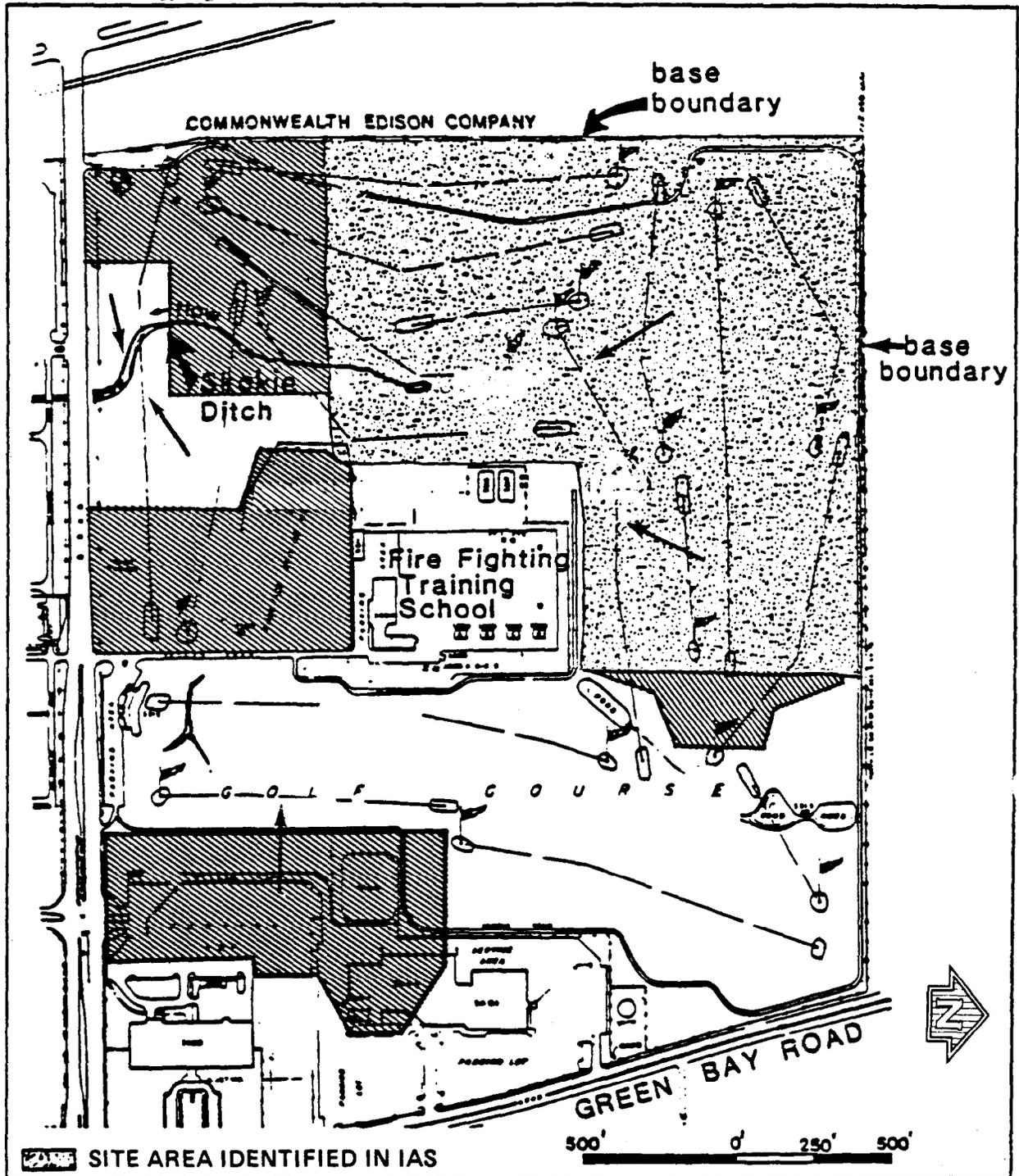
2.2 DISCUSSION OF RESULTS BY SITE

2.2.1 Site 1, Golf Course Landfill

2.2.1.1 Nature and Extent of Problems Leading to Investigation

The Golf Course Landfill (shown in Figure 2-1) is located in the northwestern corner of NTC Great Lakes, underlying more than 50 acres of the present golf course. The northern and western boundaries of the site coincide with current Installation boundaries. The Golf Course Landfill is bounded on the south by Buckley Road and on the east, in part, by Site 4, the FFTA.

According to the IAS, the landfill was operated as a trenching/burning operation between 1942 and 1967. There was a hiatus during the years when the



-  SITE AREA IDENTIFIED IN IAS
-  ADDITIONAL SITE AREA OBSERVED IN AERIAL PHOTOGRAPHS
-  GENERAL DIRECTION OF SURFACE DRAINAGE

FIGURE 2-1
GOLF COURSE LANDFILL (SITE 1)



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land title passed to the VA. Trenches were reported to be approximately 8 feet wide and 6 to 8 feet deep, reaching down to at least the top of the water table. It has been reported that trenches contained several feet of standing water at various times. It has been estimated that up to 1.5 million tons of material were placed in these trenches and ignited or otherwise disposed of at this site. Types of waste reported to have been disposed of at this location include domestic refuse; sewage sludge; POLs; perchloroethylene, carbon tetrachloride, Solvent 144, and other solvents; coal ash; and transformer oils containing PCBs. The quantities of each type of waste disposed of are not known.

It has been reported that wastes--including general refuse as trash--were disposed of directly into the landfill trenches. Free liquid oil, such as waste engine oil, from activity shops was also disposed of in this manner. When a significant volume of material was disposed of into a trench, the pile was ignited and allowed to burn to completion. Proceeding in this manner, the trenches were progressively filled and covered from west-to-east and north-to-south.

The oldest part of the landfill lies in the northwest portion of the site, while the most recent addition was completed in the southeast section. Review of aerial photographs from 1946 to 1985 shows extensive activity in this portion of the Installation, generally consistent with this description of the landfill. Additional areas of possible filling and grading not originally delineated in the IAS have been observed in aerial photographs--primarily along the south side of the FFTA and along the southeastern and southwestern corners of the golf course, but also including an area near the northeast corner of the site area identified in the IAS (see Figure 2-1). In 1967, landfilling was completed and the site was closed and reportedly covered with ash and a thin layer of topsoil. (Reportedly, ash was encountered for the first several feet when holes were dug for trees within the disposal area.) According to Installation personnel, no documented closure plan is on file. The site has been grassed over, and there is no evidence of refuse at the surface.

The IAS points out that, although there appeared to be no demonstrable migration of contaminants from the landfill to Skokie Ditch, which appears to emanate from and run through part of the golf course, such contamination is possible. Potential receptors of contaminants identified in the IAS include fish taken from Skokie Ditch/River downstream of the activity and other industrial land

uses, and any person entering the area. Because of the variety of toxic materials that may have been disposed of and the proximity of human receptors, the Golf Course Landfill was recommended for an RI in the IAS.

2.2.1.2 RI Verification Step Field Program

The field program at the Golf Course Landfill included a hydrogeologic investigation--consisting of boring/monitoring well installation and groundwater sampling at locations upgradient and downgradient of the identified portions of the landfill--and a surface water investigation involving collection of surface water samples from Skokie Ditch. No soil sampling was conducted, because the landfill is covered and vegetated, indicating that there are no exposed contaminated soils or wastes that could cause human health or environmental impacts. Furthermore, it was deemed inappropriate to drill into the landfill and disturb its contents to characterize the composition of waste materials, prior to determining if any waste constituents of concern were emanating from the fill via groundwater or surface water.

2.2.1.2.1 Hydrogeologic Investigation

Monitoring Well Installation. Shallow monitoring wells were installed at Site 1, because preliminary assessment of available data indicated groundwater as a likely contaminant migration pathway; the presence of shallow, water-bearing sands in some locations; and the lack of existing monitoring wells. It was assumed, for planning purposes, that the site was underlain by a single unconfined aquifer system and that the investigation would focus on this shallow zone. Given the extensive low permeability clayey till described in this area, localized areas of perched, semiconfined groundwater were expected. However, the few shallow wells at the installation and in the surrounding area did not provide sufficient information to confirm the existence of confined conditions.

Available information indicated that Site 1 is underlain by approximately 170 feet of glacial till over bedrock. The till is composed largely of clay, with varying amounts of silt, sand, and gravel, as well as with discontinuous water-bearing sand and gravel zones. The irregular, variable nature of the subsurface deposits can be characterized by the following description of conditions encountered by borings installed as part of a feasibility study for a new FFTU (Dames & Moore, 1987c). The borings were installed in the practice driving range just south of the existing FFTU, two at depths of 30 feet (GC-1 and GC-3) and one at 75 feet (GC-2).

The borings encountered 4 to 6 inches of topsoil, overlying a fill layer of medium dense fine-to-medium sand or medium stiff-to-stiff silty clay, mixed with organics and pieces of wood and brick. This fill varies in thickness from 3 to 8 feet. The fill is underlain in two borings by glacial till deposits composed of gray or gray-green silty clay, with varying amounts of sand and gravel, extending to the depth explored--30 feet. In the deep boring--which was located between the other two--the fill is underlain by glacially deposited medium dense brown silty sand to a depth of about 13 feet. Beneath the sand lies stiff-to-very stiff gray silty clay, extending to a depth of about 73 feet, interrupted by a 3-foot sand layer encountered at about 53 feet. At 73 feet, gray medium dense sand was encountered, extending to the explored depth of the boring at 75 feet. Groundwater was encountered at depths ranging from 4.3 to 11 feet. Thus, it appears that a silty clay layer underlies the site and exceeds 30 feet in thickness. However, the upper surface of the silty clay is irregular and is overlain by variable thicknesses of other soil material; these variations can occur over short distances. Further, the variability in the deposits leads to variations in water levels that were unanticipated based on topography and distance.

Based on the thickness of approximately 170 feet of low permeability glacial till underlying the area, the expected limited extent and discontinuity of water-bearing sand and gravel zones within the till, and the limited objectives of this initial investigation, the groundwater monitoring program was designed to examine the zone of immediate impact underlying the site. It was further expected that contaminant migration would likely occur in the shallow zone due to the low hydraulic conductivity of the till. In addition, there are no water wells on the Installation currently being used for water supply that could be impacted by contaminant migration.

Prior to well installation, it was believed that leachate was being generated and possibly migrating with groundwater flow, because wastes and their residues were reportedly placed in contact with groundwater during filling operations. Thus, another function of the new wells was to provide access to the shallow regime for the collection of groundwater samples for chemical analysis for the presence of leachate.

It was also necessary to determine the hydraulic gradient in the vicinity of the landfill because of its influence on the direction of leachate migration.

Groundwater in the Bluff-Ravine Complex commonly flows toward and discharges to surface drainage. However, there are few data to confirm this possibility in the vicinity of the landfill. In addition, activities such as trenching and landfilling, which disturb the in situ permeability of the natural soils, may result in groundwater mounding and alteration of the natural hydraulic gradient. Therefore, the monitoring wells were used to measure the water table elevation in the vicinity of the landfill to better define the hydraulic gradient.

Based on available information, the locations for nine monitoring wells were identified. Planned locations were modified if groundwater was not encountered, and one well was installed to replace a well that had gone dry (i.e., MW1-6A replaced MW1-6). The locations of the 10 wells installed at the site are shown in Figure 2-2. It was assumed that well MW1-1, on the eastern edge of the landfill, was located to provide groundwater samples representative of background ambient water quality not affected by the landfill. However, given the possibility of mounding and radial flow at this site, combined with uncertainty regarding the exact location of fill materials, it was anticipated that changes in well locations might be necessary as drilling proceeded, and no planned location was considered "fixed." Well MW4-1, associated with FFTA, was also used as a background well for Site 1 (see Figure 2-2 and Section 2.2.2.2.1). Wells MW1-1 and MW4-1 were considered to be in upgradient locations because they are outside of the landfill and FFTA areas and were considered to be hydrologically upgradient of this site based on topography and local drainage conditions.

Wells MW1-2, MW1-3, and MW1-4A are located along the landfill/installation boundary at the north side, northwest corner, and west side, respectively. These wells were installed to act as "sentinels" for contamination that may be leaving the Installation across these boundaries. The lack of information indicated that the wells could be located upgradient of the landfill; however, if radial flow exists at this site, it would result in contaminants moving toward these wells and across Installation boundaries.

Wells MW1-5 and MW1-6 and replacement well MW1-6A are located along the southern edge of the fill area, west and east of Skokie Ditch, respectively. These wells, along with MW1-7B--which was to be located on the southern edge of the golf course along the road, but was moved north along Skokie Ditch until groundwater was encountered--were assumed to be downgradient of the landfill and

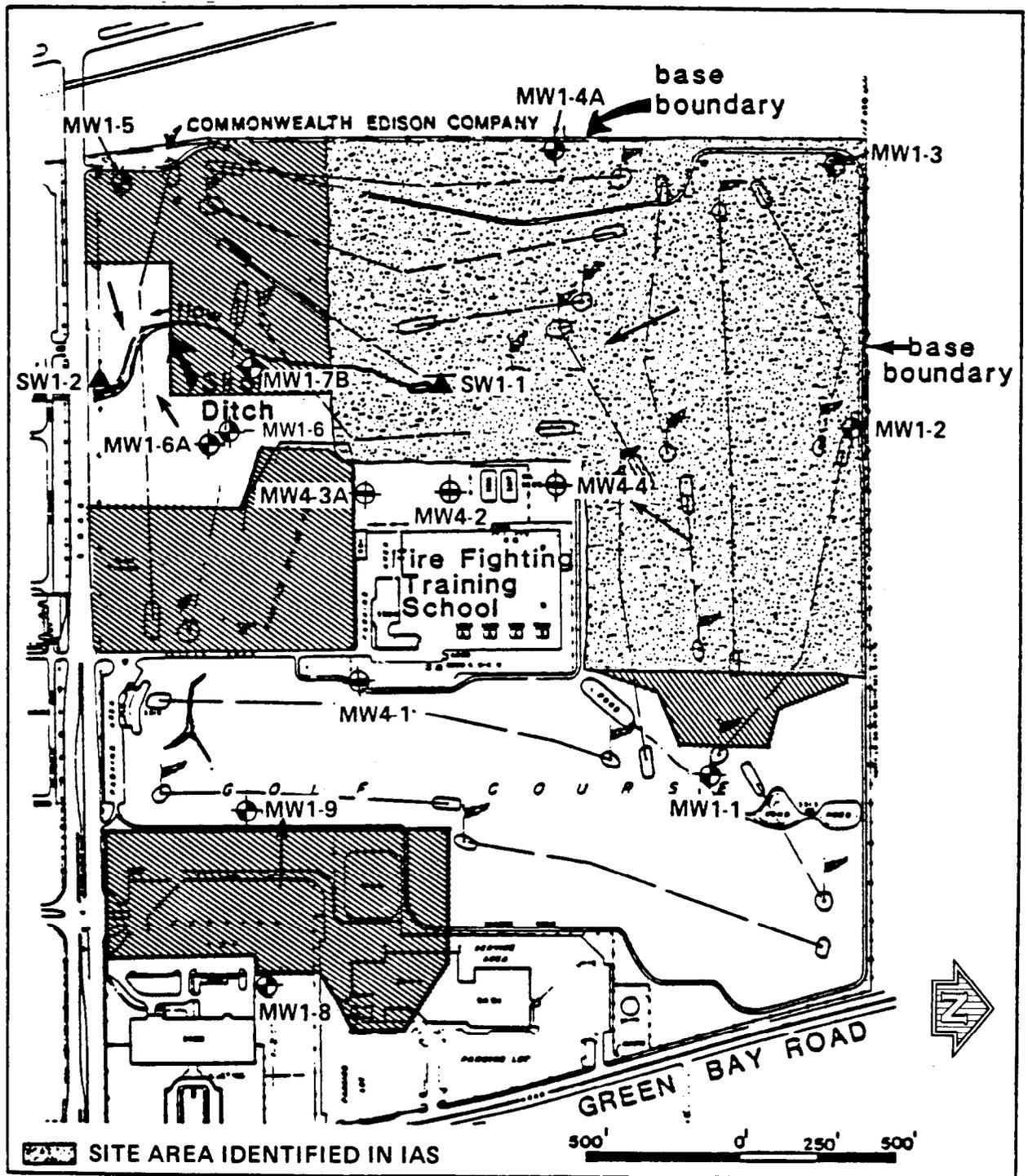


FIGURE 2-2
MONITORING WELL AND
SAMPLING LOCATIONS
GOLF COURSE LANDFILL (SITE 1) 2-17



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in proximity to the oldest portions of the landfill. These locations were included to detect leachate migrating from the landfill and possibly moving toward or discharging to Skokie Ditch. Wells MW1-8 and MW1-9 were planned to monitor a potential area of fill (as identified in aerial photographs) in the southeastern portion of the golf course, with MW1-8 presumably located upgradient of this area based on topography. Part of this area is now a parking lot.

The IAS reported that some of the same compounds used at the FFTA may also have been disposed of directly in the landfill. Groundwater at Site 1 may also be affected by any contaminants migrating from the FFTA, which could make it difficult to distinguish contaminants detected in the landfill monitoring wells from contaminants contributed by the FFTA. If contamination was found, it was hoped that comparative analysis would make it possible to "fingerprint" this source by examining the ratios between various contaminants at the FFTA and seeing if these ratios were reflected in the landfill wells. However, because the compounds and their quantities used/disposed of at these two sites have varied over time, it was unknown if it would be possible to establish distinctive ratios for compounds or to eliminate the FFTA as a source for some compounds found in landfill monitoring wells downgradient of the FFTA. (As will be shown later, the finding of a general lack of contamination in Site 1 wells made this analysis unnecessary.)

All monitoring wells were designed to accommodate both water level measurements and groundwater sample collection. The wells were constructed of 4-inch-diameter Grade 304 stainless-steel casing and 10-foot screens. Insofar as possible, the well screens were placed to straddle the water table, because POLs--a possible major site contaminant--float on the water table. Installation dates, depths, and screened intervals of the borings/wells installed at the site are summarized in Table 2-1. Further details of the well construction are discussed in Appendices A and B.

Groundwater Sampling. Groundwater samples were collected from nine newly installed monitoring wells, as shown in Figure 2-2. Wells MW1-1 and MW1-8 yielded groundwater representative of background ambient water quality not affected by the landfill. Well MW4-1 at the FFTA also served as a background well for the landfill, and was consequently monitored for all parameters of interest at both the landfill and the FFTA. Wells MW1-2 through MW1-7B and MW1-9 provided samples to detect the presence of leachate and contaminants migrating in shallow groundwater.

TABLE 2-1

Summary of Installation Dates, Depths, and
Screened Intervals for Wells Installed During the
RI Verification Step at Site 1, Golf Course Landfill
NTC Great Lakes, Illinois

<u>Boring/Well</u>	<u>Date Drilled/ Well Installed</u>	<u>Total Depth Drilled (a) (feet)</u>	<u>Screened Interval (a) (feet)</u>
MW1-1	11-9-88	17.0	6.4-16.4
MW1-2	11-10-88	17.0	6.0-16.0
MW1-3	11-11-88	39.0	28.6-38.6
MW1-4 (b)	11-15-88	25.0	--
MW1-4A	11-16-88	16.0	6.0-16.0
MW1-5	11-17-88	36.0	25.0-35.0
MW1-6 (c)	11-18-88	29.5	19.0-29.0
MW1-6A	12-7-88	31.0	21.0-31.0
MW1-7 (b)	11-21-88	40.0	--
MW1-7A (b)	11-22-88	40.0	--
MW1-7B	11-29-88	28.5	18.5-28.5
MW1-8	12-8-88	39.0	23.5-33.5
MW1-9	12-6-88	16.5	6.5-16.5

(a) Depth below ground surface.

(b) Groundwater not encountered; boring subsequently abandoned and grouted to the surface.

(c) Well subsequently found to be dry; replaced by MW1-6A.

Analytes for this set of samples included volatile and semivolatile organic compounds, priority pollutant metals, oil and grease, PCBs, chloride, and TOC. All but the last two analytes were selected based on the need to scan for a broad range of unknowns, as well as reported waste composition (including, but not limited to, domestic refuse, sewage sludge, petroleum products, various solvents, coal ash, and PCB-contaminated wastes). The latter two analytes were selected as general indicators of the presence of leachate.

These samples were collected two times during the RI Verification Step program--in early December 1988 and in late March 1989--to obtain two sets of samples for verification purposes and to detect possible seasonal fluctuations of contaminant concentrations.

2.2.1.2.2 Surface Water Investigation

Two surface water sampling locations were designated in this area, as shown in Figure 2-2. Sample SW1-1 is located near the emergence of Skokie Ditch in the center of the golf course, where effluent from the FFTA emerges through the culvert. This sample represents the head, or most upstream end of Skokie Ditch/River, that could be sampled on-post and would reflect any influence from both the landfill and the FFTA. Sample SW1-2 is located downstream at the southern edge of the golf course before Skokie Ditch/River crosses under Buckley Road. This sample would reflect the influence of any landfill-contaminated groundwater that may be discharging to the ditch and represents the quality of water in the ditch prior to its leaving the site.

Sediment in Skokie Ditch was not sampled as part of the Verification Step. The focus of this phase of the RI was to determine if contaminants could be migrating from potential contamination sources; the limited additional information obtained from a few sediment samples from a frequently stagnant ditch, fed partially by industrial discharges, would add little to this understanding. Furthermore, due to the slow moving/stagnant nature of the ditch in the golf course area, sediment transport would not be an important contaminant migration mechanism.

The analytes for this set of samples are the same as those for groundwater samples, as discussed in Section 2.2.1.2.1. These surface water samples were also collected two times during the Verification Step along with the groundwater samples.

2.2.1.3 RI Verification Step Findings

2.2.1.3.1 Hydrogeologic Investigation

Site Description--Soils, Geology, and Groundwater. The Golf Course Landfill is located in a gently undulating topography with poorly drained soils marked by a small valley trending northeast-southwest through the site. Surface ponding and soft, wet soils were noted in many locations during the initial site reconnaissance, particularly along the northern installation boundary. Elevations at the site range from approximately 680 to 715 feet above msl. This area was reported in the IAS to be underlain by approximately 10 to 15 feet of till above a sandy, water-bearing zone, with a water table from 6 to 8 feet below ground surface in this vicinity.

This site was investigated to determine if contamination, in the form of leachate, has resulted from waste disposal activities conducted at the site and has impacted local groundwater and surface water.

The well borings at the Golf Course Landfill were a maximum of 40 feet deep and did not encounter bedrock. Topsoil was thin or nonexistent due to previous site activities; surficial soil was typically less than 6 inches thick, often gravelly, and was placed to support the grass cover of the landfill. Below the surficial soil layer, the borings primarily encountered gray clay till with interbedded, and apparently lenticular, mixtures of silt, sand, and gravel. The clay typically included trace amounts of sand and/or gravel. In some instances--for example, in MW1-4A and MW1-9--sandy layers were inferred due to changes in drilling, but were too thin, only 1 to 2 feet, to allow time to stop drilling and obtain a sample. In these cases, the presence of the sand is noted in the boring description (but not shown in the symbol column) of the boring log (see Appendix B). Furthermore, because sampling was conducted at 5-foot intervals rather than continuously, the placement of lines separating the layers is often based on interpretation rather than direct evidence from a sample; therefore, layer thickness may vary somewhat from that shown in the logs in Appendix B and the cross sections presented in this section.

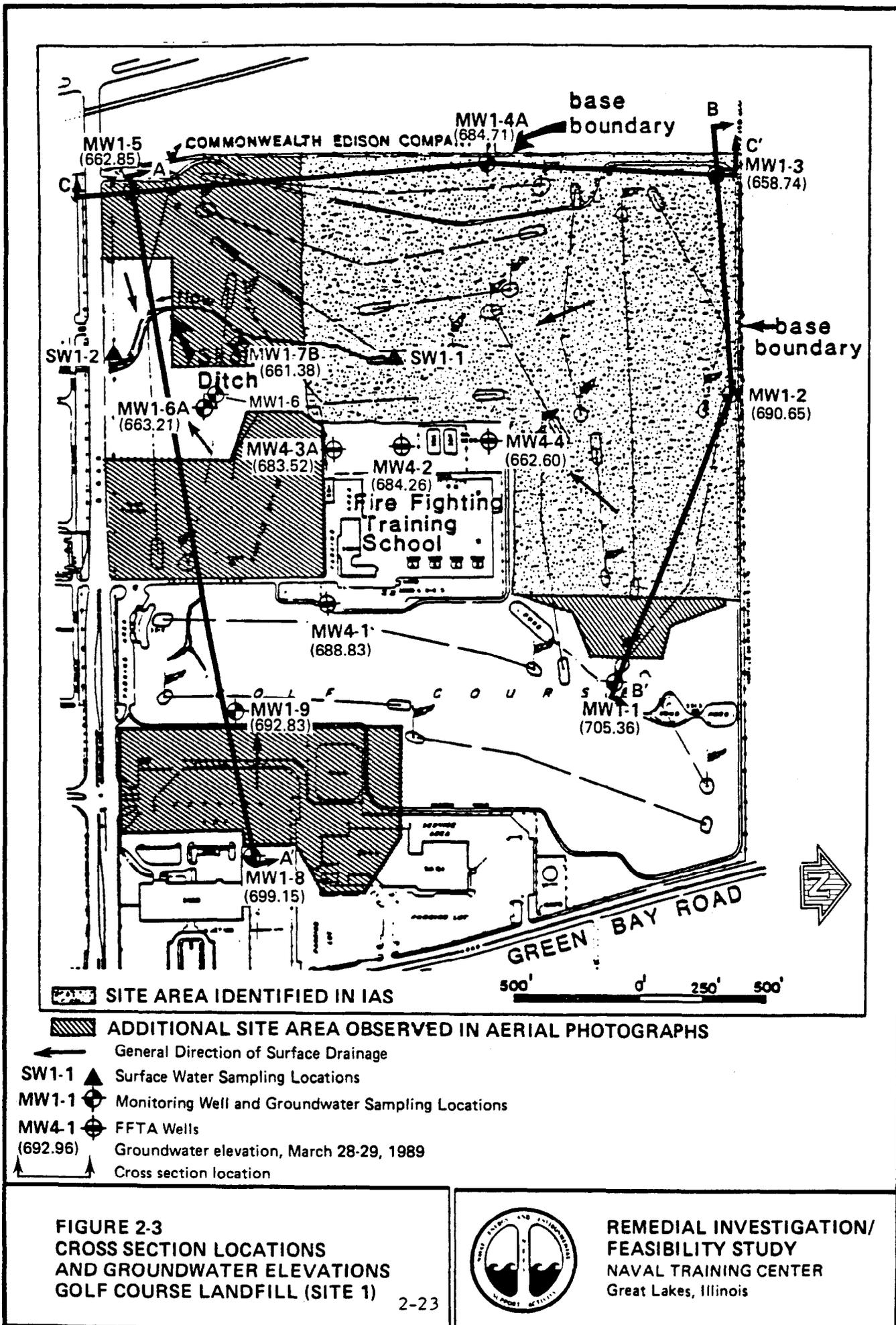
Nine new monitoring wells were sampled near the perimeter of the landfill and adjacent to disturbed areas, as identified in aerial photographs, to determine the presence of potential contamination and the direction of groundwater flow. The wells sampled are identified as MW1-1, MW1-2, MW1-3, MW1-4A, MW1-5, MW1-6A, MW1-7B, MW1-8, and MW1-9, as shown in Figure 2-2. Also shown in this

figure is MW1-6, which was drilled to 29.5 feet with a well installed to 29.0 feet. This well intercepted a thin water-bearing zone at a depth of approximately 18 feet. This zone appears to have been of limited areal extent and water content, because the well went dry within 2 weeks of installation. It is unclear whether the water encountered was absorbed by the underlying clay to which it was exposed by the well, or whether the well merely penetrated another granular layer, at about 30 feet, to which the upper zone could drain. The actual circumstances regarding the cause of this well going dry are not important; however, the indication that water-bearing zones are often lenticular and not interconnected is an important consideration in data interpretation.

The lenticular nature of the till deposits and the resulting irregular water levels are shown in cross sections; the locations of these cross sections are shown in Figure 2-3. The cross sections are illustrated in Figures 2-4 through 2-6. The cross sections present the soil texture classifications encountered in the well borings installed during the field investigation. Additional descriptions of soil textures, abbreviations, and the individual logs are presented in Appendix B. In addition, water levels encountered during the second round of sampling in March 1989 are also shown. There is no indication that shallow groundwater at NTC Great Lakes is connected to lower water-bearing zones, including the bedrock aquifer (which is used for drinking water). Thus, impermeable layers in the glacial till can act as effective barriers to downward migration of contaminants into the bedrock aquifer.

Groundwater elevations shown in Figure 2-3 are based on water level measurements taken during the second round of sampling. Depth to water and water surface elevations for the Site 1 monitoring wells are presented in Table 2-2 for both rounds of sampling. Water levels indicate that the monitoring wells appear to have penetrated two different water-bearing zones--one with a potentiometric surface less than 10 feet deep, the other with a potentiometric surface roughly 15 to 30 feet deep. There is no indication, however, that the two zones are connected, nor is there evidence that wells with similar water levels are in zones that are connected.

The conditions encountered in the glacial till indicate that, though there may be two different zones in which water occurs, deposition and erosion of the sediments have produced a complex three-dimensional picture. For example, MW1-



**FIGURE 2-3
CROSS SECTION LOCATIONS
AND GROUNDWATER ELEVATIONS
GOLF COURSE LANDFILL (SITE 1)**



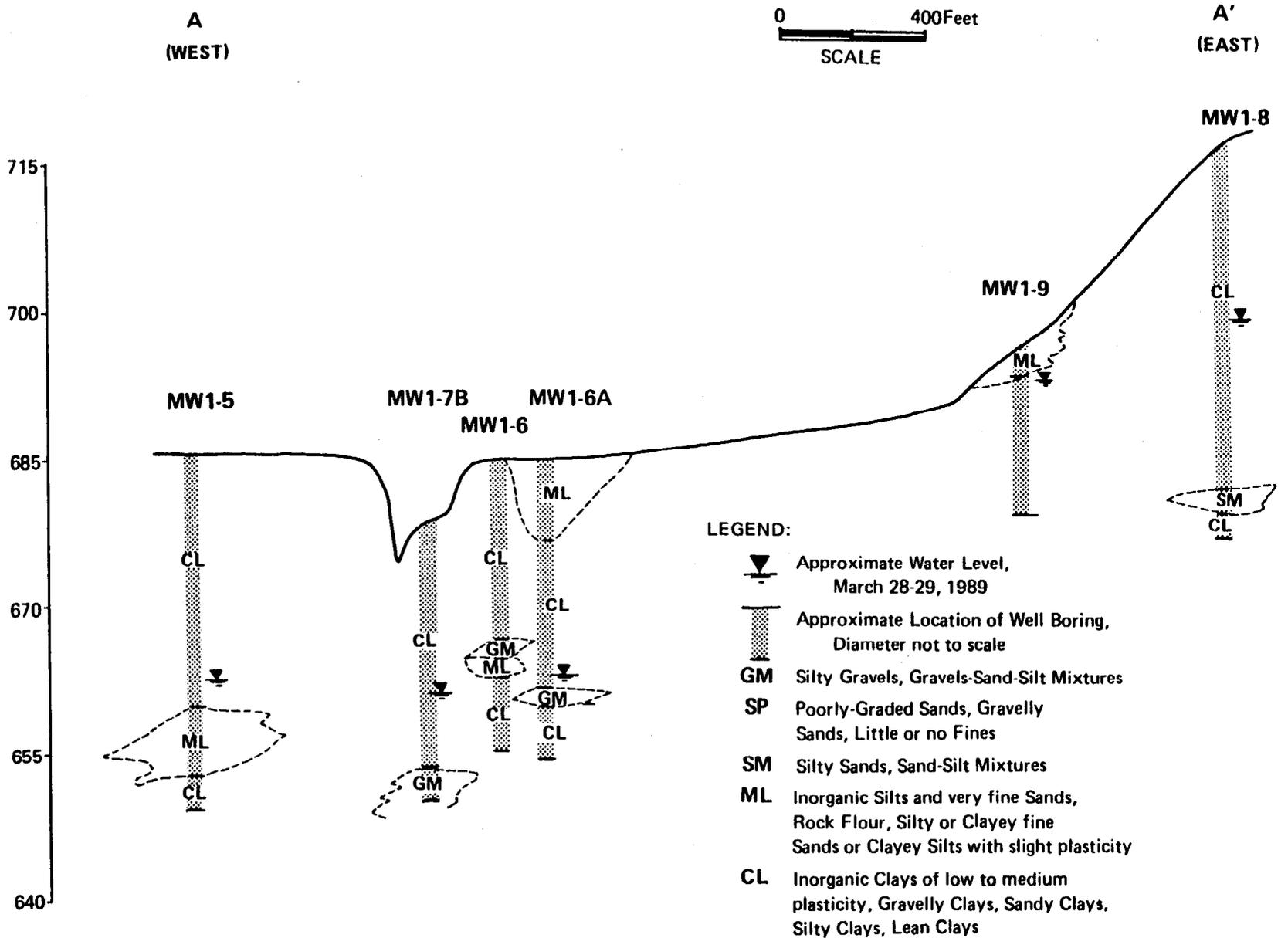
**REMEDIAL INVESTIGATION/
FEASIBILITY STUDY
NAVAL TRAINING CENTER
Great Lakes, Illinois**

FIGURE 2.4
 CROSS SECTION ALONG SOUTHERN PORTION
 OF GOLF COURSE LANDFILL (SITE 1)

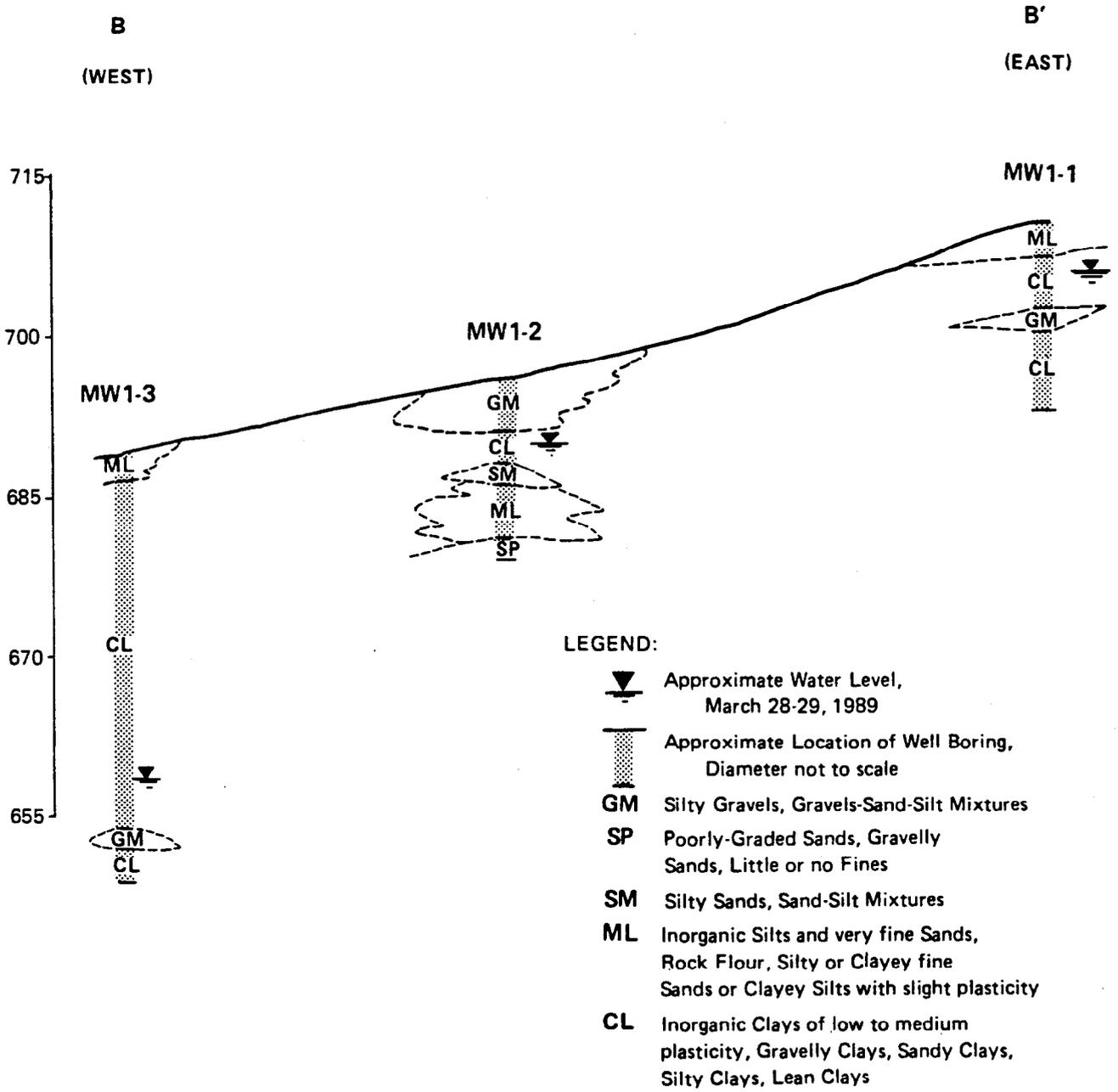
2-24



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NOTE: Soil Classifications shown are based on the Unified Soil Classification System, which is shown in additional detail in Appendix B.



LEGEND:

-  Approximate Water Level, March 28-29, 1989
-  Approximate Location of Well Boring, Diameter not to scale
- GM** Silty Gravels, Gravels-Sand-Silt Mixtures
- SP** Poorly-Graded Sands, Gravelly Sands, Little or no Fines
- SM** Silty Sands, Sand-Silt Mixtures
- ML** Inorganic Silts and very fine Sands, Rock Flour, Silty or Clayey fine Sands or Clayey Silts with slight plasticity
- CL** Inorganic Clays of low to medium plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays

NOTE: Soil Classifications shown are based on the Unified Soil Classification System, which is shown in additional detail in Appendix B.I.

**FIGURE 2-5
CROSS SECTION ALONG NORTHERN PORTION
OF GOLF COURSE LANDFILL(SITE 1)**



FIGURE 2-6
 CROSS SECTION ALONG WESTERN PORTION
 OF GOLF COURSE LANDFILL(SITE 1)

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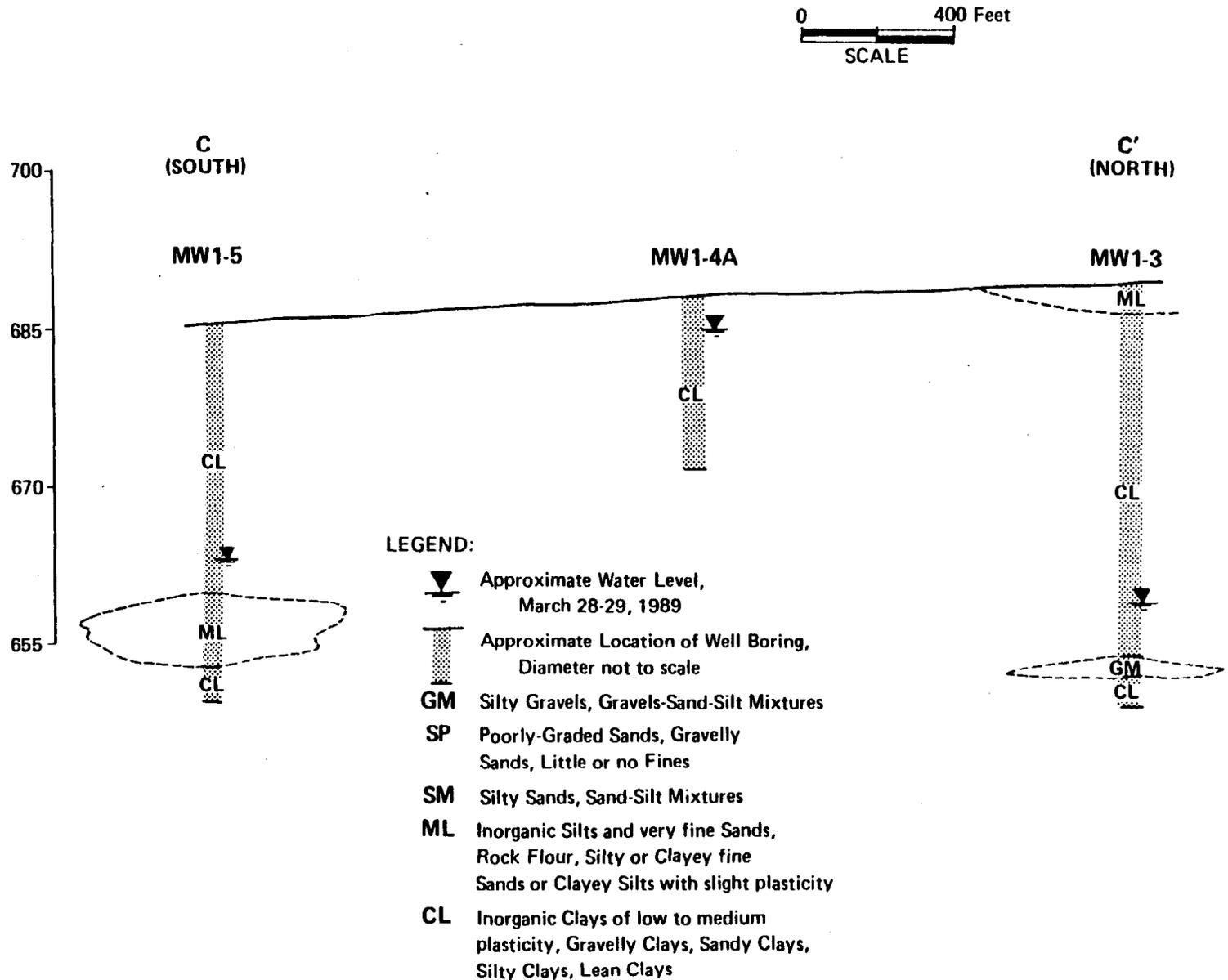


TABLE 2-2

Depth to Water and Water Surface Elevations at
 Site 1, Golf Course Landfill
 NTC Great Lakes, Illinois

Well	Top of Casing Elevation (a,b) (feet)	Round 1			Round 2		
		Date	Depth to Water (c) (feet)	Water Surface Elevation (feet)	Date	Depth to Water (c) (feet)	Water Surface Elevation (feet)
MW1-1	709.55	12-14-88	4.04	705.51	3-28-89	4.19	705.36
MW1-2	695.77	12-14-88	5.52	690.25	3-29-89	5.12	690.65
MW1-3	691.59	12-14-88	32.19	659.40	3-28-89	32.85	658.74
MW1-4A	687.57	12-14-88	4.34	683.23	3-28-89	2.86	684.71
MW1-5	686.77	12-14-88	23.23	663.54	3-29-89	23.92	662.85
MW1-6A	684.70	12-14-88	21.99	662.71	3-28-89	21.49	663.21
MW1-7B	678.75	12-14-88	16.01	662.74	3-29-89	17.37	661.38
MW1-8	716.24	12-14-88	17.89	698.35	3-29-89	17.09	699.15
MW1-9	695.31	12-14-88	2.27	693.04	3-29-89	2.35	692.96

- (a) Top of stainless-steel well casing.
- (b) Elevations are mean tide New York Harbor; subtract 0.69 feet to convert to National Geodetic Vertical Datum of 1929.
- (c) Measured from top of stainless-steel well casing.

4A encountered shallow water-bearing sand layers, but is less than 15 feet away from the boring for MW1-4, which encountered no water to a depth of 25 feet. Both MW1-4 and MW1-4A are located about midway between MW1-3 and MW1-5, as shown in Figure 2-3, but neither of the latter borings encountered shallow groundwater (as did MW1-4A). A simple interpolation between MW1-3 and MW1-5 indicates that water would be expected at a depth of about 25 to 30 feet in the vicinity of MW1-4, but this boring encountered no water to a depth of 25 feet. The data provided by these borings confirm the complex nature of the glacial subsurface at the Golf Course Landfill, which probably exists throughout the Installation.

The complexities encountered in the geologic framework also preclude any determinations of groundwater flow direction. The change in water level in the various wells between the two sampling rounds ranged from 0.08 to 1.5 feet. No consistent pattern of change is noted; that is, water levels rose in some wells, but fell in others. Information on the direction and magnitude of the change of the water levels would have aided in groundwater flow analysis. However, these data also appear to indicate the highly complex nature of groundwater at this site, because neither the direction nor magnitude of change can be correlated with either of the "aquifers" identified. Thus, at this time, it is impossible to determine the direction(s) of groundwater flow at Site 1.

However, it is reasonable to assume that the presence of ash and moderately compacted fill resulting from landfill operations would produce a local radial flow, because of the ability of water to infiltrate the fill more readily than adjacent till. Such "mounding" of groundwater within a landfill is an expected and characteristic phenomenon. Given the proximity of the monitoring wells to the known and/or interpreted limits of the landfill, and the probable mounding of groundwater within the landfill, all monitoring wells--except MW1-1, MW1-8, and MW4-1, which were originally intended as background wells--are assumed to be located downgradient of the landfill in a position to intercept/detect any migrating contamination. Downward migration of contamination is considered unlikely due to the vertical and lateral extent of the clay till.

Contamination Assessment--Groundwater. For reasons discussed in Section 1.1, the analytical data discussed in this section could not be validated under USEPA Level III and, therefore, are not considered usable for their intended

purpose. Thus, the data assessment discussion presented below is highly speculative.

Results of analyses of groundwater samples indicate the possible presence of limited contamination in the groundwater near Site 1. Constituents and concentrations detected in the groundwater samples are presented in Table 2-3. This table also indicates the potential ARAR(s) (if available) for each constituent detected. Groundwater sampling locations are shown in Figure 2-2. A summary of exceedances of drinking water standards/guidelines is presented in Table 2-4.

Background wells MW1-1, MW1-8, and MW4-1 showed essentially no contamination in either sampling round, with the exception of the Round 1 detections of (1) beryllium in wells MW1-1 and MW1-8 at concentrations of 4.0 ug/l and 5.0 ug/l, respectively, and (2) oil and grease in well MW4-1 at 49.7 mg/l, as well as a few unidentified BNAs that may be associated with the oil and grease. Well MW4-1 is also associated with the FFTA; the detection of oil and grease in FFTA wells is discussed in Section 2.2.2.3.1. The beryllium levels detected in wells MW1-1 and MW1-8 exceed the proposed MCL of 1 ug/l. However, the fact that beryllium was detected in all Site 1 wells (except MW4-1) at similar concentrations in Round 1 but was not detected in any of these wells in Round 2 is anomalous. Concentrations of other constituents detected in background wells are considered to be very low and/or attributable to laboratory procedures due to their corresponding presence in MBs. Thus, concentrations of constituents in other Site 1 wells may be compared to the background levels in evaluating groundwater quality downgradient of the different landfill areas.

Chloride was detected in first and second round samples taken from well MW1-9 at concentrations above the IPWSS/Final SMCL value. Noting that well MW1-9 is topographically downgradient of a portion of the landfill that is now a parking lot, the elevated chloride concentrations are presumably due to road salt used for deicing the lot. The hypothesis that road salt is the source of the elevated chloride may be further supported when it is noted that the chloride concentration was somewhat greater in the second round samples collected at the end of the winter season. (The first round samples were collected at the beginning of the winter season.) Since there were changes in water levels between the two sampling rounds, there are no seasonal differences that would play a role in the evaluation of chemical analysis results and groundwater quality as related to chloride and other

TABLE 2-3

Constituents Detected in Groundwater Samples
Site 1, Golf Course Landfill
RI Verification Step at
NTC Great Lakes, Illinois

Analytical Parameter	Units	Concentrations in Groundwater First Round Sampling (December 1988)											Concentrations in Groundwater Second Round Sampling (March 1989)											Potential ARAR		
		DL (a)	MW1-1	MW1-2	MW1-3	MW1-4A	MW1-5	MW1-6A	MW1-7B	MW1-8	MW1-9	MW4-1	DL	MW1-1	MW1-2	MW1-3	MW1-4A	MW1-5	MW1-6A	MW1-7B	MW1-8	MW1-9	MW1-9X(b)		MW4-1	
Chloride	mg/l	0.25	55.6	46.9	2.20	21.0	4.90	1.40	2.50	6.60	396 (c)	5.10	0.25	66.6	44.4	1.3	20.4	2.7	0.9	1.8	10.10	742 (c)	768 (c)	4.5	IPWSS/Final SMCL (d)	
Total Organic Carbon	mg/l	0.1	5	3	2	3	5	3	1	2	5	8	0.1	3.14	1.0	2.95	2.57	2.62	2.29	1.83	2.52	5.8	3.91	0.87	NA (e)	
Oil and Grease	mg/l	5	BDL (f)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	49.7 (c)	0.02	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	IPWSS (g)	
Semivolatile Organics (Tentatively Identified Compounds)																										
Unknowns (total)	ug/l	--	45	ND (h)	14	ND	9	12	13	11	67	174	--	8	10	9	13	13	18	20	9	148	120	ND	NA	
2-Ethoxyethylacetate	ug/l	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	ND	ND	11	ND	13	ND	ND	ND	ND	ND	ND	NA	
1-Methyl-2-propyl-cyclohexane	ug/l	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	ND	ND	9	ND	12	10	9	ND	ND	ND	ND	NA	
Volatile Organics (Priority Pollutants)																										
Chlorobenzene	ug/l	5	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2 (k)	BDL	Final MCL/MCLG (i)	
Acetone	ug/l	10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	17	BDL	10	BDL	BDL	12	BDL	BDL	BDL	BDL	BDL	BDL	26	BDL	NA	
Methylene chloride	ug/l	5	13	BDL	18	18	10	9	8	8	17	BDL	5	3	3	4	9	9	9	9	5	5	BDL	BDL	Proposed MCL	
Semivolatile Organics (Priority Pollutants)																										
Bis (2-ethylhexyl) phthalate	ug/l	10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	10	BDL	11 (c)	5 (c)	5 (c)	14 (c)	2.0	3.0	12.0 (c)	BDL	BDL	BDL	Proposed MCL	
Di-n-octyl phthalate	ug/l	10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	Proposed MCL	
Metals																										
Cadmium	ug/l	5	BDL	5.5 (c)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	IPWSS/Final MCL/MCLG	
Chromium (total)	ug/l	10	BDL	BDL	BDL	BDL	11	BDL	BDL	BDL	BDL	BDL	8	25.6	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	IPWSS/Final MCL	
Mercury	ug/l	0.2	0.27	0.26	0.27	0.25	0.51 (c)	0.26	0.26	0.26	0.31	0.38	0.2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	IPWSS/Final MCL	
Zinc	ug/l	3	23.4	23.4	28.9	18	16.3	20.1	31.4	19	17.2	BDL	4	19.8	17.1	7.3	29.1	9.6	8.2	BDL	6.6	66.4	BDL	BDL	IPWSS/IGWQS (j)	
Arsenic	ug/l	5	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	IPWSS/IGWQS	
Nickel	ug/l	21	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	26	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	IPWSS/Final MCL	
Silver	ug/l	3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	7	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	53.3	27.2	BDL	56.3	BDL
Copper	ug/l	3	BDL	BDL	14.0	7.5	7.5	BDL	7.5	7.5	7.5	7.5	8	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4.2 (c)	BDL	BDL	BDL	BDL	IPWSS/IGWQS
Selenium	ug/l	5	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	IPWSS/IGWQS
Beryllium	ug/l	2	4.0 (c)	4.0 (c)	4.0 (c)	4.0 (c)	4.0 (c)	4.0 (c)	2	BDL	2.06	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	IPWSS/Final MCL				
Lead	ug/l	2	BDL	BDL	BDL	BDL	BDL	BDL	3.0	BDL	2.5	BDL	3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	Proposed MCL

- (a) Detection limit.
- (b) Field duplicate.
- (c) Exceeds drinking water standard/guideline.
- (d) Illinois Public and Food Processing Water Supply Standards (IPWSS)/Final Secondary Maximum Contaminant Level (SMCL).
- (e) None available.
- (f) Below detection limit.
- (g) IPWSS.
- (h) None detected.
- (i) Final Maximum Contaminant Level (MCL)/Final Maximum Contaminant Level Goal (MCLG).
- (j) IPWSS/Illinois General Use Water Quality Standard (IGWQS).
- (k) Concentration estimated by laboratory.

NOTE: For reasons discussed in Section 1.1, these data could not be validated under USEPA Level III and, therefore, are not usable for their intended purpose.

TABLE 2-4

Summary of Exceedances of Drinking Water and
Surface Water Quality Standards/Guidelines (a)
Site 1, Golf Course Landfill
RI Verification Step at NTC Great Lakes, Illinois

<u>Sample Matrix</u>	<u>Sample No.</u>	<u>Sample Round</u>	<u>Constituent</u>	<u>Units</u>	<u>Concentration</u>	<u>Standard/ Guideline (b)</u>	<u>Type of Standard/Guideline (c)</u>
Groundwater	MW1-1	1	Beryllium	ug/l	4.0	1	Proposed MCL
	MW1-2	1	Cadmium	ug/l	5.5	5	IPWSS/Final MCL/MCLG
			Beryllium	ug/l	4.0	1	Proposed MCL
	MW1-3	1	Beryllium	ug/l	4.0	1	Proposed MCL
	MW1-4A	1	Beryllium	ug/l	4.0	1	Proposed MCL
	MW1-5	1	Mercury	ug/l	0.51	0.5	IPWSS/IGWQC
			Beryllium	ug/l	4.0	1	Proposed MCL
	MW1-6A	1	Beryllium	ug/l	4.0	1	Proposed MCL
	MW1-7B	2	Silver	ug/l	48.3	5	IPWSS/IGWQS
	MW1-8	1	Beryllium	ug/l	5.0	1	Proposed MCL
	MW1-9	2	Chloride	mg/l	596	250	IPWSS/Final SMCL
			Chloride	mg/l	742	250	IPWSS/Final SMCL
	MW1-9X (d)	2	Copper	ug/l	65.4	20	IPWSS/IGWQS
MW4-1	1	Oil and grease	mg/l	49.7	0.1	IPWSS	
Surface Water	SW1-1	1	Copper	ug/l	55.6	20	IGWQS
			Mercury	ug/l	0.52	0.5	IGWQS
		2	Chloride	mg/l	530	500	IGWQS
			Silver	ug/l	43.6	5	IGWQS
	SW1-2	2	Chloride	mg/l	646	500	IGWQS

- (a) This table does not list exceedances for methylene chloride and bis(2-ethylhexyl) phthalate, which in Site 1 samples are considered, in all cases, as laboratory artifacts, because concentrations found in samples were of the same order of magnitude as concentrations detected in laboratory MBs.
- (b) See Tables E-1 and E-2, Appendix E, for listing of standards/guidelines for drinking water and surface water quality, respectively.
- (c) Illinois General Use Water Quality Standard (IGWQS).
Illinois Public and Food Processing Water Supply Standard (IPWSS).
Secondary Maximum Contaminant Level (SMCL).
- (d) Replicate sample.

NOTE: For reasons discussed in Section 1.1, the concentration data in this table could not be validated under USEPA Level

detected constituents. The chloride contamination is not expected to be migrating from the landfill, because it was detected at low concentrations indicative of background in the other monitoring wells.

TOC was detected at relatively low concentrations in all wells during the first and second round sampling. This appears to be indicative of natural conditions in the area.

Chloride and TOC were meant to and do serve as indicator parameters at landfills to evaluate possible contamination by leachate. The results for these parameters at Site 1 serve to provide a preliminary indication that contaminants in the form of leachate may not be presently emanating from the landfill.

Oil and grease were detected in Round 1 only and in a single sample--that from MW4-1, the background well that is also associated with the FFTA. This oil and grease detection is not believed to be associated with the landfill--considering that no oil and grease were found in other Site 1 wells. The detection is most likely associated with the FFTA, as discussed in Section 2.2.2.3.1.

No priority pollutant BNAs were detected in Round 1 samples. Those detected during the second round are of no concern, because bis(2-ethylhexyl) phalate was also detected at similar concentrations in the MBs (even though its concentration in several wells sampled during the second round exceeded the proposed MCL of 4 ug/l) and di-n-octyl phalate was reported in only one well at a concentration below the laboratory DL. In addition, both of these compounds are plasticizers and common laboratory artifacts. Similarly, the BNAs identified in the library search were either detected at very low levels or were present in the MB analyses.

Methylene chloride was detected in all wells except MW1-2 during the first round and in all wells sampled during the second round. However, these methylene chloride detections do not appear to be indicative of contamination at the site, because the concentrations are similar to those in the MB analyses. Similarly, acetone was detected in a few of the wells sampled, but at concentrations also within the range established in the MB analyses. Methylene chloride and acetone are thus believed to represent laboratory artifacts rather than "real" contaminants. Finally, chlorobenzene was detected only in the second round field duplicate for well MW1-9 at a very low, estimated (i.e., below DL) concentration, well below the

proposed MCL/SMCL/MCLG value. Chlorobenzene was also detected in the second round TB at a similar concentration, indicating that this compound may have been introduced during sample transit or handling, rather than being representative of site contamination. No VOC TICs were detected.

Chromium (total), zinc, arsenic, selenium, lead, and nickel were detected in some of the wells during first and/or second round sampling events. All of these metals were detected at concentrations well below the potential ARAR concentration values noted.

Beryllium was detected in all first round samples at concentrations of 4 or 5 ug/l. As noted above, beryllium was detected in background wells MW1-1 and MW1-8. All of these detections exceed the proposed MCL for beryllium of 1 ug/l. The presence of beryllium in the background wells indicates that the concentrations detected in the first round samples are most likely not from the landfill and could be naturally occurring or perhaps anomalous. Analysis results for groundwater samples collected in the second round did not find any beryllium above laboratory DLs. It should be noted that the beryllium DL for the first round groundwater samples was 2 ug/l, while the DL for the second round was 5 ug/l. Mercury was also detected in all wells sampled during the first round, but was not detected in any wells during the second round sampling. The mercury concentrations detected in the first round were all below the IP WSS/IGWQS standards, with the exception of the concentration in well MW1-5 (0.51 ug/l), which was slightly above these standards (0.5 ug/l). Although a potential source of mercury could exist in the landfill, the overall pattern of detections indicates that there may be no such source based on the generally minor--often undetectable--concentrations of mercury observed. Cadmium was detected in well MW1-2 in the first round at a concentration of 5.5 ug/l, slightly above the potential ARAR of 5 ug/l. Cadmium was not detected in any other Site 1 wells. Furthermore, cadmium was not detected in well MW1-2 in the second round. Based on these data, it appears that any cadmium contamination in the Site 1 groundwater is very limited, and the one detection may be indicative of a laboratory aberration.

Silver was found to be below the laboratory DL and copper was found to be below the potential ARAR in all first round samples. However, each of these metals was detected above the potential ARAR in one of the downgradient wells sampled during the second round. These detections were found in wells MW1-7B and MW1-9, respectively.

The elevated concentrations found in the second round samples could indicate the presence of leachate derived from the landfill; however, the pattern of elevated detections and exceedances of the metals silver and copper, as well as elevated detections of nickel, bears some additional discussion. The single exceedance noted for silver and an elevated nickel concentration were detected in well MW1-7B. This may be the result of this well's location--extremely close to, and possibly within, a fill area noted in aerial photographs in the southwestern portion of the site. With regard to nickel, though the Illinois standards were not exceeded, nickel was found at concentrations significantly elevated above background in three wells, and one result was duplicated in the replicate samples, MW1-9/MW1-9X. This--along with the other observations in MW1-7B--could be an early indication of groundwater contamination. The exceedance for copper in MW1-9X is a questionable result, because no copper was detected in the replicate MW1-9. Thus, this copper exceedance may not even exist; even if it did, it is of lesser significance because standards for copper are based on aesthetics rather than toxicity. Also, these results appear anomalous when compared to first round findings, and the individual exceedances for silver and copper are not statistically significant.

Overall, the inconsistent presence of the metals in Rounds 1 and 2 is difficult to explain, but may be an early indication of contamination. The observation is not likely to be due to seasonal variations, because such variations (e.g., in water levels) do not appear to exist between December 1988 and March 1989, unless additional rain or melting snow between these dates resulted in the flushing of some metal contaminants from the landfill, and the higher results for beryllium and mercury in Round 1 are the opposite of those for other metals.

Finally, all groundwater samples collected from Site 1 wells were analyzed for PCBs. No PCBs were detected in any of the samples.

2.2.1.3.2 Surface Water Investigation

Site Description--Surface Water. The IAS described Skokie Ditch as an upgraded ditch with intermittent flow. Two surface water samples were collected from this ditch during the investigation, as shown in Figure 2-2. Sample SW1-1 was collected near the emergence of Skokie Ditch in the middle of the golf course. Sample SW1-2 was collected downstream, on the upstream side of Buckley Road.

According to information provided by the USGS (1967), Skokie River flowed in an underground conduit across a portion of the landfill in the mid-1960's. The conduit identified by USGS extended upstream from approximately the present outfall about halfway to the northern Installation boundary. The present golf course extends beyond the limits of the conduit identified by USGS, indicating that the conduit has been extended, probably to the northwest. Surface drainage at the golf course is collected in the open channel of Skokie Ditch, while the conduit carries flow from areas upstream of the Installation and, apparently, discharge from the FFTA decant (oil/water separator) ponds under National Pollutant Discharge Elimination System (NPDES) permit. The upstream end of the conduit was not noted during site reconnaissance or subsequent field activities but appears to be located off-post, upstream of the Installation boundary. Therefore, it was not sampled during this investigation, which was restricted to on-post sampling. Thus, the sample collected at SW1-1 may reflect activity upstream of NTC Great Lakes, as well as possible infiltration of landfill leachate (if any) into the conduit and FFTA discharges. Sample SW1-2 indicates changes in water quality as a result of any potential groundwater discharge to the stream between the conduit outfall and Buckley Road or surface runoff from the golf course and nearby areas. Thus, no true background sample was collected upstream of NTC Great Lakes, but the two samples collected provide an indication of the landfill's contribution of potential contaminants to surface water.

Surface water elevations in Skokie Ditch were obtained during the second round of sampling because surveyed reference points had not been established during the first round. The surface water elevations at the sampling points in Skokie Ditch during the second round were 676.31 feet at SW1-1 and 674.48 feet at SW1-2. These elevations are less than those in the shallowest zone of groundwater and indicate that groundwater in the shallowest zone could discharge to surface water. However, no such discharges were observed during field operations, and because of the disconnected nature of shallow groundwater-bearing zones and their possible lack of connection with Skokie Ditch, the relationship or possible inter-connection of groundwater to surface water at Site 1 cannot be determined at this time.

Off-post, Skokie Ditch becomes the Skokie River, which flows into the North Chicago River--the north branch of which enters Lake Michigan, and the south

branch of which enters a system of ship canals that eventually drains to the Mississippi River.

Contamination Assessment--Surface Water. For reasons discussed in Section 1.1, the analytical data discussed in this section could not be validated under USEPA Level III and, therefore, are not considered usable for their intended purpose. Thus, the data assessment discussion presented below is highly speculative.

Analyses of surface water samples collected from Skokie Ditch at Site 1 indicate that contaminants in the surface water are limited to chloride, oil and grease, and some heavy metals. Constituents and concentrations detected in these samples are presented in Table 2-5. This table also indicates the potential ARAR(s) (if available) for each of the constituents detected. The surface water sample locations are shown in Figure 2-2. A summary of exceedances of surface water quality standards/guidelines is presented in Table 2-4.

High chloride concentrations were detected in all surface water samples taken from the Site 1 locations in Skokie Ditch. The concentrations in second round samples exceeded the IGWQS value for chloride. As noted in the groundwater section above, a suspected source of the chloride contamination is road salt used at NTC Great Lakes and on roads throughout the region. Skokie Ditch apparently carries flow from areas upstream of the Installation and is subject to contamination by runoff from those areas. This includes U.S. Highway 41--Skokie Highway--which is a major multilane road. As with the groundwater sample analysis results for well MW1-9, chloride concentrations in surface water were higher just following the winter season than before.

TOC was detected in all surface water samples collected during the first and second rounds. All of the concentration levels, however, are very low--similar to levels in groundwater--and may reflect natural conditions.

Oil and grease were detected at both sample locations during first round sampling, but concentrations were below the DL during the second round. The oil and grease may be derived from activities at the FFTA; the lack of detection during the second round may be due to a period of reduced activity. (In fact, as will be shown in Section 2.2.2.3.2, the FFTA lagoons that discharge to the ditch contained much less petroleum product contamination in the second round than in

TABLE 2-5

Constituents Detected in Surface Water Samples
Site 1, Golf Course Landfill
RI Verification Step at
NTC Great Lakes, Illinois

Analytical Parameter	Units	Concentration in Surface Water First Round Sampling (December 1988)				Concentration in Surface Water Second Round Sampling (March 1989)			Potential ARAR	Value
		DL (a)	SW1-1	SW1-1X(b)	SW1-2	DL	SW1-1	SW1-2		
Chloride	mg/l	0.25	247	250	256	0.25	530 (c)	646 (c)	IGWQS (d)	500
Total Organic Carbon	mg/l	0.1	7	8	8	0.1	8.08	8.93	NA (e)	--
Oil and Grease	mg/l	5	7	12.8	15.6	0.002	BDL (f)	BDL	NA	--
Semivolatile Organics (Tentatively Identified Compounds)										
Unknowns (total)	ug/l	--	27	13	14	--	137	89	NA	--
Volatile Organics (Priority Pollutants)										
Acetone	ug/l	10	16	BDL	BDL	10	BDL	BDL	NA	--
Methylene chloride	ug/l	5	9	BDL	BDL	5	5	5	NA	--
Semivolatile Organics (Priority Pollutants)										
Bis (2-ethylhexyl) phthalate	ug/l	10	BDL	BDL	BDL	10	BDL	2	NA	--
Metals										
Copper	ug/l	25	55.6 (c)	BDL	BDL	9	BDL	BDL	IGWQS	20
Lead	ug/l	5	9.06	5.23	4.79	3	BDL	BDL	IGWQS	100
Mercury	ug/l	0.2	0.52 (c)	0.50	BDL	0.2	BDL	BDL	IGWQS	0.5
Zinc	ug/l	20	41.0	43.9	34.7	4	22.4	31.7	IGWQS	1,000
Silver	ug/l	10	BDL	BDL	BDL	7	43.6 (c)	BDL	IGWQS	5
Arsenic	ug/l	10	BDL	BDL	BDL	3	BDL	7.39	IGWQS	1,000
Selenium	ug/l	5	BDL	BDL	BDL	2	BDL	2.41	IGWQS	1,000

- (a) Detection limit.
 (b) Field duplicate.
 (c) Exceeds surface water criterion.
 (d) Illinois General Use Water Quality Standard.
 (e) None available.
 (f) Below detection limit.

NOTE: For reasons discussed in Section 1.1, these data could not be validated under USEPA Level III and, therefore, are not

the first.) The overflow of the two oil/water separator ponds at the FFTA empties into Skokie Ditch under NPDES permit; some oil could be in this discharge. The oil and grease--like the chloride--could also come from roadways upgradient of Site 1.

The nondetection of oil and grease in second round samples in which these constituents were detected in the first round is further discussed in Section 2.2.2.3 on the FFTA results. The fact that different analytical methods were used in the two rounds--USEPA Method 413.1 in Round 1 and 413.2 in Round 2--would not explain the different detections. Both methods would detect the heavy oil and grease fractions, while Method 413.2 would additionally detect the lighter oil fractions. This supports the contention that oil and grease were below detection levels in Skokie Ditch at the time of Round 2 sampling.

Priority pollutant VOCs and BNAs and BNA TICs detected in the surface water samples do not appear to reflect contamination based on the concentrations detected and comparison with MB results. No VOCs were detected in the library search.

Lead, zinc, arsenic, and selenium were detected in the first and/or second round surface water samples. The concentrations of all these metals were below their respective IGWQS values; therefore, their presence does not pose a serious concern at the site. The source of lead is probably the FFTA lagoons (see Section 2.2.2.3.2). Copper, silver, and mercury were detected above their respective IGWQS values for samples collected during the first or second round. None of these metals were detected in both the first and second round samples. The occurrence of copper, silver, and mercury may be related to the possible presence of these metals in groundwater at concentrations exceeding drinking water standards/guidelines. However, nickel, which was more prevalent in groundwater, was not found in surface water.

Although the IGWQS has been exceeded by concentrations of the above-identified metals, this is of little or no concern in Skokie Ditch, which generally serves here as a stormwater runoff and industrial drainage collection ditch--both on- and off-post--and is neither used for water supply nor is it an important aquatic habitat. Furthermore, the occasional reduction or lack of flow in the ditch could result in some accumulation of metals in surface water, as they suspend or dissolve in the water from underlying sediments. Considerable dilution would be

expected by the time ditch effluent reaches Skokie River and Lake Michigan and the Mississippi River.

Finally, all surface water samples collected from Site 1 were analyzed for PCBs. No PCBs were detected in any of the samples.

2.2.1.4 Site 1 Summary

Past disposal activities at the Golf Course Landfill may be the source of the very limited contamination that may be present in sampled media in the vicinity of Site 1.

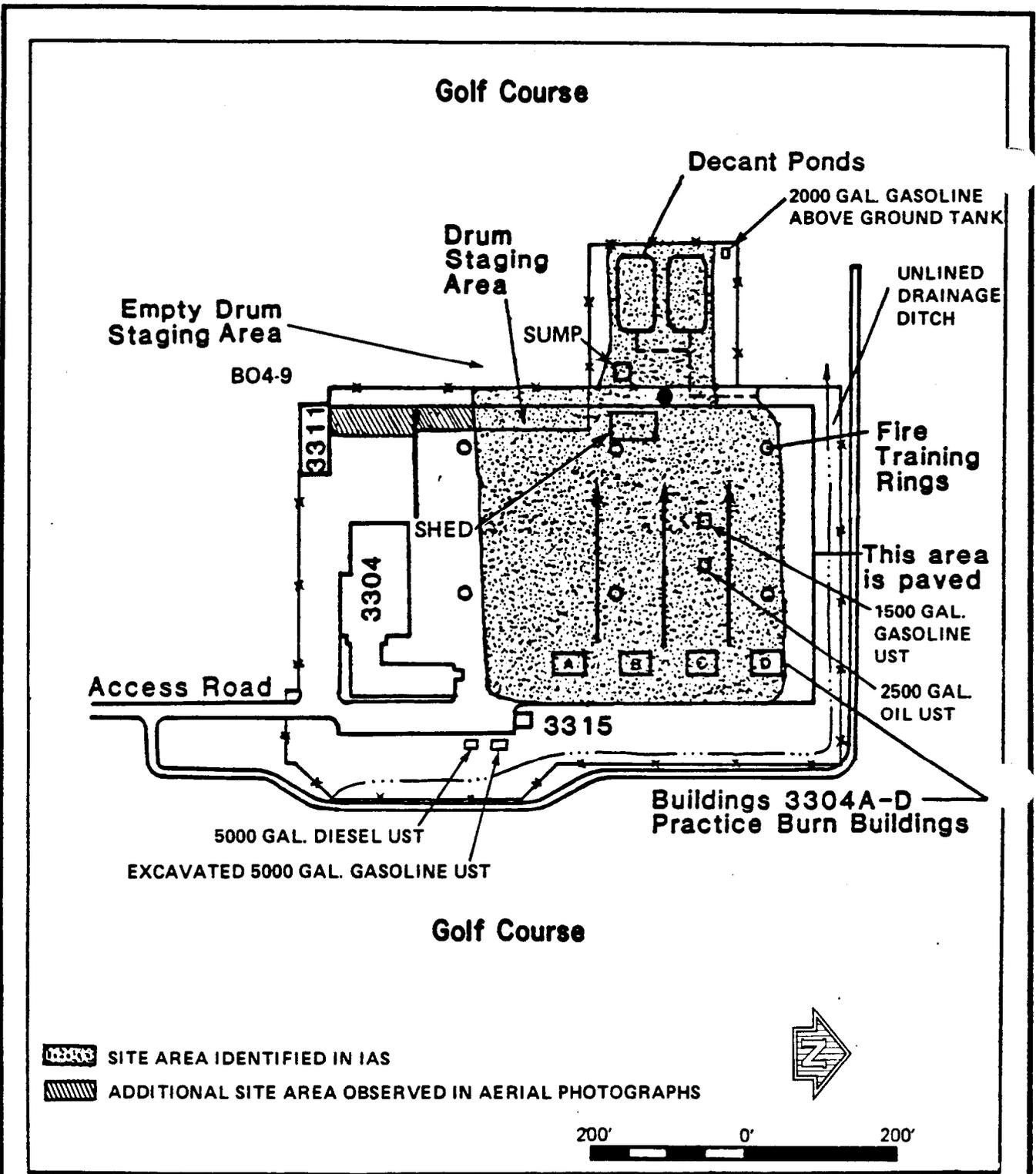
The significant contaminants detected in groundwater are cadmium, mercury, nickel, silver, and copper. Nickel was found at concentrations elevated above background in several samples but below Illinois drinking water standards. The single exceedances noted for cadmium, silver, copper, and mercury--though of potential concern--may not be statistically significant. Also detected was chloride in a single well during both sample rounds. This occurrence appears attributable to the location of this well immediately downslope of a portion of the landfill that has been developed as a parking lot.

Contaminants detected in surface waters of Skokie Ditch include oil and grease in Round 1, chloride in both rounds, and the metals copper, lead, mercury, and silver. The presence of oil and grease and lead may be linked to the FFTA, which discharges to the ditch from its oil/water separator ponds under NPDES permit. Oil and grease, as well as chloride, may also be attributable to upgradient activities, including runoff from roads that traverse the ditch in off-post areas. Of the metals listed above and for chloride, concentrations in some samples exceeded applicable surface water criteria in one or both sampling rounds. This is of little concern given the lack of aquatic life in the intermittently flowing Skokie Ditch--which is used primarily for storm drainage and receives possible discharges and runoff from industrial and agricultural activities both on- and off-post.

2.2.2 Site 4, Fire Fighting Training Area

2.2.2.1 Nature and Extent of Problems Leading to Investigation

The FFTA (Figure 2-7) is located to the southeast of the Golf Course Landfill and is surrounded on all sides by the golf course (Figure 2-1). Note that the FFTA is the name of the IR Program site and that this site encompasses the Fire Fighting



**FIGURE 2-7
FIRE FIGHTING TRAINING AREA
(SITE 4)**

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Training Unit (FFTU). It consists of a 10-acre, partially paved area, occupied by four small practice burn buildings, several open steel tanks, some underground storage tanks (USTs), and a former drum staging area and adjacent shed. The north and part of the west side of the area are bounded by an unlined ditch that is used to contain an emergency water supply for fire fighting (in case of loss of water pressure) and which can also receive site runoff, while two oil/water separator lagoons (decant ponds) occupy a portion of the west side of this area.

The FFTA site has been actively used since 1942. Review of aerial photography from 1946 to 1985 indicates that no major changes have occurred at this site--and that the description provided in the IAS is accurate, with one exception at the drum storage area, as discussed below.

The FFTA is used to stage fires in open steel tanks and smoke practice buildings for training exercises. Practice fires are set in open steel tanks with #2 fuel oil floating on water. Gasoline is used to ignite the fires. Fires are extinguished using Aqueous Film Forming Foam and dry extinguisher chemicals. In the past, other flammable materials, including other petroleum products and solvents, have been used for igniting practice fires. During the initial site reconnaissance, the concrete pavement in the vicinity of the buildings and tanks was observed to be broken in many places, with vegetation growing through. The runoff ditch contained standing water covered with an oily sheen, while the lagoons also contained standing water with a floating oily waste layer. The sides of the lagoons and surrounding area were black with heavy oily stains. Reportedly, the oil layer on the lagoon is periodically removed. Lagoon overflow goes over a dam into a manhole and discharges into Skokie Ditch on the golf course. This discharge is permitted under NPDES. The outfall is monitored, and the effluent is reportedly in compliance with permit requirements.

In about 1979, a centrifugal oil/water separator was installed in the waste line between the training areas and the lagoons (located west of the training area) to which the wastes generated by the training exercises are directed. Oil removed from the separator and residual oil skimmed manually from the lagoons were drummed, and the 55-gallon drums were stored along the western fence line of the training area.

In addition, reportedly between 1942 and 1979, the southwestern portion of the site was used for storage of drums containing waste POLs and solvents, as well

as oils and materials recovered from the training exercises. Specific chemicals that may have been stored in the drums include Solvent 144, turpentine, gasoline, #2 diesel fuel, crank case motor oil, and antifreeze. Up to 300 55-gallon drums of such materials were accumulated in this area by 1983. All materials have since been removed, and only a few empty drums awaiting disposal remained onsite at the time of the site reconnaissance in December 1987. Only miscellaneous debris and metallic objects were noted during the RI Verification Step field investigation in November-December 1988. The ground in this area is black with heavy, oily stains. The area is not diked, and runoff could reach Skokie Ditch during heavy rains. Review of aerial photography generally confirms this description of activity. Drums are evident beginning in 1970, along the southwest boundary of the FFTA between the lagoons and the southwest corner of the site. The photographs reveal that this storage area is more extensive than that originally shown in the IAS. Drums were no longer visible in 1985.

As discussed in the IAS, given the possibility of contamination from the solvents and gasoline used in the liquid waste-burning episodes of the past, and the potential migration of any contaminants lost to the environment into Skokie Ditch/River, the pathways and potential receptors are the same as those described for the Golf Course Landfill (Section 2.2.1.1). Individuals entering the fenced area and the aquatic life in Skokie Ditch/River were identified in the IAS as the main receptors. Therefore, the FFTA was recommended for an RI in the IAS.

2.2.2.2 RI Verification Step Field Program

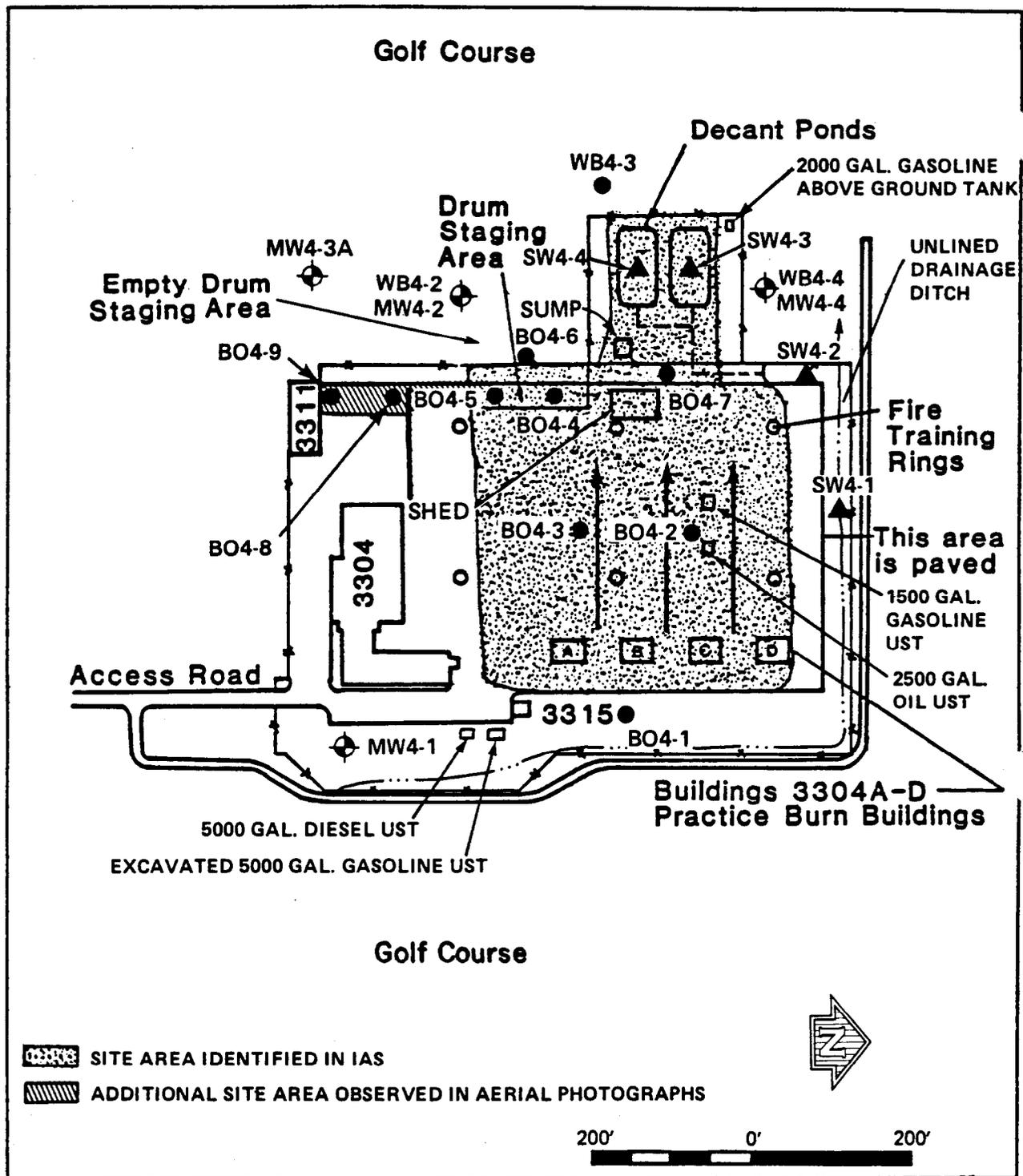
The field program at the FFTA included hydrogeologic and surface water investigations. The former included: (1) sampling of near-surface and shallow soils throughout the site to detect and evaluate the composition of residual contamination from site training and storage activities, and (2) installation and sampling of shallow groundwater monitoring wells to better define site hydrogeology and determine the potential impacts of past and present site operations on groundwater quality in the vicinity. The latter investigation included collection of water samples from the drainage ditch and decant ponds. Contaminants in these manmade surface water bodies could enter Skokie Ditch via the aforementioned NPDES outfall or possibly infiltrate into the subsurface environment.

2.2.2.2.1 Hydrogeologic Investigation

Soil Sampling. Twelve soil sampling locations--numbered BO4-1 through BO4-9 and WB4-2 through WB4-4--were designated in this area, as shown in Figure 2-8. Two composite soil samples were collected from each location--one at near-surface depths of 1.5 to 3 feet (designated by the suffix "A"), and one at shallow depths of 3.5 to 5 feet (designated by the suffix "B"). In some instances, due to poor sample recovery, the entire 2-foot split-spoon sample volume collected from 1 to 3 or 3 to 5 feet was needed to composite a sample, but this is not believed to affect sample results or evaluation. This sampling scheme was designed to provide an indication of the contamination residual in soils due to surface spills and infiltration of liquid wastes and contaminated surface runoff, as well as an indication of the degree of vertical migration of contaminants that have reached the subsurface environment. Contamination of surficial soils in some areas is visually obvious, so sampling of these soils was deemed unnecessary.

The location for BO4-1 was selected to be representative of background, ambient soil conditions not affected by site activities. Locations for BO4-2 and BO4-3 were selected to serve as checks on the infiltration of contaminated surface runoff through cracked and broken pavement. Locations for BO4-4 through BO4-9 were selected to sample areas of heavy surface contamination in the general vicinity of the former drum storage area and the lagoons. In addition, three sets of samples from approximately the same depth intervals were obtained from the boreholes drilled for wells MW4-2 through MW4-4, located around these same areas. (Since no water could be found in the boring for well MW4-3, as discussed later, this well was relocated to the location shown for MW4-3A, though soil samples from the original boring location were used for chemical analysis.) The locations and depths for all samples were selected to provide minimum coverage of this site, with the knowledge that additional sampling or monitoring could be conducted based on the analytical results for these samples. The analytes for these samples were VOCs, BNAs, oil and grease, and lead. They were selected based on materials reportedly used and stored at this site--including but not limited to POLs (including #2 fuel oil and leaded and unleaded gasolines) and various solvents.

These samples were collected on a one-time basis to provide an overall view of soil conditions. Changes in the soil regime are expected to occur slowly over time; therefore, additional sampling at these locations during the period of this



- General Direction of Surface Drainage
- MW4-1** Monitoring Well and Groundwater Sampling Location
- BO4-1** Soil Sampling Location (Samples were collected at depths 1.5-3 feet and 3.5-5 feet*)
- SW4-1** Surface Water Sampling Location

***NOTE:**
Soil samples for chemical analysis were collected at these depths in the initial borings for wells MW4-2, MW4-3, and MW4-4, and were designated by the codes WB4-2, WB4-3, and WB4-4. The boring for MW4-3 was dry and was replaced by MW4-3A.

**FIGURE 2-8
MONITORING WELL AND
SAMPLING LOCATIONS
FIRE FIGHTING TRAINING AREA
(SITE 4)**



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project was not expected to yield any additional information about site conditions. However, due to missed holding times for VOCs, BNAs, and oil and grease in the samples from WB4-2, WB4-3, and WB4-4, locations no more than 5 feet from the initial well borings were resampled for soils in conjunction with the second round of groundwater and surface water sampling.

Monitoring Well Installation. Shallow monitoring wells were installed at Site 4, because preliminary assessment of available data indicated shallow groundwater as a likely contaminant migration pathway; the presence of shallow, water-bearing sands in some locations; and the lack of existing monitoring wells. As at Site 1, it was assumed, for planning purposes, that the site was underlain by a single unconfined aquifer system and that the investigation would focus on this shallow zone. Given the extensive low permeability clayey till described in this area, localized areas of perched, semiconfined groundwater were expected. However, the few shallow wells at the Installation and in the surrounding area did not indicate the existence of confined conditions.

Available information indicated that Site 4 is underlain by approximately 170 feet of glacial till over bedrock. The till is composed largely of clay, with varying amounts of silt, sand, and gravel, as well as with discontinuous water-bearing sand and gravel zones. The irregular, variable nature of the subsurface deposits can be identified from the description of conditions encountered by borings installed as part of a feasibility study for a new Fire Fighting Training Unit (Dames & Moore, 1987c). This description and its hydrogeologic implications are discussed in Section 2.2.1.2.1.

Due to the nature of the activities in this area, large volumes of potentially contaminated surface runoff and other water are generated and collected in an unlined ditch and lagoons. This may result in the infiltration of contaminated surface water and the contribution of contaminants to groundwater and the subsurface environment in this area. In addition, the percolation of surface runoff through contaminated soils can also add constituents to groundwater. There are also a number of USTs and associated underground piping in this area that--though not specifically included by the Navy in the scope of this investigation and previously uninvestigated--could contribute contamination to groundwater if leaking. Four shallow monitoring wells were installed to collect groundwater samples for chemical analysis for the presence of potential contaminants and to

gather data for definition of the shallow hydrogeology and hydraulic gradient in this area. It was important to understand how the characteristics of fill material and possible infiltration from the ditch and lagoons may influence the gradient.

Based on available information, locations for the four monitoring wells were identified. The location of MW4-3 was changed--to MW4-3A--when no groundwater was encountered. The locations of the wells installed are shown in Figure 2-8. It was assumed that well MW4-1 in the southeastern corner of the FFTA was located to provide groundwater samples representative of background ambient water quality unaffected by the training area, and that it would also serve as a background well for the landfill (Site 1). However, given the lack of site-specific data on the hydraulic gradient in this area, it was anticipated that changes to well locations might be necessary as drilling progressed and data became available to assess flow direction. Due to the disconnected sandy water-bearing zones encountered, however, such adjustment was not possible. All wells were installed in these shallow zones where water was encountered.

Wells MW4-2, MW4-3, and MW4-4 were to be located along the western edge of the training area and the lagoons, interspersed between the FFTA and the Golf Course Landfill. Well MW4-2 was located opposite the former drum storage area. Well MW4-3 was to be located opposite the lagoons. However, as mentioned above, groundwater was not encountered at this location, and a new location farther to the south was selected for the installation of MW4-3A, near the portion of the site identified in aerial photos. Well MW4-4 was located adjacent to the lagoons and opposite one end of the runoff ditch. All of these wells were presumed to be downgradient of their respective areas of concern, though it was known that potential infiltration from the lagoons and/or runoff ditch could cause mounding on the water table and alter the hydraulic gradient.

All groundwater monitoring wells were constructed of 4-inch-diameter Grade 304 stainless-steel casing and 10-foot screens, and were designed to accommodate both water level measurements and groundwater sample collection. Table 2-6 shows the installation dates, depths, and screened intervals of the Site 4 wells. Inasmuch as possible, wells were constructed with screens straddling the mean high water table to ensure effective sampling of constituents such as fuels and oils, which tend to float on and migrate near the top of the water table. Further details of well construction are discussed in Appendix A.

TABLE 2-6

Summary of Installation Dates, Depths, and
Screened Intervals for Wells Installed During the RI
Verification Step at Site 4, Fire Fighting Training Area
NTC Great Lakes, Illinois

<u>Boring/Well</u>	<u>Date Drilled/ Well Installed</u>	<u>Total Depth Drilled (a) (feet)</u>	<u>Screened Interval (a) (feet)</u>
MW4-1	11-7-88	16.0	6.0-16.0
MW4-2	11-8-88	18.0	6.0-16.0
MW4-3 (b)	11-8-88	22.0	--
MW4-3A	11-15-88	16.0	6.0-16.0
MW4-4	11-14-88	45.0	30.0-40.0

(a) Below ground surface.

(b) Groundwater not encountered; boring subsequently abandoned and grouted to the surface.

Groundwater Sampling. Groundwater samples were collected from the four newly installed wells in this area, as shown in Figure 2-8. Well MW4-1 was installed to yield groundwater representative of the background, ambient water quality not affected by the training area. Wells MW4-2 through MW4-4 were installed to monitor for the influence of surface runoff, infiltration of contaminants from the lagoons and the collector ditch, and migration of any contaminants from the former drum storage area, in a direction presumably downgradient of the training area.

Analytes for the wells were the same as discussed earlier for the soil samples--i.e., VOCs, BNAs, oil and grease, and lead. In addition, samples from MW4-1 were also analyzed for PCBs, TOC, chloride, and the remaining priority pollutant metals, since these were also analytes of concern for the Golf Course Landfill--for which MW4-1 served as a background well. As at the landfill, two rounds of groundwater sampling were conducted at the FFTA.

2.2.2.2.2 Surface Water Investigation

Four surface water sampling locations were designated in this area, as shown in Figure 2-8. Samples SW4-1 and SW4-2 are located in two separate portions of the surface runoff collector ditch. These samples were taken to provide information on the type and concentration of constituents contained in activity-generated surface runoff that could infiltrate to the subsurface environment via the unlined ditch. Samples SW4-3 and SW4-4 were taken from the two lagoons to provide an indication of the materials concentrated in the lagoons that may be infiltrating to the subsurface environment or entering Skokie Ditch via the NPDES outfall.

The analytes for this set of samples are the same as those for FFTA soil and groundwater samples. These samples were also collected two times during the RI Verification Step, based on the same criteria previously discussed for Site 1.

2.2.2.3 RI Verification Step Findings

2.2.2.3.1 Hydrogeologic Investigation

Site Description--Soils, Geology, and Groundwater. The FFTA is surrounded by the Site 1 golf course in an area that has been graded nearly level, but is underlain by soils identified as poorly drained. The surface of the training area is

mostly covered with pavement or gravel. Elevations at the site are approximately 690 feet above msl. This area is reported in the IAS to be underlain by approximately 10 to 15 feet of till above a sandy water-bearing zone. The water was reported in the IAS to be located from 6 to 8 feet below ground surface in this vicinity.

Site 4 was investigated to determine if contamination resulting from training activities, drum storage, or other site operations is present in or migrating through the soils and groundwater at the site.

As previously described, two soil samples were collected for chemical analysis from each of nine shallow (5-foot) soil borings and from similar depths in three monitoring well borings shown in Figure 2-8. Subsurface conditions encountered in these borings were indicative of glacial till and manmade regrading of the area undoubtedly associated with construction of the FFTA. Topsoil was not present in borings within the active portion of the FFTA--where the surface is gravel and pavement--and was very thin in the well borings and BO4-6, which were outside the active portion of the site. The shallow borings generally encountered sand, with variable percentages of silt, clay, and gravel. However, borings BO4-3, BO4-6, and BO4-9 encountered material that was primarily clay in the top 2 to 3 feet overlying the sandy material, while BO4-4 encountered only clayey material below 6 inches.

Similar variations were encountered in the well borings. Borings for wells MW4-1 and MW4-2 encountered approximately 3 to 4 feet of silt or silty sand over approximately 13 feet of sand with silt, clay, and gravel. The initial boring for MW4-3 encountered only clay to a depth of 22 feet and was then replaced by MW4-3A, which encountered clay with interbedded gravel. Note that MW4-3A was located approximately 300 feet south of the original boring. Both of these borings were completed early in the field program when the variability of subsurface conditions was not yet well understood, and it was believed that a relocation of this magnitude was necessary to obtain water without conflicting with locations selected for MW4-2 and MW4-4. The boring for MW4-4 encountered 3 to 4 feet of sand, silt, and clay over approximately 40 feet of clay. As at the Golf Course Landfill, the clay contained sand, silt, and gravel in lesser proportions and may have included lenses of sand that were undetected by sampling at 5-foot intervals.

As at Site 1, water levels indicate that the monitoring wells appear to have penetrated two different water-bearing zones--one with a potentiometric surface less than 10 feet deep, the other with a potentiometric surface approximately 20 to 30 feet deep. Depth to water and water surface elevations are presented in Table 2-7, and water surface elevations are also shown in Figure 2-9. There is no indication these two zones are connected or that wells in the same apparent zones are connected. Note that between the two sampling events in December 1988 and March 1989, water levels went up in two wells and down in the other two, as shown in Table 2-8. This difference is small and ranges from 0.15 to 1.48 feet, indicating little seasonal difference in water levels that could affect analytical results. The conditions encountered in the glacial till reflect deposition and erosion, which have produced a complex three-dimensional picture. A cross section based on the well borings along the west side of the site (see Figure 2-9 for location), as shown in Figure 2-10, illustrates the generally lenticular nature of the deposits and the irregular water levels observed. Although soil samples collected from MW4-2 appear to indicate the presence of extensive sand at this location, evaluation of data from all well borings indicates that the sand is likely to be lenticular--with clay undetected in the sampled intervals--or, at most, a local pocket of limited areal extent. There are no indications that the shallow water-bearing zones are connected to the bedrock aquifer. As at Site 1, an impermeable layer of the glacial till would serve to prevent downward migration of contaminants into the bedrock aquifer.

As discussed in Section 2.2.1.3.1 for Site 1, the complexities encountered in the geologic framework also preclude certainty in determining groundwater flow direction. Groundwater elevations shown in Figure 2-9 are based on water level measurements during the second round of sampling. As previously discussed, there was no definite pattern in water level change between sampling rounds. Thus, it is not possible to determine at this time the direction(s) of groundwater flow at Site 4. In addition, the extensive network of underground piping and the presence of various underground tanks is certain to influence water levels and flow direction. These features are shown in Figure 2-11. Sand and gravel used to backfill tank excavations and pipe trenches could act as sinks or conduits for shallow groundwater flow at the site. However, the general direction of surface water runoff should carry contaminants toward the wells, and it is not unreasonable

TABLE 2-7

Depth to Water and Water Surface Elevations at
 Site 4, Fire Fighting Training Area
 RI Verification Step at NTC Great Lakes, Illinois

Well	Top of Casing Elevation (a,b) (feet)	Round 1			Round 2		
		Date	Depth to Water (c) (feet)	Water Surface Elevation (feet)	Date	Depth to Water (c) (feet)	Water Surface Elevation (feet)
MW4-1	691.47	12-7-88	2.80	688.67	3-28-89	2.64	688.83
MW4-2	689.47	12-7-88	3.73	685.74	3-29-89	5.21	684.26
MW4-3A	688.20	12-7-88	3.77	684.43	3-28-89	4.68	683.52
MW4-4	688.26	12-7-88	26.16	662.10	3-28-89	25.66	662.60

(a) Top of stainless-steel well casing.

(b) Elevations are mean tide New York Harbor; subtract 0.69 feet to convert to National Geodetic Vertical Datum of 1929.

(c) Depth to water is measured from top of stainless-steel well casing.

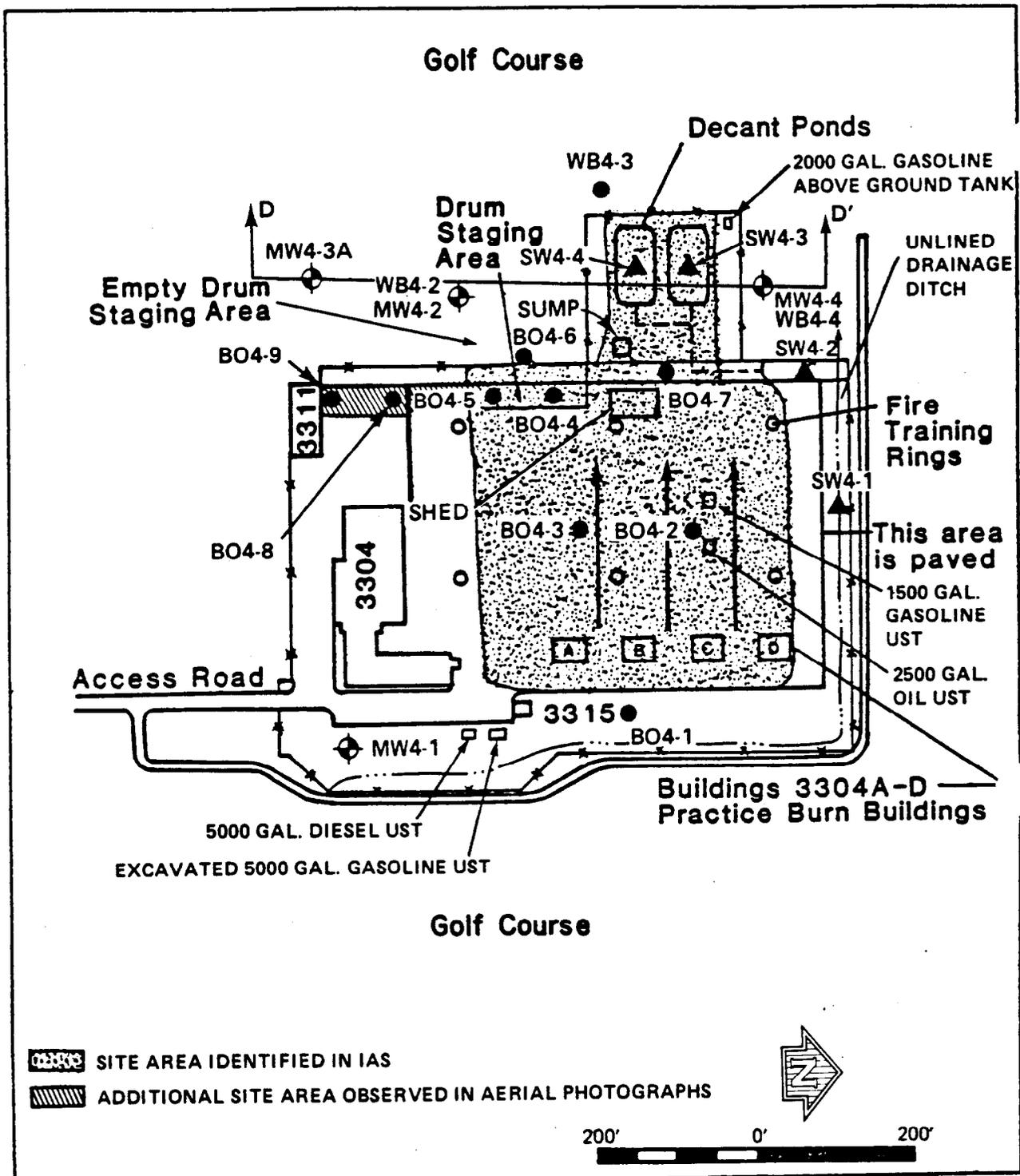


FIGURE 2-9
CROSS SECTION LOCATION
AND GROUNDWATER ELEVATIONS
FIRE FIGHTING TRAINING AREA
(SITE 4)



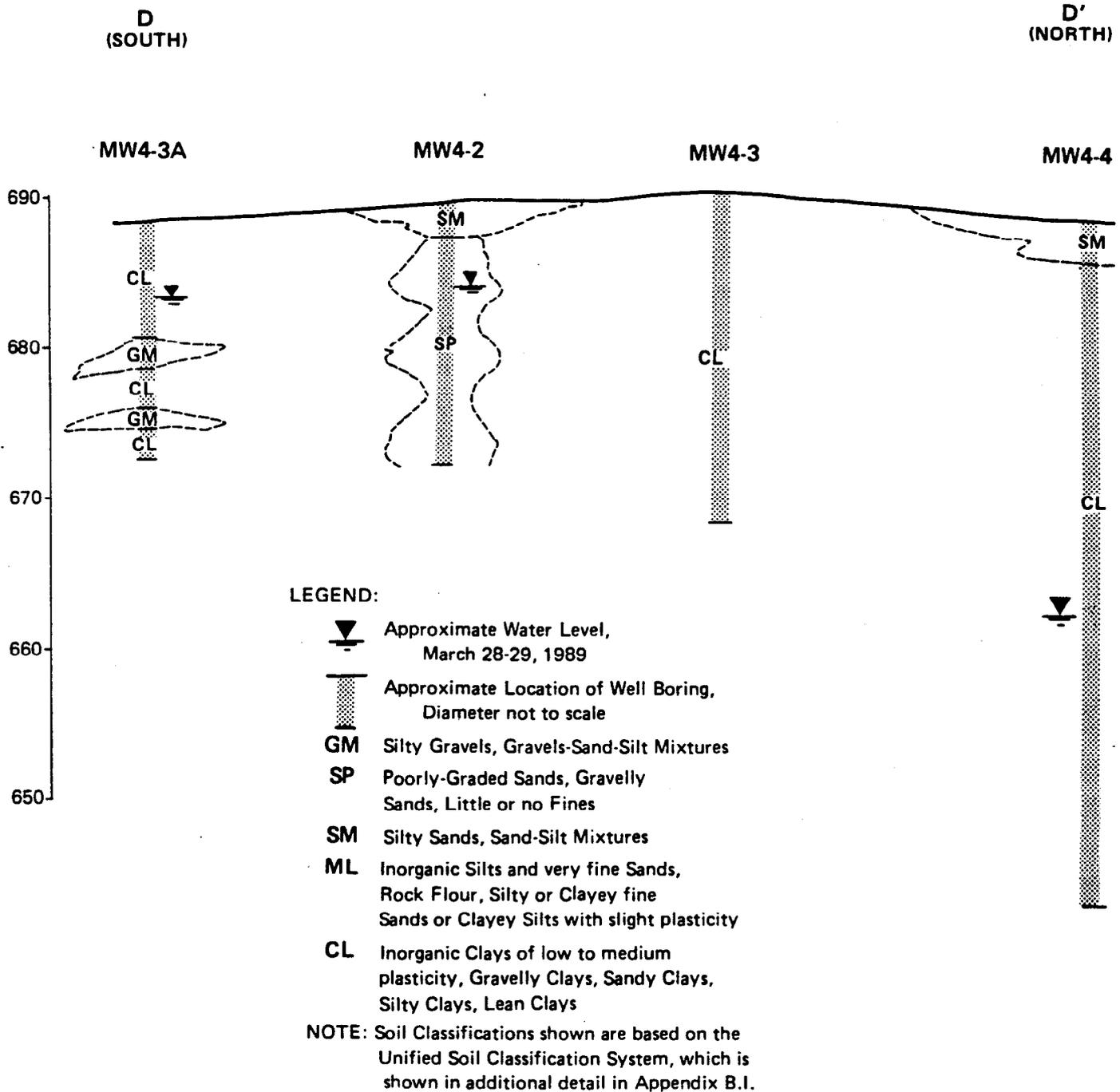
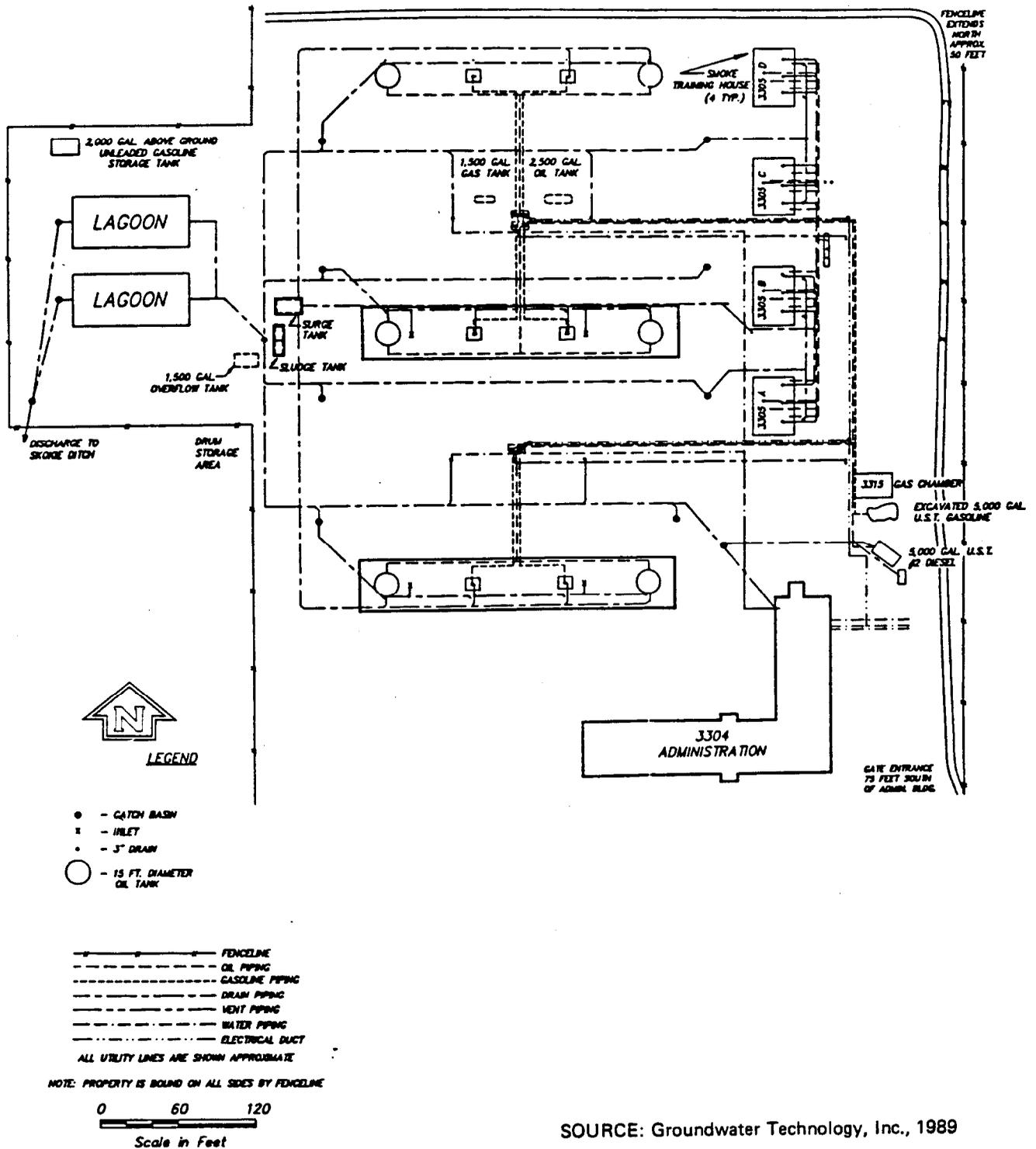


FIGURE 2-10
CROSS SECTION ALONG WEST SIDE OF
FIRE FIGHTING TRAINING AREA (SITE 4)





SOURCE: Groundwater Technology, Inc., 1989

FIGURE 2-11
LOCATIONS OF UNDERGROUND
TANKS AND PIPING
FIRE FIGHTING TRAINING AREA (Site 4)



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to assume that the wells--due to their proximity to the site--are positioned to detect contaminants from Site 4 migrating in the shallow aquifer.

Contamination Assessment--Soils and Groundwater. For reasons discussed in Section 1.1, the analytical data discussed in this section could not be validated under USEPA Level III and, therefore, are not considered usable for their intended purpose. Thus, the data assessment discussion presented below is highly speculative.

Results of analyses of samples taken near Site 4 indicate some contamination of soils by volatile and semivolatile organics, lead, and oil and grease. In addition, sample analyses results indicate that site groundwater may be contaminated with oil and grease. Constituents and their concentrations detected in the soil and groundwater samples are presented in Tables 2-8 and 2-9, respectively. Table 2-9 also indicates the potential ARAR(s) (if available) for each constituent detected in groundwater. Sample locations are shown in Figure 2-8. A summary of exceedances of drinking water standards/guidelines is presented in Table 2-10.

- o Soils--A variety of priority pollutant BNAs and BNA TICs were detected in several of the soil samples from borings BO4-1 through BO4-9, while almost none were detected in the samples from the well borings WB4-2 through WB4-4. Of the priority pollutant BNAs detected, bis(2-ethylhexyl) phthalate--a plasticizer--is, for the most part, present in some samples at concentrations less than or equal to approximately 10 times the concentrations found in MBs. Thus, all detections--with the exception of that in sample BO4-7B--are probably laboratory artifacts. The level found in BO4-7B could also be a laboratory artifact or may be attributable to some plastic material in the soil sampled here. It is believed that there is no cause for concern over this detection.

The other priority pollutant BNAs--e.g., fluoranthene, pyrene, naphthalene--are all in the class of compounds known as polyaromatic hydrocarbons (PAHs). PAHs, as well as related compounds, are also present among the BNA TICs. These are the various methylated and ethylated naphthalenes, 1,2,3,4-tetrahydro-1,8-D-naphthalene, 2,4-dimethyl-1,1'-biphenyl, and the indene and azulene derivatives. At

TABLE 2-8

Constituents Detected in Soil Samples
 Site 4, Fire Fighting Training Area
 RI Verification Step at NTC Great Lakes, Illinois

Analytical Parameter	Units	DL (a)	Concentration in Soil											
			B04-1A	B04-1A(b)	B04-1B	B04-2A	B04-2B	B04-3A	B04-3B	B04-4A	B04-4B	B04-5A	B04-5B	B04-6A
Sample Depth (ft)			1.5-3	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3
Oil and Grease	percent	0.6	BDL (c)	BDL	7.0	4.4	1.1	0.73	2.0	2.4	1.8	0.7	2.0	2.2
Semivolatile Organics (Priority Pollutants)			BDL	BDL	870	BDL								
Benzo (g,h,i) perylene	ug/kg	330	370	BDL	BDL	BDL	990	2,200	840	3,900	3,300	2,700	3,400	3,800
Bis (2-ethylhexyl) phthalate	ug/kg	330	BDL	BDL	490	BDL								
Fluoranthene	ug/kg	330	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	21,000	BDL
2-Methylnaphthalene	ug/kg	330	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3,700	BDL
Naphthalene	ug/kg	330	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Phenanthrene	ug/kg	330	BDL	BDL	570	BDL								
Pyrene	ug/kg	330	BDL	BDL	570	BDL								
Semivolatile Organics (Tentatively Identified Compounds)														
Unknowns (total)	ug/kg	--	3,380	2,230	13,390	8,360	900	1,180	640	2,240	2,040	4,890	39,500	3,230
4-Hydroxy-4-methyl-2-pentanone	ug/kg	--	ND (d)	ND	ND	ND	1,100	1,100	470	1,100	1,000	ND	ND	740
2,3-Dimethylheptane	ug/kg	--	ND (d)	ND	ND	ND	390	ND						
2-Methylotane	ug/kg	--	ND (d)	ND	ND	ND	670	ND	ND	ND	490	ND	ND	ND
3-Methylotane	ug/kg	--	ND (d)	ND	ND	ND	810	470	320	570	ND	ND	ND	ND
3-Ethyl-2,4-dimethylpentane	ug/kg	--	ND (d)	ND	ND	ND	810	630	ND	ND	ND	ND	ND	ND
3-Hexene-2,5-Dione	ug/kg	--	ND (d)	ND	ND	ND	380	630	360	960	ND	ND	ND	ND
2,4-Dimethyl-3-pentanone	ug/kg	--	ND (d)	ND	ND	ND	2,100	ND						
Tridecane	ug/kg	--	ND (d)	ND	ND	ND	130	ND	ND	ND	ND	ND	4,600	ND
10-Methyleicosane	ug/kg	--	ND (d)	ND	ND	ND	160	ND	ND	190	ND	ND	ND	ND
2,6,10,13,19-23-Hexamethyl- tetracosane	ug/kg	--	ND (d)	ND	ND	ND	180	ND						
Hexanedioicacid, dioctyl ester	ug/kg	--	ND (d)	ND	ND	ND	470	880	440	2,000	330	390	ND	810
1-Hentetracontanol	ug/kg	--	ND (d)	ND	ND	ND	450	430	ND	ND	ND	ND	ND	ND
2,3-Dimethylbutane	ug/kg	--	ND (d)	ND	ND	ND	ND	1,200	1,400	ND	ND	ND	ND	1,500
1,3-Dimethylnaphthalene	ug/kg	--	ND (d)	ND	ND	ND	ND	190	ND	ND	ND	210	22,000	ND
2,6,10,14-Tetramethylhexadecane	ug/kg	--	ND (d)	ND	ND	ND	ND	160	160	ND	ND	ND	29,000	ND
1-Dotriacontanol	ug/kg	--	ND (d)	ND	ND	ND	ND	ND	390	ND	ND	ND	ND	ND
2-Methyl-1-(1,1-dimethyl) propanoic acid	ug/kg	--	ND (d)	ND	ND	ND	ND	ND	300	ND	ND	ND	ND	ND
Nonacosane	ug/kg	--	ND (d)	ND	ND	ND	ND	ND	ND	410	ND	ND	ND	ND
1-Iodo-octatetracontane	ug/kg	--	ND (d)	ND	ND	ND	ND	ND	ND	630	ND	ND	ND	ND

- (a) Detection limit.
- (b) Field duplicate.
- (c) Below detection limit.
- (d) None detected.

NOTE: For reasons discussed in Section 1.1, these data could not be validated under USEPA Level III and, therefore, are not usable for their intended purpose.

TABLE 2-8 (cont'd)

Analytical Parameter	Units	DL (a)	Concentration in Soil												
			B04-6B	B04-7A	B04-7B	B04-8A	B04-8B	B04-9A	B04-9B	WB4-2A	WB4-2B	WB4-3A	WB4-3B	WB4-4A	WB4-4B
Sample Depth (ft):			3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5
Oil and Grease	percent	0.6	1.9	1.8	BDL	0.7	BDL	0.6	BDL						
Semivolatile Organics (Priority Pollutants)															
Benzo (g,h,i) perylene	ug/kg	330	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Bis (2-ethylhexyl) phthalate	ug/kg	330	1,700	4,900	11,000	1,900	BDL	5,600	6,300	BDL	BDL	BDL	BDL	BDL	BDL
Fluoranthene	ug/kg	330	BDL	BDL	530	BDL									
2-Methylnaphthalene	ug/kg	330	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Naphthalene	ug/kg	330	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Phenanthrene	ug/kg	330	BDL	BDL	1,000	BDL									
Pyrene	ug/kg	330	BDL	BDL	870	BDL									
Semivolatile Organics (Tentatively Identified Compounds)															
Unknowns (total)	ug/kg	--	3,770	1,840	17,900	1,900	1,510	760	5,340	1,080	6,300	190	1,570	410	1,200
4-Hydroxy-4-methyl-2-pentanone	ug/kg	--	650	800	ND	ND	ND	ND	ND	3,300	3,900	3,600	ND	4,300	3,600
2,3-Dimethylheptane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methyloctane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-Methyloctane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-Ethyl-2,4-dimethylpentane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-Hexene-2,5-Dione	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	800	ND	920	ND
2,4-Dimethyl-3-pentanone	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tridecane	ug/kg	--	ND	ND	3,600	ND									
10-Methyleicosane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6,10,13,19-23-Hexamethyl-tetracosane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexanedioic acid, dioctyl ester	ug/kg	--	ND	830	ND	ND	ND	810	1,200	ND	ND	ND	ND	ND	ND
1-Hentetracontanol	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3-Dimethylbutane	ug/kg	--	ND	ND	ND	280	270	ND							
1,3-Dimethylnaphthalene	ug/kg	--	ND	ND	2,300	ND									
2,6,10,14-Tetramethylhexadecane	ug/kg	--	ND	ND	8,000	ND									
1-Dotriacontanol	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methyl-1-(1,1-dimethyl)propanoic acid	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nonacosane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-Iodo-octatetracontane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

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TABLE 2-8 (cont'd)

Analytical Parameter	Units	DL (a)	Concentration in Soil											
			B04-1A	B04-1AX(b)	B04-1B	B04-2A	B04-2B	B04-3A	B04-3B	B04-4A	B04-4B	B04-5A	B04-5B	B04-6A
Sample Depth (ft):			1.5-3	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3
Semivolatile Organics														
(Tentatively Identified Compounds) (cont'd)														
Pentacosane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	230	ND	ND	ND	ND
Octacosane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	180	ND	ND	ND	ND
3-Methyl-3-hexyl-2-ol	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	580	ND	ND
1-Methyl-4-(1-methyl-ethyl)-o-benzene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	180	ND	ND
1-Ethylidene-1H-indene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	310	ND	ND
1,2-Dimethylnaphthalene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	300	28,000	ND
1-Docosanol	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	610	ND	ND
4-Methylnonane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4,100	ND
Methylcycloheptane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3,700	ND
2,6-Dimethylnonane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3,900	ND
2-Ethyl-1,4-dimethylbenzene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5,300	ND
1,4-Dimethyl-2-(1-methyl-ethyl) benzene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3,200	ND
2,5-Dimethylundecane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6,700	ND
Hexylcyclohexane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4,900	ND
2,3-Dihydro-1,2-dimethyl-1H-Indene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2,100	ND
3,6-Dimethyloctane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5,600	ND
1-Methylnaphthalene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	19,000	ND
1,5-Dimethylnaphthalene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3,700	ND
1,7-Dimethylnaphthalene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2,700	ND
Octylcyclohexane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	8,500	ND
2,7,10-Trimethyldodecane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	50,000	ND
3,7-Dimethylnonane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	13,000	ND
(1-Methylethyl) cyclohexane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	15,000	ND
2,6-Dimethylundecane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	14,000	ND
1-Methyl-3-(1-methylethyl) cyclo pentane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10,000	ND
2,3,7-Trimethyloctane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	16,000	ND
1,8-Dimethylnaphthalene Undecane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	14,000	ND
Undecane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	28,000	ND
1,4,6-Trimethylnaphthalene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	26,000	ND

TABLE 2-8 (cont'd)

Analytical Parameter	Units	DL (a)	Concentration in Soil												
			B04-6B	B04-7A	B04-7B	B04-8A	B04-8B	B04-9A	B04-9B	WB4-2A	WB4-2B	WB4-3A	WB4-3B	WB4-4A	WB4-6B
Sample Depth (ft):			3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5
Semivolatile Organics (Tentatively Identified Compounds) (cont'd)															
Pentacosane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Octacosane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
5-Methyl-3-hexyl-2-ol	ug/kg	--	ND	520	ND										
1-Methyl-4-(1-methyl-ethyl)-o-benzene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-Ethylidene-1H-indene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dimethylnaphthalene	ug/kg	--	ND	ND	3,700	ND									
1-Docosanol	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methylnonane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylcycloheptane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-Dimethylnonane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Ethyl-1,4-dimethylbenzene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dimethyl-2-(1-methyl-ethyl) benzene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,5-Dimethylundecane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexylcyclohexane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3-Dihydro-1,2-dimethyl-1H-indene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,6-Dimethyloctane	ug/kg	--	ND	ND	2,200	ND									
1-Methylnaphthalene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,5-Dimethylnaphthalene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,7-Dimethylnaphthalene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Octylcyclohexane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,7,10-Trimethyldodecane	ug/kg	--	ND	ND	9,900	ND									
3,7-Dimethylnonane	ug/kg	--	190	ND											
(1-Methylethyl) cyclohexane	ug/kg	--	ND	ND	2,500	ND									
2,6-Dimethylundecane	ug/kg	--	ND	ND	2,100	ND									
1-Methyl-3-(1-methylethyl) cyclo pentane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,7-Trimethyloctane	ug/kg	--	ND	ND	3,400	ND									
1,8-Dimethylnaphthalene	ug/kg	--	ND	ND	2,700	ND									
Undecane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4,6-Trimethylnaphthalene	ug/kg	--	ND	ND	3,400	ND									

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TABLE 2-8 (cont'd)

Analytical Parameter	Units	DL (a)	Concentration in Soil												
			B04-1A	B04-1AX(b)	B04-1B	B04-2A	B04-2B	B04-3A	B04-3B	B04-4A	B04-4B	B04-5A	B04-5B	B04-6A	
Sample Depth (ft):			1.5-3	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	
Semivolatile Organics															
(Tentatively Identified Compounds) (cont'd)															
2,6,11-Trimethyldodecane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	350
1,1'-Oxybis-decane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	310
1-Phenanthrenecarboxaldehyde,1,2,3,4	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
(4-Methylpentyl) cyclohexane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,6-Trimethylnaphthalene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylethylnaphthalene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-Trimethylazulene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6,10-Trimethylpentadecane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-Ethyl-5-methylheptane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,8-Dimethyltridecane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,3,4-Tetrahydro-1,8-D-naphthalene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexadecane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4,5-Trimethylnaphthalene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,6,7-Trimethylnaphthalene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,5-Dimethylundecane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4'-Dimethyl-1,1'-biphenyl	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pentylcyclohexane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acetic acid, hydrazide	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-3-penten-2-one	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE 2-8 (cont'd)

Analytical Parameter	Units	DL (a)	Concentration in Soil												
			B04-6B	B04-7A	B04-7B	B04-8A	B04-8B	B04-9A	B04-9B	WB4-2A	WB4-2B	WB4-3A	WB4-3B	WB4-4A	WB4-4B
Sample Depth (ft):			3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5
Semivolatile Organics															
(Tentatively Identified Compounds) (cont'd)															
2,6,11-Trimethyldodecane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1'-Oxybis-decane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-Phenanthrenecarboxaldehyde,1,2,3,4	ug/kg	--	1,200	ND											
(4-Methylpentyl) cyclohexane	ug/kg	--	ND	ND	2,800	ND									
2,3,6-Trimethylnaphthalene	ug/kg	--	ND	ND	2,000	ND									
Methylethylnaphthalene	ug/kg	--	ND	ND	1,400	ND									
2,4,6-Trimethylazulene	ug/kg	--	ND	ND	2,500	ND									
2,6,10-Trimethylpentadecane	ug/kg	--	ND	ND	3,900	ND									
3-Ethyl-5-methylheptane	ug/kg	--	ND	ND	2,300	ND									
4,8-Dimethyltridecane	ug/kg	--	ND	ND	1,700	ND									
1,2,3,4-Tetrahydro-1,8-D-naphthalene	ug/kg	--	ND	ND	2,000	ND									
Hexadecane	ug/kg	--	ND	ND	5,400	ND									
1,4,5-Trimethylnaphthalene	ug/kg	--	ND	ND	1,900	ND									
1,6,7-Trimethylnaphthalene	ug/kg	--	ND	ND	3,600	ND									
3,5-Dimethylundecane	ug/kg	--	ND	ND	5,100	ND									
2,4'-Dimethyl-1,1'-biphenyl	ug/kg	--	ND	ND	3,500	ND									
Pentylcyclohexane	ug/kg	--	ND	ND	2,400	ND									
Acetic acid, hydrazide	ug/kg	--	ND	ND	ND	ND	ND	270	ND						
4-Methyl-3-penten-2-one	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	180	330	ND	400	ND	ND

TABLE 2-8 (cont'd)

Analytical Parameter	Units	DL (a)	Concentration in Soil											
			B04-1A	B04-1AX(b)	B04-1B	B04-2A	B04-2B	B04-3A	B04-3B	B04-4A	B04-4B	B04-5A	B04-5B	B04-6A
Sample Depth (ft):			1.5-3	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3
Volatile Organics (Priority Pollutants)														
Acetone	ug/kg	10	BDL	70	23	17	28	32	35	24	BDL	150	28	49
Chlorobenzene	ug/kg	5	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Methylene Chloride	ug/kg	5	BDL	32	41	25	9	28	27	30	BDL	43	24	30
Toluene	ug/kg	5	14	15	12	13	10	11	11	11	20	10	10	14
Volatile Organics (Tentatively Identified Compounds)														
Unknowns (total)	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	60	420	1,440
Butylcyclohexane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	89	ND
1-Ethyl-4-methyl-trans-cyclohexane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	59	ND
1,1,2,3-Tetramethylcyclohexane A	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	200	ND
Decahydro-trans-naphthalene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	150
Methylcycloheptane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	99
Hexane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Propanol	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead	ug/g	2.5	54.2	70.0	115.0	35.2	24.5	33.8	10.8	44.6	16.8	18.8	30.0	27.0

TABLE 2-8 (cont'd)

Analytical Parameter	Units	DL (a)	Concentration in Soil												
			B04-6B	B04-7A	B04-7B	B04-8A	B04-8B	B04-9A	B04-9B	WB4-2A	WB4-2B	WB4-3A	WB4-3B	WB4-4A	WB4-4B
Sample Depth (ft):			3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5	1.5-3	3.5-5
Volatile Organics (Priority Pollutants)															
Acetone	ug/kg	10	BDL	50	43	61	72	120	51	130	BDL	BDL	BDL	BDL	BDL
Chlorobenzene	ug/kg	5	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	33	28	62	BDL	BDL
Methylene Chloride	ug/kg	5	BDL	210	14	18	220	190	150	4	BDL	7	BDL	BDL	BDL
Toluene	ug/kg	5	12	30	15	14	15	18	16	BDL	6	BDL	BDL	BDL	BDL
Volatile Organics (Tentatively Identified Compounds)															
Unknowns (total)	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Butylcyclohexane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-Ethyl-4-methyl-trans-cyclohexane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,3-Tetramethylcyclohexane A	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Decahydro-trans-naphthalene	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylcycloheptane	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexane	ug/kg	--	ND	ND	ND	ND	ND	21	13	ND	ND	ND	ND	ND	ND
2-Propanol	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	2,500	ND	ND	ND	ND	ND
Lead	ug/g	2.5	10.1	40.0	31.6	11.1	8.7	20.0	16.3	157	63.0	37.8	39.7	299.0	12.1

TABLE 2-9

Constituents Detected in Groundwater Samples
Site 4, Fire Fighting Training Area
RI Verification Step at NTC Great Lakes, Illinois

Analytical Parameter	Units	DL (a)	Concentration in Groundwater First Round Sampling (December 1988)				Concentration in Groundwater Second Round Sampling (March 1989)						Potential ARAR	Value
			MW4-1	MW4-2	MW4-3	MW4-4	DL	MW4-1	MW4-2	MW4-3	MW4-4	MW4-4x (b)		
Chloride	mg/l	0.25	5.10	NT (c)	NT	NT	0.25	4.5	NT	NT	NT	NT	IPWSS/Final SMCL (d)	250
Total Organic Carbon	mg/l	0.1	8	NT	NT	NT	0.1	0.87	NT	NT	NT	NT	NA (e)	--
Oil and Grease	mg/l	5	<u>49.7 (f)</u>	<u>237.6 (f)</u>	<u>134.3 (f)</u>	<u>85.3 (f)</u>	0.05	BDL (g)	BDL	BDL	BDL	BDL	IPWSS (h)	0.1
Semivolatile Organics (Priority Pollutants) Bis (2-ethylhexyl) phthalate	ug/l	10	BDL	BDL	BDL	BDL	10	BDL	<u>13 (f)</u>	BDL	BDL	BDL	Proposed MCL (i)	4
Semivolatile Organics (Tentatively Identified Compounds) Unknowns (total)	ug/l	--	174	72	78	78	--	ND (j)	ND	ND	ND	8.91	NA	--
Volatile Organics (Priority Pollutants) Acetone	ug/l	10	BDL	BDL	BDL	BDL	10	BDL	12	BDL	11	BDL	NA	--
Chlorobenzene	ug/l	5	BDL	BDL	BDL	BDL	5	BDL	BDL	3	BDL	BDL	Final MCL/MCLG (k)	100
Methylene Chloride	ug/l	5	BDL	BDL	BDL	ND	5	<u>13 (f)</u>	5	BDL	5	<u>12 (f)</u>	Proposed MCL	5
Metals														
Mercury	ug/l	0.2	0.38	NT	NT	NT	0.2	BDL	NT	NT	NT	NT	IPWSS/IGWQS (l)	0.5
Zinc	ug/l	20	BDL	NT	NT	NT	4	11.9	NT	NT	NT	NT	IPWSS/IGWQS (l)	1,000
Lead	ug/l	5	BDL	BDL	BDL	BDL	3	BDL	5	5.7	3.3	3.8	IPWSS/MCL (m)	50

(a) Detection limit.

(b) Field duplicate.

(c) Not tested.

(d) Illinois Public and Food Processing Water Supply Standards (IPWSS)/Final Secondary Maximum Contaminant Level (SMCL).

(e) None available.

(f) Exceeds drinking water standard/guideline.

(g) Below detection limit.

(h) IPWSS.

(i) Proposed Maximum Contaminant Level (MCL).

(j) None detected.

(k) Final MCL/Final Maximum Contaminant Level Goal (MCLG).

(l) IPWSS/Illinois General Use Water Quality Standard (IGWQS).

(m) IPWSS/Final MCL.

NOT For reasons discussed in Section 1.1, these data could be validated under USEPA Level III and, therefore, are

TABLE 2-10

Summary of Exceedances of Drinking Water and
Surface Water Quality Standards/Guidelines (a)
Site 4, Fire Fighting Training Area
RI Verification Step at NTC Great Lakes, Illinois

<u>Sample Matrix</u>	<u>Sample No.</u>	<u>Sample Round</u>	<u>Constituent</u>	<u>Units</u>	<u>Concentration</u>	<u>Standard/ Guideline (b)</u>	<u>Type of Standard/Guideline</u>
Groundwater	MW4-1	1	Oil and grease	mg/l	49.7	0.1	IPWSS (c)
	MW4-2	1	Oil and grease	mg/l	237.6	0.1	IPWSS
	MW4-3	1	Oil and grease	mg/l	134.3	0.1	IPWSS
	MW4-4	1	Oil and grease	mg/l	85.3	0.1	IPWSS

- (a) This table does not list exceedances for methylene chloride or bis(2-ethylhexyl) phthalate, which in Site 4 samples are considered, in all cases, as laboratory artifacts because concentrations found in samples were no greater than 10 times the concentrations detected in laboratory MBs.
- (b) See Tables E-1 and E-2, Appendix E, for listing of standards/guidelines, for drinking water and surface water quality, respectively.
- (c) Illinois Public and Food Processing Water Supply Standard (IPWSS).

NOTE: For reasons discussed in Section 1.1, the concentration data in this table could not be validated under USEPA Level III and, therefore, are not usable for their intended purpose.

military facilities such as NTC Great Lakes, PAHs are generally present as the byproducts of incomplete combustion. Of course, at a site like the FFTA, burning residues in site soils are expected, so the presence of PAHs would be of no surprise. However, since PAHs are often present in ash and cinders and these materials are frequently used for site fill and ground stabilization, it is also possible that the PAHs arise from these sources. This second explanation for the source of PAHs is more likely at this site because PAHs were found primarily and at the highest concentrations in the deeper (3.5- to 5-foot) samples from borings BO4-1, BO4-5, and BO4-7. The locations of these borings are certainly within areas where ash and cinders could have been used for filling and leveling the site area during its construction.

The total PAH concentrations are 1.93 ppm in sample BO4-1B, 144.2 ppm in BO4-5B, and 30.4 ppm in BO4-7B. The concentration in BO4-5B is fairly high, but not necessarily atypical of samples taken directly from ash or cinder deposits at similar sites. The presence of PAHs in background boring BO4-1 (which was meant to be indicative of uncontaminated conditions) probably arises because--though outside of the fire training area--this boring is within the area that would have been filled and leveled during construction of the FFTA. Since PAHs are generally immobile in soils--due to their insolubility and adsorption to soils--it is not likely that PAHs deposited at the surface from incomplete burning processes during fire training would infiltrate downward to the depth sampled and not be found at even higher concentrations at the shallower depth. Furthermore, PAHs would be formed in much lower concentrations during the combustion of liquid hydrocarbon fuels, such as those used at Site 4--due to their relatively complete combustion--than from the burning of such materials as coal and wood, which would be the source of ash and cinders for ground fill and stabilization. Finally, the indene, azulene, and biphenyl compounds are generally derived from the burning of coal rather than liquid fossil fuels.

On the other hand, an argument for the source of the PAHs being liquid fuel combustion is the presence of the heaviest contamination by

volatile and/or semivolatile petroleum hydrocarbons also being present in samples BO4-5B and BO4-7B, as discussed later.

Whatever the source, the presence of the PAHs may be of little concern here, due to their general prevalence at developed sites as construction materials, their immobility in the subsurface environment, and the fact that they are primarily present well below the surface where they cannot be suspended in dust and subsequently inhaled or otherwise contacted. Only in samples from borings BO4-3 and BO4-5 are these present closer to the surface, but at total concentrations of less than or approximately equal to 1 ppm in both cases.

The largest number of BNA TICs, which are also present at the highest total concentrations of any of the site contaminants, are the compounds that can be classified as petroleum hydrocarbons. These include most of the compounds listed among the BNA TICs in Table 2-8 and are the substituted straight-chain and cyclic alkanes (compounds with names ending in "-ane") and substituted benzenes. These are the types of compounds that are found in liquid hydrocarbon fuels, as well as in the biological degradation products of such fuels as would be found in areas where such fuels have been spilled. Given the heavily blackened soil areas at the site and the probable fuel leaks and spills throughout the site area, the occurrence of these compounds is certainly not unexpected. Some of those BNA TICs identified as "unknowns" may consist of these petroleum hydrocarbons and related compounds.

These semivolatile hydrocarbons are present at low-to-moderate concentrations in nearly all of the site area borings labeled BO4, with the possible exception of the background boring BO4-1 and samples from BO4-8 and BO4-9 in the additional site area identified in aerial photographs (see Figure 2-8). In the well boring (WB) samples--which are essentially outside of the main activity area of the site--only a few such compounds are present at very low concentrations. Thus, it would appear that the background area characterized by boring BO4-1 and the area outside the fenced FFTA and surrounding the lagoons--as characterized by borings WB4-2, WB4-3, and WB4-4--are not contaminated with petroleum hydrocarbons. The greatest number and

concentration of these hydrocarbons are found in shallow and/or depth samples from borings BO4-2, BO4-3, BO4-4, BO4-5, BO4-6, and BO4-7, but mostly in samples BO4-5B and BO4-7B--at total concentrations (excluding unknowns) of 260.6 and 53.2 ppm, respectively. As discussed earlier, the finding of these high levels of petroleum hydrocarbons in BO4-5B and BO4-7B appears to correlate with similar findings of high levels of PAHs in these same samples; however, it cannot be ascertained if there is some connection or if this is merely a coincidence.

Borings BO4-4 through BO4-7 are in areas of blackened soil in and around the former drum staging area and shed, where some of the heaviest spills and subsequent infiltration of oily materials have undoubtedly occurred. BO4-2 and BO4-3 are in central portions of the site where training exercises occur, and BO4-2 is also located very close to two USTs (see Figure 2-8). Furthermore, the detection of contaminants in samples from BO4-2 and BO4-3 indicates that they have been able to infiltrate through the cracks in the pavement. The finding of the heaviest contamination in the deeper samples from borings BO4-5 and BO4-7 indicates that larger spills may have occurred at these locations and that they have been able to infiltrate the sandy surface soils, driven by precipitation, surface run-on/runoff, and possibly the magnitude of the original spills. Surface soils were not sampled because of the visible contamination present, but these soils obviously also contain high concentrations of the semivolatile petroleum hydrocarbons--especially in the blackened areas. Since most samples within and just outside the site area identified in the IAS (see Figure 2-8) contained the contaminants, it is reasonable to assume that similar contamination of varying degrees is probably present in soils throughout this site area and possibly somewhat beyond its boundaries.

Other BNA TICs detected include compounds that are attributable to laboratory procedures rather than to site contamination. Many of these are ketones (compounds ending with "-one"), which are aldol condensation products that consistently arise as byproducts of the BNA extraction step for soil samples in the laboratory. Some of these have

even been detected in laboratory MBs. Most of the remaining compounds are fatty acids and fatty acid esters (e.g., hexadecanoic acid, dioctyl ester), which could arise from the presence of organic materials (e.g., parts of plants) in the samples.

The priority pollutant VOCs detected in the Site 4 soil samples are acetone, chlorobenzene, methylene chloride, and toluene. Of these, acetone, methylene chloride, and toluene are common laboratory contaminants. All of the toluene results, most of the acetone results, and many of the methylene chloride results are similar in magnitude to those in MBs. When comparing some of the concentrations of acetone and methylene chloride reported for the Site 4 soil samples with the range of concentrations detected in MBs and TBs (see Appendix C), it is noted that--though some of the Site 4 sample concentrations appear to be high (i.e., 50 ug/kg)--many of the concentrations of the three constituents are similar to those in the blanks, and all are no greater than 10 times the concentration in blanks.

Thus, according to the criteria established under the USEPA CLP, it is judged that the occurrences of these three constituents are laboratory artifacts rather than real contamination. As will be discussed later, these constituents are also not present in groundwater at the site, which further supports the argument for their nonexistence in overlying soils. If VOCs were present at this site, they would more likely be aromatics (benzene, toluene, xylene, ethylbenzene) related to fuels rather than solvents and paint thinners like acetone and methylene chloride.

Chlorobenzene was detected only in the WB samples, which--it may be recalled--were resampled in March 1989 due to missed holding times. Chlorobenzene was not detected in MBs, so the occurrence of this compound may not be laboratory related. Nevertheless, the finding of chlorobenzene in samples WB4-2B, WB4-3A, and WB4-3B is not believed to represent actual contamination for the following reasons: (1) chlorobenzene was detected in the TB associated with the sampling event, indicating possible introduction of the contaminant during shipment or handling; and (2) chlorobenzene was not found in any of the

"BO4" samples, including those that are known to contain significant contaminant levels. As will be discussed later, chlorobenzene was detected in groundwater in well MW4-3A (the replacement for MW4-3 from which WB4-3A was collected, but which is located about 400 feet to the southeast of WB4-3), but at a very low concentration (13 ug/l; see Table 2-9)--which is less than five times that found in the TB (4 ug/l). Thus, it is believed that chlorobenzene is not present in groundwater, which further supports the contention that it may not be present in the WB soil samples. Even if it was present in soil and/or groundwater, the concentration in soil is very low and the concentration in groundwater is nearly two orders of magnitude below the corresponding drinking water guideline.

A few VOC TICs were detected, mostly in samples BO4-5B and BO4-6A. The detection of 2-propanol in WB4-2A at 25,000 ug/kg is anomalous. Most of the compounds are volatile alkanes, which are petroleum hydrocarbons related to those found among the semivolatiles discussed earlier. Concentrations detected are generally low and significantly lower than those for the semivolatile petroleum hydrocarbons. Thus, it would appear that oil/fuel spill residues in soils at the FFTA are generally present in the far less hazardous form with low volatility.

Oil and grease was detected in borings BO4-1 through BO4-9 at concentrations ranging from 0.6 percent to 7 percent. No oil and grease was detected in the well boring (WB) samples. In general, oil and grease was detected in borings that also contained petroleum hydrocarbons at varying concentrations (i.e., BO4-2 through BO4-7). This would be expected based on the observations of blackened soil and known and suspected spills in these areas. However, it is also noted that the highest concentration of oil and grease (7 percent) was detected in the deeper sample from boring BO4-1, which was meant to be indicative of uncontaminated conditions. As noted previously under the discussion of PAH concentrations, this boring is within the area that would have been filled and leveled during construction of the FFTA. Consequently, the source of the elevated oil and grease in BO4-1 may be the material used as fill during construction of the FFTA and not the

ensuing FFTA activities. Another possible explanation for this detection is that organics (i.e., PAHs) in the soil may have created a false positive detection of oil and grease.

As noted in Section 2.1.5, there are no available standards or guidelines (Federal, State, or local) for contaminants in soils. Thus, the estimated concentration range for naturally occurring lead in soils, as provided by the USGS (Shacklette and Boerngen, 1984), was used as a guide for determining if lead detected at Site 4 could be attributed to site operations. (Lead was the only metal analyzed for at the site.) As shown in Appendix F, this estimated natural range is 3.7 to 53 ug/g.

Lead was detected in all soil samples, but above this estimated concentration range only in samples BO4-1A, BO4-1AX, BO4-1B, WB4-2A, WB4-2B, and WB4-4A. The lead detected in the boring BO4-1--i.e., BO4-1A, BO4-1AX, and BO4-1B--may be due to a previous minor leak or spill of leaded gasoline at this location. The finding of lead in both the shallow and deeper samples indicates that downward migration has occurred. It should be noted, however, that this is the only sample location within the fenced site area at which elevated lead levels were found, though this location was meant to serve as "background." The detection of lead contamination in samples WB4-2A, WB4-2B, and WB4-4A is unexpected, since these samples are outside the main site activity area, and WB4-2A and WB4-4A contain the highest lead concentrations (157 and 299 ug/g, respectively) found in the Site 4 vicinity. It is possible that these lead levels arise from spills or leaks in these areas, possibly from some past or present operations associated with Site 1, or from some seepage from the lagoons that contain lead in their surface water (in the case of WB4-4A only; see Section 2.2.2.3.2). In general, however, the occurrence of elevated lead concentrations does not indicate widespread contamination by lead; nearly all of the elevated levels are close to estimated natural background concentrations; and the site area itself does not appear to be contaminated by lead, at least in the sampled areas with highest probability of contamination. Also, as shown in Table 2-9 and discussed later, lead is present in samples from downgradient wells, but at levels that are an order of magnitude lower than the drinking water standard.

- o Groundwater--Analyses of groundwater samples collected at Site 4 indicated trace amounts of chloride and TOC present in background well MW4-1. The chloride detected is at a concentration well below the IPWSS/Final MCL standard value, the TOC concentration is indicative of natural conditions, and neither detection represents a contamination problem. These two constituents, as well as PCBs and all priority pollutant metals except lead, were analyzed only in well MW4-1, because it also served as a background well for Site 1.

Oil and grease was detected at significant concentrations (49.7 to 237.6 mg/l) in all groundwater samples taken during the first round of sampling, including that from the background well. However, no oil and grease was detected in any of the second round samples. The oil and grease detected during the first round sampling was well above the IPWSS standard (0.1 mg/l) in all of the wells. Normally, the detection of oil and grease in groundwater at a site such as the FFTA could be explained by possible spills or leaks of petroleum products that were heavily used or stored at the site. As shown in Figures 2-8 and 2-11, an extensive network of underground piping and USTs is used for petroleum products; possible leakage* from the piping or tanks could also result in the apparent groundwater contamination observed in Round 1. However, there are some anomalies in the data that make the results difficult, if not impossible, to explain at this stage.

The primary concern is that oil and grease was found in Round 1 at high concentrations, but not at all in Round 2. The relevant issues are as follows:

- The use of different analytical methods for oil and grease in Rounds 1 and 2 does not appear to account for the differences noted. Both Methods 413.1 (used in Round 1) and 413.2 (used in Round 2) would detect heavier oil fractions, and 413.2 would also detect the lighter fraction. Thus, the use of Method 413.2 in Round 2 should have detected oil and grease at concentrations

*To our knowledge, no studies have been performed to date to determine if the piping or tanks have leaked or are currently leaking.

approximately equal to, and possibly even greater than, those detected by Method 413.1 in Round 1.

- It appears that the difference also cannot be explained by seasonal variations between the late fall 1988 and early spring 1989 sampling events, because the water levels in the wells were not significantly different in the two rounds. If water levels had been higher in Round 2, the difference observed might have been explained by dilution effects or the possible movement of the top of the water table outside the screened interval. No other possible seasonal variations would appear to explain the difference. To our knowledge, there is no way that oil and grease detected in the fall could have dissipated by the spring.
- Oil and grease was detected in the background well MW4-1, in addition to the downgradient wells. However, this finding may not be connected with the difference in oil and grease detections between the two rounds. Well MW4-1 may be somewhat downgradient of the locations of two USTs--one current 5,000-gallon diesel tank and one 5,000-gallon gasoline tank that had been removed (see Figure 2-8). At the time of planning and well installation, it was not known that USTs were present at the site. Given this current knowledge, groundwater quality measured at well MW4-1 could be impacted by the aforementioned USTs; consequently, a better location for a Site 4 background well would be at the northeast corner of Site 4.
- As shown in Table 2-10 and as will be discussed later, there is a general lack of both volatile and semivolatile organics in both the first and second round results. If oil and grease were indeed present at the levels indicated in Round 1 data, some of these organics--most probably in the form of petroleum hydrocarbons as found in site soils--should have also been detected. This observation may indicate that contamination by oil and grease is actually not present, which would have to be confirmed through additional sampling.

The only priority pollutant BNA detected at the site was bis(2-ethylhexyl) phthalate--in well MW4-2 in Round 2 at a concentration (13 ug/l) exceeding the proposed MCL (4 ug/l). However, this compound was also detected in MB analyses at concentrations well above those found in the MW4-2 well sample. Consequently, the detection of this constituent is not considered representative of actual contamination at the site. Several unknown BNA TICs were found in the groundwater samples at low concentrations. A comparable range of unknown BNA TICs was also discovered in the MB analyses. Therefore, many of these unknown constituent detections are probably also laboratory artifacts.

Similarly, the priority pollutant VOCs methylene chloride and acetone detected in some of the wells are considered representative of laboratory artifacts, because they, too, were detected in the MB analyses at comparable concentrations. Chlorobenzene was detected in the second round groundwater sample collected from well MW4-3--at a very low estimated concentration (3 ug/l) below the laboratory DL and well below the applicable drinking water guideline. Although not detected in MBs, chlorobenzene was detected in the TB at 4 ug/l, indicating that it probably was introduced during sample shipment or handling and does not represent site contamination. No VOC TICs were detected.

The metals lead, mercury, and zinc were detected in groundwater samples collected at Site 4. Mercury and zinc were analyzed and detected only in background sample MW4-1 and are present at levels below applicable standards. Lead was detected in all wells--though only in Round 2--at low concentrations that are significantly below the respective drinking water standard. Thus, groundwater contamination of concern by lead is not indicated.

2.2.2.3.2 Surface Water Investigation

Site Description--Surface Water. Four surface water samples were collected at the FFTA, as shown in Figure 2-8. Samples SW4-1 and SW4-2 were collected from the surface runoff collector ditch (used as a source of firefighting water, when needed). Samples SW4-3 and SW4-4 were taken from the northern and

southern lagoons, respectively. The lagoons apparently discharge under NPDES permit via an underground pipe to Skokie Ditch in the conduit section beneath the golf course. Surface water runoff not collected by the ditch generally drains overland to the west toward Skokie Ditch.

During the first sampling round, considerable amounts of oil were observed to be floating on the northern lagoon and some was in the water sample collected. A slight oil sheen was observed in the northern lagoon in round 1 and in both lagoons in round 2. No oil sheen was observed in the surface runoff ditch in either round.

Contamination Assessment--Surface Water. For reasons discussed in Section 1.1, the analytical data discussed in this section could not be validated under USEPA Level III and, therefore, are not considered usable for their intended purpose. Thus, the data assessment discussion presented below is highly speculative.

Results of surface water sample analyses indicate that surface water bodies at Site 4 contain varying degrees of petroleum products, though this certainly is not unexpected given their locations and use at the FFTA. Constituents detected in the surface water samples are presented in Table 2-11. This table also provides information on available surface water quality criteria, though these are used for discussion purposes only and are not applicable here because the lagoons and ditch at the FFTA are not aquatic environments. Sample locations are shown in Figure 2-8.

Results of analyses of surface water samples tested for oil and grease indicate that contamination was present in the first round samples collected at locations SW4-3 and SW4-4. All other samples collected had no detectable concentrations of oil and grease. Samples SW4-3 and SW4-4 were collected from each of the two decant ponds. The concentration of oil and grease in sample SW4-3 was very high, measuring approximately 87 parts per thousand, whereas the concentration in sample SW4-4 was only 19.8 ppm. These results are consistent with the observations of oil in the ponds in Round 1, and the general lack of oil in the ponds in Round 2 and in the ditch in both rounds. Oil floating on the lagoon surfaces should not result in groundwater contamination, though some could end up in Skokie Ditch via the NPDES outfall if the lagoons are not skimmed frequently.

The priority pollutant BNAs detected at the FFTA site include bis(2-ethylhexyl) phthalate and the PAHs chrysene, 2-methylnaphthalene, fluorene,

TABLE 2-11

Constituents Detected in Surface Water Samples
Site 4--Fire Fighting Training Area
RI Verification Step at NTC Great Lakes, Illinois

Analytical Parameter	Units	DL (a)	Concentration in Surface Water First Round Sampling (December 1988)					Concentration in Surface Water Second Round Sampling (March 1989)					Potential ARARs	Value
			SW4-1	SW4-1X (b)	SW4-2	SW4-3	SW4-4	DL	SW4-1	SW4-2	SW4-3	SW4-4		
Oil and Grease	mg/l	5	BDL (c)	BDL	BDL	86,853	19.8	0.02	BDL	BDL	BDL	BDL	NA (d)	--
Semivolatile Organics (Priority Pollutants)														
Chrysene	ug/l	10	BDL	BDL	BDL	BDL	BDL	10	BDL	BDL	3	BDL	NA	--
Pyrene	ug/l	10	BDL	BDL	BDL	BDL	BDL	10	BDL	BDL	11	BDL	NA	--
Phenathrene	ug/l	10	BDL	BDL	BDL	BDL	BDL	10	BDL	BDL	22	BDL	NA	--
2-Methylnaphthalene	ug/l	10	BDL	BDL	BDL	2,600	BDL	10	BDL	BDL	BDL	BDL	NA	--
Bis (2-ethylhexyl) phthalate	ug/l	10	BDL	BDL	BDL	BDL	BDL	10	9	9	6	11	NA	--
Fluorene	ug/l	10	BDL	BDL	BDL	900	BDL	10	BDL	BDL	BDL	BDL	NA	--
Semivolatile Organics (Tentatively Identified Compounds)														
Unknowns (total)	ug/l	--	11	10	11	400,263	241	--	126	73	324	271	NA	--
10-Methyleicosane	ug/l	--	ND (e)	ND	9	ND	ND	--	ND	ND	380	ND	NA	--
Octacosane	ug/l	--	ND	ND	11	ND	ND	--	ND	ND	ND	ND	NA	--
Dodecane	ug/l	--	ND	ND	11	6,500	ND	--	ND	ND	ND	ND	NA	--
Nonadecane	ug/l	--	ND	ND	11	32,000	ND	--	ND	ND	ND	91	NA	--
Undecane	ug/l	--	ND	ND	11	370	ND	--	ND	ND	ND	ND	NA	--
Tricosane	ug/l	--	ND	ND	ND	ND	ND	--	ND	ND	280	ND	NA	--
2,6,10-Trimethyltetradecane	ug/l	--	ND	ND	ND	ND	ND	--	ND	ND	64	ND	NA	--
2-Methyltridecane	ug/l	--	ND	ND	ND	ND	ND	--	ND	ND	100	ND	NA	--
2,10-Dimethylundecane	ug/l	--	ND	ND	ND	ND	ND	--	ND	ND	310	ND	NA	--
7-Hexyleicosane	ug/l	--	ND	ND	ND	ND	ND	--	ND	ND	370	ND	NA	--
2,6,10,14-Tetramethylhexadecane	ug/l	--	ND	ND	ND	ND	ND	--	ND	ND	310	35	NA	--
4-Methyltridecane	ug/l	--	ND	ND	ND	ND	ND	--	ND	ND	100	ND	NA	--
Heptacosane	ug/l	--	ND	ND	ND	ND	ND	--	ND	ND	210	ND	NA	--
6-Ethyl-2-Methyldecane	ug/l	--	ND	ND	ND	ND	ND	--	ND	ND	370	ND	NA	--
2,7,10-Triethyldecane	ug/l	--	ND	ND	ND	ND	ND	--	ND	ND	64	ND	NA	--
3-Methyl-5-Propylnonane	ug/l	--	ND	ND	ND	ND	ND	--	ND	ND	130	ND	NA	--
3,6-Dimethyldecane	ug/l	--	ND	ND	ND	ND	ND	--	ND	ND	65	ND	NA	--
2-Methyl-8-Propyldecane	ug/l	--	ND	ND	ND	ND	ND	--	ND	ND	110	ND	NA	--
5-Ethylundecane	ug/l	--	ND	ND	ND	ND	ND	--	ND	ND	75	ND	NA	--
4,6-Dimethylundecane	ug/l	--	ND	ND	ND	ND	ND	--	ND	ND	160	ND	NA	--
5-Propyldecane	ug/l	--	ND	ND	ND	ND	ND	--	ND	ND	200	ND	NA	--
3,7-Dimethylnonane	ug/l	--	ND	ND	ND	ND	ND	--	ND	ND	ND	10	NA	--
Eicosane	ug/l	--	ND	ND	ND	ND	ND	--	ND	ND	ND	35	NA	--
2,6,10,13,19,23-Tetracosane	ug/l	--	ND	ND	ND	ND	ND	--	ND	ND	ND	64	NA	--

- (a) Detection limit.
 (b) Field duplicate.
 (c) Below detection limit.
 (d) None available.
 (e) None detected.
 (f) Ambient Water Quality Criteria-Freshwater Acute Criteria.
 (g) Illinois General Use Water Quality Standard.

NOTE: For reasons discussed in Section 1.1, these data could not be validated under USEPA Level III and, therefore, are not usable for their intended purpose.

TABLE 2-11 (cont'd)

Analytical Parameter	Units	DL (a)	Concentration In Surface Water First Round Sampling (December 1988)					Concentration In Surface Water Second Round Sampling (March 1989)					Potential ARARs	Value
			SW4-1	SW4-1X (b)	SW4-2	SW4-3	SW4-4	DL	SW4-1	SW4-2	SW4-3	SW4-4		
Semivolatile Organics (Tentatively Identified Compounds) (cont'd)														
Tetracosane	ug/l	--	ND	ND	ND	ND	ND	--	ND	ND	ND	30	NA	--
2,3,5-Trimethyldecane	ug/l	--	ND	ND	ND	ND	ND	--	ND	ND	ND	41	NA	--
2-Methyl-6-Propyldodecane	ug/l	--	ND	ND	ND	ND	ND	--	ND	ND	ND	90	NA	--
3,5-Dimethylundecane	ug/l	--	ND	ND	ND	ND	ND	--	ND	ND	ND	66	NA	--
2,7,10-Trimethyldodecane	ug/l	--	ND	ND	ND	ND	ND	--	ND	ND	ND	100	NA	--
2,5-Dimethyldodecane	ug/l	--	ND	ND	11	130	ND	--	ND	ND	ND	ND	NA	--
2-Methylundecane	ug/l	--	ND	ND	11	220	ND	--	ND	ND	ND	ND	NA	--
3-Methylundecane	ug/l	--	ND	ND	11	96	ND	--	ND	ND	ND	ND	NA	--
1-Methyl-4-(2-methyl) benzene	ug/l	--	ND	ND	11	90	ND	--	ND	ND	ND	ND	NA	--
3,6-Dimethyldodecane	ug/l	--	ND	ND	11	320	ND	--	ND	ND	ND	ND	NA	--
6-Propyltridecane	ug/l	--	ND	ND	11	660	ND	--	ND	ND	170	ND	NA	--
1,1'-(1,2-ethenediyl) benzene	ug/l	--	ND	ND	11	410	ND	--	ND	ND	ND	ND	NA	--
3-Methylphenanthrene	ug/l	--	ND	ND	11	700	ND	--	ND	ND	ND	ND	NA	--
Tricarbonyl (N-(Phenyl-2) iron	ug/l	--	ND	ND	11	1,400	49	--	ND	ND	ND	67	NA	--
Hexacosane	ug/l	--	ND	ND	11	ND	11	--	ND	ND	ND	ND	NA	--
2,7,10-Trimethyldodecane	ug/l	--	ND	ND	11	ND	28	--	ND	ND	ND	ND	NA	--
Hexadecane	ug/l	--	ND	ND	11	ND	21	--	ND	533	ND	130	NA	--
Heptadecane	ug/l	--	ND	ND	11	ND	74	--	ND	400	ND	ND	NA	--
2,6,10,14-Tetramethylpentadecane	ug/l	--	ND	ND	11	ND	58	--	ND	ND	ND	ND	NA	--
Pentadecane	ug/l	--	ND	ND	11	ND	ND	--	ND	ND	300	69	NA	--
2,6,10,15-Tetramethylheptadecane	ug/l	--	ND	ND	11	ND	ND	--	ND	ND	89	ND	NA	--
Volatile Organics (Priority Pollutants)														
Acetone	ug/l	10	BDL	BDL	BDL	110	11	10	BDL	BDL	10	26	NA	--
Benzene	ug/l	5	BDL	BDL	BDL	BDL	BDL	5	BDL	BDL	2	BDL	AWQC-FAC (f)	5,100
Chlorobenzene	ug/l	5	BDL	BDL	BDL	BDL	BDL	5	BDL	2	5	BDL	AWQC-FAC	11,000
Methylene Chloride	ug/l	5	5.0	BDL	5.0	BDL	BDL	5	4	5	8	96	NA	--
Volatile Organics (Tentatively Identified Compounds)														
Unknowns (total)	ug/l	--	ND	ND	ND	25	ND	--	55	ND	ND	ND	NA	--
Butanol	ug/l	--	ND	ND	ND	11	ND	--	ND	ND	ND	ND	NA	--
Lead	ug/l	2	7.78	BDL	38.0	2.23	6.73	3.0	5.67	7.94	27.0	8.48	ICWQS (g)	100

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phenanthrene, and pyrene. Because bis(2-ethylhexyl) phthalate was not detected in MBs associated with soil samples, its presence may be indicative of site contamination by plastics or the use of plastic equipment in the field. 2-Methylnaphthalene at 2,600 ug/l and fluorene at 900 ug/l were detected in the first round surface water samples taken at SW4-3 in the northern lagoon, but not in the second round. Chrysene, pyrene, and phenanthrene were detected only in the second round samples taken from location SW4-3, and all were at very low concentrations near or below the laboratory DL. The presence of PAHs appears to be connected to the combustion of oil/fuel at the site; the PAHs are products of incomplete combustion that could be present in wastes from the oil/water separator and lagoons. The concentrations appear to vary with amounts of oil and grease present. Because of their insolubility, it is unlikely that PAHs would contribute to groundwater contamination. They could be discharged into Skokie Ditch via the NPDES outfall, though none were found in the ditch in either sampling round.

A large number of BNA TICs were also detected--primarily in the lagoons. The highest concentrations were found in Round 1 in the northern lagoon and again appear to correlate with the high concentration of oil and grease in that sample. As in the soil samples, nearly all of the BNA TICs are alkanes, as would be expected to be present in lagoons used for oil/water separation. Both lagoon samples contained these compounds in both rounds. Little or none were detected in the runoff ditch samples in Round 1; some were detected in sample SW4-2 in Round 2.

Of the priority pollutant VOCs detected, acetone and methylene chloride are not considered to represent site contaminants due to their presence in MBs. As discussed earlier (Section 2.2.2.3.1), chlorobenzene is probably also not a site contaminant based on its presence in the TB. Benzene was detected only once, in the sample from the northern lagoon during Round 2, but at a very low estimated concentration (2 ug/l) below the analytical method DL. This concentration of benzene is of little concern, especially when compared with the FAC value of 5,300 ug/l, indicating that discharge of this benzene into Skokie Ditch would not adversely impact the aquatic environment (if any). VOC TICs were detected at low levels only in sample SW4-3 in Round 1--which again correlates with the high oil and grease level in that sample--and in SW4-1 from the runoff ditch.

Finally, lead was detected in lagoon and ditch surface water samples taken during the first and second rounds, but at concentrations well below the IGWQS

value. This lead may be of natural origin or may have accumulated in lagoons and ditch sediments when leaded gasoline was used at the site. The presence of lead in these surface water bodies should be of no concern because they are not aquatic environments and, since the lead concentrations are well below both the IGWQS and the drinking water standard, groundwater quality should not be (and has not been) adversely impacted. The only concern is that waters discharged from the lagoon to Skokie Ditch would contain this lead. As discussed in Section 2.2.1.3.2, some lead has been detected in Skokie Ditch surface water samples, though also at concentrations below the IGWQS, and Site 4 may be a source.

2.2.2.4 Site 4 Summary

Contamination has been found to be present in the soils, groundwater, and surface water at the FFTA. The occurrence types, and concentrations of contaminants detected, however, are of little surprise here given the nature of site operations, which undoubtedly involved some leaks and spills of petroleum products and which have resulted in visibly contaminated soil areas.

Contaminants in soils include oil and grease, PAHs, volatile and semivolatile alkanes (petroleum hydrocarbons), and lead. The PAHs are present in a few of the soil borings, but primarily in the samples collected from the 3.5- to 5-foot depth interval. PAHs--which are byproducts of incomplete combustion--could be related to the burning of liquid fossil fuels at the site, but are more likely related to the ash and cinders (from coal or wood burning) that are often used for ground fill and stabilization. PAHs are highly immobile in the environment, so should not adversely impact groundwater quality and, accordingly, have not been detected in groundwater at the site. The petroleum hydrocarbons were found throughout the site area identified in the IAS (see Figure 2-8) in samples from varying depths, but mostly in the heavily contaminated areas near the former drum staging area and shed, which are heavily oil-stained and blackened. The occurrence of these compounds is a direct result of spills and leaks during site activities. Downward infiltration as a result of heavy spills, precipitation, and surface run-on/runoff is indicated, and groundwater could be adversely impacted; there are some possible indicators that this may have already occurred. In soils samples collected from borings apparently upgradient and downgradient of the site, lead was detected at concentrations apparently elevated above estimated natural soil concentrations. This may have arisen from isolated minor spills of leaded gasoline at the sample

locations, or from past or present operations at the golf course in the case of the downgradient WB samples. In any case, the contamination appears to be isolated, the site area within the fence generally appears not to be contaminated by lead, and the elevated lead concentrations detected are not very high.

Although oil and grease was detected at concentrations ranging from 49.7 to 237.6 mg/l in all groundwater samples (including that from the background well) in the first round, groundwater contamination by oil and grease could not be confirmed since none was detected in the second round. It was noted that neither the different analytical methods used in Rounds 1 and 2 (USEPA Methods 413.1 and 413.2, respectively) nor the limited seasonal water table fluctuations observed would account for the widely different observations between the two sampling events. The general lack of volatile and semivolatile petroleum hydrocarbons in VOC and BNA analyses in both rounds may support the contention that the groundwater is not contaminated. If contamination is present, its source could be the spills and leaks during surface operations (as evidenced by contaminated soils), and/or potential though as yet unconfirmed leaks from the USTs and associated network of underground piping--which are located throughout the site and possibly upgradient of the apparent background well. The minor lead contamination in soils does not seem to have affected the groundwater.

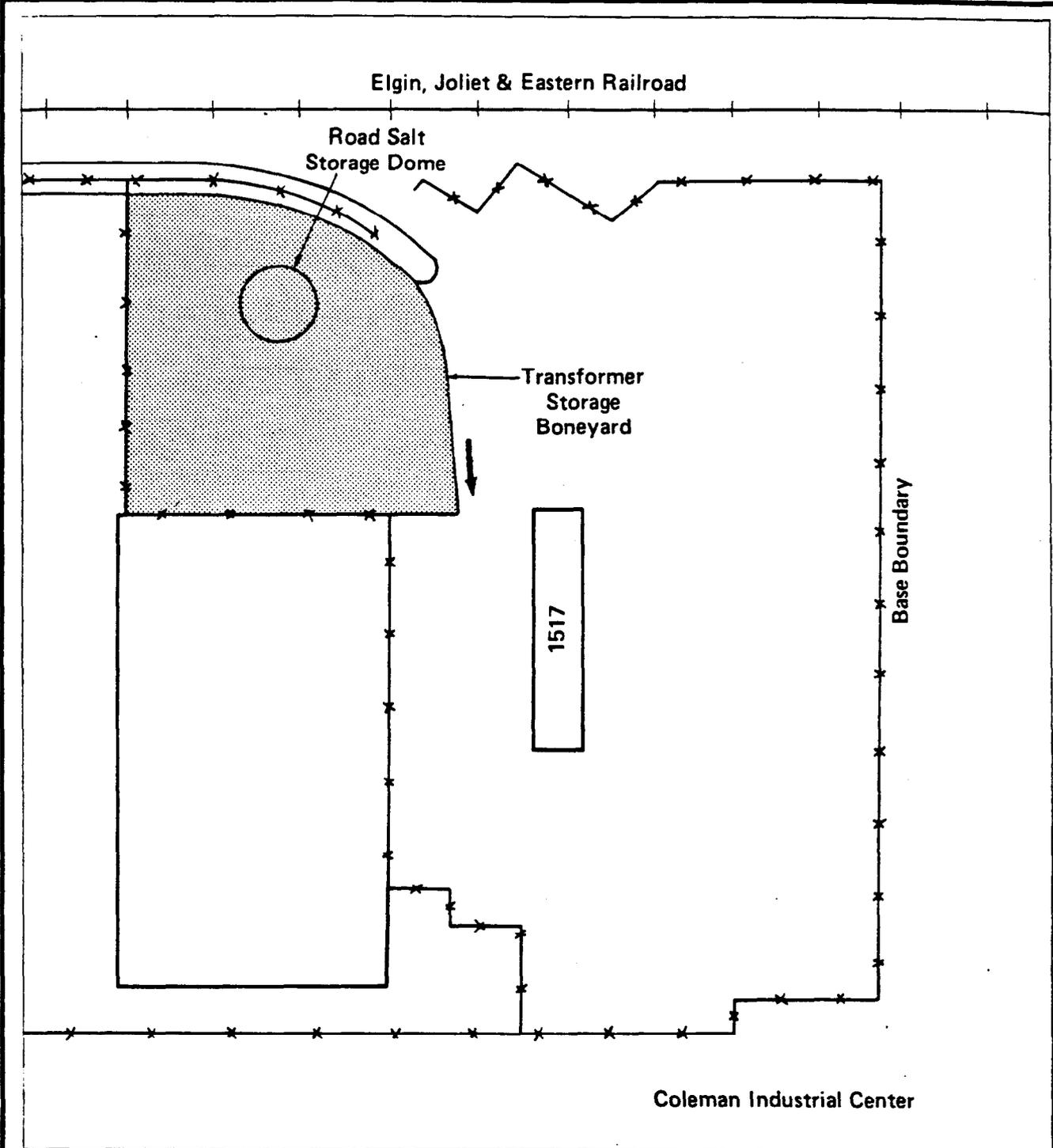
Surface water bodies at the site--which include the lagoons and a runoff ditch--contain some contamination connected with petroleum product usage at the site. Constituents detected include some PAHs, high levels of semivolatile petroleum hydrocarbons where oil and grease is also present, and lead. This contamination is not unexpected, because the lagoons were meant to receive wastewater containing oil and the ditch collects site runoff. The primary concern is for release of excess contaminants into Skokie Ditch via the NPDES outfall.

2.2.3 Site 5, Transformer Storage "Boneyard"

2.2.3.1 Nature and Extent of Problems Leading to Investigation

This area consists of approximately 2 acres located in the northwestern end of the Camp Moffett section of the Installation. It currently consists of a partially paved yard located southwest of Bldg. 1517; east of the Elgin, Joliet & Eastern Railroad right-of-way, and west of the drill field, as shown in Figure 2-12.

Between 1945 and 1985, the Transformer Storage Boneyard was reportedly used primarily for the storage of out-of-service transformers, including some filled



 Site Area Identified in IAS

 Assumed General Direction of Surface Drainage



0 100 200 Feet
SCALE

FIGURE 2-12
TRANSFORMER STORAGE "BONEYARD"
(SITE 5)

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**REMEDIAL INVESTIGATION/
FEASIBILITY STUDY**
NAVAL TRAINING CENTER
Great Lakes, Illinois

with PCB-containing oil. During the IAS, about 40 non-PCB transformers and capacitors were stored at Site 5. It is reported that the transformers may have been located anywhere within the yard during this period. Review of aerial photography covering this 40-year period reveals that objects of varying sizes and configurations have been stored in various locations in the storage yard, as well as in the drill field, the area surrounding Bldg. 1517, and the area adjacent to the north side of the storage yard and drill field. In addition, a sizable building, previously unidentified, filled most of the center of the current storage yard until sometime between 1964 and 1970, when it was no longer visible and obviously demolished. Current Installation personnel do not have any knowledge of this former structure or its uses. Since 1985, all PCB-contaminated materials have been removed to a specialized storage facility.

During the initial site reconnaissance, it was observed that the yard is currently occupied by a new salt storage dome, some out-of-service non-PCB transformers and capacitors, coils of lead-insulated cable, heavy equipment, and other miscellaneous scrap metal and materials. Open drums of motor oil and other lubricants were located near the salt dome and heavy equipment. Ground stains were evident in this and other areas of the site.

Four surface soil samples were collected in the yard in 1984. Reported analysis results indicate that the soils contained between 50 and 100 ppm PCBs. No information appears to be available on the location or depth of these samples. The IAS presented these results, but did not reference the source.

As discussed in the IAS, oily wastes and PCBs at this site are most likely tied up in the shallow soils; the most probable migration pathway was believed to be by being tracked out on vehicle tires or the shoes of employees who walk in that area. In addition, it was noted that surface runoff from major storm events may erode some of the surface soils from unpaved areas. However, the site is very flat, and no distinct drainageways are visible. Eroded materials may pool around the site or be redeposited a short distance from the site. Receptors identified in the IAS include those employees who frequently work in the Transformer Storage Boneyard and those who work in nearby areas to which "boneyard" employees may track the contaminated soils. Therefore, the site was recommended for an RI in the IAS.

2.2.3.2 RI Verification Step Field Program

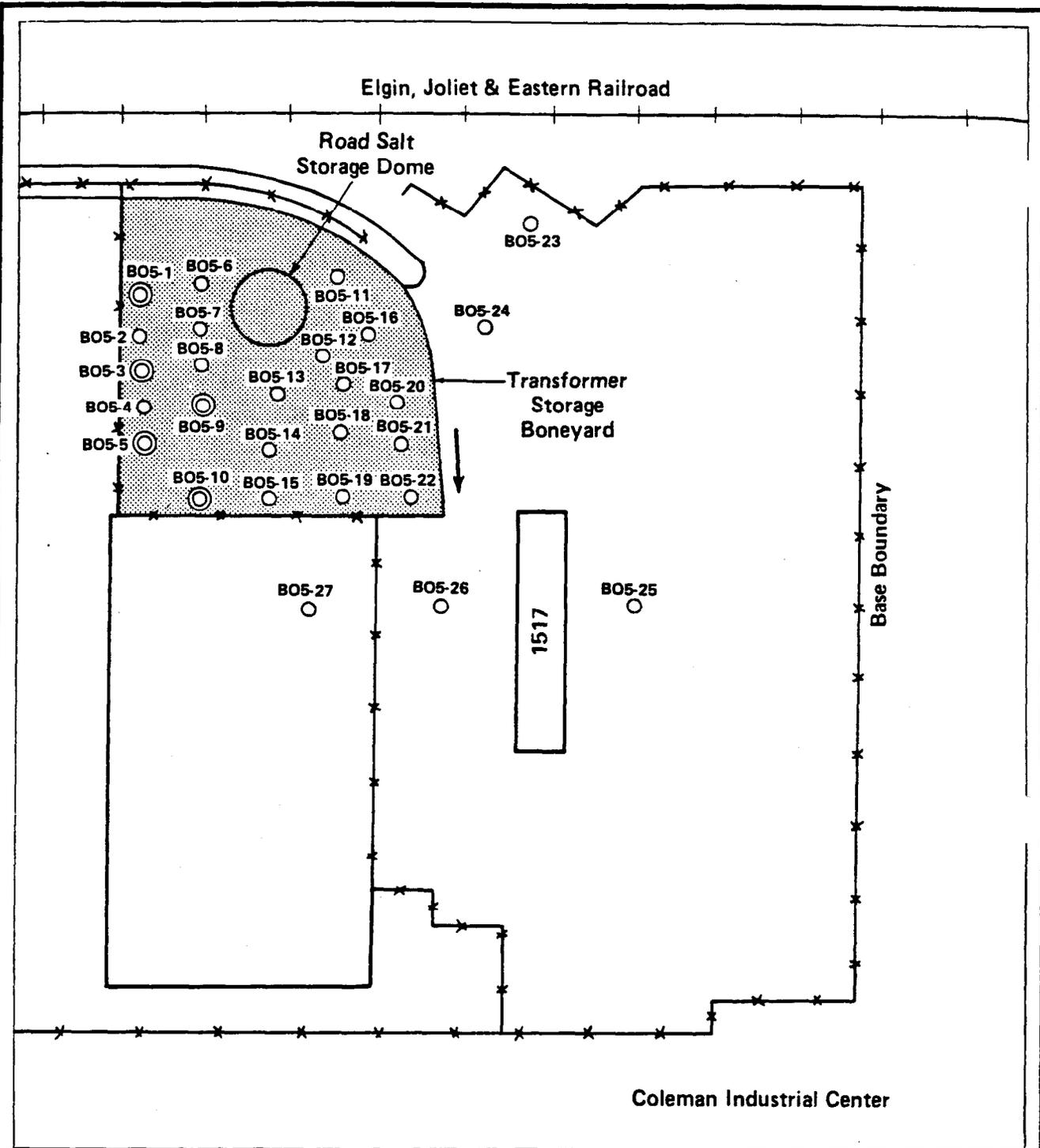
Based on the nature and behavior of the primary contaminant--PCBs--in this area (i.e., PCBs have relatively low mobility in soils) and the expected probable lack of concentrated contaminant source areas, sampling of the shallow soil zones was deemed sufficient to give an initial indication of the horizontal and vertical extent of contamination. Groundwater sampling was determined to be unnecessary during this initial verification step investigation. Furthermore, no surface water or sediment sampling was conducted, because no distinct drainageways were observed at this site.

2.2.3.2.1 Hydrogeologic Investigation

The field program at Site 5 consisted of the collection of 32 shallow soil samples. Previous soil samples taken from this site contained between 50 to 100 ppm of PCBs. However, location and depth information for these samples was not available. Therefore, the present sampling program was designed to provide coverage of the entire site area. The 22 sampling locations selected within the site area identified in the IAS (BO5-1 through BO5-22) are shown in Figure 2-13. Near-surface samples were collected from the approximate depth interval of 0.5 to 1 foot at each of these locations. In addition, five of these locations--BO5-1, BO5-3, BO5-5, BO5-9, and BO5-10--were selected at the time of sampling for the collection of samples from a depth interval of 1.5 to 2 feet to provide preliminary data on vertical extent. These locations were selected on the basis of accessibility and visual evidence of soil contamination. The deeper of the two samples at each of these locations is designated by the suffix "A."

As illustrated in Figure 2-13, the samples in the former storage yard were collected in roughly a rectangular grid pattern, adjusted to cover areas throughout the site and to account for the presence of vehicles and material stockpiles that were avoided to facilitate sampling. After the 22 samples were collected from the 0.5- to 1-foot depth, the sampling team evaluated their visual observations of soil contamination and, having noted no significant variations in appearances, selected the five locations for deeper sampling based on ease of accessibility and some visual evidence of possible contamination.

An additional five shallow sample locations outside the "boneyard" area--BO5-23 through BO5-27--were selected to be sampled at 0.5- to 1-foot depths.



-  Site Area Identified in IAS
-  Assumed General Direction of Surface Drainage
-  Soil Sampling Location, Sample Collected from a Depth of .5-1 Foot
-  Soil Sampling Location, Samples Collected from Depths of .5-1 Foot and from 1.5-2 Feet

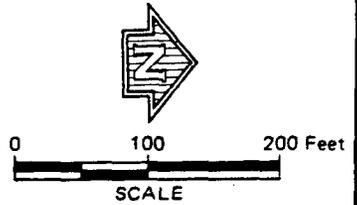


FIGURE 2-13
SOIL SAMPLING LOCATIONS
TRANSFORMER STORAGE "BONEYARD"
(SITE 5)



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These locations were selected to coincide with other areas of possible transformer storage noted in aerial photographs. The samples provide a preliminary indication of conditions beyond the "boneyard" itself.

All borings were backfilled with cuttings and materials from stockpiles on-site. The analytical parameters for these samples were PCBs, oil and grease, and lead. They were selected based on the composition of materials stored at this site, including PCB-containing transformer oils, other oils and lubricants, and lead cable insulation.

2.2.3.3 RI Verification Step Findings

2.2.3.3.1 Hydrogeologic Investigation

Site Description--Soils and Geology. The Transformer Storage Boneyard area is located in a nearly level field approximately 1,000 feet west of a branch of Pettibone Creek, with elevations about 660 feet above msl. The surface is partially paved and gravelled. No surface drainageways are evident on this site, but drainage is generally toward a storm drain south of Bldg. 1517.

The site, as well as the Installation in general, is underlain by glacial till approximately 170 feet thick with irregular and discontinuous lenses or zones of sand and gravel.

Subsurface conditions at the site are expected to be similar to those encountered at the adjacent drill field to the east. The drill field was investigated for foundation conditions as part of a feasibility study for a new FFTU (Dames & Moore, 1987c; 1988). The conditions encountered in 11 borings--seven at 30 feet (CM-1, 3, 4, 5, 8, 10, and 11), three at 70 feet (CM-6, 7, and 9), and one at 75 feet (CM-2)--at the drill field, which are expected to be similar to those at the "boneyard" area, are summarized below. (Information provided by NTC Great Lakes indicates that the new FFTU was under construction as of June 1990, but the selected location was in the RTC rather than at either area originally investigated by Dames & Moore.

Underlying the asphalt pavement and the gravel or topsoil layers at the drill field is a fill of silty clay, clayey silt, or sand, which extends to a depth of 1.5 to 3 feet below the existing ground surface. Beneath the fill, four borings encountered a 2- to 9-foot-thick stratum of gray and tan/brown medium stiff-to-very stiff

clayey silt/silty clay. Below the clayey silt/silty clay stratum in two borings, and the fill in three others, is a stratum of gray and/or brown fine-to-coarse silty/clayey sand that varies in thickness from 2.5 to 14.5 feet and, in places, is very loose at shallow depths and grades to medium dense with depth. Underlying the sand in five borings, the fill in four borings, and the silt in two others is a stratum of brown and/or gray stiff-to-hard silty clay that extends to a depth of 50 to 57 feet. Borings that extended to a depth of 30 feet terminated in the silty clay stratum. Beneath the silty clay in one boring is a 4-foot-thick pocket of gray, hard clayey silt. Underlying the silt in this one boring and the clay in the remaining deep borings is an 8- to 18-foot-thick medium dense-to-very dense stratum of gray sand. The sand stratum is underlain by a stiff-to-hard gray silty clay that is present to the explored depths of 70 to 75 feet. Groundwater was recorded at depths ranging from 1.8 to 17.6 feet in the borings.

In summary, borings at the drill field indicate that subsurface conditions to depths of 25 to 30 feet can vary significantly over short distances; however, below 30 feet, less variation and more clay are encountered. Downward migration of contaminants through the clay till is not likely. In addition, there are no water wells on the Installation currently being used for water supply that could be impacted by contaminant migration.

The present storage yard is used for vehicle and material storage. In addition to the salt storage dome, stockpiles of sand, gravel, and topsoil are kept here, apparently for roads and grounds maintenance. A variety of vehicles--mostly vans and light trucks--are parked in the yard, primarily on the south side of the salt dome. The surface of the "boneyard" is primarily loose gravel. It should be noted that the foundation/perimeter wall of the building noted in the aerial photographs (see Section 2.2.3.1) was identifiable along the south and east sides of the yard, but not elsewhere due to the presence of vehicles and material stockpiles.

As described in Section 2.2.3.2, 32 shallow soil samples were collected from 27 locations in the "boneyard" and nearby areas to attempt to characterize the vertical extent and, to a lesser degree, the horizontal extent of contaminants in the soils of the site. The soils encountered in these shallow hand auger borings consisted primarily of clay, with varying proportions of sand, silt, and gravel.

Contamination Assessment--Soils. For reasons discussed in Section 1.1, the analytical data discussed in this section could not be validated under USEPA Level

III and, therefore, are not considered usable for their intended purpose. Thus, the data assessment discussion presented below is highly speculative.

Results of analyses of soil samples taken at Site 5 indicate the presence of oil and grease and PCBs, and of lead at elevated concentrations. Constituents and their concentrations detected in the soils are presented in Table 2-12. The table also indicates the estimated concentration range for naturally occurring lead in soils of the area. Sample locations are shown in Figure 2-13.

Oil and grease was detected in nearly all soil samples collected throughout the Site 5 area in the concentration range of 0.6 to 21.0 percent. On average, surface soil samples (0.5 to 1 foot) were generally the most heavily contaminated, though oil and grease was also detected in all samples collected from the 1.5- to 2-foot depth area, indicating that downward migration has occurred. Where deeper soil samples were collected, the oil and grease concentration in the deeper samples is always lower than the concentration in the overlying surface sample. This contamination is presumably due to leaks from stored vehicles, vehicle maintenance activities, transformer storage, and possibly storage of other oily materials. The levels of oil and grease detected are relatively high but not unexpected for a storage yard of this type.

Sampling of site soils for PCBs resulted in the detection of a single PCB--Arochlor-1260, a form commonly used in PCB transformers. As shown in Figure 2-14, this contaminant was detected primarily in the northeast corner of the former storage yard--at concentrations ranging from 2,935 to 87,000 ug/kg (2.935 to 87 ppm). As discussed earlier, though the site is quite flat, drainage generally trends to the northwest, indicating that PCB-1260 possibly spilled or leaked from transformers at various portions of the site, or that site soils containing PCB-1260 may have flowed or eroded to and collected in the area in which the contaminant has been presently found. Alternatively, since PCBs tend to be tightly bound to soils and since overland flow or erosion is a contaminant migration mechanism of limited significance at this flat site, it is possible that the finding of PCB-1260 at the northwest corner of the site merely indicates that PCB transformers were stored primarily in this portion of the yard. No deeper soil samples were collected at any of the locations where PCB-1260 was detected to indicate the possibility of downward migration of the contaminant.

TABLE 2-12

Constituents Detected in Soil Samples
 Site 5, Transformer Storage Boneyard
 RI Verification Step at NTC Great Lakes, Illinois

Analytical Parameter	Units	DL (a)	Concentration in Soil											Estimated Concentration Range in Natural Soils (c)
			BO5-1 0.5-1	BO5-1A 1.5-2	BO5-1AX (b) 1.5-2	BO5-2 0.5-1	BO5-3 0.5-1	BO5-3A 1.5-2	BO5-3AX (b) 1.5-2	BO5-4 0.5-1	BO5-5 0.5-1	BO5-5A 1.5-2	BO5-6 0.5-1	
Oil and Grease	percent	0.6	2.8	1.7	2.0	5.4	6.5	3.5	2.7	0.66	21.0	0.76	1.6	--
Polychlorinated Biphenyls														
Arochlor-1016	ug/kg	80	BDL (d)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	--
Arochlor-1221	ug/kg	80	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	--
Arochlor-1232	ug/kg	80	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	--
Arochlor-1242	ug/kg	80	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	--
Arochlor-1248	ug/kg	80	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	--
Arochlor-1254	ug/kg	160	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	--
Arochlor-1260	ug/kg	160	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	--
Lead	ug/g	2.5	102.4	84.5	119.0	106.0	304	280	174.2	33.4	35.1	12.1	24.0	3.7-33

(a) Detection limit.

(b) Field duplicate.

(c) From Shacklette and Boerngen, 1984. Values noted are the estimated range for 95 percent of the samples in the USGS study.

(d) Below detection limit.

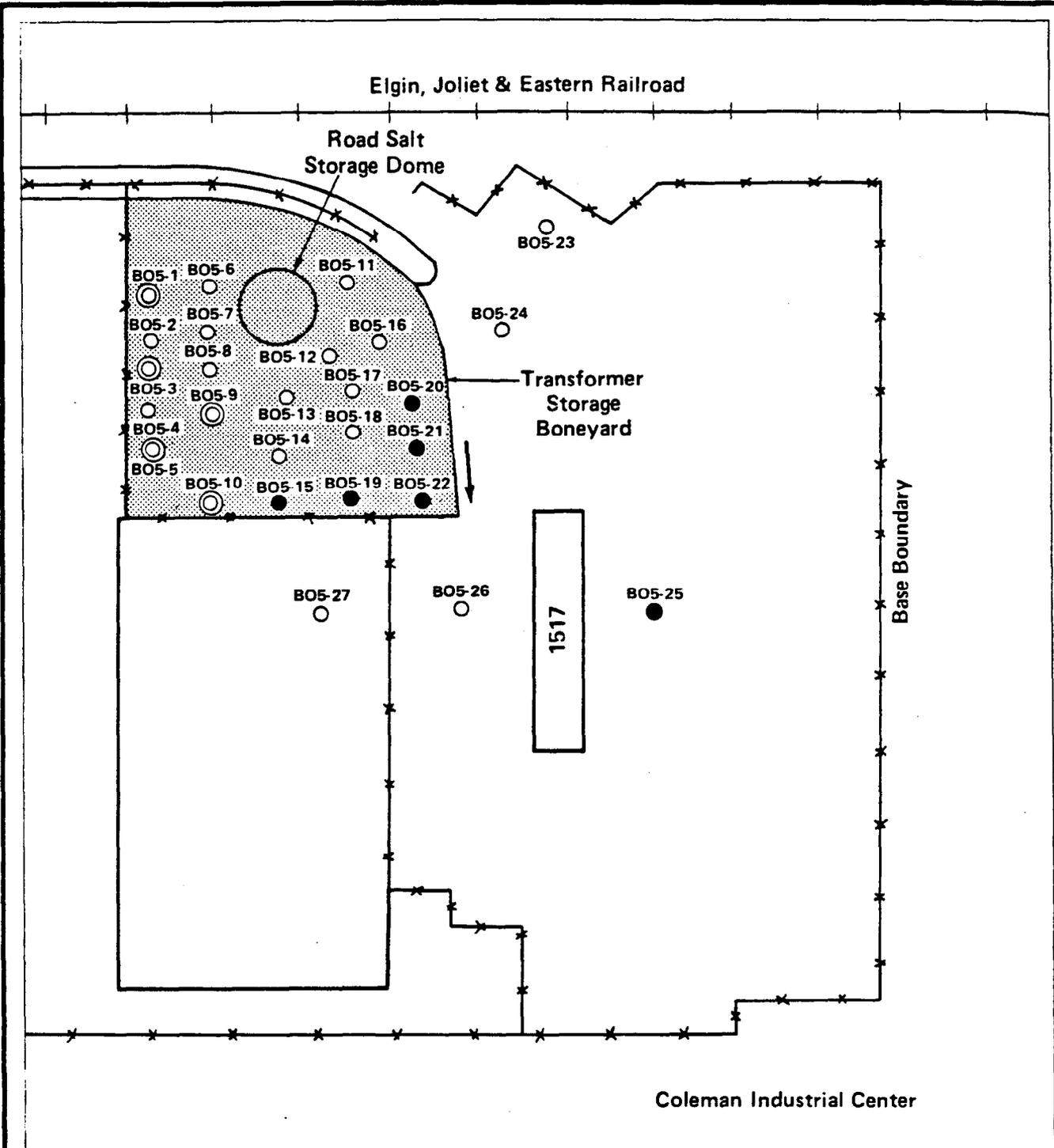
NOTE: For reasons discussed in Section 1.1, these data could not be validated under USEPA Level III and, therefore, are not usable for their intended purpose.

TABLE 2-12 (cont'd)

Analytical Parameter	Units	DL (a)	Concentration in Soil										Estimated Concentration Range in Natural Soils	
			BO5-7 0.5-1	BO5-8 0.5-1	BO5-9 0.5-1	BO5-9A 1.5-2	BO5-10 0.5-1	BO5-10A 1.5-2	BO5-11 0.5-1	BO5-12 0.5-1	BO5-13 0.5-1	BO5-14 0.5-1		BO5-15 0.5-1
Oil and Grease	percent	0.6	0.6	0.7	BDL	BDL	4.3	1.9	1.4	3.2	0.68	1.1	0.6	--
Polychlorinated Biphenyls														
Arochlor-1016	ug/kg	80	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	--
Arochlor-1221	ug/kg	80	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	--
Arochlor-1232	ug/kg	80	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	--
Arochlor-1242	ug/kg	80	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	--
Arochlor-1248	ug/kg	80	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	--
Arochlor-1254	ug/kg	160	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	--
Arochlor-1260	ug/kg	160	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2,935	--
Lead	ug/g	2.5	11.3	11.2	8.73	7.9	31.0	31.1	27.4	16.3	36.4	9.2	261.5	3.7-33

TABLE 2-12 (cont'd)

Analytical Parameter	Units	DL (a)	Concentration In Soil											Estimated Concentration Range in Natural Soils (c)	
			BO5-16 0.5-1	BO5-17 0.5-1	BO5-18 0.5-1	BO5-19 0.5-1	BO5-20 0.5-1	BO5-21 0.5-1	BO5-22 0.5-1	BO5-23 0.5-1	BO5-24 0.5-1	BO5-25 0.5-1	BO5-26 0.5-1		BO5-27 0.5-1
Sample Depth (ft):															
Oil and Grease	percent	0.6	1.9	0.6	1.6	BDL	BDL	5.3	1.2	3.3	5.3	BDL	0.6	1.05	--
Polychlorinated Biphenyls															
Arochlor-1016	ug/kg	80	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	--
Arochlor-1221	ug/kg	80	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	--
Arochlor-1232	ug/kg	80	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	--
Arochlor-1242	ug/kg	80	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	--
Arochlor-1248	ug/kg	80	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	--
Arochlor-1254	ug/kg	160	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	--
Arochlor-1260	ug/kg	160	BDL	BDL	BDL	23,000	8,400	3,200	87,000	BDL	BDL	460	BDL	BDL	--
Lead	ug/g	2.5	100.1	48.9	365.3	1,134.5	758.8	95.7	335	262	25.9	106.4	216.1	78.0	3.7-53



-  Site Area Identified in IAS
-  Assumed General Direction of Surface Drainage
-  Soil Sample Collected from .5-1 Foot
-  Soil Samples Collected from .5-1 and 1.5-2 Feet
-  Denotes Location where PCB-1260 was Detected

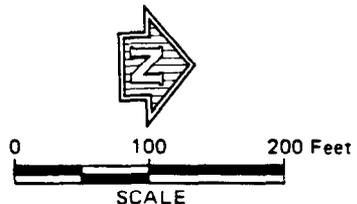


FIGURE 2-14
PCB-1260 AT SOIL SAMPLING LOCATIONS
TRANSFORMER STORAGE "BONEYARD"
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PCB-1260 was also detected in a sample collected on the north side of Bldg. 1517, but at a concentration (460 ug/kg) one to two orders of magnitude lower than the range of concentrations detected in the northeast corner of the yard. The occurrence of PCB-1260 at this location may be due to a minor spill in the area or possibly to tracking of PCBs from the storage yard by vehicle tires and workers' shoes, as suggested by the IAS.

PCB concentrations in the northeast corner of the former storage yard are both above and below 50 ppm, the level at which disposal of the contaminated soil in specially permitted landfills would be required (applicable to the 50 to 500 ppm range) under regulations promulgated under the Toxic Substances Control Act (TSCA) (40 CFR 761). In addition, some of the concentrations are in excess of potentially applicable PCB cleanup guidelines of the USEPA and the State of Illinois. Under the USEPA's PCB cleanup policy under TSCA (52 FR 10688, April 2, 1987), which is applicable to new PCB spills (as opposed to past spills), restricted access areas would require cleanup to 25 ppm PCBs, while nonrestricted areas would require cleanup to 10 ppm and removal of at least 10 inches of soil (or more if necessary to reach 10 ppm). The "boneyard" would be considered a nonrestricted access area; therefore, the second criterion would apply if some of the PCBs were from recent spills or leaks. Of course, the PCBs found here are from past spills and leaks, in which case USEPA's cleanup policy is not strictly applicable but may be relevant and appropriate. The State of Illinois does not currently have a single cleanup level for PCBs.

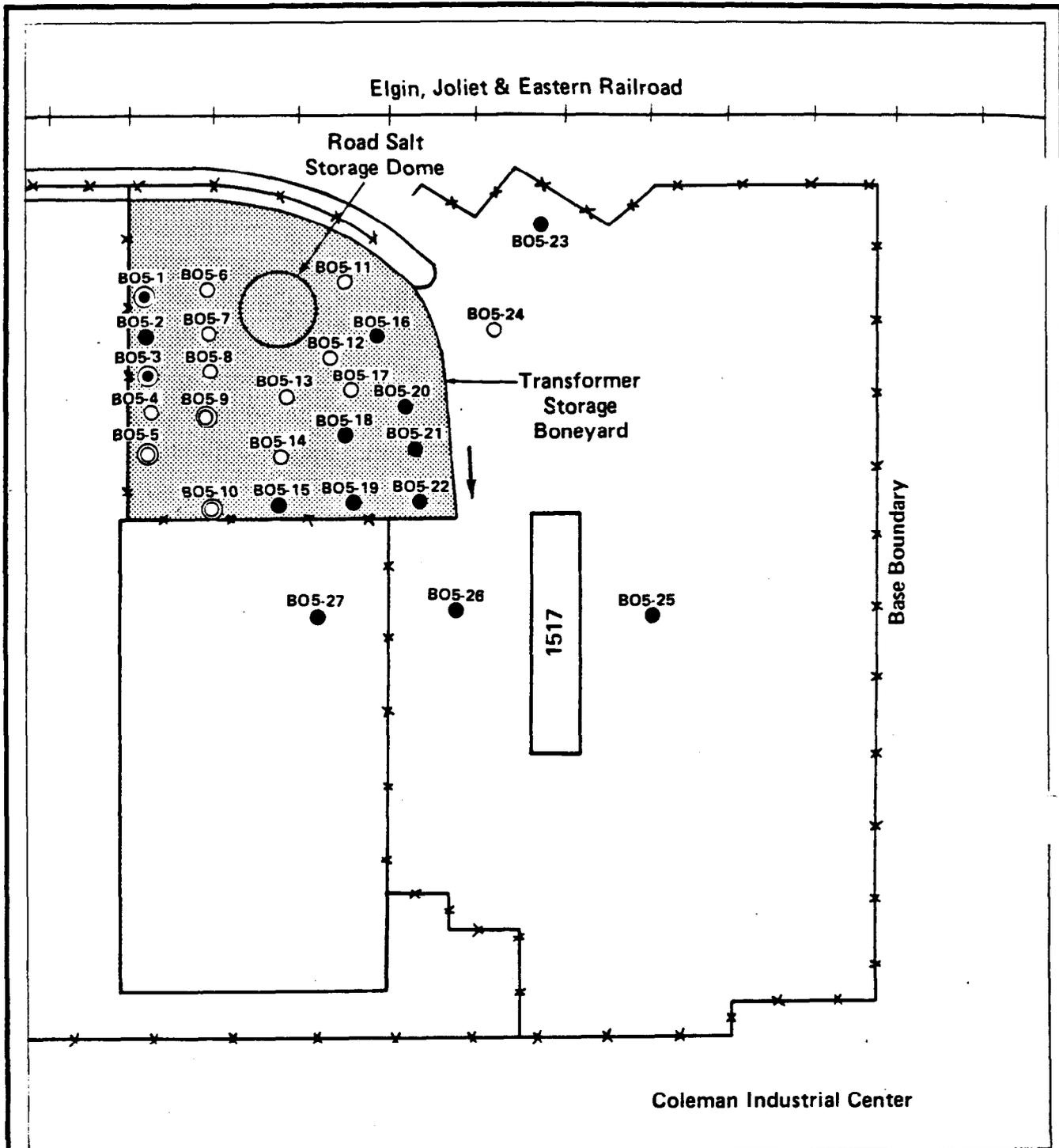
As discussed in Section 2.1.5.3, determination of appropriate soil cleanup levels is made through a "quasi-formal" procedure that is applied to all hazardous substances at specific sites. Based on this procedure, one decision on PCB cleanup that has been made by the State involved the Ability Drums site in Taswell County. At this site, the PCB cleanup level was 10 ppm in soil. This cleanup level was based on the U.S. Food and Drug Administration criterion for PCBs in food. On the basis of the above potentially applicable cleanup levels, some soils at Site 5 may require remediation.

In comparing PCB and oil and grease data, it is noted that the areas that appear to be most heavily contaminated with PCBs are not the areas with the highest oil and grease concentrations. Soil sampling locations where PCB-1260 was detected are shown in Figure 2-14. These data are contrary to the correlation that

would be expected between oil and grease and PCB concentrations, though such a correlation would be affected by differences in behavior of PCBs and oil in soils and the fact that there were (and still are) many sources of oil and grease at this site other than transformer leaks and spills.

Lead is naturally occurring in soils and was detected in all soil samples collected at the site. However, at 18 of the sampling locations, lead was detected at a concentration above the estimated concentration range for this metal in natural soils of the eastern United States. The locations with these elevated lead levels are illustrated in Figure 2-15. At these locations, lead concentrations range from 78.0 to 1,134.5 ug/g, as compared to the upper end of the estimated natural range--which is 53 ug/g. Furthermore, at locations BO5-1 and BO5-3 where such elevated lead concentrations were found at the surface, the deeper samples show similar lead concentrations, which indicates some degree of downward migration of this contaminant. The sources of lead contamination at the site may include residues from storage of lead-insulated cable or other metallic parts and scrap, and possibly spills and leaks of leaded gasoline used for the maintenance vehicles.

As is the case for PCB-1260, some of the most heavily lead-contaminated soil samples are located in the northern end of the former storage yard, which is downslope from--and could be a point of collection of materials and runoff from--the upslope site area. However, contamination by lead appears more widespread over the site area as compared to contamination by PCB-1260, based on the finding of similarly elevated lead concentrations in other portions of the site--along the fence at the south end of the yard, in an area to the northwest of the yard, and on the north and south sides of Bldg. 1517. Findings of elevated lead concentrations at four of the five locations sampled outside the yard area appear to indicate that contamination by lead could be present at many other areas outside the yard. Furthermore, findings of lead in deeper soil samples indicate downward migration of this contaminant through site soils and the potential of migration to shallow groundwater, which is susceptible to contamination. Such contamination by PCB-1260 and by oil and grease constituents is also possible, though these contaminants are less mobile in soil than lead, having lower solubilities and greater affinity for adsorption to soils.



-  Site Area Identified in IAS
-  Assumed General Direction of Surface Drainage
-  Soil Sampling Location, Sample Collected from a Depth of .5-1 Foot
-  Soil Samples Collected from .5-1 and 1.5-2 Feet
-  Denotes Location with Lead Concentrations Exceeding Natural Levels

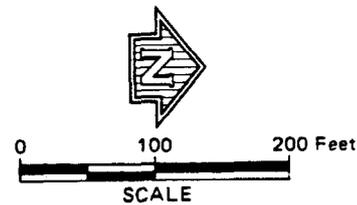


FIGURE 2-15
ELEVATED LEAD LEVELS AT
SOIL SAMPLING LOCATIONS
TRANSFORMER STORAGE "BONEYARD"
(SITE 5)

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2.2.3.4 Site 5 Summary

The storage of PCB transformers, metal materials, and vehicles, as well as vehicular traffic and maintenance activities, have apparently resulted in contamination of surficial soils (and possibly deeper soils) of the former storage yard and surrounding areas by oil and grease, PCB-1260, and lead. While PCB contamination appears to be restricted to the northeast corner of the yard, oil and grease and lead contamination is somewhat more widespread through the area. Some PCB concentrations are in excess of potential Federal and State cleanup guidelines (i.e., 10 ppm). Contamination of shallow groundwater in the area is considered possible based on contaminant concentrations present, some evidence of deeper migration in soils, and high water table conditions. Contamination of surface water is less likely because of the flat topography of the site and the strong adsorption of PCBs to soils.

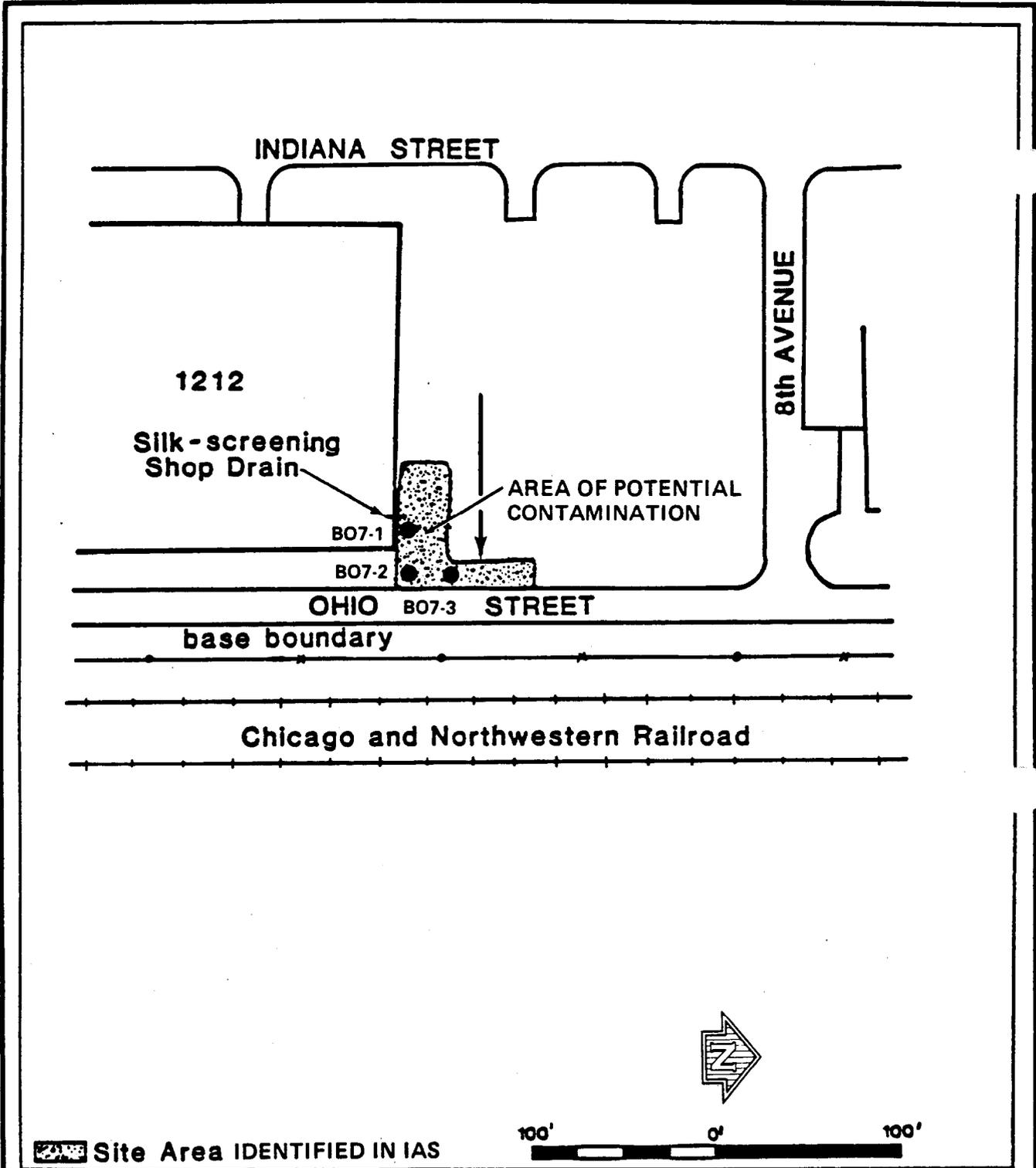
2.2.4 Site 7, RTC Silk-Screening Shop

2.2.4.1 Nature and Extent of Problems Leading to Investigation

The RTC Silk-Screening Shop is located in Bldg. 1212, in the northeastern portion of the Camp Porter section of the Installation, as shown in Figure 2-16. The silk-screening shop has been in use since 1965. A small pipe draining the washwater booth in the building permitted wastewater to exit the building through the northern exterior wall onto the adjacent unpaved ground.

The shop makes the various flags and banners used by the recruits during parades, graduations, etc. The screens are painted or dyed with ink during their preparation. The shop used a variety of materials including paint, inks, water- and oil-based lacquers, enamels, mineral spirits, acetone, thinners, and photographic emulsions. The specific materials used have reportedly changed over the years. Up until 1985, washwater from the finishing of silk screens--possibly contaminated with these products--was allowed to drain onto the ground, sometimes reportedly forming pools behind the building and along Ohio Street. Although this practice was discontinued in August 1985 (and the wastes have since been contained in a 55-gallon drum that is emptied by a private contractor), ground stains were evident on the gravelled lot in the vicinity of the drain outlet at the time of the IAS. These stains continued north-to-east into the dirt road behind the building.

The IAS reports that during periods of heavy discharge the effluent often formed pools of liquid that remained until they infiltrated the soil, were flushed



-  Site Area IDENTIFIED IN IAS
-  B07-1 ● Soil Sampling Location (samples collected at depths of 0.5-1 feet and 1.5 to 2 feet)
-  General Direction of Surface Drainage

FIGURE 2-16.
SOIL SAMPLING LOCATIONS
RTC SILK-SCREENING SHOP (SITE 7)



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away by precipitation, or evaporated. The surface soils in this area are classified either as made land (filled or developed) or silty loam. The in situ loam is characterized as slowly-to-moderately permeable. However, no site-specific information is known that describes site soils and their permeability. In the vicinity of this site, the water-bearing zones that could be considered to be aquifers lie at a depth of approximately 15 to 50 feet below the ground surface. The generally tight nature of the surface materials that might be expected here could restrict the migration of contaminants into these deeper layers. However, sandy layers could act as more permeable conduits. The IAS considered a more likely pathway to be via stormwater runoff, which could have carried the contamination directly into Pettibone Creek via overland flow or through the storm sewer inlets adjacent to the site. Once in the creek, the contamination would be free to flow directly into Lake Michigan; however, along the overland flow path, through the storm sewers, and upon entering Pettibone Creek, the washwater would have been mixed with water from several other sources and diluted by a factor of several orders of magnitude.

The IAS indicated that possible receptors include the fish and other organisms living in Pettibone Creek, the harbor, and Lake Michigan. The IAS indicated that the direct exposure of personnel living in the RTC camps is likely to be limited because of the relative inaccessibility of the area and the lack of free time allocated to personnel in the area. The above concerns led to the recommendation in the IAS that an RI be conducted at this site.

2.2.4.2 RI Verification Step Field Program

Only shallow soils were sampled at the site as part of the initial Verification Step program. Groundwater and surface water sampling were not included in the Verification Step due to the small volume of contaminants discharged and the intermittent nature of the contaminant source, the apparently greater depth to sandy aquifer materials at this location as reported in the IAS, and the lack of nearby surface water.

2.2.4.2.1 Hydrogeologic Investigation

Based on the small size of the area potentially contaminated and the limited goals of this initial investigation, soil samples were collected at three locations (BO7-1 through BO7-3), shown approximately in Figure 2-16. The three locations

were selected to provide information on the area between the shop drain and Ohio Street, where contaminated washwaters would have directly flowed and where most of the contaminant accumulation (if any) would be expected. It was believed that sufficient coverage could be obtained by spacing sampling points approximately 50 feet apart in this area. Two samples were collected at each location, at depth intervals of 0.5 to 1 foot and 1.5 to 2 feet. Prior to sampling, the gravel surface was removed at each sample location. The shallow borings were backfilled with cuttings and gravel. This program was designed to provide a preliminary indication of whether contamination is present and, if so, of the horizontal extent and shallow vertical distribution of constituents at this location.

The analytes for these samples were VOCs, silver, chromium (total), cadmium, and lead. These were selected based on the types of materials that may have been disposed of with washwater through the drain, including paints, inks, water- and oil-based lacquers, enamels, mineral spirits, acetone, thinners, and photographic emulsions.

2.2.4.3 RI Verification Step Findings

2.2.4.3.1 Hydrogeologic Investigation

Site Description--Soils and Geology. The RTC Silk-Screening Shop is located in a nearly level, developed area with elevations around 650 feet above msl. The surfaces surrounding the building area are gravelled or paved. The area directly below the drain pipe is unpaved, hard-packed gravel, sloping slightly east toward Ohio Street. Surface drainage in this vicinity is via roadways, gutters, and other low pathways, apparently draining to Pettibone Creek and Lake Michigan.

The site is underlain by glacial till approximately 170 feet thick, with irregular and discontinuous lenses or zones of sand and gravel. As at other sites at the Installation, impermeable layers in the till are likely barriers to the downward migration of contaminants. The IAS indicated that a water-bearing zone was believed to exist at a depth exceeding 15 feet at this site. The RI Verification Step field investigation was limited to shallow soils only and did not penetrate any water-bearing formations. However, based on conditions encountered at Sites 1 and 4, a potentiometric surface is expected at depth between 5 and 30 feet.

The area delineated in Figure 2-16 is primarily gravel covered and used for parking and vehicle unloading. At the time of the field investigation, construction

on the loading dock was beginning on the north side of Bldg. 1212. The soils encountered to a depth of 2 feet during sampling consisted primarily of clay, with varying proportions of sand, silt, and gravel. When the site was again observed on May 4, 1989, it was noted that the area sampled during this investigation had been disturbed by the construction activities and was partially covered with construction debris. On Ohio Street, new curbs had been installed, and the street was newly black topped. The new curbs were constructed such that they would block flow from the sample area into the street and storm drain inlets during low flow conditions.

Contamination Assessment--Soils. For reasons discussed in Section 1.1, the analytical data discussed in this section could not be validated under USEPA Level III and, therefore, are not considered usable for their intended purpose. Thus, the data assessment discussion presented below is highly speculative.

The analyses of soil samples collected at Site 7 indicate the presence of some heavy metals. The metals detected are cadmium, chromium, and lead. Constituents detected in the soil samples, along with their respective concentrations, are listed in Table 2-13. This table also provides the estimated concentration range for naturally occurring chromium and lead; this information is not available for cadmium.

Acetone, methylene chloride, and toluene are the only priority pollutant VOCs detected in the Site 7 soil samples. All of these compounds were also detected at comparable concentrations in the MB analyses, indicating that these contaminants are most likely laboratory artifacts and are not indicative of site contamination. Any VOCs disposed of through the drain pipe would have long since volatilized.

Hexane is the only volatile TIC detected in the soil samples. The concentrations detected--which ranged from 8 to 10 ug/g (ppb)--are very low and should pose no serious concerns, assuming that they represent actual contamination rather than some laboratory artifact. Although not found in MBs, the similar concentrations found in the former samples in which hexane was detected and the fact that no other VOC contamination was found may indicate laboratory-introduced contamination.

Cadmium, chromium, and/or lead were detected in all soil samples collected from Site 7. Silver was also analyzed, but was not detected in any of the samples.

TABLE 2-13

Constituents Detected in Soil Samples
 Site 7, RTC Silk-Screening Shop
 RI Verification Step at NTC Great Lakes, Illinois

Analytical Parameter	Units	DL (a)	Concentration in Soil						Estimated Concentration Range in Natural Soils (c)	
			BO7-1A 0.5-1	BO7-1B 1.5-2	BO7-2A 0.5-1	BO7-2B 1.5-2	BO7-3A 0.5-1	BO7-3AX (b) 0.5-1		BO7-3B 1.5-2
Sample Depth (ft):										
Volatile Organics (Priority Pollutants)										
Acetone	ug/kg	10	40	53	27	21	13	54	29	--
Methylene Chloride	ug/kg	5	55	43	25	15	13	19	13	--
Toluene	ug/kg	5	30	20	15	24	26	22	30	--
Volatile Organics (Tentatively Identified Compounds)										
Hexane	ug/kg	--	BDL (d)	10	BDL	8	9	BDL	8	--
Metals										
Cadmium	ug/g	0.5	BDL	BDL	1.28	1.94	1.22	1.22	BDL	--
Chromium (total)	ug/g	1	26.48	12.92	26.81	20.51	22.48	30.68	32.02	4.9-220
Lead	ug/g	2.5	37.5	74.38	413.59	36.09	208.25	48.56	31.81	3.7-53

(a) Detection limit.

(b) Field duplicate.

(c) From Shacklette and Boerngen, 1984. Values noted are the estimated range for 95 percent of the samples in the USGS study.

(d) Below detection limit.

NOTE: For reasons discussed in Section 1.1, these data could not be validated under USEPA Level III and, therefore, are not usable for their intended purpose.

Cadmium was detected at low concentrations ranging from 1.14 to 1.94 ug/g. These concentration levels are assumed to be from naturally occurring cadmium, though an estimated range for this element in natural soils is not available. Chromium was also detected at low concentrations, well within the estimated concentration range in natural soils. Contamination by lead is considered moderate, with three soil samples found to contain lead above the upper limit of the natural range (53 ug/g). The concentrations of lead in samples BO7-1B, BO7-2A, and BO7-3A were determined to be 74.38 ug/g, 413.59 ug/g, and 208.25 ug/g, respectively. The drain from the silk-screening shop, formerly used to dispose of washwaters, is located upslope of the three boring locations. The lead contamination is presumed to be from the disposal of metal-containing wastes that were drained onto the site soils.

Impacts on groundwater and surface water quality from the observed metal concentrations is considered unlikely. The heavy metal concentrations are within background for chromium and are very low for cadmium. Furthermore, even the highest concentration of lead (413.59 ug/g) is indicative of only moderate contamination. The highest levels of lead were found only in two surficial soil samples, indicating that downward migration apparently has not occurred and that the lead may be present in an insoluble form. In addition, if the water table is deeper in this area as compared to other site areas as speculated in the IAS, the shallow groundwater would be less susceptible to contamination. The possible insolubility and resulting immobility of the lead probably also serves to limit lead migration into surface water via runoff. Also, the gravel-covered site is not particularly subject to erosion. The current placement of curbing at the site may further prevent the migration of contaminants into the Ohio Street storm drains.

2.2.4.4 Site 7 Summary

The disposal of washwaters onto soils outside the RTC Silk-Screening Shop has apparently caused the lead contamination detected above the upper limit of estimated natural background concentrations in soil. Cadmium and chromium were also detected in the Site 7 soils; however, these metals were detected at low concentrations and are known or expected to be naturally occurring. The highest concentrations of lead (208.25 and 413.59 ug/g) were detected in soil samples collected near the surface.

Although groundwater and surface water could be impacted, impacts are expected to be minimal or none. If the lead is present in an insoluble and, therefore, immobile form, its migration to these media would be limited. In any event, the shallow groundwater that would receive contaminants is not used as a drinking water source, and impermeable layers in the glacial till can prevent downward contaminant migration. Impacts on surface water are expected to be minimal--primarily because of expected significant dilution of any contaminants transported from the small drainage area of the site.

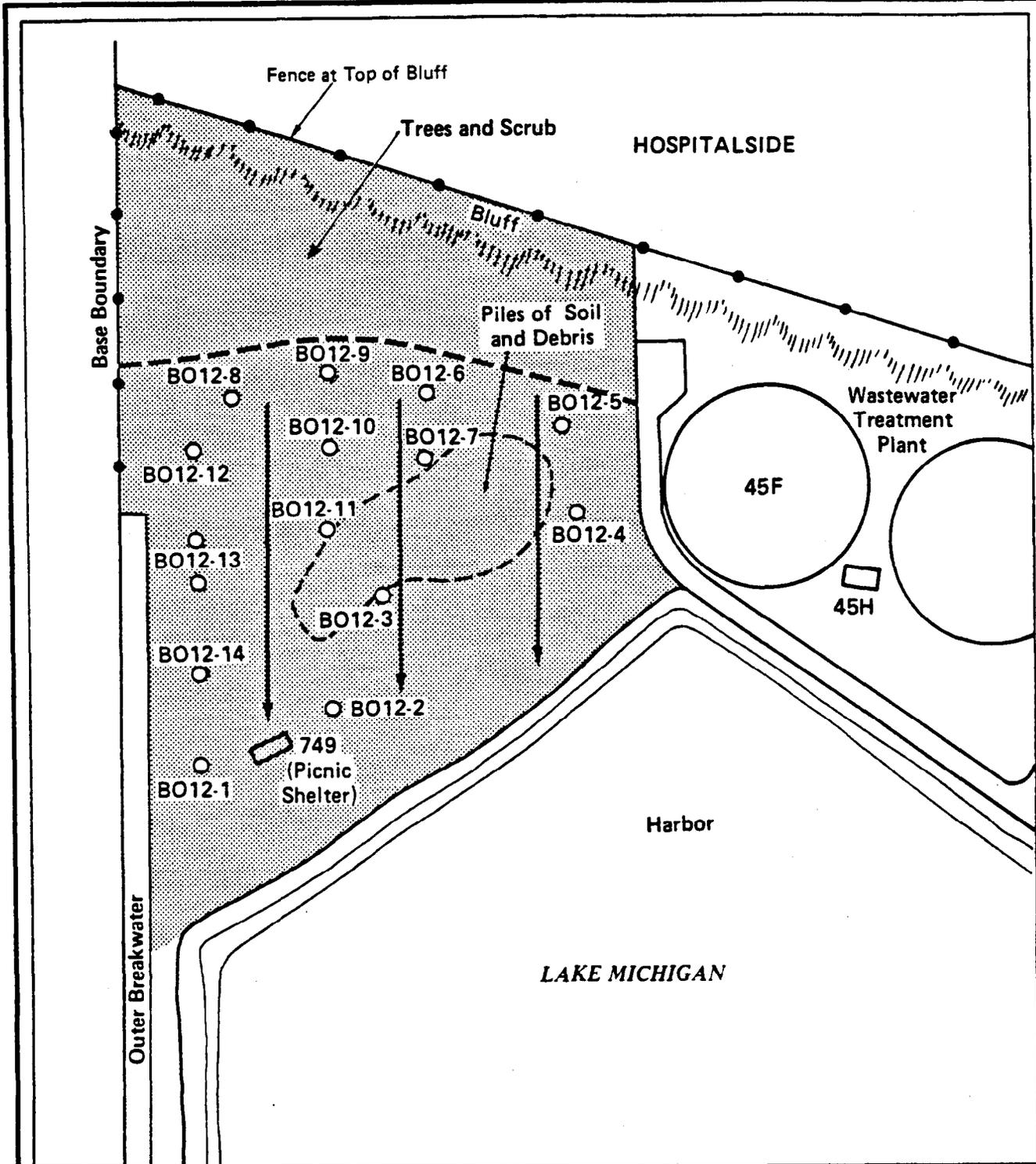
2.2.5 Site 12, Harbor Dredge Spoil Area

2.2.5.1 Nature and Extent of Problems Leading to Investigation

During harbor dredging activities in 1952 and 1970, dredge spoils were reportedly disposed of in an area directly south of the harbor and present wastewater treatment tanks, along the lakeshore. The IAS delineates the area designated as a dredge spoil disposal area near the southern installation boundary and along the lakeshore, as shown in Figure 2-17. However, no other evidence is available to confirm this location. Review of aerial photography taken at intervals from 1946 to 1985 indicates evidence of some filling and other modifications of the area over this period. However, these filling activities do not coincide with or closely follow the reported dates of harbor dredging (1952 and 1970) and, therefore, may not be related to the disposition of dredge spoils, as originally reported by the IAS. Furthermore, discussions with installation personnel regarding the 1970 dredging operations indicate that spoils from this period were placed in the lake, approximately 5 miles from shore. Installation personnel were not able to provide any personal knowledge of the 1952 dredging activities.

Sludge material disposed of during the harbor dredging activities could have a high organic material concentration (though exposure to the air could have resulted in oxidation and accelerated decomposition of the organics), and may potentially also contain heavy metals, oils, pesticides, and PCBs from industries upstream of NTC Great Lakes.

The NTC Great Lakes Master Plan (NORTHDIV, 1980) cites contamination of the Inner Harbor sediments with heavy metals, PCBs, and oils. The source of these contaminants is apparently the industries located upstream from the activity. Some of these industries are identified in the land use section of Chapter 4 of the



Site Area Identified in IAS
 Soil/Sludge Sampling Location
 (samples collected at a depth of 0.5-2, 3.5-5, and 6.5-8 feet)
 Assumed General Direction of Surface Drainage

SCALE
 0 100 Feet

FIGURE 2-17
SOIL/SLUDGE SAMPLING LOCATIONS
HARBOR DREDGE SPOIL AREA
(SITE 12)

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Master Plan. The Inner Harbor is not Navy property; however, Site 12, the Harbor Dredge Spoil Area, is Navy property.

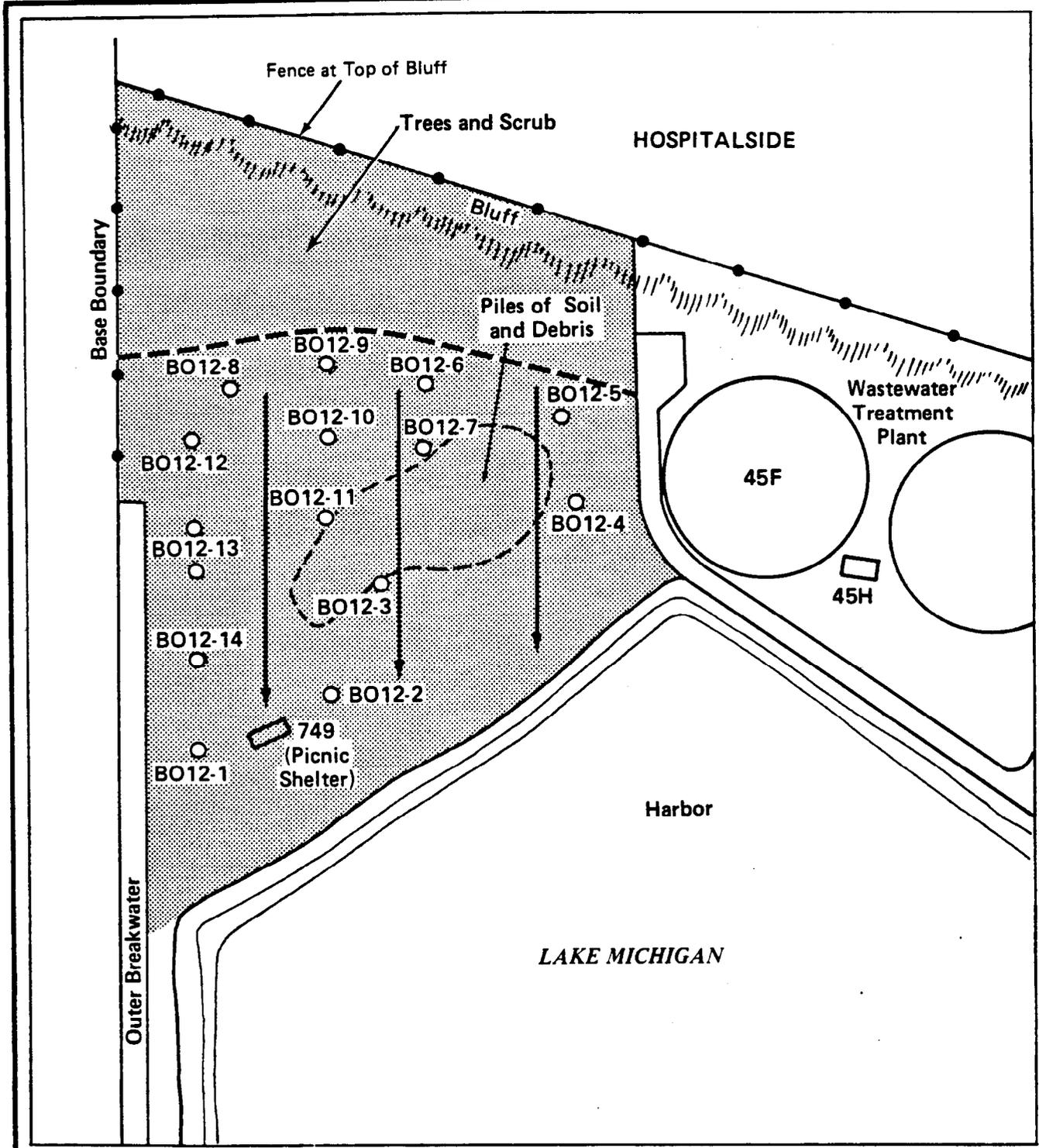
The IAS concluded that hazardous wastes generated by private industry upstream of the activity may have entered the harbor, and that these wastes may pose a threat to the environment, even though there is no history of direct dumping in the harbor. Similarly, the sediments dredged from the harbor in 1952 and 1970 may contain concentrations of hazardous materials high enough to warrant further study. Hence, the Harbor Dredge Spoil Area was recommended for an RI in the IAS.

2.2.5.2 RI Verification Step Field Program

Sampling and analysis of soils and sludge materials were used to characterize the presence (or absence) and chemical composition of site fill materials. Surface water and groundwater sampling did not appear to be warranted at Site 12 until the presence of dredge spoils had been confirmed and their chemical nature was better understood. As discussed in Section 2.2.5.1, there appears to be some uncertainty as to the exact location of dredge spoils from the two operations in 1952 and 1970, though it does appear that dredge spoils are present at this location, as will be shown later.

2.2.5.2.1 Hydrogeologic Investigation

Fourteen soil sampling locations--BO12-1 through BO12-14--were originally designated for this area, as shown in Figure 2-18. In December 1988, three composite soil samples were collected from each of these locations--one at near-surface depths of 0.5 to 2 feet, one at shallow depths of 3.5 to 5 feet, and one at greater depths of approximately 6.5 to 8 feet. This sampling scheme was designed to provide complete coverage of the site, both horizontally and vertically, though access to the western portion of the site was prevented by the presence of trees and scrub, and sampling was required around piles of soil and debris in the central portion of the site (see Figure 2-18). Sampling was designed to provide information on the thickness of the fill and the areal and vertical extent of contamination, if any, in the fill. The analytes for these samples were VOCs, priority pollutants, metals, pesticides, and PCBs. These were selected based on the types of constituents that could be contributed to harbor sediments by activities upgradient of the installation.



-  Site Area Identified in IAS
-  Soil/Sludge Sampling Location
(samples collected at a depth of 0.5-2, 3.5-5, and 6.5-8 feet)
-  Boundary of Soil and Debris Pile
-  Boundary of Piles of Trees and Scrub
-  Assumed General Direction of Surface Drainage

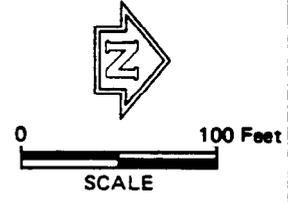


FIGURE 2-18
SOIL/SLUDGE SAMPLING LOCATIONS
FOR METALS AND VOCs, DECEMBER 1988
HARBOR DREDGE SPOIL AREA
(SITE 12)

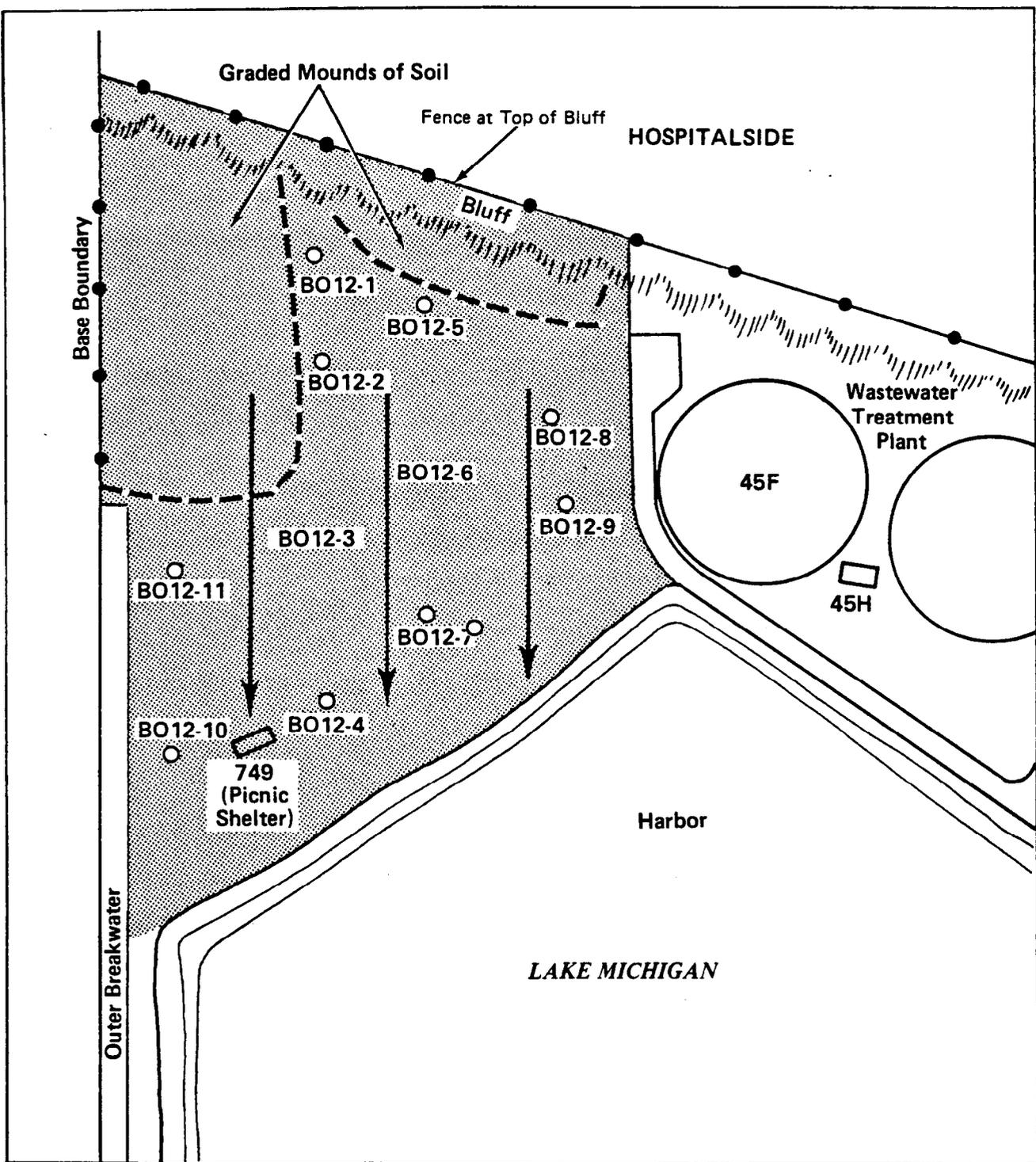


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The maximum holding times for approximately half the samples for pesticide/PCB analysis were exceeded by the laboratory, resulting in the need to recollect these samples. Thus, a second sampling event was conducted in March 1989. When the analytical results for the recollected samples became available, inconsistencies were noted between data from the first and second sampling events, which were subsequently learned to have been caused by interferences in samples collected during the initial sampling event. Accordingly, and because none of the results had been confirmed by second column confirmation (which is not required by the USEPA Method 8080 SW-846, Second Edition, analytical approach employed), it was decided that resampling of the entire site for pesticide analysis in a third sampling event would be prudent. In this way, the results for the samples could be compared on a common basis, and recurrence of the problems noted would be prevented by performing second column confirmations of all positive hits. The results of all previous soil sample analyses for pesticides/PCBs--i.e., for December 1988 (first event) and March 1989 (second event)--were considered invalid and were discarded.

Resampling of soils at the site for pesticide/PCB analysis was conducted in August 1989 (third event) at the locations shown in Figure 2-19. The analytical program was conducted in accordance with USEPA CLP protocols; and the laboratory-produced CLP data packages were subsequently validated by HAZWRAP. The data from the third sampling event are considered valid and, therefore, usable for their intended purpose.

For reasons discussed below, the sample locations for pesticides/PCBs from the third event differ somewhat from those sampled in the previous rounds, and only 11 borings (BO12-1 through BO12-11) were sampled instead of 14 (though the sampling depths were the same as those used previously). There were access problems in some portions of the site due to heavy rains on the day of sampling. Also, mounds of soil in the southwestern portion of the site--which were not present during the previous sampling rounds--now obstructed some of the original sample locations, while movement of the trees and scrub in the western portion of the site and of the soil and debris piles in the center of the site (as shown in Figure 2-18) opened up a new portion of the site for sampling. In general, however, the area available for soil sampling was somewhat smaller and/or less accessible than before. (It was also noted that some development of the site--possibly for



-  Site Area Identified in IAS
-  Soil/Sludge Sampling Location
(samples collected at a depth of 0.5-2, 3.5-5, and 6.5-8 feet)
-  Boundaries of Graded Mounds of Soil
-  Assumed General Direction of Surface Drainage

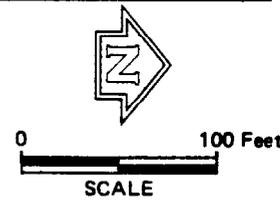


FIGURE 2-19
SOIL/SLUDGE SAMPLING LOCATIONS
FOR PESTICIDES AND PCBs, AUGUST 1989
HARBOR DREDGE SPOIL AREA
(SITE 12)



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recreation or aesthetic purposes--had recently occurred. The soil mounds to the west and southwest were fully vegetated. Also, there was a narrow strip of grass between the beach area near the lakeshore and the remainder of the site.) Given the site configuration at the time, the 11 borings that were sampled were deemed sufficient to provide adequate site coverage and indication of the presence or absence of contamination by pesticides/PCBs, which fulfilled the objectives of the Verification Step investigation.

2.2.5.3 RI Verification Step Findings

2.2.5.3.1 Hydrogeologic Investigation

Site Description--Soils and Geology. The Harbor Dredge Spoil Area is located in a flat area on the lakeshore, beneath a bluff, south of the installation sewage treatment plant. Ground elevations at the site are approximately 585 feet msl, only a few feet above lake level. The surface is partially hard-packed gravel and partially dirt and grasses. No site-specific water level data are available. However, due to the site's proximity to the lakeshore, water levels are expected to be very shallow, with some groundwater discharge to the lake. Surface runoff drains directly into Lake Michigan.

The site is underlain by approximately 100 feet of glacial till over bedrock. The composition of the underlying till is assumed to be primarily clay, but no data are available to confirm this, nor to indicate the depth to which the effects of lake activity--water level, wave action, etc.--could be anticipated. The shallow borings installed during this investigation encountered various mixtures of primarily sand and gravel, with construction debris and lesser amounts of silt and clay. This is indicative of fill being placed here and active sorting by wave action of the lake, as would be expected for lake dredgings. Borings were located to avoid drilling through piles of debris. It should be noted that additional debris was being deposited at this site while the borings were being installed. Also, at the time of the last sampling event in August 1989, it was noted that the site--which already included a picnic shelter--was possibly being further developed for recreational or aesthetic purposes, as described in Section 2.2.5.2.

Contamination Assessment--Soils. For reasons discussed in Section 1.1, with the exception of sample analysis data for pesticides/PCBs, the analytical data discussed in this section could not be validated under USEPA Level III and,

therefore, are not considered usable for their intended purpose. Thus, the data assessment discussion presented below for all constituents except pesticides/PCBs is highly speculative.

Results of analyses of soil samples taken from the Harbor Dredge Spoil Area indicate that a number of heavy metals are present in the site soils at concentrations elevated above the USGS estimated range for this area. Very low concentrations of some pesticides are also present. Volatile and heavy metal constituents and concentrations detected, along with the estimated natural range for metals (where available), are provided in Table 2-14 for samples collected in December 1988. Positive detections of pesticides in samples collected in August 1989 are presented in Table 2-15.

The priority pollutant VOCs detected--acetone, 2-butanone, methylene chloride, and toluene--are all common laboratory contaminants. Methylene chloride and toluene were detected at concentrations similar to those found in MBs; and acetone, while found at concentrations greater than in MBs, were nevertheless present at levels of less than 10 times those detected in MBs. Thus, the occurrence of these three compounds can be considered as laboratory artifacts. The detection of 2-butanone at a low concentration in a single sample may also be a laboratory artifact rather than a site contaminant.

The VOC TICs detected include unknowns (which appear at similar concentrations in MBs) and 2-ethyl-1-hexane (which appears at a very low concentration in only one sample). As with the priority pollutant VOCs, it is not believed that these detections are representative of site contamination.

Heavy metals were detected in all samples, though mostly at concentrations that could be considered naturally occurring. However, 40 of the 44 samples and each of the 14 borings contained one or more metals--including antimony, copper, lead, mercury, selenium, and/or zinc--at concentrations in excess of the upper end of the USGS estimated concentration range for natural soils. Also, cadmium and silver--for which no estimated natural concentration ranges are available--appear in a few samples at concentrations that are somewhat higher than those found in most other samples from the site. Table 2-16 analyzes the occurrence of these metals at elevated concentrations by listing for each metal the upper end of the estimated natural concentration range (where available), the number of samples in

TABLE 2-14

Volatile Organics and Metals Detected in Soil Samples (Collected December 1988)
 Site 12, Harbor Dredge Spoil Area
 RI Verification Step at NTC Great Lakes, Illinois

Analytical Parameter Sample Depth (ft):	Units	DL (a)	Concentration in Soil										
			BO12-1A 0.5-2	BO12-1B 3.5-5	BO12-1C 6.5-8	BO12-2A 0.5-2	BO12-2B 3.5-5	BO12-2C 6.5-8	BO12-3A 0.5-2	BO12-3AX (b) 0.5-2	BO12-3B 3.5-5	BO12-3C 6.5-8	BO12-4A 0.5-2
Volatile Organics (Priority Pollutants)													
Acetone	ug/kg	10	BDL(d)	BDL	36	BDL	25	143	17	18	54	23	31
2-Butanone	ug/kg	10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Methylene chloride	ug/kg	5	18	BDL	21	9	8	33	BDL	BDL	BDL	10	7
Toluene	ug/kg	5	9	8	9	9	6	8	25	BDL	10	10	8
Volatile Organics (Tentatively Identified Compounds)													
2-Ethyl-1-hexanol	ug/kg	--	ND (e)	ND	16	ND	ND	ND	ND	ND	ND	ND	ND
Unknowns (total)	ug/kg	--	ND	ND	ND	8	ND	ND	51	ND	ND	ND	ND
Metals													
Antimony	ug/g	6	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Arsenic	ug/g	1	8.46	10.0	11.5	9.11	10.06	10.60	7.60	7.40	10.70	7.08	9.04
Beryllium	ug/g	0.50	1.75	0.98	0.94	1.36	0.97	0.97	0.90	1.1	2.20	0.99	1.34
Cadmium	ug/g	0.50	1.37	3.69	1.72	3.65	2.12	BDL	1.20	2.60	4.70	1.45	2.78
Chromium (total)	ug/g	1	18.35	49.14	30.7	40.5	38.93	12.50	26.10	26.30	88.70	15.62	26.45
Copper	ug/g	2.5	85.23	132.2	41.85	230.8	93.90	25.60	77.10	101.80	285.40	47.75	93.94
Lead	ug/g	2.5	85.33	119.4	106	396.4	309.10	71.90	114.00	55.6	170	71.39	104.53
Mercury	ug/g	0.10	0.43	1.4	0.30	0.38	0.78	0.35	0.87	0.97	1.20	0.95	1.30
Nickel	ug/g	0.10	28.00	43.18	20.8	75.8	36.3	9.13	24.40	38.7	51.70	14.39	35.76
Selenium	ug/g	0.50	BDL	BDL	1.26	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Silver	ug/g	1	2.46	11.01	BDL	14.3	3.45	BDL	BDL	3.20	16.90	1.01	3.65
Zinc	ug/g	2	251.5	344.96	116.20	498.3	424.70	117.6	196.00	222.00	445.10	138.5	253.26

(a) Detection limit.

(b) Field duplicate.

(c) From Shacklette and Boerngen, 1984. Values noted are the estimated range for 95 percent of the samples in the USGS study.

(d) Below detection limit.

(e) None detected.

NOTE: For reasons discussed in Section 1.1, these data could not be validated under USEPA Level III and, therefore, are not usable for their intended purpose.

TABLE 2-14 (cont'd)

Analytical Parameter Sample Depth (ft):	Units	DL (a)	Concentration in Soil										
			BO12-4B	BO12-4C	BO12-5A	BO12-5AX (b)	BO12-5B	BO12-5C	BO12-6A	BO12-6B	BO12-6C	BO12-7A	BO12-7B
			3.5-5	6.5-8	0.5-2	0.5-2	3.5-5	6.5-8	0.5-2	3.5-5	6.5-8	0.5-2	3.5-5
Volatile Organics (Priority Pollutants)													
Acetone	ug/kg	10	BDL	89	47	165	157	12	82	150	BDL	BDL	BDL
2-Butanone	ug/kg	10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Methylene chloride	ug/kg	5	17	BDL	25	27	28	12	69	16	11	BDL	BDL
Toluene	ug/kg	5	11	BDL	6	7	12	5	7	6	BDL	BDL	BDL
Volatile Organics (Tentatively Identified Compounds)													
2-Ethyl-1-hexanol	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Unknowns (total)	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Metals													
Antimony	ug/g	6	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Arsenic	ug/g	1	8.36	7.99	9.05	7.02	13.08	3.99	8.39	4.19	9.10	6.84	9.04
Beryllium	ug/g	0.50	1.36	0.96	0.93	1.42	1.05	0.74	1.17	1.14	1.23	1.33	0.86
Cadmium	ug/g	0.50	2.83	2.37	BDL	2.60	8.73	BDL	1.21	1.76	BDL	1.95	2.52
Chromium (total)	ug/g	1	31.26	29.73	23.17	22.46	67.70	8.94	23.42	9.34	10.23	23.46	31.50
Copper	ug/g	2.5	126.82	65.85	26.62	128.51	306.96	31.80	165.31	122.16	19.78	95.32	98.92
Lead	ug/g	2.5	103.59	135.07	46.38	151.12	195.57	28.47	90.39	37.38	24.39	171.26	103.97
Mercury	ug/g	0.10	0.62	0.64	0.83	0.89	1.77	0.33	0.60	0.38	0.35	0.85	0.83
Nickel	ug/g	0.10	29.44	15.97	29.06	20.38	46.03	10.14	33.36	7.72	BDL	20.99	32.29
Selenium	ug/g	0.50	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Silver	ug/g	1	6.02	1.22	BDL	1.93	6.67	BDL	BDL	BDL	BDL	1.81	10.94
Zinc	ug/g	2	293.04	201.42	78.30	578.84	713.90	102.13	845.28	816.93	95.23	231.20	249.15

TABLE 2-14 (cont'd)

Analytical Parameter Sample Depth (ft):	Units	DL (a)	Concentration in Soil										
			BO12-7C 6.5-8	BO12-8A 0.5-2	BO12-8B 3.5-5	BO12-8C 6.5-8	BO12-9A 0.5-2	BO12-9B 3.5-5	BO12-9C 6.5-8	BO12-10A 0.5-2	BO12-10B 3.5-5	BO12-10C 6.5-8	BO12-11A 0.5-2
Volatile Organics (Priority Pollutants)													
Acetone	ug/kg	10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	86	BDL	14
2-Butanone	ug/kg	10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	34	BDL	BDL
Methylene chloride	ug/kg	5	6	BDL	17	BDL	10	7	13	9	17	7	9
Toluene	ug/kg	5	BDL	BDL	12	BDL	9	BDL	BDL	BDL	17	BDL	7
Volatile Organics (Tentatively Identified Compounds)													
2-Ethyl-1-hexanol	ug/kg	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Unknowns (total)	ug/kg	--	ND	ND	ND	50	57	ND	ND	ND	84	ND	ND
Metals													
Antimony	ug/g	6	BDL	BDL	BDL	13.97	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Arsenic	ug/g	1	7.89	6.68	13.56	7.18	BDL	4.31	4.41	6.76	10.90	6.06	5.33
Beryllium	ug/g	0.50	0.76	0.90	0.96	1.40	0.92	1.43	0.99	0.93	1.05	0.91	0.94
Cadmium	ug/g	0.50	1.84	1.39	2.12	4.46	2.03	1.23	BDL	1.96	4.05	BDL	BDL
Chromium (total)	ug/g	1	18.7	22.14	31.32	39.45	19.02	10.02	5.62	18.58	92.83	8.13	13.27
Copper	ug/g	2.5	46.63	58.44	81.83	193.12	308.45	25.88	19.18	34.76	170.83	23.25	43.87
Lead	ug/g	2.5	52.50	60.63	113.34	189.99	191.43	32.8	16.21	64.96	161.33	28.83	58.65
Mercury	ug/g	0.10	0.79	0.63	3.32	1.61	0.68	0.44	0.26	0.46	5.14	0.93	1.50
Nickel	ug/g	0.10	BDL	16.26	15.01	35.79	15.36	5.78	BDL	27.80	47.84	BDL	6.68
Selenium	ug/g	0.50	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Silver	ug/g	1	BDL	BDL	10.29	13.13	1.17	BDL	BDL	BDL	36.73	1.85	1.19
Zinc	ug/g	2	143.60	151.08	237.63	394.23	622.15	84.13	65.26	108.24	538.12	95.19	128.78

TABLE 2-14 (cont'd)

Analytical Parameter Sample Depth (ft):	Units	DL (a)	BO12-11B 3.5-5	BO12-11C 6.5-8	BO12-12A 0.5-2	BO12-12B 3.5-5	BO12-12C 6.5-8	BO12-13A 0.5-2	BO12-13B 3.5-5	BO12-13C 6.5-8	BO12-14A 0.5-2	BO12-14B 3.5-5	BO12-14C 6.5-8	Estimated Concentration Range (c)
Volatile Organics (Priority Pollutants)														
Acetone	ug/kg	10	BDL	BDL	BDL	29	29	25	40	31	24	55	58	--
2-Butanone	ug/kg	10	BDL	--										
Methylene chloride	ug/kg	5	BDL	11	BDL	21	22	13	16	23	19	34	20	--
Toluene	ug/kg	5	BDL	BDL	BDL	BDL	6	6	8	7	8	8	12	--
Volatile Organics (Tentatively Identified Compounds)														
2-Ethyl-1-hexanol	ug/kg	--	ND	--										
Unknowns (total)	ug/kg	--	ND	--										
Metals														
Antimony	ug/g	6	BDL	10.77	BDL	0.092-2.9								
Arsenic	ug/g	1	12.32	12.08	6.47	5.79	9.47	8.74	13.79	10.82	10.61	20.85	12.10	0.73-31
Beryllium	ug/g	0.50	0.94	1.28	0.95	0.94	0.92	0.94	0.98	0.99	1.14	1.20	1.26	0.86-3.5
Cadmium	ug/g	0.50	1.72	1.60	1.40	2.07	2.69	4.48	3.41	1.54	2.85	7.86	2.03	--
Chromium (total)	ug/g	1	18.95	9.43	17.25	19.60	28.58	41.28	35.99	14.18	26.24	59.78	17.35	4.9-220
Copper	ug/g	2.5	58.65	35.02	62.11	72.20	151.10	183.50	147.92	88.22	196.26	293.97	54.64	1.7-100
Lead	ug/g	2.5	176.62	219.21	103.12	83.82	110.46	129.51	148.77	66.28	117.71	197.81	57.68	3.7-53
Mercury	ug/g	0.10	0.76	0.43	0.55	0.31	0.90	0.86	1.40	0.46	0.70	0.94	0.45	0.013-051
Nickel	ug/g	0.10	13.78	5.9	8.35	20.77	43.55	41.65	35.28	9.55	39.40	78.43	14.05	1.6-77
Selenium	ug/g	0.50	BDL	0.05-1.8										
Silver	ug/g	1	0.96	BDL	BDL	BDL	3.36	4.68	7.67	7.73	BDL	9.79	21.12	1.54
Zinc	ug/g	2	180.92	212.52	196.03	166.47	282.89	382.24	391.03	157.55	496.10	528.84	153.73	9.0-180

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TABLE 2-15

Pesticides Detected in Soil Samples (Collected August 1989)
 Site 12, Harbor Dredge Spoil Area
 RI Verification Step at NTC Great Lakes, Illinois

Sample No.	Sample Depth (ft)	Pesticide Concentration (ug/kg)			Total Pesticide Concentration (ug/kg)
		4,4'-DDD	4,4'-DDE	4,4'-DDT	
<u>Detection Limit:</u>		<u>16</u>	<u>16</u>	<u>16</u>	
BO12-1A	0.5-2	110	190	BDL (a)	300
BO12-1B	3.5-5	BDL	72	42	114
BO12-1BX (b)	3.5-5	BDL	69	23	92
BO12-1C	6.5-8	BDL	BDL	BDL	BDL
BO12-2A	0.5-2	190	120	BDL	310
BO12-2B	3.5-5	140	BDL	34	174
BO12-2C	6.5-8	BDL	BDL	BDL	BDL
BO12-3A	0.5-2	21	62	36	119
BO12-3B	3.5-5	230	BDL	BDL	230
BO12-3C	6.5-8	BDL	BDL	BDL	BDL
BO12-4A	0.5-2	30	73	150	253
BO12-4B	3.5-5	220	BDL	BDL	220
BO12-4C	6.5-8	49	51	33	133
BO12-5A	0.5-2	BDL	BDL	BDL	BDL
BO12-5B	3.5-5	BDL	BDL	BDL	BDL
BO12-5C	6.5-8	BDL	BDL	BDL	BDL
BO12-6A	0.5-2	280	160	BDL	440
BO12-6B	3.5-5	240	140	160	540
BO12-6C	6.5-8	BDL	BDL	BDL	BDL
BO12-7A	0.5-2	300	380	BDL	680
BO12-7B	3.5-5	240	BDL	BDL	240
BO12-7C	6.5-8	BDL	BDL	BDL	BDL
BO12-8A	0.5-2	BDL	160	BDL	160
BO12-8B	3.5-5	BDL	BDL	BDL	BDL
BO12-8C	6.5-8	BDL	BDL	BDL	BDL
BO12-9A	0.5-2	BDL	55	BDL	55
BO12-9B	3.5-5	27	BDL	24	51
BO12-9C	6.5-8	BDL	BDL	BDL	BDL
BO12-10A	0.5-2	BDL	BDL	BDL	BDL
BO12-10B	3.5-5	BDL	830	BDL	830
BO12-10C	6.5-8	BDL	BDL	BDL	BDL
BO12-11A	0.5-2	BDL	BDL	BDL	BDL
BO12-11B	3.5-5	430	BDL	BDL	430
BO12-11C	6.5-8	36	BDL	BDL	36

(a) Below detection limit.

(b) Field duplicate.

TABLE 2-16

Occurrence of Metals at Concentrations Elevated
Above Apparent Natural Levels
Site 12, Harbor Dredge Spoil Area
RI Verification Step at NTC Great Lakes, Illinois

Metal	Upper End of Estimated Natural Concentration Range (a) (ug/g)	No. of Samples in Which Upper End of Estimated Natural Range is Exceeded or Concentration is Otherwise Elevated	Range of Concentrations in Excess of the Upper End of the Estimated Range or Otherwise Elevated (a) (ug/g)
Antimony	2.9	2	10.77 - 13.97
Cadmium	NA (b)	2	7.86 - 8.73
Copper	100	17	101.8 - 308.45
Lead	53	36	55.6 - 396.4
Mercury	0.51	30	0.55 - 5.14
Selenium	1.8	1	2.34
Silver	NA	7	10.29 - 36.73
Zinc	180	28	180.92 - 845.28

(a) See Table 2-14.

(b) NA = not available.

NOTE: For reasons discussed in Section 1.1, these data in the last column of this table could not be validated under USEPA Level III and, therefore, are not usable for their intended purpose.

which this upper concentration is exceeded or in which concentrations appear otherwise elevated, and the range of observed concentrations that are in excess of the upper end of the natural range or are otherwise elevated.

Evaluation of the information presented in Table 2-16 leads to the conclusion that of the eight metals listed, copper, lead, mercury, and zinc are--by a wide margin--present at elevated concentrations in the largest number of samples. Lead and mercury are of much greater concern from a human health toxicological standpoint than copper and zinc, and they are present in a larger number of samples at elevated concentrations than are copper and zinc. The occurrence of the other four metals at elevated levels is more isolated and, therefore, of considerably less concern. Thus, lead and mercury are the primary metals of concern in soils at this site. The elevated metals concentrations in the fill material at the site could have arisen from the deposition of lake dredgings containing metals contaminants--assuming that the fill material is, in fact, composed of dredged materials. The site soils--which are composed primarily of sands and gravels, with smaller amounts of silt and clay--appear to be characteristic of lake dredgings.

Looking at the metals concentrations reported in Table 2-14 for the metals of concern and all other metals, it is also noted that there appears to be no particular trend in concentrations with either location or depth. With regard to location, elevated metals levels appear to be spread throughout the site. With regard to depth, there is no apparent trend of increasing or decreasing concentration. These observations indicate that the metals are thoroughly distributed throughout the fill, and that they probably were not deposited at the surface and left to migrate downward. This observation may also indicate that the metals are present in an immobile (i.e, insoluble or soil-bound) state, because--if the metals were mobile--one might expect to see some trend of increasing concentration with depth caused by the dissolution and downward movement of the metals, driven by infiltrating rainwater, through the permeable sands and gravels. If the metals are indeed in an immobile state, they will not migrate through the soil column or into the lake at appreciable concentrations.

One additional noteworthy observation gleaned from the metals analysis data is that the thickness of the contaminated fill material at the site is apparently greater than 8 feet--the greatest depth sampled. This conclusion is based on the

fact that metals were found at high concentrations down to 8 feet and, thus, are probably also present at elevated levels below this depth.

No PCBs were detected in the soils of Site 12. However, as shown in Table 2-15, the pesticides 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT were detected, though at very low concentrations. Twenty of the 34 samples analyzed contained one or more of these pesticides, and the pesticides were found in 10 of the 11 borings. The bulk of the contamination is by DDD and DDE--which appear at generally higher concentrations and in many more samples than DDT. Since DDD and DDE are breakdown products of DDT, this observation indicates that the DDT originally present has degraded over time. None of the other pesticides analyzed were detected.

As is the case for metals, there appears to be no significant lateral concentration pattern for pesticides, though pesticide concentrations may be a bit lower in the northern portion of the site (at BO12-8 and BO12-9; Figure 2-19). However, unlike the situation with the metals, there is a definite trend in pesticide concentration with depth--in this case, a decrease in concentration with depth. This can be seen by evaluating the total pesticide concentrations versus sample depth in Table 2-15, which is also plotted for each boring in Figure 2-20. Most of the plots show a general decrease in total pesticide concentration with depth between the 5- and 8-foot depth sample in all borings in which pesticides were detected at the 5-foot depth. In over half the borings, there is a decrease in total pesticide concentration from the shallowest to the greatest depth sampled.

While the lack of concentration versus depth trend for the metals appeared to indicate that the metals were present in the fill materials when they were placed at the site, the trend of decreasing pesticide concentration with depth appears to indicate that the pesticides were deposited on the surface of the fill after its placement. Relatively insoluble and otherwise immobile pesticides like DDD, DDE, and DDT--when deposited on the surface--would tend to remain near the surface and migrate very slowly downward, maintaining a concentration versus depth profile at the site of decreasing concentration with depth. Furthermore, if the pesticides had been present in the fill materials--as the metals appear to have been--they would have been distributed more evenly through the fill as are the metals.

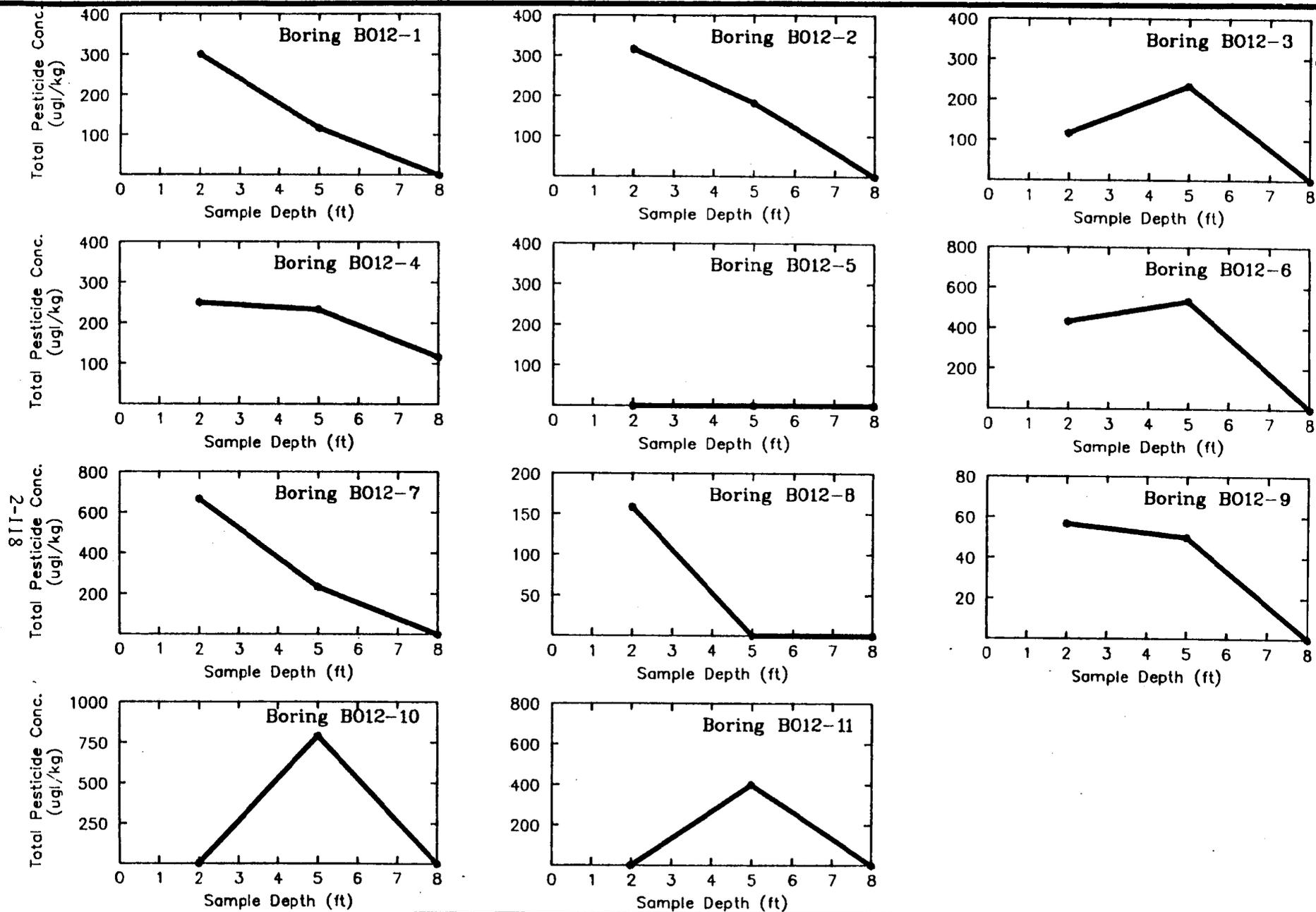


FIGURE 2-20
PLOTS OF TOTAL PESTICIDE CONCENTRATION
VERSUS SAMPLE DEPTH
SITE 12, HARBOR DREDGE SPOIL AREA



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There is no reported usage or storage of pesticides at Site 12. However, soils and plant debris from various parts of the installation have been stored in piles at this site. These piles could have included materials once treated with and containing residues of pesticides. The pesticide contamination could also have resulted from pesticide usage at the site in past years or from the erosion and transport of contaminated soil from surrounding landscaped areas of the installation over the bluff. It is likely that pesticides in the surficial site soils have also eroded into the lake, thereby resulting in a decrease in residual concentrations with time.

It is interesting to note that the same pesticides were detected--though at somewhat higher concentrations--in surface samples down to 1.5 feet at Site 6, Mainside Transformer Storage Area (see Dames & Moore, 1989). This indicates that DDT was in use throughout NTC Great Lakes. Furthermore, the soils in Site 6 are primarily impermeable clays, which served to prevent the downward migration of pesticides below 1.5 feet. However, at Site 12--where permeable sands and gravels are the prevalent soil components--downward migration of the pesticides was somewhat more feasible. Also at Site 6, there was definite evidence of erosion of the pesticides into a surface drainageway via surface runoff. A similar erosion/runoff mechanism from Site 12 soils into the lake is, therefore, also likely.

In spite of their occurrence, DDD, DDE, and DDT are not considered contaminants of concern because examination of health risk assessment data for these compounds reveals that the concentrations detected in this investigation represent little or no health risk. These data are summarized in Table 2-17. Although DDT and DDE accumulate in body fat, they are relatively nontoxic to higher animals. Reported acute oral toxicities are 250,000 ug/kg of DDT for humans and 880,000 ug/kg of DDE and 3,400,000 ug/kg of DDD for rats (Berg, 1977; Sax, 1984; USDHHS, 1984; Kirk and Othmer, 1966; Verschueren, 1983). The concentrations detected in this investigation--23 to 150 ug/kg for DDT, 51 to 830 ug/kg for DDE, and 28 to 300 ug/kg for DDD--are all lower than the established residue tolerance limit range of 500 to 7,000 ug/kg for DDT (Verschueren, 1983) and the various other biological and toxicological parameters for DDT, DDE, and DDD, presented in Table 2-17. (No residue tolerance limits are available for DDE and DDD.)

TABLE 2-17

Summary of Health Risk Assessment Data for DDT, DDE, and DDD

Parameter	Reported Data (ug/kg) (a)				
	Animal	DDT	DDE	DDD	Reference
Acute oral toxicity	Human	250,000	NA (b)	NA	Berg (1977), Sax (1984)
Oral LD ₅₀	Rat	113,000	880,000	NA	Berg (1977), USDHHS (1984), Sax (1984)
Oral LD ₅₀	Rat	200,000	NA	3,400,000	Kirk and Othmer (1966), Verschueren (1983)
Dermal LD ₅₀	Rat	3,000,000	NA	NA	Kirk and Othmer (1966)
Acute dermal LD ₅₀	Rat	2,510,000	NA	NA	Verschueren (1983)
Nontoxic concentration (average) in human fat for DDT and DDE combined (throughout U.S.)	Human	12,000	NA	NA	Kirk and Othmer (1966)
Concentration in fat (c)	Human	648,000	NA	NA	Kirk and Othmer (1966)
Tolerance range (d)	Human	0-7,000	NA	NA	Kirk and Othmer (1966)
Residue tolerance limit (FAO/WHO standards)	Human	500-7,000	NA	NA	Verschueren (1983)
Bioconcentration factor (BCF)					
• Predicted from water solubility	--	22,500,000	8,300,000	12,270,000	Kenaga (1980)
• Predicted from soil adsorption coefficient	--	27,000,000	NA	NA	Kenaga (1980)
• Flowing water (fish) - Experimental	--	61,600,000	NA	NA	Kenaga and Goring (1980)
• Static water (trout) - Experimental	--	84,500,000	27,400,000	63,830,000	Kenaga and Goring (1980)
Threshold limit values					
• TWA (e)	Human	1 mg/m ³	NA	NA	ACGIH (1984)
• STEL (f)	Human	3 mg/m ³	NA	NA	ACGIH (1984)

(a) All data reported on ug/kg unless otherwise indicated.

(b) NA = not available or not applicable.

(c) For a factory worker in perfect health.

(d) For DDT on food stuffs.

(e) TWA = time weighted average.

(f) STEL = short-term exposure limit.

2.2.5.4 Site 12 Summary

The lake dredgings or other fill materials that have been deposited at the site known as the Harbor Dredge Spoil Area contain a number of heavy metals and pesticide contaminants. Several heavy metals are present at concentrations exceeding those representative of natural soils; of these, lead and mercury are of the greatest concern due to their toxicity to humans and their prevalence throughout the areal extent of the site and at depth down to at least 8 feet, the greatest depth sampled. The metals were apparently constituents of the site fill at the time of placement. The sand and gravel fill appears to have the physical composition of, and contain contaminants that could be found in, Lake Michigan dredgings. On the other hand, the pesticides DDD, DDE, and DDT, though also present throughout the site area, are apparently confined to near-surface soils (i.e., upper 5 feet). This indicates that the pesticides were deposited on the surface of the site after the fill was placed--possibly originating from contaminated soils and plant debris stockpiled onsite, possible onsite pesticide usage, runoff from landscaped areas over the bluff, or other sources. However, the pesticides are present at concentrations that would pose little or no health risks. Further, contamination of groundwater and surface water is considered unlikely because of the apparent immobility of the metals and pesticides in the permeable fill material, the preferential discharge of shallow groundwater to the lake, and the considerable dilution of any contamination in surface runoff and groundwater upon entering and dispersing throughout the lake.

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APPENDIX A
Detailed Field Procedures and Fieldwork QA

APPENDIX A
Detailed Field Procedures and Fieldwork QA

A.1 OVERVIEW

This appendix provides specific descriptions of the field procedures employed for groundwater monitoring well installation and associated activities; for collection of samples at the five study sites; and for verifying and maintaining performance quality for monitoring well installations, for collection of environmental samples, and for subsequent chemical analysis of the samples. The Laboratory QA Plan for chemical analysis is presented in the Verification Step Work Plan for this project (Dames & Moore, 1987a).

In this RI Verification Step program, monitoring wells were drilled and installed by Fox Drilling, Inc., Itasca, Illinois, under the supervision of a qualified Dames & Moore field staff member. Samples of groundwater, surface water, soil, and sludge were collected at NTC Great Lakes by Dames & Moore field personnel. Chemical analysis of the samples was performed under subcontract to Dames & Moore by metaTRACE, Inc., Earth City, Missouri.

Included in this appendix are descriptions of the following:

- Groundwater monitoring well drilling/installation/development procedures and approach to associated activities (e.g., borehole logging, water level measurements).
- Decontamination procedures employed during well drilling/installation.
- Sample collection and sampling equipment decontamination procedures.
- Sample containerization, preservation, and holding times.
- Sample chain-of-custody.
- Specifications for field QA/QC samples.
- Specifications for field data collection and data management.
- Approach to office data organization and management.
- Requirements for the disposal of wastes generated during the field investigation.

The sections that follow discuss field procedures and associated QA requirements for soil boring/monitoring well installation and water level measurements (Section A.2), and sample collection and management (Section A.3).

A.2 SOIL BORING/MONITORING WELL INSTALLATION AND WATER LEVEL MEASUREMENTS

A.2.1 Drilling and Borehole Logging

Boreholes drilled in glacial till and sand for soil and monitoring well installation at NTC Great Lakes were drilled using 6¼-inch inside diameter (ID) hollow-stem augers (HSA). All wells were drilled using 6¼-inch ID HSAs to provide temporary casing to support surrounding soil during the well installations; the augers were removed as installation progressed. The wells installed during this investigation were intended to penetrate the shallowest water-bearing zone and to straddle the water table as identified during drilling. In several instances, the initial boring did not encounter groundwater, in which case the boring was abandoned (see Section A.2.8) and a replacement boring/well installed. In one instance, a well (MW1-6) was installed but subsequently found to be dry; it was replaced by another well (MW1-6A). The original well was not grouted to the surface in case a water level could subsequently be detected. No water was detected in this well during either round of sampling. (If this situation continues in future water level measurements, the well should be grouted to the surface.)

The potable water source used for drilling was supplied by NTC Great Lakes at the FFTA. Prior to the start of drilling, all equipment and well casing were steam cleaned as described in Section A.2.3. The drilling water was obtained from a tap in the garage portion of Bldg. 3304 and was sampled for chemical analysis during the first round of sampling (sample DW-1). The sample was analyzed for all parameters of interest at NTC Great Lakes (see Table 1-1). The only parameters detected and their concentrations are listed below:

- Chloride 13.8 mg/l
- Total Organic Carbon 2 mg/l
- Chloroform 12 ug/l
- Lead 6.54 ug/l
- Mercury 0.50 ug/l
- Zinc 79.9 ug/l.

Based on these results, the tap in the Bldg. 3304 garage is judged suitable as a drilling water source and as a potable water source for equipment rinsing prior to a final rinse with distilled water. Chloroform was found to be present because the water source is chlorinated.

Drilling was supervised by a qualified Dames & Moore field staff member, who prepared detailed logs of each well borehole and textural descriptions of shallow borings. Logs indicated field classification of soils, sampling depths, first encountered and static groundwater levels, progress of drilling, final completion depth, and the nature and resolution of any problems encountered. A sample of the boring log form used by Dames & Moore is shown in Figure A-1. Logs of well borings appear in Appendix B.

During well drilling operations, disturbed soil samples were collected using a hammer-driven split spoon every 5 feet or when a major stratigraphic change was noted. On many occasions, thin layers of sandy material were encountered and noted on drilling logs, but--due to thickness of less than 2 feet--drilling generally could not be stopped and a sample obtained before the layer was fully penetrated. Thus, these thin layers are often noted on boring logs, but not shown in the column symbolizing the materials encountered.

A.2.2 Well Construction

All monitoring wells installed during the RI Verification Step were designed for the collection of samples for volatile organic constituents and were therefore constructed of 4-inch-diameter Grade 304 stainless-steel casing and manufactured screen with a 0.010-inch slot size. All casing and screen were flush threaded. Because the casing was stainless steel and could not be cut in the field, well borings were advanced in intervals of approximately 2.5 feet, which was the shortest length of pipe available. Due to the clayey subsurface materials encountered and the slow yield of water, the following technique was adopted following the installation of the first few wells. Borings were advanced to a depth of about 15 to 20 feet; if no water-bearing formations had been identified, the augers would be withdrawn at approximately 10 feet. The drill crew would wait 1 to 2 hours, or overnight if it was near the end of the day, then check for water in the borehole. If water was present and the level clearly rising, a well would be installed; if no water was present, the boring was advanced to a greater depth--25

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LOCATION OF BORING					JOB NO		CLIENT		LOCATION		
					DRILLING METHOD					BORING NO	
										SHEET	
					SAMPLING METHOD					OF	
										DRILLING	
					WATER LEVEL						START TIME
TIME						DATE	DATE				
DATE											
CASING DEPTH											

DATUM		ELEVATION				DEPTH IN FEET	SOIL GRAPH	SURFACE CONDITIONS
SAMPLER TYPE	INCHES DEPTH RECORDED	DEPTH OF CASING	SAMPLER NO	BLOWS/FT SAMPLER	NUMBER OF RINGS			
						0		
						1		
						2		
						3		
						4		
						5		
						6		
						7		
						8		
						9		
						0		
						1		
						2		
						3		
						4		
						5		
						6		
						7		
						8		
						9		
						0		

**FIGURE A-1
SAMPLE - STANDARD BORING LOG FORMAT**



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Great Lakes, Illinois

to 30 feet--and the procedure repeated. If no water was identified at this depth, the borehole was abandoned and a replacement drilled a short distance away.

Well installation occurred within the HSAs. Screen and casing were lowered into the borehole to within 5 feet of the bottom of the borehole. Clean, appropriately sized coarse sand--Global #7, fine, rounded quartz sand with approximately 75 percent by weight between 0.020 and 0.035 inches in diameter--was placed in the annulus around the screen to approximately 2.5 feet above the top of the screen where possible. A 2.5-foot bentonite seal was placed in the annulus directly above the sand pack using bentonite pellets where possible. For wells less than 17 feet in depth, the sand was brought up from 1.0 to 1.5 feet above the top of the screen, and the bentonite seal brought up another 1 foot from that. The remainder of the annulus was sealed with a neat bentonite-cement slurry. NTC golf course personnel had requested that, because so many wells were on or along the golf course, efforts be made to minimize obstructions. Therefore, 10 of the 14 wells were installed with flush-mounted (ground level) protective "manholes" and locking airtight plugs. A 5-foot-long protective steel casing with a locking cap was installed to a depth of approximately 2.5 feet around the four wells with casing stickup. A sloped, raised cement pad was installed at ground surface around each well to minimize ponding and infiltration of surface water. Details of well construction noted are shown on well diagrams in Appendix B.

A.2.3 Decontamination Procedures

To minimize contamination of the subsurface environment from drilling and other operations, all equipment was decontaminated before use. The drill rig and all drilling tools were steam cleaned using a high-pressure steam cleaner and potable water prior to the start of any drilling. In addition, all downhole tools, samplers, and other downhole equipment were steam cleaned between boreholes to avoid carryover of contaminants. All casing and screen materials were steam cleaned with potable water to remove foreign matter prior to installation in the borehole. All cleaned materials were placed on and wrapped in clean plastic sheeting during storage and transport to the well site, so as to avoid contact with the ground or contaminated surfaces. The drill rig and tools were decontaminated offsite after leaving the installation due to sub-zero windchills.

A.2.4 Well Development

Proper well development functions to remove water, drilling muds, and other fluids or materials introduced into the aquifer as a result of borehole drilling operations. It also reduces the amount of fine-grained sediment around the gravel-packed portions of the annulus, which might otherwise clog the well screen, and enhances porosity for free flow in the screened zone.

Well development techniques that could potentially contaminate or alter the chemistry of the water-producing zones were avoided. Bailing was used as the development method. Air lift using compressed air has been found to be undesirable when dealing with groundwater that is potentially contaminated with hazardous constituents, unless water discharge from the well can be controlled and directed. A 3-inch prebailer was used to develop all wells.

All well development equipment was appropriately decontaminated prior to use and between wells to minimize cross-contamination (see Section A.3.1.2). Prior to development, the static water level and well depth were measured and recorded. The objective of well development was to obtain water that was visually free of sediment. Field conductivity, temperature, and pH measurements of development water samples were made to track changes that indicated the complete removal of potentially contaminated water from the well.

A.2.5 Field Measurement of Temperature, pH, and Conductivity

Changes in the pH, conductivity, and temperature of groundwater/surface water can indicate changes in the condition of an aquifer/stream and can also affect the chemistry of a water sample. Measurements of temperature, pH, and conductivity were made in the field during development, as described above in Section A.2.4, and were performed on aliquots of all water samples collected at the site to track changes in water quality and changes in samples after collection, respectively.

Measurements were made using portable meters and USEPA Methods 170.1 (temperature), 120.1 (pH), and 150.1 (conductivity). All instruments were calibrated prior to the beginning of the project. pH and conductivity meters were calibrated in the field at the beginning and end of each day of use, using standard solutions. All probes were decontaminated prior to each sample to minimize cross-contamination.

In general, the procedure for taking a field conductivity measurement consisted of measuring the temperature of the water sample at the sampling site; adjusting the temperature to correct readings of conductivity at 25°C (unless the meter automatically measured and corrected for temperature); rinsing the conductivity probe in the water sample aliquot contained in a small glass beaker; discarding the beaker contents and adding fresh aliquot; reading and recording temperature-corrected conductivity; and vigorously rinsing the conductivity probe with distilled water.

Field pH measurements are made within 5 minutes after sampling to avoid changes in pH that occur during sample storage. The general measuring procedure was as follows, with variations according to manufacturer's recommendations: measurement of calibration buffer solution temperature; adjustment of pH meter temperature compensation control to buffer temperature; adjustment of the meter to the buffer pH using two buffer solutions that bracket the expected sample pH; adjustment or repair of the pH meter if the measured pH of either buffer differed from the buffer pH by more than 0.1 pH unit; measurement of the sample temperature, site temperature compensation, and reading sample pH; and vigorously rinsing the pH probe and storing in distilled water.

A.2.6 Surveying of Well Locations and Elevations

Accurately locating wells in relationship to each other, as well as to other known locations, is necessary to interpret the data from these points and to define the site-specific hydrogeology. The elevation of the well is also an important factor in relating water level measurements from well to well, and in relating the vertical distribution of constituents in the subsurface.

The locations and elevations of all reference marks, monitoring wells, and other relevant locations (surface water sampling points in Skokie Ditch/River) were determined by a licensed surveyor--Land Surveys Limited, Verona, Wisconsin--after all well installations were completed. Location coordinates were provided for each point to within ± 1 foot and related to longitude and latitude or to the Illinois State Planar Coordinate System. Ground elevations for reference marks, borings, and wells; elevations for the top of well casings; and elevations of the water surface at stream sampling points were determined to within ± 0.05 foot, based on the datum used at NTC Great Lakes, which is mean tide New York

Harbor. Subtracting 0.69 foot from elevations based on this datum converts to the National Geodetic Vertical Datum (NGVD) of 1929.

A.2.7 Water Level Measurements

Water level measurements during and after drilling of a borehole/well are useful for assessing the hydraulic gradient and appropriate locations for new monitoring wells. These measurements are also necessary for finalizing the optimum well design and construction (e.g., screen and seal placement).

Water table elevations can be measured in a variety of ways, using a variety of tools. For the purposes of discrete water level measurements during drilling and well development operations in this project, and during sample collection, a measuring tape with a weight that could be lowered into the open borehole or well casing was used.

A.2.8 Boring/Well Abandonment Procedures

To protect the integrity of the subsurface environment and underlying aquifer, it is important to employ proper procedures in abandoning boreholes or wells. Improperly sealed boreholes/wells can provide a direct conduit for surface runoff and contaminants to reach the subsurface.

Consistent with IEPA requirements, shallow boreholes (up to 5 feet) were backfilled with cuttings; deeper abandoned boreholes and wells were grouted shut. A tremie pipe was used to place grout in the deeper holes from the bottom to ground surface. Complete records of the borehole/well and abandonment procedures were made and placed in the project files.

A.3 SAMPLE COLLECTION AND MANAGEMENT

The procedures described in this section ensured that representative environmental samples were obtained, and that these samples were properly containerized, preserved, shipped, and otherwise handled to maintain their chemical integrity. The use of these sampling and associated techniques significantly reduced the possibility of sample contamination from external sources and allowed for verification of proper sampling and sampling equipment decontamination procedures.

A.3.1 Sample Collection and Sampling Equipment Decontamination Procedures

This section describes procedures employed for collection of groundwater, surface water, and soil samples at NTC Great Lakes, and associated procedures for sampling equipment decontamination. The techniques employed in collecting and preparing replicate samples in the field are also discussed. The source of potable water used during equipment decontamination, as discussed in Section A.2.1, was supplied by NTC Great Lakes.

A.3.1.1 Groundwater

To ensure that cross-contamination between wells did not occur, all reusable equipment that was used to measure and sample the groundwater (e.g., bailers, tapes, ropes) was vigorously cleaned prior to use in each well. All nondedicated sampling equipment was decontaminated by washing with a nonphosphate detergent, rinsing with hexane (where oily materials were contacted), rinsing with potable water, and final rinsing with distilled water. All bailers and equipment used for purging wells were washed with nonphosphate detergent, rinsed with potable water, and final rinsed with distilled water. Expendable equipment that was difficult or impractical to clean (e.g., wire, ropes, filter media, etc.) was discarded after each sample and replaced by new equipment for subsequent samples. Similar procedures were employed during sample collection of surface water and soils.

The sampling equipment was protected from ground surface contamination at all times by spreading clean plastic sheeting around the well. To ensure that contamination did not occur from the plastic sheeting, new protective sheeting was used at each well (as well as at other types of sampling locations). Additionally, to prevent equipment contamination from windblown particles, all sampling equipment was covered with plastic sheeting prior to its insertion into the well.

A primary consideration in obtaining a representative groundwater sample from a monitoring well is to guard against mixing the sample with standing, stagnant water in the well casing. In a nonpumping well, there will be little or no vertical mixing of the volume of water above the screened interval, and stratification may occur. Such stagnant water may contain foreign or degraded material, resulting in an unrepresentative sample and misleading chemical data. Therefore, purging of nonpumping wells is necessary prior to sample collection.

Dames & Moore used the following procedures when collecting groundwater samples from all monitoring wells:

- For the newly installed wells, samples were collected no sooner than 2 days after well development had been completed.
- Upon removal of the well cap and prior to sampling, the air above the well head was sampled with a photoionization detector. The procedure to be followed if high concentrations of volatile organics were detected is presented in the project-specific Health and Safety Plan (Dames & Moore, 1987a).
- Prior to purging and sampling each well, measurement (to within ± 0.1 foot) of the depth from the top of the well casing (not protective casing) to the top of the water was recorded in the sampling logbook.
- The depth from the top of the casing to the bottom of the well casing was measured (to within ± 0.1 foot) and recorded.
- The depth to the top of the water was subtracted from the depth to the bottom of the well casing, and the height of standing water in the casing and saturated annulus was determined. The diameter, height, and estimated porosity of the sand pack, as recorded by the Dames & Moore field drilling supervisor during well construction, were available during sampling activities.
- A quantity of water from the well equal to five times the calculated volume of water in the well, including the saturated annulus, was removed.
- If recharge rates were slow, wells were purged to dryness at least four times, and the water level was allowed to recover prior to sample withdrawal.
- Samples for chemical analysis were collected immediately after bailing was complete, and the water level has recovered to a level sufficient for sampling. Methods were employed to minimize sample aeration.
- The samples were collected using a 2-inch stainless-steel bailer.
- All samples were placed in properly sized and cleaned containers.

Sample containers of appropriate volume and construction were prepared and provided by the laboratory to ensure the collection of sufficient volumes for all specified analyses. The samples were collected so as to minimize aeration as water entered the bottle. Care was taken to avoid external contamination of the sample container cap after it was removed and prior to replacement on the filled container.

- All samples for volatile analysis were bailed with a stainless-steel bailer and collected in screw-cap, septum-top glass vials and filled so that no air bubbles were present to allow volatilization to occur. These samples were not filtered.
- After obtaining chemical analysis samples, a second sample was taken for temperature, conductivity, and pH measurements, and the results were recorded in the sampling logbook.
- Samples for metals analysis were filtered in the field using a 0.45-micron filter, and preserved according to USEPA requirements and laboratory instructions. Samples for VOCs, TOC, and oil and grease were not filtered. Samples for other nonvolatiles were filtered in the laboratory as specified.
- Any appropriate preservative was added, and the vial was capped securely.
- Samples were labeled in accordance with chain-of-custody procedures.
- Sample bottle(s) were placed in an ice (4°C) chest immediately after sampling and delivered to the laboratory by overnight courier.

A.3.1.2 Surface Water

All reusable sampling equipment was cleaned and treated as specified in Section A.3.1.1. Before sampling, the precleaned sampling equipment was rinsed downflow of the sampling point to prevent disturbance of the sediment near the sampling point and to prevent cross-contamination. After sampling was completed at one location, the equipment was decontaminated before the next sample was collected.

Samples were collected by immersing the sample container; the appropriate preservative was then added; and the container was capped securely. Surface water samples were not filtered. Finally, the container was labeled and placed in

an ice (4°C) chest to be delivered to the laboratory. A water sample was also collected at each location for temperature, pH, and conductivity measurements.

A.3.1.3 Soils

In general, Dames & Moore observed the following procedures when collecting soil samples and samples from sludge (i.e., dredge spoil) deposits:

- All sample points were marked with a surveying flag that displayed the sample point code number. The location was recorded on a suitable installation map for future reference. Locations were determined by tape measurements from permanent or semipermanent landmarks.
- Prior to sampling, all surface vegetation, rocks, and debris were removed to allow collection of a clean and representative sample.
- Shallow soil samples were collected using a split-spoon sampler during borehole drilling (Sites 4 and 12), or with a hand auger, shovel, or soil scoop, as appropriate (Sites 5 and 7). Split-spoon samples were composited over a depth interval of approximately 1.5 to 2 feet or the length of sample recovered in the sampler.

During shallow soil boring at Sites 4 and 12--conducted with 4-inch outside-diameter (OD) solid-stem augers--the boring was drilled to the appropriate depth for the first sample (0.5 foot at Site 12 and 1.5 feet at Site 4). The auger was withdrawn, the sample was collected with a split spoon, and the boring was advanced to the next sampling depth. This method minimized the volume of cuttings generated and the amount of borehole to be grouted or backfilled.

- Reusable sampling equipment was decontaminated prior to sampling and between sampling locations to prevent cross-contamination. The drill rig and all drilling tools were steam cleaned prior to the start of drilling. In addition, between boreholes, all downhole tools, samplers, etc., were steam cleaned.
- Samples for chemical analyses were placed, stored, and shipped (in a cooler at 4°C) in wide-mouth amber glass bottles.
- Samples were marked with identifying information and logged in the field notebook.

Where samples were collected over a long depth interval (e.g., at the FFTA and the Harbor Dredge Spoil Area), it was necessary to composite the material retrieved from that depth interval to obtain a representative sample of correct volume for analysis.

Samples collected for analysis of VOCs were collected using the following procedure: The sampler was opened, and the outer layer of the sample (which was in contact with the sampler) was stripped away using a stainless-steel spatula or knife. A "strip" of soil the length of the sample was removed using a clean spatula or knife and placed directly into the appropriate cleaned sample container. This was accomplished as quickly as possible to avoid loss of volatiles and to minimize other changes to the sample. The container was immediately capped and stored in a cooler at 4°C.

Samples for other analyses were collected using the following procedure: Soil materials were extracted from the split-spoon sampler or other sampling device and placed in a clean stainless-steel bucket. In the case of loose, unconsolidated sediments, the Dames & Moore field samplers used a clean, stainless-steel spatula to mix the soil to form a more homogeneous mixture. The mixture was then quartered and placed in a sample container(s) appropriate to the required analyses. In the case of cohesive sediments, the Dames & Moore field samplers used a clean, stainless-steel spatula to extract a sufficient number of segments from the sample at regular intervals to obtain a sufficient sample volume for analysis. Compositing was accomplished as quickly as possible to minimize changes to the sample. All reusable equipment used was thoroughly cleaned between sampling locations (as specified in Section A.3.1.1) to minimize cross-contamination.

A.3.1.4 Replicate Samples

Replicate samples of water and soil/sludge were collected and analyzed to check laboratory precision (see Section A.3.3). Collection procedures described in the preceding sections were used. The frequency of field replicate collection is specified in Section A.3.3.

All duplicate soil and water samples, other than those for volatile organic analysis, were composited upon collection in an appropriately large container with the original sample in the field. The samples were then homogenized and subsampled, using the appropriate unit sample containers, at a suitable uncontaminated location. Duplicate samples for volatile organic analysis were collected in succession in glass vials with Teflon septa caps. The volatiles were subsampled.

A.3.2 Sample Containers, Preservation, and Maximum Holding Times

A.3.2.1 Sample Containers

For water samples, sample containers were chosen that were compatible with the analytes of interest. In general, glass bottles with Teflon-lined caps were used for samples for organics analysis, and plastic (polyethylene) bottles were used for samples for metals analysis. Samples for volatiles analysis were collected in glass vials with Teflon septa caps. For soil and sludge samples, wide-mouth, amber glass bottles with Teflon-lined lids were used. Specific sample container requirements are specified in Table A-1. All sample containers were cleaned in the laboratory prior to shipment to the field.

A.3.2.2 Sample Preservation

Water samples for metals analyses were collected in polyethylene bottles and preserved with nitric acid to $\text{pH} < 2$. Groundwater samples for metals only were filtered prior to preservation in the field. Each sample for metals analyses was then cooled to 4°C . Samples for chloride analysis required no preservation. Water samples for organic analyses, with the exception of TOC and oil and grease, were collected in appropriate glass bottles, cooled to 4°C , and stored in the dark inside a sealed ice chest. Samples for TOC and oil and grease were acidified to $\text{pH} < 2$, then cooled to 4°C . All soil and sludge samples were collected in appropriate glass bottles, cooled to 4°C , and stored in the dark. Sample preservation requirements are summarized in Table A-1.

To provide for the shortest in-transit storage periods, all environmental samples were shipped in appropriate containers by priority air express so that they reached the laboratory for immediate placement in refrigerated storage.

A.3.2.3 Sample Holding Times

The time that a preserved sample may be held between sampling and analysis is based on the analyte(s) of interest. Holding time limitations are intended to minimize chemical change in a sample before it is analyzed. The holding time is the maximum time allowable between sample collection and analysis. Allowable holding times apply to both solid and aqueous samples. For NTC Great Lakes chemical analyses, the maximum holding times for samples are provided in Table A-1.

TABLE A-1

Information on Sample Containers, Preservation, and Holding Times
RI Verification Step at NTC Great Lakes

<u>Analyte</u>	<u>Container Requirements</u>	<u>Preservation</u>	<u>Maximum Holding Time</u>
----- Water Samples -----			
Priority pollutant metals	1-quart plastic bottle	HNO ₃ to pH < 2, cool to 4°C	28 days for mercury, 6 months for others
VOCs	40-ml glass vials with Teflon septum caps, 2 per sample	HCl to pH < 2, cool to 4°C	14 days
BNAs	1-gallon amber glass bottle with Teflon-lined cap	Cool to 4°C, store in dark	7 days until extraction, 40 days after extraction
Pesticides/PCBs	1-gallon amber glass bottle with Teflon-lined cap	Cool to 4°C, store in dark	7 days until extraction, 40 days after extraction
TOC	8-ounce amber glass bottle	HCl or H ₂ SO ₄ to pH < 2, cool to 4°C	28 days
Oil and grease	1-quart glass jars, 2 per sample	H ₂ SO ₄ to pH < 2, cool to 4°C	28 days
Chloride	1-quart plastic bottle	None required	28 days
----- Soil/Sludge Samples -----			
All analytes listed above except VOCs	250-ml wide-mouth amber glass jar with Teflon-lined cap ^a	Cool to 4°C, store in dark	Same as above for corresponding water samples
VOCs	40-ml glass vials with Teflon septum caps, 2 per sample	Cool to 4°C	14 days

^aFor sampling soil/sediment with very high water content, two 1-quart wide-mouth amber glass jars were required.

A.3.3 Field QA/QC Samples

The QA/QC protocol for this project included the use of field QA/QC samples to verify the soundness of sample techniques, chain-of-custody, and chemical analysis results. The following types of samples were prepared/collected:

- VOC trip blanks--consisted of distilled water in VOC bottles, to monitor any sample contamination that might have occurred during handling or shipping. These bottles were shipped to the field and returned to the laboratory, but not opened in the field.
- Field blanks--consisted of distilled water poured through the cleaned bailer assembly or other sampling equipment into appropriately preserved bottles, to check the effectiveness of sampling equipment decontamination procedures.
- Replicate samples (see Section A.3.1.4)--to check laboratory analytical precision.

In addition, a sample of the potable water used in drilling and for washing/rinsing equipment was collected from a source designated by NTC Great Lakes at the FFTA, and it was analyzed for all constituents of concern in the RI (see Section A.2.1).

Specifications for the preparation/collection of the above samples for shipment to the laboratory, as part of the sampling program for NTC Great Lakes specified in Table 1-1, are presented in Table A-2. Each sample, with the exception of the VOC trip blanks, was analyzed for all parameters listed in Table 1-1. The trip blanks were analyzed only for VOCs.

A.3.4 Sample Chain-of-Custody

A.3.4.1 Sample Collection, Handling, and Identification

Field records were completed at the time a sample was collected and was signed or initialed, including the date and time, by the sample collector(s). Field records were maintained in a bound notebook and contained the following information:

- Names and affiliations of sample collector(s)
- General description of the day's field activities
- Documentation of weather conditions during the previous 48 hours
- Field equipment calibration data
- Unique sample number

TABLE A-2

Specifications for Field QA/QC Samples
 RI Verification Step at NTC Great Lakes

<u>Field QA/QC Sample Type</u>	<u>Frequency</u>
VOC trip blanks	5% of all samples per round of sampling
Field blanks	5% of all samples per round of sampling
Replicate samples	5% of samples of each matrix per round of sampling
Drilling/wash/rinsing water	One time per water source

- Project/installation name or identification
- Purpose of sample/analysis
- Field measurements of temperature, pH, and conductivity
- Date and time of sampling
- Source/location of sample
- Sample matrix
- Method of sample collection
- Volumes of groundwater removed before sampling, where applicable
- Water level measurements (where applicable)
- Preservative used
- Analyses required
- Serial number(s) on seal(s) and transportation case(s), if any.

Also, at the time of sample collection, each sample was identified by affixing a pressure-sensitive gummed label on the container. Notations on the label were made in waterproof, indelible ink and covered with clear tape. Information on the sample label included:

- Unique sample number.
- Project number or identification.
- Source of sample (including identification number, name, location, and sample type).
- Preservative used.
- Analyses required.
- Name of collector(s).
- Date and time of collection.

Chain-of-custody forms were also completed for each sample or group of samples as appropriate. An example of the chain-of-custody record is provided in Figure A-2.

The sample container was then placed in a transportation case (i.e., ice chest) along with the custody record form and pertinent field records. The case was then sealed and labeled.

A.3.4.2 Transfer of Custody and Shipment

When transferring the possession of the samples, the transferee signed and recorded the date and time on the chain-of-custody record. Custody transfers

accounted for each individual sample, though samples were transferred as a group. Every person who took custody filled in the appropriate section of a chain-of-custody record. To prevent undue proliferation of custody records, the number of persons involved in the chain of possession was as few as possible.

The sampling crew chief was responsible for seeing that samples were properly preserved, labeled, packaged, and dispatched to the laboratory for analysis. This responsibility included filling out, dating, and signing the appropriate portion of the chain-of-custody record.

All packages sent to the laboratory were accompanied by the chain-of-custody record and other pertinent forms. A copy of these forms was retained by the sample collectors and transferred to the project files upon completion of sampling at the installation.

Samples were shipped daily via overnight courier to the laboratory. Samples were packed in coolers to avoid breakage, and all samples were iced. The sampling crew chief provided airbill numbers to the laboratory sample custodian when samples were shipped. Delivery from the airport directly to the laboratory was made by the overnight courier service. Overnight couriers did not sign the individual chain-of-custody forms. Airbill receipts are considered valid addendums to the chain-of-custody forms.

A.3.5 Field Measurements of Temperature, pH, and Conductivity

See Section A.2.5 for a discussion of these procedures.

A.3.6 Field Data Management/Recordkeeping

Accountability for a sample begins when the sample is taken from its natural environment. A bound logbook was maintained to record the acquisition of each sample. Entries were made in waterproof ink. Only samples for one installation were entered in a given logbook. The logbook contained information to distinguish one sample from another. The information to be included is presented in Section A.3.4.

In addition to the field notebook, each sample was labeled and chain-of-custody records were prepared as discussed in Section A.3.4.

When samples were shipped to the laboratory, entries were made in the logbook noting date of shipment, number of shipping containers, samples sent, and carrier.

Chain-of-custody records for all environmental samples and field QA/QC samples, laboratory results, and any other data generated as a result of this task are maintained on file. Copies will be provided for review by ORNL and regulatory agencies as requested.

Sampling locations were noted on site drawings, which became part of the permanent project records. Monitoring well locations were surveyed, as discussed in Section A.2.6. Other sampling locations were noted with respect to permanent landmarks or site features (i.e., surface water samples) or, where necessary, were taped off from permanent or semipermanent site features (i.e., soil boring and sampling locations).

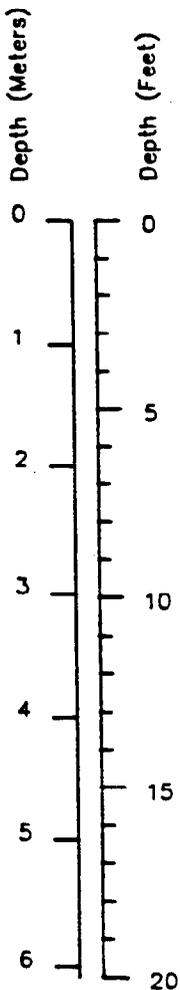
APPENDIX B
Geotechnical Information

B.1 BORING LOGS

BORING MW1-1

Surface Elevation: 709.9 Feet

Location: Site 1, Golf Course Landfill (GCLF)



Blow Count
Samples

Symbols

Description

Blow Count	Symbols	Description
8	ML	SILT, DARK BROWN TO BLACK, TRACE CLAY, GRAVEL AND ORGANIC MATERIAL, STIFF
7	CL	CLAY, WITH SILT AND GRAVEL, BROWNISH-YELLOW WITH BLACK AND GRAY MOTTLING, MEDIUM STIFF, MOIST
12	GM	GRAVEL WITH SAND, DARK GRAY, MEDIUM DENSE, WET
24	CL	CLAY, WITH SILT, DARK GRAY, TRACE GRAVEL STIFF, MOIST
		GRADING VERY STIFF

BORING COMPLETED AT A DEPTH OF 17.0 FEET ON 11-9-88

GROUNDWATER ENCOUNTERED AT A DEPTH OF 8.8 FEET ON 11-9-88

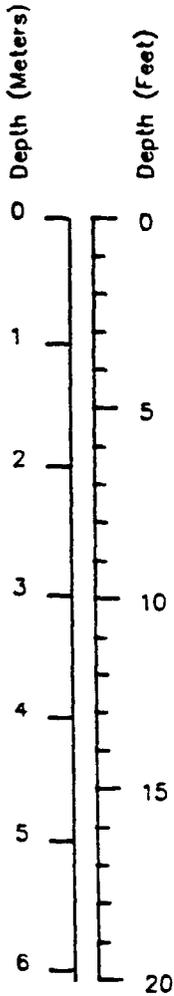
WELL INSTALLED TO A DEPTH OF 16.4 FEET ON 11-9-88

PLATE
LOG OF BORING

BORING MW1-2

Surface Elevation: 696.0 Feet

Location: Site 1, GCLF



Blow Count	Samples	Symbols	Description
13	☑	GM	GRAVEL, WITH SAND AND SILT, BLACK, MEDIUM DENSE
8	☑	CL	CLAY, WITH SAND AND SILT, TAN WITH YELLOW STAINING, STIFF
		SM	COARSE SAND WITH SILT, GRAY AND BLACK, MEDIUM DENSE, WET
12	☑	ML	SILT, WITH FINE SAND, GRAY, STIFF, WET
12	☑	SP	SAND, WITH GRAVEL, TRACE FINES, GRAY TO BLACK, MEDIUM DENSE, WET

BORING COMPLETED AT A DEPTH OF 17.0 FEET ON 11-10-88

WELL INSTALLED TO A DEPTH OF 16.0 FEET ON 11-10-88

PLATE
LOG OF BORING

BORING MW1-3

Surface Elevation: 689.2 Feet

Location: Site 1, GCLF

Depth (Meters)	Depth (Feet)	Blow Count	Samples	Symbols	Description
0	0	10	☑	ML	SILT, LIGHT BROWN, TRACE SAND, STIFF, DRY; TOP 3 INCHES ARE FILL (CINDERS)
1					
	5	38	☑		CLAY, WITH SILT, YELLOW TO GRAY TRACE GRAVEL, HARD, DRY
2					
	10	36	☑		
3					
	15	18	☑		GRADING MEDIUM BROWN GRADING GRAY, MOIST
4					
	20	19	☑	CL	GRADING VERY STIFF
5					
	25	14	☑		GRADING WITH INCREASING MOISTURE
6					
	30	17	☑		GRADING WITH LESS GRAVEL, INCREASING MOISTURE
7					
	35			GM	GRAVEL, WITH SAND, GRAY, LOOSE, WET
8		9	☑	CL	CLAY, GRAY, TRACE SILT AND GRAVEL, STIFF, WET
9					
	40				BORING COMPLETED AT A DEPTH OF 39.0 FEET ON 11-11-88

PLATE
LOG OF BORING

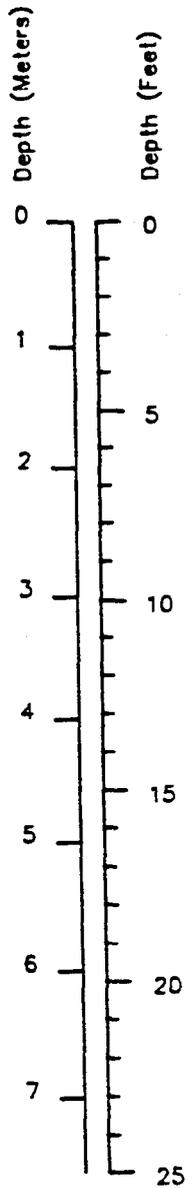
GROUNDWATER ENCOUNTERED AT A DEPTH OF
29.5 FEET ON 11-11-88

WELL INSTALLED TO A DEPTH OF 38.6 FEET ON 11-11-88

BORING MW1-4

Surface Elevation: 688.0 Feet

Location: Site 1, GCLF



Blow Count

Samples

Symbols

Description

8



CLAY, WITH SILT, LIGHT BROWN WITH TRACE BLACK AND YELLOW MOTTLING, TRACE GRAVEL, STIFF, DRY; TOP TWO INCHES ARE DARK BROWN CLAYEY SILT AND ORGANIC MATTER

14



GRADING DARK BROWN

7



GRADING MEDIUM BROWN, YELLOW MOTTLING TRACE SILT AND GRAVEL, MEDIUM STIFF, MOIST

26



GRADING MEDIUM BROWN TO GRAY, VERY STIFF

19



16



CL

BORING COMPLETED AT A DEPTH OF 25.0 FEET ON 11-15-88

GROUNDWATER NOT ENCOUNTERED

BORING GROUTED TO THE SURFACE ON 11-16-88

BORING MW1-4A

Surface Elevation: 688.1 Feet

Location: Site 1, GCLF

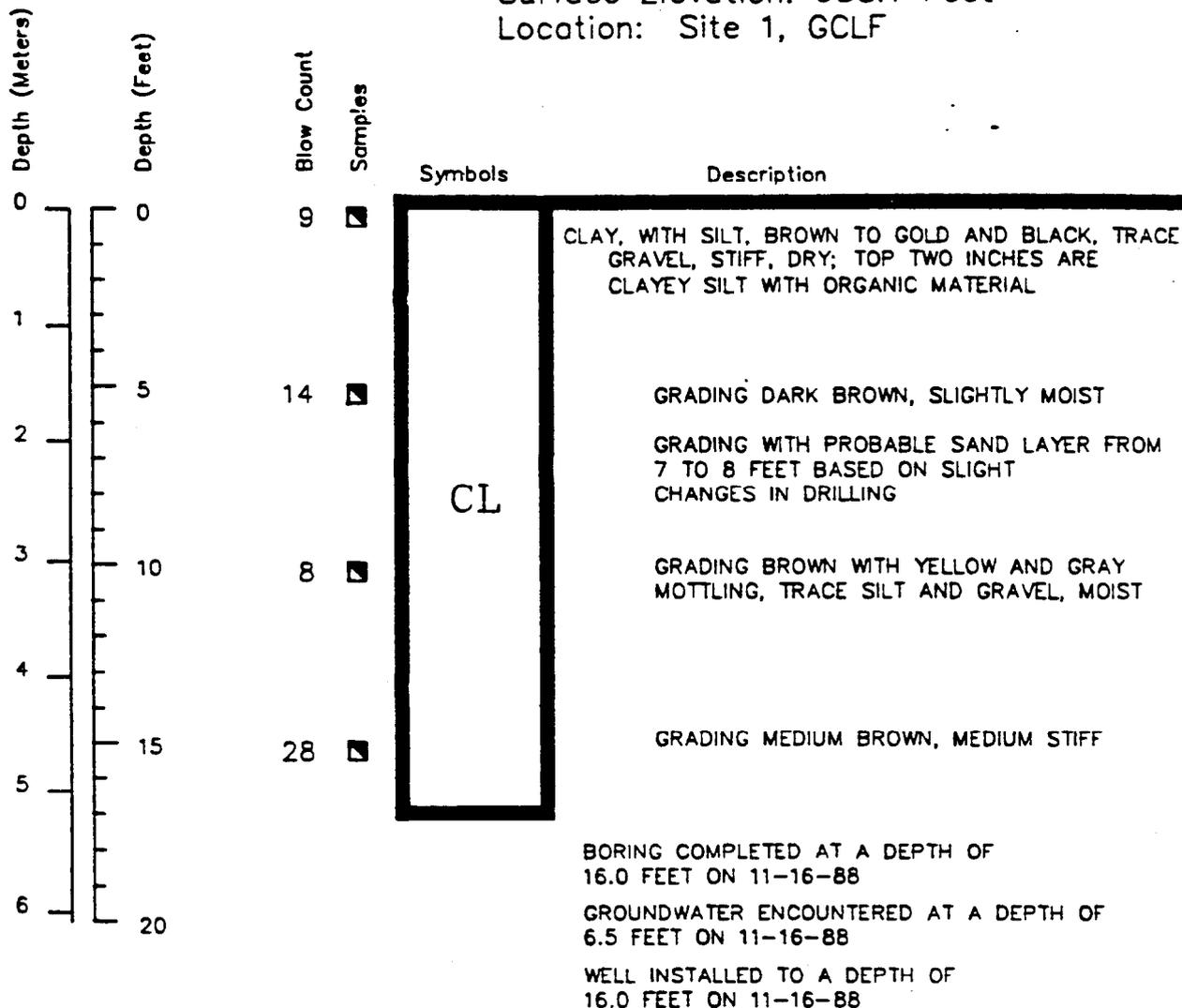
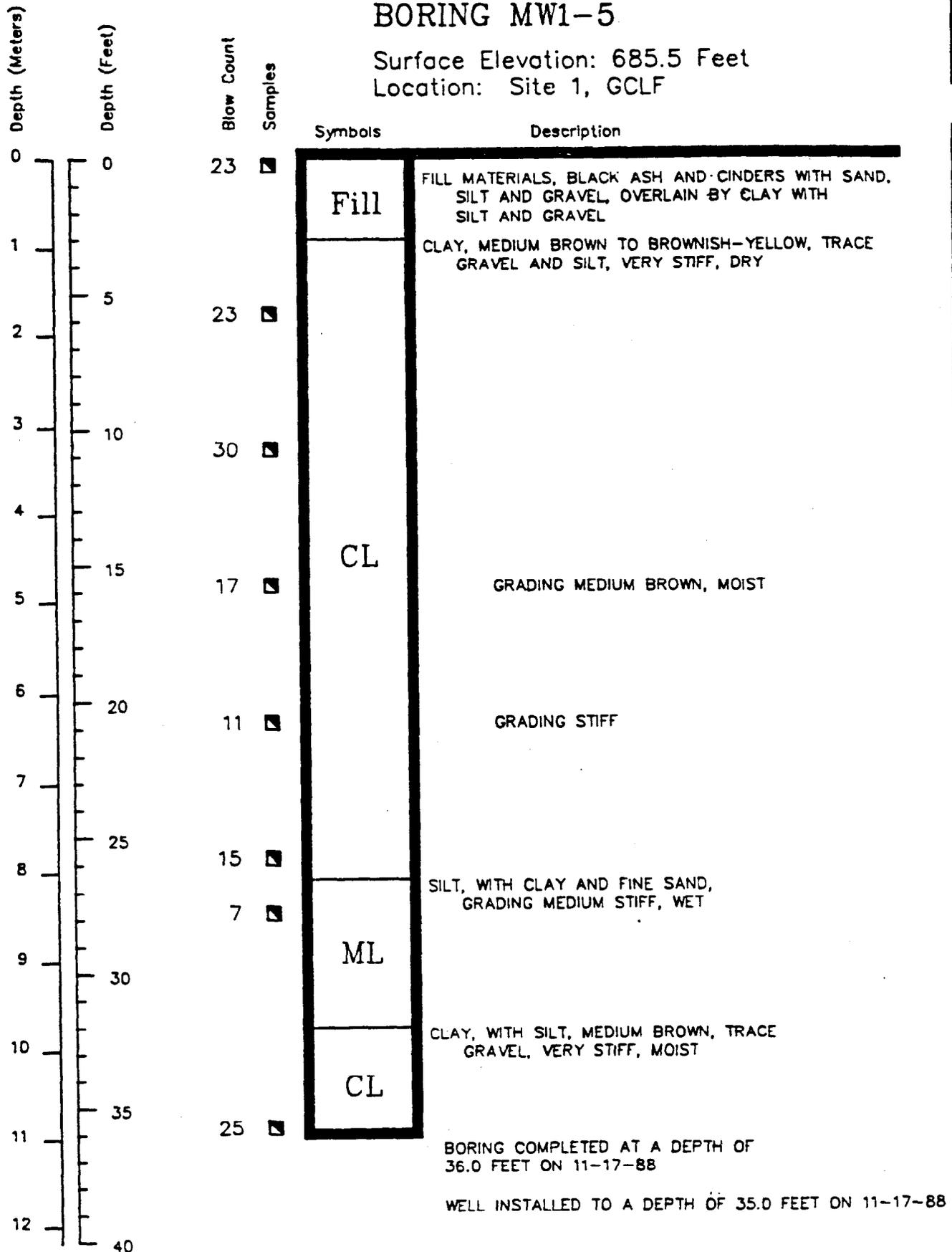


PLATE
LOG OF BORING

BORING MW1-5

Surface Elevation: 685.5 Feet

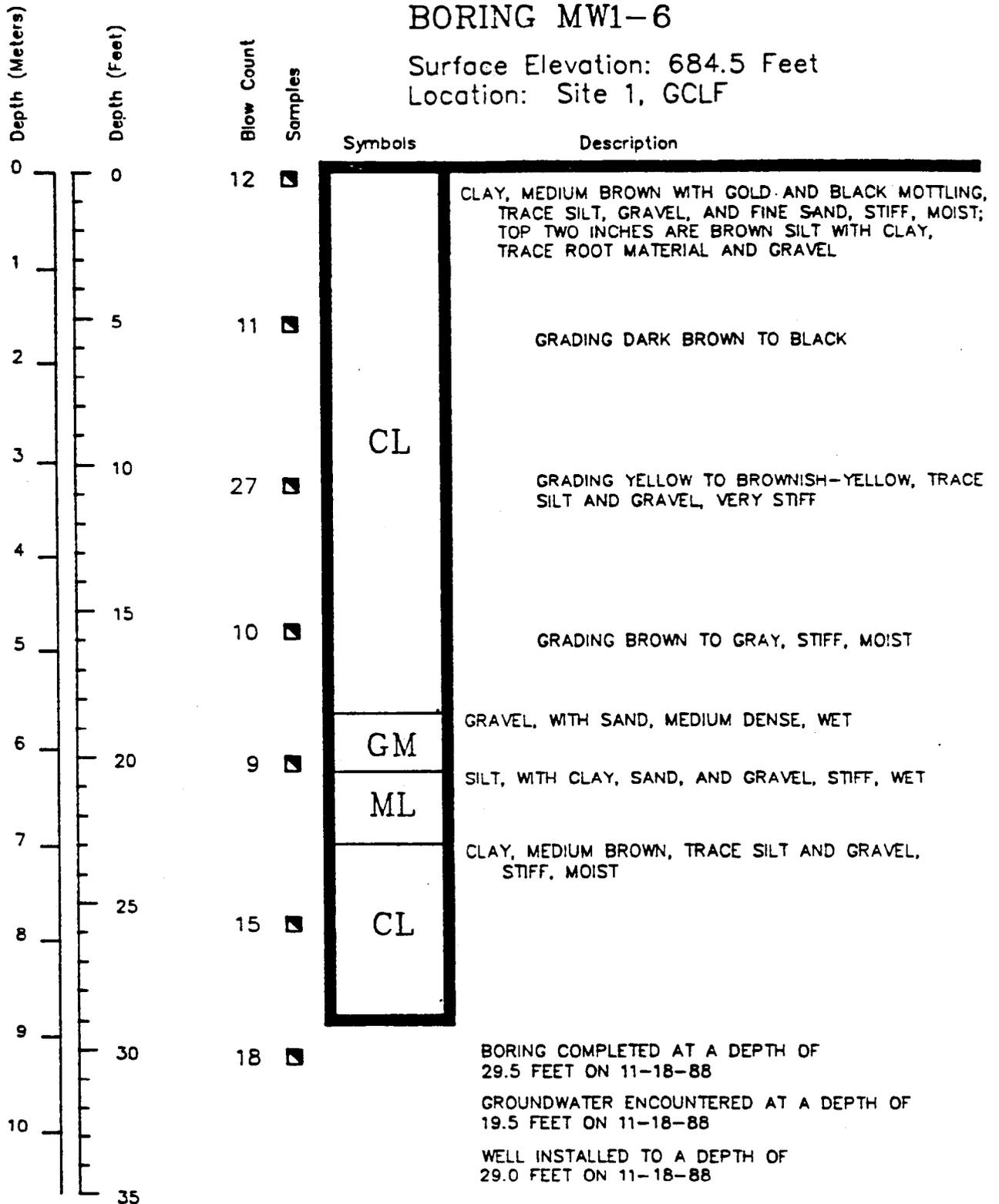
Location: Site 1, GCLF



BORING MW1-6

Surface Elevation: 684.5 Feet

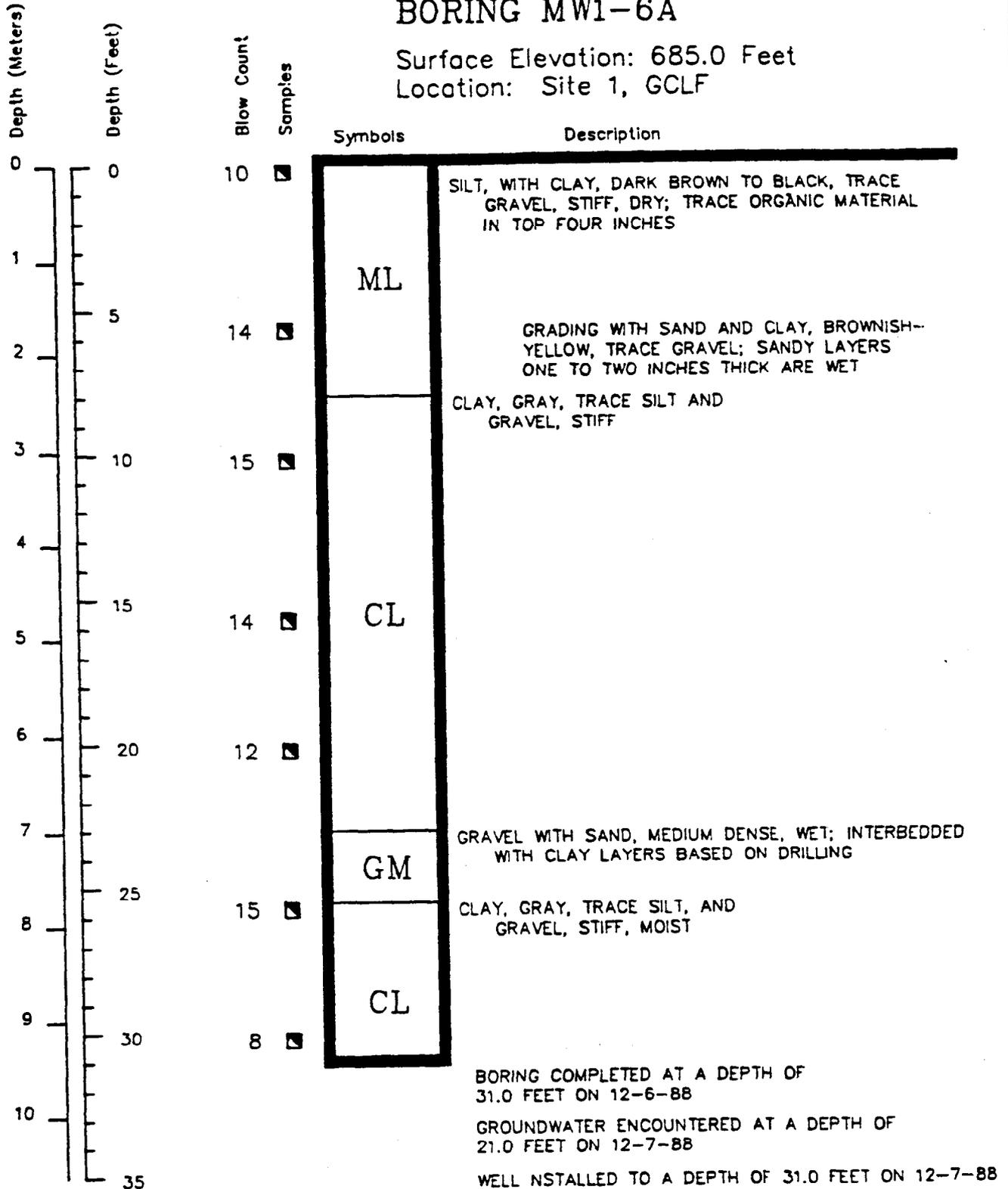
Location: Site 1, GCLF



BORING MW1-6A

Surface Elevation: 685.0 Feet

Location: Site 1, GCLF



BORING MW1-7

Surface Elevation: 680.0 FEET

Location: Site 1, GCLF

Depth (Meters)	Depth (Feet)	Blow Count	Samples	Symbols	Description
0	0	14	☑	ML	SILT, WITH CLAY AND GRAVEL, DARK BROWN, TRACE ORGANIC MATERIAL IN TOP SIX INCHES
1	5	34	☑	CL	CLAY, WITH SILT AND GRAVEL, YELLOW TO BROWNISH-YELLOW, HARD
2	10	17	☑		GRADING BROWNISH-YELLOW, TRACE SILT AND GRAVEL, VERY STIFF, MOIST
3	15	19	☑	ML	SILT, WITH CLAY, MEDIUM BROWN, TRACE GRAVEL, MEDIUM DENSE, MOIST
4	20	15	☑		
5	25	26	☑	CL	CLAY, MEDIUM BROWN, TRACE SILT AND GRAVEL, VERY STIFF, MOIST
6	30	17	☑		
7	35	17	☑		
8	40	20	☑		BORING COMPLETED AT A DEPTH OF 40.0 FEET ON 11-21-88
					GROUNDWATER NOT ENCOUNTERED
					BORING GROUTED TO THE SURFACE ON 11-21-88

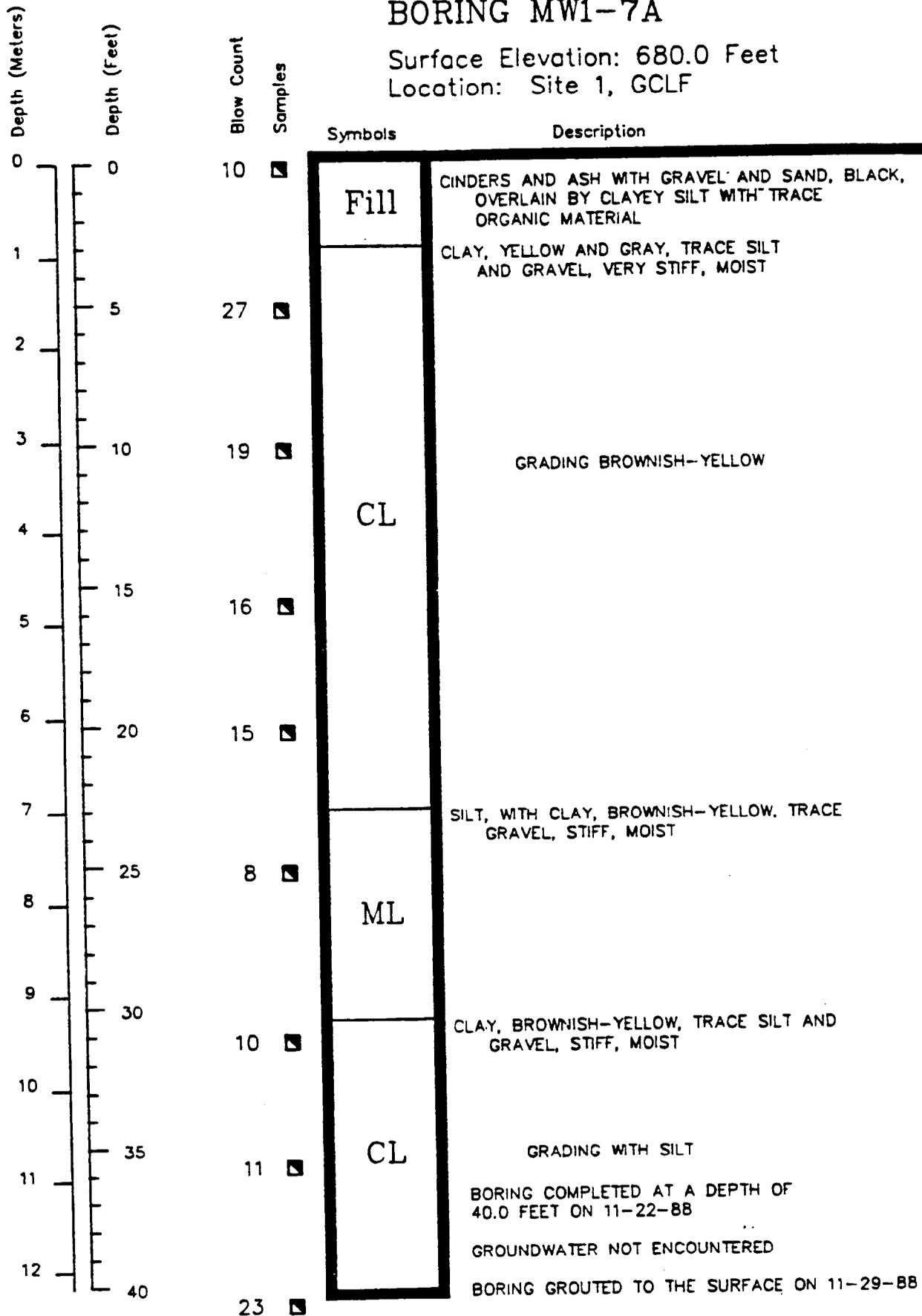
PLATE
LOG OF BORING

B-11

BORING MW1-7A

Surface Elevation: 680.0 Feet

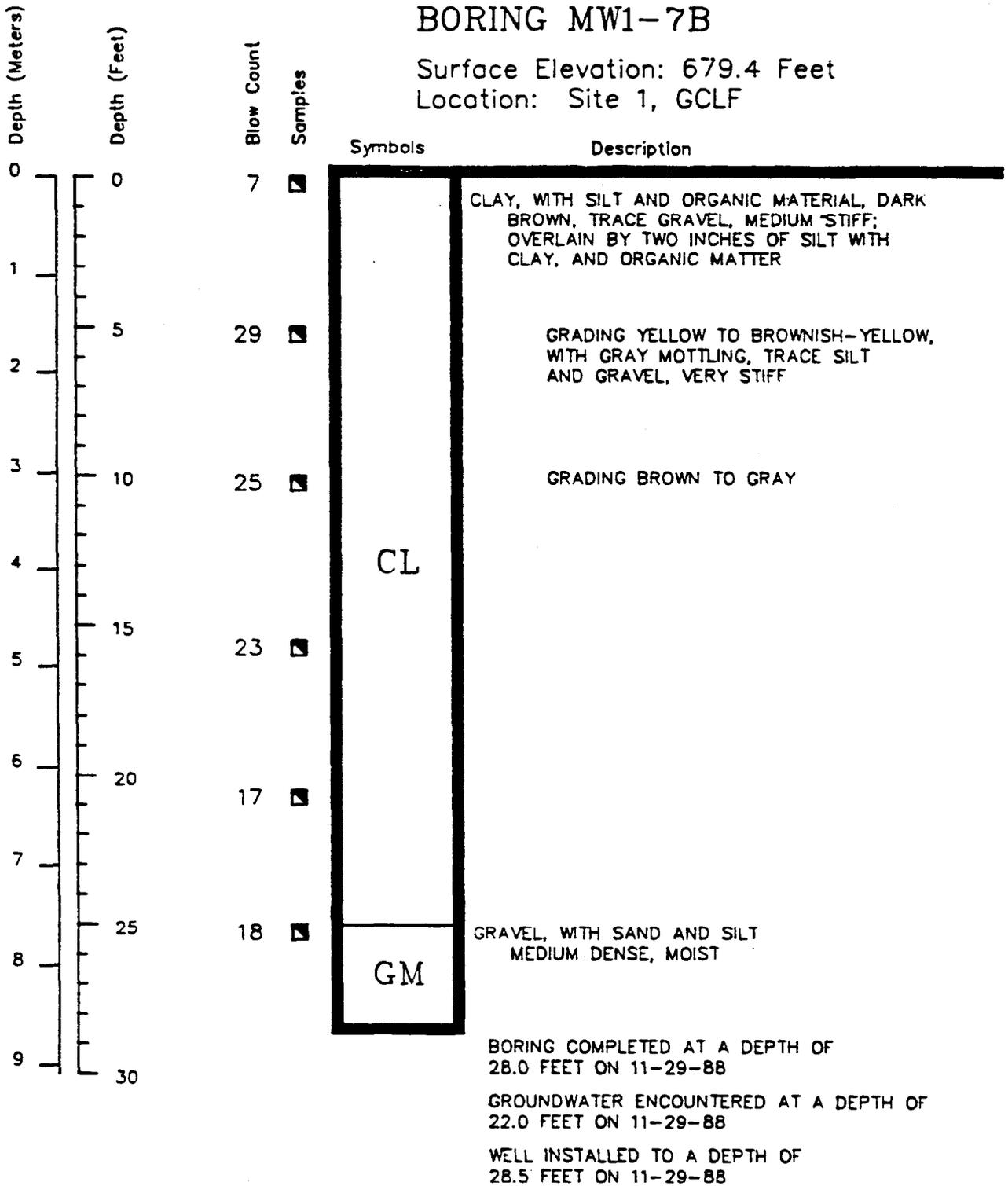
Location: Site 1, GCLF



BORING MW1-7B

Surface Elevation: 679.4 Feet

Location: Site 1, GCLF



BORING MW1-8

Surface Elevation: 716.5 Feet

Location: Site 1, GCLF

Depth (Meters)	Depth (Feet)	Blow Count	Samples	Symbols	Description
0	0	13	☑		CLAY, WITH SILT, YELLOW, TRACE GRAVEL, STIFF, DRY; overlain by four inches of clayey silt with organic material
1	5	26	☑		GRADING WITH GRAY AND BLACK MOTTLING, VERY STIFF
2	10	36	☑		GRADING HARD
3	15	18	☑		GRADING GRAY, VERY STIFF, MOIST
4	20	15	☑	CL	GRADING STIFF
5	25	16	☑		GRADING VERY STIFF
6	30	17	☑		GRADING TRACE SAND
7	35	42	☑	SM	SAND, WITH SILT AND GRAVEL, DENSE, WET
8	40	26	☑	CL	CLAY, GRAY, TRACE SILT, MOIST

PLATE
LOG OF BORING

BORING COMPLETED AT A DEPTH OF 39.0 FEET ON 12-7-88; COLLAPSED BELOW A DEPTH OF 34.0 FEET ON 12-8-88

WELL INSTALLED TO A DEPTH OF 33.5 FEET ON 12-8-88

B-14

Domes & Moore

BORING MW1-9

Surface Elevation: 695.6 Feet

Location: Site 1, GCLF

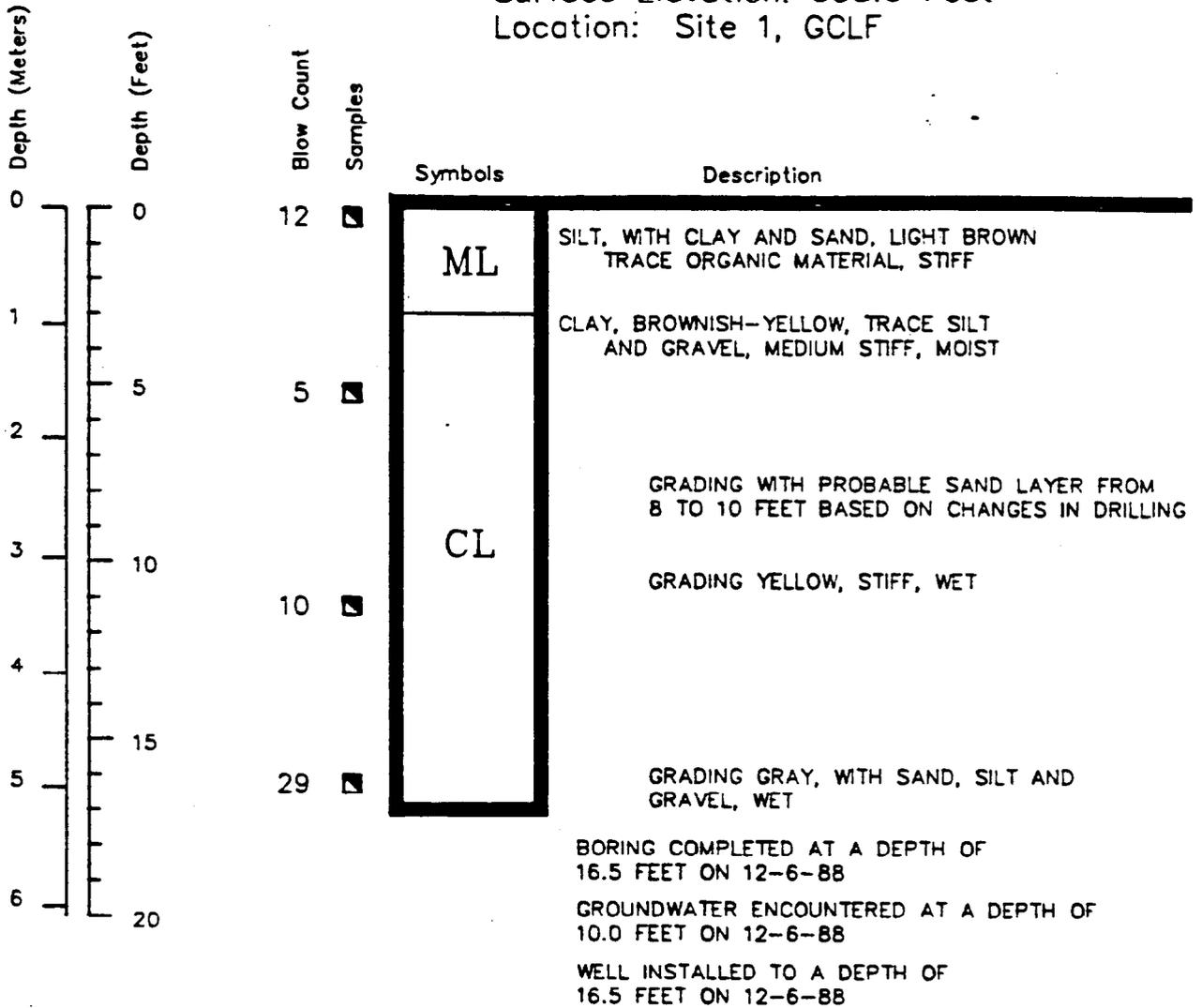
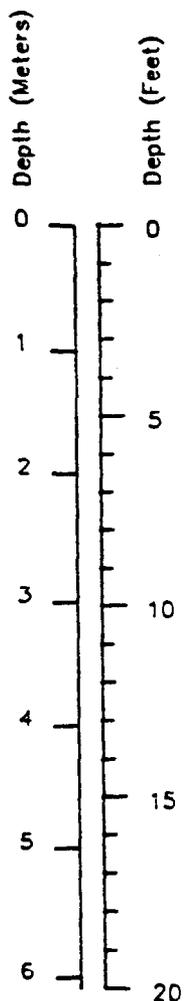


PLATE
LOG OF BORING

BORING MW4-1

Surface Elevation: 691.8 Feet

Location: Site 4, Fire Fighting Training Area (FFTA)



Blow Count
Samples

Blow Count	Symbols	Description
9	ML	SILT, DARK BROWN, TRACE CLAY, TRACE ORGANIC MATERIAL, STIFF, MOIST
13	SM	SAND, WITH SILT AND CLAY, LIGHT BROWN, TRACE GRAVEL, MEDIUM DENSE, WET
8		GRADING WITH SILT, LIGHT GRAY
12	CL	CLAY, WITH SAND AND SILT, LIGHT BROWN, STIFF, WET

BORING COMPLETED AT A DEPTH OF 16.0 FEET ON 11-7-88

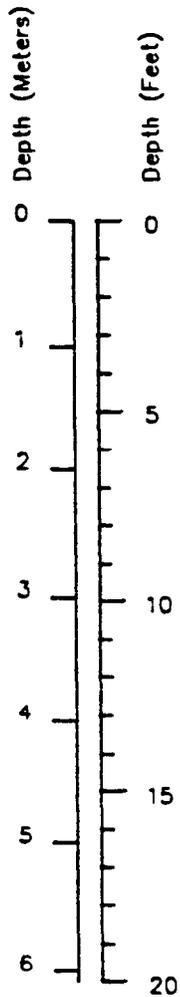
GROUNDWATER ENCOUNTERED AT A DEPTH OF 4.0 FEET ON 11-7-88

WELL INSTALLED TO A DEPTH OF 16.0 FEET ON 11-7-88

PLATE
LOG OF BORING

BORING MW4-2

Surface Elevation: 689.8 Feet
 Location: Site 4, (FFTA)



Blow Count

Samples

Symbols

Description

Blow Count	Samples	Symbols	Description
14	☑	SM	SAND, WITH SILT AND CLAY, LIGHT BROWN, TRACE GRAVEL, MEDIUM DENSE, DRY
14	☑		SAND, WITH GRAVEL AND SILT, LIGHT BROWN, MEDIUM DENSE, WET
13	☑	SP	GRADING RUNNING SANDS
15	☑		

BORING COMPLETED AT A DEPTH OF 18.0 FEET ON 11-8-88

GROUNDWATER ENCOUNTERED AT A DEPTH OF 4.0 FEET ON 11-7-88

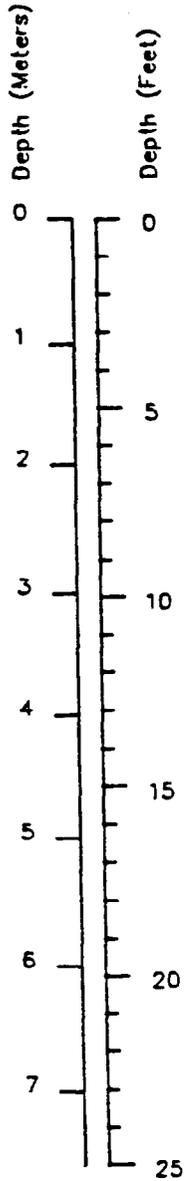
WELL INSTALLED TO A DEPTH OF 16.0 FEET ON 11-8-88

PLATE
 LOG OF BORING

BORING MW4-3

Surface Elevation: 689.0 FEET

Location: Site 4, FFTA



Blow Count	Samples
15	☐
12	☐
14	☐
20	☐
15	☐

Symbols

Description



CLAY, WITH SILT, DARK BROWN TO BLACK, TRACE GRAVEL, STIFF, DRY; TOP 12 INCHES ARE SILT, WITH CLAY, DARK BROWN, ABUNDANT ORGANIC MATERIAL

GRADING BROWNISH-YELLOW

GRADING LIGHT BROWN TO BROWNISH-YELLOW

GRADING GRAY, TRACE SILT AND GRAVEL, VERY STIFF, MOIST

BORING COMPLETED AT A DEPTH OF 22.0 FEET ON 11-8-88

GROUNDWATER NOT ENCOUNTERED

BORING GROUTED TO THE SURFACE ON 11-14-88

BORING MW4-3A

Surface Elevation: 688.4 Feet

Location: Site 4, FFTA

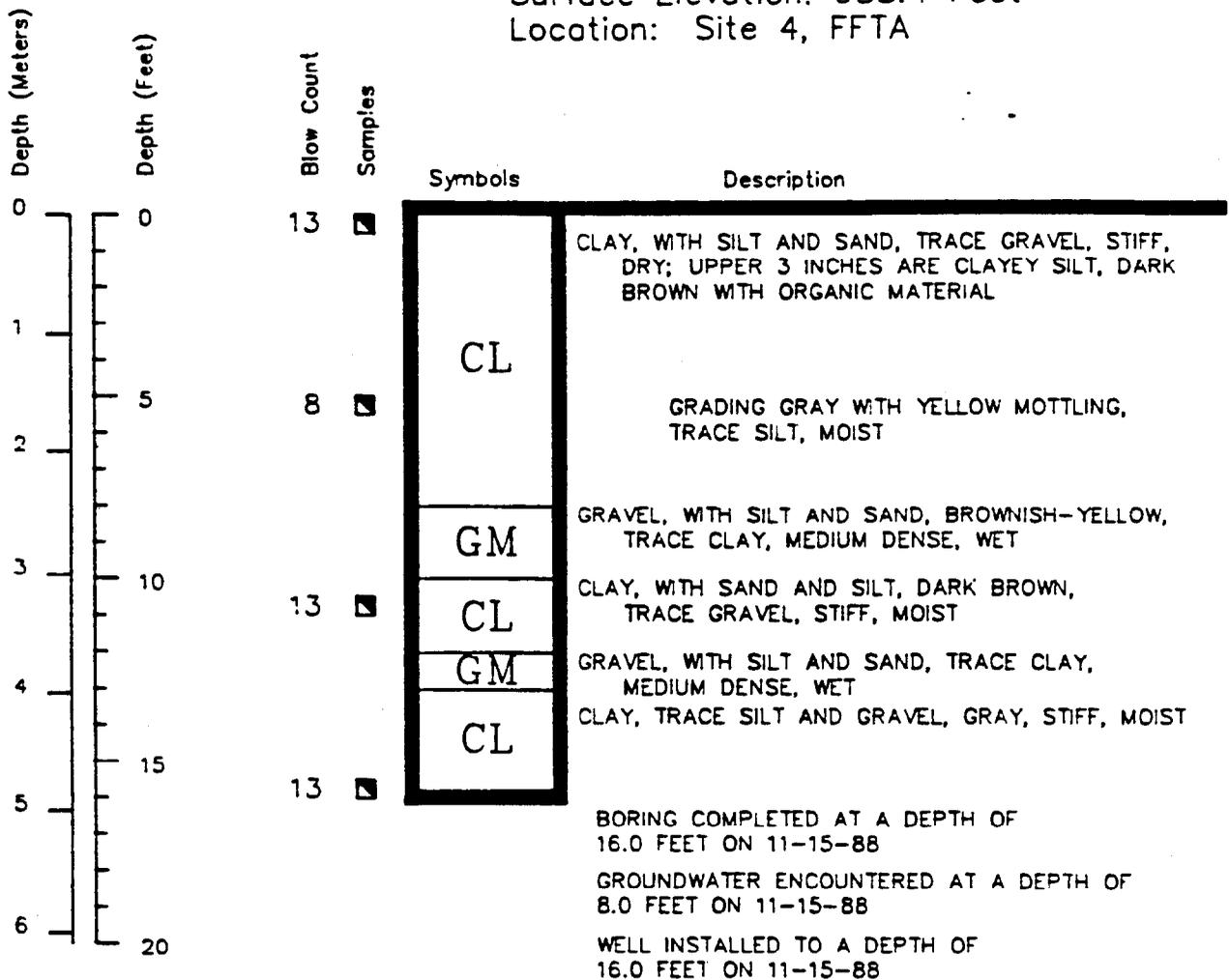


PLATE
LOG OF BORING

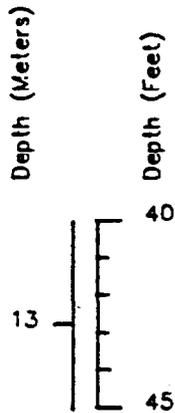
BORING MW4-4

Surface Elevation: 687.0 Feet

Location: Site 4, FFTA

Depth (Meters)	Depth (Feet)	Blow Count	Samples	Symbols	Description
0	0			SM	SAND, WITH SILT AND CLAY, DARK BROWN TO BLACK, TRACE GRAVEL, TRACE ORGANIC MATERIAL, MEDIUM DENSE, MOIST
1	5	14	☑		
2		16	☑		CLAY, WITH SILT, MEDIUM BROWN, TRACE GRAVEL, VERY STIFF, MOIST
3	10	17	☑		GRADING GRAY, TRACE SILT, TRACE GRAVEL, VERY STIFF, MOIST
4				CL	
5	15	10	☑		GRADING STIFF
6	20	12	☑		
7					
8	25	12	☑		
9					
10	30	11	☑		
11					
12	35	30	☑		GRADING VERY STIFF
	40				

BORING MW4-4 (Cont'd.)



Blow Count
 Samples

33

24

Symbols	Description
<div style="border: 2px solid black; padding: 10px; width: 80px; height: 80px; display: flex; align-items: center; justify-content: center;"> CL </div>	

BORING COMPLETED AT A DEPTH OF 45.0 FEET ON 11-14-88; BACKFILLED WITH BENTONITE FROM 40.0 TO 45.0 FEET ON 11-14-88

GROUNDWATER ENCOUNTERED AT A DEPTH OF 14.5 FEET ON 11-14-88 WITH HOLE OPEN TO A DEPTH OF 17.5 FEET

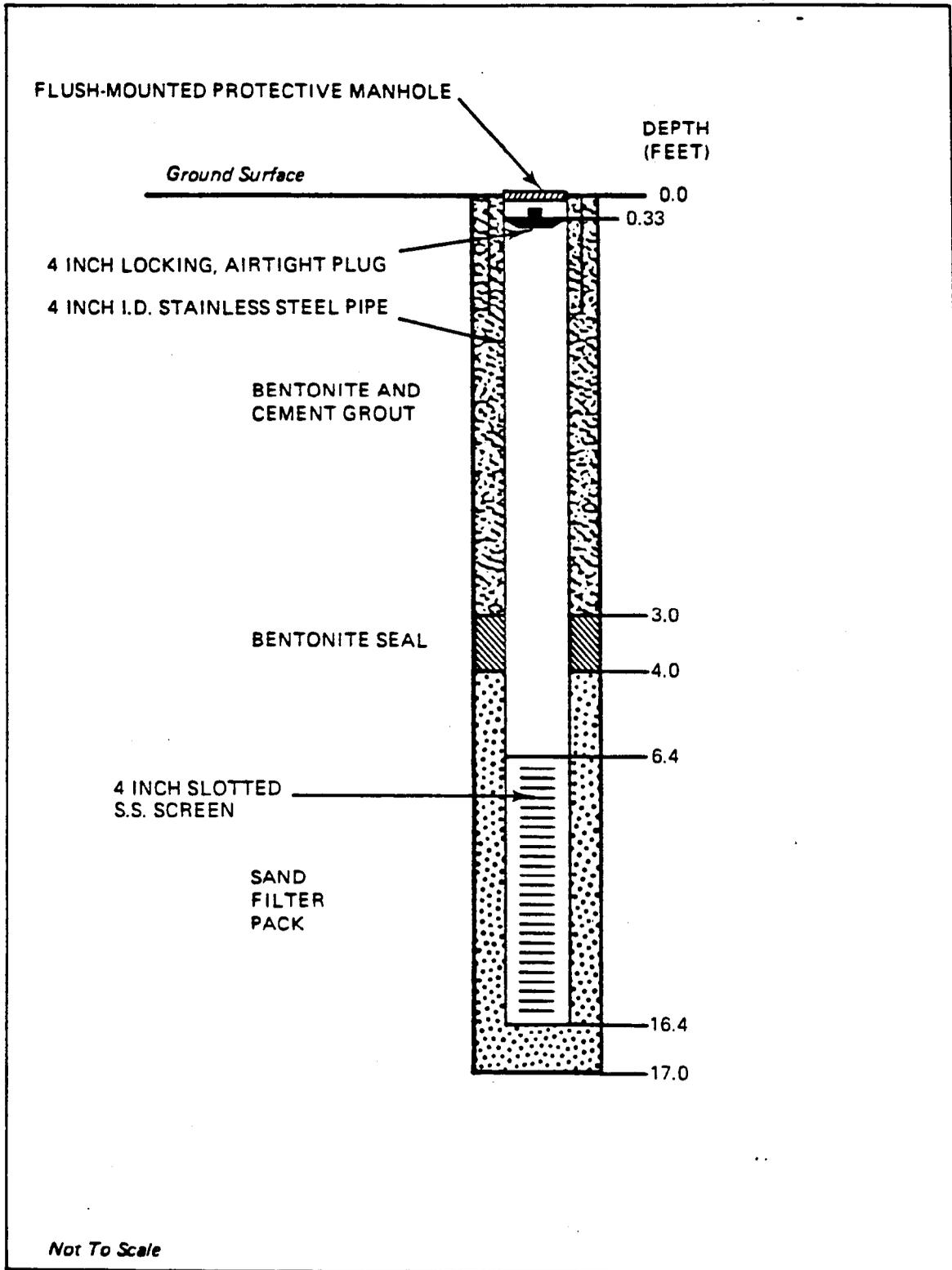
WELL INSTALLED TO A DEPTH OF 40.0 FEET ON 11-14-88

PLATE
 LOG OF BORING

B.2 WELL CONSTRUCTION DIAGRAMS

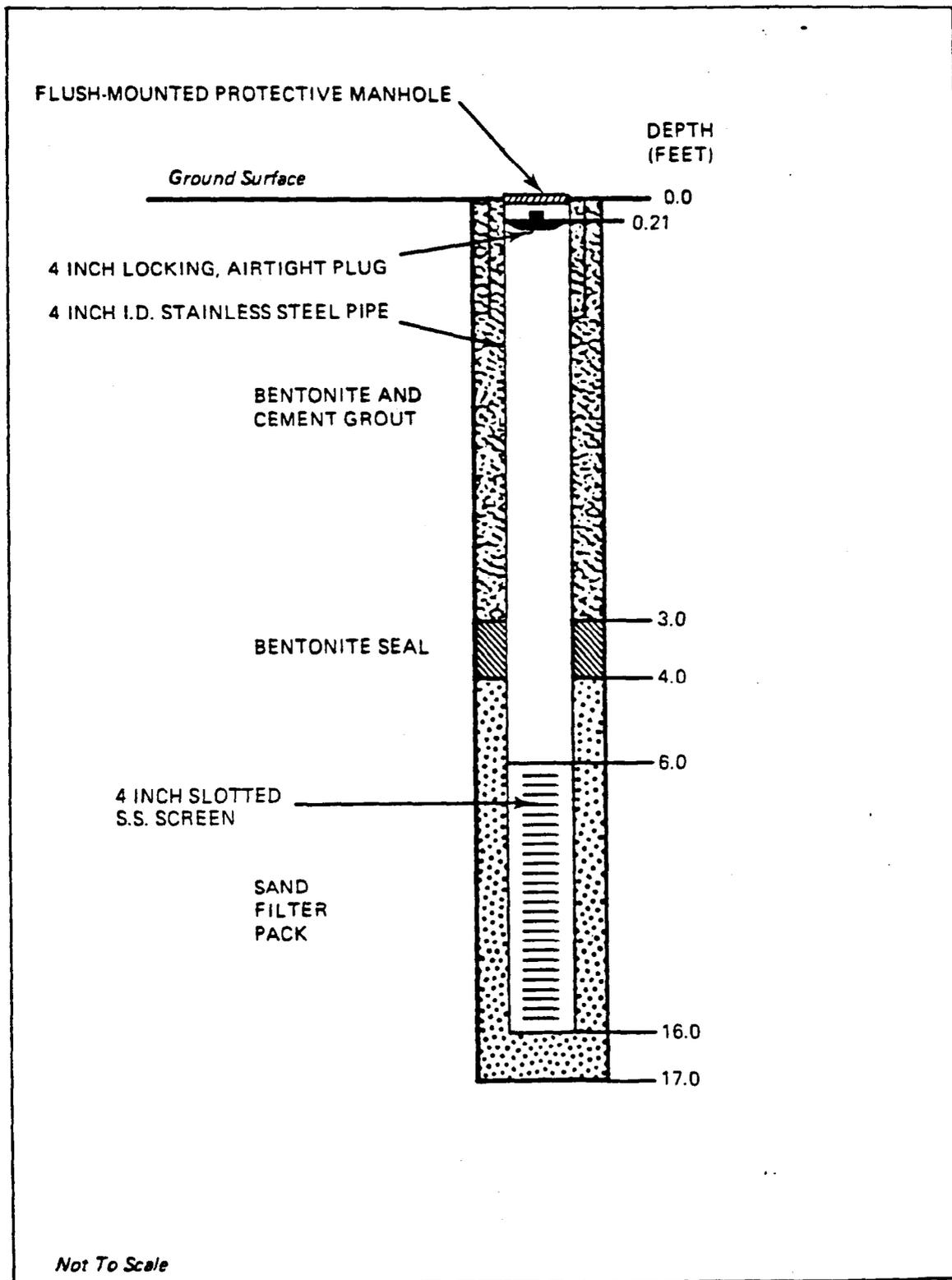
MONITORING WELL MW1-1
INSTALLATION DIAGRAM

Installation Date: 11-9-88
Surface Elevation: 709.9
Top of S.S. Casing Elevation: 709.55



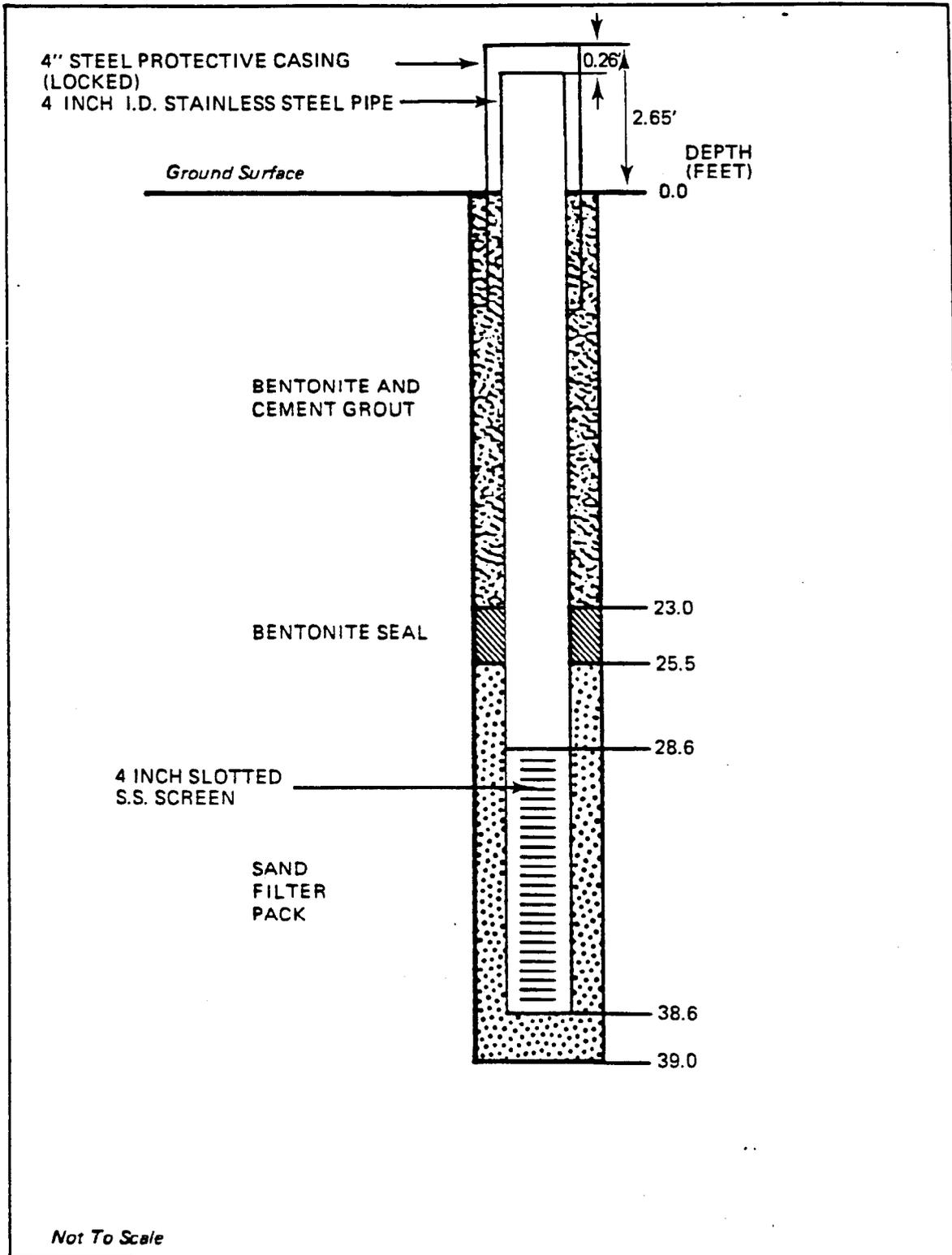
MONITORING WELL MW1-2 INSTALLATION DIAGRAM

Installation Date: 11-10-88
Surface Elevation: 696.0
Top of S.S. Casing Elevation: 695.77



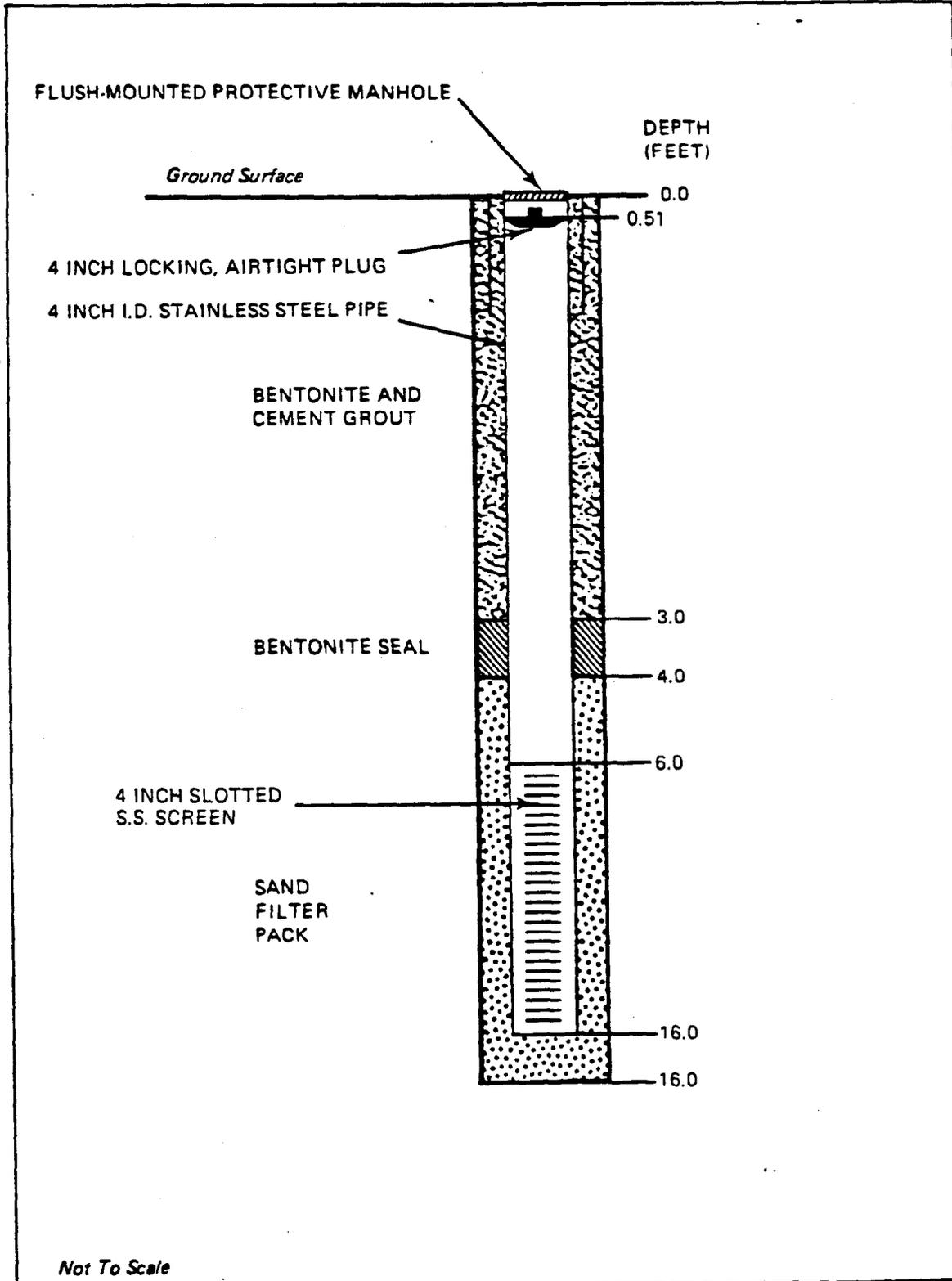
MONITORING WELL MW1-3 INSTALLATION DIAGRAM

Installation Date: 11-11-88
Surface Elevation: 689.2
Top of S.S. Casing Elevation: 691.59



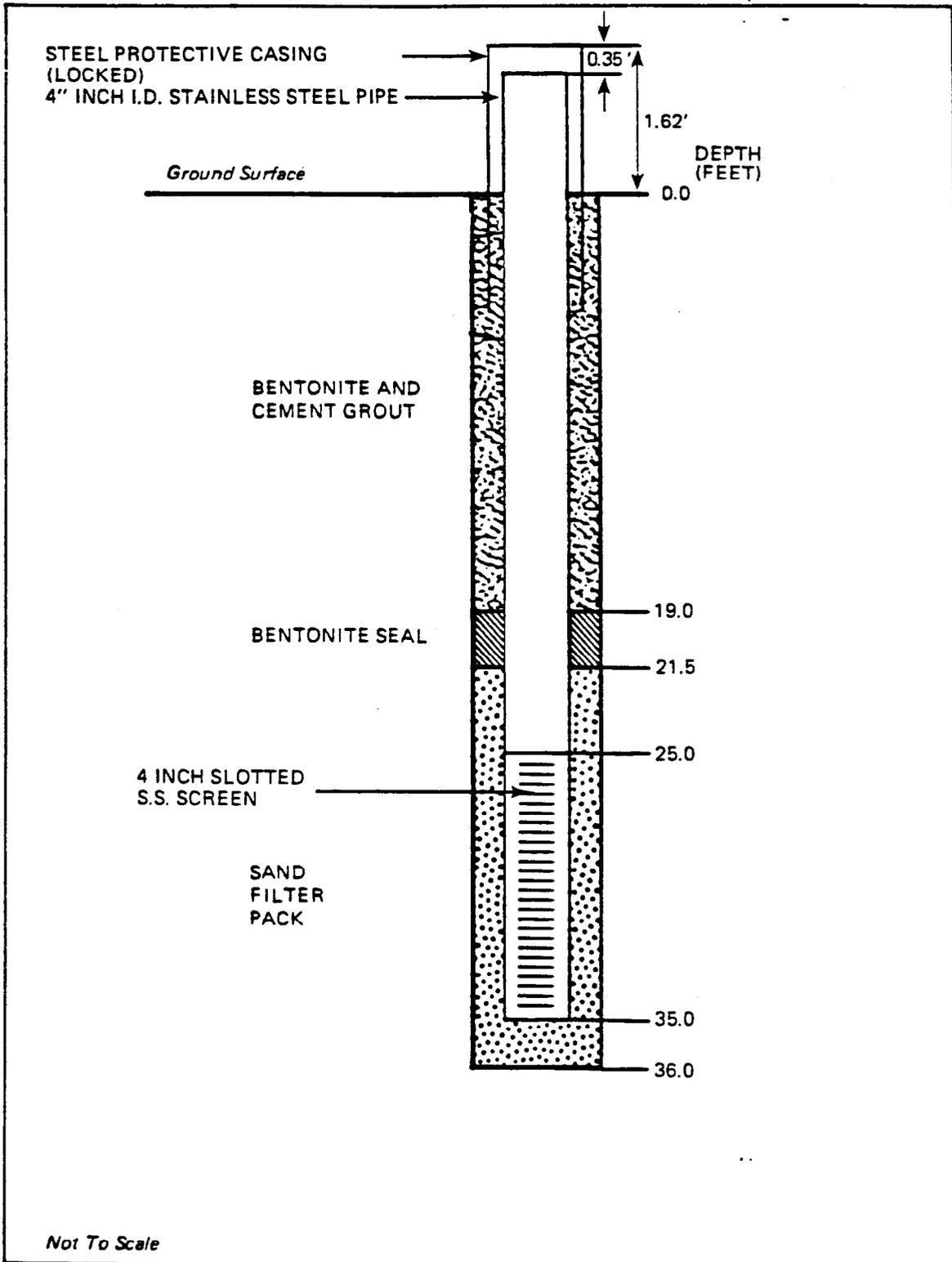
MONITORING WELL MW1-4A INSTALLATION DIAGRAM

Installation Date: 11-16-88
Surface Elevation: 688.1
Top of S.S. Casing Elevation: 687.57



MONITORING WELL MW1-5 INSTALLATION DIAGRAM

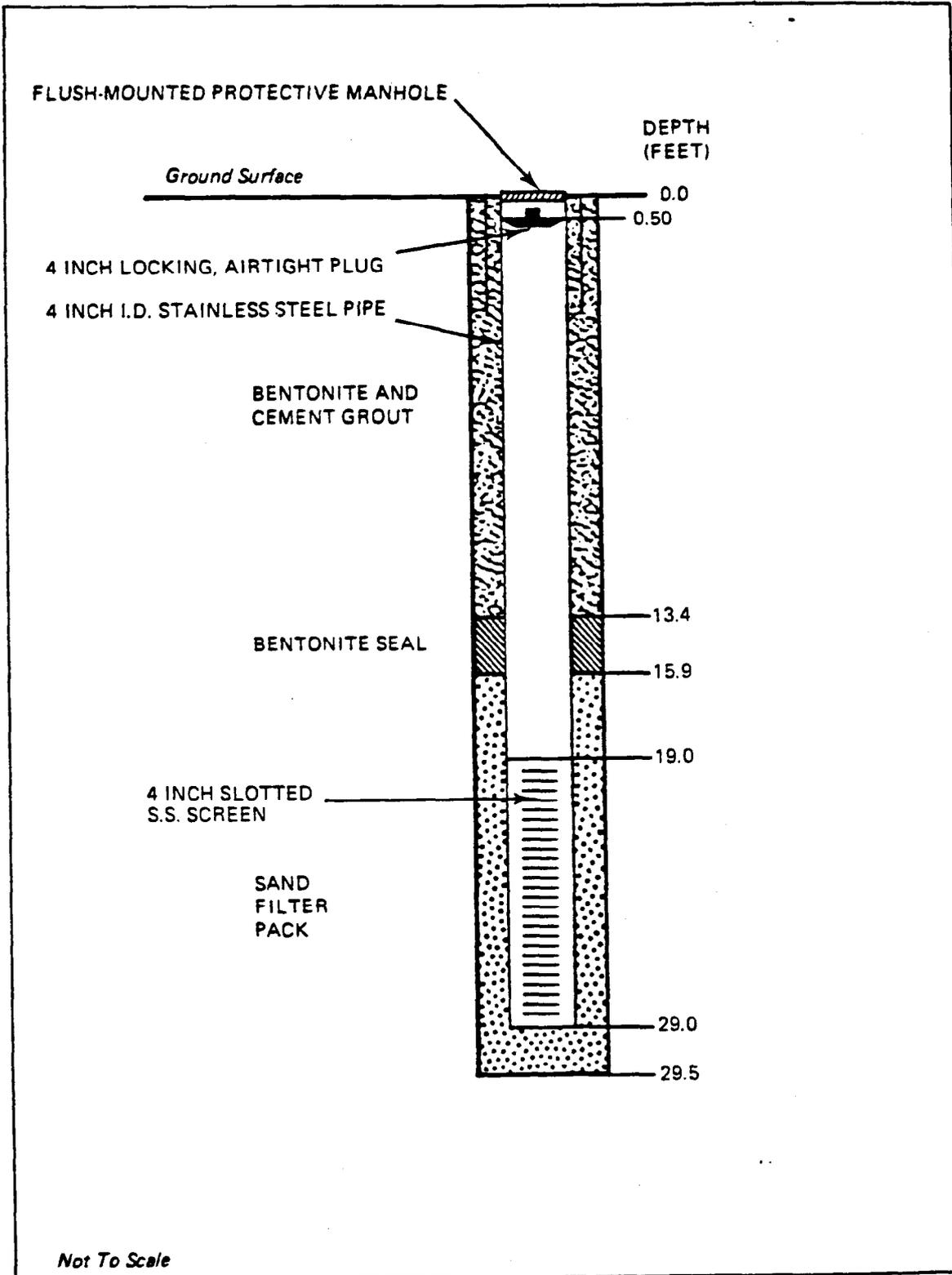
Installation Date: 11-17-88
Surface Elevation: 685.5
Top of S.S. Casing Elevation: 686.77



Not To Scale

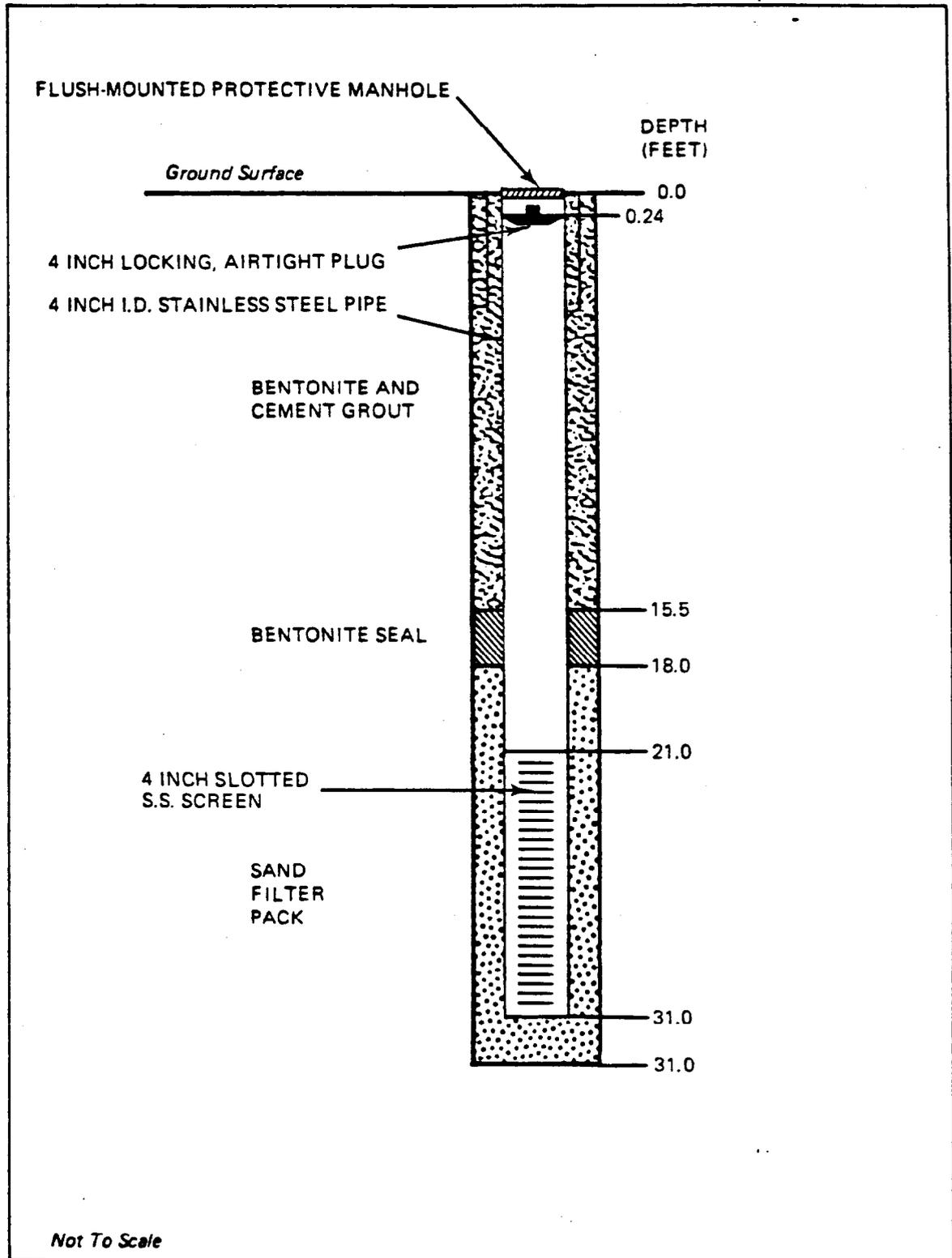
MONITORING WELL MW1-6 INSTALLATION DIAGRAM

Installation Date: 11-18-88
Surface Elevation: 684.5
Top of Casing Elevation: 684.01



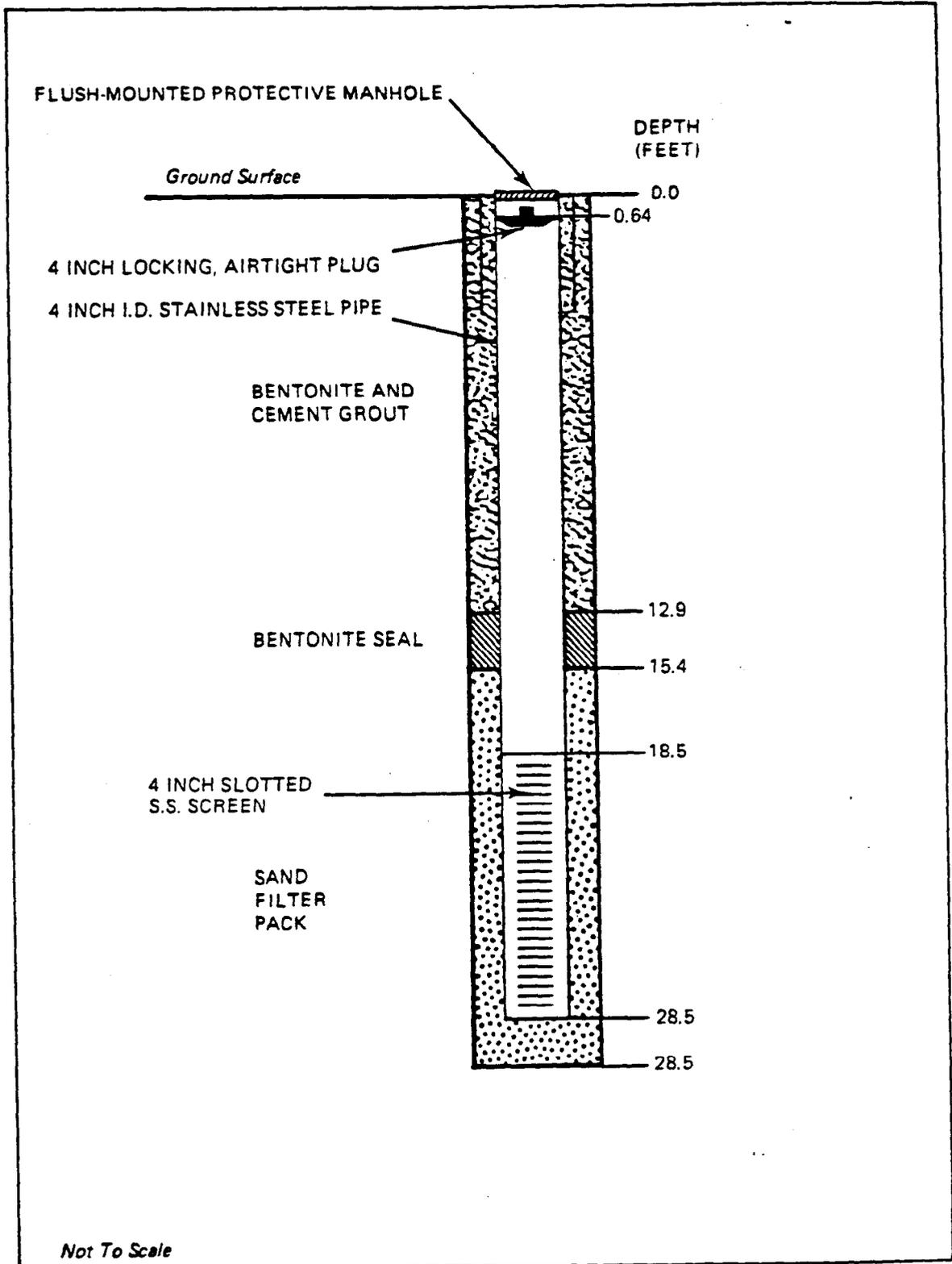
MONITORING WELL MW1-6A INSTALLATION DIAGRAM

Installation Date: 12-7-88
Surface Elevation: 685.0
Top of S.S. Casing Elevation: 684.70



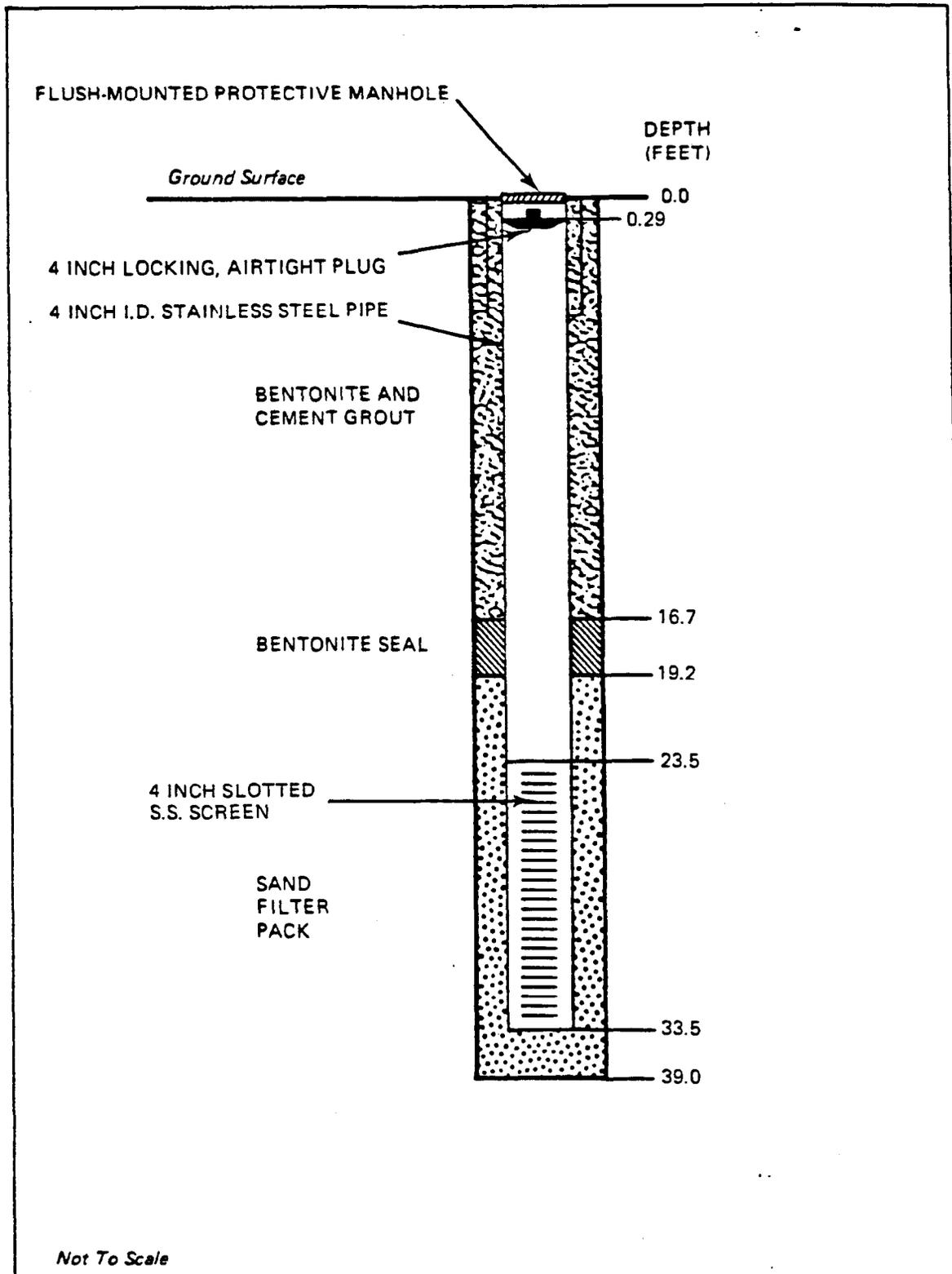
MONITORING WELL MW1-7B INSTALLATION DIAGRAM

Installation Date: 11-29-88
Surface Elevation: 679.4
Top of S.S. Casing Elevation: 678.75



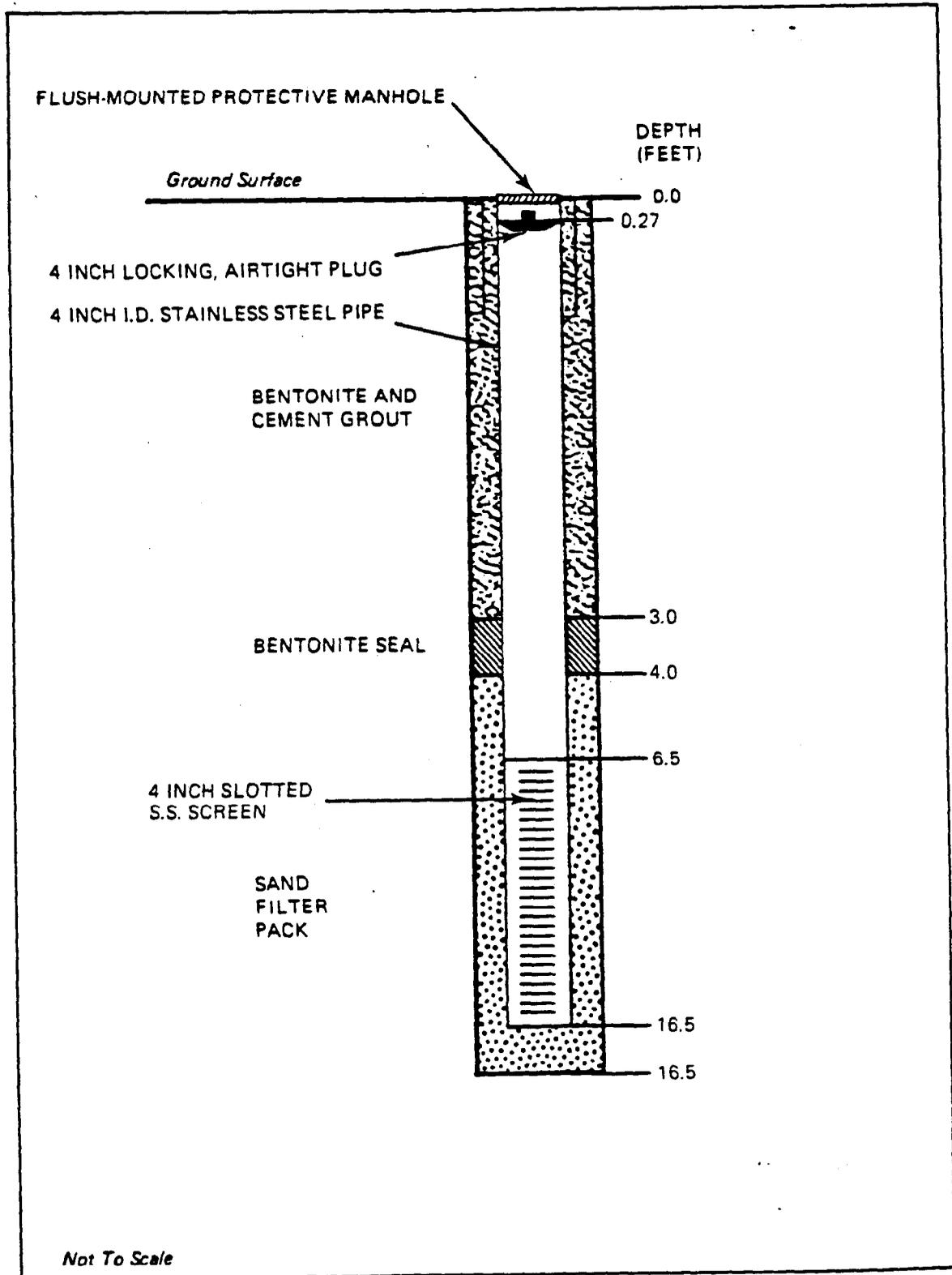
MONITORING WELL MW1-8 INSTALLATION DIAGRAM

Installation Date: 12-8-88
Surface Elevation: 716.5
Top of S.S. Casing Elevation: 716.24



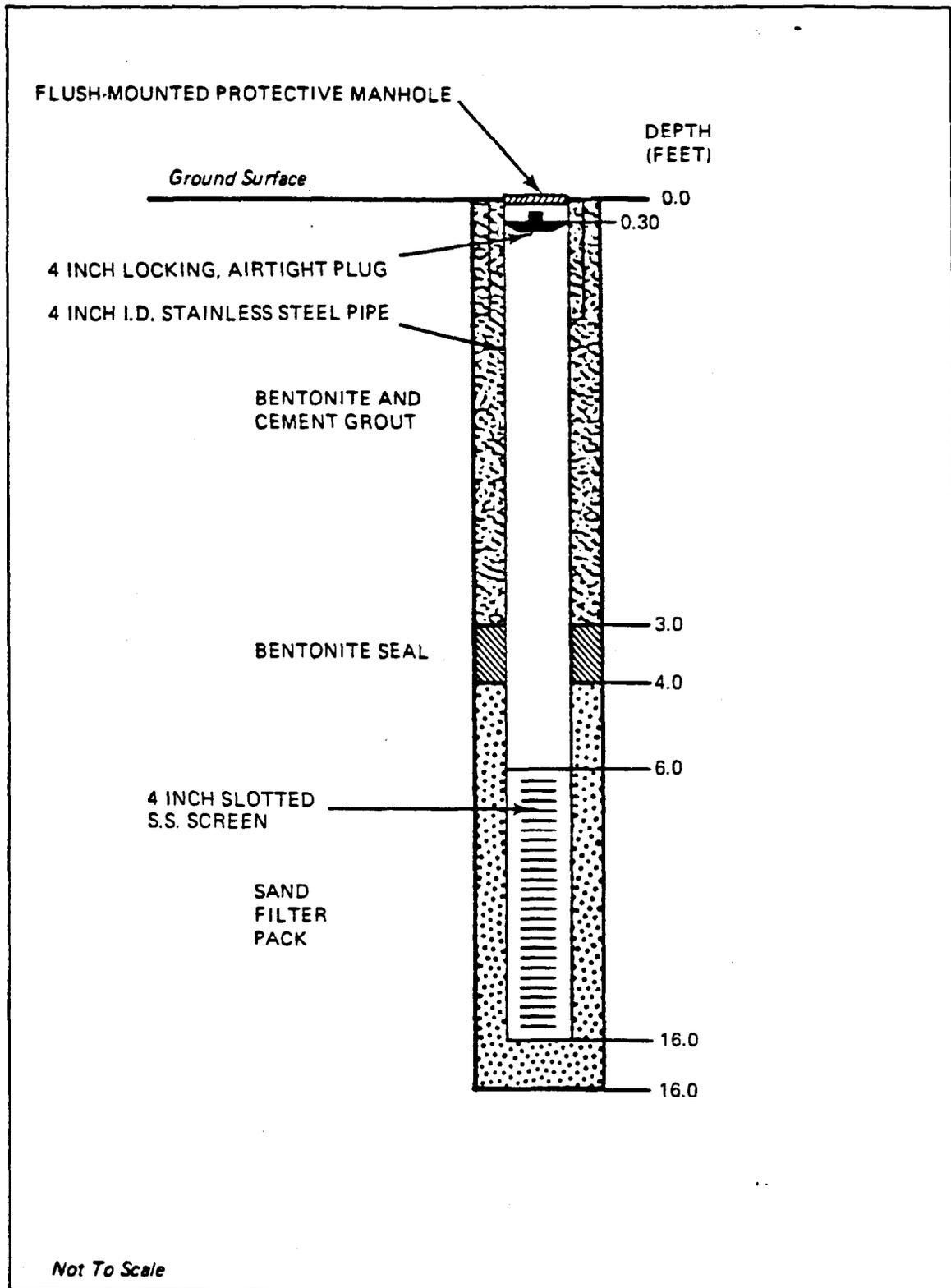
MONITORING WELL MW1-9 INSTALLATION DIAGRAM

Installation Date: 12-6-88
Surface Elevation: 695.6
Top of S.S. Casing Elevation: 695.31



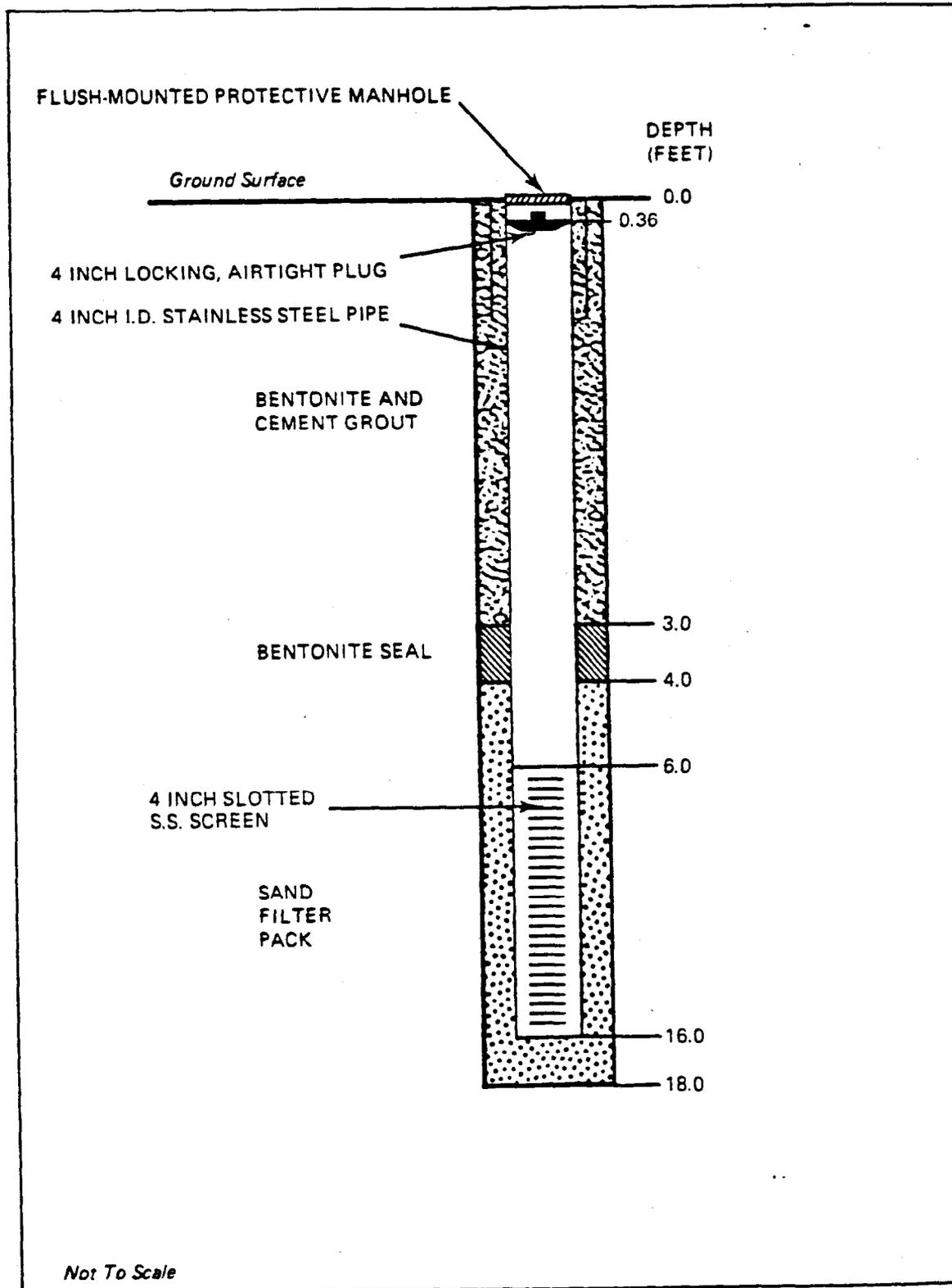
MONITORING WELL MW4-1 INSTALLATION DIAGRAM

Installation Date: 11-7-88
Surface Elevation: 691.8
Top of S.S. Casing Elevation: 691.47



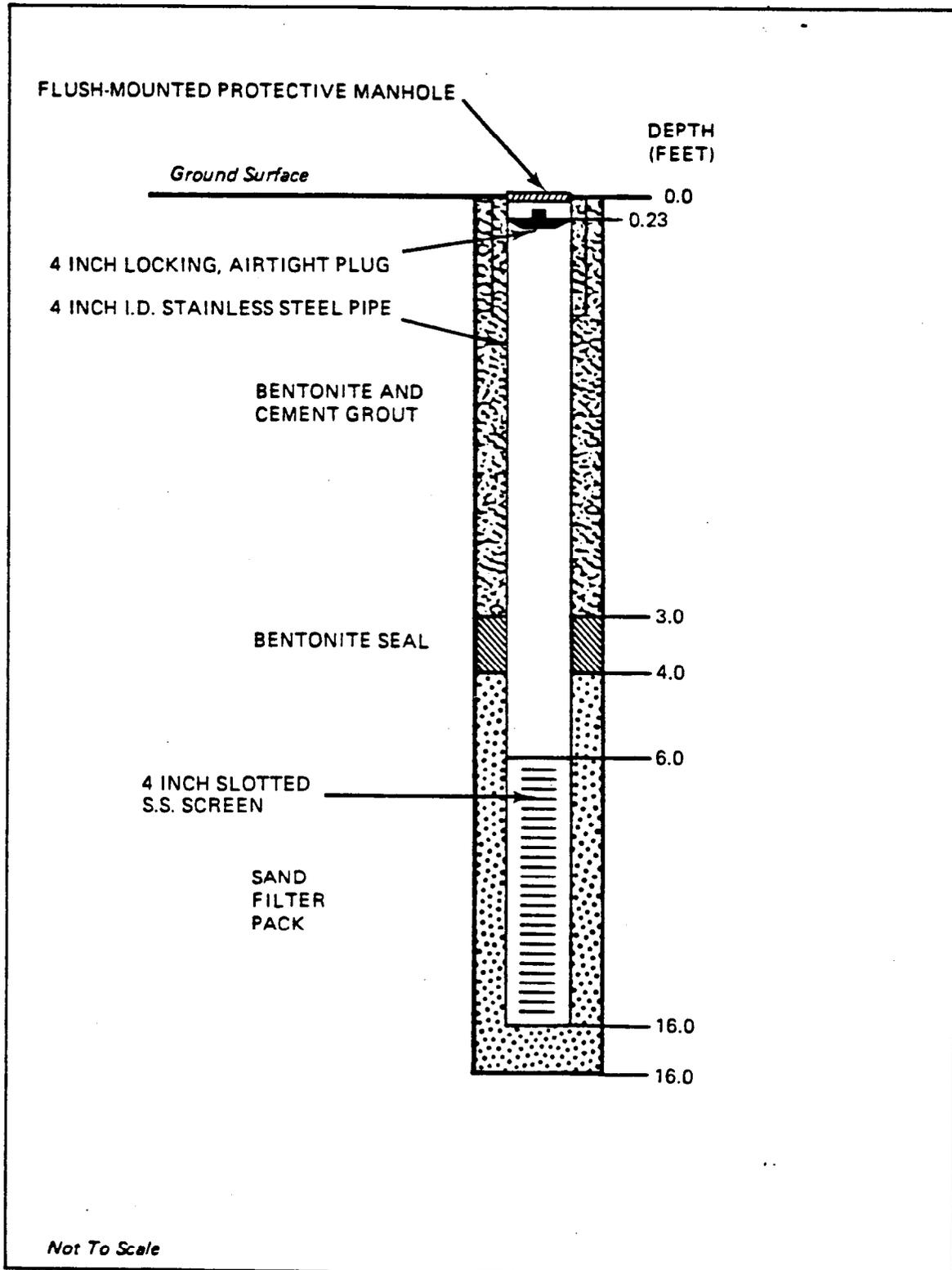
MONITORING WELL MW4-2 INSTALLATION DIAGRAM

Installation Date: 11-8-88
Surface Elevation: 689.8
Top of S.S. Casing Elevation: 689.47



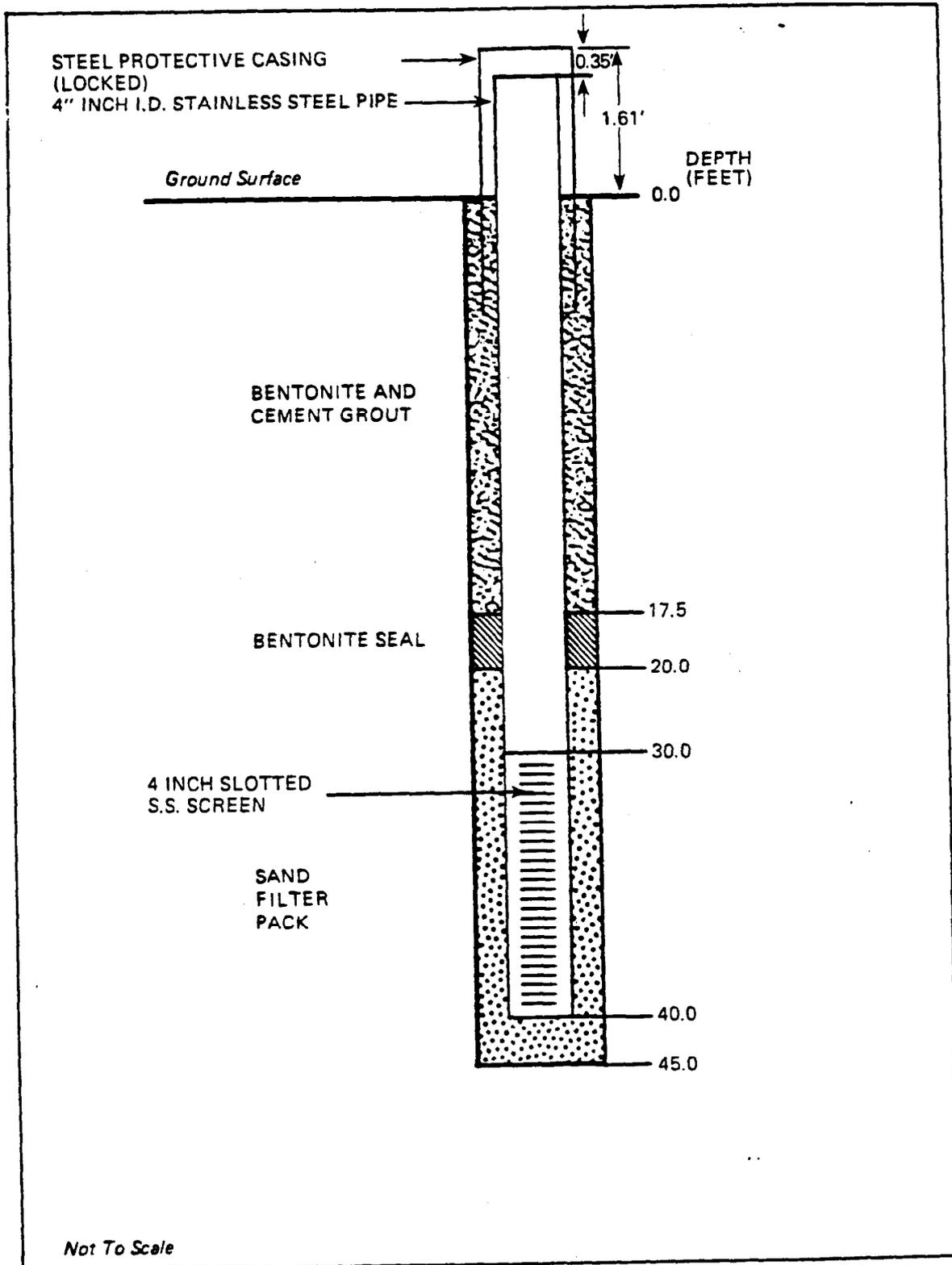
MONITORING WELL MW4-3A INSTALLATION DIAGRAM

Installation Date: 11-15-88
Surface Elevation: 688.4
Top of S.S. Casing Elevation: 688.20



MONITORING WELL MW4-4 INSTALLATION DIAGRAM

Installation Date: 11-14-88
Surface Elevation: 687.0
Top of S.S. Casing Elevation: 688.26



Not To Scale

B.3 WELL DEVELOPMENT RECORDS

WELL PURGING/DEVELOPMENT RECORD

Seq. # _____

Project Name: Great Lakes NTC Project No.: 00124-189
Location: Great Lakes III Client: NCCSA

Well Designation: MW 1-1

Date(s) of Well Installation: 11/9/88

Date(s) and Time of Development: 11.30.88 (830-1105)

Development Equipment: 3" PVC Bailer

Static Water Level to TOC
Before Development: 4.76'
24 Hours After Development: 4.40'

Quantity of Water in Well Prior to Development
Standing in Well: 37 gallons (5 vol)
Contained in Annulus (assume 30% porosity): 48.1 gal (5 vol) total

pH/Conductivity/Temperature		
Before:	<u>7.13</u>	<u>890 uS</u> / <u>9.3°C</u>
During, T ₁ :	<u>7.17</u>	<u>937 uS</u> / <u>9.4°C</u>
T ₂ :	<u>7.17</u>	<u>906 uS</u> / <u>9.3°C</u>
After Development	<u>7.06</u>	<u>854 uS</u> / <u>9.6°C</u>

Depth (TOC) to Bottom of Well: 16.01'

Screen Length: 10.0'

Depth to Sediment: Before/After Development 16.01' / 16.01'

Water Characteristics and Changes During Development

Clarity: cloudy
Color: grey
Particulates: silty
Odor: none

Length of Stickup: stick down = 0.34'

Quantity of Water Removed/Time for Removal
Incremental: 21 gal / 21 gal / 6 gal / (830-1105)
Total: 48 gal

Quantity of Mud/Water Lost, Removed, or Added During Drilling/Well Installation: 0

Comments: _____

Field Engr./Geologist/Technician Signature: CH Kypel
Date: 12/19/88

WELL PURGING/DEVELOPMENT RECORD

Project Name: Great Lakes NTC Project No.: 00124-189
 Location: Great Lakes Till Client: NEESA

Well Designation: MW 1-2

Date(s) of Well Installation: 11.10.88

Date(s) and Time of Development: 11.30.88 (845-1335)

Development Equipment: 3" PVC Bailer

Static Water Level to TOC
 Before Development: 5.21'
 24 Hours After Development: ~~6.00~~ 5.35'

Quantity of Water in Well Prior to Development
 Standing in Well: 35 gallons (5 vol)
 Contained in Annulus (assume 30% porosity): 45.5 gal (5 vol) total

pH/Conductivity/Temperature

Before:	<u>6.83</u>	<u>1120 μS</u>	<u>9.0°C</u>
During, T ₁ :	<u>6.80</u>	<u>1230 μS</u>	<u>8.8°C</u>
T ₂ :	<u>7.64</u>	<u>1099 μS</u>	<u>9.1°C</u>
After Development	<u>7.23</u>	<u>1078 μS</u>	<u>9.8°C</u>

Depth (TOC) to Bottom of Well: 16.01'

Screen Length: 10.0'

Depth to Sediment: Before/After Development 16.01' / 16.01'

Water Characteristics and Changes During Development

Clarity: Cloudy
 Color: grey - Brown
 Particulates: silty
 Odor: None

Length of Stickup: stick-down = 0.24'

Quantity of Water Removed/Time for Removal
 Incremental: 13 gal / 13 gal / 10 gal / 9.5 gal
 Total: 45.5 gal / (845 - 1335)

Quantity of Mud/Water Lost, Removed, or Added During Drilling/Well Installation: 0

Comments: _____

Field Engr./Geologist/Technician Signature: CHP Kuep
 Date: 12/19/88

WELL PURGING/DEVELOPMENT RECORD

Seq. # _____

Project Name: Great Lakes NTC
Location: Great Lakes III

Project No.: 00124-189
Client: NEESA

Well Designation: MW1-3

Date(s) of Well Installation: 11.10.88 - 11.11.88

Date(s) and Time of Development: 11.30.88 (10⁰⁰ - 13⁴⁵)

Development Equipment: 3" PVC Bailer

Static Water Level to TOC
Before Development: 32.46'
24 Hours After Development: ~~32.46'~~ 32.50'

Quantity of Water in Well Prior to Development
Standing in Well: 29 gal (5 vol)
Contained in Annulus (assume 30% porosity): 37.7 gal (5 vol) total

pH/Conductivity/Temperature
Before: 7.87 / 715.45 / 8.8°C
During, T₁: 7.89 / 870.45 / 7.6°C
T₂: 7.83 / 843.45 / 7.9°C
After Development 7.78 / 820.45 / 8.1°C

Depth (TOC) to Bottom of Well: 41.32'

Screen Length: 10.0'

Depth to Sediment: Before/After Development 41.32' / 41.32'

Water Characteristics and Changes During Development

Clarity: cloudy
Color: grey
Particulates: silty
Odor: None

Length of Stickup: 2.52'

Quantity of Water Removed/Time for Removal
Incremental: 9.5 gal / 11 gal / 9 gal / 8.5 gal
Total: 38 gallons / (10⁰⁰ - 13⁴⁵)

Quantity of Mud/Water Lost, Removed, or Added During Drilling/Well Installation: 0

Comments: _____

Field Engr./Geologist/Technician Signature: CH K...
Date: 12/19/88

WELL PURGING/DEVELOPMENT RECORD

Project Name: Great Lakes NTC
 Location: Great Lakes III

Project No.: 00124-189
 Client: NEESA

Well Designation: MW1-4A

Date(s) of Well Installation: 11.16.88

Date(s) and Time of Development: 11.30.88 / 12.1.88 / 12.3.88 / 12.5.88

Development Equipment: 3" PVC Bailer

Static Water Level to TOC
 Before Development: 5.32'
 24 Hours After Development: —

Quantity of Water in Well Prior to Development
 Standing in Well: 35 gallons (5 vol)
 Contained in Annulus (assume 30% porosity): 45.5 gal (5 vol) total

pH/Conductivity/Temperature			
Before:	<u>7.15</u>	<u>1490 μS</u>	<u>10.4°C</u>
During, T ₁ :	<u>7.30</u>	<u>1410 μS</u>	<u>9.5°C</u>
T ₂ :	<u>7.25</u>	<u>1506 μS</u>	<u>8.2°C</u>
After Development:	<u>7.18</u>	<u>1480 μS</u>	<u>11.3°C</u>

Depth (TOC) to Bottom of Well: 16.01'

Screen Length: 10.0'

Depth to Sediment: Before/After Development 16.01' / 16.01'

Water Characteristics and Changes During Development

Clarity: cloudy
 Color: light Brown
 Particulates: silty
 Odor: None

Length of Stickup: Stickdown = 0.53'

Quantity of Water Removed/Time for Removal
 Incremental: see below
 Total: 37.5 gal

Quantity of Mud/Water Lost, Removed, or Added During Drilling/Well Installation: 0

Comments: very slow recovery - developed in increments of:
11 gal / 5 gal / 1 gal / 3 gal / 8.5 gal / 4 gal / 5 gal = 37.5 gal

Field Engr./Geologist/Technician Signature: [Signature]
 Date: 12/19/88

WELL PURGING/DEVELOPMENT RECORD

Project Name: Great Lakes NTC Project No.: 00124-189
 Location: Great Lakes III Client: NEESA

Well Designation: MW 1-5

Date(s) of Well Installation: 11.17.88

Date(s) and Time of Development: 11.30.88 - 12.1.88

Development Equipment: 3" PVC Bailer

Static Water Level to TOC
 Before Development: 23.22'
 24 Hours After Development: ~~23.22'~~ 23.41'

Quantity of Water in Well Prior to Development
 Standing in Well: 40.5 gal (5 vol)
 Contained in Annulus (assume 30% porosity): 52.65 gal (5 vol) total

pH/Conductivity/Temperature

	pH	Conductivity (µS)	Temperature (°C)
Before:	<u>9.90</u>	<u>800</u>	<u>9.8°C</u>
During, T ₁ :	<u>7.88</u>	<u>860</u>	<u>9.0°C</u>
T ₂ :	<u>7.89</u>	<u>842</u>	<u>8.9°C</u>
After Development	<u>8.09</u>	<u>700</u>	<u>9.7°C</u>

Depth (TOC) to Bottom of Well: 35.71'

Screen Length: 10.0'

Depth to Sediment: Before/After Development 35.71' / 35.71'

Water Characteristics and Changes During Development

Clarity: cloudy
 Color: light Brown
 Particulates: silty
 Odor: None

Length of Stickup: 1.33'

Quantity of Water Removed/Time for Removal
 Incremental: 15 gal / 13 gal / 13 gal / 13 gal
 Total: 54 gal

Quantity of Mud/Water Lost, Removed, or Added During Drilling/Well Installation: 0

Comments: _____

Field Engr./Geologist/Technician Signature: CH K
 Date: 12/19/88

WELL PURGING/DEVELOPMENT RECORD

Project Name: Great Lakes NTC Project No.: 00124-189
 Location: Great Lakes III Client: NEESA

Well Designation: MW 1-6A

Date(s) of Well Installation: 12-6-88 - 12-7-88

Date(s) and Time of Development: 12-11-88 (1300-1435)

Development Equipment: 3" PVC Bailer

Static Water Level to TOC

Before Development: 21.41'

24 Hours After Development: 22.72'

Quantity of Water in Well Prior to Development

Standing in Well: 31.7 gal (5 vol)

Contained in Annulus (assume 30% porosity): 41.2 gal (5 vol) total

pH/Conductivity/Temperature

Before: 7.99 / 611 μ S / 10.10°C

During, T₁: 8.23 / 625 μ S / 9.40°C

T₂: 9.30 / 471 μ S / 9.30°C

After Development 8.38 / 568 μ S / 10.5°C

Depth (TOC) to Bottom of Well: 31.18'

Screen Length: 10.0'

Depth to Sediment: Before/After Development 31.18 / 31.18

Water Characteristics and Changes During Development

Clarity: cloudy

Color: gray

Particulates: silly

Odor: NONE

Length of Sticks: stickdown = ~~0.26~~ 0.26'

Quantity of Water Removed/Time for Removal

Incremental: 17 gal / 8 gal / 10 gal / 7 gal / (1300-1435)

Total: 42 gal / (1300-1435)

Quantity of Mud/Water Lost, Removed, or Added During Drilling/Well Installation: 0

Comments: _____

Field Engr./Geologist/Technician Signature: CHP Kupf

Date: 12/16/88

WELL PURGING/DEVELOPMENT RECORD

Seq. # _____

Project Name: Great Lakes NTC Project No.: 00124-189
 Location: Great Lakes III Client: NEESA

Well Designation: MW 1-7B

Date(s) of Well Installation: 11.29.88 - 11.30.88

Date(s) and Time of Development: 12.3.88 - 12.4.88

Development Equipment: 3" PVC Bailer

Static Water Level to TOC
 Before Development: 15.95'
 24 Hours After Development: 16.14'

Quantity of Water in Well Prior to Development
 Standing in Well: 40.7 gal (5 vol)
 Contained in Annulus (assume 30% porosity): 53 gal (5 vol) total

pH/Conductivity/Temperature

Before:	<u>11.54</u>	<u>1386 uS</u>	<u>12.0°C</u>
During, T ₁ :	<u>8.77</u>	<u>860 uS</u>	<u>11.7°C</u>
T ₂ :	<u>7.98</u>	<u>804 uS</u>	<u>10.8°C</u>
After Development	<u>8.11</u>	<u>803 uS</u>	<u>10.3°C</u>

Depth (TOC) to Bottom of Well: 28.48'

Screen Length: 10.0'

Depth to Sediment: Before/After Development 28.48' / 28.48'

Water Characteristics and Changes During Development
 Clarity: Cloudy
 Color: grey
 Particulates: silty
 Odor: None

Length of ~~Stickup~~: stick down = 0.63'

Quantity of Water Removed/Time for Removal
 Incremental: 22.5 gal / 8 gal / 11.5 gal / 11 gal / 12.3.88 - 12.4.88
 Total: 53 gal / 12.3.88 - 12.4.88

Quantity of Mud/Water Lost, Removed, or Added During Drilling/Well Installation: 0

Comments: _____

Field Engr./Geologist/Technician Signature: CH Kump
 Date: 12/19/88

WELL PURGING/DEVELOPMENT RECORD

Project Name: Great Lakes NTC Project No.: 00124-189
 Location: Great Lakes III Client: NEESA

Well Designation: MW 1-8

Date(s) of Well Installation: 12-7-88 - 12-8-88

Date(s) and Time of Development: 12-11-88 (12³⁰-15⁰⁰)

Development Equipment: 3" PVC Bailer

Static Water Level to TOC

Before Development: 17.47'
 24 Hours After Development: 19.23'

Quantity of Water in Well Prior to Development

Standing in Well: 55 gal (5 vol)
 Contained in Annulus (assume 30% porosity): 71.5 gal (5 vol) total

pH/Conductivity/Temperature

Before:	<u>9.71</u>	<u>1720 45</u>	<u>12.5°C</u>
During, T ₁ :	<u>7.22</u>	<u>1580 45</u>	<u>11.8°C</u>
T ₂ :	<u>7.22</u>	<u>1543 45</u>	<u>11.9°C</u>
After Development	<u>7.42</u>	<u>1427 45</u>	<u>12.0°C</u>

Depth (TOC) to Bottom of Well: 34.43'

Screen Length: 10.0'

Depth to Sediment: Before/After Development 34.43' / 34.43'

Water Characteristics and Changes During Development

Clarity: cloudy
 Color: gray
 Particulates: silty
 Odor: None

Length of Sticks: stickdown = 0.32'

Quantity of Water Removed/Time for Removal

Incremental: see Below
 Total: 72 gal / 12-11-88 (12³⁰-15⁰⁰)

Quantity of Mud/Water Lost, Removed, or Added During Drilling/Well Installation: 0

Comments: Development Increments: 31 gal / 11 gal / 10 gal / 10 gal / 10 gal

Field Engr./Geologist/Technician Signature: CAR Kuo
 Date: 12/14/88

WELL PURGING/DEVELOPMENT RECORD

Project Name: Great Lakes NTC Project No.: 00124-189
Location: Great Lakes III Client: NEESA

Well Designation: MW1-9

Date(s) of Well Installation: 12.6.88

Date(s) and Time of Development: 12.8.88 (745-1236)

Development Equipment: 3" PVC Bailer

Static Water Level to TOC
Before Development: 2.74'
24 Hours After Development: 2.29'

Quantity of Water in Well Prior to Development
Standing in Well: 43 gal (5 vol)
Contained in Annulus (assume 30% porosity): 56 gal (5 vol) total

pH/Conductivity/Temperature
Before: 6.66 / 3220 uS / 8.4°C
During, T₁: 6.54 / 2760 uS / 8.4°C
T₂: 6.59 / 3050 uS / 10.1°C
After Development: 6.63 / 3080 uS / 10.7°C

Depth (TOC) to Bottom of Well: 16.01'

Screen Length: 10.0'

Depth to Sediment: Before/After Development 16.01' / 16.01'

Water Characteristics and Changes During Development
Clarity: Cloudy
Color: grey
Particulates: Silty
Odor: None

Length of Stallop: stickdown = 0.22'

Quantity of Water Removed/Time for Removal
Incremental: 15 gal / 18 gal / 18 gal / 6 gal / 12.8.88 (745-1236)
Total: 57 gal / 12.8.88 (745-1236)

Quantity of Mud/Water Lost, Removed, or Added During Drilling/Well Installation: 0

Comments: _____

Field Engr./Geologist/Technician Signature: CH Kuy
Date: 12/19/88

WELL PURGING/DEVELOPMENT RECORD

Project Name: Great Lakes NTC Project No.: 00124-189
Location: Great Lakes T11 Client: NEESA

Well Designation: MW 4-1

Date(s) of Well Installation: 11.7.88

Date(s) and Time of Development: 11.29.88 (8³⁵-13³⁵)

Development Equipment: 3" PVC Bailer

Static Water Level to TOC
Before Development: 2.66'
24 Hours After Development: ~~2.66~~ 4.71'

Quantity of Water in Well Prior to Development
Standing in Well: 44 gal (5 vol)
Contained in Annulus (assume 30% porosity): 57.2 (5 vol) total

pH/Conductivity/Temperature		
Before:	<u>7.23</u>	<u>810 uS</u> / <u>11.0°C</u>
During, T ₁ :	<u>7.14</u>	<u>867 uS</u> / <u>10.7°C</u>
T ₂ :	<u>7.16</u>	<u>824 uS</u> / <u>10.9°C</u>
After Development	<u>7.12</u>	<u>830 uS</u> / <u>11.0°C</u>

Depth (TOC) to Bottom of Well: 16.01'

Screen Length: 10.0'

Depth to Sediment: Before/After Development 16.01' / 16.01'

Water Characteristics and Changes During Development
Clarity: cloudy
Color: grey
Particulates: silty
Odor: none

Length of Stiletop: stick-down = 0.34'

Quantity of Water Removed/Time for Removal
Incremental: 2 gal / 16 gal / 16 gal / 16 gal
Total: 50 gal total

Quantity of Mud/Water Lost, Removed, or Added During Drilling/Well Installation: -

Comments: _____
- Developed 5 volumes + 30%

Field Engr./Geologist/Technician Signature: [Signature]
Date: 12.19.88

WELL PURGING/DEVELOPMENT RECORD

Seq. # _____

Project Name: Great Lakes NTC Project No.: 00124-189
 Location: Great Lakes III Client: NEESA

Well Designation: MW4-2

Date(s) of Well Installation: 11.7.88 - 11.8.88

Date(s) and Time of Development: 11.29.88 - 12.1.88

Development Equipment: 3" PVC Bailer

Static Water Level to TOC
 Before Development: 1.29'
 24 Hours After Development: ~~1.29'~~ 3.69'

Quantity of Water in Well Prior to Development
 Standing in Well: 48 gallons (5 vol)
 Contained in Annulus (assume 30% porosity): 62.4 gallons (5 vol) total

pH/Conductivity/Temperature		
Before:	<u>7.88</u>	<u>569 uS</u> / <u>10.1°C</u>
During, T ₁ :	<u>7.68</u>	<u>662 uS</u> / <u>10.2°C</u>
T ₂ :	<u>7.60</u>	<u>710 uS</u> / <u>10.5°C</u>
After Development	<u>7.44</u>	<u>849 uS</u> / <u>9.9°C</u>

Depth (TOC) to Bottom of Well: 16.01'

Screen Length: 10.0'

Depth to Sediment: Before/After Development 15.87' / 16.01'

Water Characteristics and Changes During Development
 Clarity: Cloudy
 Color: 9-11
 Particulates: Silty
 Odor: None

Length of Stielap: stick-down = 0.23'

Quantity of Water Removed/Time for Removal
 Incremental: See Below
 Total: 62.5 gal

Quantity of Mud/Water Lost, Removed, or Added During Drilling/Well Installation: 0

Comments: slow recharger - Developed in increments of:
11 gal / 3.5 gal / 4 gal / 6.5 gal / 9 gal / 10 gal / 10 gal / 8.5 gal
= 62.5 gal

Field Engr./Geologist/Technician Signature: CH Kumpf
 Date: 12.17.88

WELL PURGING/DEVELOPMENT RECORD

Project Name: Great Lakes NTC Project No.: 00124-189
 Location: Great Lakes III Client: NEESA

Well Designation: MW4-3A

Date(s) of Well Installation: 11.15.88

Date(s) and Time of Development: 11.29.88 (9⁰⁰-13¹⁰)

Development Equipment: 3" PVC Bailer

Static Water Level to TOC
 Before Development: 4.41'
 24 Hours After Development: ~~0.00~~ 3.91'

Quantity of Water in Well Prior to Development
 Standing in Well: 36 gal (5 vol)
 Contained in Annulus (assume 30% porosity): 46.8 gal (5 vol) total

pH/Conductivity/Temperature

Before:	<u>7.10</u>	<u>1047 uS</u>	<u>10.6°C</u>
During, T ₁ :	<u>7.02</u>	<u>1063 uS</u>	<u>10.6°C</u>
T ₂ :	<u>6.94</u>	<u>1080 uS</u>	<u>10.40°C</u>
After Development	<u>6.92</u>	<u>1038 uS</u>	<u>10.7°C</u>

Depth (TOC) to Bottom of Well: 16.01'

Screen Length: 10.0'

Depth to Sediment: Before/After Development 15.39' / 16.01'

Water Characteristics and Changes During Development
 Clarity: Cloudy
 Color: Grey to tan
 Particulates: Silty
 Odor: None

Length of Stielup: stick-down = 0.35'

Quantity of Water Removed/Time for Removal
 Incremental: see below ↓
 Total: 47.5 gal

Quantity of Mud/Water Lost, Removed, or Added During Drilling/Well Installation: 0

Comments: Slow Recharge - Developed in increments of
14.5 gal / 15 gal / 14 gal / 4 gal = 47.5 gal

Field Engr./Geologist/Technician Signature: CH [Signature]
 Date: 12.19.88

B.4 TOPOGRAPHIC SURVEY DATA

Land

Surveys

Limited

Gregg E. Miller

Registered Land Surveyor

2816 White Crossing Road

Verona, WI. 53593

(608)845-8342

January 18, 1989

Dames and Moore
7101 Wisconsin Avenue
Suite 700
Bethesda, Maryland 20814

Attn: Ron Frew

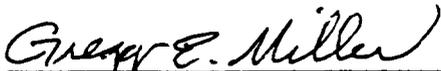
Dear Ron;

I am sending you enclosed, a copy of the base map provided to me by Bob Ogradowsky of NTCGL of the Fire Fighter Training Area and Golf Course on which I have shown the locations of the Monitoring Wells. Also enclosed is a tabulation of data showing the elevations(ground, protective, and steel) of the wells as well as coordinates for each well based upon the Illinois State Planar Coordinate System, as requested on Purchase Order No. WA 1612.

All wells plotted well on the Base Map with the exception of MW 1-7, which is physically and actually on the ground East of the ditch line, but plots on the West side of the ditch. I suspect the ditch may not be shown properly, since the well location was checked several times.

If you have any questions regarding the information herein, or if I can be of service to you further, please contact me at your convenience.

Sincerely;



Gregg E. Miller, RLS.

enclosure

Land**Surveys****Limited****Gregg E. Miller****Registered Land Surveyor**

2816 White Crossing Road

Verona, Wj. 53593

(608)845-8342

Monitoring Well Location and Elevation Table

<u>Monitoring Well No.</u>	<u>Casing Elevation</u>	<u>S. Steel Elevation</u>	<u>Ground Elevation</u>	<u>Northing</u>	<u>Easting</u>
MW 1-1	709.88	709.55	709.9	2,057,479	626,055
MW 1-2	695.98	695.77	696.0	2,057,972	624,820
MW 1-3	691.85	691.59	689.2	2,057,926	623,893
MW 1-4A	688.08	687.57	688.1	2,056,833	623,866
MW 1-5	687.12	686.77	685.5	2,055,564	623,923
MW 1-6	684.51	684.01	684.5	2,055,837	624,733
MW 1-6A	684.94	684.70	685.0	2,055,800	624,853
MW 1-7B	679.39	678.75	679.4	2,055,993	624,526
MW 1-8	716.53	716.24	716.5	2,055,980	626,684
MW 1-9	695.58	695.31	695.6	2,055,972	626,145
MW 4-1	691.77	691.47	691.8	2,056,395	625,659
MW 4-3A	688.43	688.20	688.4	2,056,334	625,046
MW 4-2	689.83	689.47	689.8	2,056,522	625,062
MW 4-4	688.61	688.26	687.0	2,056,950	625,028

Note: Elevations shown in the table above are referenced to the Datum used on the Base, which is Mean Tide New York Harbor. To convert this datum to National Geodetic Vertical Datum, 1929, Subtract 0.69 feet from the information given in the table above.

Benchmark information for this tabulation was obtained from the Public Works Office in Building 1A on NTCGL.

Conversion information was obtained from the National Geodetic Survey Office, New York, New York.

Well suffixes and numbers (MW4-2/4-3A) corrected by Dames & Moore, February, 1989.

Land

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Surface Water Sampling Point Elevations

SW 1-1 Elevation= 678.49 Elevation shown is the top of the
box culvert under Buckley Road, over
the center partition of the culvert.

sw 1-2 Elevation=679.50 Elevation shown is for a 60 penny spike
in a 14" tree 4 feet East of the ditch.
The spike is on the West side of the
tree and 2-3 feet above the ground surface.

Note: Elevations shown in the information above are referenced
to the Datum used in the Base, which is Mean Tide New York
Harbor. To convert this datum to National Geodetic Vertical
Datum, 1929, Subtract 0.69 feet from the information
shown above.

APPENDIX C
Summary of Positive Blank Sample Analysis Results

**C.1 VOLATILE AND SEMIVOLATILE ORGANIC ANALYSIS
RESULTS FOR LABORATORY METHOD BLANKS**

TABLE C-1

Constituents Detected in Laboratory Method Blanks From
GC/MS Water Sample Analyses of Volatile Organic Compounds
RI Verification Step of NTC Great Lakes, Illinois
First Round Sampling (December 1988)

Analyte	DL (b) (ug/l)	Concentration (ug/l) in Method Blanks by Sample ID Number (a)						Concentration Range (ug/l)
		VBLK J344A	VBLK J346A	VBLK J348	VBLK J353B	VBLK J354	VBLK J355	
Priority Pollutants								
Acetone	10	38	BDL (c)	BDL	BDL	18	18	BDL - 38
Methylene chloride	5	8	18	5	BDL	BDL	BDL	BDL - 18
Tentatively Identified Compounds (d)								
1,4-Dioxane	--	6	9	7	ND (e)	5	5	ND - 9

(a) See Section G.6.3, Appendix G, for samples associated with each method blank.

(b) Detection limit.

(c) Below detection limit.

(d) From library search.

(e) Not detected.

NOTE: For reasons discussed in Section 1.1, these data could not be validated under USEPA Level III and, therefore, are not usable for their intended purpose.

TABLE C-2

Constituents Detected in Laboratory Method Blanks From
GC/MS Water Sample Analyses of Volatile Organic Compounds
RI Verification Step of NTC Great Lakes, Illinois
Second Round Sampling (March 1989)

Analyte	DL (b) (ug/l)	Concentration (ug/l) in Method Blanks by Sample ID Number (a)					Concentration Range (ug/l)
		VBLK C101A	VBLK E095	VBLK C100B	VBLK C103	VBLK C101A	
Priority Pollutants							
Acetone	10	15	11	22	BDL (c)	15	BDL - 22
Methylene chloride	5	6	3	4	7	6	3 - 7

(a) See Section G.6.3, Appendix G, for samples associated with each method blank.

(b) Detection limit.

(c) Below detection limit.

NOTE: For reasons discussed in Section 1.1, these data could not be validated under USEPA Level III and, therefore, are not usable for their intended purpose.

TABLE C-3

Constituents Detected in Laboratory Method Blanks From
GC/MS Soil Sample Analyses of Volatile Organic Compounds
RI Verification Step at NTC Great Lakes, Illinois

Analyte	DL (b) (ug/l)	Concentration (ug/l) in Method Blanks By Sample ID Number (a)															Concentration Range (ug/l)
		VBLK C344	VBLK C345A	VBLK C347	VBLK C348	VBLK C349	VBLK C351	VBLK C352C	VBLK C353B	VBLK C354	VBLK C355	VBLK C356	VBLK C357	VBLK C362D	VBLK C092	VBLK J090B	
Priority Pollutants																	
Acetone	10	17	23	11	17	22	8	BDL (c)	13	5	18	42	14	14	BDL	BDL	BDL - 42
Chloroform	5	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2	BDL	BDL	BDL - 2
1,2-Dichloroethene (total)	5	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4	BDL	BDL	BDL	BDL - 4
Methylene Chloride	5	BDL	6	5	7	14	BDL	BDL	BDL	6	17	10	7	10	22	3	BDL - 22
Toluene	5	7	14	14	10	9	5	4	8	4	3	3	3	1	BDL	BDL	BDL - 14
Trichloroethene	5	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2	BDL	BDL	BDL	BDL - 2
Tentatively Identified Compounds (d)																	
1,4-Dioxane	--	18	51	86	46	52	53	ND (e)	ND	27	25	33	50	ND	ND	ND	ND - 86
1-Ethyl-2-methylbenzene	--	ND	ND	ND	ND	ND	ND	ND	ND	126	ND	ND	ND	ND	ND	ND	ND - 126
Unknowns (total)	--	ND	ND	ND	ND	ND	ND	ND	ND	90	ND	ND	ND	ND	ND	ND	ND - 90

C-5

- (a) See Section G.6.3, Appendix G, for samples associated with each method blank.
- (b) Detection limit.
- (c) Below detection limit.
- (d) From library search.
- (e) Not detected.

NOTE: For reasons discussed in Section 1.1, these data could not be validated under USEPA Level III and, therefore, are not usable for their intended purpose.

TABLE C-4

Constituents Detected in Laboratory Method Blanks From
GC/MS Water Sample Analyses of Semivolatile Organic Compounds
RI Verification Step at NTC Great Lakes, Illinois
First Round Sampling (December 1988)

Analyte	DL (b) (ug/l)	Concentration (ug/l) in Method Blanks By Sample ID Number (a)							Concentration Range (ug/l)
		SBLK 536	SBLK 542	SBLK 548	SBLK 557	SBLK 564	SBLK 569	SBLK 575	
Priority Pollutants									
Bis(2-ethylhexyl) phthalate	10	BDL (c)	BDL	BDL	BDL	BDL	2	BDL	BDL - 2
Tentatively Identified Compounds (d)									
2-(2-Ethoxyethoxy) ethanol	--	ND (e)	ND	ND	ND	ND	ND	11	ND - 11
Unknowns (total)	--	ND	18	ND	37	ND	ND	ND	ND - 37

(a) See Section G.6.3, Appendix G, for samples associated with each method blank.

(b) Detection limit.

(c) Below detection limit.

(d) From library search.

(e) None detected.

NOTE: For reasons discussed in Section 1.1, these data could not be validated under USEPA Level III and, therefore, are not usable for their intended purpose.

TABLE C-5

Constituents Detected in Laboratory Method Blanks From
GC/MS Water Sample Analyses of Semivolatile Organic Compounds
RI Verification Step at NTC Great Lakes, Illinois
Second Round Sampling (March 1989)

Analyte	DL (b) (ug/l)	Concentration (ug/l) in Method Blanks By Sample ID Number (a)							Concentration Range (ug/l)
		SBLK 654A	SBLK 654B	SBLK 655A	SBLK 678A	SBLK 658A	SBLK 658B	SBLK 679A	
Priority Pollutants									
Bis(2-ethylhexyl) phthalate	10	580	270	34	22	100	100	1.0	1 - 580
Tentatively Identified Compounds (c)									
Unknowns (total)	--	10	ND	10	ND (d)	130	80	21	ND - 130
1-Methyl-2-propylcyclohexane	--	ND	ND	ND	ND	ND	ND	10	ND - 10

(a) See Section G.6.3, Appendix G, for samples associated with each method blank.

(b) Detection limit.

(c) From library search.

(d) None detected.

NOTE: For reasons discussed in Section 1.1, these data could not be validated under USEPA Level III and, therefore, are not usable for their intended purpose.

TABLE C-6

Constituents Detected in Laboratory Method Blanks From
GC/MS Soil Sample Analyses of Semivolatile Organic Compounds
RI Verification Step at NTC Great Lakes, Illinois

Analyte	DL (b) (ug/l)	Concentration (ug/l) in Method Blanks By Sample ID Number (a)			Concentration Range (ug/l)
		SBLK 538B	SBLK 539	SBLK 570	
Tentatively Identified Compounds (c)					
1,1,2,2-Tetramethylcyclopropane	--	ND (d)	ND	3,700	ND - 3,700
2,6-Dimethylfuran	--	ND	ND	610	ND - 610
2,3-Dimethylheptane	--	ND	ND	240	ND - 240
3,4-Dimethylheptane	--	ND	ND	130	ND - 130
3,5-Dimethylheptane	--	ND	ND	240	ND - 240
2,3,4-Trimethylhexone	--	ND	ND	340	ND - 340
Unknowns (total)	--	2,220	1,600	3,620	1,600 - 3,620

(a) See Section G.6.3, Appendix G, for samples associated with each method blank.

(b) Detection limit.

(c) From library search.

(d) Not detected.

NOTE: For reasons discussed in Section 1.1, these data could not be validated under USEPA Level III and, therefore, are not usable for their intended purpose.

C.2 FIELD BLANK (EQUIPMENT RINSATE BLANK) ANALYSIS RESULTS

TABLE C-7

Constituents Detected in Field Blanks (Equipment Rinsate Blanks)
RI Verification Step at NTC Great Lakes, Illinois

Analytical Parameter	Units	DL (a)	First Round Sampling (December 1988)							Second Round Sampling (March 1989)				
			MW1-9Z	MW4-4Z	BO4-6BZ	BO5-10AZ	BO5-13Z	BO7-3BZ	BO12-14CZ	DL	MW1-9Z	MW4-4Z	BO12-7CZ	BO12-14CZ
Chloride	mg/l	0.25	0.49	BDL (b)	NT (c)	NT	NT	NT	NT	0.25	0.40	NT	NT	NT
Total Organic Carbon	mg/l	0.1	BDL	1.0	NT	NT	NT	NT	NT	0.1	BDL	NT	NT	NT
Semivolatile Organics (Tentatively Identified Compounds)														
Unknowns (total)	ug/l	--	ND (d)	ND	ND	NT	NT	NT	NT	--	ND	130	NT	NT
2-Ethylhexanoic acid	ug/l	--	ND	ND	14	NT	NT	NT	NT	--	ND	ND	NT	NT
Volatile Organics (Priority Pollutants)														
Acetone	ug/l	10	BDL	BDL	21.0	NT	NT	BDL	BDL	10.0	21.0	BDL	NT	NT
Chlorobenzene	ug/l	5	BDL	BDL	BDL	NT	NT	BDL	BDL	5.0	3.0	2.0	NT	NT
Methylene chloride	ug/l	5	BDL	8.0	11.0	NT	NT	BDL	7.0	5.0	6.0	4.0	NT	NT
Toluene	ug/l	5	BDL	BDL	10.0	NT	NT	BDL	BDL	5.0	BDL	BDL	NT	NT
Metals														
Arsenic	ug/l	10	BDL	NT	NT	NT	NT	NT	BDL	3.0	5.94	NT	NT	NT
Beryllium	ug/l	5	BDL	NT	NT	NT	NT	NT	407.20	5.0	BDL	NT	NT	NT
Lead	ug/l	5	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3.0	BDL	5.44	NT	NT
Mercury	ug/l	0.2	0.27	NT	NT	NT	NT	NT	0.40	0.2	BDL	NT	NT	NT
Zinc	ug/l	20	BDL	NT	NT	NT	NT	NT	BDL	4.0	6.6	NT	NT	NT

- (a) Detection limit.
 (b) Below detection limit.
 (c) Not tested.
 (d) None detected.

NOTE: For reasons discussed in Section 1.1, these data could not be validated under USEPA Level III and, therefore, are not usable for their intended purpose.

C.3 TRIP BLANK ANALYSIS RESULTS

TABLE C-8

VOCs Detected in Trip Blanks
 RI Verification Step at NTC Great Lakes, Illinois

Compound	DL (a) (ug/l)	Concentration (ug/l) in Trip Blanks (b)						Concentration Range (ug/l)
		12/1/89	12/2/89	12/7/89	12/9/89	12/14/89	3/29/89	
Priority Pollutants								
Methylene chloride	5	8	6	BDL (c)	5	9	6	BDL-19
Acetone	10	BDL	BDL	BDL	25	43	BDL	BDL-43
Chlorobenzene	5	BDL	BDL	BDL	BDL	BDL	4	BDL-4

(a) Detection limit.

(b) Dates shown are trip blank shipment dates to the laboratory.

(c) Below detection limit.

NOTE: For reasons discussed in Section 1.1, these data could not be validated under USEPA Level III and, therefore, are not usable for their intended purpose.

APPENDIX D
Summary and Evaluation of
Exceedances of Maximum Holding Times

TABLE D-1

Summary and Evaluation of Exceedances of Maximum Holding Times
RI Verification Step at NTC Great Lakes, Illinois

Sample No(s).	Sample Round	Analytical Parameter	Maximum Holding Time Exceeded	Actual Holding Time	Magnitude of Exceedance	Laboratory Explanation	Data Reviewer's Remarks
MW1-3	1	BNAs	7 days until extraction	8 days	1 day	Sample was initially extracted within holding time. However, the sample extract vial was found to be dry at the time of the concentration step. Thus, re-extraction was necessary.	Exceedance of 1 day is insignificant; data considered acceptable.
WB4-2A through 4B	--	BNAs	7 days until extraction	10 days	3 days	Laboratory confusion; used USEPA CLP holding time of 10 days until extraction.	Data considered acceptable; CLP holding time was met.
MW4-1	2	PCBs	7 days until extraction	13 days	6 days	None provided.	Holding time not grossly exceeded; PCBs should be stable over the short additional storage period. Data are considered acceptable.
MW4-3A	2	BNAs	7 days until extraction	9 days	2 days	See explanation for samples WB4-2A through 4B.	See remarks for samples WB4-2A through 4B.
BO3-9A	--	PCBs	7 days until extraction	10 days	3 days	See explanation for samples WB4-2A through 4B.	See remarks for samples WB4-2A through 4B.
BO12-7A through 14C (a)	--	Pesticides/PCBs	7 days until extraction	10 days	3 days	See explanation for samples WB4-2A through 4B.	See remarks for samples WB4-2A through 4B.

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(a) Not including B012-7CZ and 14CZ.

APPENDIX E
Potential ARARs for Groundwater and Surface Water

TABLE E-1

Drinking Water Standards and Guidelines for
 Constituents Detected in Groundwater Samples,
 RI Verification Step at NTC Great Lakes, Illinois
 (concentrations in ug/l)

Constituent	Safe Drinking Water Act Criteria						USEPA Lifetime Health Advisory (g (70 kg)	AWQC Adj. for Drinking Water (h)	Illinois General Use Water Quality Standard (i)	Illinois Public and Food Processing Water Supply Standards (j)	Criteria Used for Comparison in This Report		Explanation
	Final MCL (a)	Proposed MCL (b)	Final SMCL (c)	Proposed SMCL (d)	Final MCLG (e)	Proposed MCLG (f)					Type	Value	
Metals													
Arsenic	50	--	--	50	--	--	50	0.025	1,000 (l)	50 (l)	IPWSS/Final MCL	50	Legally enforceable criteria
Beryllium	--	1	--	--	--	--	--	0.0639	--	--	Proposed MCL	1	Proposed Federal guidelines
Cadmium	5	--	--	--	5	--	5	10	50 (l)	5 (l)	IPWSS/Final MCL	5	Legally enforceable criteria
Chromium (total)	100	--	--	--	100	--	100	179,000 (k)	50 (m)	100	IPWSS/Final MCL	100	Legally enforceable criteria
Copper	--	1,300	1,000	--	--	1,300	--	1,000	20 (l)	20 (l)	IPWSS/IGWQS	20	Legally enforceable criteria
Lead	5	--	--	--	0	--	--	50	100 (l)	5 (l)	IPWSS/Final MCL	50	Legally enforceable criteria
Mercury	2	--	--	--	2	--	2	10	0.5 (l)	0.5 (l)	IPWSS/IGWQS	0.5	Legally enforceable criteria
Nickel	--	100	--	--	--	100	100	15.4	1,000 (l)	1,000 (l)	IPWSS/IGWQS	1,000	Legally enforceable criteria
Selenium	30	--	--	--	30	--	--	10	1,000 (l)	10 (l)	IPWSS	10	Legally enforceable criterion
Silver	--	--	100	--	--	--	100	50	5 (l)	5 (l)	IPWSS/IGWQS	5	Legally enforceable criteria
Zinc	--	--	5,000	--	--	--	2,000	5,000	1,000	1,000	IPWSS/IGWQS	1,000	Legally enforceable criteria
Volatile Organics (Priority Pollutants)													
Acetone	--	--	--	--	--	--	--	--	--	--	--	--	No criteria available
Chlorobenzene	100	--	--	--	100	--	100	488	--	--	Final MCL/MCLG	100	Legally enforceable criteria
Methylene chloride	--	5	--	--	--	0	--	0.19 (n)	--	--	Proposed MCL	5	Proposed Federal guidelines
Semivolatile Organics (Priority Pollutants)													
Bis(2-ethylhexyl) phthalate	--	4	--	--	--	0	--	21,000	--	--	Proposed MCL	4	Proposed Federal guidelines
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	No criteria available
Chloride	--	--	250,000	--	--	--	--	--	500,000	250,000	IPWSS	250,000	Legally enforceable criterion
Total Organic Carbon	--	--	--	--	--	--	--	--	--	--	--	--	No criteria available
Oil and Grease	--	--	--	--	--	--	--	--	--	100 (o)	IPWSS	100	Legally enforceable criterion

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TABLE E-1 (cont'd)

- (a) Final Maximum Contaminant Level (MCL); Drinking Water Regulations and Health Advisories (DWRHA), USEPA Office of Water, April 1991.
- (b) Proposed MCL; DWRHA, USEPA Office of Water, April 1991.
- (c) Final Secondary Maximum Contaminant Level (SMCL); DWRHA, USEPA Office of Water, April 1991.
- (d) Proposed SMCL; DWRHA, USEPA Office of Water, April 1991.
- (e) Final Maximum Contaminant Level Goal (MCLG); DWRHA, USEPA Office of Water, April 1991.
- (f) Proposed MCLG; DWRHA, USEPA Office of Water, April 1991.
- (g) DWRHA, USEPA Office of Water, April 1991.
- (h) Ambient Water Quality Criteria (AWQC) for protection of human health--adjusted for drinking water only.
- (i) Illinois General Use Water Quality Standards (IGWQS), which must be met in waters of the State for which there is no specific designation; Illinois EPA, Title 35, Subtitle C, Chapter I, Part 302.
- (j) Illinois Public and Food Processing Water Supply Standards (IPWSS) which are cumulative with the IGWQS and must be met in all waters designated for public or for food processing use. Waters of the State are generally designated for public and food processing use; Illinois EPA, Title 35, Subtitle C, Chapter I, Part 302.
- (k) For trivalent form.
- (l) For total concentration of the element.
- (m) For hexavalent form.
- (n) For halomethanes.
- (o) For oil (hexane-solubles or equivalent).

TABLE E-2

Surface Water Quality Criteria
for Constituents Detected in Surface Water Samples
RI Verification Step at NTC Great Lakes, Illinois
(concentrations in ug/l)

Constituent	AWOC (a)		IGWQS (d)
	FAC (b)	FCC (c)	
Metals			
Arsenic	380 (e)	190 (e)	1,000 (f)
Copper	18	12	20 (f)
Lead	82	3.2	100 (f)
Mercury	2.4	0.012	0.5 (f)
Selenium	280	36	1,000 (f)
Silver	4.1	0.12	5 (f)
Zinc	120	110	1,000
Volatile Organics (Priority Pollutants)			
Acetone			
Benzene	5,300		
Chlorobenzene	11,000 (g)		
Methylene chloride			
Semivolatile Organics (Priority Pollutants)			
Chrysene			
Bis(2-ethylhexyl) phthalate			
2-Methylnaphthalene			
Phenathrene			
Pyrene			
Fluorene			
Chloride			500,000
Total Organic Carbon			
Oil and Grease			

- (a) Ambient Water Quality Criteria; 45 FR 79318.
 (b) Freshwater Acute Criteria.
 (c) Freshwater Chronic Criteria.
 (d) Illinois General Use Water Quality Standards, which must be met in waters of the State for which there is no specific designation; Illinois EPA, Title 35, Subtitle C, Chapter I, Part 302.
 (e) For trivalent form.
 (f) For total concentration of the element.
 (g) For halomethanes.

APPENDIX F
Concentrations of Metals in Surficial
Soils of the Eastern United States

TABLE F-1

Concentrations of Metals in Surficial Soils of the
Eastern United States as Reported by the
U.S. Geological Survey (a,b)
(concentrations in ug/g)

<u>Metal</u>	<u>Observed Range</u>	<u>Estimated Arithmetic Mean</u>	<u>Geometric Mean</u>	<u>Geometric Deviation</u>	<u>Estimated Range for 95 Percent of Samples in USGS Study</u>
Antimony	<1-8.8	0.76	0.52	2.38	0.092-2.9
Arsenic	<0.1-73	7.4	4.8	2.56	0.73-31
Beryllium	<1-7	0.85	0.55	2.53	0.086-3.5
Cadmium	NR (c)	NR	NR	NR	--
Chromium (total)	<1-1,000	52	33	2.60	4.9-220
Copper	<1-700	22	13	2.80	1.7-100
Lead	<10-300	17	14	1.95	3.7-53
Mercury	<0.01-3.4	0.12	0.081	2.52	0.013-0.51
Nickel	<5-700	18	11	2.64	1.6-77
Selenium	<0.1-3.9	0.45	0.30	2.44	0.050-1.8
Silver	NR	NR	NR	NR	--
Zinc	<5-2,900	52	40	2.11	9.0-180

(a) Adapted from USGS data presented in Shacklette, H. T., and J. G. Boerngen, 1984. Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States, U.S. Geological Survey Professional Paper 1270.

(b) For metals detected in NTC Great Lakes samples.

(c) Not reported.