USATHAMA

U.S. Army Toxic and Hazardous Materials Agency

FINAL ASSESSMENT REPORT

PETROLEUM LEAK/SPILL AREA
IOWA ARMY AMMUNITION PLANT, IOWA

Contract No. DAAA15-85-D-0008
Delivery No. 2

Prepared for

U.S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
Aberdeen Proving Ground, Maryland 21010

Prepared by

DAMES & MOORE
A Professional Limited Partnership
7101 Wisconsin Avenue
Bethesda, Maryland 20814

DISTRIBUTION LIMITED TO U.S. GOVERNMENT AGENCY
FOR PROTECTION OF PRIVILEGED INFORMATION
EVALUATING ANOTHER COMMAND: MARCH 1990

REQUEST FOR THIS DOCUMENT MUST BE REFERRED TO:
COMMANDER
U.S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010-5401

MARCH 1990

3C 1
5 3

DAMES & MOORE A PROFESSIONAL LIMITED PARTNERSHIP
7101 WISCONSIN AVENUE, SUITE 700, BETHESDA, MARYLAND 20814-4870
(301) 652-2215 TELEX: 315528

March 15, 1990

U.S. Army Toxic and Hazardous
Materials Agency
Building E4435
Aberdeen Proving Ground, Maryland 21010

Attn: CETHA-IR-A/Mr. Pete Rissell

Re: Transmittal of the Final Assessment Report, Petroleum Leak/Spill Area, Iowa Army Ammunition Plant (IAAP)
Contract No. DAAA15-88-D-0008
Delivery Order No. 2

Dear Mr. Rissell:

This letter transmits five (5) bound copies and one (1) camera-ready copy of the above-referenced report. At your request, we are also sending five (5) copies to Mr. Leon Baxter at IAAP and two (2) copies to Ms. Leslie Campbell at the Iowa Department of Natural Resources (IDNR).

Please contact me if you have any questions.

Sincerely,

DAMES & MOORE

William D. Eaton

William D. Eaton
Project Manager

WDE/kmb

Enclosures

OFFICES WORLDWIDE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION
Unclassified.

1b. RESTRICTIVE MARKINGS
None.

2a. SECURITY CLASSIFICATION AUTHORITY
N/A

2b. DECLASSIFICATION/DOWNGRADING SCHEDULE
N/A

3. DISTRIBUTION/AVAILABILITY OF REPORT
Distribution limited to U.S. Government Agencies only for protection of privileged information evaluating another command: March 1990. Requests for this document must be referred to: Commander, Iowa Army Ammunition Plant, Middletown, Iowa, 52638.

4. PERFORMING ORGANIZATION REPORT NUMBER(S)

5. MONITORING ORGANIZATION REPORT NUMBER(S)
CETHA-IR-CR-90050

6a. NAME OF PERFORMING ORGANIZATION
DAMES & MOORE
A Professional Limited Partnership

6b. OFFICE SYMBOL (if applicable)

7a. NAME OF MONITORING ORGANIZATION
U.S. Army Toxic and Hazardous Materials Agency

6c. ADDRESS (City, State, and ZIP Code)
7101 Wisconsin Avenue, Suite 700
Bethesda, Maryland 20814

7b. ADDRESS (City, State, and ZIP Code)
ATTN: CETHA-IR-A
Aberdeen Proving Ground, Maryland 21010-5401

8a. NAME OF FUNDING/SPONSORING ORGANIZATION
U.S. Army Toxic and Hazardous Materials Agency

8b. OFFICE SYMBOL (if applicable)
CETHA-IR-A

9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
DAAA15-88-D-0008

8c. ADDRESS (City, State, and ZIP Code)
ATTN: CETHA-IR-A
Aberdeen Proving Ground, MD 21010-5401

10. SOURCE OF FUNDING NUMBERS

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification)
Final Assessment Report, Petroleum Leak/Spill Area, Iowa Army Ammunition Plant, Iowa

12. PERSONAL AUTHOR(S)
Philip Klinedinst, Nelson Spessard, William Eaton, and Richard Tucker

13a. TYPE OF REPORT
FINAL

13b. TIME COVERED
FROM **6/89** TO **3/90**

14. DATE OF REPORT (Year, Month, Day)
3-16-90

15. PAGE COUNT
180

16. SUPPLEMENTARY NOTATION

17. COSATI CODES

FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
Iowa Army Ammunition Plant; Leaking Underground Storage Tank; LUST; Gasoline Spill; Environmental Evaluation; Petroleum Leak

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This report evaluates the extent and location of soils and groundwater contaminated by the release of hydrocarbons at the Petroleum Leak/Spill Area (PL/SA) at IAAP. This investigation was required by the USEPA (RCRA, UST, Subpart F,280.65) and the State of Iowa (Subrule 135.7 (6), Chapter 135 of the Iowa Administrative Code), because, during the excavation of underground storage tanks, contaminated soils were found to be in contact with groundwater. Suspected contamination at the PL/SA caused the removal of three USTs (prior to the present investigation), in accordance with Iowa Administrative Code, Chapter 135, "Underground Storage Tanks."

Based on Dames & Moore's initial site visit, a two-phased investigation program was recommended for the PL/SA:

(1) An initial soil gas survey to give a preliminary indication of the occurrence of volatile contamination and potential groundwater flow direction, and

(2) Follow-up geotechnical work consisting of installation of soil borings and monitoring wells, and collection and analysis of samples of soil, groundwater, surface water, and sediment.

(Continued on Reverse)

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS

21. ABSTRACT SECURITY CLASSIFICATION
Unclassified.

22a. NAME OF RESPONSIBLE INDIVIDUAL
Peter Rissell

22b. TELEPHONE (Include Area Code)
301-671-3921

22c. OFFICE SYMBOL
CETHA-IR-A

19. ABSTRACT (Continued from previous page)

The principal conclusions concerning contamination extent and migration potential are as follows:

(1) Shallow groundwater contamination is horizontally confined to the immediate vicinity of the contamination source area, and in the vertical direction groundwater contamination is almost entirely limited to the shallow groundwater table;

(2) Contaminated groundwater has not impacted the deep portions of the glacial till;

(3) The extent of soil contamination indicated by the soil purgeable aromatics analyses is similar to the extent of contamination indicated by the groundwater chemistry results--soil contamination is limited to the immediate vicinity of the site in both the horizontal and vertical directions;

(4) Contamination at the source area has not impacted the closest, downgradient stream.

Potential hazards posed by the spill appear to be low based on the available data, due in part to the absence of free-floating product, the limited extent of contaminant migration, and absence of buildings (excluding the gasoline station) coincident with the contaminated area. However, elevated concentrations of organic vapors in soil in the immediate vicinity (within approximately 50 feet) of monitoring well DM-1 indicate that caution should be exercised during potential future excavation activities that may be conducted at the site (e.g., associated with standard maintenance of subsurface utilities). Potential human health risks posed by the site are considered to be negligible because the groundwater is not a drinking water source and contaminated subsurface soils are isolated from potential human activities. Potential environmental risks posed by the site are also considered to be negligible because contamination discharge to the surface is not occurring and because the available data indicates low contaminant migration potential.

No additional site remediation activities are presently recommended because:

(1) No free-floating product has been detected at the site;

(2) The bulk of the highly contaminated soil adjacent to the leaking UST's was removed during excavation of the UST's;

(3) Both groundwater and soil contamination are confined to the immediate vicinity of the site;

(4) Discharge of contaminated groundwater to the surface environment is not occurring;

(5) The natural horizontal and vertical gradient at the site is low.

CONTENTS

CONTENTS (cont'd)

FIGURES

TABLES

ACRONYMS

AMCCOM	U.S. Army Armament Munitions and Chemical Command
BTEX	Benzene, toluene, ethylbenzene and total xylenes
ERG	Environmental Research Group
FID	Flame ionization detector
GC	Gas chromatograph
IAAP	Iowa Army Ammunition Plant
ID	Inside diameter
m/sec	Meters per second
msl	Mean sea level
NPDES	National Pollutant Discharge Elimation System
OD	Outside diameter
OVA	Organic Vapor Analyzer
PA/SA	Petroleum Leak/Spill Area
PID	Photoionization detector
ppb	Parts per billion
ppm	Parts per million
psi	Per square inch
PVC	Polyvinyl chloride
SCS	Sterns, Conrad, and Schmidt
TH	Total hydrocarbons
TPH	Total petroleum hydrocarbons
TRC	Tracer Research Corporation
ug/l	micrograms per liter
USAEHA	U.S. Army Environmental Hygiene Agency
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank

Final Assessment Report: Petroleum Leak/Spill Area
March 1990

EXECUTIVE SUMMARY

This document is the Assessment Report for the Petroleum Leak/Spill Area (PL/SA), Iowa Army Ammunition Plant (IAAP), Middletown, Iowa. The PL/SA is located next to a small service station situated near the north-central boundary of IAAP (Figure ES-1). The PL/SA is approximately 350 feet south of the intersection of Texas Avenue and North Drive. Bordering the PL/SA to the west, north, and east are Texas Avenue, Building No. 500-144, and Building No. 500-129, respectively.

This report evaluates the extent and location of soils and groundwater contaminated by the release of hydrocarbons at the Petroleum Leak/Spill Area (PL/SA) at IAAP. This investigation is required by the USEPA (RCRA, UST, Subpart F, 280.65) and the State of Iowa (Subrule 135.7 (6), Chapter 135 of the Iowa Administrative Code), because, during the excavation of underground storage tanks, contaminated soils were found to be in contact with groundwater. Suspected contamination at the PL/SA caused the removal of three USTs (Figure ES-2) (prior to the present investigation), in accordance with Iowa Administrative Code, Chapter 135, "Underground Storage Tanks." PACE Laboratories (PACE Laboratories, Inc., 1988) subsequently performed field analyses on soils excavated during removal of the two 10,000-gallon underground gasoline tanks and one 10,000-gallon underground diesel tank, and documented the presence of hydrocarbons using Organic Vapor Analyzers (OVAs).

Three composite soil samples collected from around the diesel tank and analyzed (PACE Laboratories, Inc., 1988) on November 8 had a range of 50 to 500 ppm total organic vapors. The excavation was enlarged on November 10, and seven additional soil samples from the bottom of the excavation were collected and analyzed. A composite soil sample had a concentration of 250 ppm. The detailed results seemed to indicate that, while the soils immediately adjacent to the tanks were contaminated, over-excavation to the north and east resulted in rapidly decreasing concentrations (PACE Laboratories, Inc., 1988). On November 15, 1988, additional soils were excavated from the south wall, and soil analyses indicated increasing contamination. At this time, it was discovered that--prior to installation of the three tanks of current concern (Figure ES-2)--two previously excavated 2,500-gallon underground gasoline tanks had been located approximately 8 feet

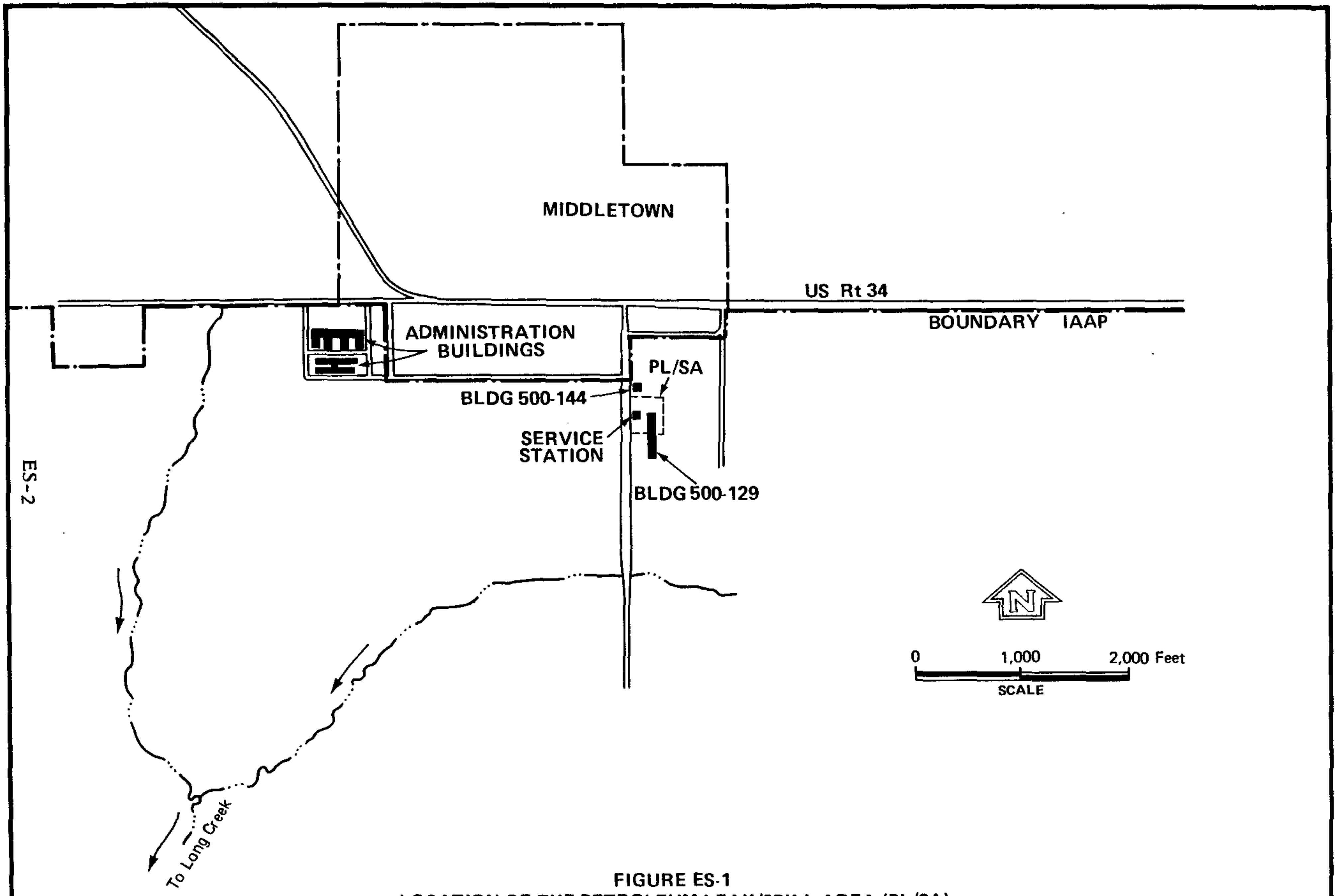


FIGURE ES-1
LOCATION OF THE PETROLEUM LEAK/SPILL AREA (PL/SA)
AT IAAP

Dames & Moore

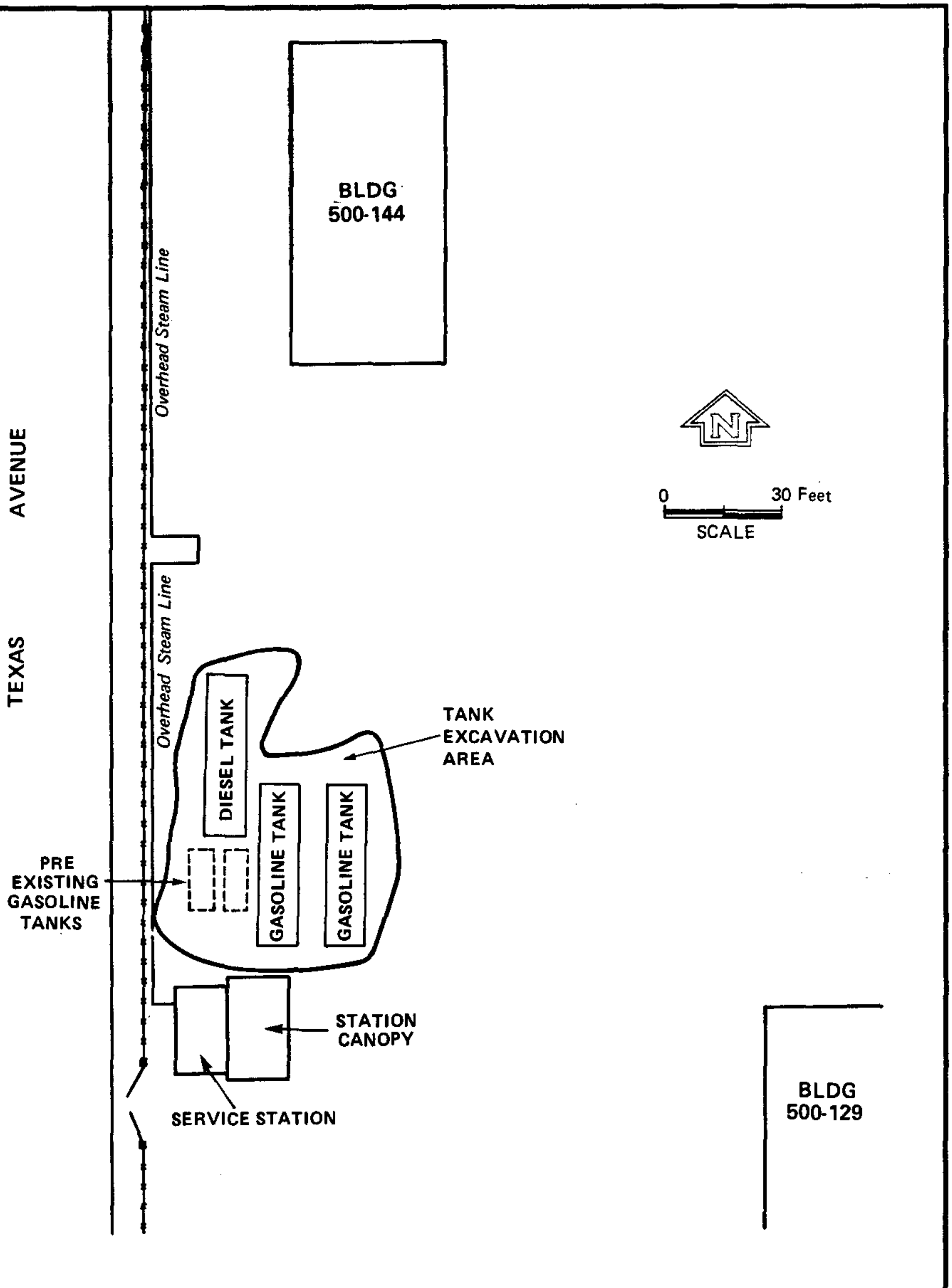


FIGURE ES-2
LOCATION OF EXCAVATED STORAGE TANKS

north of the service station (PACE Laboratories, Inc., 1988). On November 17, 1988, soils were excavated to within approximately 1 foot of the northern wall of the gas station building. Results of soil analyses ranged from 2,500 to 20,000 ppm total organic vapors. Groundwater began to flow into the center hole of the excavation, and a gasoline sheen was noted on the water surface (PACE Laboratories, Inc., 1988).

Based on Dames & Moore's review of the PACE report (1988) and the findings of Dames & Moore's initial site visit, a two-phased investigation program was recommended for the PL/SA:

- An initial soil gas survey to give a preliminary indication of the occurrence of volatile contamination and potential groundwater flow direction.
- Followup geotechnical work consisting of installation of soil borings and monitoring wells, and collection and analysis of samples of soil, groundwater, surface water, and sediment.

The soil gas samples were analyzed in the field at the time of sample collection, using a Varian Model 3300 gas chromatograph (GC), equipped with a flame ionization detector (FID). The FID facilitated the detection of aromatics--benzene, toluene, xylenes, ethylbenzene, and the C_1 through C_{10} aliphatics.

The scope of the drilling and soil sampling program is summarized in Tables ES-1 and ES-2. This scope was defined based on the results of the PACE (1988) site investigation, the Dames & Moore initial site visit, and the soil gas survey. All geotechnical activities were conducted in accordance with the USATHAMA "Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports, March 1987." The sampling program also consisted of collection and analysis of three surface water and sediment samples from a downgradient tributary. All samples were analyzed for benzene, toluene, xylenes, ethylbenzene, total petroleum hydrocarbons, and lead.

Based on the soil gas analyses for TH, benzene, and toluene, an approximate 100-foot-wide hydrocarbon soil gas plume appears to extend approximately 100 to 200 feet south of the southeast corner of the excavation. The soil gas concentrations in excess of 10,000 ppb may indicate the presence of free product occurring

TABLE ES-1

Location and Justification for Borings/Wells

Wells	Borings	Depth (feet)	Location	Rationale
DM-1		20	Service station well cluster	Locations immediately downgradient of highest soil gas readings to detect possible downward migration of contaminants and potential free product
DM-2		35	Service station well cluster	
DM-3		55	Service station well cluster	
DM-4		20	Downgradient well cluster	Precise locations were determined after the installation of wells DM-8, and DM-9, and borings D-11 and DM-14, and an assessment of the groundwater flow direction was made based on water table elevations
DM-5		35	Downgradient well cluster	
DM-6		55	Downgradient well cluster	
DM-7		20	Upgradient of excavation	To measure background groundwater quality and elevation
DM-8		20	East of soil gas plume	To assess groundwater conditions near the eastern limit of the soil gas plume
DM-9		20	West of soil gas plume	To assess groundwater conditions near the western limit of the soil gas plume
DM-10		20	Farthest downgradient well	To locate downgradient limit of suspected groundwater plume
	DM-11	20	Area of highest confirmed soil gas concentration	To evaluate the potential occurrence of free hydrocarbons
	DM-12	20	Area of soil gas nondetects east of the service station	To assess the reliability of soil gas nondetects adjacent of excavation

TABLE ES-1 (cont'd)

Wells	Borings	Depth (feet)	Location	Rationale
	DM-13	20	Area of soil gas detects in the range of 0.1 to 100 ppb	To document the reliability of soil gas results adjacent to excavation
	DM-14	20	Area of soil gas detects in the range of 0.1 to 100 ppb	To document the reliability of soil gas results adjacent to excavation

TABLE ES-2

Summary of Soil Boring/ Sampling and Well Installation Program

Boring No.	Conversion to 4-Inch PVC Well?	Depth (feet)	Split-Spoon Sampling Depths (feet)[a]	Total Soil Samples	Samples Submitted for Chemical Analysis	Screen Length (feet)
DM-1	Yes	20	2.5, 5, 7.5, 10, 15,	5	3	10
DM-2	Yes[b]	35	25, 30, 35[c]	3	3	5
DM-3	Yes[b]	55	25, 30, 35, 40, 45, 50, 55[c]	7	7	5
DM-4	Yes	20	2.5, 5, 7.5, 10, 15,	5	3	10
DM-5	Yes[b]	35	25, 30, 35[c]	3	0	5
DM-6	Yes[b]	55	25, 30, 35, 40, 45, 50, 55[c]	7	0	5
DM-7[d]	Yes	20	2.5, 5, 7.5, 10,	5	0	10
DM-8	Yes	20	2.5, 5, 7.5, 10, 15,	5	3	10
DM-9	Yes	20	2.5, 5, 7.5, 10, 15,	5	2	10
DM-10[e]	Yes	20	2.5, 5, 7.5, 10,	5	0	10
DM-11	No	20	2.5, 5, 7.5, 10, 15, 20	6	2	NA
DM-12	No	20	2.5, 5, 7.5, 10, 15, 20	6	3	NA
DM-13	No	20	2.5, 5, 7.5, 10, 15, 20	6	3	NA
DM-14	No	20	2.5, 5, 7.5, 10, 15, 20	6	3	NA
				74	32	

---

[a] Underlined split-spoon sample depths represent soil samples submitted for chemical analysis.

[b] Well double-cased in accordance with USATHAMA geotechnical requirements to minimize the potential for subsurface contamination or cross-contamination (USATHAMA, 1987; Paragraph IIIA1a1).

[c] Soil sampling above 20-foot depth not possible because the first 20 feet of the boring will be drilled using a 16-inch diameter solid-stem auger which does not facilitate split-spoon sampling.

[d] Background well.

[e] More distant, downgradient well.

as residue in the soil or floating on the water table. The area encompassed by the 10,000 ppb contour (Figures ES-3 and ES-4) is approximately 20 feet wide and 40 feet long, and is located south of the excavation and 25 feet east of the station pump island. Inasmuch as most of the area surrounding the excavation generally does not exhibit elevated hydrocarbon concentrations, it appears to be relatively uncontaminated. This finding is in agreement with reports that none of the USTs recently removed from this excavation were leaking.

The principal conclusions concerning the extent and migration potential of the contamination are as follows:

Groundwater

- Shallow groundwater contamination is horizontally confined to the immediate vicinity of the contamination source area (generally does not extend beyond approximately 50 feet from the southern boundary of the excavated area).
- In the vertical direction, groundwater contamination is almost entirely limited to the shallow groundwater table.
- Contaminated groundwater has not impacted the deep portions of the glacial till.

Soil

- The extent of soil contamination indicated by the purgeable aromatics analyses is similar to the extent of contamination indicated by the groundwater chemistry results--soil contamination is limited to the immediate vicinity of the site in both the horizontal and vertical directions.
- The soil gas monitoring results indicate the occurrence of fuel-related hydrocarbons throughout an area roughly coincident with the area of subsurface contamination defined by the groundwater and soil monitoring program.

Surface Water/Sediments

- Contamination at the source area has not impacted the closest, downgradient stream.

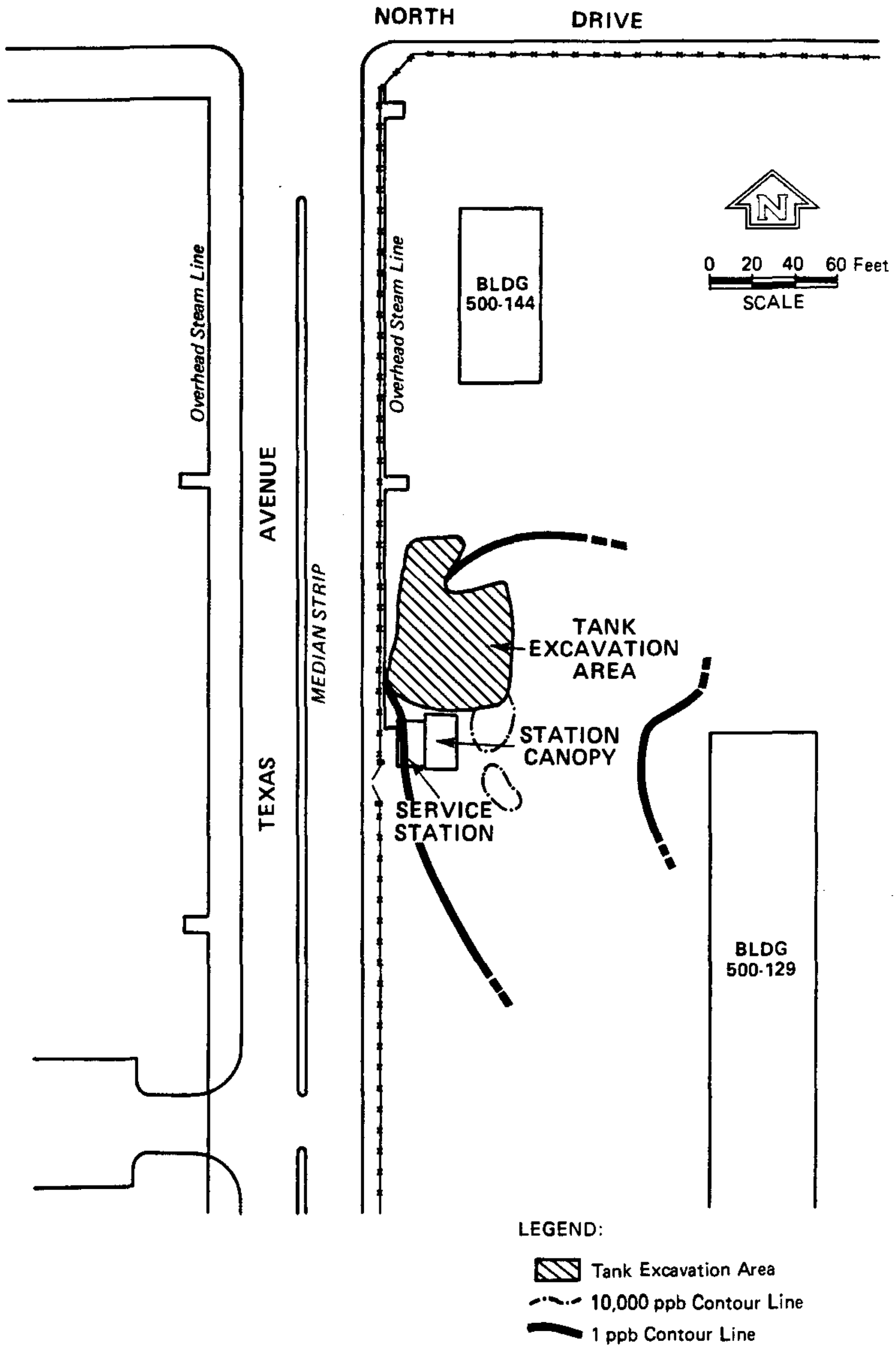


FIGURE ES-3
SUMMARY OF TOTAL HYDROCARBON RESULTS

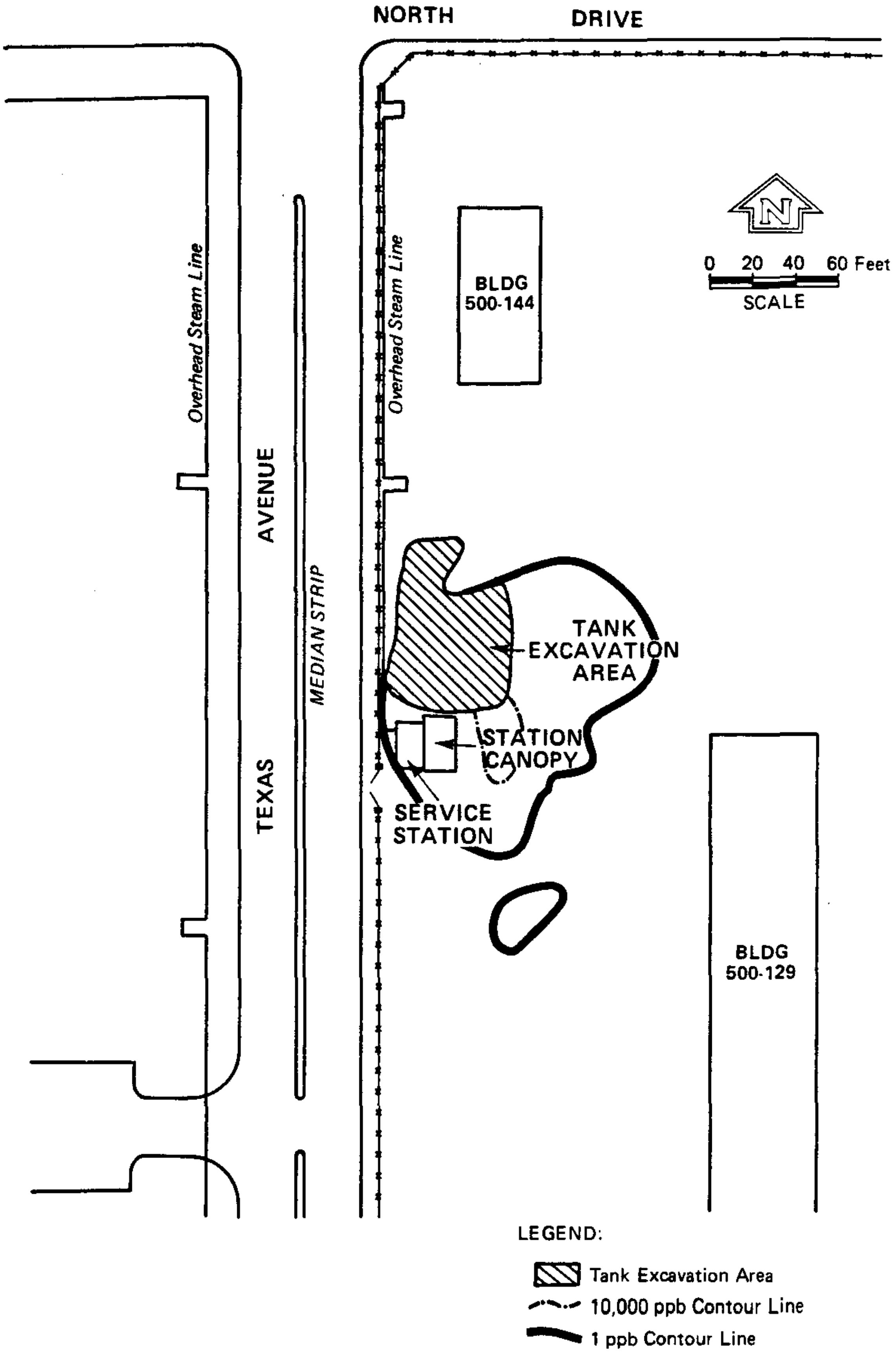


FIGURE ES-4
SUMMARY OF BENZENE RESULTS

- This conclusion regarding the site's non-impact of surface water quality is supported by the groundwater and soil monitoring data for soil samples from the immediate vicinity of the site which indicate rapid attenuation of site-related contamination.

Potential hazards posed by the spill appear to be low based on the available data, due in part to the absence of free-floating product, the limited extent of contaminant migration, and absence of buildings (excluding the gasoline station) coincident with the contaminated area. However, elevated concentrations of organic vapors in soil in the immediate vicinity (within approximately 50 feet) of monitoring well DM-1 indicate that caution should be exercised during potential future excavation activities that may be conducted at the site (e.g., associated with standard maintenance of subsurface utilities). Potential human health risks posed by the site are considered to be negligible because the groundwater is not a drinking water source and contaminated subsurface soils are isolated from potential human activities. Potential environmental risks posed by the site are also considered to be negligible because contamination discharge to the surface is not occurring and because the available data indicates low contaminant migration potential.

The apparent confinement of contamination to the immediate vicinity of the site is attributable to three principal factors:

- Relatively small total volume of fuel leaked to the subsurface, evidenced by the lack of free-floating product on the water table, the frequent absence of an oil slick/sheen on ponded water in the open excavation at the site, and lack of observation of fuel-saturated soil during drilling of the soil borings.
- Rapid and effective initial remedial responses initiated by IAAP that included over-excavation of contaminated soils during excavation of the leaking tanks, and periodic pumping of water (discharged to a Corp of Engineers designed oil/water separator) from the open excavation in order to confine shallow contaminated groundwater to the immediate vicinity of the site.
- Very low horizontal and vertical hydraulic gradient at the site, combined with low permeability, high clay-content glacial deposits that

underlie the site which, together, impede contaminant migration away from the site.

No additional site remediation activities are presently recommended because:

- No free-floating product has been detected at the site.
- The bulk of the highly contaminated soil adjacent to the leaking UST's was removed during excavation of the UST's.
- Both groundwater and soil contamination are confined to the immediate vicinity of the site.
- Discharge of contaminated groundwater to the surface environment is not occurring.
- The natural horizontal and vertical gradient at the site is low.

IAAP should, however, take steps to assure that potential future operators of excavation equipment at the site are notified of the potential to encounter organic vapors during excavation. The gasoline station should periodically be monitored for the potential accumulation of organic vapors. However, because the gas station is subject to prevailing winds and the bulk of the contaminated soil has been removed, the likelyhood of accumulation of organic vapors is reduced.

The documented downward hydraulic gradient should be confirmed by additional groundwater level monitoring. If the downward gradient is confirmed, semi-annual sampling and analysis of groundwater samples from monitoring wells DM-1 through DM-6 should be conducted for purgeable hydrocarbons and lead.

1.0 INTRODUCTION

This document is the Assessment Report for the Petroleum Leak/Spill Area (PL/SA), Iowa Army Ammunition Plant (IAAP), Middletown, Iowa. This report is being submitted under the requirements of Delivery Order No.2, contract No. DAAA15-88-D-0008.

The intent of this report is to evaluate the extent and location of soils and groundwater contaminated by the release of hydrocarbons at the PL/SA at IAAP. This investigation is required by the USEPA (RCRA, UST, Subpart F, 280.65) and the State of Iowa (Subrule 135.7 (6), Chapter 135 of the Iowa Administrative Code), because, during the excavation of underground storage tanks, contaminated soils were found to be in contact with groundwater. Both the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) and the State of Iowa, Department of Natural Resources have stipulated that this investigation address the following issues:

1. Delineation of the vertical and horizontal extent of contamination in both soil and groundwater.
2. The direction of contaminant migration.
3. Ranges of contaminant concentrations in soils and groundwater.
4. A description of the geohydrologic section.
5. Presentation of a map illustrating the configuration of the contaminated area.

Suspected contamination at the PL/SA caused the removal of three USTs, in accordance with Iowa Administrative Code, Chapter 135, "Underground Storage Tanks." PACE Laboratories (PACE Laboratories, Inc. 1988) subsequently performed field analyses on soils excavated during removal of the two 10,000-gallon underground gasoline tanks and one 10,000-gallon underground diesel tank, and documented the presence of hydrocarbons using Organic Vapor Analyzers (OVAs).

Dames & Moore was contracted by USATHAMA to further characterize the site. A soil gas survey was performed by Tracer Research Corporation (TRC) under the direction of Dames & Moore. On the basis of these data, four soil borings and

10 monitoring well locations were selected. Soils from the borings, groundwater from the installed wells, and downgradient surface water and sediment samples from the closest stream were analyzed for total petroleum hydrocarbons, purgeable aromatics and lead. The results of these analyses are presented in Table 4-4.

2.0 PHYSICAL SETTING

2.1 INSTALLATION DESCRIPTION

IAAP is a U.S. Government-owned, contractor-operated (Mason & Hanger-Silas Mason Co., Inc.) military industrial installation under the jurisdiction of the Commanding General, Headquarters, U.S. Army Armament Munitions and Chemical Command (AMCCOM) (USATHAMA, 1980). IAAP is located in Middletown, Iowa, approximately 10 miles west of Burlington, Iowa (Figure 2-1). The installation consists of approximately 20,000 acres, of which approximately 50 percent is leased for agriculture and 37 percent is forested; the remaining area is used for administrative and industrial operations (USATHAMA, 1980).

IAAP was created from farmland during World War II. Wartime production was begun in September 1941 and terminated in August 1945. Mason & Hanger-Silas Mason Co., Inc. has been the operating contractor since 1951. Large-caliber projectiles and small ammunition components are produced at the installation.

The current mission of the installation is to load, assemble, and pack ammunition items. The mission also includes storage, issue, inventory reporting, checking of inspection equipment, and maintenance of related records (USATHAMA, 1980).

2.2 BACKGROUND SITE DESCRIPTION

2.2.1 Location

The PL/SA is located next to a small service station situated near the north-central boundary of IAAP (Figure 2-2). The PL/SA is approximately 350 feet south of the intersection of Texas Avenue and North Drive. Bordering the PL/SA to the west, north, and east are Texas Avenue, Building No. 500-144, and Building No. 500-129, respectively.

2.2.2 Topography

IAAP is located within the Dissected Till Plains section of the Central Lowlands Province of the United States. This section is typified by relatively flat-lying strata that have been modified by glaciation and subsequently dissected by recent stream activity.

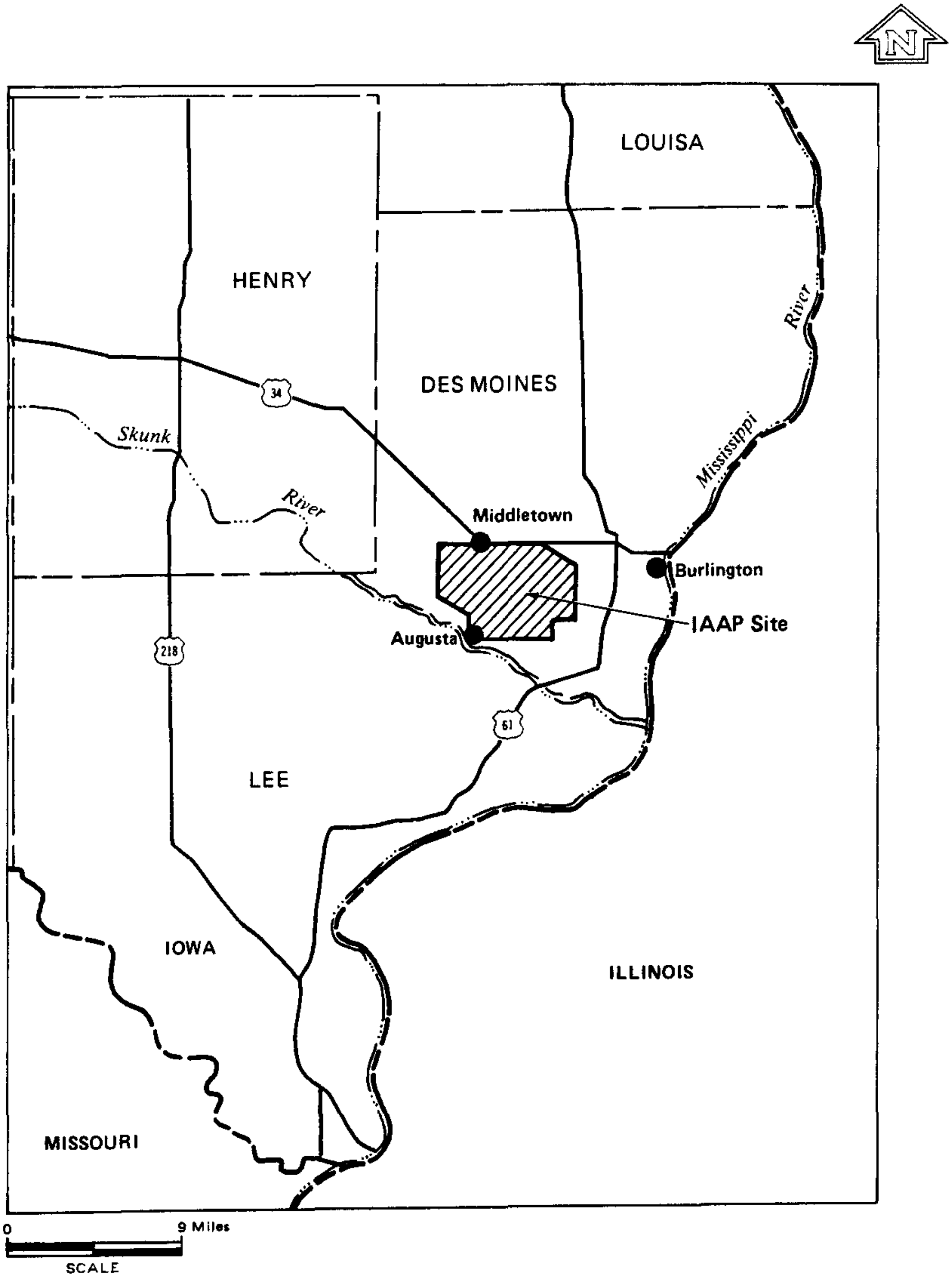


FIGURE 2-1
LOCATION OF THE IOWA ARMY AMMUNITION PLANT
MIDDLETOWN, DES MOINES COUNTY, IOWA

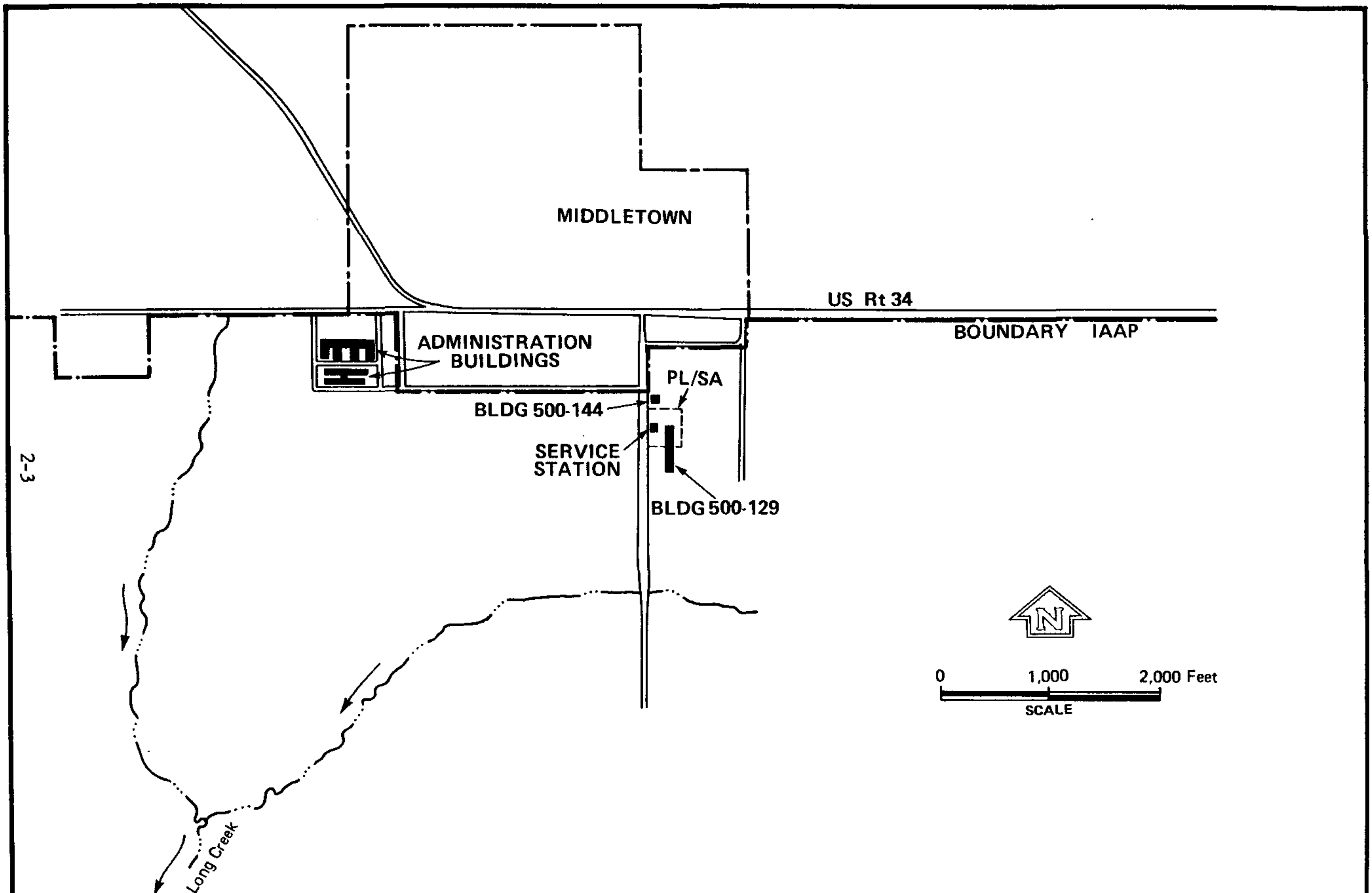


FIGURE 2-2
LOCATION OF THE PETROLEUM LEAK/SPILL AREA (PL/SA)
AT IAAP

Dames & Moore

The topography characteristic of this section of the Central Lowlands Province is generally flat-lying. IAAP consists mainly of flat-lying terrain in the north, flat-to-rolling terrain dissected by shallow drainageways in the center, and a gently undulating upland plateau with steep hilly areas near the margins of the stream valleys in the south. Elevations within IAAP range from 730 feet above mean sea level (msl) in the north to 530 feet msl in the south. This range of elevations results in total relief of approximately 200 feet across IAAP, with a regional slope toward the south-southeast.

In the immediate vicinity of the PL/SA, the ground surface is relatively flat, with a gradual slope to the south.

2.2.3 Geology

2.2.3.1 Regional. The bedrock underlying IAAP consists of a sequence of limestones interbedded with varying thicknesses of shales and sandstones, ranging in age from Cambro-Ordovician to Mississippian (Harris et al., 1964). These sedimentary rocks generally strike northwest-southeast and dip gradually northeastward in the vicinity of IAAP. The age, formation names, and thicknesses of bedrock units encountered by a 1,930-foot-deep well drilled in the northern part of the installation are presented in Table 2-1. The uppermost bedrock is Mississippian aged limestone that was encountered at a depth of 137 feet.

The bedrock is unconformably overlain by glacial till, consisting of clay and silt, with small amounts of sand and gravel. The till is mainly attributed to glaciation during the Pleistocene; however, southeast Iowa was also covered by a glacier during the Kansan glacial period. Therefore, some of the till at IAAP was likely deposited during the Kansan glacial period as well. The till ranges in thickness from 0 to 140 feet, on average, with the greatest thickness occurring in the northern portion of IAAP and thinning to the south. Table 2-1 shows a till thickness of 137 feet from a well located near the northern part of the installation. The till is widely variable in composition and stratification across IAAP.

Overlying the till is loess, consisting of clayey silt deposited primarily by wind. Available data indicate that the loess deposits at IAAP range in thickness from 2 to 6 feet.

2.2.3.2 Site-Specific. Soils excavated to a depth of 16 feet during removal of the three underground tanks during November 8-17, 1988, were described as "clay

TABLE 2-1

Summary of Bedrock Units Underlying IAAP

System	Formation Name	Rock Type	Depth to Top of Interval (ft)[a]	Unit Thickness (ft)[a]
Quaternary	Loess/till	Predominantly clay and silt	0	137.0
Mississipian	Keokuk	Limestone with interbedded chert	137.0	194.0
Mississippian	Kinderhook (Mapel Mill)	Shale	331.0	168.0
Devonian	Cedar Valley	Limestone	499.0	171.0
Devonian	Wapsipinican	Shale	670.0	28.0
Ordovician	Maquokota and Galena	Limestone	698.0	215.0
Ordovician	Glenwood	Sandstone	913.0	9.0
Ordovician	Probable Glenwood	Shale	922.0	37.0
Ordovician	St. Peter	Sandstone	959.0	141.0
Ordovician	Probable Prairie du Chien Group	Cherty, dolomitic Limestone with minor interbeds of shale and sandstone	1,100.0	538.0
Cambrian	Jordan	Sandstone	1,638.0	150.0
Cambrian	Unnamed	Limestone	1,788.0	144.4

---

[a] Determined from the log for IAAP groundwater well No. 4 drilled in the northern part of the installation to a total depth of 1,930 feet.

material" (PACE Laboratories, Inc., 1988). The detailed description of site-specific geology is presented in Section 4.2.

2.2.4 Hydrology/Hydrogeology

2.2.4.1 Regional. The PL/SA is located at the upstream end of the surface water drainage system at IAAP, between Long Creek and Brush Creek, both of which flow generally from the northwest to the southeast (Figure 2-3). The closest stream to the PL/SA is an intermittent tributary to Long Creek, located approximately 1,600 feet south of the PL/SA. Four aquifers have been identified in southeastern Iowa (Coble and Roberts, 1971). The uppermost, or drift, aquifer is a discontinuous surficial aquifer comprised of unconsolidated glacial and fluvial deposits. The water table in these deposits is locally found to be relatively close to the surface. The shallow water table is probably due to the low vertical permeability of these deposits and the existence of perched water conditions. Wells screened in this aquifer are generally of low yield.

The shallowest bedrock aquifer at IAAP, the Mississippian aquifer, occurs within the Warsaw Formation (Battelle, 1984). The Mississippian aquifer is composed primarily of limestone and dolomite (Warsaw and Keokuk Formations). Groundwater in this formation flows via fractures and joints or bedding planes, which are zones of secondary permeability.

The Devonian aquifer (Cedar Valley Limestone) underlies the Mississippian and is separated from it by an aquiclude of shales (Battelle, 1984). It is composed mainly of carbonate rocks. The Cambro-Ordovician aquifer underlies and is separated from the Devonian aquifer by thick shale (Wopsipinican Formation) and dolomite (Maquoket and Galena Formations) deposits. The Cambro-Ordovician aquifer is predominantly dolomite, but also contains two sandstone units--the St. Peter and the Jordan Formations. The latter occurs at a depth of approximately 1,500 feet and is a principal water-bearing zone in the vicinity of IAAP.

Lateral groundwater flow in the drift aquifer is strongly controlled by topography (USAEHA, 1985; Battelle, 1984; SCS, 1982). Predicted groundwater flow paths in this uppermost discontinuous aquifer are toward the creeks and are generally consistent with surface drainage patterns. Flow direction in the uppermost bedrock aquifer is more strongly influenced by the dip of the bedrock surface and the orientation of fractures, joints, and cracks in the formation. This

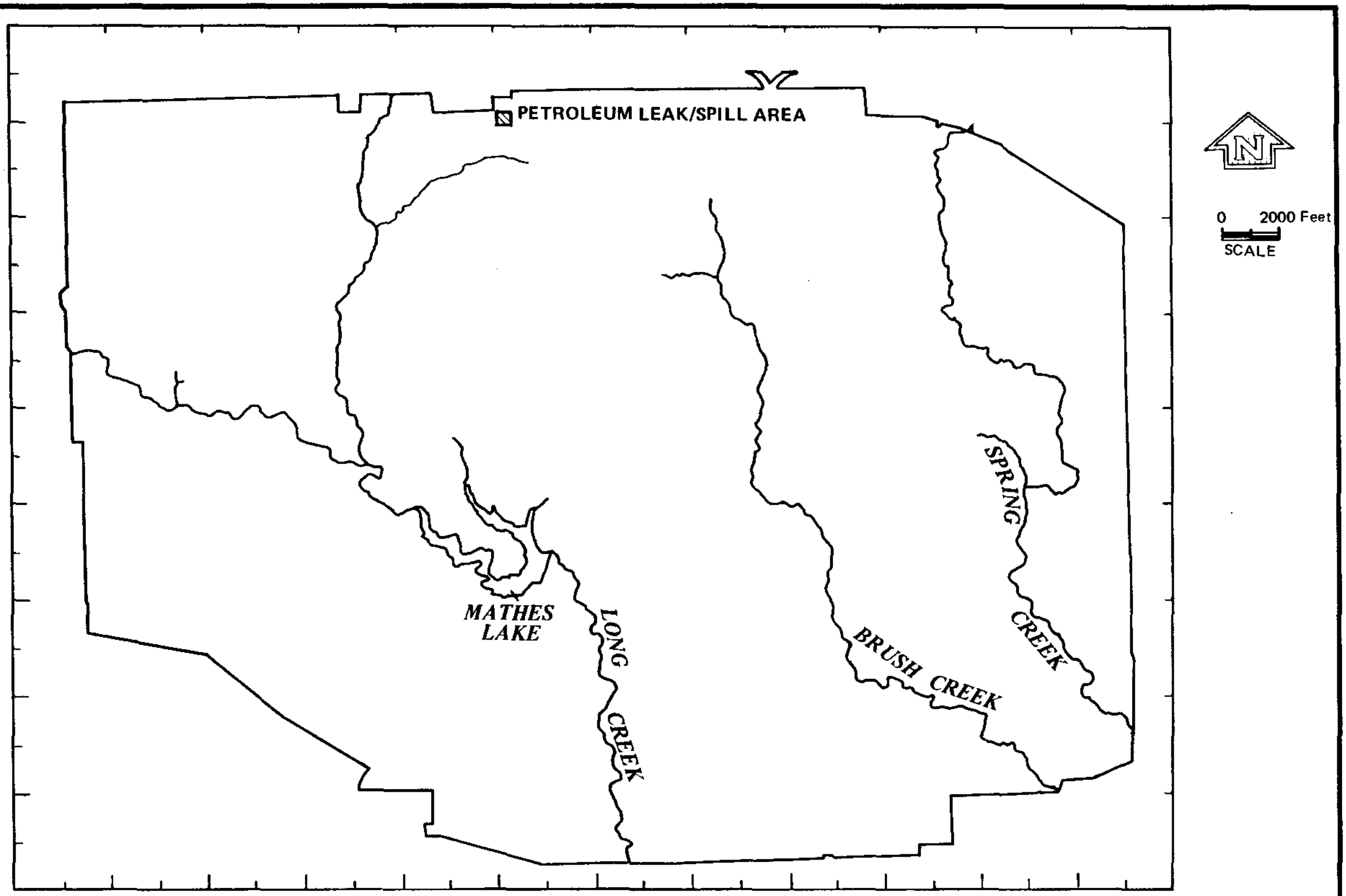


FIGURE 2-3
PRINCIPAL STREAMS AT IOWA ARMY AMMUNITION PLANT

would suggest that the groundwater in this aquifer flows generally south-southeast toward the Skunk and Mississippi Rivers.

Groundwater recharge to the uppermost aquifers is expected to occur in the broad, flat fields that lie between drainages. However, recharge is expected to be low due to the low vertical permeability of the soils. Groundwater discharge from the uppermost drift and bedrock aquifers is expected to occur at the major drainages around IAAP during the periods of high groundwater levels. This is evidenced by the observation of seeps along waterways during several of the field investigations conducted at IAAP (not related to the present study) and the artesian well conditions observed in three shallow/deep well pairs installed along Brush Creek.

Hydraulic conductivities of the unconsolidated aquifer have been measured using slug tests conducted during field investigations at other IAAP sites (SCS, 1982; ERG, 1982; Battelle, 1984). These measurements generally indicate values for conductivity on the order of 10^{-5} to 10^{-6} meters per second (m/sec). Conductivities of the bedrock aquifer have not been measured onsite or in the vicinity of the plant offsite. Fractures in the till or the bedrock could result in substantially higher secondary permeabilities in these two aquifers. Clear evidence of a well-developed system of bedrock fractures has not been observed during other site investigations conducted at IAAP.

2.2.4.2 Site-Specific. Soil excavation conducted at the PL/SA during tank removal, in November 1988, resulted in groundwater infiltration at a depth of approximately 16 feet. Dames & Moore measured the top of the water surface in the excavation on July 26, 1989. The depth to the water surface was approximately 6.5 feet. The detailed discussion of site-specific hydrology/hydrogeology is presented in Section 4.2.3.

3.0 TECHNICAL APPROACH FOR THE SAMPLING PROGRAM

The scope of the present investigation was determined by reviewing the results of the PACE (1988) study, presented in Appendix A, and Dames & Moore's initial site visit. The results of the PACE study and Dames & Moore's site visit are summarized below, followed by a discussion of the scope of the present investigation.

3.1 FINDINGS OF THE PACE SITE INVESTIGATION

The three USTs were removed on November 8 and 9, 1988, (Figure 3-1), and at this time field instruments were used to screen soil samples. These instruments were a Foxboro, Century 128 organic vapor analyzer (OVA) and a Foxboro, Century 88 OVA. All samples were analyzed by PACE by filling a 1-gallon zip-lock plastic bag with soil approximately one-third full, warming the sample, and inserting the OVA probe into the bag. Three composite soil samples collected from around the diesel tank and analyzed on November 8 had a range of 50 to 500 ppm total organic vapors. Soils excavated on November 9 from adjacent to the diesel tank smelled of hydrocarbons and were hauled to an asphalt parking lot that had been designated as a stockpile area at IAAP (PACE Laboratories, Inc., 1988).

The excavation was enlarged on November 10, and seven additional soil samples from the bottom of the excavation were collected and analyzed. A composite soil sample had a concentration of 250 ppm total organic vapors. The detailed results seemed to indicate that, while the soils immediately adjacent to the tanks were contaminated, over-excavation to the north and east resulted in rapidly decreasing concentrations (PACE Laboratories, Inc., 1988).

On November 15, 1988, additional soils were excavated from the south wall, and soil analyses indicated increasing contamination. At this time, it was discovered that--prior to installation of the three tanks of current concern (Figure 3-1)--two previously excavated 2,500-gallon underground gasoline tanks had been located approximately 8 feet north of the service station (PACE Laboratories, Inc., 1988).

On November 17, 1988, soils were excavated to within approximately 1 foot of the northern wall of the gas station building. Results of soil analyses ranged from 2,500 to 20,000 ppm total organic vapors. Groundwater began to flow into the center hole of the excavation, and a gasoline sheen was noted on the water surface (PACE Laboratories, Inc., 1988).

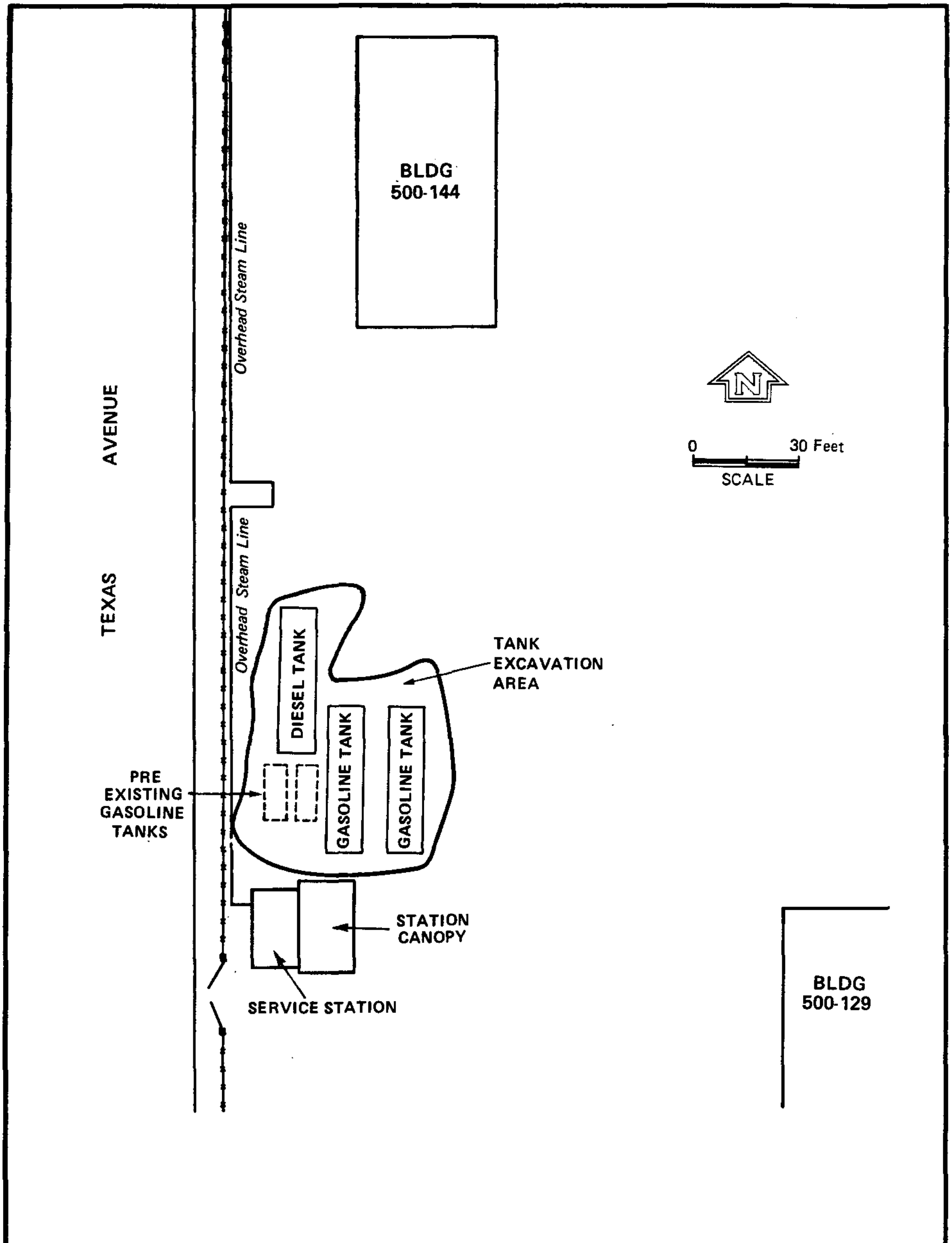


FIGURE 3-1
LOCATION OF EXCAVATED STORAGE TANKS

Subsequent to removal of the diesel tank, the two gasoline tanks, and the contaminated soil, IAAP personnel initiated a preliminary remedial program consisting of site monitoring for the potential occurrence of free-floating fuel within the open excavation, and pumping and treatment of contaminated groundwater. The site monitoring portion of the program has revealed that no free-floating fuel accumulated on the water within the open excavation.

The groundwater pumping and treatment portion of the preliminary mitigation program consisted of periodically pumping accumulated groundwater out of the excavation, and treatment to reduce the concentrations of potential fuel contaminants that may be present. The treatment process consisted of delivery of the pumped groundwater to a Corp of Engineers designed oil/water separator (no fuel has been collected because the influent to the oil/water separator has not contained visible free-floating fuel). To date, a total volume of approximately 96,000 gallons of groundwater has been pumped and treated in this fashion.

3.2 FINDINGS OF DAMES & MOORE'S INITIAL SITE VISIT

The following observations made during Dames & Moore's preliminary site visit (August, 1989) attest to the apparent effectiveness of the IAAP mitigation program:

- No fuel sheen was observed on water in the open excavation.
- No fuel odors were observed in the vicinity of the excavation.
- No discolored soil was observed around the perimeter of the excavation.
- Aquatic organisms (small fish, frogs, and insects) were living in the accumulated water in the excavation.

To develop a technical approach to the site investigation for soil and groundwater contamination at the PL/SA, Dames & Moore conducted a preliminary site visit and reviewed an existing site investigation report (PACE Laboratories, Inc., 1988), presented in Appendix A. Reports of investigations conducted at other sites at IAAP were also reviewed in preparation for the preliminary site visit (USATHAMA, 1980; SCS, 1982; ERG, 1982; Battelle, 1984; AEHA, 1985; Dames &

Moore, 1986; Dames & Moore, 1989). During the preliminary site visit on July 26-27, 1989, representatives of Dames & Moore and the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) met with representatives of IAAP to conduct a field survey of the PL/SA. Two drilling water samples were collected from the existing IAAP J-Yard well (to be used during future monitoring well construction), and one distilled water sample (from a distilled water sample source, to be used during future sampling activities) were collected for chemical analysis.

During the field survey, the following objectives were accomplished:

- Establish relative location of underground utilities to avoid during the drilling and soil gas investigations.
- Survey the excavation, buildings, and the steamline that surround the PL/SA to create a base map on which future work will be plotted.
- Locate an IAAP-operated oil/water separator and ascertain its suitability for disposal of potential excess drill water and groundwater generated during future monitoring well construction.
- Discuss with USATHAMA and IAAP personnel site mitigation activities conducted to date.

3.3 SCOPE OF DAMES & MOORE'S SITE INVESTIGATION

Based on Dames & Moore's review of the PACE report (1988) and the findings of Dames & Moore's initial site visit, a two-phased investigation program was recommended for the PL/SA:

- An initial soil gas survey to give a preliminary indication of the occurrence of volatile contamination and potential groundwater flow direction.
- Followup geotechnical work consisting of installation of soil borings and monitoring wells, and collection and analysis of samples of soil, groundwater, surface water, and sediment.

The scope of the soil gas survey is presented, followed by a discussion of the geotechnical and sampling programs.

3.3.1 Soil Gas Survey

The soil gas survey (Appendix B) was conducted by Tracer Research Corporation (TRC) on August 24, 1989, under the direction of Dames & Moore. The survey was conducted as an initial screening tool to identify the areas that may require additional investigation or remediation, and to assist in determining appropriate locations for future subsurface soil sampling and monitoring wells.

Figure 3-2 shows the area evaluated by the soil gas survey. This area was defined by initially taking soil gas samples on a 20-foot grid spacing from around the area of the excavated tanks. After review of these initial data, and with the concurrence of the Dames & Moore field geologist, TRC expanded the area of investigation to the south and southeast of the existing excavation--the area of soil gas contamination indicated by the initial soil gas samples. After the lateral extent of elevated soil gas readings was defined, the Dames & Moore field geologist directed TRC to fill in between data points in areas of high soil gas readings to provide additional detail. As a consequence of this procedure, a total of 56 soil gas samples were analyzed.

The service station building (approximately 300 square feet, excluding canopy and pump island) and piles of gravel to be used in the new tank installations (covering approximately 800 square feet) were areas where soil gas samples could not be taken. However, soil gas samples were taken from around the perimeter of the gas station building and the perimeter of the gravel piles.

The soil gas samples were collected by extracting soil gas from the subsurface, by vacuum, through a small-diameter hollow metal rod, which was pneumatically driven into the ground a distance of approximately 3 feet. Where necessary, approximately 1-inch-diameter holes were drilled through asphalt or concrete to provide access to the subsurface. All holes were repaired by filling with sand and gravel to within a few inches of the surface, and then filling the remainder of the hole with asphalt.

The soil gas samples were analyzed in the field at the time of sample collection, using a Varian Model 3300 gas chromatograph (GC), equipped with a flame ionization detector (FID). The FID facilitated the detection of aromatics--benzene, toluene, xylenes, ethylbenzene, and the C_1 through C_{10} aliphatics. Generally, individual hydrocarbons in the C_1 through C_{10} range may

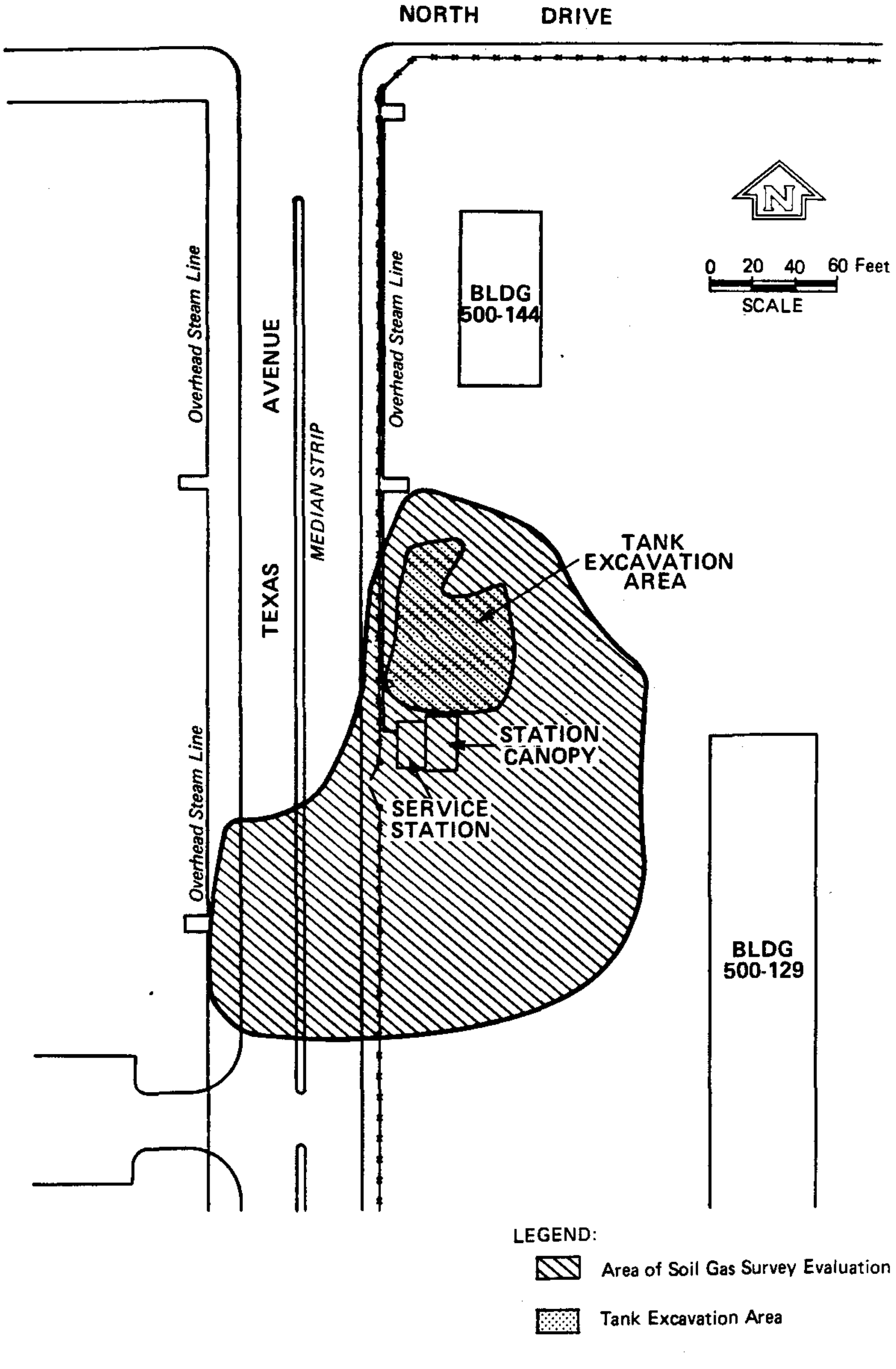


FIGURE 3-2
AREA ENCOMPASSED BY THE SOIL GAS SURVEY

not be present at high enough concentrations to be reported; however, the sum of the individual hydrocarbon concentrations is reported as total hydrocarbons (TH). TH is typically the most important parameter for detecting subsurface vapor related to hydrocarbon fuels.

Initially, carbon dioxide was also analyzed using colormetric tubes. Carbon dioxide can be a useful indirect indicator of hydrocarbon contamination because it is a byproduct of hydrocarbon biodegradation. However, a total of only 17 samples were analyzed for carbon dioxide at this site, because carbon dioxide did not appear to be a useful parameter for defining the limits of soil contamination. The lack of consistently elevated carbon dioxide concentrations in areas of known hydrocarbon contamination suggests several possibilities concerning hydrocarbon degradation at this site:

- Possibly, only limited hydrocarbon degradation is occurring due to less than optimal conditions, (eg. low oxygen/nutrient levels), thus producing only low concentrations of carbon dioxide.
- Hydrocarbon degradation may be occurring, but complete conversion to end products (carbon dioxide and water) is not occurring.
- The rate of generation of carbon dioxide is too low for appreciable concentrations of carbon dioxide to accumulate with the shallow subsurface.

Regardless of the reason why elevated concentrations of carbon dioxide were not detected, the lack of correlation between carbon dioxide concentrations and hydrocarbon concentrations indicated that at this site, carbon dioxide was not a useful parameter for assessing the extent of shallow subsurface soil contamination. The findings of this soil gas survey are presented in Section 4.1.

3.3.1.1 Soil Borings. The scope of the drilling and soil sampling program is summarized in Tables 3-1 and 3-2. This scope was defined based on the results of the PACE (1988) site investigation (see Section 3.1), the Dames & Moore initial site visit (see Section 3.2), and the soil gas survey (see Section 3.3.1). All geotechnical activities were conducted in accordance with the USATHAMA "Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports, March 1987."

TABLE 3-1

Location and Justification for Borings/Wells

Wells	Borings	Depth (feet)	Location	Rationale
DM-1		20	Service station well cluster	Locations immediately downgradient of highest soil gas readings to detect possible downward migration of contaminants and potential free product
DM-2		35	Service station well cluster	
DM-3		55	Service station well cluster	
DM-4		20	Downgradient well cluster	Precise locations were determined after the installation of wells DM-8, and DM-9, and borings D-11 and DM-14, and an assessment of the groundwater flow direction was made based on water table elevations
DM-5		35	Downgradient well cluster	
DM-6		55	Downgradient well cluster	
DM-7		20	Upgradient of excavation	To measure background groundwater quality and elevation
DM-8		20	East of soil gas plume	To assess groundwater conditions near the eastern limit of the soil gas plume
DM-9		20	West of soil gas plume	To assess groundwater conditions near the western limit of the soil gas plume
DM-10		20	Farthest downgradient well	To locate downgradient limit of suspected groundwater plume
	DM-11	20	Area of highest confirmed soil gas concentration	To evaluate the potential occurrence of free hydrocarbons
	DM-12	20	Area of soil gas nondetects east of the service station	To assess the reliability of soil gas nondetects adjacent of excavation

TABLE 3-1 (cont'd)

Wells	Borings	Depth (feet)	Location	Rationale
	DM-13	20	Area of soil gas detects in the range of 0.1 to 100 ppb	To document the reliability of soil gas results adjacent to excavation
	DM-14	20	Area of soil gas detects in the range of 0.1 to 100 ppb	To document the reliability of soil gas results adjacent to excavation

TABLE 3-2

Summary of Soil Boring/ Sampling and Well Installation Program

Boring No.	Conversion to 4-Inch PVC Well?	Depth (feet)	Split-Spoon Sampling Depths (feet)[a]	Total Soil Samples	Samples Submitted for Chemical Analysis	Screen Length (feet)
DM-1	Yes	20	2.5, 5, 7.5, 10, 15,	5	3	10
DM-2	Yes[b]	35	25, 30, 35[c]	3	3	5
DM-3	Yes[b]	55	25, 30, 35, 40, 45, 50, 55[c]	7	7	5
DM-4	Yes	20	2.5, 5, 7.5, 10, 15,	5	3	10
DM-5	Yes[b]	35	25, 30, 35[c]	3	0	5
DM-6	Yes[b]	55	25, 30, 35, 40, 45, 50, 55[c]	7	0	5
DM-7[d]	Yes	20	2.5, 5, 7.5, 10,	5	0	10
DM-8	Yes	20	2.5, 5, 7.5, 10, 15,	5	3	10
DM-9	Yes	20	2.5, 5, 7.5, 10, 15,	5	2	10
DM-10[e]	Yes	20	2.5, 5, 7.5, 10,	5	0	10
DM-11	No	20	2.5, 5, 7.5, 10, 15, 20	6	2	NA
DM-12	No	20	2.5, 5, 7.5, 10, 15, 20	6	3	NA
DM-13	No	20	2.5, 5, 7.5, 10, 15, 20	6	3	NA
DM-14	No	20	2.5, 5, 7.5, 10, 15, 20	6	3	NA
				74	32	

---

[a] Underlined split-spoon sample depths represent soil samples submitted for chemical analysis.

[b] Well double-cased in accordance with USATHAMA geotechnical requirements to minimize the potential for subsurface contamination or cross-contamination (USATHAMA, 1987; Paragraph IIIA1a1).

[c] Soil sampling above 20-foot depth not possible because the first 20 feet of the boring will be drilled using a 16-inch diameter solid-stem auger which does not facilitate split-spoon sampling.

[d] Background well.

[e] More distant, downgradient well.

The drilling of eight 20-foot-deep borings (DM-1, DM-4, DM-8, DM-9, DM-11, DM-12, DM-13, And DM-14) and the collection of soil samples from these borings for chemical analysis were undertaken to assess the areal and vertical extent of potential soil contamination. Locations of these borings are shown in Figure 3-3. The rationale for these boring locations is summarized in Table 3 -1. Four of these borings (DM-1, DM-4, DM-8, and DM-9) were completed as monitoring wells. The other four borings (DM-11 thru DM-14) were grouted to the surface.

Soil samples for chemical analysis were collected, using a split-spoon sampler, from depths of 2.5, 5, and 7.5 feet from borings DM-1, DM-4, DM-8, DM-9 (excluding the 7.5-foot depth from DM-9 because of insufficient soil recovery) and DM-11 through DM-14 (excluding the 2.5-foot sample depth from boring DM-11 because of insufficient soil recovery) to assess the vertical extent of potential soil contamination. Most of these samples were taken at or above the top of the water table. However, because of suspected contamination in the area of DM-1 (indicated by photoionization detector values as high as 10,000 ppm in split spoon soil samples, see boring logs in Appendix C) additional samples for chemical analysis were taken from the following nearby wells/depths: DM-2: 25, 30 and 35 feet; DM-3: 25, 30, 35, 40, 45, 50, and 55 feet.

Fifteen percent of the soil samples listed in Table 3-2 (i.e., 12 samples) were submitted for physical analysis to better describe the subsurface materials. Samples which were submitted for physical analysis were samples from the 2.5-, 5-, 7.5-, and 10-foot depths, from borings DM-7 and DM-10; and samples from the 25, 30-, 35-, and 40-foot depths from boring DM-6. Tests included Atterberg limits, sieve grain size distribution, and assignment of Unified Soil Classification System (USCS) symbols (see Appendix D).

In addition to illustrating the boring/well locations, Figure 3-3 also illustrates the locations of buildings that immediately border the site to the north and east. Building 500-129 houses the motor pool. Activities conducted here includes tune-ups, oil changes, and brake and minor engine repairs. Building 500-144 houses the auxiliary heating plant, which uses a No. 6 fuel oil fired burner. This heating plant is only used during unusually cold weather when the capacity of the regular heating plant is exceeded. The surface fuel oil storage tank for the auxiliary heating plant is located 200 feet east of the plant.

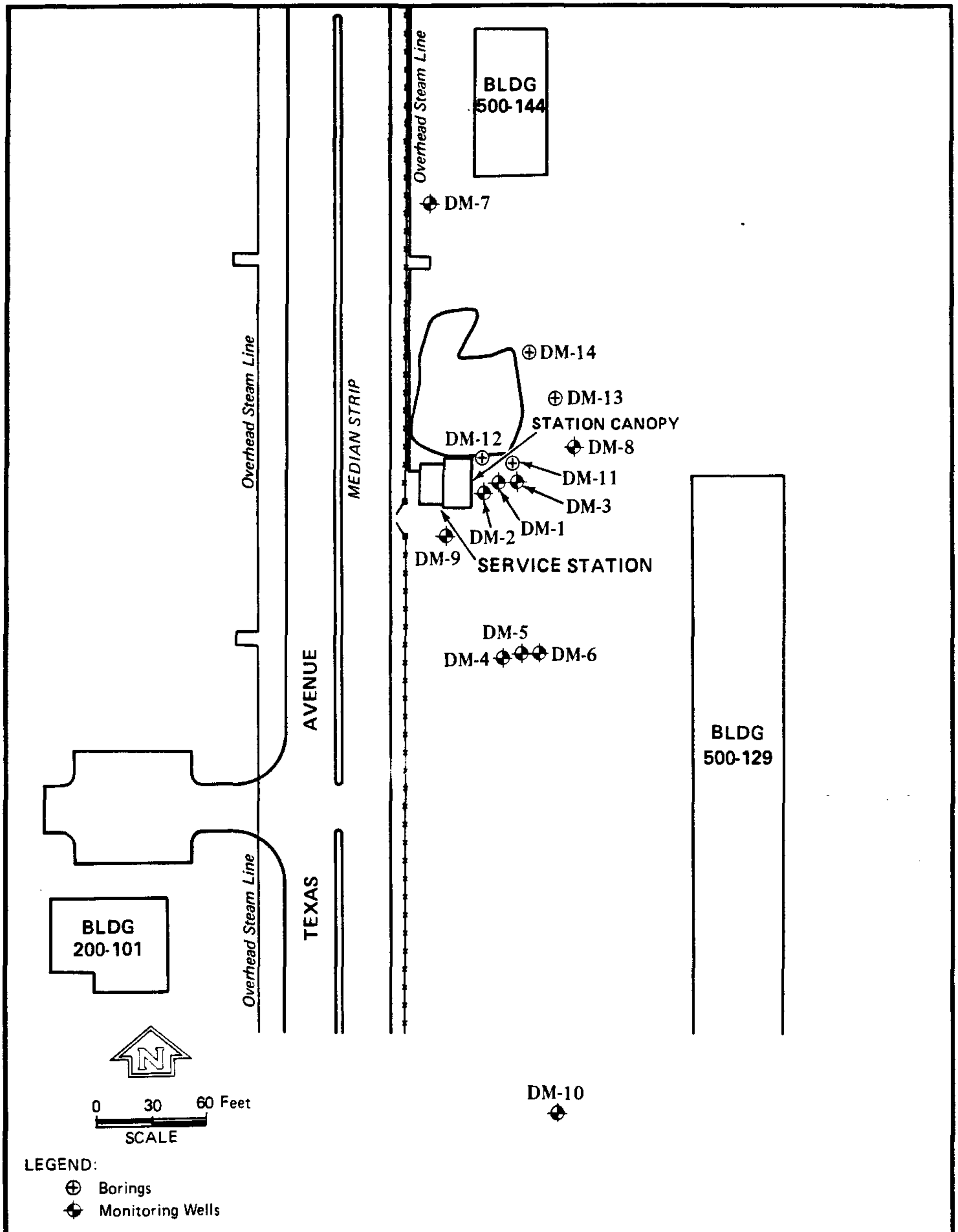


FIGURE 3-3
BORING AND MONITORING WELL LOCATIONS

3.3.1.2 Monitoring Wells. Four of the soil borings (DM-1, DM-4, DM-8, DM-9) were converted to shallow 4-inch-diameter PVC monitoring wells (Figure 3-4). The purpose of these water table wells was to determine water levels for groundwater contouring, to evaluate the areal extent of the dissolved contaminant plume, and to evaluate the potential occurrence of a free-floating product layer on the shallow groundwater table. Two additional shallow (20-foot-deep) water table wells (DM-7 and DM-10) were also installed (Figure 3-3)--one is a background well, and the other was installed far enough downgradient to assess the downgradient limit of a potential plume.

Four deeper 4-inch PVC wells (DM-2, DM-3, DM-5, and DM-6) were installed in order to assess the vertical extent of the potential plume. Wells DM-2 and DM-3 were installed approximately 10 feet to the southwest and 10 feet east of well DM-1, respectively. Potential groundwater contaminant concentrations were suspected to vary in the vertical direction at the PL/SA because of the probable occurrence of interbedded, high clay content strata. These well clusters facilitate discrete measurement of hydraulic heads and contaminant concentrations, while avoiding potential cross-contamination problems typically associated with single, fully penetrating monitoring wells. Well construction diagrams are presented in Appendix E.

The depths of wells DM-1, DM-2, and DM-3 are 15, 35, and 55 feet, respectively. Likewise, a second cluster consists of wells DM-4, DM-5, and DM-6, with depths of 15, 35, and 54 feet respectively.

The first well cluster (DM-1, DM-2, and DM-3) is located immediately downgradient of the contaminated groundwater, as indicated by the soil gas survey, and the second well cluster is located further downgradient (Figure 3-3). The precise location of the second cluster was determined after the shallow groundwater gradient was defined to ensure that the second cluster was in the downgradient location. This gradient definition was made using water levels from monitoring wells DM-8 and DM-9 and borings DM-11 and DM-14. Table 3-1 summarizes the rationale for the selected monitoring well locations.

All borings were installed using hollow-stem augers and all wells are 4-inch PVC. Drill cuttings were stockpiled onsite at a location designated by IAAP personnel.

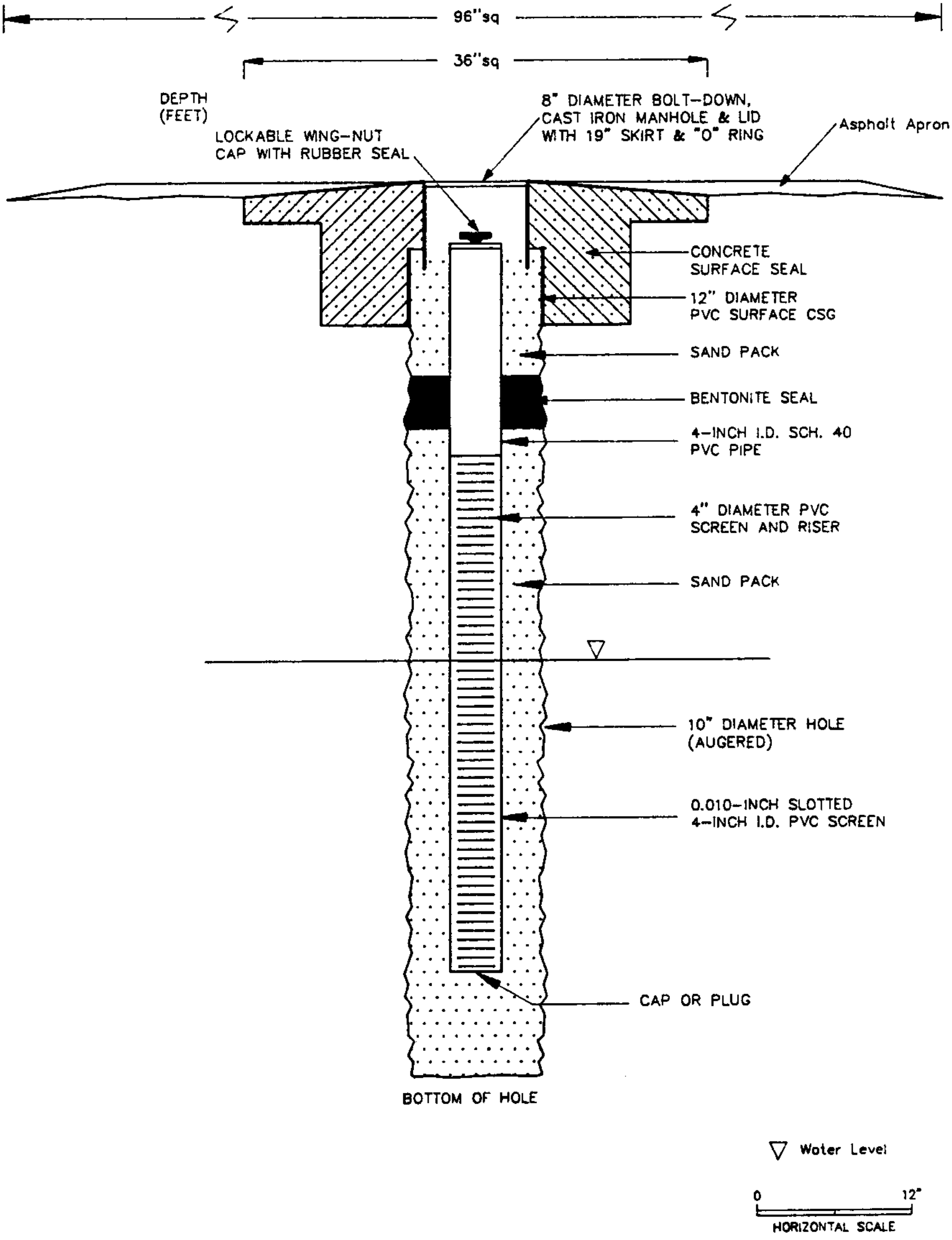


FIGURE 3-4

MONITORING WELL INSTALLATION DIAGRAM, SHALLOW WELLS

The four deeper wells in the two clusters were installed as follows (see Figure 3-5:

- A 16-inch hole was drilled to 20 feet using an auger.
- A 12-inch steel surface casing was set to 20.5 feet in the hole.
- The 2-inch annular spacing between the 16-inch hole and 12-inch casing was grouted. The casing was firmly seated before grouting, and there was no grout leakage inside the casing.
- Grout was allowed to set for a minimum of 24 hours.
- A 6 1/4-inch ID, 10-inch OD hollow-stem auger, was used to drill the hole to its completion depth inside the 12-inch casing.
- PVC casing and screen were set inside the auger, and the well installation was completed in accordance with USATHAMA (USATHAMA, 1987) requirements.

A Dames & Moore geologist supervised the drilling of each borehole and maintained continuous detailed subsurface logs by examining drill cuttings, recording samples, and noting groundwater levels when first encountered and just before abandoning each borehole by grouting. In addition, a daily field log included such information as the progress of drilling operations, problems encountered, and sampling procedures. All original boring logs and field notes were submitted to USATHAMA according to its requirements (USATHAMA, 1987). Copies of all boring logs were submitted to IAAP.

All drilling equipment was steam-cleaned prior to arrival onsite, in accordance with the USATHAMA geotechnical requirements (USATHAMA, 1987). Additionally, all sampling equipment, downhole drilling equipment (such as augers and drill rods), and any parts of the drill rig that potentially had contact with contaminants were decontaminated in accordance with USATHAMA requirements after the drilling of each boring. The equipment was decontaminated by steam cleaning at a steam temperature of 220°F and pressure of 1,000 pounds per square inch (psi).

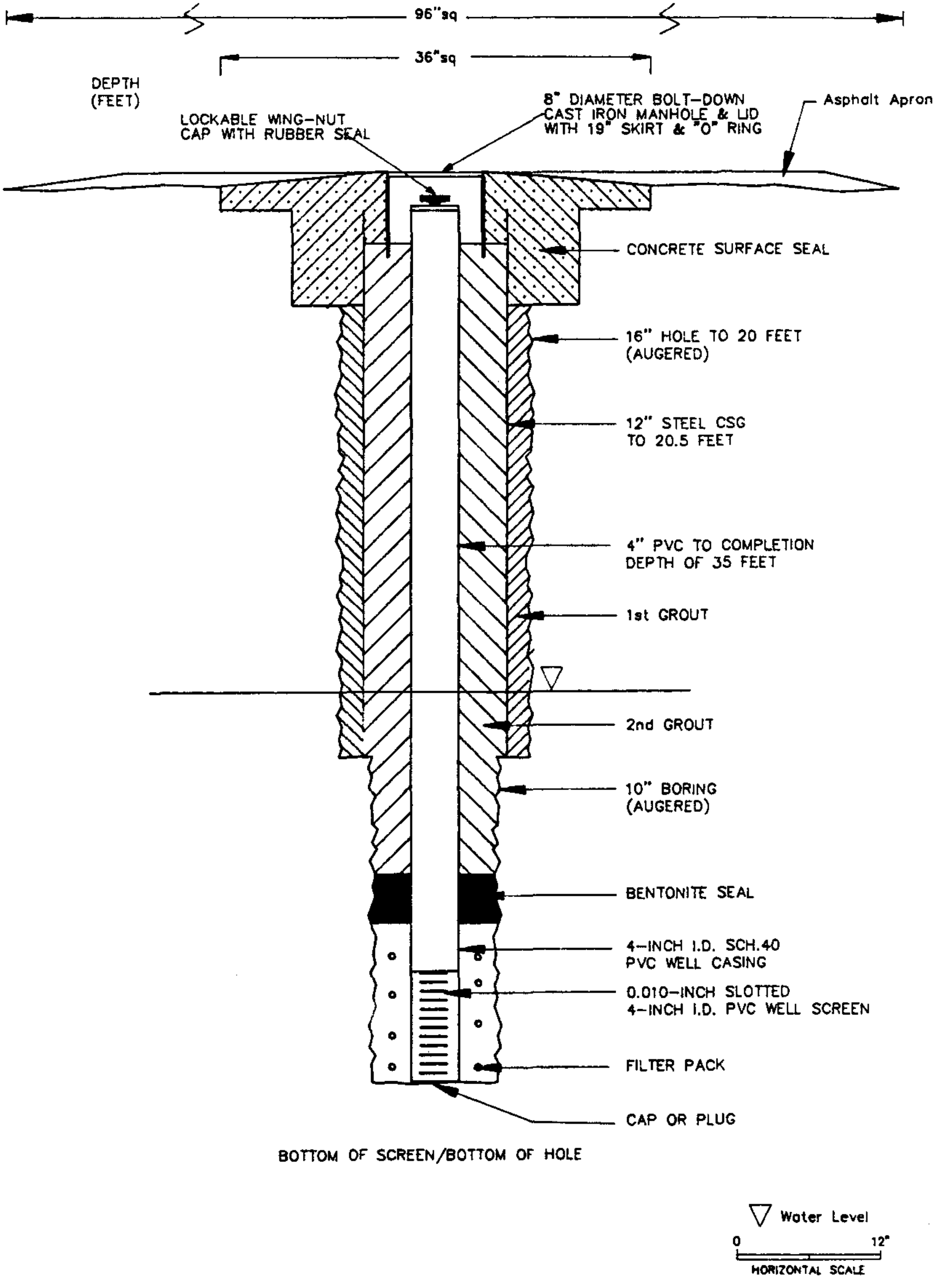


FIGURE 3-5
MONITORING WELL INSTALLATION DIAGRAM
FOR 35 AND 55-FOOT-DEEP CLUSTER WELLS

3.3.2 Chemical Analysis Program

The scope of the chemical analysis program is summarized in Table 3-3, which documents the types and number of environmental samples, and the analytical parameters and test methods employed. All environmental sampling and chemical analyses were conducted in accordance with the USATHAMA Quality Assurance Program (2nd Edition, March 1987). The chemical analyses of the environmental samples were performed by metaTRACE Laboratories using USATHAMA-certified test methods when available. All samples were analyzed for purgeable aromatics (benzene, toluene, total xylenes, and ethylbenzene), lead, and total petroleum hydrocarbons (TPH) when possible. The rationale for each analysis is as follows:

Proposed Analytical Parameter (s)	Rationale
Purgeable aromatics--benzene, toluene, total xylenes, and ethylbenzene only	Evaluate concentrations of volatile fuel components with potential human health risks
Lead	Evaluate potential contamination by leaded fuels
TPH	Determine total fuel concentrations

3.3.2.1 Groundwater. One groundwater sample was collected from each of the 10 monitoring wells. Samples analyzed for lead were filtered in the field.

No groundwater samples contained free-floating product as determined by visual inspection. In fact, the only well suspected of have free-floating product, DM-1, was checked with "Kolor Kut" gasoline gauging paste prior to purging the well. No hydrocarbons were detected. This paste was spread on a gauge rod at the liquid level location, and the rod was lowered into the well until the paste came into contact with the water table. The paste changes color if free phase hydrocarbons are present.

The waiting time between development of the newly installed monitoring wells and groundwater sampling was at least 7 days. USATHAMA granted this waiver from 14 to 7 days for this task only, with the stipulation that groundwater measurements of temperature, pH, and conductivity show evidence of equilibrium, prior to groundwater sampling. Table 3-4 presents the values for these

TABLE 3-3

Summary of the Analytical Program for the PL/SA Site Investigation

	Number of Samples						
Parameter	Groundwater	Surface Water	Sediment	Soil	Drilling[b] Water	Rinse[b] Water	Total
Purgeable aromatics[a]	10	1	3	32	2	2	50
Lead	10	1	3	32	2	2	50
TPH	10	1	3	32	2	2	50

---

[a] Includes benzene, toluene, total xylenes, and ethylbenzene.

[b] Two drilling water samples and one rinse water sample were collected during the initial site reconnaissance (July 26-27, 1989). Holding times were exceeded; therefore, resampling was conducted during the field program, as per USATHAMA approval. A second rinse water sample was also collected during the field program, as planned.

TABLE 3-4

Groundwater Chemistry Indicators, Well DM-4

Date	pH	Conductivity	Temperature
10/16/89[a]	7.13	837	17.1
10/16/89[b]	6.58	838	17.4
10/16/89[c]	6.54	850	17.2
10/17/89	6.28	777	18.5
10/24/89	6.55	857	19.2
10/26/89	6.81	873	19.5

---

[a] Before well development.

[b] During well development.

[c] After well development.

parameters, measured in monitoring well DM-4. For all three water chemistry indicators (pH, conductivity and temperature) the measured values show no obvious trend with time after well installation. Instead these values stay relatively constant, with minor fluctuations up or down, indicating equilibration.

Water and wastewater from well purging and equipment decontamination were collected and disposed of in the IAAP Corp of Engineers designed oil/water separator when evidence of contamination was present.

3.3.2.2 Soil. A total of 32 soil samples were taken from split-spoons and submitted for chemical analysis to metaTRACE Laboratories. These split-spoon samples were taken from the following 10 borings: two soil samples from DM-9 and DM-11; three soil samples from DM-1, DM-2, DM-4, DM-8, DM-12, DM-13, and DM-14; and seven soil samples from DM-3 (see Table 3-2). The analytical parameters were the same as those previously summarized in Table 3-3.

3.3.2.3 Surface Water and Sediment. One sediment sample was collected from each of three locations along the tributary to Long Creek, southwest of the site (Figure 3-6). Only one surface water sample was collected (SW-3), because the other sample locations were dry at the time of sampling. This tributary to Long Creek is in the suspected downgradient, shallow groundwater flow direction from the PL/SA. The three sediment samples (upgradient, intermediate, and downgradient) and one surface water sample are intended to document any impact of the fuel leak/spill to this tributary. The surface water sample that was analyzed for lead was not filtered.

3.3.2.4 Drilling Water/Rinse Water. Two groundwater samples from an existing water supply well at IAAP (J-Yard well) were sampled during the initial site visit (August 1989). The two drilling water samples were analyzed in separate lots, for the parameters summarized in Table 3-3. Also, one distilled water sample from a local retail source was sampled and analyzed concurrently with the J-Yard well samples.

The holding time was exceeded for purgeable aromatics. Consequently, the J-Yard well was resampled at the start of the field program and analyzed, in separate lots, for a second time for purgeable aromatics. One distilled water sample was analyzed for purgeable aromatics a second time.

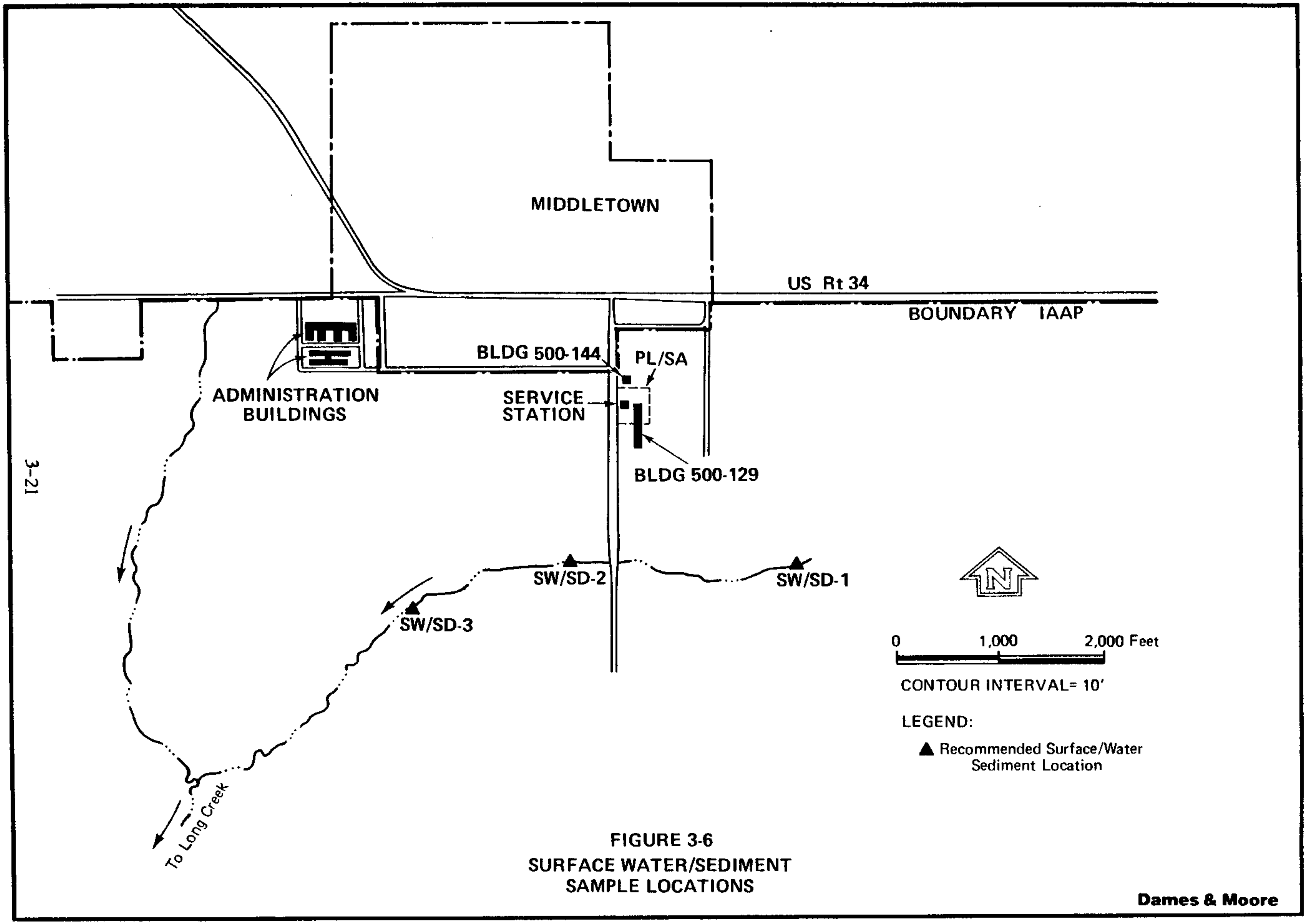


FIGURE 3-6
SURFACE WATER/SEDIMENT
SAMPLE LOCATIONS

Dames & Moore

A second distilled water equipment rinse sample was analyzed, in a lot separate from the first distilled water sample, for the parameters summarized in Table 3-3. Holding times were met for the reanalysis of the two drilling water samples, the first distilled water sample, and the first and only analysis of the second distilled water rinse sample.

4.0 FINDINGS

This section presents the findings of the soil gas survey, the geotechnical investigation, and the chemical analysis program.

4.1 SOIL GAS SURVEY RESULTS

Four of 56 soil gas sample locations had TH values greater than 10,000 ppb. Based on experience with similar sites, TRC reported that TH concentrations in excess of 10,000 ppb may be indicative of free fuel, either absorbed to soil or floating on the water table. All four locations are south of the excavation and east of the service station building, as illustrated in Figure 4-1. TH concentrations range from below detection (0.07 ppb) to 280,000 ppb (Appendix B). Figure 3 in Appendix B presents a more complete summary of the TH results.

Three of 56 soil gas sample locations had benzene values greater than 10,000 ppb. All of these locations are roughly coincident with the area of elevated TH concentrations, as illustrated in Figure 4-2. Benzene concentrations range from below detection (0.01 ppb) to 66,000 ppb (Appendix B). Figure 2 in Appendix B presents a more complete summary of the benzene results.

One of 56 soil gas sample locations had toluene concentrations greater than 10,000 ppb. The location of the sample is coincident with the area of elevated TH concentrations. Toluene concentrations ranged from below detection (0.01 ppb) to 22,000 ppb (Appendix B). Insufficient toluene was detected to facilitate contouring.

No ethylbenzene concentrations were greater than 10,000 ppb. Ethylbenzene values ranged from below detection (0.02 ppb) to 210 ppb (Appendix B). Xylene was detected in only one sample, slightly in excess of the detection limit.

After review of these results, TH, benzene, and--to a lesser extent--toluene appear to be the best indicators of subsurface contamination, as evidenced by the greater number of positive detections for these analytes, and because the locations of the detections are similar for the three compounds. Based on these three analytes, the predominant area of soil gas contamination (approximately 3,200 square feet) is to the south and southeast of the tank excavation area and east of the service station building, as illustrated in Figures 2 and 3, Appendix B. The hydrocarbon soil gas plume is approximately 100 feet wide and appears to extend approximately 100 to 200 feet south of the southeastern corner of the excavation.

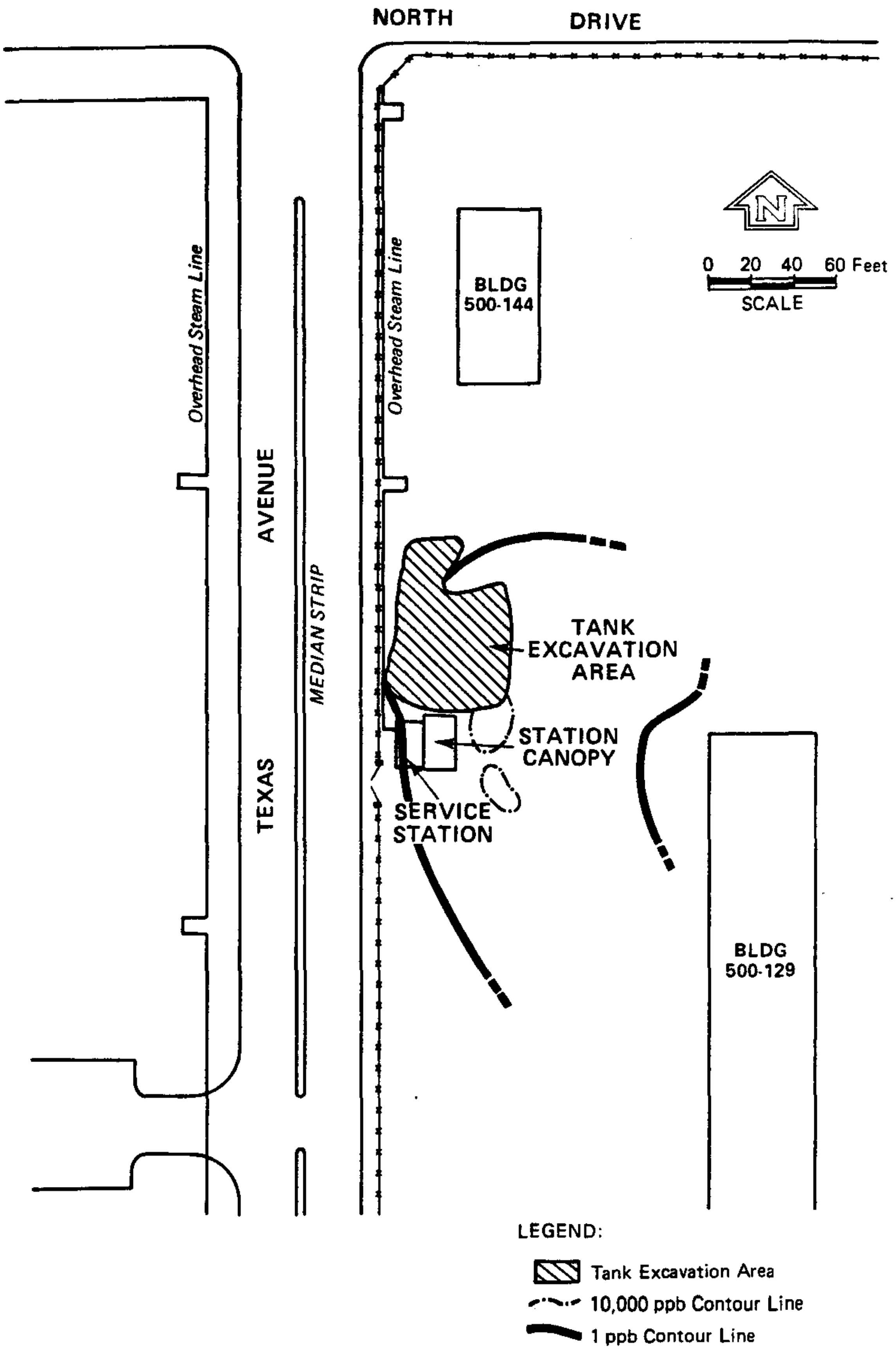


FIGURE 4-1
SUMMARY OF TOTAL HYDROCARBON RESULTS

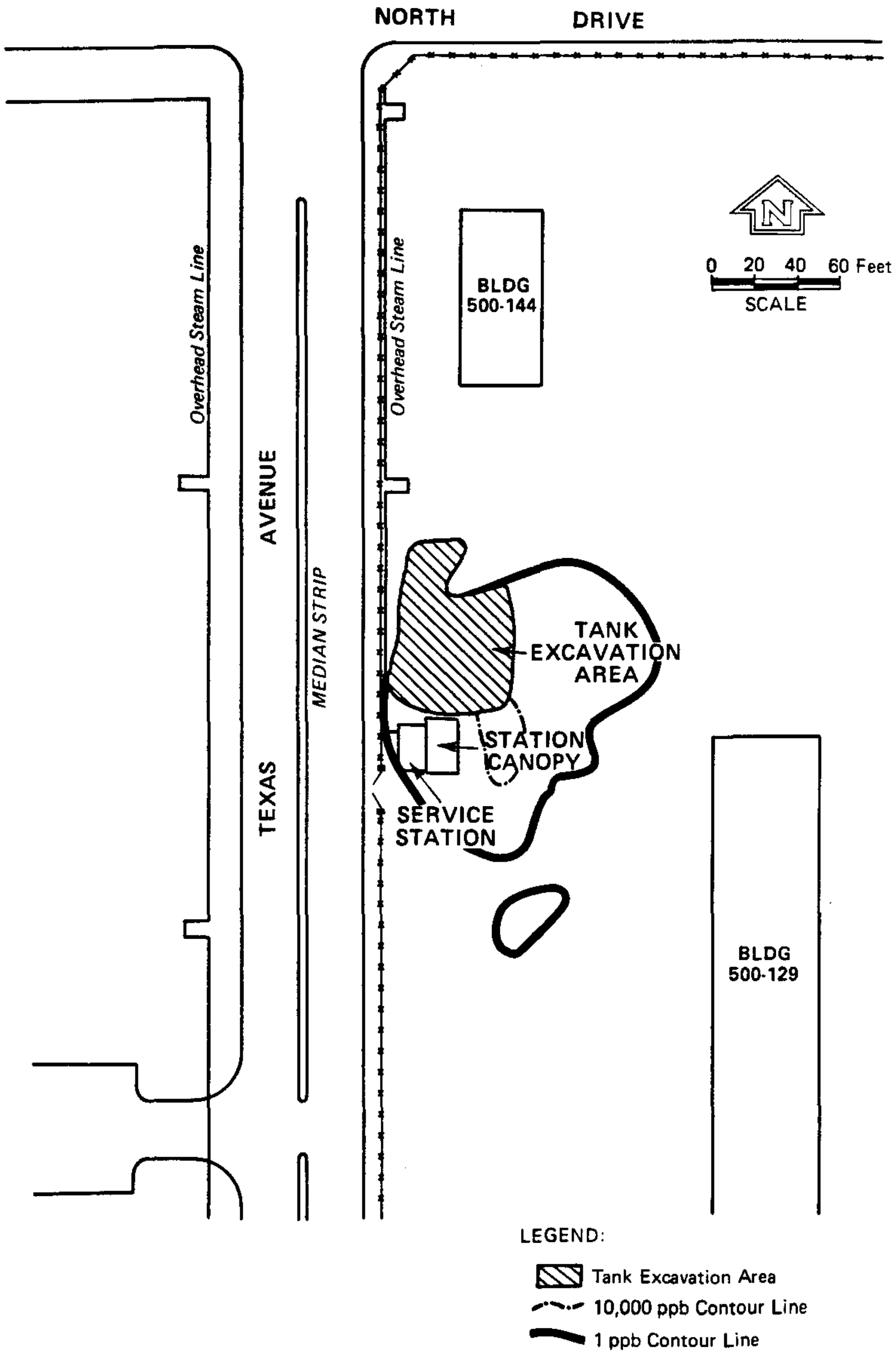


FIGURE 4-2
SUMMARY OF BENZENE RESULTS

In contrast to the soil analysis results from PACE Laboratories (Appendix A), TRC did not find high soil gas readings between the service station building and the excavation. These nondetects/low detects could have been caused by a number of circumstances, such as:

- The intake of surface air from the side of the excavation during soil gas sampling.
- Decreases in soil gas contaminant concentrations in response to natural venting, which may have occurred between the time of the PACE and TRC surveys.

4.1.1 Summary

Based on the soil gas analyses for TH, benzene, and toluene, an approximate 100-foot-wide hydrocarbon soil gas plume appears to extend approximately 100 to 200 feet south of the southeast corner of the excavation. The soil gas concentrations in excess of 10,000 ppb may indicate the presence of free product occurring as residue in the soil or floating on the water table. The area encompassed by the 10,000 ppb contour (Figures 3-3 and 3-4) is approximately 20 feet wide and 40 feet long, and is located south of the excavation and 25 feet east of the station pump island. Inasmuch as most of the area surrounding the excavation generally does not exhibit elevated hydrocarbon concentrations, it appears to be relatively uncontaminated. This finding is in agreement with reports that none of the USTs recently removed from this excavation were leaking.

The area of elevated soil gas contamination possibly represents southward migration of contamination derived from the excavation, or contamination derived from underground fuel pipelines, if such pipelines are present this far east (approximately 25 feet) of the service station pump island. Soil gas samples from the immediate vicinity of the pump islands did not exhibit contaminant concentrations as high as soil gas samples collected from the area further to the east. The lower soil gas concentrations suggest that underground fuel lines associated with the pump island may not be the dominant source of the observed soil gas contamination.

A verbal report to IAAP by the Iowa Department of Natural Resources indicating that installation of the new replacement fuel storage tanks could proceed is supported by the current soil gas survey results, which indicate that the bulk of the subsurface soil gas contamination is located south of the excavation. The soil gas survey results appear to indicate that remedial activities conducted to date by IAAP and PACE Laboratories, Inc. have been effective in significantly reducing the occurrence of hydrocarbon contamination throughout the area of the open excavation. The potential occurrence of free product and groundwater contamination east and south of the station indicates the need to continue site monitoring via the installation of monitoring wells and soil borings.

4.2 GEOTECHNICAL RESULTS

The following discussion of the geotechnical results addresses: 1) physical observations of chemical contamination, 2) stratigraphy, and 3) groundwater occurrence.

4.2.1 Physical Observations of Chemical Contamination

This section describes physical observations of chemical contamination made in the field while drilling and sampling. The results of laboratory chemical analysis are presented in Section 4.3. Observations made in the field include odor, visible discoloration of soil or water, oily sheen or texture, and photoionization detector (PID) readings.

Evidence of hydrocarbons was obvious in five borings--DM-1, DM-2, DM-3, DM-11, and DM-12. A gasoline odor was apparent during drilling of the first 10 to 15 feet of these borings. Although no hydrocarbon staining was identified on any soil samples, some split-spoon soil samples emitted vapors which gave Photoionization detection readings as high as 10,000 ppm. In general, these high PID readings were from soil samples taken at or above the top of the water table, between depths of 2 and 10 feet, in borings DM-1, DM-11, and DM-12, as summarized in Table 4-1. PID readings less than 10 ppm were recorded for split-spoon samples taken below the steel casing (0.5 to 20.5 feet) in borings DM-2 and DM-3. All of these borings, which emitted a gasoline odor during drilling are located in areas identified by TRC as having high soil gas readings (see Figures 4-1 and 4-2 and Figures 1, 2, and 3 in Appendix A). No free-floating fuel was observed at the site.

TABLE 4-1

Physical Observations Of Chemical Contamination

Boring	Depth (feet) (a)	Noticable Odor During Drilling	Visible Soil Discoloration	Groundwater Sheen	PID (ppm)
DM-1	2.5-4.5	Yes	No	No	3,700
	5-7	Yes	No	No	10,000
	7.5-9.5	Yes	No	No	3,200
	10-12	No	No	No	0
	15-17	No	No	No	0
DM-2	0-10	Yes	No	No	0
	25-27	No	No	No	0
	30-32	No	No	No	0
	35-37	No	No	No	0
DM-3	0-10	Yes	No	No	0
	25-27	No	No	No	0
	30-32	No	No	No	8
	35-37	No	No	No	1
	40-42	No	No	No	5
	45-47	No	No	No	0
	50-52	No	No	No	0
	55-57	No	No	No	0
DM-4	2.5-4.5	No	No	No	7
	5-7	No	No	No	0
	7.5-9.5	No	No	No	0
	10-12	No	No	No	0
	15-17	No	No	No	0
DM-5	25-27	No	No	No	0
	30-32	No	No	No	0
	35-27	No	No	No	(b)
DM-6	25-27	No	No	No	0
	30-32	No	No	No	0
	35-37	No	No	No	(b)
	40-42	No	No	No	0
	45-47	No	No	No	(b)
	50-52	No	No	No	0
	55-57	No	No	No	(b)
DM-7	2.5-4.5	No	No	No	25
	5-7	No	No	No	0
	7.5-9.5	No	No	No	0
	10-12	No	No	No	0
	15-17	No	No	No	0

TABLE 4-1 (cont'd)

Boring	Depth (feet) (a)	Noticeable Odor During Drilling	Visible Soil Discoloration	Groundwater Sheen	PID (ppm)
DM-8	2.5-4.5	No	No	No	0
	5-7	No	No	No	0
	7.5-9.5	No	No	No	0
	10-12	No	No	No	0
	15-17	No	No	No	0
DM-9	2.5-4.5	No	No	No	0
	57	No	No	No	0
	10-12	No	No	No	0
	15-17	No	No	No	0
DM-10	2.5-4.5	No	No	No	(b)
	5-7	No	No	No	(b)
	7.5-9.5	No	No	No	(b)
	10-12	No	No	No	(b)
	15-17	No	No	No	(b)
DM-11	5-7	Yes	No	No	9,750
	7.5-9.5	Yes	No	No	6,130
	10-12	No	No	No	0
	15-17	No	No	No	0
	20-22	No	No	No	0
DM-12	2.5-4.5	Yes	No	No	650
	5-7	Yes	No	No	3,300
	7.5-9.5	Yes	No	No	10,000
	10-12	No	No	No	22
	15-17	No	No	No	135
	20-22	No	No	No	20
DM-13	2.5-4.5	No	No	No	0
	5-7	No	No	No	0
	7.5-9.5	No	No	No	0
	10-12	No	No	No	0
	15-17	No	No	No	0
	20-22	No	No	No	0
DM-14	2.5-4.5	No	No	No	0
	5-7	No	No	No	0
	7.5-9.5	No	No	No	0
	10-12	No	No	No	0
	15-17	No	No	No	0
	20-22	No	No	No	0

(a) Depth refers to a split-spoon sample depth or depth of cuttings.
(b) Not monitored with a PID meter.

4.2.2 Stratigraphy

Only two types of deposits were encountered during drilling at the PL/SA--loess and glacial till (see the boring logs in Appendix C). The loess at this location is predominantely clay with minor amounts of silt, and trace amounts of sand. The glacial till is also predominantely clay with minor to trace amounts of silt, sand and fine gravel.

The sieve analyses for split-spoon samples taken from borings DM-7 and DM-10 at depths of 2.5, 5.0, 7.5, and 10.0 feet, and boring DM-6 at depths of 25, 30, 35, and 40 feet are presented in Appendix D. The lithologic differences between the loess and the glacial till are notable. Sieve analyses for DM-7 and DM-10 at depths of 2.5, 5.0, and 7.5 feet (loess) are 97 percent or greater silt and clay. The sieve analyses for the 10- to 12-foot depth interval for the same borings show greater than 14 percent sand or fine gravel. Clearly, the formation boundary between the loess and glacial till is between 8 and 10 feet, at these two borings. The sieve analyses for DM-6 between 25 and 42 feet also show greater than 14 percent sand and gravel in the glacial till.

There are only two sieve analyses for the shallow glacial till, and four sieve analyses for deeper glacial till. The sedimentology between them is similar. Field descriptions of the shallow glacial till are similar to descriptions of the deep glacial till.

The field boring logs generally agree with these sieve analyses. A descriptive indicator of the glacial till is the presence of fine gravel. In the boring logs, fine gravel is not usually observed until the 10- to 12-foot split-spoon sample. Only one split-spoon sample (Boring DM-8, 15.0 to 17.0 feet) had more than a minor amount of sand. This sand layer appear to be isolated and discontinuous.

Figure 4-3 illustrates the location of a north-south cross section across the site. The stratigraphy for the cluster wells is illustrated by the deep and shallow well at each cluster. Figure 4-4 illustrates the subsurface stratigraphy corresponding to this section. The ground surface elevations of all of the wells are within two feet of each other. All of the soil shown in the cross section are lean clays according to the Unified Soil Classification. However, the more coarse clastic glacial till is distinguishable lithologically and appears to be the water-bearing formation. Indeed, the shallow water tables may be coincident with the formation boundary between the glacial till and the more clay rich loess.

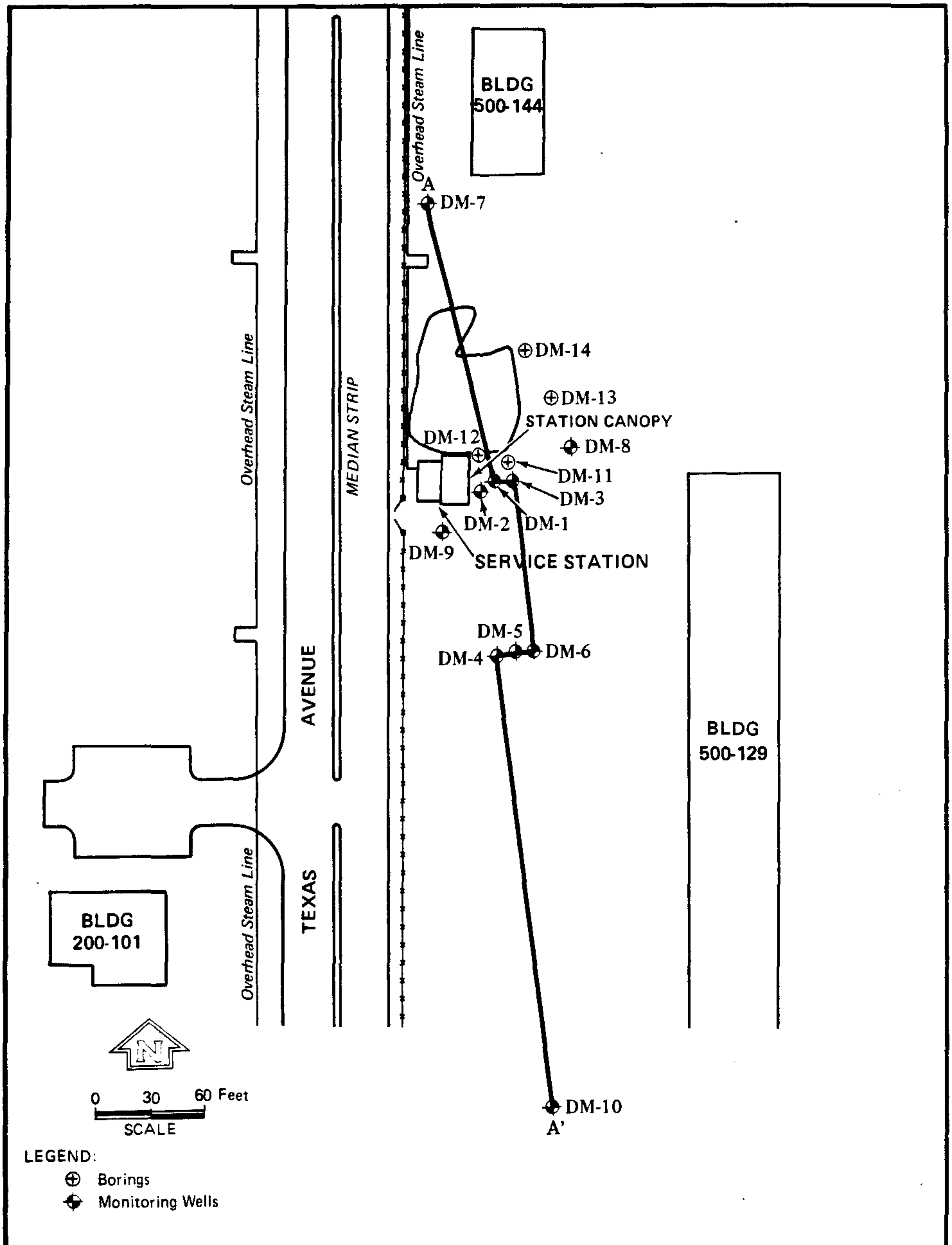
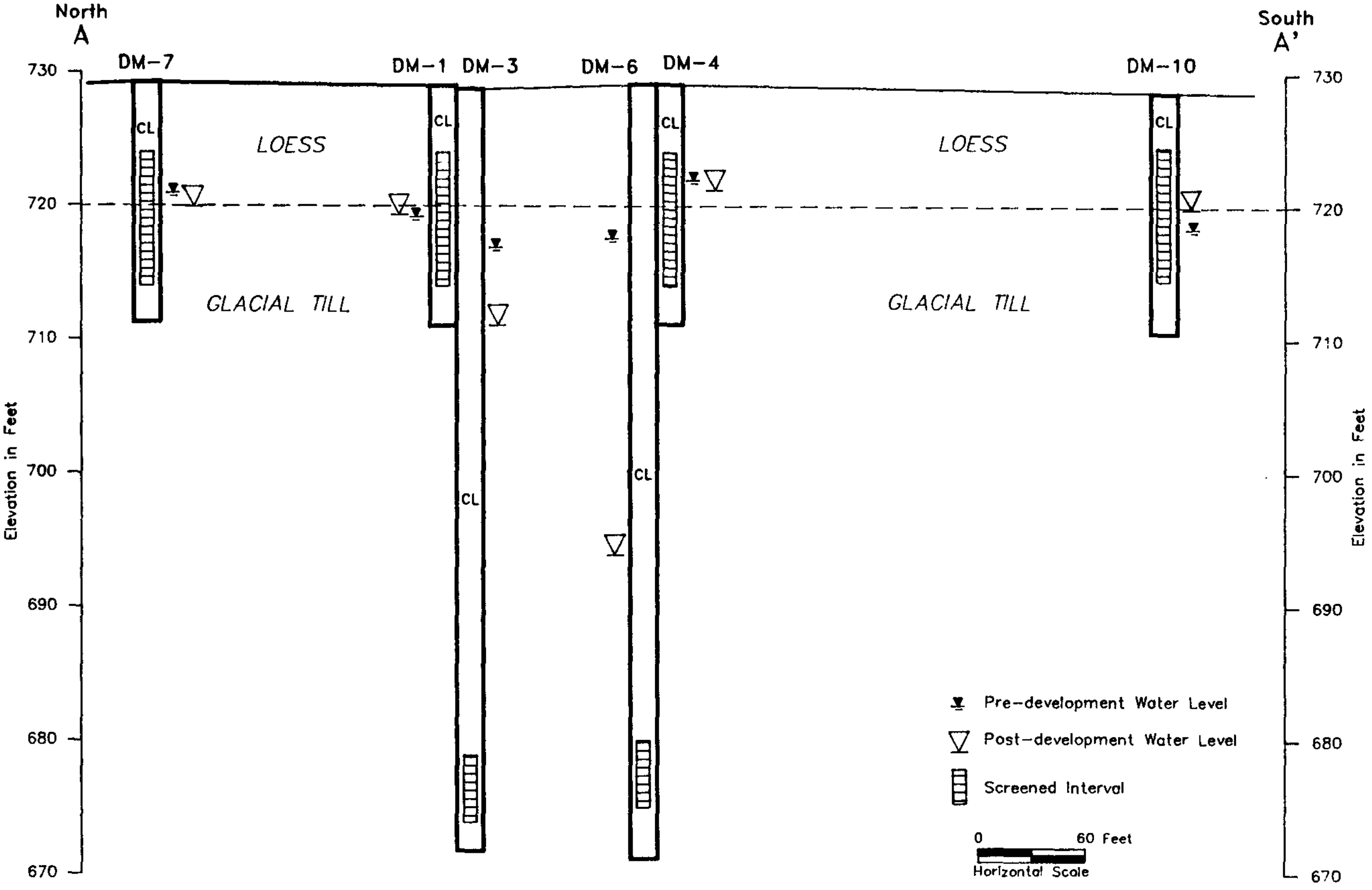


FIGURE 4-3
LOCATION OF NORTH–SOUTH CROSS SECTION



See Figure 4-3 for Location of Section

FIGURE 4-4
NORTH-SOUTH CROSS-SECTION
PETROLEUM LEAK AREA
IAAP

DAMES & MOORE

Based on physical observations, the most contaminated soil appears to be the loess and the uppermost several feet of the glacial till. Gasoline odors and high PID readings, when present, were found within the interval from a depth of 1 to 2 feet down to the top of the water table.

4.2.3 Groundwater

4.2.3.1 Shallow Horizontal Gradient. Table 4-2 presents the groundwater elevation monitoring results for the monitoring wells at the PL/SA. This table includes associated data such as ground elevations, measuring point elevations, etc. Survey data used to determine elevations are presented in Appendix F. Two rounds of groundwater elevation measurements are presented in the table--measurements prior to well development and measurements subsequent to well development.

Figures 4-5 and 4-6 illustrate the direction of the water table (shallow wells), based on the pre-development and post-development monitoring data, respectively. The inferred flow direction illustrated in both figures is southward, based principally on the observation that the water table elevation in the southern-most well (DM-10) is consistently less than the water table elevations measured in the other wells. One exception is well DM-1, for which the water table elevation illustrated in Figure 4-6 is less than the water table elevation measured at well DM-10. The water table near well DM-1 may have been artificially lowered due to pumping of groundwater out of the UST excavation on October 16.

Observations of the relative water level recovery rates for the various monitoring wells were made during drill, well development, and well purging. This information is summarized in Table 4-3. This information does not indicate obvious trends in the spacial variability of the water level recovery rates for the shallow monitoring wells.

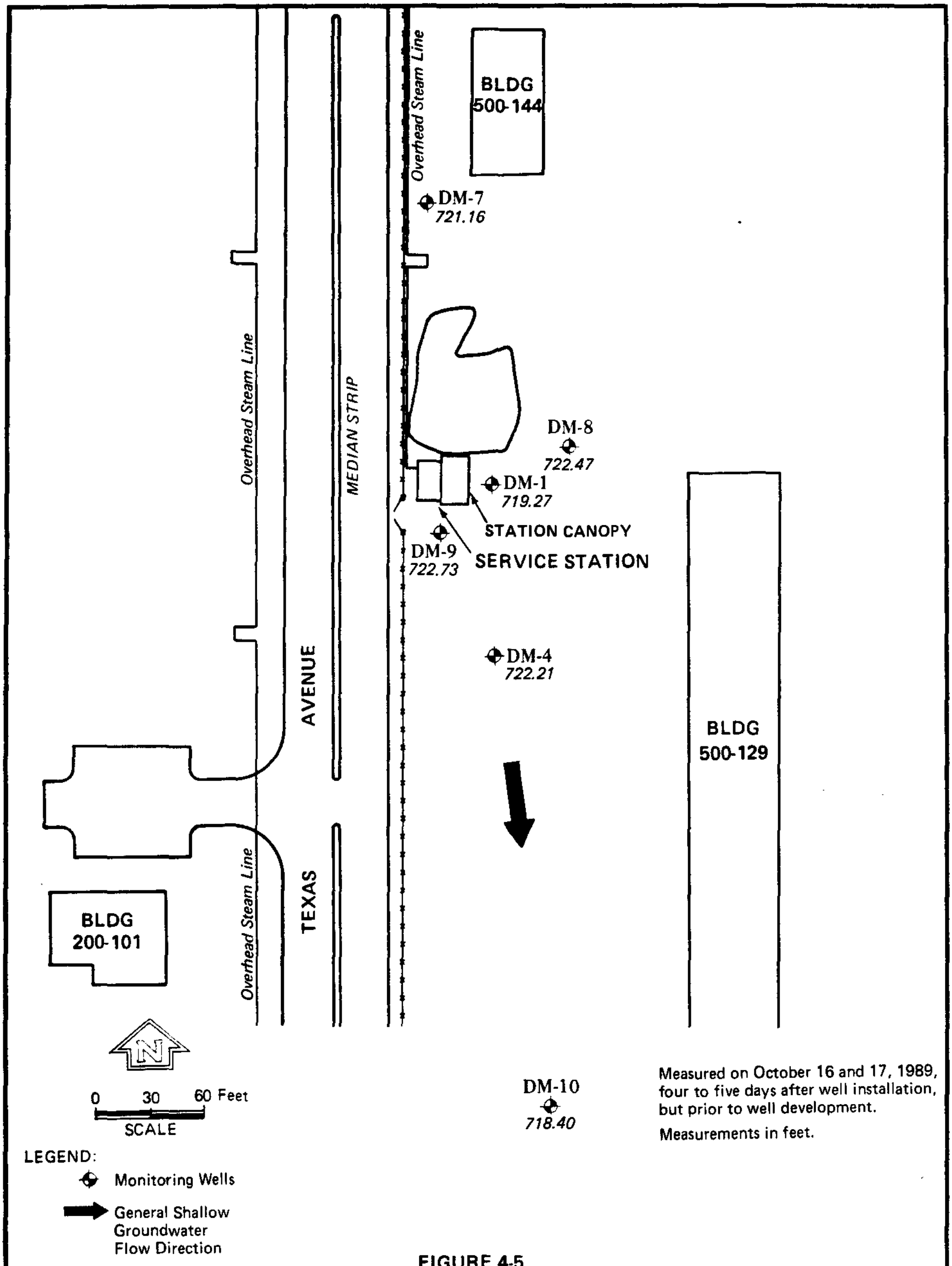
4.2.3.2 Vertical Gradient. The groundwater elevation data in Table 4-2 is conflicting relative to the vertical hydraulic gradient. The well cluster furthest downgradient from the site (comprised of monitoring well DM-8, DM-9, and DM-10) indicates a downward gradient. This is consistent with observations made at other sites at IAAP (not addressed by the present study) which, like the gasoline station site, are coincident with surface water drainage basin divides. The downward gradient at the southern well cluster was observed during both monitoring periods (post- and pre-well development).

TABLE 4-2

Groundwater Elevation Data

			Post-Well Development Measurements (b)			Pre-Well Development Measurements (b)		
Well	Ground Elevation	TOC (a) Elevation	Groundwater Elevation	Depth To Water From TOC	Date	Groundwater Elevation	Depth To Water From TOC	Date
DM-1	729.00	728.39	719.35	9.04	10-24-89	719.27	9.12	10-17-89
DM-2	729.00	728.12	695.88	32.24	11-07-89	696.48	31.24	10-27-89
DM-3	728.80	727.84	711.05	16.79	11-07-89	717.11	10.73	10-27-89
DM-4	729.10	728.67	721.44	7.23	10-24-89	722.21	6.46	10-16-89
DM-5	729.10	728.66	720.66	8.00	11-07-89	720.06	8.60	10-27-89
DM-6	729.10	728.50	693.91	34.59	11-07-89	717.70	10.80	10-28-89
DM-7	729.40	728.76	720.36	8.40	10-24-89	721.16	7.60	10-16-89
DM-8	728.80	728.23	720.40	7.83	10-24-89	722.47	5.76	10-16-89
DM-9	729.00	728.43	720.58	7.85	10-24-89	722.73	5.70	10-16-89
DM-10	728.60	727.56	720.21	7.35	10-24-89	718.40	9.16	10-16-89

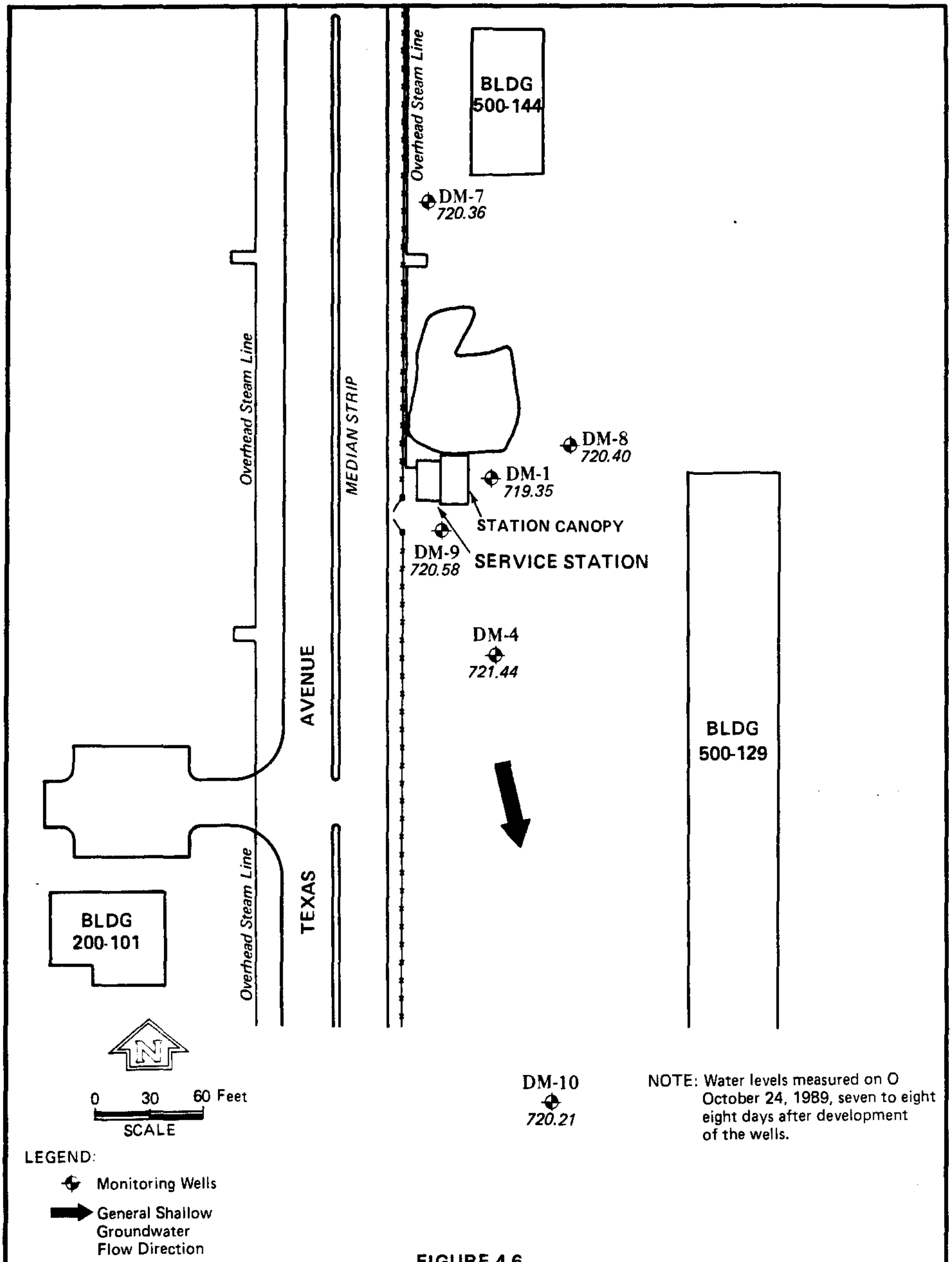
(a) "TOC" represents the top of casing, which is the reference point for the groundwater measurements.
(b) All measurements made using a ruled tape with an attached plopper.



Measured on October 16 and 17, 1989, four to five days after well installation, but prior to well development.

Measurements in feet.

FIGURE 4-5
WATER TABLE ELEVATION –
PRE WELL DEVELOPMENT



NOTE: Water levels measured on O October 24, 1989, seven to eight eight days after development of the wells.

FIGURE 4-6
WATER TABLE ELEVATION – POST WELL DEVELOPMENT

TABLE 4-3

Water Level Recovery Rates

	Recovery Rate (a)				
Well	High	Medium	Medium-Low	Low	Very Low
DM-1					X
DM-2					X
DM-3				X	
DM-4			X		
DM-5		X			
DM-6					X
DM-7			X		
DM-8			X		
DM-9				X	
DM-10				X	

(a) Based on observations of recovery after well development and purging. "High" recovery rate approximates less than one hour. "Very low" recovery rate approximates greater than one day.

The groundwater elevation for the northern well cluster (comprised of monitoring well DM-1, DM-2, and DM-3) indicates an upward gradient. It is suspected that this "apparent" upward gradient is an artifact of the very low recovery rate observed for monitoring well DM-2 and the potential influences that pumping water from the UST excavation may have had on the water level in well DM-1. Specifically, low recovery for well DM-2 suggests than an unusually long period of time is necessary for the water level in well DM-2 to equilibrate with the groundwater in the surrounding glacial till. It is possible that monitoring well DM-2 was not fully equilibrated when the water level in this well was measured, thus giving a lower groundwater elevation relative to the deeper well (DM-3). Well DM-3 exhibited a greater water level recovery rate (see Table 4-3). As will be discussed in Section 4.3, the groundwater chemistry data support the interpretation of a downward hydraulic gradient.

4.3 CHEMISTRY RESULTS

The chemistry results discussed below are based on a review of Level II data obtained directly from metaTRACE, Inc., rather than Level III data from USATHAMA. Prior to submittal of the data to Dames & Moore, metaTRACE corrected the data for dilution, moisture content, and accuracy. The use of the Level II data was justified and approved by USATHAMA so that a data assessment could be performed by Dames & Moore earlier than would have been possible had Dames & Moore waited for Level III data to become available. The following sections discuss the results of the data QA/QC assessment and the analytical results for the groundwater, soil, and surface water/sediment samples (Appendix G).

4.3.1 Data QA/QC Assessment

The data QA/QC assessment consisted of the following steps:

- Check Holding Times

  This step consisted of reviewing the sample sampling date and the subsequent date of extraction and/or analysis and comparing the elapsed time with the limits as specified by EPA document 136 (40 CFR Part 136).

- Checking Method Blanks and Spikes

  This step consisted of reviewing the method blanks and spike analytical results to determine if there was evidence of laboratory contamination or unacceptable spike recovery. The spike recoveries for Toluene, Benzene, and Ethylbenzene were compared to the spike recoveries for these chemicals specified for EPA method 602 (USEPA-136). No spike recovery limits were assessed for xylenes because the spike limits for the individual xylene isomers are not specified by EPA for Method 602. The spike recovery analysis for lead consisted of a review of the variance of the spike from the known spike concentration. There are at this time no required spike recoveries specified for TPH.

- Evaluation of Drill and Rinse Water Results

  This step consisted of comparing site sample analytical results to the results of analysis of the drill water and rinse water samples.

- Review of Data Outliers

  The purpose of this step was to identify analytical results that were obviously inconsistent with the overall trend established by the bulk of the analytical results. Such inconsistent outliers were discussed with the laboratory to assess the possibility that sample misidentification may have occurred while the sample was in the custody of the laboratory.

The results of each of these data validation steps are discussed below.

4.3.1.1 Holding Times. Of the 52 samples on which this assessment is based, 22 were not analyzed within their USATHAMA-designated holding times. These samples are marked with asterisks in Table 4-4. The holding times for the 22 samples varied between 14 and 26 days (less than 1 day to 12 days in excess of the allowable holding time). Purgeable aromatics is the only analytical category for which holding times were exceeded. Data corresponding to samples whose holding times were exceeded are included in the assessment because a review of the data indicated no obvious inconsistencies with the data corresponding to samples whose holding times were met. In addition, there appears to be an expected consistency of concentrations in the areas known to be contaminated.

TABLE 4-4

Summary of the Analytical Results

MEDIUM/SAMPLE I.D.								ANALYTE(UG/L, UG/G)						
GROUNDWATER				RINSE WATER	SOIL	SURFACE WATER	SEDIMENT	PURGEABLE AROMATICS					TPH	LEAD
GLACIAL TILL			BEDROCK					BENZ	TOL	EBENZ	MXYLENE	O&PXYLENE		
SHALLOW	MIDDLE	DEEP												
DM-1								1260	1620	543	1060	1170	LT 2000	6.18
	DM-2							0.17	LT 0.446	LT 0.522	LT 3.45	LT 4.03	LT 2000	LT 2.16
		DM-3						LT 0.104	LT 0.446	LT 0.522	LT 3.45	LT 4.03	LT 2000	LT 2.16
DM-4								LT 0.104	LT 0.446	LT 0.522	LT 3.45	LT 4.03	LT 2000	LT 2.16
	DM-5							LT 0.104	LT 0.446	LT 0.522	LT 3.45	LT 4.03	LT 2000	LT 2.16
		DM-6						LT 0.104	LT 0.446	LT 0.522	LT 3.45	LT 4.03	LT 2000	LT 2.16
DM-7								LT 0.104	LT 0.446	LT 0.522	LT 3.45	LT 4.03	LT 2000	LT 2.16
DM-8								LT 0.104	LT 0.446	LT 0.522	LT 3.45	LT 4.03	LT 2000	LT 2.16
DM-9								LT 0.104	LT 0.446	LT 0.522	LT 3.45	LT 4.03	LT 2000	LT 2.16
DM-10								LT 0.104	LT 0.446	LT 0.522	LT 3.45	LT 4.03	LT 2000	LT 2.16
			DRILL-1(a)					LT 0.104	LT 0.446	LT 0.522	LT 3.45	LT 4.03	LT 2000	2.4
			DRILL-2*(a)					LT 0.104	LT 0.446	LT 0.522	LT 3.45	LT 4.03	LT 2000	2.19
				RINSE-1(a)				0.22	0.6	LT 0.522	LT 3.45	LT 4.03	LT 2000	11.3
				RINSE-2*				0.26	0.61	LT 0.522	LT 3.45	LT 4.03	LT 2000	6.56
					DM1-2.5*			5.32	2.22	31.65	38.1	33.7	(b)	(b)
					DM1-5.0*			39.7	116	56.1	81.8	71.4	121	LT 92.3
					DM1-7.5*			0.56	2.27	0.93	1.1	1.18	81.7	LT 92.3
					DM2-25.0			LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	LT 20	LT 92.3
					DM2-30.0			LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	LT 20	LT 92.3
					DM2-35.0			LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	LT 20	LT 92.3
					DM3-25.0			LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	LT 20	LT 92.3
					DM3-30.0			LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	LT 20	(b)
					DM3-35.0			LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	240	LT 92.3
					DM3-40.0			LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	LT 20	LT 92.3
					DM3-45.0			LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	LT 20	LT 92.3
					DM3-50.0			LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	365	LT 92.3
					DM3-55.0			LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	LT 20	LT 92.3
					DM4-2.5*			LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	115	LT 92.3
					DM4-5.0*			LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	102	LT 92.3
					DM4-7.5*			LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	134	LT 92.3
					DM8-2.5			LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	LT 20	LT 92.3
					DM8-5.0			LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	42.0(d)	LT 92.3
					DM8-7.5			LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	LT 20	LT 92.3

TABLE 4-4 (cont'd)

MEDIUM/SAMPLE I.D.								ANALYTE(UG/L. UG/G)						
GROUNDWATER				RINSE WATER	SOIL	SURFACE WATER	SEDIMENT	PURGEABLE AROMATICS					TPH	LEAD
GLACIAL TILL			BEDROCK					BENZ	TOL	EBENZ	MXYLENE	O&PXYLENE		
SHALLOW	MIDDLE	DEEP												
					DM9-2.5			LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	LT 20	LT 92.3
					DM9-5.0			LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	LT 20	LT 92.3
					DM11-5.0*			26.6	44.3	41.3	46.8	40.9	LT 20	LT 92.3
					DM11-7.5*			3.78	6.98	4.01	5	4.55	LT 20	LT 92.3
					DM12-2.5*			18.7	96.2	49.0	67.1	59.2	489	LT 92.3
					DM12-5.0*			12.8	40.5	48.6	62.5	56.2	88.6(d)	LT 92.3
					DM12-7.5*			31.3	82.0	51.9	65	53	100	LT 92.3
					DM13-2.5*			LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	139	LT 92.3
					DM13-5.0*			LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	81.8	LT 92.3
					DM13-7.5*			LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	LT 20	LT 92.3
					DM14-2.5*			LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	(b)	(b)
					DM14-5.0*			LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	LT 20	LT 92.3
					DM14-7.5*			LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	LT 20	LT 92.3
						SW-1		(c)	(c)	(c)	(c)	(c)	(c)	(c)
						SW-2		(c)	(c)	(c)	(c)	(c)	(c)	(c)
						SW-3		LT 0.104	LT 0.446	LT 0.522	LT 3.45	LT 4.03	LT 2000	LT 2.16
							SD-1*	LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	34.2	LT 92.3
							SD-2*	LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	64.7	LT 92.3
							SD-3*	LT 0.0156	LT 0.0178	LT 0.0161	LT 0.02	LT 0.04	3110	106

(a) SAMPLED DURING INITIAL SITE VISIT, BUT HOLDING TIMES FOR PURGEABLE AROMATICS WERE EXCEEDED BY METARACE; THEREFORE, WATER SOURCE WAS RESAMPLED TO FACILITATE REANALYSIS OF PURGEABLE AROMATICS. HOLDING TIMES WERE MET FOR THE REANALYSIS OF DRILL-1, DRILL-2, AND RINSE-1, AND THE FIRST AND ONLY ANALYSIS OF RINSE-2.

(b) INSUFFICIENT SAMPLE FOR CHEMICAL ANALYSIS.

(c) SAMPLE STATION DRY; THEREFORE NOT SAMPLED.

(d) SAMPLES DM8-5.0 AND DM12-5.0 WERE REANALYZED FOR TPH ON 12/18/89 DUE TO SAMPLE MISIDENTIFICATION BY THE LABORATORY.

* HOLDING TIME EXCEEDED

4.3.1.2 Method Blanks and Spikes. Analysis of the blanks and spikes showed that no blanks indicated any signs of laboratory contamination. The spike ranges also appeared to be within acceptable recovery ranges. The spikes used in the volatile analysis were within USEPA specified limits. The analytical results of spikes used for the lead analysis varied to a maximum of less than 2% of the spiked concentration.

4.3.1.3 Rinse Water/Drill Water. Benzene, toluene, and lead were detected in the rinse water and drill water samples. Because the rinse water was obtained as bottled water from a local store the associated contamination is not site related. The levels of lead detected in the drill water are also considered not to be site-related because of the distance of the drill water source well from the spill/leak site.

The occurrence of lead in the drill water and rinse water could, however, have caused cross-contamination of site samples. The rinse water was used to wash off sampling equipment during sample collection, and the drill water was used during the drilling of the wells placed at the site. The impact of the lead-contaminated drill water and rinse water on the other samples is considered to have been minimal. Lead was detected in only two site samples--DM-1 (6.18 ug/L) and SD-3 (193 ug/g).

4.3.1.4 Review of Data Outliers. The data obtained from metaTRACE, Inc. exhibited good correlation between what was detected and what was expected to be detected based on the soil gas survey results. The initial variations which were found in the TPHC analysis of samples DM8-5.0 and DM12-5.0 (Table 4-4) are believed to be the result of a reporting error (see discussion in Section 4.3.3.3).

4.3.2 Groundwater

4.3.2.1 Purgeable Aromatics. The volatile organic results for groundwater are listed in Table 4-4. Hydrocarbons were detected in the groundwater samples collected from monitoring wells DM-1 and DM-2. The total benzene, toluene, ethylbenzene and total xylenes (BTEX) content of the sample from DM-1 was 5650 ug/l. The benzene concentration was 1260 ug/l for DM-1. DM-2, which is proximate to DM-1 and completed deeper than DM-1 (35 feet compared to 15 feet), was the only other groundwater sample that tested positive for BTEX any dissolved phase (0.17 ug/l benzene). No other hydrocarbon components were detected in the sample from DM-1. DM-3 (adjacent to DM-1 and DM-2, but completed at 55 feet).

All three wells were drilled within a 30 foot area but monitor different levels of groundwater vertically. This indicates that vertical migration to the intermediate depth (35 feet) has occurred but that migration to the deeper depth (55 feet) has not occurred. The observation of negligible migration is further supported by the downgradient well cluster represented by monitoring wells DM-4, 5, and 6 which exhibited no detectable BTEX. Both vertical and horizontal migration is restricted to the immediate vicinity of the site.

4.3.2.2 Lead. The groundwater sample at DM-1 was the only sample to test positive for lead (6.18 ug/l). As with the volatiles, lead concentrations in the groundwater are limited to a small portion (one sample) of the site. The lead results support the observation of limited migration.

4.3.2.3 Total Petroleum Hydrocarbons. None of the groundwater samples tested positive for TPH.

4.3.3 Soil

4.3.3.1 Purgeable Aromatics. The soil sample results for BTEX indicate that the contamination is principally confined to the shallow subsurface in the immediate vicinity of the spill/leak site, and decreases significantly with distance away from the source area. As indicated in Table 4-4, BTEX was detected only in soil samples from borings DM-1, DM-11, and DM-12 (Figure 3-3). The maximum concentration of total BTEX was 365 ug/g and was found in monitoring well DM-1 at the 5 foot depth level from surface. Monitoring wells DM-11 and DM-12 had their highest BTEX soil concentrations at the 5 foot interval (200 ug/g total BTEX) and 2.5 foot interval (291 ug/g) total BTEX, respectively. Lateral extent of BTEX constituents in the vadose zone are detected at locations DM-1, DM-11 and DM-12.

4.3.3.2 Lead. None of the soil samples tested positive for lead.

4.3.3.3 Total Petroleum Hydrocarbons. During data review it was noted that the TPH results reported by the laboratory for two soil samples (DM12-5.0 and DM8-5.0 appeared to have been switched. Suggestive of this were the following observations:

- The TPH concentration (289 ug/g) reported for sample DM8-5.0 was high relative to the nondetections reported for the adjacent soil samples (DM8-2.5 and DM8-7.5) collected from the same boring as sample DM8-5.0.

- The TPH concentration (less than detection) reported for sample DM12-5.0 was low relative to the detections reported for the overlying soil sample (DM12-2.5; 489 ug/g) and the underlying soil sample (DM12-7.5; 100 ug/g), collected from the same boring as sample DM12-5.0.
- The anticipated TPH concentration (between 489 and 100 ug/g) for soil sample DM12-5.0 was suspiciously close to the TPH concentration reported for sample DM8-5.0.

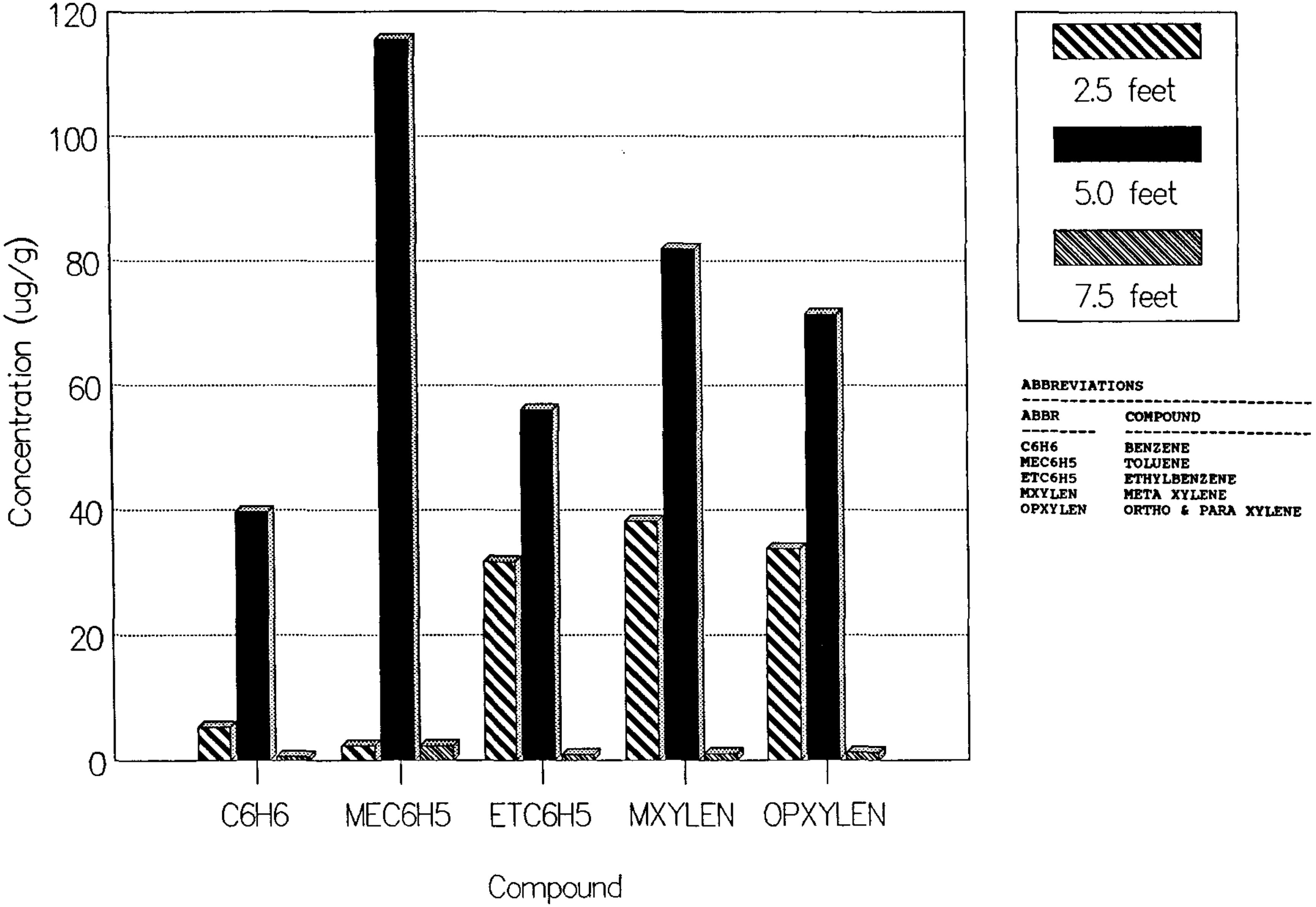
Based on these observations, the laboratory double-checked the sample labels and confirmed that the label or TPH results for samples DM8-5.0 and DM12-5.0 had been switched. At the request of Dames & Moore the laboratory retested these two samples for TPH. Table 4-4 contains the results of the second TPH analyses for these two samples. The results of both analyses are presented in Appendix G.

Other soil sample results that appear unusual (possibly suggestive of sample misidentification) are the TPH results for samples DM3-35 (240 ug/g) and DM3-50 (365 ug/g) because none of the other soil samples from this boring tested positive for TPH, including samples (DM3-25 and DM3-50) that are closer to the contamination source. However, label switching for these samples could not be confirmed; therefore, the results presented in Table 4-4 are the same as the results originally presented in Appendix G.

The TPH results presented in Table 4-4 indicate that the soil contamination is primarily limited to the immediate vicinity of the source area, with TPH concentrations generally decreasing to nondetected below a sampled depth of 7.5 feet. The few positive detections of TPH in the shallow soil at locations not immediately adjacent to the source area may possibly be related to the occurrence of asphalt throughout the monitored area.

4.3.4 Surface Water and Sediment

4.3.4.1 Purgeable Aromatics. Volatiles (BTEX) were not detected in any of these samples.



ABBREVIATIONS

ABBR	COMPOUND
C6H6	BENZENE
MEC6H5	TOLUENE
ETC6H5	ETHYLBENZENE
MXYLEN	META XYLENE
OPXYLEN	ORTHO & PARA XYLENE

FIGURE 4-7

CONCENTRATION OF ORGANICS IN SOIL SAMPLES FROM VARIOUS DEPTHS FROM BORING DM-1

Dames & Moore

4.3.4.2 Lead. A high lead concentration (150 ug/g) was detected in the sediment sample from location SD-3 (Figure 3-6). All other samples were below detection limits of methodology. The occurence of lead in this one sample is most likely the result of a source not related to the subject site, possibly roadway runoff from leaded fuels.

4.3.4.3 Total Petroleum Hydrocarbons. High TPH concentrations (variable from 34 to 3110 ug/g) were observed in the sediment samples while no TPH was above detectable limits in the surface water samples. The occurence of TPH at these locations is most likely the result of a source not related to subject site. This is supported by the observation that contaminant migration potential is confirmed to be rather low based on near-source sample results.

4.3.5 Summary

The assessment performed by Dames & Moore was based on level II data. For this reason Dames & Moore performed its own data analysis in an attempt to reduce any discrepancies that may exist between the level II and the level III data. It is noted that the holding times were exceeded for a number of samples but all other factors such as spike recoveries and blanks appeared to be within acceptable limits. Although, because of the numerous holding time exceedances, an absolute quantification of contamination concentrations can not be made, a qualitative evaluation of the data indicates that general conclusions are supportable. High lead concentrations detected in some of the samples are most likely associated with non site-related contamination, as well as some localized organic contamination. There is little if any lead contamination in the surrounding spill/lead area, and organic contamination is limited to the immediate vicinity of the leak/spill. This observation coincides with the PACE survey and soil gas survey conclusions.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

The present and previous (PACE Laboratories, 1988) investigations have confirmed the presence of soil and groundwater contamination associated with leaked fuel at the IAAP gasoline service station. The principal conclusions concerning the extent and migration potential of the contamination are as follows:

Groundwater

- Shallow groundwater contamination is horizontally confined to the immediate vicinity of the contamination source area (generally does not extend beyond approximately 50 feet from the southern boundary of the excavated area).
- In the vertical direction, groundwater contamination is almost entirely limited to the shallow groundwater table. The single exception to this is the detection of less than 1 ug/l of benzene in monitoring well DM-2 (middle glacial till monitoring well). It is noteworthy that the concentration of benzene detected in groundwater from this monitoring well is less than the concentration of benzene twice detected in the bottled rinse water on two separate occasions. The possibility that the use of the bottled rinse water during sampling may be the source of the single detection of benzene in the groundwater sample from the middle glacial till cannot be ruled out.
- Contaminated groundwater has not impacted the deep portions of the glacial till.

Soil

- The extent of soil contamination indicated by the purgeable aromatics analyses is similar to the extent of contamination indicated by the groundwater chemistry results-- soil contamination is limited to the immediate vicinity of the site in both the horizontal and vertical directions.
- Evidence contrary to this conclusion are the occasional TPH outliers (i.e., TPH results for boring DM-3 at the 35-foot depth). However, the

reliability of the TPH results as an indication of site-related contamination is questionable because of the frequently observed poor correlation between the TPH and purgeable aromatics results. Specifically, relatively high concentrations of purgeable aromatics were observed in soil and groundwater at DM-1; however, the concentration of TPH at DM-1 was less than the concentration of TPH at DM-3 despite the fact that no purgeable aromatics were detected in either groundwater or soil at DM-3.

- Possibly, the TPH results have been influenced by non-site-related sources such as asphalt roads/parking areas which contain a high proportion of heavy hdrocarbons such as the TPH analytical procedure is suitable for detecting.
- The soil gas monitoring results indicate the occurrence of fuel-related hydrocarbons throughout an area roughly coincident with the area of subsurface contamination defined by the groundwater and soil monitoring program.

Surface Water/Sediments

- The lack of correlation between the purgeable aromatic chemistry results for the surface water/sediment samples and the groundwater and soil samples from the immediate vicinity of the site indicate that contamination at the source area has not impacted the closest, downgradient stream.
- This conclusion regarding the site's non-impact of surface water quality is supported by the groundwater and soil monitoring data for soil samples from the immediate vicinity of the site which indicate rapid attenuation of site-related contamination.
- The elevated concentrations of TPH observed in the sediment samples from the downgradient stream likely are related to runoff from other areas at IAAP that are not related to the gasoline station (i.e., nearby motorpool garages and service facilities, etc.).

Potential hazards posed by the spill appear to be low based on the available data, due in part to the absence of free-floating product, the limited extent of contaminant migration, and absence of buildings (excluding the gasoline station) coincident with the contaminated area. However, elevated concentrations of organic vapors in soil in the immediate vicinity (within approximately 50 feet) of monitoring well DM-1 indicate that caution should be exercised during potential future excavation activities that may be conducted at the site (e.g., associated with standard maintenance of subsurface utilities). Potential human health risks posed by the site are considered to be negligible because the ground water is not a drinking water source and contaminated subsurface soils are isolated from potential human activities. Potential environmental risks posed by the site are also considered to be negligible because contamination discharge to the surface is not occurring and because the available data indicates low contaminant migration potential.

The apparent confinement of contamination to the immediate vicinity of the site is attributable to three principal factors:

- Relatively small total volume of fuel leaked to the subsurface, evidenced by the lack of free-floating product on the water table, the frequent absence of an oil slick/sheen on ponded water in the open excavation at the site, and lack of observation of fuel-saturated soil during drilling of the soil borings.
- Rapid and effective initial remedial responses initiated by IAAP that included over-excavation of contaminated soils during excavation of the leaking tanks, and periodic pumping of water (discharged to a Corp of Engineers designed oil/water separator) from the open excavation in order to confined shallow contaminated groundwater to the immediate vicinity of the site.
- Very low horizontal and vertical hydraulic gradient at the site, combined with low permeability, high clay-content glacial deposits that underlie the site which, together, impede contaminant migration away from the site.

5.2 RECOMMENDATIONS

No additional site remediation activities are presently recommended because:

- No free-floating product has been detected at the site.

- The bulk of the highly contaminated soil adjacent to the leaking UST's was removed during excavation of the UST's.
- Both groundwater and soil contamination are confined to the immediate vicinity of the site.
- Discharge of contaminated groundwater to the surface environment is not occurring.
- The natural horizontal and vertical gradient at the site is low.

IAAP should, however, take steps to assure that potential future operators of excavation equipment at the site are notified of the potential to encounter organic vapors during excavation. The gasoline station should periodically be monitored for the potential accumulation of organic vapors. However, because the gas station is subject to prevailing winds and the bulk of the contaminated soil has been removed, the likelyhood of accumulation of organic vapors is reduced.

The documented downward hydraulic gradient should be confirmed by additional groundwater level monitoring. If the downward gradient is confirmed, semi-annual sampling and analysis of groundwater samples from monitoring wells DM-1 through DM-6 should be conducted for purgeable hydrocarbons and lead.

6.0 REFERENCES

Battelle, 1984. Follow-on Study of Environmental Contamination at the Iowa Army Ammunition Plant, Battelle Project Management Division, Richland, Washington.

Coble, R.W. and J.V. Roberts, 1971. The Water Resources of Southeast Iowa, Water Atlas No. 4, Iowa Geological Survey, Iowa City.

Dames & Moore, 1986. Midwest Site Confirmatory Survey--Sampling Report for Iowa Army Ammunition Plant, Report No. AMXTH-IR-FR-86083.

Dames & Moore, 1989. Endangerment Assessment for Iowa Army Ammunition Plant: Former Line 1 Impoundment and Line 800 Pink Water Lagoon, prepared for U.S. Army Toxic and Hazardous Materials Agency, Contract No. DAA15-85-D-0016, Task No. 0001.

ERG (Environmental Research Group, Inc.), 1982. Contamination Survey Iowa Army Ammunition Plant, Report No. DRXTH-AS-CR-82137, Ann Arbor, Michigan.

Harris, Stanley E. and M.C. Parker, 1964. Stratigraphy of the Osage Series in Southeastern Iowa, Report of Investigation No. 1, Iowa Geological Sruvey, Iowa City.

PACE Laboratories, Inc., 1988. Underground Storage Tank Removal at Iowa Army Ammunition Plant, Coralville, Iowa, November 1988.

SCS, 1981. Underground Pollution Investigation at Iowa Army Ammunition Plant, Burlington, Iowa, Contract No. DACA87-80-C-033, SCS Engineers, Long Beach, California.

USAEHA, 1985. Investigation of Groundwater Contamination, Iowa Army Ammunition Plant, Middletown, Iowa, Water Quality Engineering Consultation No. 31-24-0673-35.

USATHAMA, 1980. Installation Assessment of Iowa Army Ammunition Plant, Report No. 127, January 1980.

USATHAMA, 1987. Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports.

USATHAMA, 1987. USATHAMA, March 1987, Quality Assurance Program, 2nd Edition.

USEPA, 1985. The Endangerment Assessment Handbook, Office Waste Programs Enforcement, Contract No. 68-01-7037, Washington, D.C.

APPENDIX A

PACE REPORT

UNDERGROUND STORAGE TANK REMOVAL

AT

IOWA ARMY AMMUNITION PLANT

Prepared For: M & W Contractors
Creve Coeur, Illinois

Prepared By: PACE Laboratories, Inc.
Coralville, Iowa

Date: November 18, 1988

Mike 11/18/88
Mike Saeugling
Division Director

encl 1 to
encl 1

INTRODUCTION:

The following report describes the analyses performed on soils excavated during the removal of two 10,000 gallon underground gasoline tanks and one 10,000 gallon underground diesel tank at the Iowa Army Ammunition Plant in Middletown, Iowa.

BACKGROUND:

The soil analyses were performed on four days during the period from November 9, 1988 to November 17, 1988. The instruments used for the analyses were a Foxboro, Century 128 organic vapor analyzer (OVA) and a Foxboro, Century 88 OVA. All samples were analyzed by filling a one gallon, zip-lock plastic bag with soil, approximately one-third full, warming the sample, and inserting the OVA probe into the bag. The OVA was calibrated each day with two standard gases; a less-than-1 ppm total hydrocarbon standard and a 100 ppm methane in air standard. Sample descriptions and OVA results are shown in Appendix I.

SCOPE OF WORK:

All three tanks were removed on November 8 and 9, 1988. Soils initially removed around the diesel tank were stockpiled on the site. Three composite samples were collected and analyzed with results ranging from 50 parts per million (ppm), total organic vapors, to 500 ppm. (See Appendix I and plan sheet). All soils excavated on November 9, 1988 smelled of hydrocarbons and were hauled to an asphalt parking lot, designated as a stock-pile area on the plant site.

The excavation was enlarged on November 10, 1988 (see plan sheet) and additional samples were collected and analyzed. The results of the analyses seemed to indicate that while the soils immediately adjacent to the tanks were contaminated, over-excavation to the north and east resulted in rapidly decreasing concentrations. Continued excavation to the west and south were discontinued due to encroachments on the gas station building and an over-head steam line. All soils removed on November 10, 1988 were hauled to the stockpile area. A composite sample of this soil was collected, analyzed, and a concentration of 250 ppm was recorded.

On November 15, 1988 additional soils were excavated from the south wall (see plan sheet). Soil analyses indicated increasing contamination. At this time it was discovered that two 2500 gallon underground gasoline tanks had formerly been located approximately 8 feet north of the gas station building.

On November 17, 1988 soils were excavated to within approximately 1 foot of the gas station building. Strong gasoline vapors and discolored soil (gray-green) indicating contamination were noted during excavation. Results of soil analyses ranged from 2500 ppm to 20,000 ppm total organic vapors. Additionally, samples were collected from the bottom of the excavation, below the floor approximately 4 feet (@ 16' depth); one from the center of the excavation and another along the west wall. Vapor concentrations of 1500 ppm and 1200 ppm respectively were recorded. Groundwater immediately began to flow into the center hole, and a gasoline sheen was noted on the water surface.

During the entire course of excavation - with the exception of crushed rock associated with the tank back-fill and the asphalt parking sub-base - all soils were clay material.

Samples were not collected for laboratory analysis at this time.

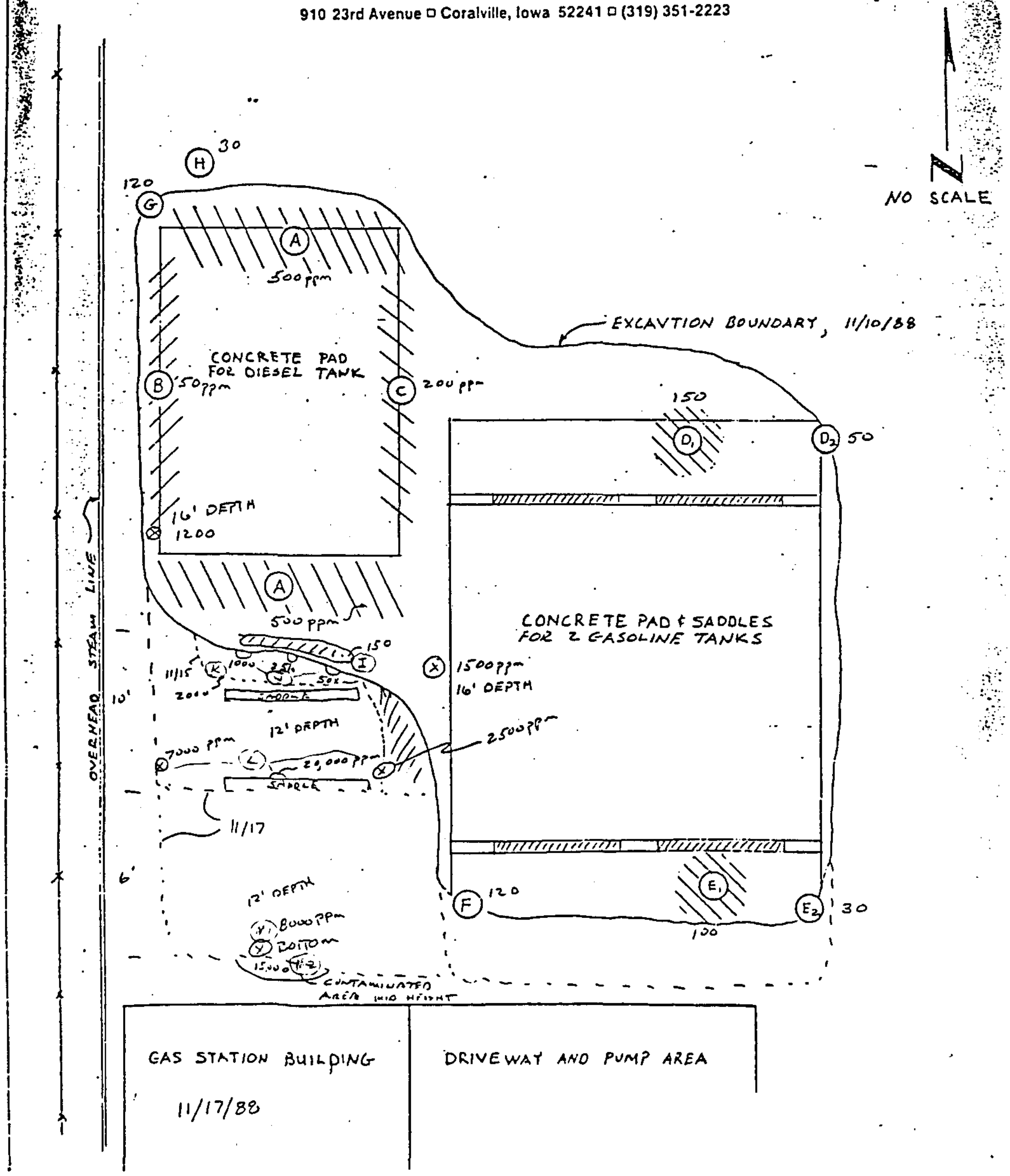
APPENDIX I

Sample	Date	Description	Total Organic Vapors (ppm)
A	11/09/88	Initial excavation from both ends of diesel tank	500
B	11/09/88	Initial excavation from west side of diesel tank	50
C	11/09/88	Initial excavation from east side of diesel tank	200
D_1	11/10/88 (AM)	Bottom of excavation, north end of gasoline tank saddles	150
D_2	11/10/88 (PM)	Bottom of excavation, north end of gasoline tank saddles	50
E_1	11/10/88 (AM)	Bottom of excavation, south end of gasoline tank saddles	100
E_2	11/10/88 (PM)	Bottom of excavation, south end of gasoline tank saddles	30
F	11/10/88	Bottom of excavation, south west corner	120
G	11/10/88	Bottom of excavation, north west corner	120
H	11/10/88	1 foot below excavation bottom, 4 feet north of north wall	30
I	11/15/88	Bottom of excavation, south of diesel tank	150
J	11/15/88	Bottom of excavation, south of diesel tank	250 500 1000
K	11/15/88	Composite along floor of excavation boundary	2000
L	11/17/88	Floor of excavation around 2500 gallon gasoline tank saddles	2500 7000 20,000
M_1	11/17/88	Floor of excavation adjacent to building	8000
M_2	11/17/88	Wall of excavation (@ 6' depth) adjacent to building	15,000

pace laboratories, inc.
PROFESSIONAL ANALYTICAL CHEMISTRY & ENGINEERING

Offices:
Minneapolis, Minnesota
Tampa, Florida
Coralville, Iowa

910 23rd Avenue □ Coralville, Iowa 52241 □ (319) 351-2223



APPENDIX B

TRACER RESEARCH CORPORATION REPORT

Note: The soil gas unit (ug/l) presented in this report represents micrograms per liter of gas, not water. The unit "ug/l" corresponds to parts per billion (ppb), which is used in the text of this report.

Tracer Research Corporation

PREPARED FOR:

Dames & Moore
7101 Wisconsin Avenue
Suite 70
Bethesda, Maryland 20814

SHALLOW SOIL GAS INVESTIGATION IOWA ARMY AMMUNITION PLANT MIDDLETOWN, IOWA

AUGUST 1989

SUBMITTED BY:

Tracer Research Corporation

IAAP.MSG
H-147-89-SG

TABLE OF CONTENTS

INTRODUCTION

A shallow soil gas investigation was performed by Tracer Research Corporation (TRC) at the Iowa Army Ammunition Plant in Middletown, Iowa. The investigation was conducted on August 2, 3 and 4, 1989 under contract to Dames & Moore. The purpose of the investigation was to determine the distribution and extent of subsurface petroleum compounds at the facility where leaking underground storage tanks were formerly stored.

For this survey, a total of 56 soil gas samples were collected and analyzed in the field. Samples were analyzed for the following compounds:

benzene
toluene
ethylbenzene
xylenes
total hydrocarbons (THC)

The compounds in this suite were chosen because of their suspected presence in the subsurface and amenability to soil gas technology. Xylenes are reported as the total of the three xylene isomers and total hydrocarbons are approximately C4-C9 aliphatic, alicyclic and aromatic compounds.

Soil gas samples were screened on the flame ionization detector (FID). Analytical results are condensed in Appendix A and reported in micrograms per liter (ug/L). A sampling location map along with isoconcentration contours are attached.

SHALLOW SOIL GAS INVESTIGATION - METHODOLOGY

Soil gas contaminant investigation refers to a method developed by TRC for investigating underground contamination from volatile organic chemicals (VOCs) such as industrial solvents, cleaning fluids and petroleum products by looking for their vapors in the shallow soil gas. The method involves pumping a small amount of soil gas out of the ground through a hollow probe driven into the ground and analyzing the gas for the presence of volatile contaminants. The presence of VOCs in shallow soil gas indicates the observed compounds may either be in the vadose zone near the probe or in groundwater below the probe. The soil gas technology is most effective in mapping low molecular weight halogenated solvent chemicals and petroleum hydrocarbons possessing high vapor pressures and low aqueous solubilities. These compounds readily partition out of the groundwater and into the soil gas as a result of their high gas/liquid partitioning coefficients. Once in the soil gas, VOCs diffuse vertically and horizontally through the soil to the ground surface where they dissipate into the atmosphere. The contamination acts as a source and the above ground atmosphere acts as a sink, and typically a concentration gradient develops between the two. The concentration gradient in soil gas between the source and ground surface may be locally distorted by hydrologic and geologic anomalies (e.g. clays, perched water); however, soil gas mapping generally remains effective because distribution of the contamination is usually broader in areal extent than the local geologic barriers and is defined using a large data base. The presence of geologic obstructions on a small scale tends to create anomalies in the soil gas-groundwater correlation, but generally does not obscure the broader areal picture of the contaminant distribution.

EQUIPMENT

Tracer Research Corporation utilized a one ton Ford analytical field van that was equipped with one gas chromatograph and two Spectra Physics SP4270 computing integrators. In addition, the van has two built-in gasoline powered generators that provide the electrical power (110 volts AC) to operate all of the gas chromatographic instruments and field equipment. A specialized hydraulic mechanism consisting of two cylinders and a set of jaws was used to drive and withdraw the sampling probes. A hydraulic hammer was used to assist in driving probes past cobbles and through unusually hard soil.

SAMPLING PROCEDURES

Sampling probes consist of 7-foot lengths of 3/4 inch diameter hollow steel pipe that are fitted with detachable drive points. Soil gas samples were collected by driving the steel probe to a depth of 1-4 feet into the ground. Once inserted into the ground, the above-ground end of the sampling probes were fitted with a steel reducer and a length of polyethylene tubing leading to a vacuum pump. To adequately purge the volume of air within the probe, 2 to 5 liters of gas were evacuated with a vacuum pump. During the soil gas evacuation, samples were collected in a glass syringe by inserting a syringe needle through a silicone rubber segment in the evacuation line and down into the steel probe. Ten milliliters of gas were collected for immediate analysis in the TRC analytical field van. Soil gas was subsampled (duplicate injections) in volumes ranging from 1 uL to 2 mL, depending on the VOC concentration at any particular location.

ANALYTICAL PROCEDURES

A Varian 3300 gas chromatograph equipped with a flame ionization detector (FID) was used for the soil gas analyses. The FID was used to analyze for benzene, toluene, ethylbenzene, xylenes and total hydrocarbons. Compounds were separated on a 6' by 1/8" OD packed column with OV-101 as the stationary phase. Nitrogen was used as the carrier gas.

Hydrocarbon compounds detected in soil gas were identified by chromatographic retention time. Quantification of compounds was achieved by comparison of the detector response of the sample with the response measured for calibration standards (external standardization). Instrument calibration checks were run periodically throughout the day as were system blanks to check for contamination in the soil gas sampling equipment. Air samples were also routinely analyzed to check for background levels in the atmosphere.

Detection limits for the compounds of interest are a function of the injection volume as well as the detector sensitivity for individual compounds. Thus, the detection limit varies with the sample size. Generally, the larger the injection size the greater the sensitivity. However, peaks for compounds of interest must be kept within the linear range of the analytical equipment. If any compound has a high concentration, it is necessary to use small injections, and in some cases to dilute the sample to keep it within linear range. This may cause decreased detection limits for other compounds in the analyses. The detection limits range down to 0.01 ug/L for compounds such as benzene and toluene depending on the conditions of the measurement, in particular, the sample size. If any component being analyzed is not detected, the detection limit for that compound in that analysis is given as a "less than" value (e.g. <0.01 ug/L). Detection limits obtained from GC analyses are calculated from the current response factor, the sample size, and the estimated minimum peak size (area) that would have been visible under the conditions of the measurement.

QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

Tracer Research Corporation's normal quality assurance procedures were followed in order to prevent any cross-contamination of soil gas samples.

- Steel probes are used only once during the day and then washed with high pressure soap and hot water spray or steam-cleaned to eliminate the possibility of cross-contamination. Enough probes are carried on each van to avoid the need to reuse any during the day.
- Probe adaptors (steel reducer and tubing) are used once during the course of the day and cleaned at the end of each working day by baking in the GC oven. The tubing is replaced periodically as needed during the job to insure

cleanliness and good fit.

- Silicone tubing (connecting the adaptor to the vacuum pump) is replaced as needed to insure proper sealing around the syringe needle. This tubing does not directly contact soil gas samples.
- Glass syringes are usually used for only one sample per day and are washed and baked out at night. If they must be used twice, they are purged with carrier gas (nitrogen) and baked out between probe samplings.
- Septa through which soil gas samples are injected into the chromatograph are replaced on a daily basis to prevent possible gas leaks from the chromatographic column.
- Analytical instruments were calibrated each day by analytical standards from Chem Service, Inc. Calibration checks are also run after approximately every five soil gas sampling locations.
- 2 cc subsampling syringes are checked for contamination prior to sampling each day by injecting nitrogen carrier gas into the gas chromatograph.
- Prior to sampling each day, system blanks are run to check the sampling apparatus (probe, adaptor, 10 cc syringe) for contamination by drawing ambient air from above ground through the system and comparing the analysis to a concurrently sampled air analysis.
- All sampling and 2 cc subsampling syringes are decontaminated each day and no such equipment is reused before being decontaminated. Microliter size subsampling syringes are reused only after a nitrogen carrier gas blank is run to insure it is not contaminated by the previous sample.
- Soil gas pumping is monitored by a vacuum gauge to insure that an adequate gas flow from the vadose zone is maintained. A negative pressure (vacuum) of 2 in. Hg less than the maximum capacity of the pump (evacuation rate >0.02 cfm) usually indicates that a reliable gas sample cannot be obtained because the soil has a very low air permeability.

RESULTS

Analytical results generated during the soil gas investigation at the Iowa Army Ammunition Plant show a distinct hydrocarbon plume in the vicinity of the gas station. The analytical results are presented in Appendix A and reported in micrograms per liter (ug/L). All samples were analyzed for benzene, toluene, ethylbenzene, xylenes and total hydrocarbons. A sampling location map along with isoconcentration contour maps for benzene and total hydrocarbons are attached.

Ambient air samples were collected during the course of the investigation to help evaluate the level of significance for the selected VOCs. The level of significance is simply the level above which is considered to be significant in terms of groundwater or soil contamination. Concentrations of the petroleum compounds were only detected in two of the eight air samples; 1) the air sample collected at 11:37 on 8/3/89 (THC - 2 ug/L), and 2) the air sample collected at 16:36 on 8/3/89 (benzene - 0.02 ug/L). The remaining air samples reported non-detect levels for hydrocarbons. The level of significance for the petroleum compounds is based on several factors; concentrations in ambient air, background levels, and TRC's past experience. Based on the evaluation of these factors, the level of significance for benzene is considered to be any detectable concentration while the level significance for total hydrocarbons is approximately 1 ug/L. In other words, soil gas concentrations that are greater than the level of significance may indicate possible hydrocarbon contamination in the vicinity. In addition, TRC's experience has shown that concentrations greater than 10,000 ug/L may indicate either product residue in the soil or floating product at depth.

A large portion of the first day of the survey was spent investigating the perimeter of the tank excavation area. The first 16 sampling locations, SG-01 through SG-16, were placed at approximately 10 to 20 foot intervals along the perimeter of the tank excavation area in order to provide information regarding the presence of petroleum compounds in the subsurface. High concentrations were detected on the south side of the tank excavation area at sampling location SG-09. After investigating the perimeter of the tank excavation area, sampling continued south from sampling location SG-09. Concentrations detected at sampling locations SG-17 through SG-31 reveal a subsurface plume, which appears to be emanating from the area east of the gas station and south of the tank excavation. Further samples were collected in order to define the areal extent of migration and to further define the possible source area.

Of the compounds detected during this survey, only benzene and total hydrocarbons were detected at a sufficient number of locations to be contoured. Toluene was detected at ten sampling locations at concentrations ranging from 0.03 to 22,000 ug/L. Ethylbenzene was detected at sampling locations SG-05 (0.3 ug/L) and SG-19 (210 ug/L). Xylenes were only detected at one sampling location, SG-40 (0.1 ug/L). The distributions of benzene and total hydrocarbons are depicted in Figures 2 and 3, respectively. Soil gas concentrations of benzene and total hydrocarbons range as follows; benzene - non-detect (0.01 ug/L) to 66,000 ug/L, and total hydrocarbons - non detect (<0.07 ug/L) to 280,000 ug/L. The distribution of hydrocarbon compounds is fairly well defined by the benzene and total hydrocarbon contours. However, several of the sampling location concentrations located within the contours -(THC - SG-10, SG-25 and SG-50, benzene - SG-10, SG-32, SG-45 and SG-47)- may be anomalous. To avoid obscuring the distribution of hydrocarbons, the anomalous data points were not considered when formulating contours.

CONCLUSIONS

Elevated concentrations of petroleum hydrocarbons, including benzene, toluene and xylenes were detected in the soil gas in the vicinity of the gas station on the Iowa Army Ammunition Plant. Elevated concentrations of total hydrocarbons were also measured in the soil gas. The results of the survey depict a plume of hydrocarbons located just east of the gas station and south of the tank evacuation area. The plume is defined by benzene and total hydrocarbon contours ranging from 1 to 100,000 ug/L. High concentrations (>10,000 ug/L) detected just to the east of the gas station and south of the tank excavation area probably represent soil and/or groundwater contamination. The lateral extent of contamination is fairly well defined by the 1 ug/L contour. However, lower concentrations not located within these contours may represent low level contamination.

Hydrocarbon concentrations measured in the soil gas range over seven orders of magnitude on this site. The highest concentrations are indicative of levels typically detected in areas where gasoline is present as a residue in the soil or as floating product. However, in order to confirm the nature of the delineated soil gas plume TRC recommends that conventional methods (soil borings, monitoring wells, etc.) be employed.

APPENDIX A: CONDENSED DATA

DAMES & MOORE/IOWA ARMY AMMUNITIONS PLANT/BURLINGTON, IOWA JOB#H-147-89-SG

Sample	Depth	Date	CO2 (ug/l)	Benzene (ug/l)	Toluene (ug/l)	Ethyl Benzene (ug/l)	Xylenes (ug/l)	Total Hydroc. (ug/l)
Air		08/02	N/A	<0.01	<0.01	<0.02	<0.02	<0.07
SG-01	3'	08/02	1	<0.01	<0.01	<0.02	<0.02	<0.07
SG-02	3'	08/02	2	<0.01	<0.01	<0.02	<0.02	<0.07
SG-03	3'	08/02	<0.1	<0.01	<0.01	<0.02	<0.02	<0.07
SG-04	3'	08/02	0.1	0.4	1	<0.03	<0.03	2
SG-05	1'	08/02	0.1	8	8	0.3	<0.06	23
Air		08/02	N/A	<0.01	<0.01	<0.02	<0.02	<0.07
SG-06	2'	08/02	0.4	1	2	<0.03	<0.03	6
SG-07	2'	08/02	2	7	4	<0.07	<0.06	33
SG-08	2'	08/02	0.6	14	<0.1	<0.07	<0.06	71
SG-09	3'	08/02	13	66,000	<30	<35	<30	280,000
SG-10	3'	08/02	<0.1	<0.1	<0.1	<0.2	<0.2	<0.7
SG-11	3'	08/02	0.5	1	<0.01	<0.02	<0.02	1
SG-12	3'	08/02	1	1	<0.01	<0.02	<0.02	4
SG-13	2'	08/02	<0.1	<0.01	<0.01	<0.02	<0.02	0.1
SG-14	3'	08/02	0.8	<0.01	<0.01	<0.02	<0.02	<0.07
SG-15	3'	08/02	1	<0.01	<0.01	<0.02	<0.02	<0.07
SG-16	3'	08/02	1	<0.01	<0.01	<0.02	<0.02	<0.07
SG-17	3'	08/02	11	340	<0.3	<0.3	<0.3	830
SG-18	3'	08/02	N/A	62,000	22,000	<69	<60	180,000
Air		08/02	N/A	<0.01	<0.01	<0.02	<0.02	<0.07

N/A not analyzed

Analyzed by: S. Norris
Checked by: K. Wilson
Proofed by: L. Gaplander

Tracer Research Corporation

DAMES & MOORE/IOWA ARMY AMMUNITION PLANT/BURLINGTON, IOWA JOB#H-147-89-SG

Sample	Depth	Date	Benzene (ug/l)	Toluene (ug/l)	Ethyl Benzene (ug/l)	Xylenes (ug/l)	Total Hydroc. (ug/l)
Air		08/03	<0.02	<0.02	<0.02	<0.02	<0.08
SG-19	3'	08/03	40,000	<160	210	<81	200,000
SG-20	1.5'	08/03	9	<0.2	<0.2	<0.2	46
SG-21	2'	08/03	0.3	<0.03	<0.04	<0.03	9
SG-22	2'	08/03	410	19	<4	<3	2800
SG-23	2'	08/03	<6	<6	<4	<3	560
SG-24	2'	08/03	34	<0.3	<0.2	<0.2	140
SG-25	2'	08/03	0.1	<0.02	<0.02	<0.02	0.4
SG-26	3'	08/03	<0.02	<0.02	<0.02	<0.02	<0.08
SG-27	2'	08/03	0.6	<0.02	<0.02	<0.02	4
SG-28	3'	08/03	0.07	<0.02	<0.02	<0.02	0.8
SG-29	3'	08/03	<0.03	<0.03	<0.04	<0.03	10
SG-30	1'	08/03	0.05	<0.02	<0.02	<0.02	2
SG-31	3'	08/03	8	<0.03	<0.04	<0.03	28
Air		08/03	<0.02	<0.02	<0.02	<0.02	2
SG-32	3'	08/03	0.5	<0.03	<0.04	<0.03	2
SG-33	3'	08/03	1	<0.03	<0.04	<0.03	2
SG-34	3'	08/03	3	<0.03	<0.04	<0.03	20
SG-35	2'	08/03	<0.06	<0.03	<0.04	<0.03	1
SG-36	2'	08/03	2	4	<0.04	<0.03	8
SG-37	2'	08/03	0.8	2	<0.04	<0.03	4
SG-38	2'	08/03	<0.06	0.03	<0.04	<0.03	4
SG-39	3'	08/03	<0.02	<0.02	<0.02	<0.02	<0.08
SG-40	3'	08/03	<0.03	<0.02	<0.02	0.1	0.5
SG-41	1.5'	08/03	<0.02	<0.02	<0.02	<0.02	1
SG-42	3'	08/03	<0.02	<0.02	<0.02	<0.02	<0.08
SG-43	3'	08/03	<0.02	<0.02	<0.02	<0.02	<0.08
SG-44	3'	08/03	<0.02	<0.02	<0.02	<0.02	<0.08
Air		08/03	0.02	<0.02	<0.02	<0.02	<0.08

Analyzed by: S. Norris
Checked by: K. Wilson
Proofed by:

DAMES & MOORE/IOWA ARMY AMMUNITIONS PLANT/BURLINGTON, IOWA JOB#H-147-89-SG

Sample	Depth	Date	Benzene (ug/l)	Toluene (ug/l)	Ethyl Benzene (ug/l)	Xylenes (ug/l)	Total Hydroc. (ug/l)
Air		08/04	<0.02	<0.02	<0.02	<0.02	<0.08
SG-45	3'	08/04	<0.02	<0.02	<0.02	<0.02	<0.08
SG-46	2'	08/04	980	<34	<19	<16	8800
SG-47	2'	08/04	0.3	<0.03	<0.02	<0.02	20
SG-48	3'	08/04	3600	300	<19	<16	18,000
SG-49	2'	08/04	1100	<34	<19	<16	5600
SG-50	3'	08/04	<0.02	<0.02	<0.02	<0.02	<0.08
SG-51	2'	08/04	6	<0.2	<0.2	<0.2	29
SG-52	2'	08/04	5	<0.2	<0.2	<0.2	27
SG-53	2'	08/04	40	<3	<4	<3	380
SG-54	3'	08/04	2	<0.07	<0.08	<0.06	12
SG-55	2'	08/04	32	<0.2	<0.2	<0.2	120
SG-56	2.5'	08/04	5	<0.07	<0.08	<0.06	14
Air		08/04	<0.02	<0.02	<0.02	<0.02	<0.08

Analyzed by: S. Norris
Checked by: K. Wilson
Proofed by: L. Laplander

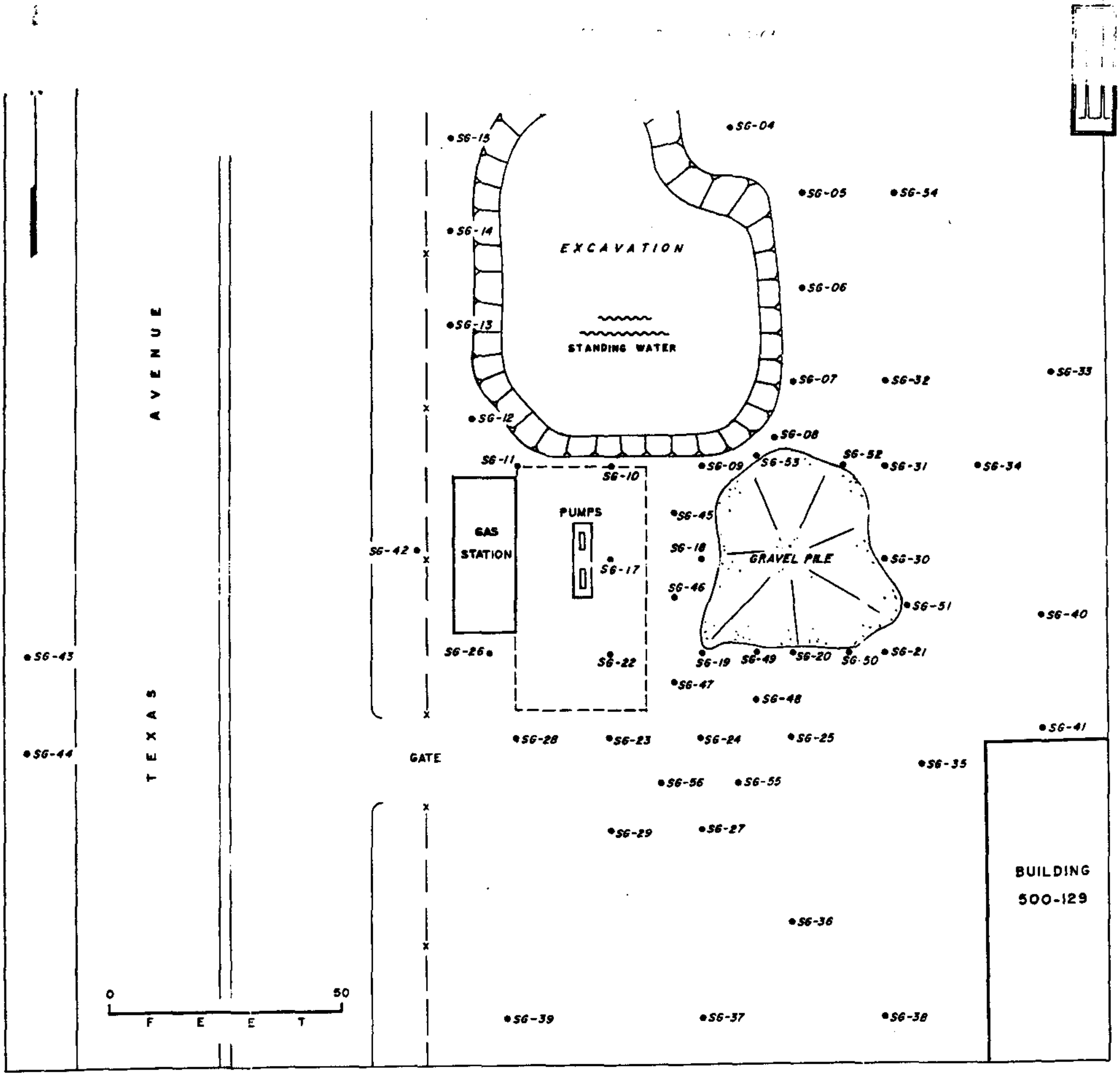


FIGURE 1

IOWA ARMY
AMMUNITION PLANT
GAS STATION AREA
SAMPLING LOCATIONS

MIDDLETOWN, IOWA
AUGUST 1989

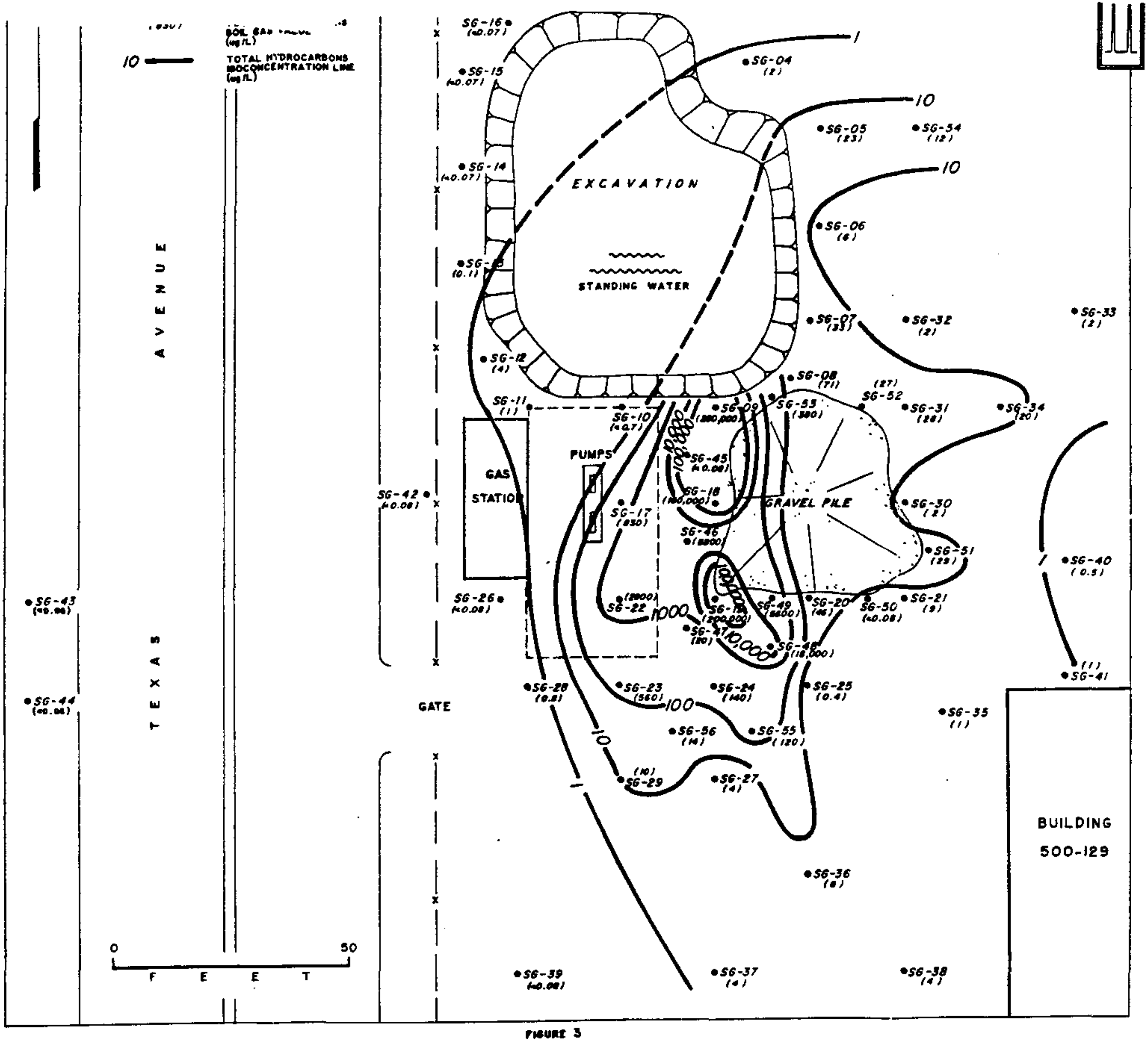


FIGURE 3

IOWA ARMY
AMMUNITION PLANT
GAS STATION AREA

TOTAL HYDROCARBONS

MIDDLETOWN, IOWA
AUGUST 1989

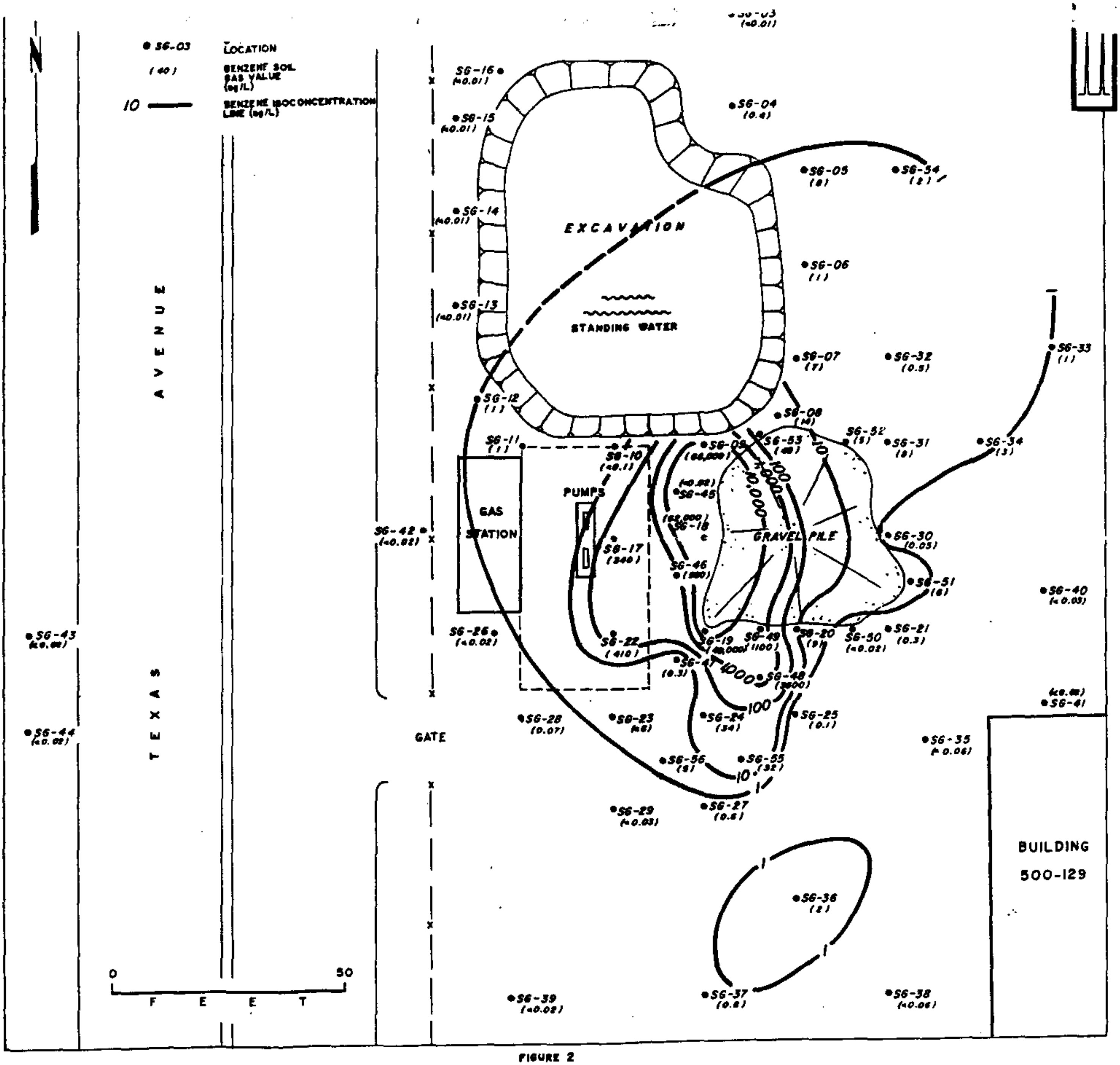


FIGURE 2

IOWA ARMY AMMUNITION PLANT

GAS STATION AREA

BENZENE

MIDDLETOWN, IOWA
AUGUST 1989

APPENDIX C

SOIL BORING LOGS

KEY TO SAMPLES:

8 ◩ INDICATES DEPTH OF DISTURBED OBTAINED WITH A STANDARD SPLIT SPOON SAMPLER.

NUMBER OF BLOWS REQUIRES REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER ONE FOOT WITH A 140-POUND WEIGHT FALLING 30 INCHES. (N-VALUES FROM SPT)

⧅ INDICATES DEPTH OF STANDARD SPLIT SPOON SAMPLING ATTEMPT WITH NO RECOVERY.

NOTES:

1. ELEVATIONS REFER TO MEAN SEA LEVEL DATUM.
2. SOILS ARE CLASSIFIED ACCORDING TO THE UNIFIED SOIL CLASSIFICATION SYSTEM.
3. THE DISCUSSION IN THE TEXT IS NECESSARY FOR A PROPER UNDERSTANDING OF THE NATURE OF THE SUBSURFACE MATERIALS.

KEY TO LOG OF BORINGS

DAMES & MOORE
SOIL CLASSIFICATION AND DESCRIPTION

CLASSIFICATION AND DESCRIPTION

	Component	% by Weight	Plasticity	Unified Soil Classification Symbol	Description
FINE-GRAINED SOILS:	Major	>50	Medium	CL	Lean clay
			High	CH	Fat clay
			Low to medium	CL-ML	Silty clay
			Low	ML	Silt
			Low to medium	MH	Elastic silt
			Low to medium	OL	Organic silt or clay
			High	OH	Organic silt or clay
	Minor	30-50			and sand or gravel
		12-30			some
		5-12			little
		0-5			trace
COARSE-GRAINED SOILS:	Major	>50			Sand or Gravel
	Minor	30-50		SM, SC, GM, GC	and clay or silt
		12-30		SM, SC, GM, GC	some
		5-12		SP-SM, SP-SC, etc.	little
		0-5		SP, SW, GP, GW	trace
OTHER:				PT	Peat

ADDITIONAL DESCRIPTORS

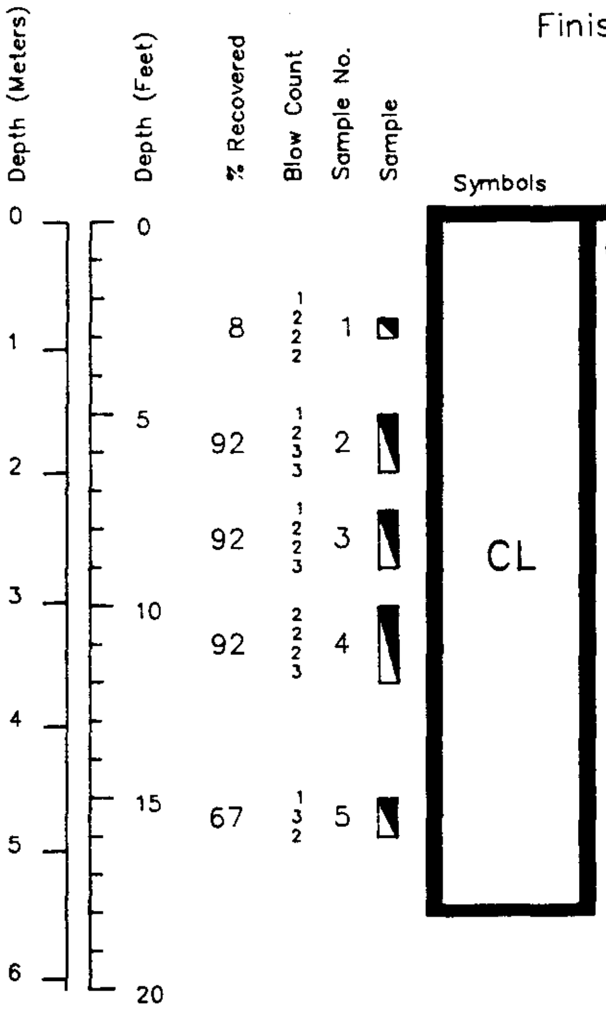
GRAIN SIZES:	silt, clay		passing No. 200 sieve
	sand	fine	No. 200 to No. 40
		medium	No. 40 to No. 10
		coarse	No. 10 to No. 4
	gravel	fine	No. 4 to ¾"
		coarse	¾" to 3"
	cobble		3" to 12"
	boulder		>12"

STRATIFICATION:	stringer	< ¼
	layer	¼" to 12"
	stratum	>12"
	lens	discontinuous seam
MOISTURE:	dry, moist, or wet	
ANGULARITY:	angular, subangular, subrounded, rounded	

BORING DM-1

Surface Elevation: 729.0 Feet
Location: Iowa AAP

Start: 13:30 on 10-12-89
Finish: 15:00 on 10-12-89



% Recovered	Blow Count	Sample No.
8	1 2 2 2	1
92	1 2 3 3	2
92	1 2 2 3	3
92	2 2 2 3	4
67	1 3 2	5

Description

CLAY, TRACE SILT, MOIST, VERY DARK GRAY 10YR3/1 (MUNSELL), MEDIUM STIFF, STRONG PETROLEUM ODOR
HNU: 3,700 PPM

GRADING GRAY 10YR6/1
HNU: 10,000 PPM

HNU: 3,200 PPM

▼ GROUNDWATER ENCOUNTERED AT 9.8 FEET ON 10-17-89

GRADING SOME SILT, TRACE SAND, DARK YELLOWISH-BROWN 10YR4/4 HNU: 0 PPM

GRADING TRACE GRAVEL, YELLOWISH-BROWN 10 YR5/6 HNU: 0 PPM

AUGERED TO BOTTOM OF HOLE 18.0 FEET ON 10-12-89

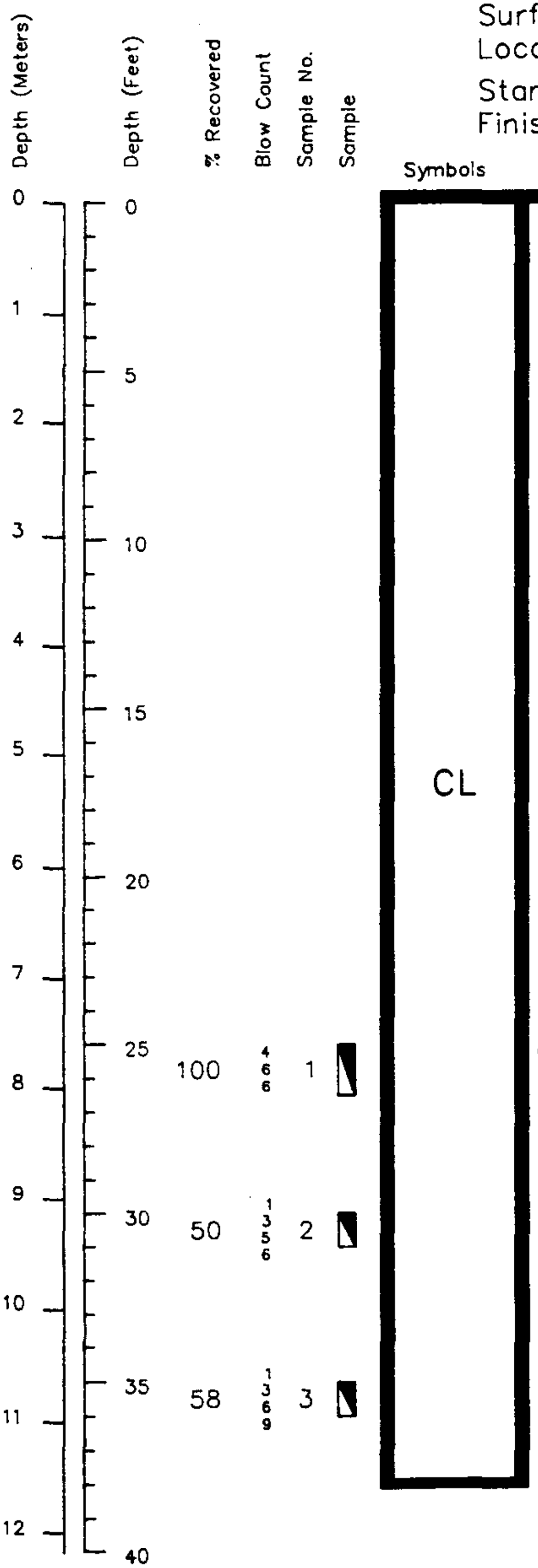
WELL INSTALLED TO A DEPTH OF 15.0 FEET ON 10-12-89

ALL SAMPLES TAKEN WITH A 24-INCH SPLIT SPOON SAMPLER

Dames & Moore

BORING DM-2

Surface Elevation: 729.0 Feet
Location: Iowa AAP
Start: 10:30 on 10-24-89
Finish: 10:10 on 10-26-89



% Recovered	Blow Count	Sample No.	Description
100	4 6 6	1	CLAY, SOME SILT, TRACE SAND, TRACE GRAVEL, MOIST, DARK GRAY 10YR4/1 (MUNSELL), STIFF HNU: 0 PPM
50	1 3 5 6	2	GRADING LITTLE SAND, DARK GRAY 10YR4/1 TO DARK YELLOWISH-BROWN 10YR4/4 HNU: 0 PPM
58	1 3 6 9	3	GRADING LITTLE SILT, MOTTLED GRAY 10YR6/1 TO DARK GRAY 10YR4/1 HNU: 0 PPM

▼ GROUNDWATER ENCOUNTERED AT 32.66 FEET ON 10-27-89

AUGERED TO BOTTOM OF HOLE AT 38.0 FEET ON 10-26-89

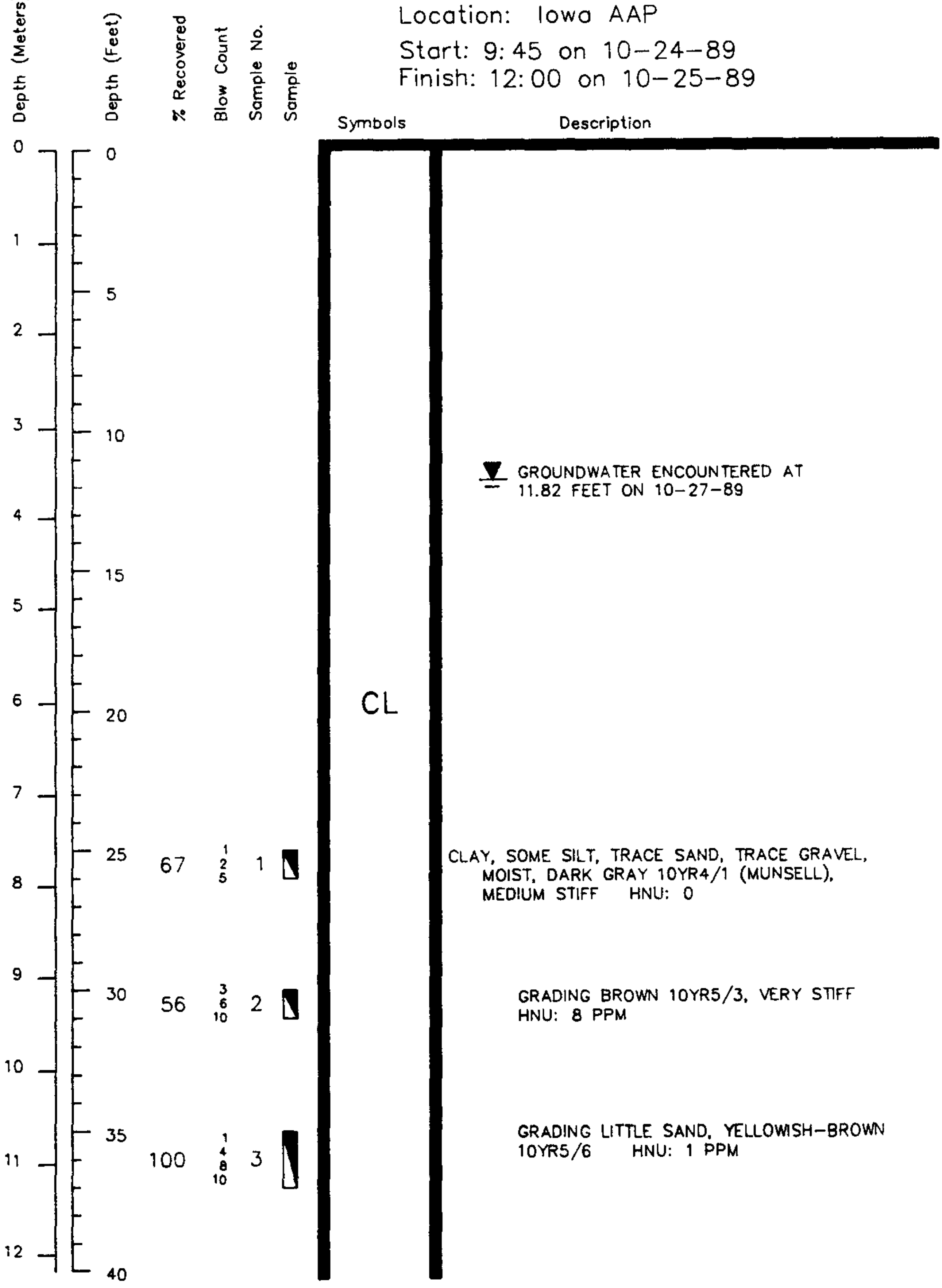
WELL INSTALLED TO A DEPTH OF 35.0 FEET ON 10-26-89

ALL SAMPLES TAKEN WITH A 24-INCH SPLIT SPOON SAMPLER

Dames & Moore

BORING DM-3

Surface Elevation: 728.8 Feet
Location: Iowa AAP
Start: 9:45 on 10-24-89
Finish: 12:00 on 10-25-89

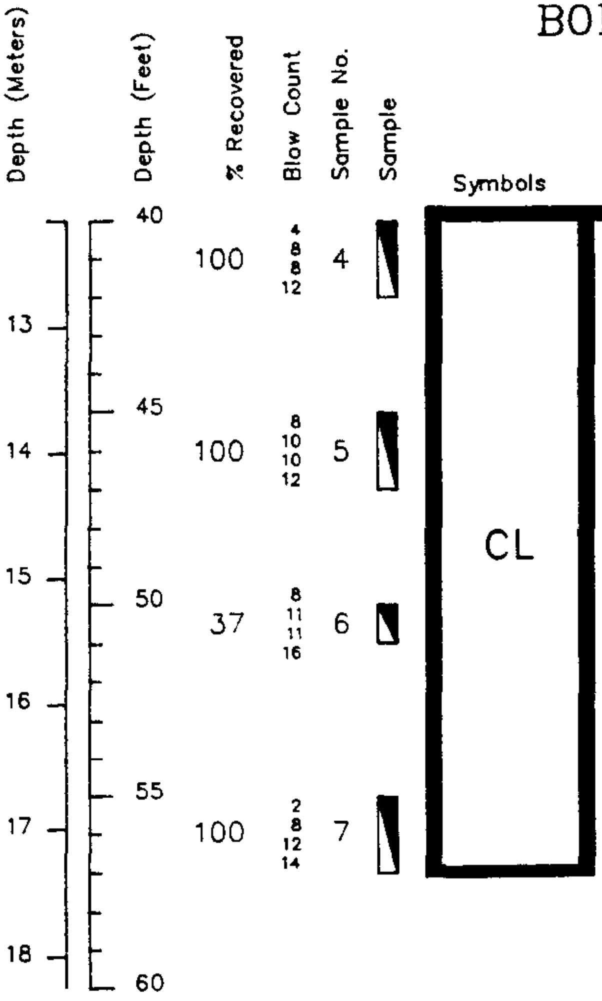


▼ GROUNDWATER ENCOUNTERED AT 11.82 FEET ON 10-27-89

% Recovered	Blow Count	Sample No.	Description
67	1 2 5	1	CLAY, SOME SILT, TRACE SAND, TRACE GRAVEL, MOIST, DARK GRAY 10YR4/1 (MUNSELL), MEDIUM STIFF HNU: 0
56	3 6 10	2	GRADING BROWN 10YR5/3, VERY STIFF HNU: 8 PPM
100	1 4 8 10	3	GRADING LITTLE SAND, YELLOWISH-BROWN 10YR5/6 HNU: 1 PPM

Dames & Moore

BORING DM-3, Cont'd.



% Recovered	Blow Count	Sample No.	Description
100	4 8 8 12	4	HNU: 5 PPM
100	8 10 10 12	5	HNU: 0 PPM
37	8 11 11 16	6	GRADING LITTLE SILT, TRACE SAND, DARK GRAY 10YR4/1 HNU: 0 PPM
100	2 8 12 14	7	GRADING SOME SILT, SOME SAND, YELLOWISH-BROWN 10YR5/4 HNU: 0 PPM

AUGERED TO BOTTOM OF HOLE AT 57.0 FEET ON 10-25-89

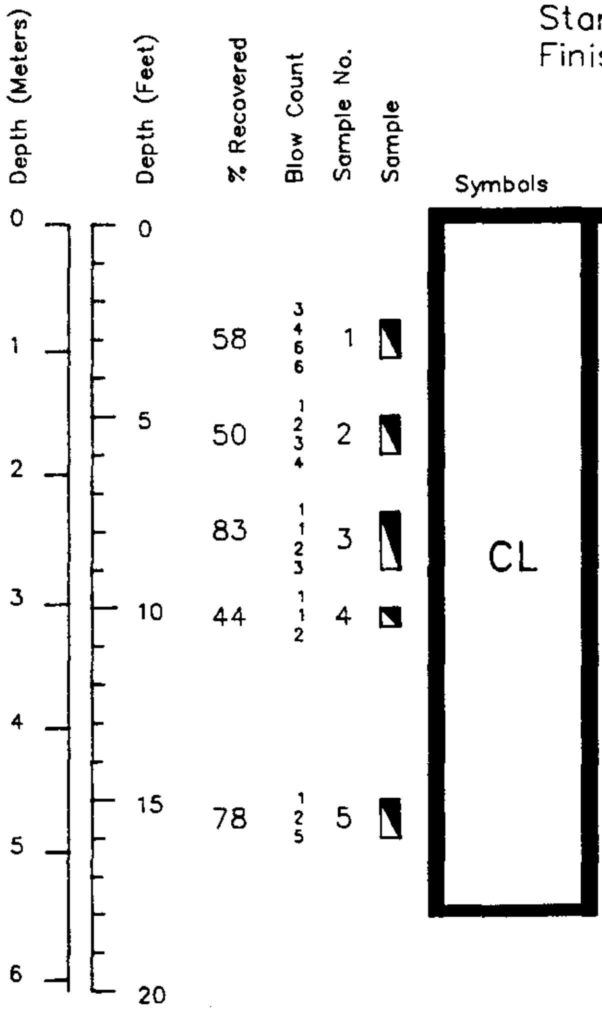
WELL INSTALLED TO A DEPTH OF 55.0 FEET ON 10-26-89

ALL SAMPLES TAKEN WITH A 24-INCH SPLIT SPOON SAMPLER

BORING DM-4

Surface Elevation: 729.1 Feet
Location: Iowa AAP

Start: 9:40 on 10-12-89
Finish: 11:10 on 10-12-89



% Recovered	Blow Count	Sample No.
58	3 4 6 6	1
50	1 2 3 4	2
83	1 1 2 3	3
44	1 1 2	4
78	1 2 5	5

Description

CLAY, TRACE SILT, MOIST, STIFF, VERY DARK GRAY
10YR3/1 (MUNSELL) HNU: 7.0 PPM

GRADING GRAY 10YR6/1
HNU: 0 PPM

HNU: 0 PPM

GROUNDWATER ENCOUNTERED AT
9.0 FEET ON 10-12-89
GRADING DARK GRAY 10YR4/1
HNU: 0 PPM

HNU: 0 PPM

AUGERED TO BOTTOM OF HOLE
18.0 FEET ON 10-12-89

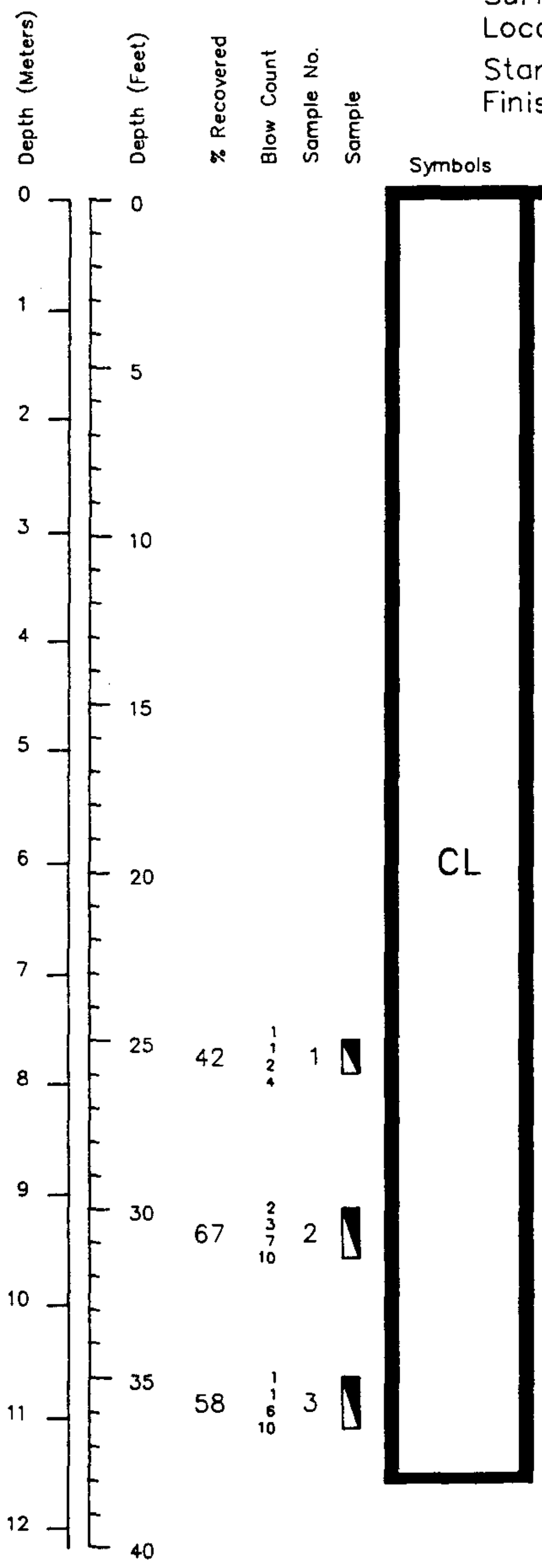
WELL INSTALLED TO A DEPTH OF
15.0 FEET ON 10-12-89

ALL SAMPLES TAKEN WITH A 24-INCH
SPLIT SPOON SAMPLER

Dames & Moore

BORING DM-5

Surface Elevation: 729.1 Feet
Location: Iowa AAP
Start: 8:45 on 10-24-89
Finish: 11:00 on 10-25-89



GROUNDWATER ENCOUNTERED AT 9.23 FEET ON 10-27-89

% Recovered	Blow Count	Sample No.	Description
42	1 1 2 4	1	CLAY, TRACE SILT, TRACE GRAVEL, MOIST, MEDIUM STIFF, GRAYISH-BROWN 10YR5/2 (MUNSELL) HNU: 0 PPM
67	2 3 7 10	2	GRADING VERY STIFF, DARK GRAY 10YR4/1 HNU: 0 PPM
58	1 1 6 10	3	

AUGERED TO BOTTOM OF HOLE AT 38.0 FEET ON 10-25-89

WELL INSTALLED TO A DEPTH OF 35.0 FEET ON 10-26-89

ALL SAMPLES TAKEN WITH A 24-INCH SPLIT SPOON SAMPLER

Dames & Moore

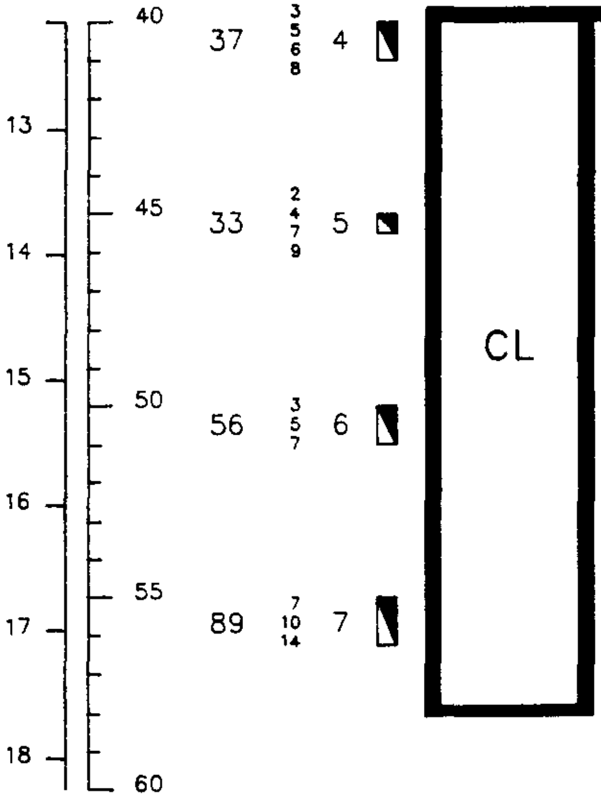
BORING DM-6

Surface Elevation: 729.1 Feet
Location: Iowa AAP
Start: 8:50 on 10-24-89
Finish: 17:30 on 10-26-89

Depth (Meters)	Depth (Feet)	% Recovered	Blow Count	Sample No.	Sample	Symbols	Description
0	0					CL	
1							
	5						
2							
3							
	10						
							▼ GROUNDWATER ENCOUNTERED AT 11.55 FEET ON 10-28-89
4							
	15						
5							
6							
	20						
7							
	25	50	1 4 6 7	1	◪		CLAY, SOME SILT, LITTLE SAND, LITTLE GRAVEL, MOIST, STIFF, DARK GRAY 10YR4/1 ±(MUNSELL) HNU: 0
8							
9							
	30	42	1 5 6 8	2	◪		GRADING TRACE SAND, TRACE GRAVEL, GRAY 10YR5/1 HNU: 0
10							
	35	50	4 5 9 11	3	◪		GRADING VERY STIFF, GRAY 10YR6/1, MOTTLED YELLOWISH-BROWN 10YR5/4
11							
12							
	40						

Dames & Moore

BORING DM-6, Cont'd.



Depth (Feet)	% Recovered	Blow Count	Sample No.	Sample	Symbols	Description
40	37	3 5 6 8	4	◪	CL	GRADING LITTLE SILT, STIFF, GRAY 10YR5/1 MOTTLED YELLOWISH-BROWN 10YR5/4 HNU: 0
45	33	2 4 7 9	5	◪		GRADING SOME SILT, GRAY 10YR5/1
50	56	3 5 7	6	◪		GRADING LITTLE SAND, LITTLE GRAVEL, GRAYISH-BROWN 10YR5/2 HNU: 0
55	89	7 10 14	7	◪		GRADING VERY STIFF, YELLOWISH-BROWN 10YR5/4

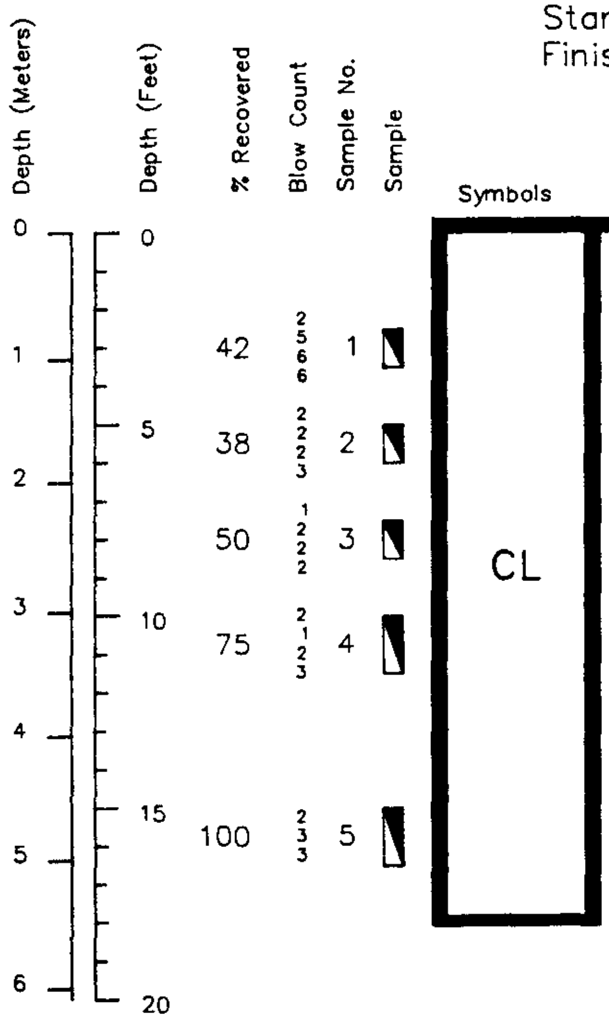
AUGERED TO BOTTOM OF HOLE AT 58.0 FEET ON 10-26-89

WELL INSTALLED TO A DEPTH OF 54.0 FEET ON 10-27-89

ALL SAMPLES TAKEN WITH A 24-INCH SPLIT SPOON SAMPLER

BORING DM-7

Surface Elevation: 729.4 Feet
Location: Iowa AAP
Start: 8:00 on 10-11-89
Finish: 9:30 on 10-11-89



Description

CLAY, SOME SILT, MOIST, STIFF, VERY DARK GRAY 10YR3/1 (MUNSELL)
HNU: 25.0 PPM IN THE BOREHOLE

GRADING MEDIUM STIFF, GRAY 10YR5/1
HNU: 0 PPM IN THE BOREHOLE

GRADING YELLOWISH-BROWN 10YR5/6
HNU: 0 PPM IN THE BOREHOLE

▼ GROUNDWATER ENCOUNTERED AT 11.0 FEET ON 10-11-89
GRADING LITTLE SILT, TRACE GRAVEL, DARK GRAY 10YR4/1
HNU: 0 PPM IN THE BOREHOLE

GRADING TRACE SAND, DARK GRAY 10YR4/1
HNU: 0 PPM IN THE BOREHOLE

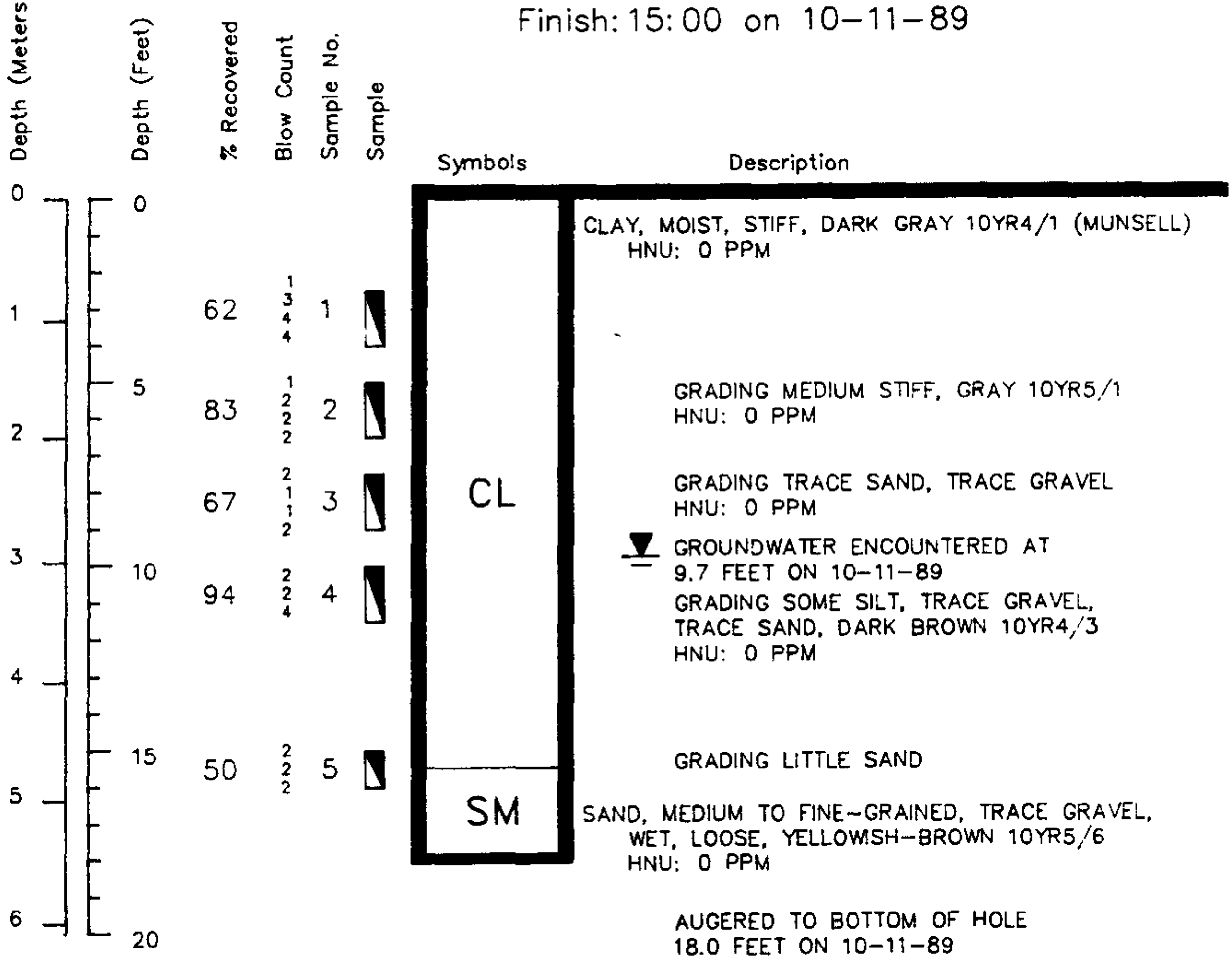
AUGERED TO BOTTOM OF HOLE 18.0 FEET ON 10-12-89

WELL INSTALLED TO A DEPTH OF 15.0 FEET ON 10-11-89

ALL SAMPLES TAKEN WITH A 24-INCH SPLIT SPOON SAMPLER

BORING DM-8

Surface Elevation: 728.8 Feet
Location: Iowa AAP
Start: 13:40 on 10-11-89
Finish: 15:00 on 10-11-89



% Recovered	Blow Count	Sample No.
62	1 3 4 4	1
83	1 2 2 2	2
67	2 1 1 2	3
94	2 2 4	4
50	2 2 2	5

CLAY, MOIST, STIFF, DARK GRAY 10YR4/1 (MUNSELL)
HNU: 0 PPM

GRADING MEDIUM STIFF, GRAY 10YR5/1
HNU: 0 PPM

GRADING TRACE SAND, TRACE GRAVEL
HNU: 0 PPM

▼ GROUNDWATER ENCOUNTERED AT
9.7 FEET ON 10-11-89

GRADING SOME SILT, TRACE GRAVEL, TRACE SAND, DARK BROWN 10YR4/3
HNU: 0 PPM

GRADING LITTLE SAND

SAND, MEDIUM TO FINE-GRAINED, TRACE GRAVEL, WET, LOOSE, YELLOWISH-BROWN 10YR5/6
HNU: 0 PPM

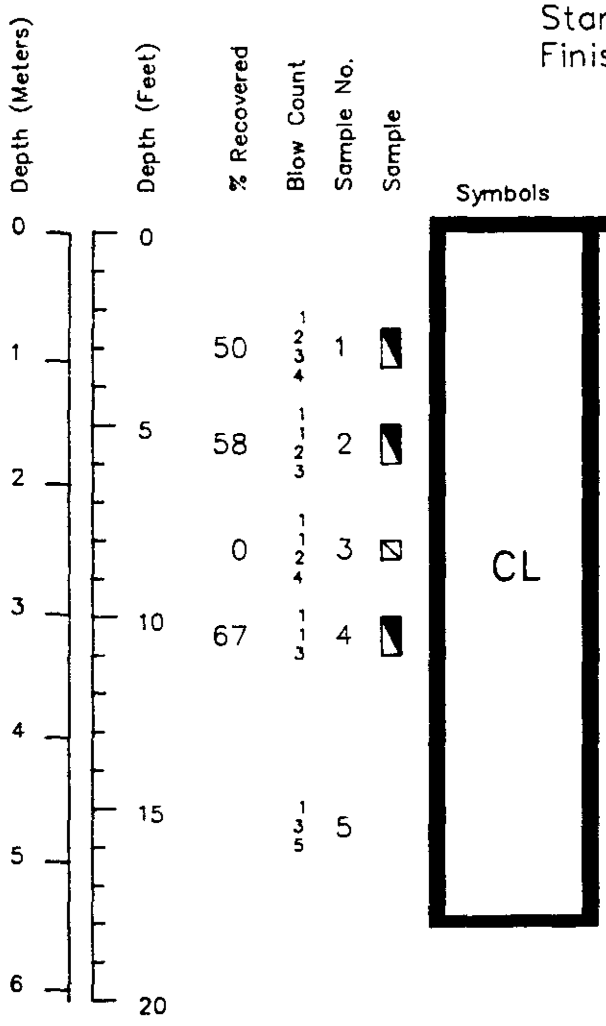
AUGERED TO BOTTOM OF HOLE
18.0 FEET ON 10-11-89

WELL INSTALLED TO A DEPTH OF
15.0 FEET ON 10-11-89

ALL SAMPLES TAKEN WITH A 24-INCH SPLIT SPOON SAMPLER

BORING DM-9

Surface Elevation: 729.0 Feet
Location: Iowa AAP
Start: 13:30 on 10-11-89
Finish: 14:40 on 10-11-89



Description

CLAY, TRACE SILT, MOIST, MEDIUM STIFF,
BLACK 10YR2/1 (MUNSELL) HNU: 0 PPM

GRADING GRAY 10YR6/1
HNU: 0 PPM

GRADING TRACE SAND, TRACE GRAVEL
HNU: 0 PPM

▼ GROUNDWATER ENCOUNTERED AT
10.0 FEET ON 10-11-89

GRADING STIFF, MOIST, YELLOWISH-BROWN,
10YR5/6 HNU: 0 PPM

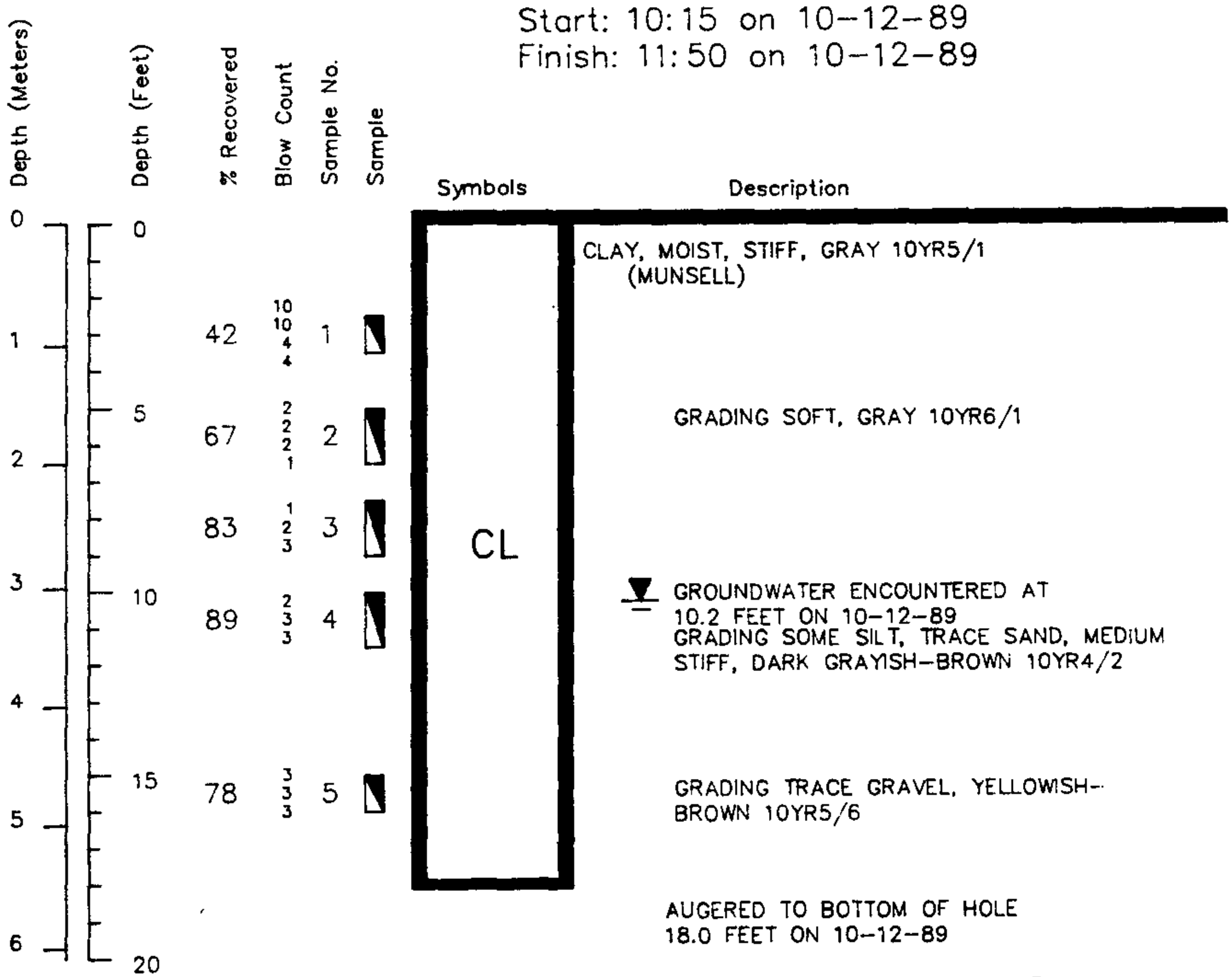
AUGERED TO BOTTOM OF HOLE
18.0 FEET ON 10-11-89

WELL INSTALLED TO A DEPTH OF
15.0 FEET ON 10-11-89

ALL SAMPLES TAKEN WITH A 24-INCH
SPLIT SPOON SAMPLER

BORING DM-10

Surface Elevation: 728.6 Feet
Location: Iowa AAP
Start: 10:15 on 10-12-89
Finish: 11:50 on 10-12-89



% Recovered	Blow Count	Sample No.
42	10 10 4 4	1
67	2 2 2 1	2
83	1 2 3	3
89	2 3 3	4
78	3 3 3	5

CLAY, MOIST, STIFF, GRAY 10YR5/1 (MUNSELL)

GRADING SOFT, GRAY 10YR6/1

▼ GROUNDWATER ENCOUNTERED AT 10.2 FEET ON 10-12-89

GRADING SOME SILT, TRACE SAND, MEDIUM STIFF, DARK GRAYISH-BROWN 10YR4/2

GRADING TRACE GRAVEL, YELLOWISH-BROWN 10YR5/6

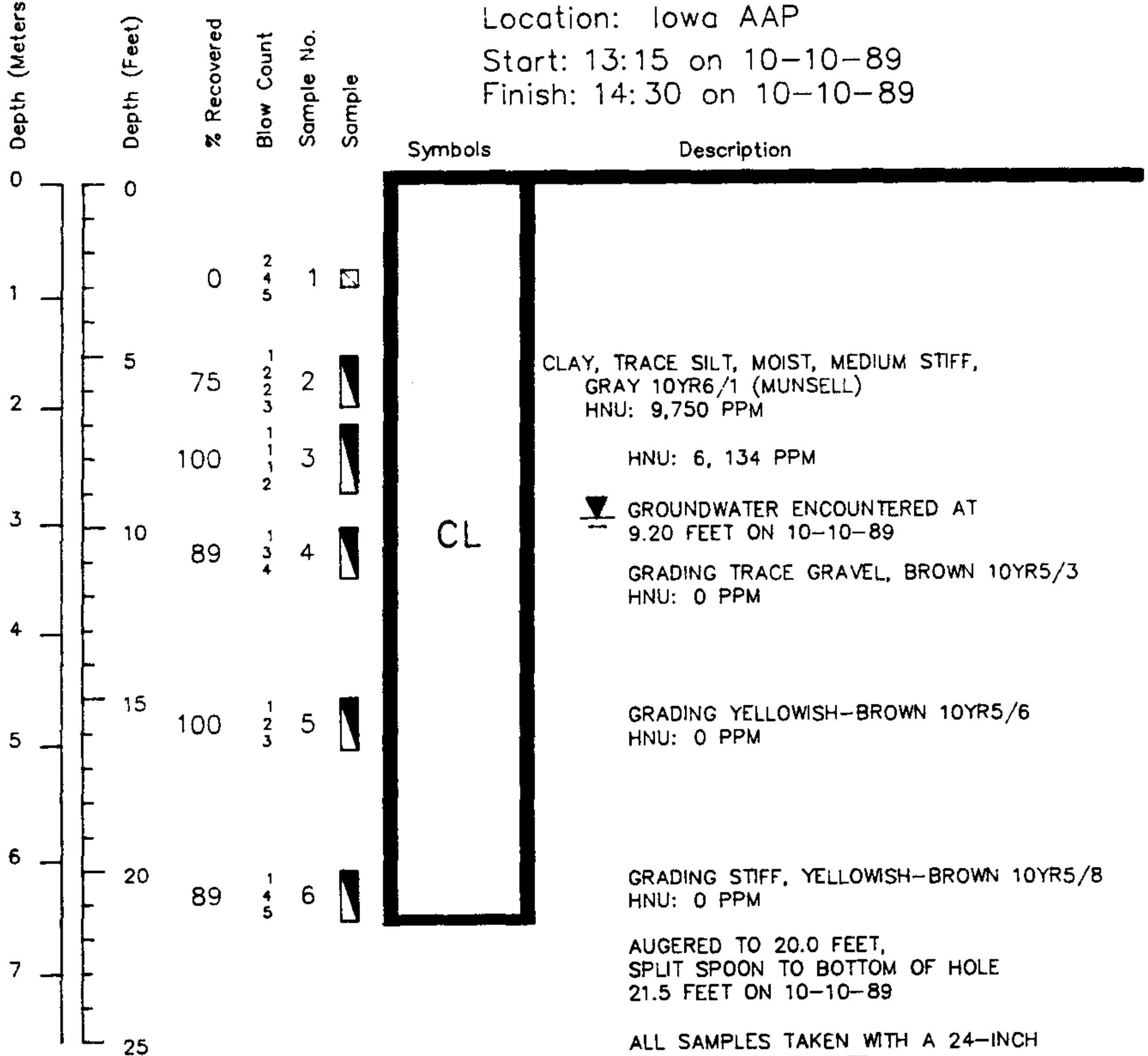
AUGERED TO BOTTOM OF HOLE 18.0 FEET ON 10-12-89

WELL INSTALLED TO A DEPTH OF 15.3 FEET ON 10-12-89

ALL SAMPLES TAKEN WITH A 24-INCH SPLIT SPOON SAMPLER

BORING DM-11

Surface Elevation: 729.0 Feet
Location: Iowa AAP
Start: 13:15 on 10-10-89
Finish: 14:30 on 10-10-89



% Recovered	Blow Count	Sample No.
0	2 4 5	1
75	1 2 2 3	2
100	1 1 1 2	3
89	1 3 4	4
100	1 2 3	5
89	1 4 5	6

CLAY, TRACE SILT, MOIST, MEDIUM STIFF,
GRAY 10YR6/1 (MUNSELL)
HNU: 9,750 PPM

HNU: 6, 134 PPM

GROUNDWATER ENCOUNTERED AT
9.20 FEET ON 10-10-89

GRADING TRACE GRAVEL, BROWN 10YR5/3
HNU: 0 PPM

GRADING YELLOWISH-BROWN 10YR5/6
HNU: 0 PPM

GRADING STIFF, YELLOWISH-BROWN 10YR5/8
HNU: 0 PPM

AUGERED TO 20.0 FEET,
SPLIT SPOON TO BOTTOM OF HOLE
21.5 FEET ON 10-10-89

ALL SAMPLES TAKEN WITH A 24-INCH
SPLIT SPOON SAMPLER

Dames & Moore

BORING DM-12

Surface Elevation: 729.0 Feet
Location: Iowa AAP
Start: 9:00 on 10-10-89
Finish: 11:00 on 10-10-89

Depth (Meters)	Depth (Feet)	% Recovered	Blow Count	Sample No.
0	0			
1		67	2 4 4	1
	5			
2		100	1 2 2 4	2
		75	1 1 2 4	3
3	10			
		100	1 2 4 5	4
4				
	15			
		89	1 2 4	5
5				
6				
	20			
		22	1 4 5	6
7				
	25			

Symbols

CL

Description

CLAY, TRACE SILT, STIFF, MOIST,
BLACK 10YR2/1 (MUNSELL)
HNU: 650 PPM

GRADING MEDIUM STIFF, GRAY 10YR5/1
HNU: 3,300 PPM

HNU: >9999 PPM

▼ GROUNDWATER ENCOUNTERED AT
9.7 FEET ON 10-10-89

GRADING STIFF, BLACK 10YR2/1
HNU: 22 PPM

GRADING SOME GRAVEL, SOME SAND, WET,
MEDIUM STIFF, GRAY 10YR5/1

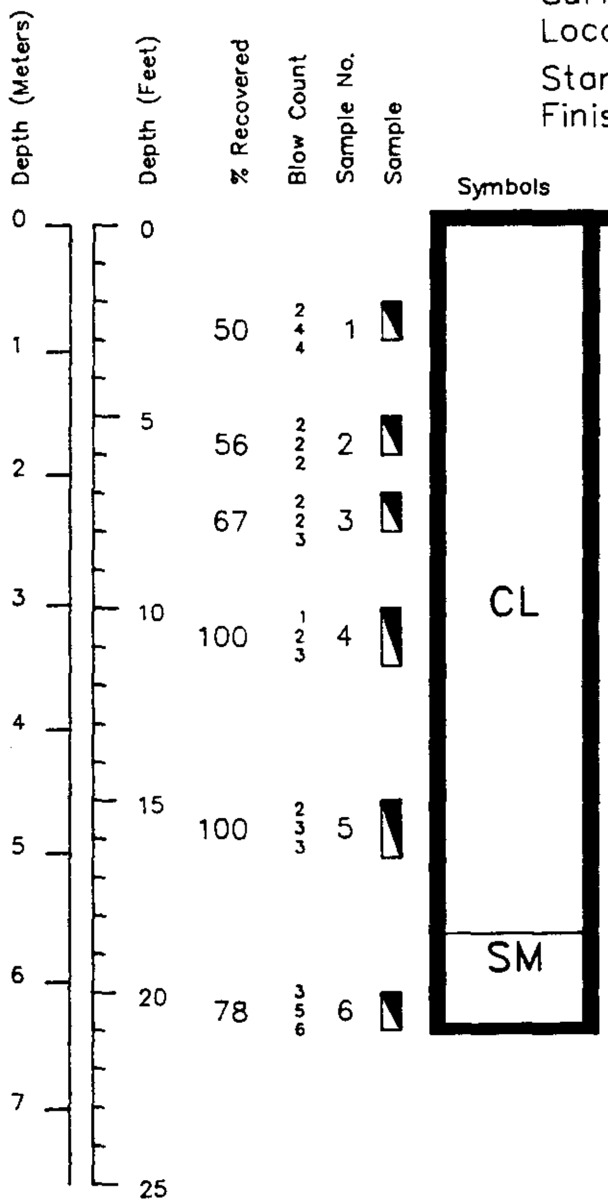
GRADING TRACE SILT, TRACE SAND, TRACE
GRAVEL, WET, STIFF, DARK BROWN 10YR3/3

AUGERED TO 20.0 FEET,
SPLIT SPOON TO BOTTOM OF HOLE
20.5 FEET ON 10-10-89

ALL SAMPLES TAKEN WITH A 24-INCH
SPLIT SPOON SAMPLER

BORING DM-13

Surface Elevation: 729.0 Feet
Location: Iowa AAP
Start: 13:00 on 10-10-89
Finish: 14:30 on 10-10-89



% Recovered	Blow Count	Sample No.
50	2 4 4	1
56	2 2 2	2
67	2 2 3	3
100	1 2 3	4
100	2 3 3	5
78	3 5 6	6

Description

CLAY, SOME SILT, MOIST, VERY DARK GRAY 10YR3/1 (MUNSELL) STIFF HNU: 0 PPM

GRADING GRAYISH-BROWN 10YR5/2
MEDIUM STIFF HNU: 0 PPM

HNU: 0 PPM

GRADING DARK YELLOWISH-BROWN
10YR4/4 HNU: 0 PPM

▼ GROUNDWATER ENCOUNTERED AT
12.0 FEET ON 10-10-89

GRADING LITTLE SAND, TRACE GRAVEL,
YELLOWISH-BROWN 10YR5/8
HNU: 0 PPM

SAND, MEDIUM TO FINE-GRAINED, TRACE COARSE-GRAINED SOME SILT, SOME CLAY, TRACE GRAVEL, MEDIUM DENSE

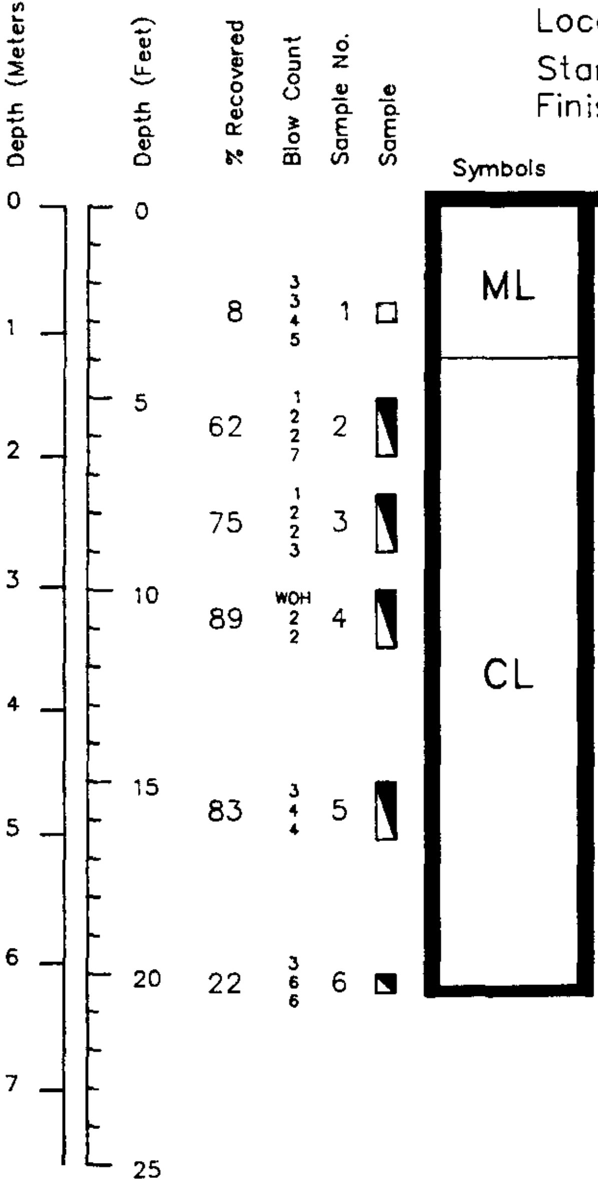
AUGERED TO 20.0 FEET,
SPLIT SPOON TO BOTTOM OF HOLE
21.0 FEET ON 10-10-89

ALL SAMPLES TAKEN WITH A 24-INCH
SPLIT SPOON SAMPLER

Dames & Moore

BORING DM–14

Surface Elevation: 729.0 Feet
Location: Iowa AAP
Start: 8:30 on 10–10–89
Finish: 11:00 on 10–10–89



% Recovered	Blow Count	Sample No.
8	3 3 4 5	1
62	1 2 2 7	2
75	1 2 2 3	3
89	WOH 2 2	4
83	3 4 4	5
22	3 6 6	6

Description

SILT, MOIST, VERY DARK GRAY 10YR3/1 (MUNSELL)
HNU: 0 PPM

CLAY, MOIST, GRAY 10YR5/1, STIFF
HNU: 0 PPM

GRADING DARK YELLOWISH–BROWN 10YR4/4
MEDIUM STIFF HNU: 0 PPM

▼ GROUNDWATER ENCOUNTERED AT
9.7 FEET ON 10–10–89

GRADING SOME SILT, STIFF
HNU: 0 PPM

GRADING LITTLE GRAVEL, TRACE SAND,
OLIVE 5Y4/4 HNU: 0 PPM

AUGERED TO 20.0 FEET,
SPLIT SPOON TO BOTTOM OF HOLE
20.5 FEET ON 10–10–89

ALL SAMPLES TAKEN WITH A 24–INCH
SPLIT SPOON SAMPLER

Dames & Moore

APPENDIX D

PHYSICAL SOIL TESTING RESULTS

Hannibal Testing Laboratories, Inc.
P. O. Box 387 4500 Paris Gravel Road
HANNIBAL, MISSOURI 63401

(314) 221-7714

LETTER OF TRANSMITTAL

Received
11/13/89 WDE

DATE 11-8-89
JOB NO. 89-842
ATTENTION Bill Eaton
RE: IAAP Ammunition Plant: Burlington, Iowa: Summary of Laboratory Classification Test Data and Sieve Analyses

TO Dames & Moore
7101 Wisconsin Avenue, Suite 700
Bethesda, Maryland 20814-4870

GENTLEMEN:

WE ARE SENDING YOU ☒ Attached ☐ Under separate cover via ____________ the following items:

☐ Shop drawings ☐ Prints ☐ Plans ☐ Samples ☐ Specifications

☐ Copy of letter ☐ Change order ☐ ____________

COPIES	DATE	NO.	DESCRIPTION
1	10-31-89		Summary of Laboratory Classification Test Data
1	10-26-89		Sieve Analyses DM-6, 25 Ft., 30 Ft., 35 FT., & 40 Ft.
1	10-11-89		Sieve Analyses DM-7, 2.5 Ft., 5 Ft., 7½ Ft, & 10 Ft.
1	10-12-89		Sieve Analyses DM-10, 2½ Ft., 5 Ft., 7½ Ft., & 10 Ft.

THESE ARE TRANSMITTED as checked below:

☐ For approval ☐ Approved as submitted ☐ Resubmit ____ copies for approval

☒ For your use ☐ Approved as noted ☐ Submit ____ copies for distribution

☒ As requested ☐ Returned for corrections ☐ Return ____ corrected prints

☐ For review and comment ☐ ____________

☐ FOR BIDS DUE ____________ 19____ ☐ PRINTS RETURNED AFTER LOAN TO US

REMARKS ____________

COPY TO ____________

SIGNED:
Ronald W. Craven, P.E.

If enclosures are not as noted, kindly notify us at once.

HANNIBAL TESTING LABORATORIES, INC.
P. O. BOX 387
HANNIBAL, MISSOURI 63401

HTL FORM 49

SUMMARY OF LABORATORY CLASSIFICATION TEST DATA

PROJECT: IAAP BURLINGTON, IOWA PETROLEUM LEAK/SPILL AREA

PROJECT NO.: 89-842

CLIENT : DAMES & MOORE

BORING NO.	SAMPLE NO.	SAMPLE DEPTH	SAMPLE DESCRIPTION	W_L %	W_N %	W_P %	γ PCF	γ_d PCF	Qu TSF	Qp TSF	N	SOIL CLASSIFICATION AASHTO	UNIFIED
DM-6		25 FT.	GRAY SANDY SILTY CLAY, TRACE OF FINE GRAVEL	27		15							CL
DM-6		30 FT.	GRAY MOTTLED YELLOW BROWN CLAY, LITTLE SAND	66		22							CH
DM-6		35 FT.	GRAY MOTTLED YELLOW BROWN SANDY CLAY	52		19							CH
DM-6		40 FT.	YELLOW BROWN MOTTLED GRAY SILTY CLAY, SOME SAND, TRACE OF GRAVEL	48		17							CL
DM-7		2.5 FT.	DARK BROWNISH GRAY CLAY, TRACE OF FINE SAND	56		25							CH
DM-7		5 FT.	YELLOW BROWN MOTTLED GRAY CLAY	55		24							CH
DM-7		7½ FT.	YELLOW BROWN MOTTLED GRAY SILTY CLAY, TRACE OF FINE SAND	45		25							CL
DM-7		10 FT.	YELLOW BROWN MOTTLED GRAY SILTY CLAY, SOME SAND	43		17							CL

HANNIBAL TESTING LABORATORIES, INC.
P. O. BOX 387
HANNIBAL, MISSOURI 63401

HTL FORM 49

SUMMARY OF LABORATORY CLASSIFICATION TEST DATA

PROJECT: IAAP BURLINGTON, IOWA
PETROLEUM LEAK/SPILL AREA

PROJECT No.: 89-842

CLIENT : DAMES & MOORE

BORING NO.	SAMPLE NO.	SAMPLE DEPTH	SAMPLE DESCRIPTION	W_L %	W_N %	W_P %	γ PCF	γ_d PCF	Qu TSF	Qp TSF	N	SOIL CLASSIFICATION AASHTO	SOIL CLASSIFICATION UNIFIED
DM-10		2½ FT.	YELLOW BROWN MOTTLED GRAY AND LIGHT GRAY CLAY, TRACE OF FINE SAND	65		28							CH
DM-10		5 FT.	LIGHT GRAY MOTTLED YELLOW BROWN CLAY, TRACE OF FINE SAND	54		25							CH
DM-10		7½ FT.	YELLOW BROWN MOTTLED GRAY CLAY, TRACE OF FINE SAND	57		26							CH
DM-10		10 FT.	GRAY MOTTLED DARK YELLOW BROWN SILTY CLAY, LITTLE SAND	48		20							CL

HTL FORM NO. 62 PROJECT NO. 89-842

SIEVE ANALYSIS

PROJECT PETROLEUM LEAK/SPILL AREA IOWA ARMY AMMUNITION PLANT

LOCATION BURLINGTON, IOWA

CLIENT DAMES & MOORE

TEST METHOD ASTM D 1140 & D 422

SAMPLE DESCRIPTION GRAY SANDY SILTY CLAY, TRACE OF FINE GRAVEL, (CL)

SAMPLE SOURCE TEST BORING DM - 6

BORING OR TEST PIT NO. DM-6

SAMPLE NO.

SAMPLE DEPTH 25 FT.

SAMPLE TYPE S.S.

MAXIMUM PARTICLE SIZE

WT. OF OVEN DRY SAMPLE & TARE

WT. OF TARE

WT. OF OVEN DRY SAMPLE = Ws

U.S. STANDARD SIEVE SIZE OR NUMBER	WT. RETAINED ON THIS SIEVE	% RETAINED ON THIS SIEVE	CUMULATIVE		SPECIFICATION LIMITS % PASSING
			% RETAINED	% PASSING	
3 Inch					
2 Inch					
1½ Inch					
1 Inch					
3/4 Inch					
1/2 Inch					
3/8 Inch		0	0	100	
No. 3					
No. 4		4.5	4.5	95.5	
No. 6					
No. 8					
No. 10		2.0	6.5	93.5	
No. 16					
No. 20					
No. 30					
No. 40		7.9	14.4	85.6	
No. 50					
No. 60					
No. 70					
No. 100					
No. 140					
No. 200		22.5	36.9	63.1	
Pan					
TOTALS					

COMMENTS	TOTAL SHOULD EQUAL Ws	TOTAL SHOULD EQUAL 100%	TOTAL ÷ 100 = FINENESS MODULUS		
TECHNICIAN'S REMARKS:			FINENESS MODULUS EQUALS		

SEE DEFINITIONS & NOTES ON REVERSE SIDE

SAMPLE OBTAINED BY HTL 10-26-89
DATE

TESTED BY T. HEMME 10-31-89
TECHNICIAN DATE

CHECKED BY R. CRAVEN 11-7-89
PROJECT ENGINEER DATE

Hannibal Testing Laboratories, Inc.
P.O. BOX 387 • 4500 PARIS GRAVEL ROAD
HANNIBAL, MISSOURI 63401 • (314) 221-7714

HTL FORM NO. 62

PROJECT NO. 89-842

SIEVE ANALYSIS

PROJECT PETROLEUM LEAK/SPILL AREA IOWA ARMY AMMUNITION PLANT

LOCATION BURLINGTON, IOWA

CLIENT DAMES & MOORE

TEST METHOD ASTM D 1140 & D 422

SAMPLE DESCRIPTION GRAY MOTTLED YELLOW BROWN CLAY, LITTLE SAND (CH)

SAMPLE SOURCE TEST BORING DM - 6

BORING OR TEST PIT NO. DM-6

SAMPLE NO.

SAMPLE DEPTH 30 FT.

SAMPLE TYPE S.S.

MAXIMUM PARTICLE SIZE

WT. OF OVEN DRY SAMPLE & TARE

WT. OF TARE

WT. OF OVEN DRY SAMPLE = Ws

U.S. STANDARD SIEVE SIZE OR NUMBER	WT. RETAINED ON THIS SIEVE	% RETAINED ON THIS SIEVE	CUMULATIVE		SPECIFICATION LIMITS % PASSING
			% RETAINED	% PASSING	
3 Inch					
2 Inch					
1½ Inch					
1 Inch					
3/4 Inch					
1/2 Inch					
3/8 Inch					
No. 3					
No. 4		0	0	100	
No. 6					
No. 8					
No. 10		0.2	0.2	99.8	
No. 16					
No. 20					
No. 30					
No. 40		3.4	3.6	96.4	
No. 50					
No. 60					
No. 70					
No. 100					
No. 140					
No. 200		12.1	15.7	84.3	
Pan					
TOTALS					

COMMENTS	TOTAL SHOULD EQUAL Ws	TOTAL SHOULD EQUAL 100%	TOTAL ÷ 100 = FINENESS MODULUS		
TECHNICIAN'S REMARKS:			FINENESS MODULUS EQUALS		

SEE DEFINITIONS & NOTES ON REVERSE SIDE

SAMPLE OBTAINED BY HTL 10-26-89 DATE

TESTED BY T. HEMME TECHNICIAN 10-31-89 DATE

CHECKED BY R. CRAVEN PROJECT ENGINEER 11-7-89 DATE

Hannibal Testing Laboratories, Inc.
P.O. BOX 387 • 4500 PARIS GRAVEL ROAD
HANNIBAL, MISSOURI 63401 • (314) 221-7714

HTL FORM NO. 62

PROJECT NO. 89-842

SIEVE ANALYSIS

PROJECT PETROLEUM LEAK/SPILL AREA IOWA ARMY AMMUNITION PLANT

LOCATION BURLINGTON, IOWA

CLIENT DAMES & MOORE

TEST METHOD ASTM D 1140 & D 422

SAMPLE DESCRIPTION GRAY MOTTLED YELLOW BROWN SANDY CLAY, (CH)

SAMPLE SOURCE TEST BORING DM - 6

BORING OR TEST PIT NO. DM-6

SAMPLE NO.

SAMPLE DEPTH 35 FT.

SAMPLE TYPE S.S.

MAXIMUM PARTICLE SIZE

WT. OF OVEN DRY SAMPLE & TARE

WT. OF TARE

WT. OF OVEN DRY SAMPLE = Ws

U.S. STANDARD SIEVE SIZE OR NUMBER	WT. RETAINED ON THIS SIEVE	% RETAINED ON THIS SIEVE	CUMULATIVE		SPECIFICATION LIMITS % PASSING
			% RETAINED	% PASSING	
3 Inch					
2 Inch					
1½ Inch					
1 Inch					
3/4 Inch					
1/2 Inch					
3/8 Inch					
No. 3					
No. 4		0	0	100	
No. 6					
No. 8					
No. 10		0.06	0.06	99.9	
No. 16					
No. 20					
No. 30					
No. 40		5.1	5.16	94.8	
No. 50					
No. 60					
No. 70					
No. 100					
No. 140					
No. 200		21.7	26.86	73.1	
Pan					
TOTALS				☒	☒

COMMENTS	TOTAL SHOULD EQUAL Ws	TOTAL SHOULD EQUAL 100%	TOTAL ÷ 100 = FINENESS MODULUS		
TECHNICIAN'S REMARKS:			FINENESS MODULUS EQUALS		

SEE DEFINITIONS & NOTES ON REVERSE SIDE

SAMPLE OBTAINED BY HTL 10-26-89
DATE

TESTED BY T. HEMME 10-31-89
TECHNICIAN DATE

CHECKED BY R. CRAVEN 11-7-89
PROJECT ENGINEER DATE

Hannibal Testing Laboratories, Inc.
P.O. BOX 387 • 4500 PARIS GRAVEL ROAD
HANNIBAL, MISSOURI 63401 • (314) 221-7714

HTL FORM NO. 62

PROJECT NO. 89-842

SIEVE ANALYSIS

PROJECT PETROLEUM LEAK/SPILL AREA IOWA ARMY AMMUNITION PLANT

LOCATION BURLINGTON, IOWA

CLIENT DAMES & MOORE

TEST METHOD ASTM D 1140 & D 422

SAMPLE DESCRIPTION YELLOW BROWN MOTTLED GRAY SILTY CLAY, SOME SAND, TRACE OF GRAVEL,(CL)

SAMPLE SOURCE TEST BORING DM - 6

BORING OR TEST PIT NO. DM-6

SAMPLE NO.

SAMPLE DEPTH 40 FT.

SAMPLE TYPE S.S.

MAXIMUM PARTICLE SIZE

WT. OF OVEN DRY SAMPLE & TARE

WT. OF TARE

WT. OF OVEN DRY SAMPLE = Ws

U.S. STANDARD SIEVE SIZE OR NUMBER	WT. RETAINED ON THIS SIEVE	% RETAINED ON THIS SIEVE	CUMULATIVE % RETAINED	CUMULATIVE % PASSING	SPECIFICATION LIMITS % PASSING
3 Inch					
2 Inch					
1½ Inch					
1 Inch					
3/4 Inch					
1/2 Inch					
3/8 Inch		0	0	100	
No. 3					
No. 4		0.5	0.5	99.5	
No. 6					
No. 8					
No. 10		0.3	0.8	99.2	
No. 16					
No. 20					
No. 30					
No. 40		4.7	5.5	94.5	
No. 50					
No. 60					
No. 70					
No. 100					
No. 140					
No. 200		18.0	23.5	76.5	
Pan					
TOTALS					

COMMENTS	TOTAL SHOULD EQUAL Ws	TOTAL SHOULD EQUAL 100%	TOTAL ÷ 100 = FINENESS MODULUS		
TECHNICIAN'S REMARKS:			FINENESS MODULUS EQUALS		

SEE DEFINITIONS & NOTES ON REVERSE SIDE

SAMPLE OBTAINED BY HTL 10-26-89 DATE

TESTED BY T. HEMME TECHNICIAN 10-31-89 DATE

CHECKED BY R. CRAVEN PROJECT ENGINEER 11-7-89 DATE

Hannibal Testing Laboratories, Inc.
P.O. BOX 387 • 4500 PARIS GRAVEL ROAD
HANNIBAL, MISSOURI 63401 • (314) 221-7714

HTL FORM NO. 62 PROJECT NO. 89-842

SIEVE ANALYSIS

PROJECT PETROLEUM LEAK/SPILL AREA IOWA ARMY AMMUNITION PLANT
LOCATION BURLINGTON, IOWA
CLIENT DAMES & MOORE
TEST METHOD ASTM D 1140 & D 422
SAMPLE DESCRIPTION DARK BROWNISH GRAY CLAY, TRACE OF FINE SAND, (CH)
SAMPLE SOURCE TEST BORING DM - 7
BORING OR TEST PIT NO. DM-7
SAMPLE NO.
SAMPLE DEPTH 2.5 FT.
SAMPLE TYPE S.S.
MAXIMUM PARTICLE SIZE
WT. OF OVEN DRY SAMPLE & TARE
WT. OF TARE
WT. OF OVEN DRY SAMPLE = Ws

U.S. STANDARD SIEVE SIZE OR NUMBER	WT. RETAINED ON THIS SIEVE	% RETAINED ON THIS SIEVE	CUMULATIVE		SPECIFICATION LIMITS % PASSING
			% RETAINED	% PASSING	
3 Inch					
2 Inch					
1½ Inch					
1 Inch					
3/4 Inch					
1/2 Inch					
3/8 Inch					
No. 3					
No. 4					
No. 6					
No. 8					
No. 10					
No. 16					
No. 20					
No. 30					
No. 40					
No. 50					
No. 60					
No. 70					
No. 100					
No. 140					
No. 200		1.2	1.2	98.9	
Pan					
TOTALS					

COMMENTS	TOTAL SHOULD EQUAL Ws	TOTAL SHOULD EQUAL 100%	TOTAL ÷ 100 = FINENESS MODULUS		
TECHNICIAN'S REMARKS:			FINENESS MODULUS EQUALS		

SEE DEFINITIONS & NOTES ON REVERSE SIDE

SAMPLE OBTAINED BY HTL 10-11-89 DATE
TESTED BY T. HEMME TECHNICIAN 10-31-89 DATE
CHECKED BY R. CRAVEN PROJECT ENGINEER 11-7-89 DATE

Hannibal Testing Laboratories, Inc.
P.O. BOX 387 • 4500 PARIS GRAVEL ROAD
HANNIBAL, MISSOURI 63401 • (314) 221-7714

HTL FORM NO. 62 PROJECT NO. 89-842

SIEVE ANALYSIS

PROJECT PETROLEUM LEAK/SPILL AREA IOWA ARMY AMMUNITION PLANT LOCATION BURLINGTON, IOWA

CLIENT DAMES & MOORE TEST METHOD ASTM D 1140 & D 422

SAMPLE DESCRIPTION YELLOW BROWN MOTTLED GRAY CLAY, (CH)

SAMPLE SOURCE TEST BORING DM - 7

BORING OR TEST PIT NO. DM-7
SAMPLE NO.
SAMPLE DEPTH 5 FT.
SAMPLE TYPE S.S.

MAXIMUM PARTICLE SIZE
WT. OF OVEN DRY SAMPLE & TARE
WT. OF TARE
WT. OF OVEN DRY SAMPLE = Ws

U.S. STANDARD SIEVE SIZE OR NUMBER	WT. RETAINED ON THIS SIEVE	% RETAINED ON THIS SIEVE	CUMULATIVE		SPECIFICATION LIMITS % PASSING
			% RETAINED	% PASSING	
3 Inch					
2 Inch					
1½ Inch					
1 Inch					
3/4 Inch					
1/2 Inch					
3/8 Inch					
No. 3					
No. 4					
No. 6					
No. 8					
No. 10					
No. 16					
No. 20					
No. 30					
No. 40					
No. 50					
No. 60					
No. 70					
No. 100					
No. 140					
No. 200		0	0	100	
Pan					
TOTALS					

COMMENTS	TOTAL SHOULD EQUAL Ws	TOTAL SHOULD EQUAL 100%	TOTAL ÷ 100 = FINENESS MODULUS		
TECHNICIAN'S REMARKS:			FINENESS MODULUS EQUALS		

SEE DEFINITIONS & NOTES ON REVERSE SIDE

SAMPLE OBTAINED BY HTL 10-11-89 DATE

TESTED BY T. HEMME 10-31-89
TECHNICIAN DATE

CHECKED BY R. CRAVEN 11-7-89
PROJECT ENGINEER DATE

Hannibal Testing Laboratories, Inc.
P.O. BOX 387 • 4500 PARIS GRAVEL ROAD
HANNIBAL, MISSOURI 63401 • (314) 221-7714

HTL FORM NO. 62

PROJECT NO. 89-842

SIEVE ANALYSIS

PROJECT PETROLEUM LEAK/SPILL AREA IOWA ARMY AMMUNITION PLANT

LOCATION BURLINGTON, IOWA

CLIENT DAMES & MOORE

TEST METHOD ASTM D 1140 & D 422

SAMPLE DESCRIPTION YELLOW BROWN MOTTLED GRAY SILTY CLAY, TRACE OF FINE SAND, (CL)

SAMPLE SOURCE TEST BORING DM - 7

BORING OR TEST PIT NO. DM-7
SAMPLE NO.
SAMPLE DEPTH 7½ FT.
SAMPLE TYPE S.S.

MAXIMUM PARTICLE SIZE
WT. OF OVEN DRY SAMPLE & TARE
WT. OF TARE
WT. OF OVEN DRY SAMPLE = Ws

U.S. STANDARD SIEVE SIZE OR NUMBER	WT. RETAINED ON THIS SIEVE	% RETAINED ON THIS SIEVE	CUMULATIVE		SPECIFICATION LIMITS % PASSING
			% RETAINED	% PASSING	
3 Inch					
2 Inch					
1½ Inch					
1 Inch					
3/4 Inch					
1/2 Inch					
3/8 Inch					
No. 3					
No. 4					
No. 6					
No. 8					
No. 10					
No. 16					
No. 20					
No. 30					
No. 40					
No. 50					
No. 60					
No. 70					
No. 100					
No. 140					
No. 200		1.2	1.2	98.8	
Pan					
TOTALS					

COMMENTS	TOTAL SHOULD EQUAL Ws	TOTAL SHOULD EQUAL 100%	TOTAL ÷ 100 = FINENESS MODULUS		
TECHNICIAN'S REMARKS:			FINENESS MODULUS EQUALS		

SEE DEFINITIONS & NOTES ON REVERSE SIDE

SAMPLE OBTAINED BY HTL 10-11-89 DATE

TESTED BY T. HEMME TECHNICIAN 10-31-89 DATE

CHECKED BY R. CRAVEN PROJECT ENGINEER 11-7-89 DATE

Hannibal Testing Laboratories, Inc.
P.O. BOX 387 • 4500 PARIS GRAVEL ROAD
HANNIBAL, MISSOURI 63401 • (314) 221-7714

HTL FORM NO. 62

PROJECT NO. 89-842

SIEVE ANALYSIS

PROJECT PETROLEUM LEAK/SPILL AREA IOWA ARMY AMMUNITION PLANT

LOCATION BURLINGTON, IOWA

CLIENT DAMES & MOORE

TEST METHOD ASTM D 1140 & D 422

SAMPLE DESCRIPTION YELLOW BROWN MOTTLED GRAY SILTY CLAY, SOME SAND, (CL)

SAMPLE SOURCE TEST BORING DM - 7

BORING OR TEST PIT NO. DM-7

SAMPLE NO.

SAMPLE DEPTH 10 FT.

SAMPLE TYPE S.S.

MAXIMUM PARTICLE SIZE

WT. OF OVEN DRY SAMPLE & TARE

WT. OF TARE

WT. OF OVEN DRY SAMPLE = Ws

U.S. STANDARD SIEVE SIZE OR NUMBER	WT. RETAINED ON THIS SIEVE	% RETAINED ON THIS SIEVE	CUMULATIVE % RETAINED	CUMULATIVE % PASSING	SPECIFICATION LIMITS % PASSING
3 Inch					
2 Inch					
1½ Inch					
1 Inch					
3/4 Inch					
1/2 Inch					
3/8 Inch					
No. 3					
No. 4		0	0	100	
No. 6					
No. 8					
No. 10		0.6	0.6	99.4	
No. 16					
No. 20					
No. 30					
No. 40		4.7	5.3	94.7	
No. 50					
No. 60					
No. 70					
No. 100					
No. 140					
No. 200		16.3	21.6	78.4	
Pan					
TOTALS					

COMMENTS	TOTAL SHOULD EQUAL Ws	TOTAL SHOULD EQUAL 100%	TOTAL ÷ 100 = FINENESS MODULUS		
TECHNICIAN'S REMARKS:			FINENESS MODULUS EQUALS		

SEE DEFINITIONS & NOTES ON REVERSE SIDE

SAMPLE OBTAINED BY HTL 10-11-89 DATE

TESTED BY T. HEMME 10-31-89
TECHNICIAN DATE

CHECKED BY R. CRAVEN 11-7-89
PROJECT ENGINEER DATE

Hannibal Testing Laboratories, Inc.
P.O. BOX 387 • 4500 PARIS GRAVEL ROAD
HANNIBAL, MISSOURI 63401 • (314) 221-7714

HTL FORM NO. 62

PROJECT NO. 89-842

SIEVE ANALYSIS

PROJECT PETROLEUM LEAK/SPILL AREA IOWA ARMY AMMUNITION PLANT

LOCATION BURLINGTON, IOWA

CLIENT DAMES & MOORE

TEST METHOD ASTM D 1140 & D 422

SAMPLE DESCRIPTION YELLOW BROWN MOTTLED GRAY & LIGHT GRAY CLAY, TRACE OF FINE SAND,(CH)

SAMPLE SOURCE TEST BORING DM - 10

BORING OR TEST PIT NO. DM-10

SAMPLE NO.

SAMPLE DEPTH 2½ FT.

SAMPLE TYPE S.S.

MAXIMUM PARTICLE SIZE

WT. OF OVEN DRY SAMPLE & TARE

WT. OF TARE

WT. OF OVEN DRY SAMPLE = Ws

U.S. STANDARD SIEVE SIZE OR NUMBER	WT. RETAINED ON THIS SIEVE	% RETAINED ON THIS SIEVE	CUMULATIVE		SPECIFICATION LIMITS % PASSING
			% RETAINED	% PASSING	
3 Inch					
2 Inch					
1½ Inch					
1 Inch					
3/4 Inch					
1/2 Inch					
3/8 Inch					
No. 3					
No. 4					
No. 6					
No. 8					
No. 10					
No. 16					
No. 20					
No. 30					
No. 40					
No. 50					
No. 60					
No. 70					
No. 100					
No. 140					
No. 200		2.6	2.6	97.4	
Pan					
TOTALS					

COMMENTS	TOTAL SHOULD EQUAL Ws	TOTAL SHOULD EQUAL 100%	TOTAL ÷ 100 = FINENESS MODULUS		
TECHNICIAN'S REMARKS:			FINENESS MODULUS EQUALS		

SEE DEFINITIONS & NOTES ON REVERSE SIDE

SAMPLE OBTAINED BY HTL 10-12-89 DATE

TESTED BY T. HEMME 10-31-89
TECHNICIAN DATE

CHECKED BY R. CRAVEN 11-7-89
PROJECT ENGINEER DATE

Hannibal Testing Laboratories, Inc.
P.O. BOX 387 • 4500 PARIS GRAVEL ROAD
HANNIBAL, MISSOURI 63401 • (314) 221-7714

HTL FORM NO. 62

PROJECT NO. 89-842

SIEVE ANALYSIS

PROJECT PETROLEUM LEAK/SPILL AREA IOWA ARMY AMMUNITION PLANT

LOCATION BURLINGTON, IOWA

CLIENT DAMES & MOORE

TEST METHOD ASTM D 1140 & D 422

SAMPLE DESCRIPTION LIGHT GRAY MOTTLED YELLOW BROWN CLAY, TRACE OF FINE SAND, (CH)

SAMPLE SOURCE TEST BORING DM - 10

BORING OR TEST PIT NO. DM-10

SAMPLE NO.

SAMPLE DEPTH 5 FT.

SAMPLE TYPE S.S.

MAXIMUM PARTICLE SIZE

WT. OF OVEN DRY SAMPLE & TARE

WT. OF TARE

WT. OF OVEN DRY SAMPLE = Ws

U.S. STANDARD SIEVE SIZE OR NUMBER	WT. RETAINED ON THIS SIEVE	% RETAINED ON THIS SIEVE	CUMULATIVE		SPECIFICATION LIMITS % PASSING
			% RETAINED	% PASSING	
3 Inch					
2 Inch					
1½ Inch					
1 Inch					
3/4 Inch					
1/2 Inch					
3/8 Inch					
No. 3					
No. 4					
No. 6					
No. 8					
No. 10					
No. 16					
No. 20					
No. 30					
No. 40					
No. 50					
No. 60					
No. 70					
No. 100					
No. 140					
No. 200		0.8	0.8	99.2	
Pan					
TOTALS				☒	☒

COMMENTS	TOTAL SHOULD EQUAL Ws	TOTAL SHOULD EQUAL 100%	TOTAL ÷ 100 = FINENESS MODULUS		
TECHNICIAN'S REMARKS:			FINENESS MODULUS EQUALS		

SEE DEFINITIONS & NOTES ON REVERSE SIDE

SAMPLE OBTAINED BY HTL 10-12-89 DATE

TESTED BY T. HEMME 10-31-89
TECHNICIAN DATE

CHECKED BY R. CRAVEN 11-7-89
PROJECT ENGINEER DATE

Hannibal Testing Laboratories, Inc.
P.O. BOX 387 • 4500 PARIS GRAVEL ROAD
HANNIBAL, MISSOURI 63401 • (314) 221-7714

HTL FORM NO. 62 PROJECT NO. 89-842

SIEVE ANALYSIS

PROJECT PETROLEUM LEAK/SPILL AREA IOWA ARMY AMMUNITION PLANT
LOCATION BURLINGTON, IOWA
CLIENT DAMES & MOORE
TEST METHOD ASTM D 1140 & D 422
SAMPLE DESCRIPTION YELLOW BROWN MOTTLED GRAY CLAY, TRACE OF FINE SAND, (CH)
SAMPLE SOURCE TEST BORING DM - 10

BORING OR TEST PIT NO. DM-10
SAMPLE NO.
SAMPLE DEPTH 7½ FT.
SAMPLE TYPE S.S.
MAXIMUM PARTICLE SIZE
WT. OF OVEN DRY SAMPLE & TARE
WT. OF TARE
WT. OF OVEN DRY SAMPLE = Ws

U.S. STANDARD SIEVE SIZE OR NUMBER	WT. RETAINED ON THIS SIEVE	% RETAINED ON THIS SIEVE	CUMULATIVE		SPECIFICATION LIMITS % PASSING
			% RETAINED	% PASSING	
3 Inch					
2 Inch					
1½ Inch					
1 Inch					
3/4 Inch					
1/2 Inch					
3/8 Inch					
No. 3					
No. 4					
No. 6					
No. 8					
No. 10					
No. 16					
No. 20					
No. 30					
No. 40					
No. 50					
No. 60					
No. 70					
No. 100					
No. 140					
No. 200		0.6	0.6	99.4	
Pan					
TOTALS				☒	☒

COMMENTS	TOTAL SHOULD EQUAL Ws	TOTAL SHOULD EQUAL 100%	TOTAL ÷ 100 = FINENESS MODULUS		
TECHNICIAN'S REMARKS:			FINENESS MODULUS EQUALS		

SEE DEFINITIONS & NOTES ON REVERSE SIDE

SAMPLE OBTAINED BY HTL 10-12-89
DATE

TESTED BY T. HEMME 10-31-89
TECHNICIAN DATE

CHECKED BY R. CRAVEN 11-7-89
PROJECT ENGINEER DATE

Hannibal Testing Laboratories, Inc.
P.O. BOX 387 • 4500 PARIS GRAVEL ROAD
HANNIBAL, MISSOURI 63401 • (314) 221-7714

HTL FORM NO. 62 PROJECT NO. 89-842

SIEVE ANALYSIS

PROJECT PETROLEUM LEAK/SPILL AREA IOWA ARMY AMMUNITION PLANT LOCATION BURLINGTON, IOWA

CLIENT DAMES & MOORE TEST METHOD ASTM D 1140 & D 422

SAMPLE DESCRIPTION GRAY MOTTLED DARK YELLOW BROWN SILTY CLAY, LITTLE SAND, (CL)

SAMPLE SOURCE TEST BORING DM - 10

BORING OR TEST PIT NO. DM-10
SAMPLE NO.
SAMPLE DEPTH 10 FT.
SAMPLE TYPE S.S.

MAXIMUM PARTICLE SIZE
WT. OF OVEN DRY SAMPLE & TARE
WT. OF TARE
WT. OF OVEN DRY SAMPLE = Ws

U.S. STANDARD SIEVE SIZE OR NUMBER	WT. RETAINED ON THIS SIEVE	% RETAINED ON THIS SIEVE	CUMULATIVE % RETAINED	CUMULATIVE % PASSING	SPECIFICATION LIMITS % PASSING
3 Inch					
2 Inch					
1½ Inch					
1 Inch					
3/4 Inch					
1/2 Inch					
3/8 Inch		0	0	100	
No. 3					
No. 4		0.8	0.8	99.2	
No. 6					
No. 8					
No. 10		0.5	1.3	98.7	
No. 16					
No. 20					
No. 30					
No. 40		2.4	3.7	96.3	
No. 50					
No. 60					
No. 70					
No. 100					
No. 140					
No. 200		11.1	14.8	85.2	
Pan					
TOTALS				☒	☒

COMMENTS	TOTAL SHOULD EQUAL Ws	TOTAL SHOULD EQUAL 100%	TOTAL ÷ 100 = FINENESS MODULUS		
TECHNICIAN'S REMARKS:			FINENESS MODULUS EQUALS		

SEE DEFINITIONS & NOTES ON REVERSE SIDE

SAMPLE OBTAINED BY HTL 10-12-89 DATE

TESTED BY T. HEMME TECHNICIAN 10-31-89 DATE

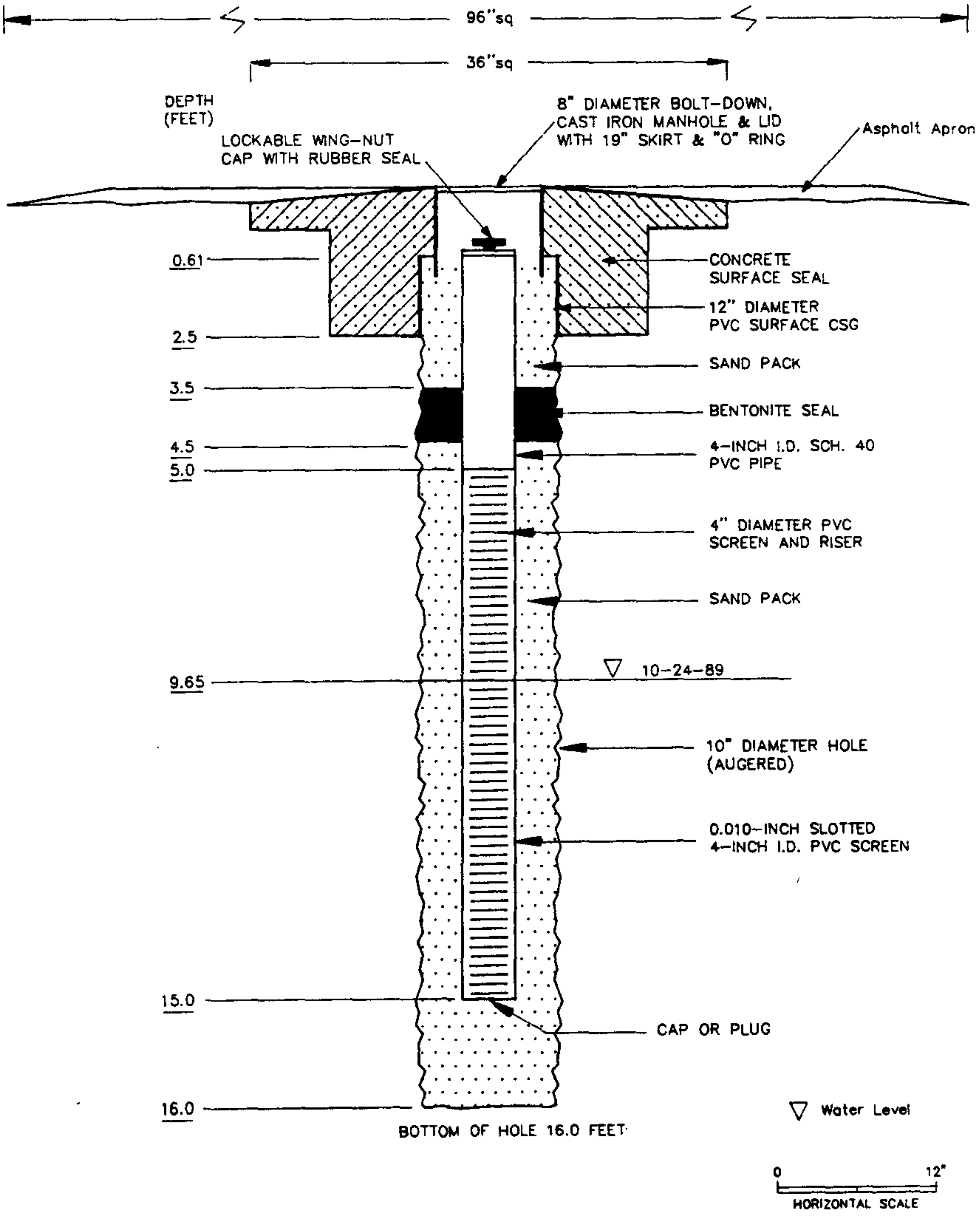
CHECKED BY R. CRAVEN PROJECT ENGINEER 11-7-89 DATE

Hannibal Testing Laboratories, Inc.
P.O. BOX 387 • 4500 PARIS GRAVEL ROAD
HANNIBAL, MISSOURI 63401 • (314) 221-7714

APPENDIX E

WELL CONSTRUCTION DIAGRAMS

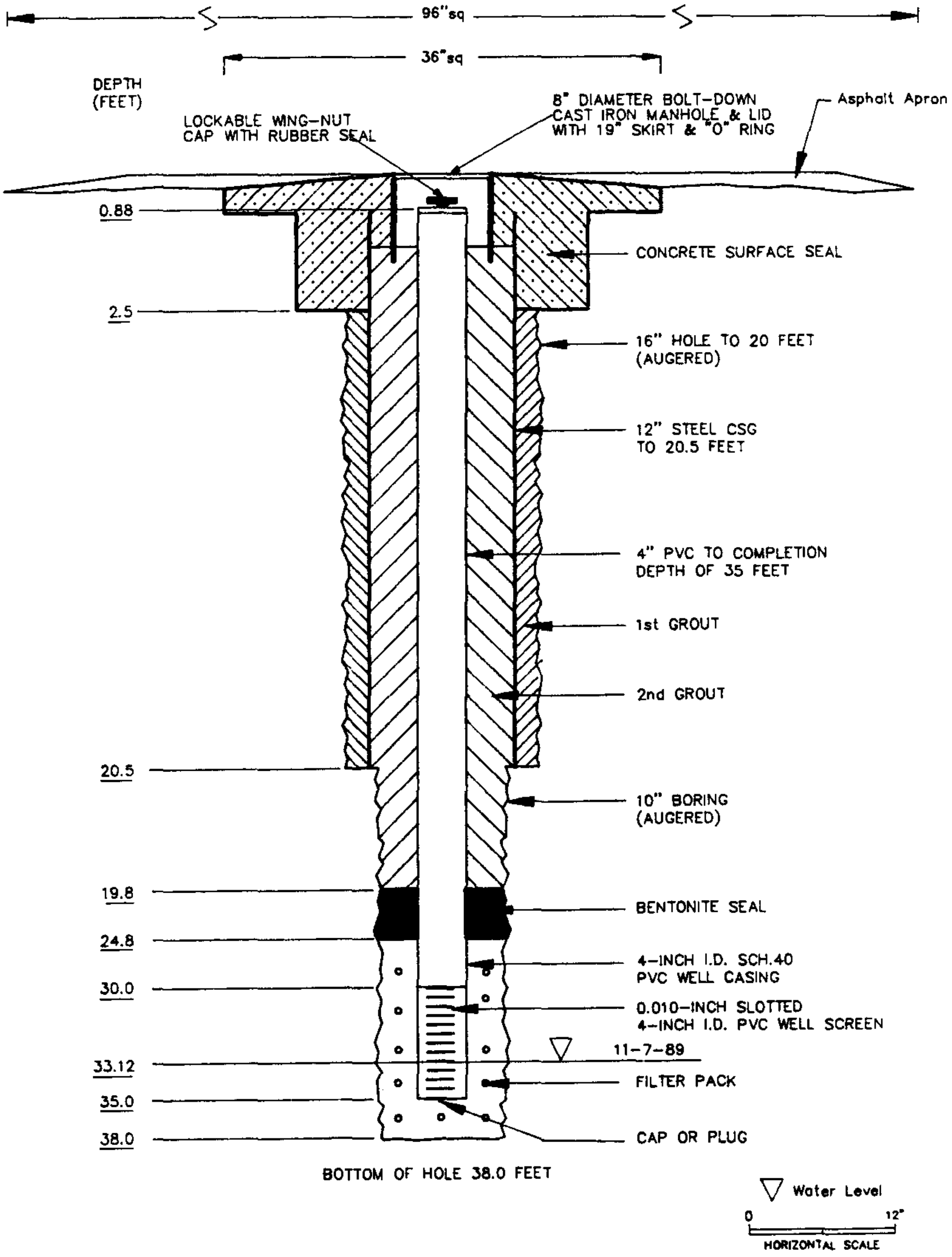
Location: DM-1
Installation Date: 10-12-89
Surface Elevation: 729.0 Feet
Top of 4" PVC Casing Elevation: 728.39 Feet



DM-1
MONITORING WELL CONSTRUCTION DIAGRAM

DAMES & MOORE

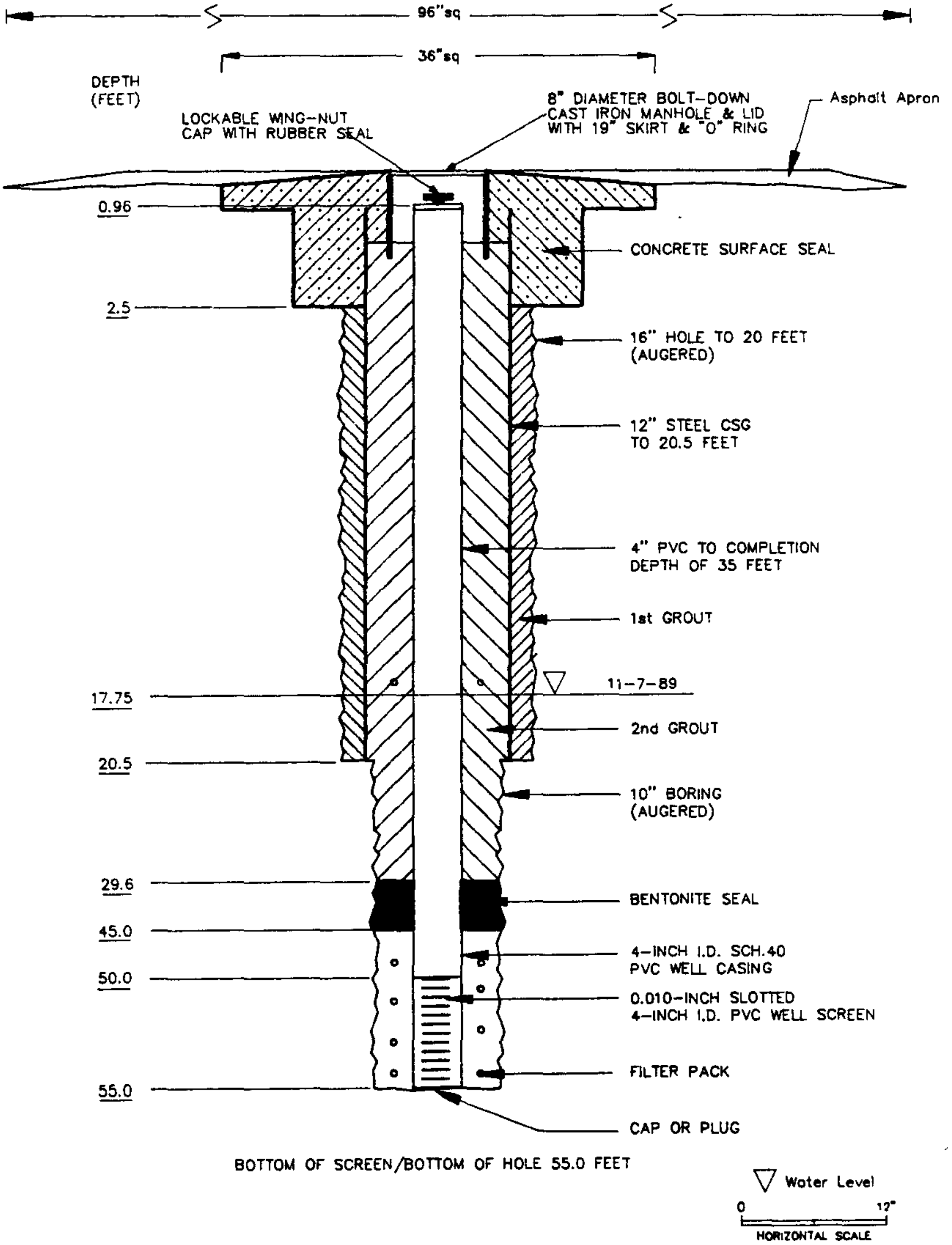
Location: DM-2
Installation Date: 10-26-89
Surface Elevation: 729.0 Feet
Top of 4" PVC Casing Elevation: 728.12 Feet



DM-2
MONITORING WELL CONSTRUCTION DIAGRAM

DAMES & MOORE

Location: DM-3
Installation Date: 10-26-89
Surface Elevation: 728.8 Feet
Top of 4" PVC Casing Elevation: 727.84 Feet

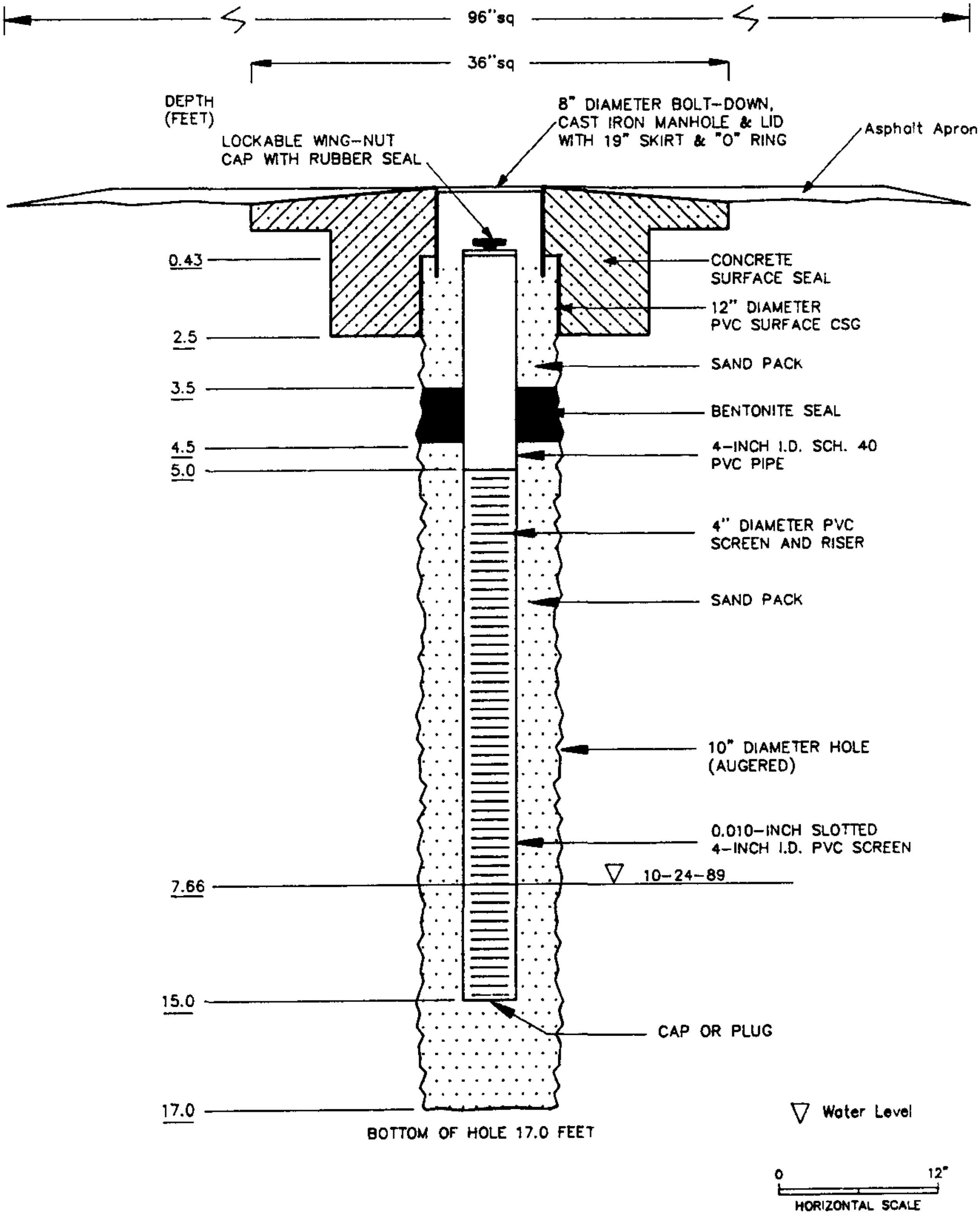


BOTTOM OF SCREEN/BOTTOM OF HOLE 55.0 FEET

DM-3
MONITORING WELL CONSTRUCTION DIAGRAM

DAMES & MOORE

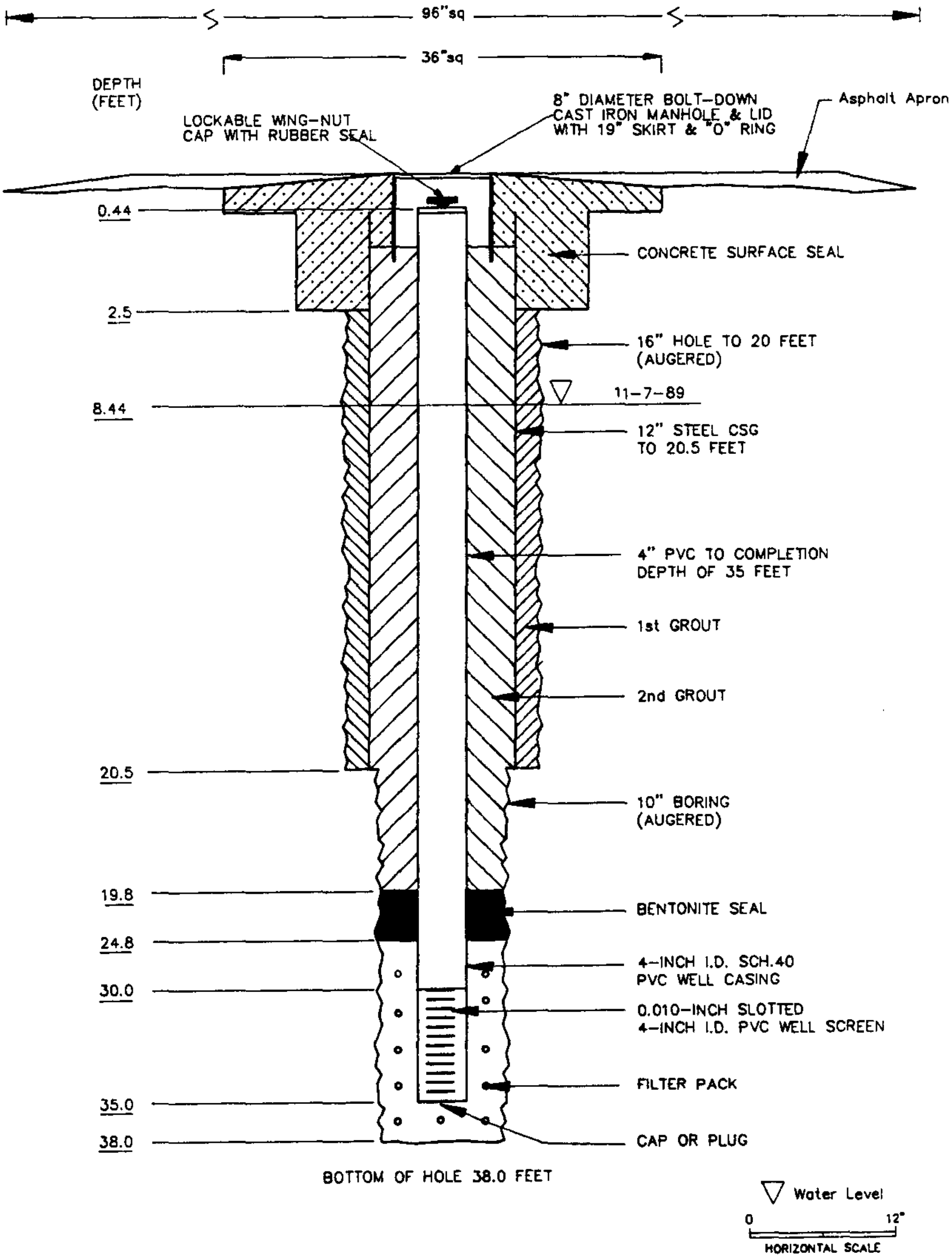
Location: DM-4
Installation Date: 10-12-89
Surface Elevation: 729.1 Feet
Top of 4" PVC Casing Elevation: 728.67 Feet



DM-4
MONITORING WELL CONSTRUCTION DIAGRAM

DAMES & MOORE

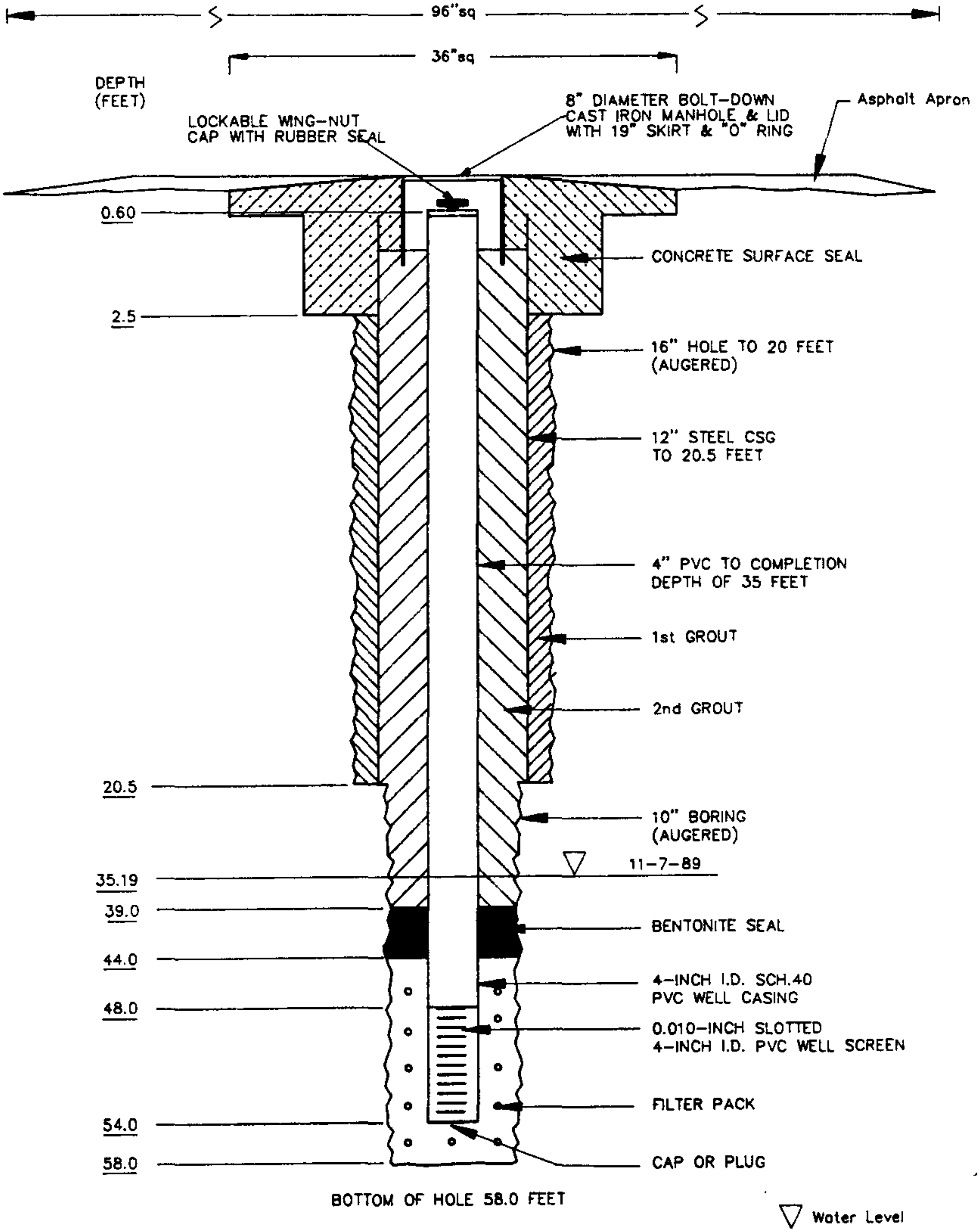
Location: DM-5
Installation Date: 10-26-89
Surface Elevation: 729.1 Feet
Top of 4" PVC Casing Elevation: 728.66 Feet



DM-5
MONITORING WELL CONSTRUCTION DIAGRAM

DAMES & MOORE

Location: DM-6
Installation Date: 10-27-89
Surface Elevation: 729.1 Feet
Top of 4" PVC Casing Elevation: 728.50 Feet



▽ Water Level

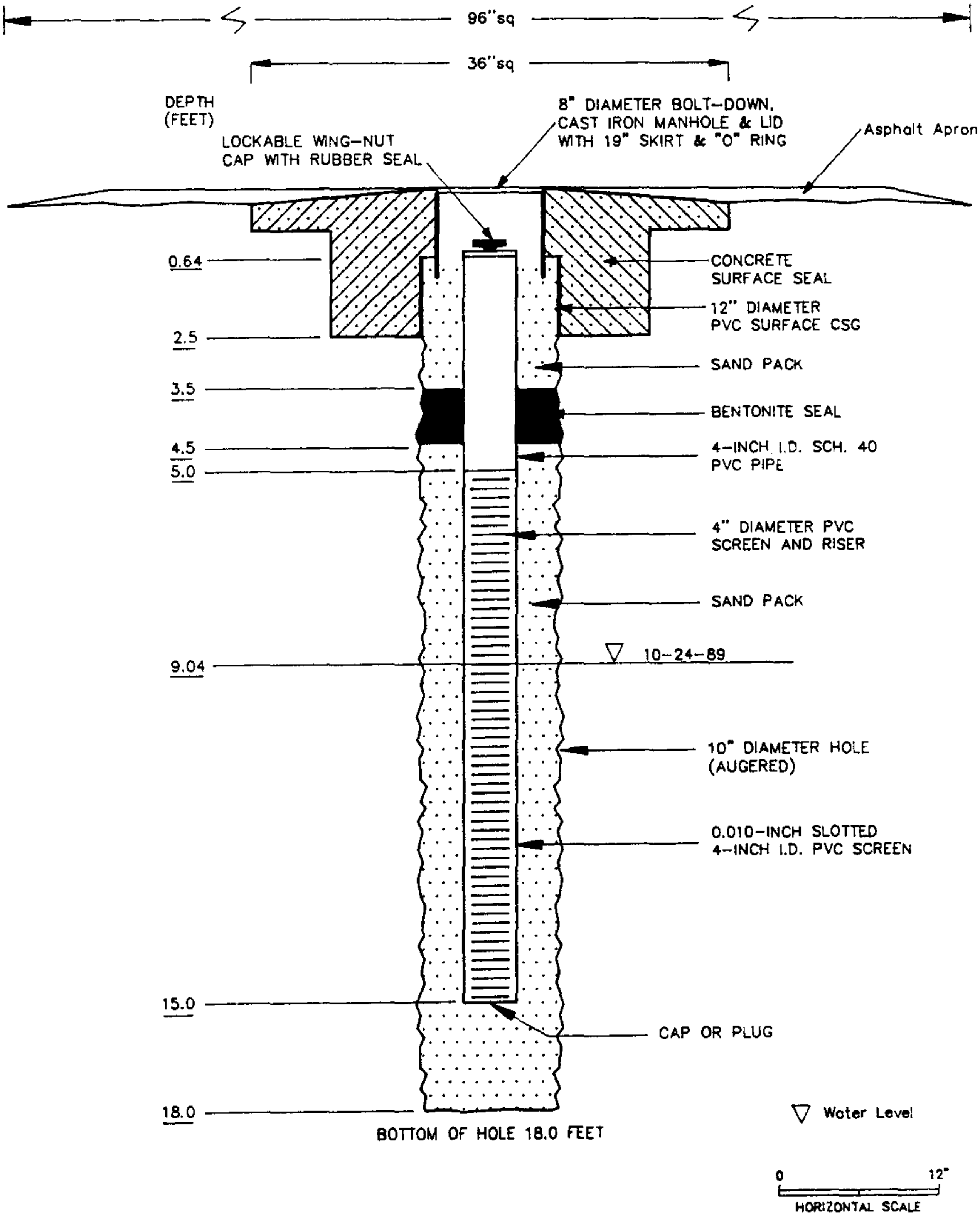
0 12"
HORIZONTAL SCALE

Problems with the PVC installation made a 4-inch sand pack below the screen unavoidable

DM-6
MONITORING WELL CONSTRUCTION DIAGRAM

DAMES & MOORE

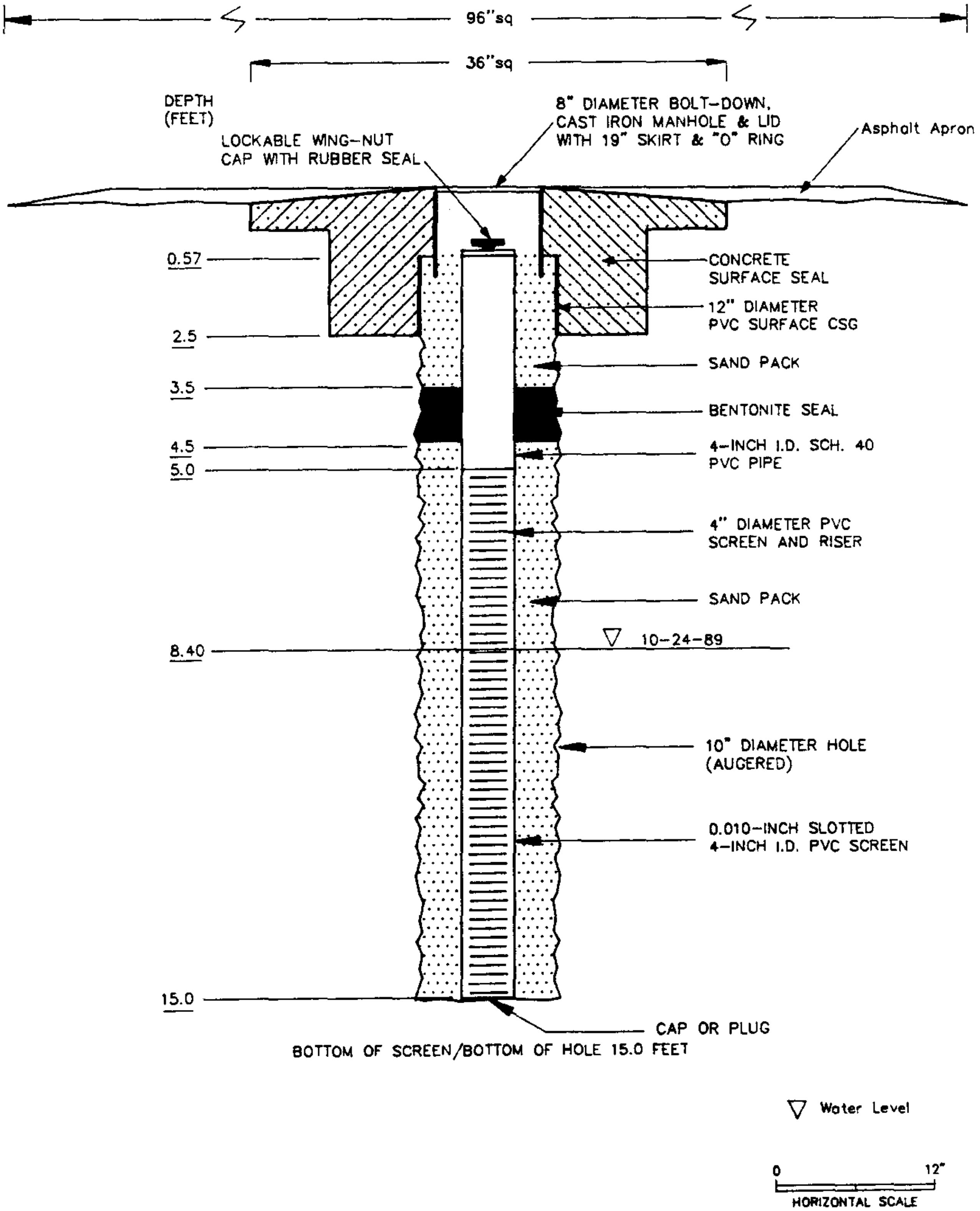
Location: DM-7
Installation Date: 10-11-89
Surface Elevation: 729.4 Feet
Top of 4" PVC Casing Elevation: 728.76 Feet



DM-7
MONITORING WELL CONSTRUCTION DIAGRAM

DAMES & MOORE

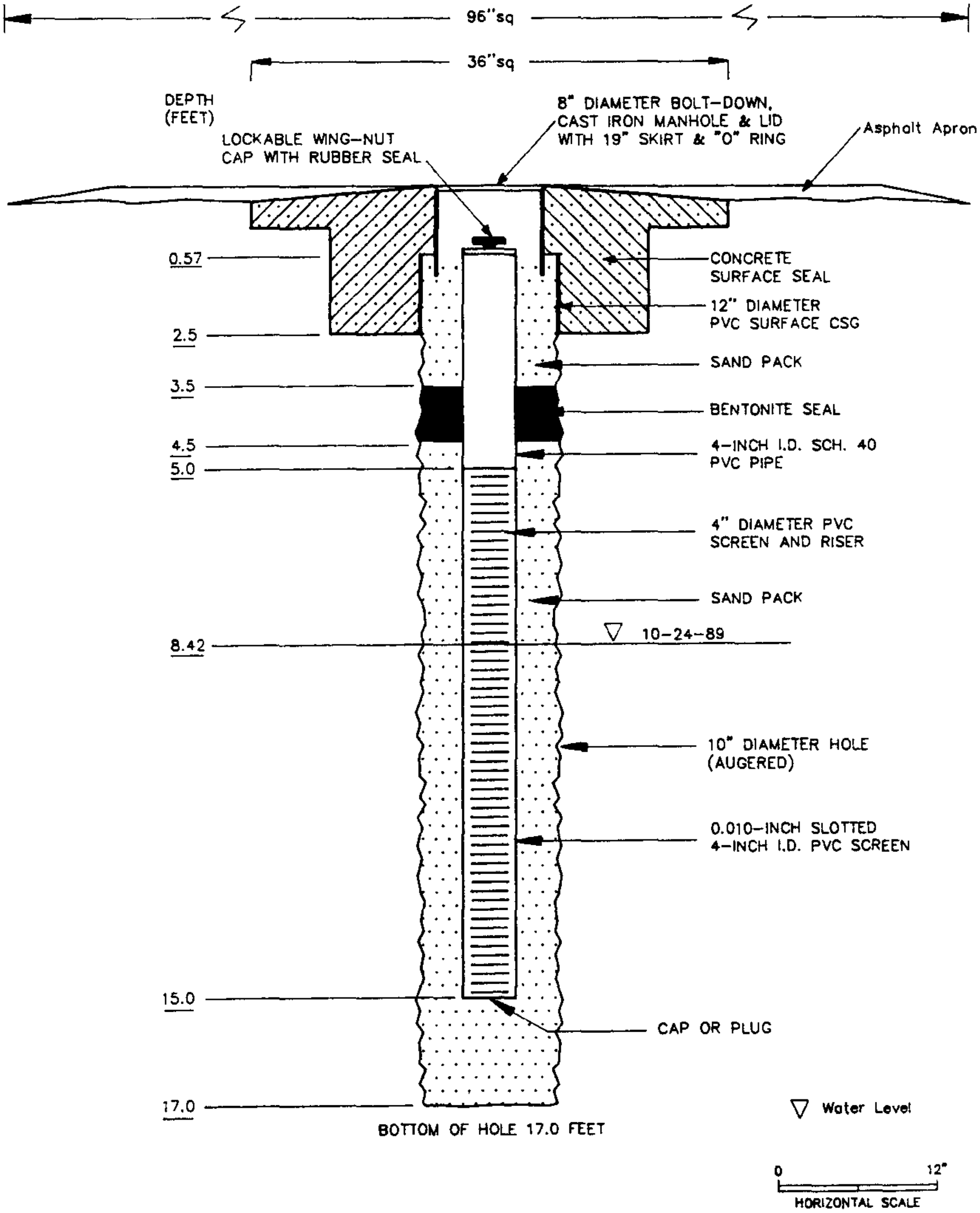
Location: DM-8
Installation Date: 10-11-89
Surface Elevation: 728.8 Feet
Top of 4" PVC Casing Elevation: 728.23 Feet



DM-8
MONITORING WELL CONSTRUCTION DIAGRAM

DAMES & MOORE

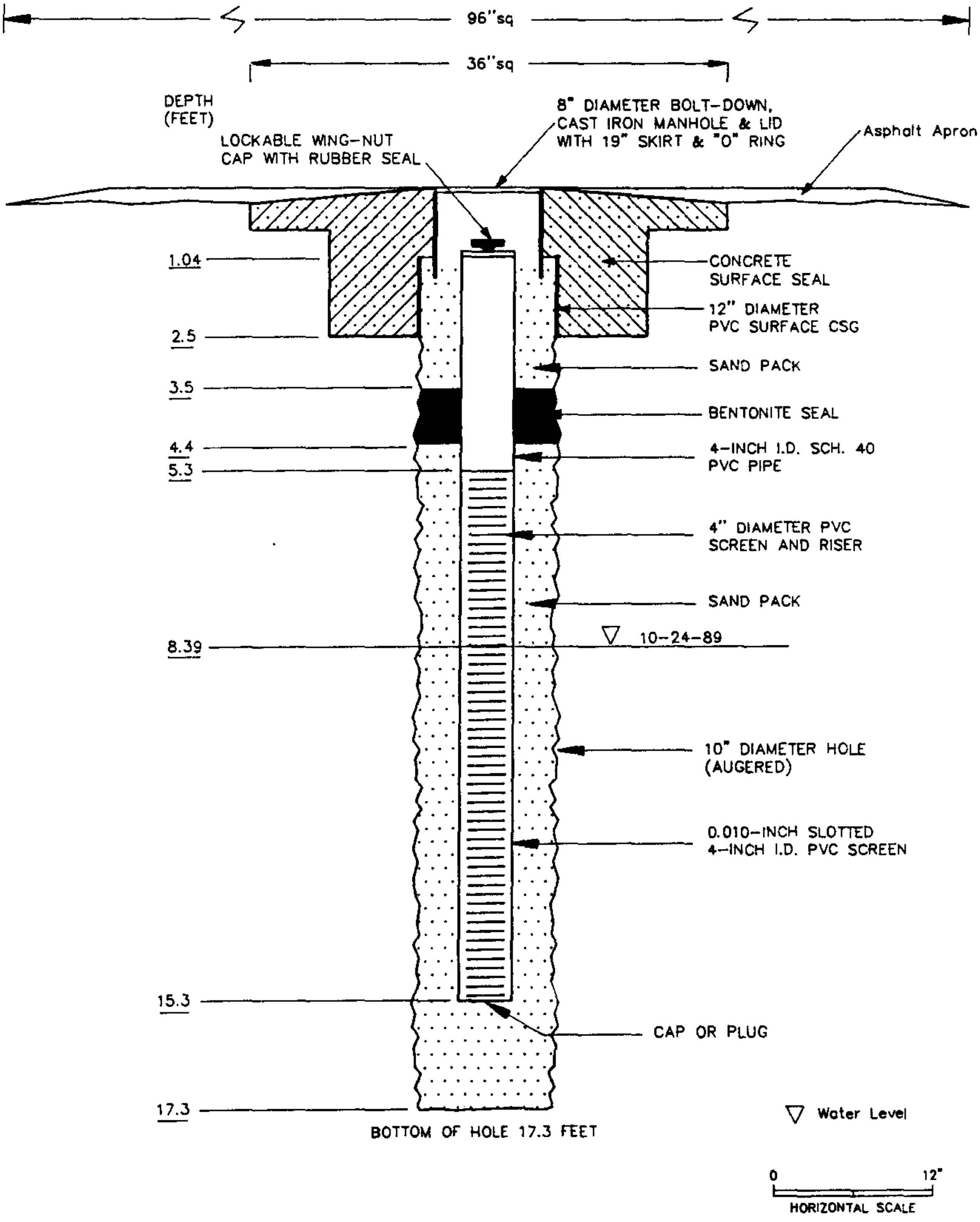
Location: DM-9
Installation Date: 10-11-89
Surface Elevation: 729.0 Feet
Top of 4" PVC Casing Elevation: 728.43 Feet



DM-9
MONITORING WELL CONSTRUCTION DIAGRAM

DAMES & MOORE

Location: DM-10
Installation Date: 10-12-89
Surface Elevation: 728.6 Feet
Top of 4" PVC Casing Elevation: 727.56 Feet



DM-10
MONITORING WELL CONSTRUCTION DIAGRAM

DAMES & MOORE

APPENDIX F

SURVEY RESULTS

SMITH ENGINEERING ASSOCIATES, INC.
Engineers & Land Surveyors

Received 11/13/89
WDE

1297-3
November 8, 1989

Bill Eaton
DAMES & MOORE
7101 Wisconsin Avenue
Bethesda, Maryland 20814

Subject: Monitoring Wells - IAAP - Burlington, Iowa

Dear Bill:

Enclosed is a sketch showing the paint marks we found and a copy of field notes showing the well locations with reference to the imaginary line between the "old" paint marks.

Also enclosed are sheets 1 and 2 showing well coordinates and elevations.

Please call if you have any questions.

Very truly yours,

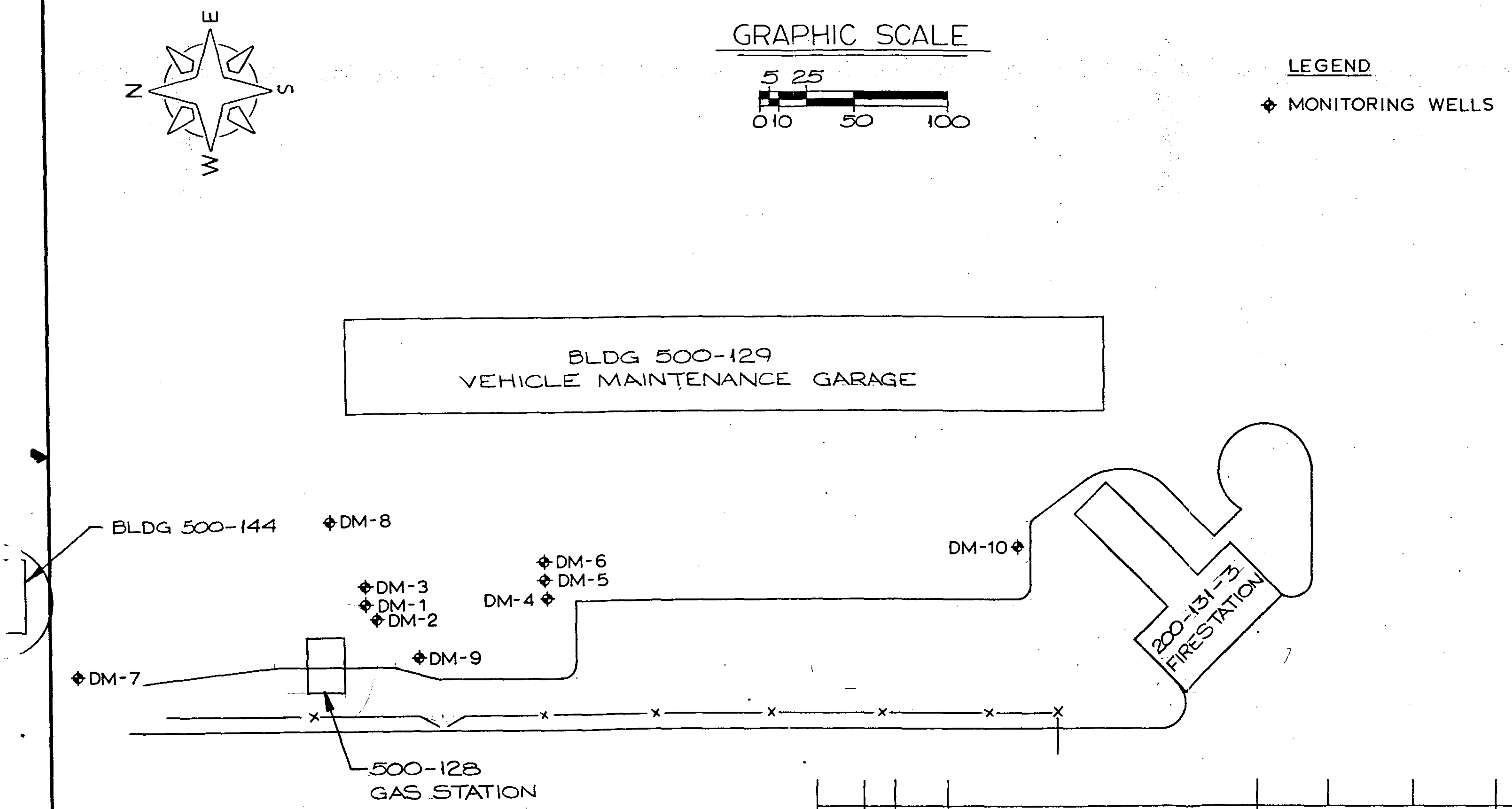
SMITH ENGINEERING ASSOCIATES, INC.

Jerry L. Miller

Jerry L. Miller, L.S.

JLM:tj

o 1115 SUMMER STREET BURLINGTON, IOWA 52601 319 • 752 • 3603
o 862 NORTH PRAIRIE GALESBURG, ILLINOIS 61401 309 • 343 • 1268



PARTIAL SHOP AREA PLAN

SCALE 1"=50'

REV.	BY	DATE	DESCRIPTION	APPROVAL	DATE

IOWA ARMY AMMUNITION PLANT
MIDDLETOWN, IOWA
OPERATED BY
MASON & HANGER
SILAS MASON CO., INC.

DESIGN	DRAWN	APPROVAL

MONITORING WELLS
SHOP AND GAS
STATION AREA

IOWA ARMY AMMUNITION PLANT
MIDDLETOWN, IOWA

BOOK 170C PG. 1
E.O. NO.
W.O. NO.
DATE NOV. 8, 1989

DRAWING NO.
1297-3 1 OF 2

77740

MONITORING WELL LOCATION AND ELEVATION

WELL LOCATION NO.	ELEV. TOP OF 4" PVC WELL CASING (WEST EDGE)	GROUND ELEV. AT WELL	COORDINATES (FEET) X (EAST)	Y (NORTH)
DM-1	728.39	729.0	2,620,936	308,254
DM-2	728.12	729.0	2,620,929	308,248
DM-3	727.84	728.8	2,620,946	308,254
DM-4	728.67	729.1	2,620,941	308,157
DM-5	728.66	729.1	2,620,951	308,159
DM-6	728.50	729.1	2,620,960	308,160
DM-7	728.76	729.4	2,620,896	308,406
DM-8	728.23	728.8	2,620,980	308,274
DM-9	728.43	729.0	2,620,908	308,225
DM-10	727.56	728.6	2,620,974	307,907

ORIGIN BENCHMARK = "X" IN THE STEEL BASE PLATE SOUTHWEST CORNER PIER OF ADMINISTRATION AREA WATER TOWER.
PUBLISHED IAAP DATUM ELEVATION = 725.15

COORDINATES ARE BASED UPON PLANE COORDINATE SYSTEM FOR STATE OF IOWA - SOUTH ZONE

REV.	BY	DATE	DESCRIPTION	APPROVAL	DATE

IOWA ARMY AMMUNITION PLANT
MIDDLETOWN, IOWA
OPERATED BY
MASON & HANGER
SILAS MASON CO., INC.

DESIGN	DRAWN	APPROVAL

MONITORING WELLS
SHOP AND GAS
STATION AREA

IOWA ARMY AMMUNITION PLANT
MIDDLETOWN, IOWA

BOOK 170C PG. 1
E.O. NO.
W.O. NO.
DATE NOV. 8, 1989
DRAWING NO.
1297-3 2 OF 2

APPENDIX G

ANALYTICAL RESULTS

Note: Although the metaTRACE analytical data presented in this appendix may contain greater than three significant figures, only three significant figures are considered appropriate. Therefore, the analytical results presented in the text of this report were rounded to three significant figures.

metaTRACE, Inc. 13715 Rider Trail North • Earth City, MO 63045 • (314) 298-8566

January 8, 1990

Mr. Bill Eaton
Dames & Moore
7101 Wisconsin Ave
Suite 700
Bethesda, MD 20814-4870

Dear Bill:

Enclosed please find an electronic and a hard copy of the data for the Iowa AAP project. The data has been entered utilizing Lotus format Version 2.01.

As indicated, samples (both soil and water) were received from 7/27/89 to 11/8/89 and analyzed for TPHC, Pb AND GC VOA's. Dames & Moore's field sampling numbers were given unique lab and lot numbers by metaTRACE for log in and tracking purposes. The field sample numbers are listed on the lotus report as "site I.D.".

The analytical results have been corrected to reflect what will appear in Level 3 of the IRDMS. This "Level 3" result is deemed NEW CONC on the Lotus Report.

If there are any questions on this project, please feel free to call.

Thank you for choosing metaTRACE for these analytical services.

Sincerely,

Dan K. Nuske

Dan K. Nuske
Asst. Proj Mgr

DKN:pck

Enclosures

metaTRACE, INC.
Project No: 115-23
Client: DAMES&MOORE

Date Received: 07/27/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGL)	CONC. (UGL)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGL)
00	N/A	08/18/89	TPHC	AIM002	DRILL 1	AA31803	N/A	<2000	N/A	1.0	N/A	<2000 ✓
00	N/A	08/18/89	TPHC	AIM001	RINSE 1	AA31802	N/A	<2000	N/A	1.0	N/A	<2000 ✓
00	N/A	08/18/89	TPHC	AIM003	DRILL 2	AA31815	N/A	<2000	N/A	1.0	N/A	<2000 ✓
00	N/A	08/18/89	TPHC	AIM004	N/A	BLK 267	N/A	<2000	N/A	1.0	N/A	<2000 ✓
00	N/A	08/18/89	TPHC	N/A	N/A	SPK 267	16520	16530	N/A	1.0	N/A	16530

Date Received: 10/10/89

00	N/A	10/17/89	TPHC	FAB001	RINSE 2	AB01293	N/A	<2000	N/A	1.0	N/A	<2000 ✓
00	N/A	10/17/89	TPHC	FAB002	N/A	BLK 16	N/A	<2000	N/A	1.0	N/A	<2000
00	N/A	10/17/89	TPHC	N/A	N/A	SPK 16	16800	21760	N/A	1.0	N/A	21760

Date Received: 10/11/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGG)	CONC. (UGG)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGG)
00	N/A	10/17/89	TPHC	FAC001	DM14-5	AB01295	N/A	<20	0.77	1.0	N/A	<20 ✓
00	N/A	10/17/89	TPHC	FAC002	DM14-7.5	AB01296	N/A	<20	0.78	1.0	N/A	<20 ✓
00	N/A	10/17/89	TPHC	FAC003	DM13-2.5	AB01297	N/A	111.0	0.80	1.0	N/A	138.75 ✓
00	N/A	10/17/89	TPHC	FAC004	DM13-5	AB01298	N/A	68.7	0.84	1.0	N/A	81.79 ✓
00	N/A	10/17/89	TPHC	FAC005	DM13-7.5	AB01299	N/A	<20	0.74	1.0	N/A	<20 ✓
00	N/A	10/17/89	TPHC	FAC006	DM12-2.5	AB01300	N/A	371.4	0.76	1.0	N/A	488.68 ✓
00	N/A	10/17/89	TPHC	FAC007	DM12-5	AB01301	N/A	<20	0.79	1.0	N/A	<20 —
00	N/A	10/17/89	TPHC	FAC008	DM12-7.5	AB01302	N/A	75.2	0.75	1.0	N/A	100.27 ✓
00	N/A	10/17/89	TPHC	FAC009	DM11-5	AB01303	N/A	<20	0.78	1.0	N/A	<20 ✓
00	N/A	10/17/89	TPHC	FAC010	DM11-7.5	AB01304	N/A	<20	0.78	1.0	N/A	<20 ✓

Date Received: 10/12/89

00	N/A	10/17/89	TPHC	FAC011	DM8-2.5	AB01307	N/A	<20	0.78	1.0	N/A	<20 ✓
00	N/A	10/17/89	TPHC	FAC012	DM8-5	AB01308	N/A	227.98	0.79	1.0	N/A	288.58 —
00	N/A	10/17/89	TPHC	FAC013	DM8-7.5	AB01309	N/A	<20	0.78	1.0	N/A	<20 ✓
00	N/A	10/17/89	TPHC	FAC014	DM9-2.5	AB01310	N/A	<20	0.76	1.0	N/A	<20 ✓
00	N/A	10/17/89	TPHC	FAC015	DM9-5	AB01311	N/A	<20	0.79	1.0	N/A	<20 ✓
00	N/A	10/17/89	TPHC	FAC016	N/A	BLK 15	N/A	<20	N/A	1.0	N/A	<20
00	N/A	10/17/89	TPHC	N/A	N/A	SPK 15	840.05	711.2	N/A	1.0	N/A	711.20

Rerun per client request. Sample labels were switched in lab.

00	N/A	12/18/89	TPHC	FA0001	DM12-5	AB01301	N/A	70.0	0.79	1.0	N/A	88.61
00	N/A	12/18/89	TPHC	FA0002	DM8-5	AB01308	N/A	33.15	0.79	1.0	N/A	41.96
00	N/A	12/18/89	TPHC	FA0003	N/A	BLK 26	N/A	<20	N/A	1.0	N/A	<20
00	N/A	12/18/89	TPHC	N/A	N/A	SPK 26	840	1065	N/A	1.0	N/A	1065

metaTRACE, INC.
Project No: 115-23
Client: DAMES&MOORE

Date Received: 10/13/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGG)	CONC. (UGG)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGG)
00	N/A	10/19/89	TPHC	FAE001	DM1-5	AB01323	N/A	93.38	0.77	1.0	N/A	121.27 ✓
00	N/A	10/19/89	TPHC	FAE002	DM1-7.5	AB01324	N/A	65.36	0.80	1.0	N/A	81.70 ✓
00	N/A	10/19/89	TPHC	FAE003	DM4-2.5	AB01325	N/A	95.71	0.83	1.0	N/A	115.31 ✓
00	N/A	10/19/89	TPHC	FAE004	DM4-5.0	AB01326	N/A	79.37	0.78	1.0	N/A	101.76 ✓
00	N/A	10/19/89	TPHC	FAE005	DM4-7.5	AB01327	N/A	107.38	0.80	1.0	N/A	134.22 ✓
00	N/A	10/19/89	TPHC	FAE006	N/A	BLK 18	N/A	<20	N/A	1.0	N/A	<20
00	N/A	10/19/89	TPHC	N/A	N/A	SPK 18	805.4	613.9	N/A	1.0	N/A	613.90

Date Received: 10/25/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGL)	CONC. (UGL)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGL)
00	N/A	11/01/89	TPHC	FAF001	DM-1	AB01796	N/A	<2000	N/A	1.0	N/A	<2000 ✓
00	N/A	11/01/89	TPHC	FAF002	DM-4	AB01797	N/A	<2000	N/A	1.0	N/A	<2000 ✓
00	N/A	11/01/89	TPHC	FAF003	DM-7	AB01798	N/A	<2000	N/A	1.0	N/A	<2000 ✓
00	N/A	11/01/89	TPHC	FAF004	DM-8	AB01799	N/A	<2000	N/A	1.0	N/A	<2000 ✓
00	N/A	11/01/89	TPHC	FAF005	DM-9	AB01800	N/A	<2000	N/A	1.0	N/A	<2000 ✓
00	N/A	11/01/89	TPHC	FAF006	DM-10	AB01801	N/A	<2000	N/A	1.0	N/A	<2000 ✓
00	N/A	11/01/89	TPHC	FAF007	N/A	BLK 23	N/A	<2000	N/A	1.0	N/A	<2000
00	N/A	11/01/89	TPHC	N/A	N/A	SPK 23	16800	11810	N/A	1.0	N/A	11810

Date Received: 10/26/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGG)	CONC. (UGG)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGG)
00	N/A	10/31/89	TPHC	FAG001	DM3-30	AB01819	N/A	<20	0.79	1.0	N/A	<20 ✓
00	N/A	10/31/89	TPHC	FAG002	DM3-25	AB01820	N/A	<20	0.85	1.0	N/A	<20 ✓
00	N/A	10/31/89	TPHC	FAG003	DM3-35	AB01821	N/A	206.6	0.86	1.0	N/A	240.23 ✓
00	N/A	10/31/89	TPHC	FAG004	DM3-40	AB01822	N/A	<20	0.89	1.0	N/A	<20 ✓
00	N/A	10/31/89	TPHC	FAG005	DM3-45	AB01823	N/A	<20	0.89	1.0	N/A	<20 ✓
00	N/A	10/31/89	TPHC	FAG006	DM3-50	AB01824	N/A	299.3	0.82	1.0	N/A	365.00 ✓
00	N/A	10/31/89	TPHC	FAG007	DM3-55	AB01825	N/A	<20	0.89	1.0	N/A	<20

Date Received: 10/27/89

00	N/A	10/31/89	TPHC	FAG008	DM2-25	AB01894	N/A	<20	0.79	1.0	N/A	<20 ✓
00	N/A	10/31/89	TPHC	FAG009	DM2-30	AB01895	N/A	<20	0.84	1.0	N/A	<20 ✓
00	N/A	10/31/89	TPHC	FAG010	DM2-35	AB01896	N/A	<20	0.87	1.0	N/A	<20 ✓
00	N/A	10/31/89	TPHC	FAG011	N/A	BLK 22	N/A	<20	N/A	1.0	N/A	<20
00	N/A	10/31/89	TPHC	N/A	N/A	SPK 22	839.98	498.2	N/A	1.0	N/A	498.20

metaTRACE, INC.
Project No: 115-23
Client: DAMES&MOORE

Date Received: 11/08/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGL)	CONC. (UGL)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGL)
00	N/A	11/20/89	TPHC	FAI001	DM-2	AB02209	N/A	<2000	N/A	1.0	N/A	<2000
00	N/A	11/20/89	TPHC	FAI002	DM-3	AB02210	N/A	<2000	N/A	1.0	N/A	<2000
00	N/A	11/20/89	TPHC	FAI003	DM-5	AB02211	N/A	<2000	N/A	1.0	N/A	<2000
00	N/A	11/20/89	TPHC	FAI004	DM-6	AB02212	N/A	<2000	N/A	1.0	N/A	<2000
00	N/A	11/20/89	TPHC	FAI005	SW-3	AB02213	N/A	<2000	N/A	1.0	N/A	<2000
00	N/A	11/20/89	TPHC	FAI006	N/A	BLK 24	N/A	<2000	N/A	1.0	N/A	<2000
00	N/A	11/20/89	TPHC	N/A	N/A	SPK 24	16.8	25.62	N/A	1.0	N/A	25.62

Date Received: 11/09/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGG)	CONC. (UGG)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGG)
00	N/A	11/20/89	TPHC	FAJ001	SD-1	AB02214	N/A	22.6	0.66	1.0	N/A	34.24 ✓
00	N/A	11/20/89	TPHC	FAJ002	SD-2	AB02215	N/A	45.3	0.70	1.0	N/A	64.71 ✓
00	N/A	11/20/89	TPHC	FAJ003	SD-3	AB02216	N/A	2300	0.74	1.0	N/A	3108.10 ✓
00	N/A	11/20/89	TPHC	FAJ004	N/A	BLK 25	N/A	<20	N/A	1.0	N/A	<20
00	N/A	11/20/89	TPHC	N/A	N/A	SPK 25	839	615.8	N/A	1.0	N/A	615.8

Project No: 115-23
Client: DAMES&MOORE

Date Received: 07/27/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGL)	CONC. (UGL)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGL)
SD11	METALS/WATER/GFAA	08/30/89	PB	E0I002	DRILL 1	AA31803	N/A	3.05	N/A	1.0	1.27	2.40 ✓
SD11	METALS/WATER/GFAA	08/30/89	PB	E0I001	RINSE 1	AA31802	N/A	14.4	N/A	1.0	1.27	11.34 ✓
SD11	METALS/WATER/GFAA	08/30/89	PB	E0I003	N/A	PREP BLK	N/A	<2.16	N/A	1.0	1.27	<2.16
SD11	METALS/WATER/GFAA	08/30/89	PB	E0I004	N/A	LOW SPK	5.0	5.09	N/A	1.0	N/A	5.09
SD11	METALS/WATER/GFAA	08/30/89	PB	E0I005	N/A	HIGH SPK	15.0	14.4	N/A	1.0	N/A	14.4
SD11	METALS/WATER/GFAA	08/30/89	PB	E0I006	N/A	HIGH SPK2	15.0	14.6	N/A	1.0	N/A	14.6
SD11	METALS/WATER/GFAA	08/30/89	PB	E0J001	DRILL 2	AA31815	N/A	2.78	N/A	1.0	1.27	2.19 ✓
SD11	METALS/WATER/GFAA	08/30/89	PB	E0J002	N/A	PREP BLK	N/A	<2.16	N/A	1.0	1.27	<2.16
SD11	METALS/WATER/GFAA	08/30/89	PB	E0J003	N/A	LOW SPK	5.0	5.33	N/A	1.0	N/A	5.33
SD11	METALS/WATER/GFAA	08/30/89	PB	E0J004	N/A	HIGH SPK	15.0	14.3	N/A	1.0	N/A	14.3
SD11	METALS/WATER/GFAA	08/30/89	PB	E0J005	N/A	HIGH SPK2	15.0	15.7	N/A	1.0	N/A	15.7

Date Received: 10/10/89

SD11	METALS/WATER/GFAA	10/24/89	PB	FBG001	RINSE 2	AB01293	N/A	8.33	N/A	1.0	1.27	6.56 ✓
SD11	METALS/WATER/GFAA	10/24/89	PB	FBG002	N/A	PREP BLK	N/A	<2.16	N/A	1.0	1.27	<2.16
SD11	METALS/WATER/GFAA	10/24/89	PB	FBG003	N/A	LOW SPK	5.0	4.71	N/A	1.0	N/A	4.71
SD11	METALS/WATER/GFAA	10/24/89	PB	FBG004	N/A	HIGH SPK	15.0	15.7	N/A	1.0	N/A	15.7
SD11	METALS/WATER/GFAA	10/24/89	PB	FBG005	N/A	HIGH SPK2	15.0	14.1	N/A	1.0	N/A	14.1

metaTRACE. INC.
Project No: 115-23
Client: DAMES&MOORE

Date Received: 10/11/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGG)	CONC. (UGG)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGG)
JS05	METALS/SOIL/ICAP	10/20/89	PB	EX0001	DM14-5	AB01295	N/A	<92.3	0.77	1.0	0.960	<92.3 ✓
JS05	METALS/SOIL/ICAP	10/20/89	PB	EX0002	DM14-7.5	AB01296	N/A	<92.3	0.78	1.0	0.960	<92.3 ✓
JS05	METALS/SOIL/ICAP	10/20/89	PB	EX0003	DM13-2.5	AB01297	N/A	<92.3	0.80	1.0	0.960	<92.3 ✓
JS05	METALS/SOIL/ICAP	10/20/89	PB	EX0004	DM13-5	AB01298	N/A	<92.3	0.84	1.0	0.960	<92.3 ✓
JS05	METALS/SOIL/ICAP	10/20/89	PB	EX0005	DM13-7.5	AB01299	N/A	<92.3	0.74	1.0	0.960	<92.3 ✓
JS05	METALS/SOIL/ICAP	10/20/89	PB	EX0006	DM12-2.5	AB01300	N/A	<92.3	0.76	1.0	0.960	<92.3 ✓
JS05	METALS/SOIL/ICAP	10/20/89	PB	EX0007	DM12-5	AB01301	N/A	<92.3	0.79	1.0	0.960	<92.3 ✓
JS05	METALS/SOIL/ICAP	10/20/89	PB	EX0008	DM12-7.5	AB01302	N/A	<92.3	0.75	1.0	0.960	<92.3 ✓
JS05	METALS/SOIL/ICAP	10/20/89	PB	EX0009	DM11-5	AB01303	N/A	<92.3	0.78	1.0	0.960	<92.3 ✓
JS05	METALS/SOIL/ICAP	10/20/89	PB	EX0010	DM11-7.5	AB01304	N/A	<92.3	0.78	1.0	0.960	<92.3 ✓

Date Received: 10/12/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGG)	CONC. (UGG)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGG)
JS05	METALS/SOIL/ICAP	10/20/89	PB	EX0011	DM8-2.5	AB01307	N/A	<92.3	0.78	1.0	0.960	<92.3 ✓
JS05	METALS/SOIL/ICAP	10/20/89	PB	EX0012	DM8-5	AB01308	N/A	<92.3	0.79	1.0	0.960	<92.3 ✓
JS05	METALS/SOIL/ICAP	10/20/89	PB	EX0013	DM8-7.5	AB01309	N/A	<92.3	0.78	1.0	0.960	<92.3 ✓
JS05	METALS/SOIL/ICAP	10/20/89	PB	EX0014	DM9-2.5	AB01310	N/A	<92.3	0.76	1.0	0.960	<92.3 ✓
JS05	METALS/SOIL/ICAP	10/20/89	PB	EX0015	DM9-5	AB01311	N/A	<92.3	0.79	1.0	0.960	<92.3 ✓

Date Received: 10/13/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGG)	CONC. (UGG)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGG)
JS05	METALS/SOIL/ICAP	10/20/89	PB	EX0016	DM1-5	AB01323	N/A	<92.3	0.77	1.0	0.960	< 92.3 ✓
JS05	METALS/SOIL/ICAP	10/20/89	PB	EX0017	DM4-2.5	AB01325	N/A	<92.3	0.83	1.0	0.960	< 92.3 ✓
JS05	METALS/SOIL/ICAP	10/20/89	PB	EX0018	DM4-5.0	AB01326	N/A	<92.3	0.78	1.0	0.960	< 92.3 ✓
JS05	METALS/SOIL/ICAP	10/20/89	PB	EX0019	DM4-7.5	AB01327	N/A	<92.3	0.80	1.0	0.960	< 92.3 ✓
JS05	METALS/SOIL/ICAP	10/20/89	PB	EX0020	N/A	PREP BLK	N/A	<92.3	N/A	1.0	0.960	< 92.3
JS05	METALS/SOIL/ICAP	10/20/89	PB	EX0021	N/A	LOW SPK	200	187.5	N/A	1.0	N/A	187.5
JS05	METALS/SOIL/ICAP	10/20/89	PB	EX0022	N/A	HIGH SPK	500	470.5	N/A	1.0	N/A	470.5
JS05	METALS/SOIL/ICAP	10/20/89	PB	EX0023	N/A	HIGH SPK2	500	469.1	N/A	1.0	N/A	469.1

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGG)	CONC. (UGG)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGG)
JS05	METALS/SOIL/ICAP	10/24/89	PB	EXW001	DM1-7.5	AB01324	N/A	<92.3	0.80	1.0	0.960	< 92.3 ✓
JS05	METALS/SOIL/ICAP	10/24/89	PB	EXW002	N/A	PREP BLK	N/A	<92.3	N/A	1.0	0.960	< 92.3
JS05	METALS/SOIL/ICAP	10/24/89	PB	EXW003	N/A	LOW SPK	200	192.4	N/A	1.0	N/A	192.4
JS05	METALS/SOIL/ICAP	10/24/89	PB	EXW004	N/A	HIGH SPK	500	476.5	N/A	1.0	N/A	476.5
JS05	METALS/SOIL/ICAP	10/24/89	PB	EXW005	N/A	HIGH SPK2	500	487.3	N/A	1.0	N/A	487.3

metaTRACE. INC.
Project No: 115-23
Client: DAMES&MOORE

Date Received: 10/25/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGL)	CONC. (UGL)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGL)
SD11	METALS/WATER/GFAA	11/22/89	PB	FB0001	DM-1	AB01796	N/A	7.85	N/A	1.0	1.27	6.18✓
SD11	METALS/WATER/GFAA	11/22/89	PB	FB0002	DM-4	AB01797	N/A	<2.16	N/A	1.0	1.27	<2.16✓
SD11	METALS/WATER/GFAA	11/22/89	PB	FB0003	DM-7	AB01798	N/A	<2.16	N/A	1.0	1.27	<2.16✓
SD11	METALS/WATER/GFAA	11/22/89	PB	FB0004	DM-8	AB01799	N/A	<2.16	N/A	1.0	1.27	<2.16✓
SD11	METALS/WATER/GFAA	11/22/89	PB	FB0005	DM-9	AB01800	N/A	<2.16	N/A	1.0	1.27	<2.16✓
SD11	METALS/WATER/GFAA	11/22/89	PB	FB0006	DM-10	AB01801	N/A	<2.16	N/A	1.0	1.27	<2.16✓
SD11	METALS/WATER/GFAA	11/22/89	PB	FB0007	N/A	PREP BLK	N/A	<2.16	N/A	1.0	1.27	<2.16
SD11	METALS/WATER/GFAA	11/22/89	PB	FB0008	N/A	LOW SPK	5.0	4.77	N/A	1.0	N/A	4.77
SD11	METALS/WATER/GFAA	11/22/89	PB	FB0009	N/A	HIGH SPK	15.0	15.03	N/A	1.0	N/A	15.03
SD11	METALS/WATER/GFAA	11/22/89	PB	FB0010	N/A	HIGH SPK2	15.0	14.93	N/A	1.0	N/A	14.93

Date Received: 10/26/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGG)	CONC. (UGG)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGG)
JS05	METALS/SOIL/ICAP	11/10/89	PB	FEB001	DM3-25	AB01820	N/A	<92.3	0.85	1.0	0.960	<92.3✓
JS05	METALS/SOIL/ICAP	11/10/89	PB	FEB002	DM3-35	AB01821	N/A	<92.3	0.86	1.0	0.960	<92.3✓
JS05	METALS/SOIL/ICAP	11/10/89	PB	FEB003	DM3-40	AB01822	N/A	<92.3	0.89	1.0	0.960	<92.3✓
JS05	METALS/SOIL/ICAP	11/10/89	PB	FEB004	DM3-45	AB01823	N/A	<92.3	0.89	1.0	0.960	<92.3✓
JS05	METALS/SOIL/ICAP	11/10/89	PB	FEB005	DM3-50	AB01824	N/A	<92.3	0.82	1.0	0.960	<92.3✓
JS05	METALS/SOIL/ICAP	11/10/89	PB	FEB006	DM3-55	AB01825	N/A	<92.3	0.89	1.0	0.960	<92.3✓

Date Received: 10/27/89

JS05	METALS/SOIL/ICAP	11/10/89	PB	FEB007	DM2-25	AB01894	N/A	<92.3	0.79	1.0	0.960	<92.3✓
JS05	METALS/SOIL/ICAP	11/10/89	PB	FEB008	DM2-30	AB01895	N/A	<92.3	0.84	1.0	0.960	<92.3✓
JS05	METALS/SOIL/ICAP	11/10/89	PB	FEB009	DM2-35	AB01896	N/A	<92.3	0.87	1.0	0.960	<92.3✓
JS05	METALS/SOIL/ICAP	11/10/89	PB	FEB010	N/A	PREP BLK	N/A	<92.3	N/A	1.0	0.960	<92.3
JS05	METALS/SOIL/ICAP	11/10/89	PB	FEB011	N/A	LOW SPK	200	185.7	N/A	1.0	N/A	185.7
JS05	METALS/SOIL/ICAP	11/10/89	PB	FEB012	N/A	HIGH SPK	500	465.7	N/A	1.0	N/A	465.7
JS05	METALS/SOIL/ICAP	11/10/89	PB	FEB013	N/A	HIGH SPK2	500	468.3	N/A	1.0	N/A	468.3

metaTRACE, INC.
Project No: 115-23
Client: DAMES&MOORE

Date Received: 11/08/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGL)	CONC. (UGL)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGL)
SD11	METALS/WATER/GFAA	11/27/89	PB	FIG001	DM-2	AB02209	N/A	<2.16	N/A	1.0	1.27	<2.16 ✓
SD11	METALS/WATER/GFAA	11/27/89	PB	FIG002	DM-3	AB02210	N/A	<2.16	N/A	1.0	1.27	<2.16 ✓
SD11	METALS/WATER/GFAA	11/27/89	PB	FIG003	DM-5	AB02211	N/A	<2.16	N/A	1.0	1.27	<2.16 ✓
SD11	METALS/WATER/GFAA	11/27/89	PB	FIG004	DM-6	AB02212	N/A	<2.16	N/A	1.0	1.27	<2.16 ✓
SD11	METALS/WATER/GFAA	11/27/89	PB	FIG005	SW-3	AB02213	N/A	<2.16	N/A	1.0	1.27	<2.16 ✓
SD11	METALS/WATER/GFAA	11/27/89	PB	FIG006	N/A	PREP BLK	N/A	<2.16	N/A	1.0	1.27	<2.16
SD11	METALS/WATER/GFAA	11/27/89	PB	FIG007	N/A	LOW SPK	5.0	5.74	N/A	1.0	N/A	5.74
SD11	METALS/WATER/GFAA	11/27/89	PB	FIG008	N/A	HIGH SPK	15.0	14.89	N/A	1.0	N/A	14.89
SD11	METALS/WATER/GFAA	11/27/89	PB	FIG009	N/A	HIGH SPK2	15.0	15.42	N/A	1.0	N/A	15.42

Date Received: 11/08/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGG)	CONC. (UGG)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGG)
JS05	METALS/SOIL/ICAP	11/21/89	PB	FEY001	SD-1	AB02214	N/A	<92.3	0.66	1.0	0.960	<92.3 ✓
JS05	METALS/SOIL/ICAP	11/21/89	PB	FEY002	SD-2	AB02215	N/A	<92.3	0.70	1.0	0.960	<92.3 ✓
JS05	METALS/SOIL/ICAP	11/21/89	PB	FEY003	SD-3	AB02216	N/A	106.3	0.74	1.0	0.960	149.63 ✓
JS05	METALS/SOIL/ICAP	11/21/89	PB	FEY004	N/A	PREP BLK	N/A	<92.3	N/A	1.0	0.960	<92.3
JS05	METALS/SOIL/ICAP	11/21/89	PB	FEY005	N/A	LOW SPK	200	182.8	N/A	1.0	N/A	182.8
JS05	METALS/SOIL/ICAP	11/21/89	PB	FEY006	N/A	HIGH SPK	500	465.8	N/A	1.0	N/A	465.8
JS05	METALS/SOIL/ICAP	11/21/89	PB	FEY007	N/A	HIGH SPK2	500	468.9	N/A	1.0	N/A	468.9

metaTRACE. INC.
Project No: 115-23
Client: DAMES&MOORE

Date Received: 10/10/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGL)	CONC. (UGL)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGL)
U001	VOLATILES/WATER/601/602	10/23/89	BENZENE	EZD001	DRILL 1	AB01290	N/A	<.104	N/A	1.0	1.06	<.104 ✓
U001	VOLATILES/WATER/601/602	10/23/89	TOLUENE	EZD001	DRILL 1	AB01290	N/A	<.446	N/A	1.0	1.21	<.446 ✓
U001	VOLATILES/WATER/601/602	10/23/89	ETHYLBENZENE	EZD001	DRILL 1	AB01290	N/A	<.522	N/A	1.0	1.01	<.522 ✓
U001	VOLATILES/WATER/601/602	10/23/89	M-XYLENE	EZD001	DRILL 1	AB01290	N/A	<3.45	N/A	1.0	1.02	<3.45 ✓
U001	VOLATILES/WATER/601/602	10/23/89	O&P-XYLENE	EZD001	DRILL 1	AB01290	N/A	<4.03	N/A	1.0	0.99	<4.03 ✓
U001	VOLATILES/WATER/601/602	10/23/89	BENZENE	EZD002	RINSE 1	AB01292	N/A	0.23	N/A	1.0	1.06	0.22 ✓
U001	VOLATILES/WATER/601/602	10/23/89	TOLUENE	EZD002	RINSE 1	AB01292	N/A	0.73	N/A	1.0	1.21	0.60 ✓
U001	VOLATILES/WATER/601/602	10/23/89	ETHYLBENZENE	EZD002	RINSE 1	AB01292	N/A	<.522	N/A	1.0	1.01	<.522 ✓
U001	VOLATILES/WATER/601/602	10/23/89	M-XYLENE	EZD002	RINSE 1	AB01292	N/A	<3.45	N/A	1.0	1.02	<3.45 ✓
U001	VOLATILES/WATER/601/602	10/23/89	O&P-XYLENE	EZD002	RINSE 1	AB01292	N/A	<4.03	N/A	1.0	0.99	<4.03 ✓
U001	VOLATILES/WATER/601/602	10/23/89	BENZENE	EZD003	N/A	BLK	N/A	<.104	N/A	1.0	1.06	<.104
U001	VOLATILES/WATER/601/602	10/23/89	TOLUENE	EZD003	N/A	BLK	N/A	<.446	N/A	1.0	1.21	<.446
U001	VOLATILES/WATER/601/602	10/23/89	ETHYLBENZENE	EZD003	N/A	BLK	N/A	<.522	N/A	1.0	1.01	<.522
U001	VOLATILES/WATER/601/602	10/23/89	M-XYLENE	EZD003	N/A	BLK	N/A	<3.45	N/A	1.0	1.02	<3.45
U001	VOLATILES/WATER/601/602	10/23/89	O&P-XYLENE	EZD003	N/A	BLK	N/A	<4.03	N/A	1.0	0.99	<4.03
U001	VOLATILES/WATER/601/602	10/23/89	BENZENE	EZD004	N/A	LOW SPK	0.20	0.23	N/A	1.0	N/A	0.23
U001	VOLATILES/WATER/601/602	10/23/89	TOLUENE	EZD004	N/A	LOW SPK	1.00	1.12	N/A	1.0	N/A	1.12
U001	VOLATILES/WATER/601/602	10/23/89	ETHYLBENZENE	EZD004	N/A	LOW SPK	1.00	1.34	N/A	1.0	N/A	1.34
U001	VOLATILES/WATER/601/602	10/23/89	M-XYLENE	EZD004	N/A	LOW SPK	4.00	3.80	N/A	1.0	N/A	3.80
U001	VOLATILES/WATER/601/602	10/23/89	O&P-XYLENE	EZD004	N/A	LOW SPK	8.00	7.00	N/A	1.0	N/A	7.00
U001	VOLATILES/WATER/601/602	10/23/89	BENZENE	EZD005	N/A	HIGH SPK	3.50	4.08	N/A	1.0	N/A	4.08
U001	VOLATILES/WATER/601/602	10/23/89	TOLUENE	EZD005	N/A	HIGH SPK	7.50	8.59	N/A	1.0	N/A	8.59
U001	VOLATILES/WATER/601/602	10/23/89	ETHYLBENZENE	EZD005	N/A	HIGH SPK	3.00	3.75	N/A	1.0	N/A	3.75
U001	VOLATILES/WATER/601/602	10/23/89	M-XYLENE	EZD005	N/A	HIGH SPK	15.0	14.41	N/A	1.0	N/A	14.41
U001	VOLATILES/WATER/601/602	10/23/89	O&P-XYLENE	EZD005	N/A	HIGH SPK	30.0	31.87	N/A	1.0	N/A	31.87
U001	VOLATILES/WATER/601/602	10/23/89	BENZENE	EZD006	N/A	HIGH SPK2	3.50	3.60	N/A	1.0	N/A	3.60
U001	VOLATILES/WATER/601/602	10/23/89	TOLUENE	EZD006	N/A	HIGH SPK2	7.50	7.27	N/A	1.0	N/A	7.27
U001	VOLATILES/WATER/601/602	10/23/89	ETHYLBENZENE	EZD006	N/A	HIGH SPK2	3.00	3.15	N/A	1.0	N/A	3.15
U001	VOLATILES/WATER/601/602	10/23/89	M-XYLENE	EZD006	N/A	HIGH SPK2	15.0	11.66	N/A	1.0	N/A	11.66
U001	VOLATILES/WATER/601/602	10/23/89	O&P-XYLENE	EZD006	N/A	HIGH SPK2	30.0	24.76	N/A	1.0	N/A	24.76

metaTRACE, INC.
Project No: 115-23
Client: DAMES&MOORE

Date Received: 10/10/89

METHOD NUMBER	METHOD NAME		ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGL)	CONC. (UGL)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGL)
U001	VOLATILES/WATER/601/602	*	10/24/89	BENZENE	EZE001	DRILL 2	AB01291	N/A	<.104	N/A	1.0	1.06	<.104 ✓
U001	VOLATILES/WATER/601/602	*	10/24/89	TOLUENE	EZE001	DRILL 2	AB01291	N/A	<.446	N/A	1.0	1.21	<.446 ✓
U001	VOLATILES/WATER/601/602	*	10/24/89	ETHYLBENZENE	EZE001	DRILL 2	AB01291	N/A	<.522	N/A	1.0	1.01	<.522 ✓
U001	VOLATILES/WATER/601/602	*	10/24/89	M-XYLENE	EZE001	DRILL 2	AB01291	N/A	<3.45	N/A	1.0	1.02	<3.45 ✓
U001	VOLATILES/WATER/601/602	*	10/24/89	O&P-XYLENE	EZE001	DRILL 2	AB01291	N/A	<4.03	N/A	1.0	0.99	<4.03 ✓
U001	VOLATILES/WATER/601/602	*	10/24/89	BENZENE	EZE002	RINSE 2	AB01293	N/A	0.27	N/A	1.0	1.06	0.26 ✓
U001	VOLATILES/WATER/601/602	*	10/24/89	TOLUENE	EZE002	RINSE 2	AB01293	N/A	0.74	N/A	1.0	1.21	0.61 ✓
U001	VOLATILES/WATER/601/602	*	10/24/89	ETHYLBENZENE	EZE002	RINSE 2	AB01293	N/A	<.522	N/A	1.0	1.01	<.522 ✓
U001	VOLATILES/WATER/601/602	*	10/24/89	M-XYLENE	EZE002	RINSE 2	AB01293	N/A	<3.45	N/A	1.0	1.02	<3.45 ✓
U001	VOLATILES/WATER/601/602	*	10/24/89	O&P-XYLENE	EZE002	RINSE 2	AB01293	N/A	<4.03	N/A	1.0	0.99	<4.03 ✓
U001	VOLATILES/WATER/601/602		10/24/89	BENZENE	EZE003	N/A	BLK	N/A	<.104	N/A	1.0	1.06	<.104
U001	VOLATILES/WATER/601/602		10/24/89	TOLUENE	EZE003	N/A	BLK	N/A	<.446	N/A	1.0	1.21	<.446
U001	VOLATILES/WATER/601/602		10/24/89	ETHYLBENZENE	EZE003	N/A	BLK	N/A	<.522	N/A	1.0	1.01	<.522
U001	VOLATILES/WATER/601/602		10/24/89	M-XYLENE	EZE003	N/A	BLK	N/A	<3.45	N/A	1.0	1.02	<3.45
U001	VOLATILES/WATER/601/602		10/24/89	O&P-XYLENE	EZE003	N/A	BLK	N/A	<4.03	N/A	1.0	0.99	<4.03
U001	VOLATILES/WATER/601/602		10/24/89	BENZENE	EZE004	N/A	LOW SPK	0.20	0.17	N/A	1.0	N/A	0.17
U001	VOLATILES/WATER/601/602		10/24/89	TOLUENE	EZE004	N/A	LOW SPK	1.00	1.50	N/A	1.0	N/A	1.50
U001	VOLATILES/WATER/601/602		10/24/89	ETHYLBENZENE	EZE004	N/A	LOW SPK	1.00	1.05	N/A	1.0	N/A	1.05
U001	VOLATILES/WATER/601/602		10/24/89	M-XYLENE	EZE004	N/A	LOW SPK	4.00	3.62	N/A	1.0	N/A	3.62
U001	VOLATILES/WATER/601/602		10/24/89	O&P-XYLENE	EZE004	N/A	LOW SPK	8.00	6.43	N/A	1.0	N/A	6.43
U001	VOLATILES/WATER/601/602		10/24/89	BENZENE	EZE005	N/A	HIGH SPK	3.50	3.65	N/A	1.0	N/A	3.65
U001	VOLATILES/WATER/601/602		10/24/89	TOLUENE	EZE005	N/A	HIGH SPK	7.50	7.96	N/A	1.0	N/A	7.96
U001	VOLATILES/WATER/601/602		10/24/89	ETHYLBENZENE	EZE005	N/A	HIGH SPK	3.00	3.49	N/A	1.0	N/A	3.49
U001	VOLATILES/WATER/601/602		10/24/89	M-XYLENE	EZE005	N/A	HIGH SPK	15.0	13.40	N/A	1.0	N/A	13.40
U001	VOLATILES/WATER/601/602		10/24/89	O&P-XYLENE	EZE005	N/A	HIGH SPK	30.0	29.78	N/A	1.0	N/A	29.78
U001	VOLATILES/WATER/601/602		10/24/89	BENZENE	EZE006	N/A	HIGH SPK2	3.50	3.27	N/A	1.0	N/A	3.27
U001	VOLATILES/WATER/601/602		10/24/89	TOLUENE	EZE006	N/A	HIGH SPK2	7.50	6.66	N/A	1.0	N/A	6.66
U001	VOLATILES/WATER/601/602		10/24/89	ETHYLBENZENE	EZE006	N/A	HIGH SPK2	3.00	2.86	N/A	1.0	N/A	2.86
U001	VOLATILES/WATER/601/602		10/24/89	M-XYLENE	EZE006	N/A	HIGH SPK2	15.0	10.93	N/A	1.0	N/A	10.93
U001	VOLATILES/WATER/601/602		10/24/89	O&P-XYLENE	EZE006	N/A	HIGH SPK2	30.0	22.50	N/A	1.0	N/A	22.50

* Analysis date exceeds hold time.

metaTRACE, INC.
Project No: 115-23
Client: DAMES&MOORE

Date Received: 10/11/89

METHOD NUMBER	METHOD NAME		ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGG)	CONC. (UGG)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGG)
L001	VOLATILES/SOIL/601/602	*	10/25/89	BENZENE	EZF001	DM14-2.5	AB01294	N/A	<.0156	0.89	1.0	0.916	<.0156 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	TOLUENE	EZF001	DM14-2.5	AB01294	N/A	<.0178	0.89	1.0	0.882	<.0178 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	ETHYLBENZENE	EZF001	DM14-2.5	AB01294	N/A	<.0161	0.89	1.0	0.752	<.0161 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	M-XYLENE	EZF001	DM14-2.5	AB01294	N/A	<.0200	0.89	1.0	N/A	<.0200 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	O&P-XYLENE	EZF001	DM14-2.5	AB01294	N/A	<.0400	0.89	1.0	N/A	<.0400 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	BENZENE	EZF002	DM14-5	AB01295	N/A	<.0156	0.77	1.0	0.916	<.0156 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	TOLUENE	EZF002	DM14-5	AB01295	N/A	<.0178	0.77	1.0	0.882	<.0178 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	ETHYLBENZENE	EZF002	DM14-5	AB01295	N/A	<.0161	0.77	1.0	0.752	<.0161 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	M-XYLENE	EZF002	DM14-5	AB01295	N/A	<.0200	0.77	1.0	N/A	<.0200 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	O&P-XYLENE	EZF002	DM14-5	AB01295	N/A	<.0400	0.77	1.0	N/A	<.0400 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	BENZENE	EZF003	DM14-7.5	AB01296	N/A	<.0156	0.78	1.0	0.916	<.0156 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	TOLUENE	EZF003	DM14-7.5	AB01296	N/A	<.0178	0.78	1.0	0.882	<.0178 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	ETHYLBENZENE	EZF003	DM14-7.5	AB01296	N/A	<.0161	0.78	1.0	0.752	<.0161 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	M-XYLENE	EZF003	DM14-7.5	AB01296	N/A	<.0200	0.78	1.0	N/A	<.0200 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	O&P-XYLENE	EZF003	DM14-7.5	AB01296	N/A	<.0400	0.78	1.0	N/A	<.0400 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	BENZENE	EZF004	DM13-2.5	AB01297	N/A	<.0156	0.80	1.0	0.916	<.0156 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	TOLUENE	EZF004	DM13-2.5	AB01297	N/A	<.0178	0.80	1.0	0.882	<.0178 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	ETHYLBENZENE	EZF004	DM13-2.5	AB01297	N/A	<.0161	0.80	1.0	0.752	<.0161 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	M-XYLENE	EZF004	DM13-2.5	AB01297	N/A	<.0200	0.80	1.0	N/A	<.0200 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	O&P-XYLENE	EZF004	DM13-2.5	AB01297	N/A	<.0400	0.80	1.0	N/A	<.0400 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	BENZENE	EZF005	DM13-5	AB01298	N/A	<.0156	0.84	1.0	0.916	<.0156 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	TOLUENE	EZF005	DM13-5	AB01298	N/A	<.0178	0.84	1.0	0.882	<.0178 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	ETHYLBENZENE	EZF005	DM13-5	AB01298	N/A	<.0161	0.84	1.0	0.752	<.0161 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	M-XYLENE	EZF005	DM13-5	AB01298	N/A	<.0200	0.84	1.0	N/A	<.0200 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	O&P-XYLENE	EZF005	DM13-5	AB01298	N/A	<.0400	0.84	1.0	N/A	<.0400 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	BENZENE	EZF006	DM13-7.5	AB01299	N/A	<.0156	0.74	1.0	0.916	<.0156 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	TOLUENE	EZF006	DM13-7.5	AB01299	N/A	<.0178	0.74	1.0	0.882	<.0178 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	ETHYLBENZENE	EZF006	DM13-7.5	AB01299	N/A	<.0161	0.74	1.0	0.752	<.0161 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	M-XYLENE	EZF006	DM13-7.5	AB01299	N/A	<.0200	0.74	1.0	N/A	<.0200 ✓
L001	VOLATILES/SOIL/601/602	*	10/25/89	O&P-XYLENE	EZF006	DM13-7.5	AB01299	N/A	<.0400	0.74	1.0	N/A	<.0400

* Analysis date exceeds hold time.

metaTRACE, INC.
Project No: 115-23
Client: DAMES&MOORE

Date Received: 10/12/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGG)	CONC. (UGG)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGG)
L001	VOLATILES/SOIL/601/602	10/25/89	BENZENE	EZF007	DM8-2.5	AB01307	N/A	<.0156	0.78	1.0	0.916	<.0156
L001	VOLATILES/SOIL/601/602	10/25/89	TOLUENE	EZF007	DM8-2.5	AB01307	N/A	<.0178	0.78	1.0	0.882	<.0178
L001	VOLATILES/SOIL/601/602	10/25/89	ETHYLBENZENE	EZF007	DM8-2.5	AB01307	N/A	<.0161	0.78	1.0	0.752	<.0161
L001	VOLATILES/SOIL/601/602	10/25/89	M-XYLENE	EZF007	DM8-2.5	AB01307	N/A	<.0200	0.78	1.0	N/A	<.0200
L001	VOLATILES/SOIL/601/602	10/25/89	O&P-XYLENE	EZF007	DM8-2.5	AB01307	N/A	<.0400	0.78	1.0	N/A	<.0400 ✓
L001	VOLATILES/SOIL/601/602	10/25/89	BENZENE	EZF008	DM8-5	AB01308	N/A	<.0156	0.79	1.0	0.916	<.0156
L001	VOLATILES/SOIL/601/602	10/25/89	TOLUENE	EZF008	DM8-5	AB01308	N/A	<.0178	0.79	1.0	0.882	<.0178
L001	VOLATILES/SOIL/601/602	10/25/89	ETHYLBENZENE	EZF008	DM8-5	AB01308	N/A	<.0161	0.79	1.0	0.752	<.0161
L001	VOLATILES/SOIL/601/602	10/25/89	M-XYLENE	EZF008	DM8-5	AB01308	N/A	<.0200	0.79	1.0	N/A	<.0200
L001	VOLATILES/SOIL/601/602	10/25/89	O&P-XYLENE	EZF008	DM8-5	AB01308	N/A	<.0400	0.79	1.0	N/A	<.0400 ✓
L001	VOLATILES/SOIL/601/602	10/25/89	BENZENE	EZF009	DM8-7.5	AB01309	N/A	<.0156	0.78	1.0	0.916	<.0156 ✓
L001	VOLATILES/SOIL/601/602	10/25/89	TOLUENE	EZF009	DM8-7.5	AB01309	N/A	<.0178	0.78	1.0	0.882	<.0178 ✓
L001	VOLATILES/SOIL/601/602	10/25/89	ETHYLBENZENE	EZF009	DM8-7.5	AB01309	N/A	<.0161	0.78	1.0	0.752	<.0161 ✓
L001	VOLATILES/SOIL/601/602	10/25/89	M-XYLENE	EZF009	DM8-7.5	AB01309	N/A	<.0200	0.78	1.0	N/A	<.0200 ✓
L001	VOLATILES/SOIL/601/602	10/25/89	O&P-XYLENE	EZF009	DM8-7.5	AB01309	N/A	<.0400	0.78	1.0	N/A	<.0400 ✓
L001	VOLATILES/SOIL/601/602	10/25/89	BENZENE	EZF010	DM9-2.5	AB01310	N/A	<.0156	0.76	1.0	0.916	<.0156 ✓
L001	VOLATILES/SOIL/601/602	10/25/89	TOLUENE	EZF010	DM9-2.5	AB01310	N/A	<.0178	0.76	1.0	0.882	<.0178 ✓
L001	VOLATILES/SOIL/601/602	10/25/89	ETHYLBENZENE	EZF010	DM9-2.5	AB01310	N/A	<.0161	0.76	1.0	0.752	<.0161 ✓
L001	VOLATILES/SOIL/601/602	10/25/89	M-XYLENE	EZF010	DM9-2.5	AB01310	N/A	<.0200	0.76	1.0	N/A	<.0200 ✓
L001	VOLATILES/SOIL/601/602	10/25/89	O&P-XYLENE	EZF010	DM9-2.5	AB01310	N/A	<.0400	0.76	1.0	N/A	<.0400 ✓
L001	VOLATILES/SOIL/601/602	10/25/89	BENZENE	EZF011	DM9-5	AB01311	N/A	<.0156	0.79	1.0	0.916	<.0156 ✓
L001	VOLATILES/SOIL/601/602	10/25/89	TOLUENE	EZF011	DM9-5	AB01311	N/A	<.0178	0.79	1.0	0.882	<.0178 ✓
L001	VOLATILES/SOIL/601/602	10/25/89	ETHYLBENZENE	EZF011	DM9-5	AB01311	N/A	<.0161	0.79	1.0	0.752	<.0161 ✓
L001	VOLATILES/SOIL/601/602	10/25/89	M-XYLENE	EZF011	DM9-5	AB01311	N/A	<.0200	0.79	1.0	N/A	<.0200 ✓
L001	VOLATILES/SOIL/601/602	10/25/89	O&P-XYLENE	EZF011	DM9-5	AB01311	N/A	<.0400	0.79	1.0	N/A	<.0400 ✓

metaTRACE, INC.
Project No: 115-23
Client: DAMES&MOORE

Date Received: 10/12/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGG)	CONC. (UGG)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGG)
L001	VOLATILES/SOIL/601/602	10/25/89	BENZENE	EZF012	N/A	PREP BLK	N/A	<.0156	N/A	1.0	0.916	<.0156
L001	VOLATILES/SOIL/601/602	10/25/89	TOLUENE	EZF012	N/A	PREP BLK	N/A	<.0178	N/A	1.0	0.882	<.0178
L001	VOLATILES/SOIL/601/602	10/25/89	ETHYLBENZENE	EZF012	N/A	PREP BLK	N/A	<.0161	N/A	1.0	0.752	<.0161
L001	VOLATILES/SOIL/601/602	10/25/89	M-XYLENE	EZF012	N/A	PREP BLK	N/A	<.0200	N/A	1.0	N/A	<.0200
L001	VOLATILES/SOIL/601/602	10/25/89	O&P-XYLENE	EZF012	N/A	PREP BLK	N/A	<.0400	N/A	1.0	N/A	<.0400
L001	VOLATILES/SOIL/601/602	10/25/89	BENZENE	EZF013	N/A	LOW SPK	0.04	0.0257	N/A	1.0	N/A	0.0257
L001	VOLATILES/SOIL/601/602	10/25/89	TOLUENE	EZF013	N/A	LOW SPK	0.04	0.0312	N/A	1.0	N/A	0.0312
L001	VOLATILES/SOIL/601/602	10/25/89	ETHYLBENZENE	EZF013	N/A	LOW SPK	0.04	0.0274	N/A	1.0	N/A	0.0274
L001	VOLATILES/SOIL/601/602	10/25/89	M-XYLENE	EZF013	N/A	LOW SPK	0.04	0.0329	N/A	1.0	N/A	0.0329
L001	VOLATILES/SOIL/601/602	10/25/89	O&P-XYLENE	EZF013	N/A	LOW SPK	0.08	0.0912	N/A	1.0	N/A	0.0912
L001	VOLATILES/SOIL/601/602	10/25/89	BENZENE	EZF014	N/A	HIGH SPK	0.30	0.1878	N/A	1.0	N/A	0.1878
L001	VOLATILES/SOIL/601/602	10/25/89	TOLUENE	EZF014	N/A	HIGH SPK	0.30	0.1831	N/A	1.0	N/A	0.1831
L001	VOLATILES/SOIL/601/602	10/25/89	ETHYLBENZENE	EZF014	N/A	HIGH SPK	0.30	0.1813	N/A	1.0	N/A	0.1813
L001	VOLATILES/SOIL/601/602	10/25/89	M-XYLENE	EZF014	N/A	HIGH SPK	0.75	0.4101	N/A	1.0	N/A	0.4101
L001	VOLATILES/SOIL/601/602	10/25/89	O&P-XYLENE	EZF014	N/A	HIGH SPK	1.50	0.8006	N/A	1.0	N/A	0.8006
L001	VOLATILES/SOIL/601/602	10/25/89	BENZENE	EZF015	N/A	HIGH SPK2	0.30	0.1990	N/A	1.0	N/A	0.1990
L001	VOLATILES/SOIL/601/602	10/25/89	TOLUENE	EZF015	N/A	HIGH SPK2	0.30	0.1967	N/A	1.0	N/A	0.1967
L001	VOLATILES/SOIL/601/602	10/25/89	ETHYLBENZENE	EZF015	N/A	HIGH SPK2	0.30	0.1975	N/A	1.0	N/A	0.1975
L001	VOLATILES/SOIL/601/602	10/25/89	M-XYLENE	EZF015	N/A	HIGH SPK2	0.75	0.4732	N/A	1.0	N/A	0.4732
L001	VOLATILES/SOIL/601/602	10/25/89	O&P-XYLENE	EZF015	N/A	HIGH SPK2	1.50	0.8435	N/A	1.0	N/A	0.8435

metaTRACE. INC.
Project No: 115-23
Client: DAMES&MOORE

Date Received: 10/11/89

METHOD NUMBER	METHOD NAME		ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGG)	CONC. (UGG)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGG)
L001	VOLATILES/SOIL/601/602	*	11/06/89	BENZENE	EZK001	DM12-2.5	AB01300	N/A	0.026	0.76	500	0.916	18.67 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	TOLUENE	EZK001	DM12-2.5	AB01300	N/A	0.129	0.76	500	0.882	96.22 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	ETHYLBENZENE	EZK001	DM12-2.5	AB01300	N/A	0.056	0.76	500	0.752	48.99 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	M-XYLENE	EZK001	DM12-2.5	AB01300	N/A	0.102	0.76	500	N/A	67.10 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	O&P-XYLENE	EZK001	DM12-2.5	AB01300	N/A	0.090	0.76	500	N/A	59.21 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	BENZENE	EZK002	DM11-7.5	AB01304	N/A	0.054	0.78	50	0.916	3.78 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	TOLUENE	EZK002	DM11-7.5	AB01304	N/A	0.096	0.78	50	0.882	6.98 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	ETHYLBENZENE	EZK002	DM11-7.5	AB01304	N/A	0.047	0.78	50	0.752	4.01 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	M-XYLENE	EZK002	DM11-7.5	AB01304	N/A	0.078	0.78	50	N/A	5.00 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	O&P-XYLENE	EZK002	DM11-7.5	AB01304	N/A	0.071	0.78	50	N/A	4.55 ✓

Date Received: 10/13/89

METHOD NUMBER	METHOD NAME		ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGG)	CONC. (UGG)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGG)
L001	VOLATILES/SOIL/601/602	*	11/06/89	BENZENE	EZK003	DM1-2.5	AB01322	N/A	0.077	0.79	50	0.916	5.32 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	TOLUENE	EZK003	DM1-2.5	AB01322	N/A	0.031	0.79	50	0.882	2.22 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	ETHYLBENZENE	EZK003	DM1-2.5	AB01322	N/A	0.376	0.79	50	0.752	31.65 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	M-XYLENE	EZK003	DM1-2.5	AB01322	N/A	0.602	0.79	50	N/A	38.10 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	O&P-XYLENE	EZK003	DM1-2.5	AB01322	N/A	0.532	0.79	50	N/A	33.67 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	BENZENE	EZK004	DM1-5	AB01323	N/A	0.056	0.77	500	0.916	39.70 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	TOLUENE	EZK004	DM1-5	AB01323	N/A	0.157	0.77	500	0.882	115.59 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	ETHYLBENZENE	EZK004	DM1-5	AB01323	N/A	0.065	0.77	500	0.752	56.13 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	M-XYLENE	EZK004	DM1-5	AB01323	N/A	0.126	0.77	500	N/A	81.82 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	O&P-XYLENE	EZK004	DM1-5	AB01323	N/A	0.110	0.77	500	N/A	71.43 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	BENZENE	EZK005	DM1-7.5	AB01324	N/A	0.082	0.80	5.0	0.916	0.56 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	TOLUENE	EZK005	DM1-7.5	AB01324	N/A	0.32	0.80	5.0	0.882	2.27 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	ETHYLBENZENE	EZK005	DM1-7.5	AB01324	N/A	0.112	0.80	5.0	0.752	0.93 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	M-XYLENE	EZK005	DM1-7.5	AB01324	N/A	0.176	0.80	5.0	N/A	1.10 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	O&P-XYLENE	EZK005	DM1-7.5	AB01324	N/A	0.188	0.80	5.0	N/A	1.18 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	BENZENE	EZK006	DM4-2.5	AB01325	N/A	<.0156	0.83	1.0	0.916	<.0156 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	TOLUENE	EZK006	DM4-2.5	AB01325	N/A	<.0178	0.83	1.0	0.882	<.0178 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	ETHYLBENZENE	EZK006	DM4-2.5	AB01325	N/A	<.0161	0.83	1.0	0.752	<.0161 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	M-XYLENE	EZK006	DM4-2.5	AB01325	N/A	<.0200	0.83	1.0	N/A	<.0200 ✓
L001	VOLATILES/SOIL/601/602	*	11/06/89	O&P-XYLENE	EZK006	DM4-2.5	AB01325	N/A	<.0400	0.83	1.0	N/A	<.0400 ✓

* Analysis date exceeds hold time.

Project No: 115-23
Client: DAMES&MOORE

Date Received: 10/13/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGG)	CONC. (UGG)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGG)
L001	VOLATILES/SOIL/601/602	* 11/06/89	BENZENE	EZK007	DM4-5.0	AB01326	N/A	<.0156	0.78	1.0	0.916	<.0156 ✓
L001	VOLATILES/SOIL/601/602	* 11/06/89	TOLUENE	EZK007	DM4-5.0	AB01326	N/A	<.0178	0.78	1.0	0.882	<.0178 ✓
L001	VOLATILES/SOIL/601/602	* 11/06/89	ETHYLBENZENE	EZK007	DM4-5.0	AB01326	N/A	<.0161	0.78	1.0	0.752	<.0161 ✓
L001	VOLATILES/SOIL/601/602	* 11/06/89	M-XYLENE	EZK007	DM4-5.0	AB01326	N/A	<.0200	0.78	1.0	N/A	<.0200 ✓
L001	VOLATILES/SOIL/601/602	* 11/06/89	O&P-XYLENE	EZK007	DM4-5.0	AB01326	N/A	<.0400	0.78	1.0	N/A	<.0400 ✓
L001	VOLATILES/SOIL/601/602	* 11/06/89	BENZENE	EZK008	DM4-7.5	AB01327	N/A	<.0156	0.80	1.0	0.916	<.0156 ✓
L001	VOLATILES/SOIL/601/602	* 11/06/89	TOLUENE	EZK008	DM4-7.5	AB01327	N/A	<.0178	0.80	1.0	0.882	<.0178 ✓
L001	VOLATILES/SOIL/601/602	* 11/06/89	ETHYLBENZENE	EZK008	DM4-7.5	AB01327	N/A	<.0161	0.80	1.0	0.752	<.0161 ✓
L001	VOLATILES/SOIL/601/602	* 11/06/89	M-XYLENE	EZK008	DM4-7.5	AB01327	N/A	<.0200	0.80	1.0	N/A	<.0200 ✓
L001	VOLATILES/SOIL/601/602	* 11/06/89	O&P-XYLENE	EZK008	DM4-7.5	AB01327	N/A	<.0400	0.80	1.0	N/A	<.0400 ✓

Date Received: 10/26/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGG)	CONC. (UGG)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGG)
L001	VOLATILES/SOIL/601/602	11/06/89	BENZENE	EZK009	DM3-30	AB01819	N/A	<.0156	0.79	1.0	0.916	<.0156 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	TOLUENE	EZK009	DM3-30	AB01819	N/A	<.0178	0.79	1.0	0.882	<.0178 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	ETHYLBENZENE	EZK009	DM3-30	AB01819	N/A	<.0161	0.79	1.0	0.752	<.0161 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	M-XYLENE	EZK009	DM3-30	AB01819	N/A	<.0200	0.79	1.0	N/A	<.0200 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	O&P-XYLENE	EZK009	DM3-30	AB01819	N/A	<.0400	0.79	1.0	N/A	<.0400 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	BENZENE	EZK010	DM3-25	AB01820	N/A	<.0156	0.85	1.0	0.916	<.0156 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	TOLUENE	EZK010	DM3-25	AB01820	N/A	<.0178	0.85	1.0	0.882	<.0178 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	ETHYLBENZENE	EZK010	DM3-25	AB01820	N/A	<.0161	0.85	1.0	0.752	<.0161 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	M-XYLENE	EZK010	DM3-25	AB01820	N/A	<.0200	0.85	1.0	N/A	<.0200 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	O&P-XYLENE	EZK010	DM3-25	AB01820	N/A	<.0400	0.85	1.0	N/A	<.0400 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	BENZENE	EZK011	DM3-35	AB01821	N/A	<.0156	0.86	1.0	0.916	<.0156
L001	VOLATILES/SOIL/601/602	11/06/89	TOLUENE	EZK011	DM3-35	AB01821	N/A	<.0178	0.86	1.0	0.882	<.0178 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	ETHYLBENZENE	EZK011	DM3-35	AB01821	N/A	<.0161	0.86	1.0	0.752	<.0161 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	M-XYLENE	EZK011	DM3-35	AB01821	N/A	<.0200	0.86	1.0	N/A	<.0200 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	O&P-XYLENE	EZK011	DM3-35	AB01821	N/A	<.0400	0.86	1.0	N/A	<.0400 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	BENZENE	EZK012	DM3-40	AB01822	N/A	<.0156	0.89	1.0	0.916	<.0156 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	TOLUENE	EZK012	DM3-40	AB01822	N/A	<.0178	0.89	1.0	0.882	<.0178 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	ETHYLBENZENE	EZK012	DM3-40	AB01822	N/A	<.0161	0.89	1.0	0.752	<.0161 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	M-XYLENE	EZK012	DM3-40	AB01822	N/A	<.0200	0.89	1.0	N/A	<.0200 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	O&P-XYLENE	EZK012	DM3-40	AB01822	N/A	<.0400	0.89	1.0	N/A	<.0400 ✓

* Analysis date exceeds hold time.

metaTRACE, INC.
Project No: 115-23
Client: DAMES&MOORE

Date Received: 10/26/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGG)	CONC. (UGG)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGG)
L001	VOLATILES/SOIL/601/602	11/06/89	BENZENE	EZK013	DM3-45	AB01823	N/A	<.0156	0.89	1.0	0.916	<.0156 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	TOLUENE	EZK013	DM3-45	AB01823	N/A	<.0178	0.89	1.0	0.882	<.0178
L001	VOLATILES/SOIL/601/602	11/06/89	ETHYLBENZENE	EZK013	DM3-45	AB01823	N/A	<.0161	0.89	1.0	0.752	<.0161
L001	VOLATILES/SOIL/601/602	11/06/89	M-XYLENE	EZK013	DM3-45	AB01823	N/A	<.0200	0.89	1.0	N/A	<.0200
L001	VOLATILES/SOIL/601/602	11/06/89	O&P-XYLENE	EZK013	DM3-45	AB01823	N/A	<.0400	0.89	1.0	N/A	<.0400
L001	VOLATILES/SOIL/601/602	11/06/89	BENZENE	EZK014	DM3-50	AB01824	N/A	<.0156	0.82	1.0	0.916	<.0156 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	TOLUENE	EZK014	DM3-50	AB01824	N/A	<.0178	0.82	1.0	0.882	<.0178
L001	VOLATILES/SOIL/601/602	11/06/89	ETHYLBENZENE	EZK014	DM3-50	AB01824	N/A	<.0161	0.82	1.0	0.752	<.0161
L001	VOLATILES/SOIL/601/602	11/06/89	M-XYLENE	EZK014	DM3-50	AB01824	N/A	<.0200	0.82	1.0	N/A	<.0200
L001	VOLATILES/SOIL/601/602	11/06/89	O&P-XYLENE	EZK014	DM3-50	AB01824	N/A	<.0400	0.82	1.0	N/A	<.0400
L001	VOLATILES/SOIL/601/602	11/06/89	BENZENE	EZK015	DM3-55	AB01825	N/A	<.0156	0.89	1.0	0.916	<.0156 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	TOLUENE	EZK015	DM3-55	AB01825	N/A	<.0178	0.89	1.0	0.882	<.0178 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	ETHYLBENZENE	EZK015	DM3-55	AB01825	N/A	<.0161	0.89	1.0	0.752	<.0161 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	M-XYLENE	EZK015	DM3-55	AB01825	N/A	<.0200	0.89	1.0	N/A	<.0200 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	O&P-XYLENE	EZK015	DM3-55	AB01825	N/A	<.0400	0.89	1.0	N/A	<.0400 ✓

Date Received: 10/27/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGG)	CONC. (UGG)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGG)
L001	VOLATILES/SOIL/601/602	11/06/89	BENZENE	EZK016	DM2-25	AB01894	N/A	<.0156	0.79	1.0	0.916	<.0156 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	TOLUENE	EZK016	DM2-25	AB01894	N/A	<.0178	0.79	1.0	0.882	<.0178 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	ETHYLBENZENE	EZK016	DM2-25	AB01894	N/A	<.0161	0.79	1.0	0.752	<.0161 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	M-XYLENE	EZK016	DM2-25	AB01894	N/A	<.0200	0.79	1.0	N/A	<.0200 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	O&P-XYLENE	EZK016	DM2-25	AB01894	N/A	<.0400	0.79	1.0	N/A	<.0400 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	BENZENE	EZK017	DM2-30	AB01895	N/A	<.0156	0.84	1.0	0.916	<.0156 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	TOLUENE	EZK017	DM2-30	AB01895	N/A	<.0178	0.84	1.0	0.882	<.0178 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	ETHYLBENZENE	EZK017	DM2-30	AB01895	N/A	<.0161	0.84	1.0	0.752	<.0161 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	M-XYLENE	EZK017	DM2-30	AB01895	N/A	<.0200	0.84	1.0	N/A	<.0200 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	O&P-XYLENE	EZK017	DM2-30	AB01895	N/A	<.0400	0.84	1.0	N/A	<.0400 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	BENZENE	EZK018	DM2-35	AB01896	N/A	<.0156	0.87	1.0	0.916	<.0156 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	TOLUENE	EZK018	DM2-35	AB01896	N/A	<.0178	0.87	1.0	0.882	<.0178 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	ETHYLBENZENE	EZK018	DM2-35	AB01896	N/A	<.0161	0.87	1.0	0.752	<.0161 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	M-XYLENE	EZK018	DM2-35	AB01896	N/A	<.0200	0.87	1.0	N/A	<.0200 ✓
L001	VOLATILES/SOIL/601/602	11/06/89	O&P-XYLENE	EZK018	DM2-35	AB01896	N/A	<.0400	0.87	1.0	N/A	<.0400 ✓

Date Received: 10/27/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGG)	CONC. (UGG)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGG)
L001	VOLATILES/SOIL/601/602	11/06/89	BENZENE	EZK019	N/A	PREP BLK	N/A	<.0156	N/A	1.0	0.916	<.0156
L001	VOLATILES/SOIL/601/602	11/06/89	TOLUENE	EZK019	N/A	PREP BLK	N/A	<.0178	N/A	1.0	0.882	<.0178
L001	VOLATILES/SOIL/601/602	11/06/89	ETHYLBENZENE	EZK019	N/A	PREP BLK	N/A	<.0161	N/A	1.0	0.752	<.0161
L001	VOLATILES/SOIL/601/602	11/06/89	M-XYLENE	EZK019	N/A	PREP BLK	N/A	<.0200	N/A	1.0	N/A	<.0200
L001	VOLATILES/SOIL/601/602	11/06/89	O&P-XYLENE	EZK019	N/A	PREP BLK	N/A	<.0400	N/A	1.0	N/A	<.0400
L001	VOLATILES/SOIL/601/602	11/06/89	BENZENE	EZK020	N/A	LOW SPK	0.04	0.04	N/A	1.0	N/A	0.04
L001	VOLATILES/SOIL/601/602	11/06/89	TOLUENE	EZK020	N/A	LOW SPK	0.04	0.05	N/A	1.0	N/A	0.05
L001	VOLATILES/SOIL/601/602	11/06/89	ETHYLBENZENE	EZK020	N/A	LOW SPK	0.04	0.05	N/A	1.0	N/A	0.05
L001	VOLATILES/SOIL/601/602	11/06/89	M-XYLENE	EZK020	N/A	LOW SPK	0.04	0.05	N/A	1.0	N/A	0.05
L001	VOLATILES/SOIL/601/602	11/06/89	O&P-XYLENE	EZK020	N/A	LOW SPK	0.08	0.09	N/A	1.0	N/A	0.09
L001	VOLATILES/SOIL/601/602	11/06/89	BENZENE	EZK021	N/A	HIGH SPK	0.30	0.33	N/A	1.0	N/A	0.33
L001	VOLATILES/SOIL/601/602	11/06/89	TOLUENE	EZK021	N/A	HIGH SPK	0.30	0.33	N/A	1.0	N/A	0.33
L001	VOLATILES/SOIL/601/602	11/06/89	ETHYLBENZENE	EZK021	N/A	HIGH SPK	0.30	0.33	N/A	1.0	N/A	0.33
L001	VOLATILES/SOIL/601/602	11/06/89	M-XYLENE	EZK021	N/A	HIGH SPK	0.30	0.33	N/A	1.0	N/A	0.33
L001	VOLATILES/SOIL/601/602	11/06/89	O&P-XYLENE	EZK021	N/A	HIGH SPK	0.60	0.66	N/A	1.0	N/A	0.66
L001	VOLATILES/SOIL/601/602	11/06/89	BENZENE	EZK022	N/A	HIGH SPK2	0.30	0.33	N/A	1.0	N/A	0.33
L001	VOLATILES/SOIL/601/602	11/06/89	TOLUENE	EZK022	N/A	HIGH SPK2	0.30	0.33	N/A	1.0	N/A	0.33
L001	VOLATILES/SOIL/601/602	11/06/89	ETHYLBENZENE	EZK022	N/A	HIGH SPK2	0.30	0.33	N/A	1.0	N/A	0.33
L001	VOLATILES/SOIL/601/602	11/06/89	M-XYLENE	EZK022	N/A	HIGH SPK2	0.30	0.33	N/A	1.0	N/A	0.33
L001	VOLATILES/SOIL/601/602	11/06/89	O&P-XYLENE	EZK022	N/A	HIGH SPK2	0.60	0.66	N/A	1.0	N/A	0.66

metaTRACE, INC.
Project No: 115-23
Client: DAMES&MOORE

Date Received: 10/11/89

METHOD NUMBER	METHOD NAME		ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGG)	CONC. (UGG)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGG)
L001	VOLATILES/SOIL/601/602	*	10/30/89	BENZENE	EZ6001	DM12-5	AB01301	N/A	0.074	0.79	125	0.916	12.78
L001	VOLATILES/SOIL/601/602	*	10/30/89	TOLUENE	EZ6001	DM12-5	AB01301	N/A	0.226	0.79	125	0.882	40.54
L001	VOLATILES/SOIL/601/602	*	10/30/89	ETHYLBENZENE	EZ6001	DM12-5	AB01301	N/A	0.231	0.79	125	0.752	48.60
L001	VOLATILES/SOIL/601/602	*	10/30/89	M-XYLENE	EZ6001	DM12-5	AB01301	N/A	0.395	0.79	125	N/A	62.50
L001	VOLATILES/SOIL/601/602	*	10/30/89	O&P-XYLENE	EZ6001	DM12-5	AB01301	N/A	0.355	0.79	125	N/A	56.17
L001	VOLATILES/SOIL/601/602	*	10/30/89	BENZENE	EZ6002	DM12-7.5	AB01302	N/A	0.086	0.75	250	0.916	31.30
L001	VOLATILES/SOIL/601/602	*	10/30/89	TOLUENE	EZ6002	DM12-7.5	AB01302	N/A	0.217	0.75	250	0.882	82.01
L001	VOLATILES/SOIL/601/602	*	10/30/89	ETHYLBENZENE	EZ6002	DM12-7.5	AB01302	N/A	0.117	0.75	250	0.752	51.86
L001	VOLATILES/SOIL/601/602	*	10/30/89	M-XYLENE	EZ6002	DM12-7.5	AB01302	N/A	0.195	0.75	250	N/A	65.00
L001	VOLATILES/SOIL/601/602	*	10/30/89	O&P-XYLENE	EZ6002	DM12-7.5	AB01302	N/A	0.159	0.75	250	N/A	53.00
L001	VOLATILES/SOIL/601/602	*	10/30/89	BENZENE	EZ6003	DM11-5	AB01303	N/A	0.152	0.78	125	0.916	26.59
L001	VOLATILES/SOIL/601/602	*	10/30/89	TOLUENE	EZ6003	DM11-5	AB01303	N/A	0.244	0.78	125	0.882	44.33
L001	VOLATILES/SOIL/601/602	*	10/30/89	ETHYLBENZENE	EZ6003	DM11-5	AB01303	N/A	0.194	0.78	125	0.752	41.34
L001	VOLATILES/SOIL/601/602	*	10/30/89	M-XYLENE	EZ6003	DM11-5	AB01303	N/A	0.292	0.78	125	N/A	46.80
L001	VOLATILES/SOIL/601/602	*	10/30/89	O&P-XYLENE	EZ6003	DM11-5	AB01303	N/A	0.255	0.78	125	N/A	40.86
L001	VOLATILES/SOIL/601/602		10/30/89	BENZENE	EZ6004	N/A	PREP BLK	N/A	<.0156	N/A	1.0	0.916	<.0156
L001	VOLATILES/SOIL/601/602		10/30/89	TOLUENE	EZ6004	N/A	PREP BLK	N/A	<.0178	N/A	1.0	0.882	<.0178
L001	VOLATILES/SOIL/601/602		10/30/89	ETHYLBENZENE	EZ6004	N/A	PREP BLK	N/A	<.0161	N/A	1.0	0.752	<.0161
L001	VOLATILES/SOIL/601/602		10/30/89	M-XYLENE	EZ6004	N/A	PREP BLK	N/A	<.0200	N/A	1.0	N/A	<.0200
L001	VOLATILES/SOIL/601/602		10/30/89	O&P-XYLENE	EZ6004	N/A	PREP BLK	N/A	<.0400	N/A	1.0	N/A	<.0400
L001	VOLATILES/SOIL/601/602		10/30/89	BENZENE	EZ6005	N/A	LOW SPK	0.04	0.04	N/A	1.0	N/A	0.04
L001	VOLATILES/SOIL/601/602		10/30/89	TOLUENE	EZ6005	N/A	LOW SPK	0.04	0.02	N/A	1.0	N/A	0.02
L001	VOLATILES/SOIL/601/602		10/30/89	ETHYLBENZENE	EZ6005	N/A	LOW SPK	0.04	0.04	N/A	1.0	N/A	0.04
L001	VOLATILES/SOIL/601/602		10/30/89	M-XYLENE	EZ6005	N/A	LOW SPK	0.04	0.04	N/A	1.0	N/A	0.04
L001	VOLATILES/SOIL/601/602		10/30/89	O&P-XYLENE	EZ6005	N/A	LOW SPK	0.08	0.08	N/A	1.0	N/A	0.08
L001	VOLATILES/SOIL/601/602		10/30/89	BENZENE	EZ6006	N/A	HIGH SPK	0.30	0.31	N/A	1.0	N/A	0.31
L001	VOLATILES/SOIL/601/602		10/30/89	TOLUENE	EZ6006	N/A	HIGH SPK	0.30	0.20	N/A	1.0	N/A	0.20
L001	VOLATILES/SOIL/601/602		10/30/89	ETHYLBENZENE	EZ6006	N/A	HIGH SPK	0.30	0.29	N/A	1.0	N/A	0.29
L001	VOLATILES/SOIL/601/602		10/30/89	M-XYLENE	EZ6006	N/A	HIGH SPK	0.30	0.30	N/A	1.0	N/A	0.30
L001	VOLATILES/SOIL/601/602		10/30/89	O&P-XYLENE	EZ6006	N/A	HIGH SPK	0.60	0.60	N/A	1.0	N/A	0.60
L001	VOLATILES/SOIL/601/602		10/30/89	BENZENE	EZ6007	N/A	HIGH SPK2	0.30	0.33	N/A	1.0	N/A	0.33
L001	VOLATILES/SOIL/601/602		10/30/89	TOLUENE	EZ6007	N/A	HIGH SPK2	0.30	0.21	N/A	1.0	N/A	0.21
L001	VOLATILES/SOIL/601/602		10/30/89	ETHYLBENZENE	EZ6007	N/A	HIGH SPK2	0.30	0.31	N/A	1.0	N/A	0.31
L001	VOLATILES/SOIL/601/602		10/30/89	M-XYLENE	EZ6007	N/A	HIGH SPK2	0.30	0.32	N/A	1.0	N/A	0.32
L001	VOLATILES/SOIL/601/602		10/30/89	O&P-XYLENE	EZ6007	N/A	HIGH SPK2	0.60	0.64	N/A	1.0	N/A	0.64

* Analysis date exceeds hold time.

metaTRACE. INC.
Project No: 115-23
Client: DAMES&MOORE

Date Received: 10/25/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGL)	CONC. (UGL)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGL)
U001	VOLATILES/WATER/601/602	11/01/89	BENZENE	EZL001	DM-1	AB01796	N/A	26.77	N/A	50.0	1.06	1262.73 ✓
U001	VOLATILES/WATER/601/602	11/01/89	TOLUENE	EZL001	DM-1	AB01796	N/A	39.25	N/A	50.0	1.21	1621.90 ✓
U001	VOLATILES/WATER/601/602	11/01/89	ETHYLBENZENE	EZL001	DM-1	AB01796	N/A	10.96	N/A	50.0	1.01	542.57 ✓
U001	VOLATILES/WATER/601/602	11/01/89	M-XYLENE	EZL001	DM-1	AB01796	N/A	21.55	N/A	50.0	1.02	1056.37 ✓
U001	VOLATILES/WATER/601/602	11/01/89	O&P-XYLENE	EZL001	DM-1	AB01796	N/A	23.12	N/A	50.0	0.99	1167.67 ✓
U001	VOLATILES/WATER/601/602	11/01/89	BENZENE	EZL002	DM-4	AB01797	N/A	<.104	N/A	1.0	1.06	<.104 ✓
U001	VOLATILES/WATER/601/602	11/01/89	TOLUENE	EZL002	DM-4	AB01797	N/A	<.446	N/A	1.0	1.21	<.446 ✓
U001	VOLATILES/WATER/601/602	11/01/89	ETHYLBENZENE	EZL002	DM-4	AB01797	N/A	<.522	N/A	1.0	1.01	<.522 ✓
U001	VOLATILES/WATER/601/602	11/01/89	M-XYLENE	EZL002	DM-4	AB01797	N/A	<3.45	N/A	1.0	1.02	<3.45 ✓
U001	VOLATILES/WATER/601/602	11/01/89	O&P-XYLENE	EZL002	DM-4	AB01797	N/A	<4.03	N/A	1.0	0.99	<4.03 ✓
U001	VOLATILES/WATER/601/602	11/01/89	BENZENE	EZL003	DM-7	AB01798	N/A	<.104	N/A	1.0	1.06	<.104 ✓
U001	VOLATILES/WATER/601/602	11/01/89	TOLUENE	EZL003	DM-7	AB01798	N/A	<.446	N/A	1.0	1.21	<.446 ✓
U001	VOLATILES/WATER/601/602	11/01/89	ETHYLBENZENE	EZL003	DM-7	AB01798	N/A	<.522	N/A	1.0	1.01	<.522 ✓
U001	VOLATILES/WATER/601/602	11/01/89	M-XYLENE	EZL003	DM-7	AB01798	N/A	<3.45	N/A	1.0	1.02	<3.45 ✓
U001	VOLATILES/WATER/601/602	11/01/89	O&P-XYLENE	EZL003	DM-7	AB01798	N/A	<4.03	N/A	1.0	0.99	<4.03 ✓
U001	VOLATILES/WATER/601/602	11/01/89	BENZENE	EZL004	DM-8	AB01799	N/A	<.104	N/A	1.0	1.06	<.104 ✓
U001	VOLATILES/WATER/601/602	11/01/89	TOLUENE	EZL004	DM-8	AB01799	N/A	<.446	N/A	1.0	1.21	<.446 ✓
U001	VOLATILES/WATER/601/602	11/01/89	ETHYLBENZENE	EZL004	DM-8	AB01799	N/A	<.522	N/A	1.0	1.01	<.522 ✓
U001	VOLATILES/WATER/601/602	11/01/89	M-XYLENE	EZL004	DM-8	AB01799	N/A	<3.45	N/A	1.0	1.02	<3.45 ✓
U001	VOLATILES/WATER/601/602	11/01/89	O&P-XYLENE	EZL004	DM-8	AB01799	N/A	<4.03	N/A	1.0	0.99	<4.03 ✓
U001	VOLATILES/WATER/601/602	11/01/89	BENZENE	EZL005	DM-9	AB01800	N/A	<.104	N/A	1.0	1.06	<.104 ✓
U001	VOLATILES/WATER/601/602	11/01/89	TOLUENE	EZL005	DM-9	AB01800	N/A	<.446	N/A	1.0	1.21	<.446 ✓
U001	VOLATILES/WATER/601/602	11/01/89	ETHYLBENZENE	EZL005	DM-9	AB01800	N/A	<.522	N/A	1.0	1.01	<.522 ✓
U001	VOLATILES/WATER/601/602	11/01/89	M-XYLENE	EZL005	DM-9	AB01800	N/A	<3.45	N/A	1.0	1.02	<3.45 ✓
U001	VOLATILES/WATER/601/602	11/01/89	O&P-XYLENE	EZL005	DM-9	AB01800	N/A	<4.03	N/A	1.0	0.99	<4.03 ✓
U001	VOLATILES/WATER/601/602	11/01/89	BENZENE	EZL006	DM-10	AB01801	N/A	<.104	N/A	1.0	1.06	<.104 ✓
U001	VOLATILES/WATER/601/602	11/01/89	TOLUENE	EZL006	DM-10	AB01801	N/A	<.446	N/A	1.0	1.21	<.446 ✓
U001	VOLATILES/WATER/601/602	11/01/89	ETHYLBENZENE	EZL006	DM-10	AB01801	N/A	<.522	N/A	1.0	1.01	<.522 ✓
U001	VOLATILES/WATER/601/602	11/01/89	M-XYLENE	EZL006	DM-10	AB01801	N/A	<3.45	N/A	1.0	1.02	<3.45 ✓
U001	VOLATILES/WATER/601/602	11/01/89	O&P-XYLENE	EZL006	DM-10	AB01801	N/A	<4.03	N/A	1.0	0.99	<4.03 ✓

metaTRACE, INC.

Project No: 115-23
Client: DAMES&MOORE

Date Received: 10/25/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGL)	CONC. (UGL)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGL)
U001	VOLATILES/WATER/601/602	11/01/89	BENZENE	EZL007	N/A	PREP BLK	N/A	<.104	N/A	1.0	1.06	<.104
U001	VOLATILES/WATER/601/602	11/01/89	TOLUENE	EZL007	N/A	PREP BLK	N/A	0.85	N/A	1.0	1.21	0.70
U001	VOLATILES/WATER/601/602	11/01/89	ETHYLBENZENE	EZL007	N/A	PREP BLK	N/A	<.522	N/A	1.0	1.01	<.522
U001	VOLATILES/WATER/601/602	11/01/89	M-XYLENE	EZL007	N/A	PREP BLK	N/A	<3.45	N/A	1.0	1.02	<3.45
U001	VOLATILES/WATER/601/602	11/01/89	O&P-XYLENE	EZL007	N/A	PREP BLK	N/A	<4.03	N/A	1.0	0.99	<4.03
U001	VOLATILES/WATER/601/602	11/01/89	BENZENE	EZL008	N/A	LOW SPK	0.20	0.20	N/A	1.0	N/A	0.20
U001	VOLATILES/WATER/601/602	11/01/89	TOLUENE	EZL008	N/A	LOW SPK	1.00	0.70	N/A	1.0	N/A	0.70
U001	VOLATILES/WATER/601/602	11/01/89	ETHYLBENZENE	EZL008	N/A	LOW SPK	1.00	0.78	N/A	1.0	N/A	0.78
U001	VOLATILES/WATER/601/602	11/01/89	M-XYLENE	EZL008	N/A	LOW SPK	4.00	4.08	N/A	1.0	N/A	4.08
U001	VOLATILES/WATER/601/602	11/01/89	O&P-XYLENE	EZL008	N/A	LOW SPK	8.00	7.40	N/A	1.0	N/A	7.40
U001	VOLATILES/WATER/601/602	11/01/89	BENZENE	EZL009	N/A	HIGH SPK	3.50	3.01	N/A	1.0	N/A	3.01
U001	VOLATILES/WATER/601/602	11/01/89	TOLUENE	EZL009	N/A	HIGH SPK	7.50	6.64	N/A	1.0	N/A	6.64
U001	VOLATILES/WATER/601/602	11/01/89	ETHYLBENZENE	EZL009	N/A	HIGH SPK	3.00	2.76	N/A	1.0	N/A	2.76
U001	VOLATILES/WATER/601/602	11/01/89	M-XYLENE	EZL009	N/A	HIGH SPK	15.0	11.60	N/A	1.0	N/A	11.60
U001	VOLATILES/WATER/601/602	11/01/89	O&P-XYLENE	EZL009	N/A	HIGH SPK	30.0	25.03	N/A	1.0	N/A	25.03
U001	VOLATILES/WATER/601/602	11/01/89	BENZENE	EZL010	N/A	HIGH SPK2	3.50	2.97	N/A	1.0	N/A	2.97
U001	VOLATILES/WATER/601/602	11/01/89	TOLUENE	EZL010	N/A	HIGH SPK2	7.50	5.97	N/A	1.0	N/A	5.97
U001	VOLATILES/WATER/601/602	11/01/89	ETHYLBENZENE	EZL010	N/A	HIGH SPK2	3.00	2.51	N/A	1.0	N/A	2.51
U001	VOLATILES/WATER/601/602	11/01/89	M-XYLENE	EZL010	N/A	HIGH SPK2	15.0	10.69	N/A	1.0	N/A	10.69
U001	VOLATILES/WATER/601/602	11/01/89	O&P-XYLENE	EZL010	N/A	HIGH SPK2	30.0	23.32	N/A	1.0	N/A	23.32

metaTRACE, INC.
Project No: 115-23
Client: DAMES&MOORE

Date Received: 11/08/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGL)	CONC. (UGL)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGL)
U001	VOLATILES/WATER/601/602	11/16/89	BENZENE	EZU001	DM-2	AB02209	N/A	0.18	N/A	1.0	1.06	0.17
U001	VOLATILES/WATER/601/602	11/16/89	TOLUENE	EZU001	DM-2	AB02209	N/A	<.446	N/A	1.0	1.21	<.446
U001	VOLATILES/WATER/601/602	11/16/89	ETHYLBENZENE	EZU001	DM-2	AB02209	N/A	<.522	N/A	1.0	1.01	<.522
U001	VOLATILES/WATER/601/602	11/16/89	M-XYLENE	EZU001	DM-2	AB02209	N/A	<3.45	N/A	1.0	1.02	<3.45
U001	VOLATILES/WATER/601/602	11/16/89	O&P-XYLENE	EZU001	DM-2	AB02209	N/A	<4.03	N/A	1.0	0.99	<4.03
U001	VOLATILES/WATER/601/602	11/16/89	BENZENE	EZU002	DM-3	AB02210	N/A	<.104	N/A	1.0	1.06	<.104
U001	VOLATILES/WATER/601/602	11/16/89	TOLUENE	EZU002	DM-3	AB02210	N/A	<.446	N/A	1.0	1.21	<.446
U001	VOLATILES/WATER/601/602	11/16/89	ETHYLBENZENE	EZU002	DM-3	AB02210	N/A	<.522	N/A	1.0	1.01	<.522
U001	VOLATILES/WATER/601/602	11/16/89	M-XYLENE	EZU002	DM-3	AB02210	N/A	<3.45	N/A	1.0	1.02	<3.45
U001	VOLATILES/WATER/601/602	11/16/89	O&P-XYLENE	EZU002	DM-3	AB02210	N/A	<4.03	N/A	1.0	0.99	<4.03
U001	VOLATILES/WATER/601/602	11/16/89	BENZENE	EZU003	DM-5	AB02211	N/A	<.104	N/A	1.0	1.06	<.104
U001	VOLATILES/WATER/601/602	11/16/89	TOLUENE	EZU003	DM-5	AB02211	N/A	<.446	N/A	1.0	1.21	<.446
U001	VOLATILES/WATER/601/602	11/16/89	ETHYLBENZENE	EZU003	DM-5	AB02211	N/A	<.522	N/A	1.0	1.01	<.522
U001	VOLATILES/WATER/601/602	11/16/89	M-XYLENE	EZU003	DM-5	AB02211	N/A	<3.45	N/A	1.0	1.02	<3.45
U001	VOLATILES/WATER/601/602	11/16/89	O&P-XYLENE	EZU003	DM-5	AB02211	N/A	<4.03	N/A	1.0	0.99	<4.03
U001	VOLATILES/WATER/601/602	11/16/89	BENZENE	EZU004	DM-6	AB02212	N/A	<.104	N/A	1.0	1.06	<.104
U001	VOLATILES/WATER/601/602	11/16/89	TOLUENE	EZU004	DM-6	AB02212	N/A	<.446	N/A	1.0	1.21	<.446
U001	VOLATILES/WATER/601/602	11/16/89	ETHYLBENZENE	EZU004	DM-6	AB02212	N/A	<.522	N/A	1.0	1.01	<.522
U001	VOLATILES/WATER/601/602	11/16/89	M-XYLENE	EZU004	DM-6	AB02212	N/A	<3.45	N/A	1.0	1.02	<3.45
U001	VOLATILES/WATER/601/602	11/16/89	O&P-XYLENE	EZU004	DM-6	AB02212	N/A	<4.03	N/A	1.0	0.99	<4.03
U001	VOLATILES/WATER/601/602	11/16/89	BENZENE	EZU005	SW-3	AB02213	N/A	<.104	N/A	1.0	1.06	<.104
U001	VOLATILES/WATER/601/602	11/16/89	TOLUENE	EZU005	SW-3	AB02213	N/A	<.446	N/A	1.0	1.21	<.446
U001	VOLATILES/WATER/601/602	11/16/89	ETHYLBENZENE	EZU005	SW-3	AB02213	N/A	<.522	N/A	1.0	1.01	<.522
U001	VOLATILES/WATER/601/602	11/16/89	M-XYLENE	EZU005	SW-3	AB02213	N/A	<3.45	N/A	1.0	1.02	<3.45
U001	VOLATILES/WATER/601/602	11/16/89	O&P-XYLENE	EZU005	SW-3	AB02213	N/A	<4.03	N/A	1.0	0.99	<4.03

metaTRACE. INC.
Project No: 115-23
Client: DAMES&MOORE

Date Received: 11/08/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGL)	CONC. (UGL)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGL)
U001	VOLATILES/WATER/601/602	11/16/89	BENZENE	EZU006	N/A	PREP BLK	N/A	<.104	N/A	1.0	1.06	<.104
U001	VOLATILES/WATER/601/602	11/16/89	TOLUENE	EZU006	N/A	PREP BLK	N/A	<.446	N/A	1.0	1.21	<.446
U001	VOLATILES/WATER/601/602	11/16/89	ETHYLBENZENE	EZU006	N/A	PREP BLK	N/A	<.522	N/A	1.0	1.01	<.522
U001	VOLATILES/WATER/601/602	11/16/89	M-XYLENE	EZU006	N/A	PREP BLK	N/A	<3.45	N/A	1.0	1.02	<3.45
U001	VOLATILES/WATER/601/602	11/16/89	O&P-XYLENE	EZU006	N/A	PREP BLK	N/A	<4.03	N/A	1.0	0.99	<4.03
U001	VOLATILES/WATER/601/602	11/16/89	BENZENE	EZU007	N/A	LOW SPK	.20	0.25	N/A	1.0	N/A	0.25
U001	VOLATILES/WATER/601/602	11/16/89	TOLUENE	EZU007	N/A	LOW SPK	1.0	1.26	N/A	1.0	N/A	1.26
U001	VOLATILES/WATER/601/602	11/16/89	ETHYLBENZENE	EZU007	N/A	LOW SPK	1.0	1.36	N/A	1.0	N/A	1.36
U001	VOLATILES/WATER/601/602	11/16/89	M-XYLENE	EZU007	N/A	LOW SPK	4.0	5.87	N/A	1.0	N/A	5.87
U001	VOLATILES/WATER/601/602	11/16/89	O&P-XYLENE	EZU007	N/A	LOW SPK	8.0	12.22	N/A	1.0	N/A	12.22
U001	VOLATILES/WATER/601/602	11/16/89	BENZENE	EZU008	N/A	HIGH SPK	3.5	3.94	N/A	1.0	N/A	3.94
U001	VOLATILES/WATER/601/602	11/16/89	TOLUENE	EZU008	N/A	HIGH SPK	7.5	7.73	N/A	1.0	N/A	7.73
U001	VOLATILES/WATER/601/602	11/16/89	ETHYLBENZENE	EZU008	N/A	HIGH SPK	3.0	4.06	N/A	1.0	N/A	4.06
U001	VOLATILES/WATER/601/602	11/16/89	M-XYLENE	EZU008	N/A	HIGH SPK	15.0	16.19	N/A	1.0	N/A	16.19
U001	VOLATILES/WATER/601/602	11/16/89	O&P-XYLENE	EZU008	N/A	HIGH SPK	30.0	34.01	N/A	1.0	N/A	34.01
U001	VOLATILES/WATER/601/602	11/16/89	BENZENE	EZU009	N/A	HIGH SPK2	3.5	4.12	N/A	1.0	N/A	4.12
U001	VOLATILES/WATER/601/602	11/16/89	TOLUENE	EZU009	N/A	HIGH SPK2	7.5	9.33	N/A	1.0	N/A	9.33
U001	VOLATILES/WATER/601/602	11/16/89	ETHYLBENZENE	EZU009	N/A	HIGH SPK2	3.0	4.41	N/A	1.0	N/A	4.41
U001	VOLATILES/WATER/601/602	11/16/89	M-XYLENE	EZU009	N/A	HIGH SPK2	15.0	17.25	N/A	1.0	N/A	17.25
U001	VOLATILES/WATER/601/602	11/16/89	O&P-XYLENE	EZU009	N/A	HIGH SPK2	30.0	36.41	N/A	1.0	N/A	36.41

metaTRACE, INC.
Project No: 115-23
Client: DAMES&MOORE

Date Received: 11/08/89

METHOD NUMBER	METHOD NAME		ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGG)	CONC. (UGG)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGG)
L001	VOLATILES/SOIL/601/602	*	11/24/89	BENZENE	EZV001	SD-1	AB02214	N/A	<.0156	0.66	1.0	0.916	<.0156
L001	VOLATILES/SOIL/601/602	*	11/24/89	TOLUENE	EZV001	SD-1	AB02214	N/A	<.0178	0.66	1.0	0.882	<.0178
L001	VOLATILES/SOIL/601/602	*	11/24/89	ETHYLBENZENE	EZV001	SD-1	AB02214	N/A	<.0161	0.66	1.0	0.752	<.0161
L001	VOLATILES/SOIL/601/602	*	11/24/89	M-XYLENE	EZV001	SD-1	AB02214	N/A	<.0200	0.66	1.0	N/A	<.0200
L001	VOLATILES/SOIL/601/602	*	11/24/89	O&P-XYLENE	EZV001	SD-1	AB02214	N/A	<.0400	0.66	1.0	N/A	<.0400
L001	VOLATILES/SOIL/601/602	*	11/24/89	BENZENE	EZV002	SD-2	AB02215	N/A	<.0156	0.70	1.0	0.916	<.0156
L001	VOLATILES/SOIL/601/602	*	11/24/89	TOLUENE	EZV002	SD-2	AB02215	N/A	<.0178	0.70	1.0	0.882	<.0178
L001	VOLATILES/SOIL/601/602	*	11/24/89	ETHYLBENZENE	EZV002	SD-2	AB02215	N/A	<.0161	0.70	1.0	0.752	<.0161
L001	VOLATILES/SOIL/601/602	*	11/24/89	M-XYLENE	EZV002	SD-2	AB02215	N/A	<.0200	0.70	1.0	N/A	<.0200
L001	VOLATILES/SOIL/601/602	*	11/24/89	O&P-XYLENE	EZV002	SD-2	AB02215	N/A	<.0400	0.70	1.0	N/A	<.0400
L001	VOLATILES/SOIL/601/602	*	11/24/89	BENZENE	EZV003	SD-3	AB02216	N/A	<.0156	0.74	1.0	0.916	<.0156
L001	VOLATILES/SOIL/601/602	*	11/24/89	TOLUENE	EZV003	SD-3	AB02216	N/A	<.0178	0.74	1.0	0.882	<.0178
L001	VOLATILES/SOIL/601/602	*	11/24/89	ETHYLBENZENE	EZV003	SD-3	AB02216	N/A	<.0161	0.74	1.0	0.752	<.0161
L001	VOLATILES/SOIL/601/602	*	11/24/89	M-XYLENE	EZV003	SD-3	AB02216	N/A	<.0200	0.74	1.0	N/A	<.0200
L001	VOLATILES/SOIL/601/602	*	11/24/89	O&P-XYLENE	EZV003	SD-3	AB02216	N/A	<.0400	0.74	1.0	N/A	<.0400
L001	VOLATILES/SOIL/601/602		11/24/89	BENZENE	EZV004	N/A	PREP BLK	N/A	<.0156	N/A	1.0	0.916	<.0156
L001	VOLATILES/SOIL/601/602		11/24/89	TOLUENE	EZV004	N/A	PREP BLK	N/A	<.0178	N/A	1.0	0.882	<.0178
L001	VOLATILES/SOIL/601/602		11/24/89	ETHYLBENZENE	EZV004	N/A	PREP BLK	N/A	<.0161	N/A	1.0	0.752	<.0161
L001	VOLATILES/SOIL/601/602		11/24/89	M-XYLENE	EZV004	N/A	PREP BLK	N/A	<.0200	N/A	1.0	N/A	<.0200
L001	VOLATILES/SOIL/601/602		11/24/89	O&P-XYLENE	EZV004	N/A	PREP BLK	N/A	<.0400	N/A	1.0	N/A	<.0400

* Analysis date exceeds hold time.

metaTRACE, INC.
Project No: 115-23
Client: DAMES&MOORE

Date Received: 11/08/89

METHOD NUMBER	METHOD NAME	ANALYSIS DATE	COMPOUND	LOT	SITE ID	LAB NUMBER	SPIKE (UGG)	CONC. (UGG)	SOLID FRACT	DIL.	ACC.	NEW CONC (UGG)
L001	VOLATILES/SOIL/601/602	11/24/89	BENZENE	EZV005	N/A	LOW SPK	0.04	0.05	N/A	1.0	N/A	0.05
L001	VOLATILES/SOIL/601/602	11/24/89	TOLUENE	EZV005	N/A	LOW SPK	0.04	0.04	N/A	1.0	N/A	0.04
L001	VOLATILES/SOIL/601/602	11/24/89	ETHYLBENZENE	EZV005	N/A	LOW SPK	0.04	0.04	N/A	1.0	N/A	0.04
L001	VOLATILES/SOIL/601/602	11/24/89	M-XYLENE	EZV005	N/A	LOW SPK	0.04	0.05	N/A	1.0	N/A	0.05
L001	VOLATILES/SOIL/601/602	11/24/89	O&P-XYLENE	EZV005	N/A	LOW SPK	0.08	0.09	N/A	1.0	N/A	0.09
L001	VOLATILES/SOIL/601/602	11/24/89	BENZENE	EZV006	N/A	HIGH SPK	0.30	0.37	N/A	1.0	N/A	0.37
L001	VOLATILES/SOIL/601/602	11/24/89	TOLUENE	EZV006	N/A	HIGH SPK	0.30	0.36	N/A	1.0	N/A	0.36
L001	VOLATILES/SOIL/601/602	11/24/89	ETHYLBENZENE	EZV006	N/A	HIGH SPK	0.30	0.35	N/A	1.0	N/A	0.35
L001	VOLATILES/SOIL/601/602	11/24/89	M-XYLENE	EZV006	N/A	HIGH SPK	0.30	0.36	N/A	1.0	N/A	0.36
L001	VOLATILES/SOIL/601/602	11/24/89	O&P-XYLENE	EZV006	N/A	HIGH SPK	0.60	0.71	N/A	1.0	N/A	0.71
L001	VOLATILES/SOIL/601/602	11/24/89	BENZENE	EZV007	N/A	HIGH SPK2	0.30	0.36	N/A	1.0	N/A	0.36
L001	VOLATILES/SOIL/601/602	11/24/89	TOLUENE	EZV007	N/A	HIGH SPK2	0.30	0.35	N/A	1.0	N/A	0.35
L001	VOLATILES/SOIL/601/602	11/24/89	ETHYLBENZENE	EZV007	N/A	HIGH SPK2	0.30	0.34	N/A	1.0	N/A	0.34
L001	VOLATILES/SOIL/601/602	11/24/89	M-XYLENE	EZV007	N/A	HIGH SPK2	0.30	0.34	N/A	1.0	N/A	0.34
L001	VOLATILES/SOIL/601/602	11/24/89	O&P-XYLENE	EZV007	N/A	HIGH SPK2	0.60	0.68	N/A	1.0	N/A	0.68