REMEDIAL INVESTIGATION/CORRECTIVE ACTION DESIGN REPORT

BUILDING 511
FORT SNELLING, MINNESOTA

MPCA LEAK# 5614

PREPARED FOR:

CTS ENVIRONMENTAL SERVICES
P.O. BOX 9
WINTER, WI 54896

PREPARED BY:

REMEDIATION SERVICES, INC.
102 SOUTH 29th AVENUE WEST, SUITE 100 DULUTH, MINNESOTA 55806
(218) 722-6013

SEPTEMBER 1995

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INTRODUCTION AND PURPOSE

This report summarizes the results of a remedial investigation conducted near building 511 Fort Snelling, Minneapolis, Minnesota (MPCA Leak #5614). The purpose of the investigation was to determine the extent and magnitude of petroleum contamination encountered by Agassiz Environmental Systems Inc., of Hancock, Minnesota, during the removal of two waste oil underground storage tanks (USTs) on October 4, 1993. Remediation Services Inc. (RSI) was authorized to begin the remedial investigation in November, 1994 by Leo Kelly of CTS Environmental Services. The investigation was initiated on November 28 at Building 511, Fort Snelling, hereafter referred to as "the site."

SCOPE OF INVESTIGATION

A total of seven (7) soil borings were advanced, using a hollow stem auger; three (3) of the borings were converted to monitoring wells. Analytical results were compiled and evaluated.

The purpose of an RI is to determine the extent and magnitude of petroleum contamination. A Corrective Action Design (CAD) is normally included with an RI report. Groundwater has been impacted, and soil contamination is still present, but further corrective actions are not recommended in this report due to the limited aerial extent of remaining contamination and the limiting hydrogeologic characteristics of the area.

BACKGROUND INFORMATION

Site Location

Fort Snelling - Building 511 is located in Minneapolis, Minnesota. The site is in Hennepin County in the NW $\frac{1}{4}$ of the SW $\frac{1}{4}$ of Section 20, Township 28 North, Range 24 West. The approximate coordinates are: 44°, 53′, 19" North Latitude, and 93°, 12′, 20" West Longitude (Figure 1).

Site History

Petro Tanks (St. Paul, Minnesota) removed two (2) Underground Storage Tanks (USTs) on October 4, 1993. Both tanks had capacities of 250 gallons. Agassiz Environmental Systems served as the environmental consultant during the UST removal. According to the excavation report (Appendix A), both tanks were used to store waste oil. The age of the tanks is unknown but both were found to be in poor condition with visible holes and pitting.

A total of 90 cubic yards of contaminated soil was removed from the tank basin and the immediate area. The soils from the stockpile and the tank basin excavation had levels of contamination ranging from 3 to 320 ppm, as determined from a flame ionization detector (FID).

Soil samples were collected from the site and laboratory analytical results confirmed a release (Appendix A). Low levels of PCB contamination (8.1 ppm) were detected in the stockpile sample, and the maximum DRO concentration was 4900 ppm in the excavated soils. BETX and other VOCs were also present. Since bottom samples were contaminated at 15 feet, and the water table is at or above this level, the groundwater was thought to be impacted.

Agassiz recommended that a remedial investigation be conducted to determine the horizontal and vertical extent and magnitude of subsurface contamination.

RSI was retained to conduct the RI. Borings and wells were installed in November, 1994. Three rounds of water samples were collected in December, 1994, May, 1995 and August, 1995.

Site Description

The Fort Snelling Military Reserve is located west and south of the Mississippi River within Minneapolis City Limits. The regional gradient dips gently to the south.

Building 511 - Fort Snelling is on the western edge of the military reserve area. The site is over 200 feet north of Building 511 where two (2) side by side tanks were removed. North and east of the tank basin are paved streets. An open, grassed covered field occurs to the west of the former tank basin.

REMEDIAL INVESTIGATION RESULTS

Soil Borings

A total of seven (7) soil borings were advanced on November 28, 1994 by Traut Hydrotech. Three (3) of the soil borings (SB-1, SB-4, and SB-5) were converted to monitoring wells. Soil Boring SB-1 was positioned in the tank basin while the other borings were positioned 25 to 35 feet from the tank basin, with the exception of SB-5 (MW-3) which is 52 feet east of SB-1, on the east side of an access road (Figure 2).

The soils encountered in the borings generally fine (texturally) upward with interbedded coarse grained materials occasionally observed in the stratigraphic section. Soils were massive to finely bedded to 12 feet, becoming mostly massive gravel with coarse sand below 12 feet. Figure 3 illustrates a geologic cross section of the site.

Soil samples were field screened with a portable PID (photoionization detector, MicroTip Model Mp-1000). The cumulative table of the field screening results can be located in Table 1. The field screening results are also included on the soil boring logs in Appendix B. The Maximum headspace, PID reading was 58 ppm at 10 to 12 feet in SB-1. Other borings with PID readings exceeding 10 ppm include SB-2 (8 to 12 feet), SB-4 (10 to 12 feet), and SB-5 (10 to 12 feet). The maximum headspace readings were all associated with the top of the water table.

Laboratory analytical soil samples were chosen in reference to headspace results. Detectable Diesel Range Organics (DRO) were encountered in SB-1 (2571 ppm) at a depth of 14 to 16 feet and at 18 to 20 feet (10.5 ppm). None of the other soil borings had detectable levels of DRO. A total of 14 Volatile Organic Compounds (VOCs) were detected in SB-1 (14 to 16 feet). Other soil samples had traces of VOCs which were slightly above the detection level or between the practical quantitative response and the detection level. Benzene was only found in one sample from SB-4, but given the low concentration (.0032 ppm) this response may be questionable. Low levels of naphthalene were identified in all of the soil samples with the highest concentration (1.86 ppm) occurring in SB-1. A tabulation of hydrocarbon contaminants is provided in Table 2.

The soils were also analyzed for RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver). Soil boring SB-1 had slightly higher levels of lead (11.6 ppm) than background values but concentrations were still well below the 100 ppm (MPCA, defined hazardous) level. A laboratory report for all analyses is included in Appendix C.

Soil sampling techniques followed MPCA Fact Sheet #15, *Soil and Groundwater Analytical Sample Collection Procedures*. Groundwater was encountered at 11.5 feet in SB-1 and SB-2. The boring logs are included in Appendix B.

GROUNDWATER MONITORING WELLS

All drilling operations were supervised by an experienced environmental geologist. This individual was responsible for overseeing appropriate decontamination, sample screening, and well design.

The monitoring wells were installed through the hollow-stem auger. The screen was installed so that it intersected the water table. As the auger was removed, the annulus between the screen and the borehole wall was filled with clean, well sorted (#30) sand. The screens were Johnson brand, all being ten (10) foot long with #10 (.010 inch) slot openings. All pipe material was schedule 40, and two (2) inches in diameter. The screen was capable of retaining at least 90 percent of the sand pack. The screens were flush-threaded into the riser pipe. No glue or lubricant was used.

A bentonite seal was placed on top of the sand pack. After the seal was installed, the auger was removed from the borehole and a mixture of clean water, concrete, and Quickgel were emplaced above the bentonite seal. The wells were completed by installing six (6) inch protective casing. The protective casing was installed approximately three (3) feet below grade and the well secured with a Master Lock.

Construction diagrams and Minnesota Department of Health (MDH) permits are included in Appendix D.

The elevation for the top of each monitoring well, along with the

ground levels are recorded in Table 3. The elevations were obtained using standard surveying techniques with a level and tripod. The northeast corner of Building 511 was used as a relative bench mark and assigned an elevation of 100 feet.

Groundwater Sampling

The monitoring wells were developed on December 19, 1994 and sampled on December 20, 1994, May 2, 1995 and August 29, 1995. Groundwater was analyzed for DRO, VOC, dissolved RCRA metals, and Aroclor (PCBs: 1016, 1221, 1232, 1242, 1248, 1254, and 1260). Since no PCBs were detected during the first sampling event, this parameter was omitted for the second sampling event. Similarly, RCRA metals were omitted from the last sampling event because concentrations were below Health Risk Limits (HRLs) for these parameters.

The wells were sampled after five (5) well volumes were removed from the wells. A duplicate and field blank were collected; a trip blank was transported for the duration of the sampling event for purposes of quality control. The water samples were delivered to Midwest Analytical Services (Cambridge, MN), along with chain of custody documents. Analytical results are included in Appendix E and tabulated in Table 4.

HYDROGEOLOGIC INVESTIGATION

The site is located approximately one mile northwest of the confluence of the Minnesota and Mississippi Rivers. The overall fining upward character of the sediments suggests a fluvial origin of the impacted sediments. It is possible that immediately after glacial recession that coarse grained sand and gravels were transported into the area by the then-dominant, Minnesota River. When the energy regime dropped, the corresponding sediment size decreased. Organic rich overbank sediments and occasional oxbow lacustrine sediments then became the primary deposits.

A major portion of the aquifer is in the deeper, coarse grained sand and gravels, but the primary soil contamination is in the finer grained materials. Coarse grained sands and gravel commonly have hydraulic conductivities of 10^{-3} to 10^{-1} cm/sec.

The regional gradient across the site is 0.45 percent to the southeast and the porosity is estimated to be 32 percent. Groundwater flow velocity is estimated from the following Darcy relationship:

$$V_x = (K \times dh/dl)/ne$$

where:

V_x = groundwater velocity
K = hydraulic conductivity

dh/dh = hydraulic gradient
ne = effective porosity

Therefore, the groundwater flow velocity is calculated to be:

$(1 \times 10^{-2}$ cm/sec X .0045) / .32
$= 1.4 \times 10^{-6}$ cm/sec
= .004 feet/day
= 1.46 feet/year

This maximum velocity approximates groundwater movement in porous (sandy) sediments, but contaminant velocity may be much slower due to the presence of organic materials which retard petroleum migration. Considering the presence of overbank sediments and other organic materials, it is not likely that contamination is able to move at this velocity.

A groundwater contour map is shown in Figure 4. This map suggests that monitoring wells MW-2 and MW-3 are down gradient wells, but they may be located near the side of the contaminant plume.

DISCUSSION

Contaminant transport by advection involves the transfer of contaminants by virtue of groundwater motion. Normally this is the primary means of contaminant transport except where the hydraulic gradient is extremely low or where porosity and the hydraulic conductivity are low due to fine grained sedimentary textures. Contaminant transport by dispersion may be significant at this site. If dispersion is the main component of transport, the concentrations of contaminants should continue to decrease with time.

Fact Sheets #6 and #24 (Hydrology characterization work sheet) and are included in Appendix E. A domestic well search was not conducted, since the entire area down gradient of the site is on municipal water. Furthermore, none of the parameters tested were above MDH Health Risk Limits (HRL) or Recommended Allowable Limits (RAL) in any of the monitoring wells.

There are no buildings near the tank basin that are likely to incur vapor encroachment by virtue of the release. Therefore a formal vapor risk assessment was not necessary.

The extent of soil contamination is difficult to assess since action levels for VOCs were not exceeded, according to laboratory results. However, SB-1 and SB-2 did have PID responses in excess of 10 ppm. Soil borings SB-4 and SB-5 had PID responses that were close to the 10 ppm guideline for DRO contamination while soils from SB-3, SB-6, and SB-7 were below action levels. Small amounts of contamination remained at the bottom of the tank excavation but PID responses from the borings

suggest that soil is not contaminated outside of a vertical interval from 10 to 12 feet. Subtracting the area of the tank basin, and using a maximum of 2 feet of contamination, the remaining volume of impacted soil is calculated at 1,800 cubic feet (44.4 cubic yards). This is derived using an area of approximately 900 square feet outside the tank basin area. Approximately one-third of this area is beneath the street serving the area.

Groundwater contamination appears to be declining in Monitoring Well MW-1 and all parameters formerly present in MW-3 were not detected in the last sampling event. This decline probably indicates that removal of the tank basin soils was effective in reducing groundwater impact.

CONCLUSIONS AND RECOMMENDATIONS

Soil and groundwater impact have been effectively minimized by removing 90 cubic yards of soil from the former tank basin. Low levels of soil contamination remain on the site but groundwater impact is not expected to increase. Considering the porous nature of the sediments at the site, passive bioremediation should continue to reduce the levels of contamination.

Low levels of VOC contamination are present in MW-1 but the steady decline of most parameters suggests that further investigation is not warranted. Most of the remaining soil contamination is beneath impermeable surfaces (asphalt) such that downward leaking will be minimal. Closure is ultimately the decision of the MPCA; RSI believes information presented in this report will be useful in making a determination.

STATEMENT OF CARE

The recommendations contained in this report represent professional opinions. These opinions were arrived at in accordance with currently accepted hydrogeologic and engineering practices at this time for this particular site. Other than this no warranty is implied or intended.

This report was prepared by: Earl F. Fashbaugh

Earl F. Fashbaugh
Hydrogeologist (RSI)

This report was reviewed by:

Robert J. Maslowski
Project Manager (RSI)

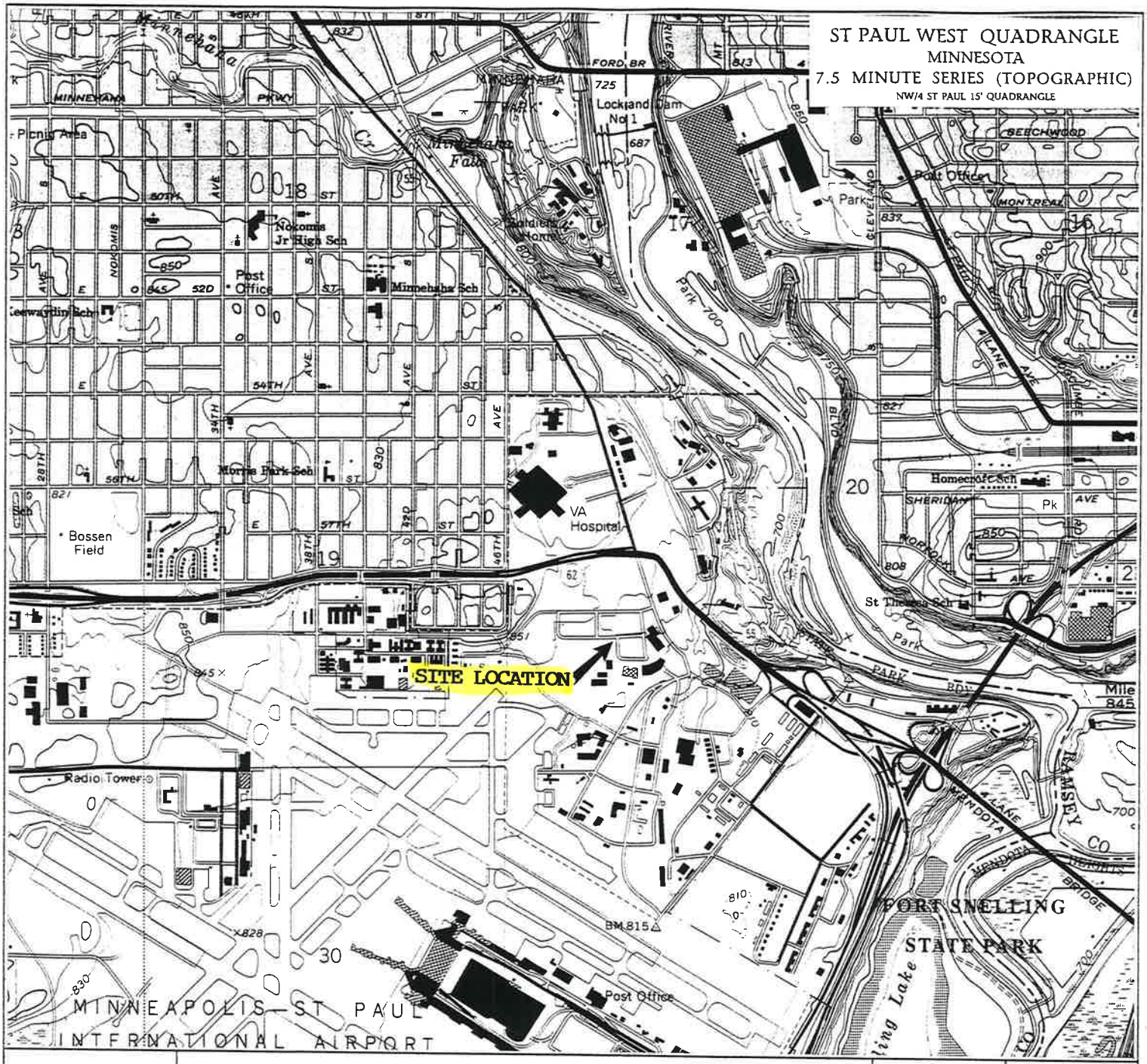

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FIGURE 1 – SITE LOCATION MAP

BUILDING 511 – FORT SNELLING

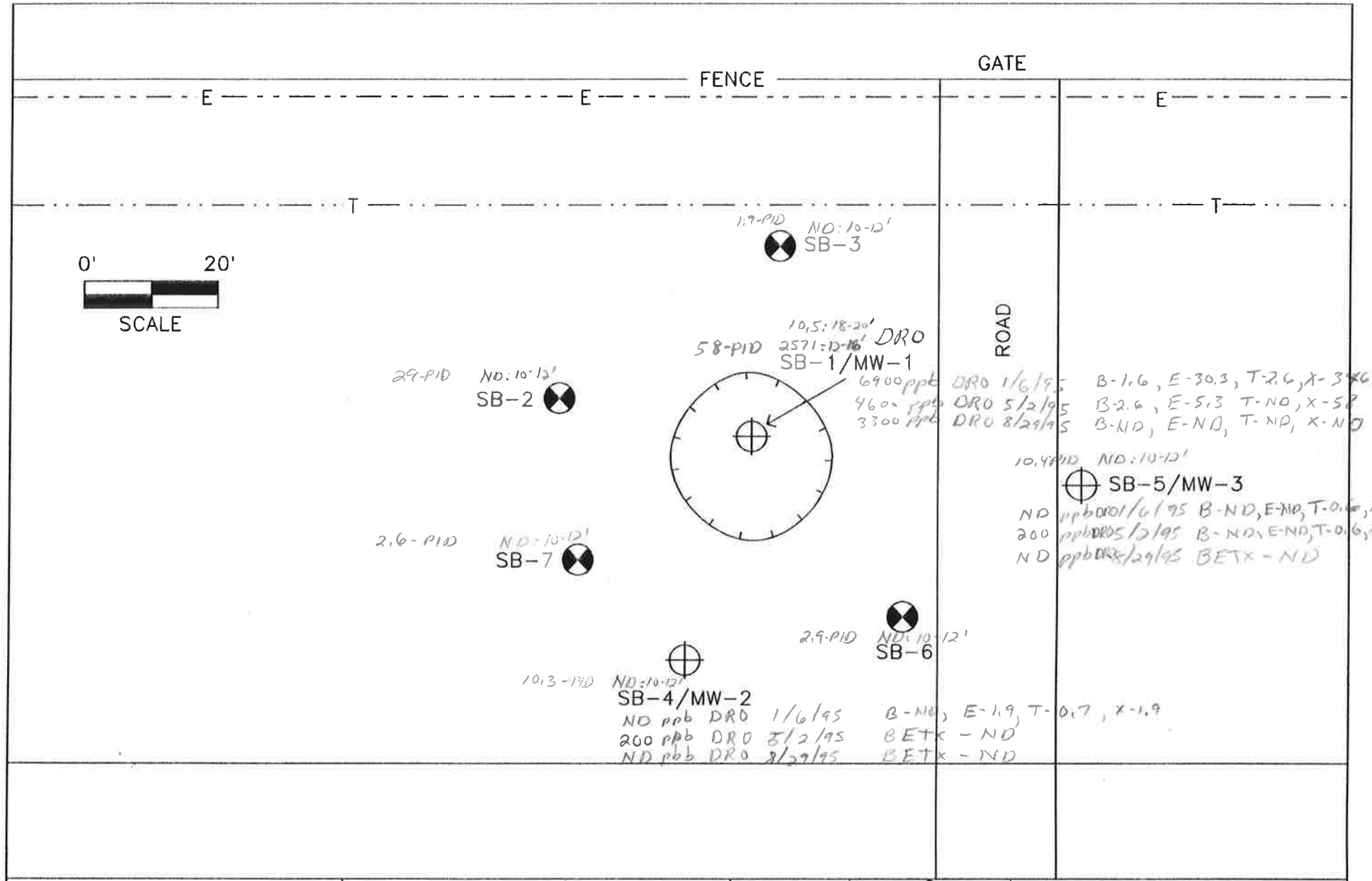
MINN.
QUADRANGLE LOCATION

SCALE 1:24,000

1 0 MILES 1 2

5000 0 FEET 5000 10000

CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929



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LEGEND:
- SOIL BORING
- MONITORING WELL
- EXCAVATION LIMIT
- TELEPHONE
- ELECTRIC

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DATE: 10/3/95
REVISED:

FIGURE 2
SITE MAP WITH BORING/WELL LOCATIONS
BUILDING 511
FORT SNELLING

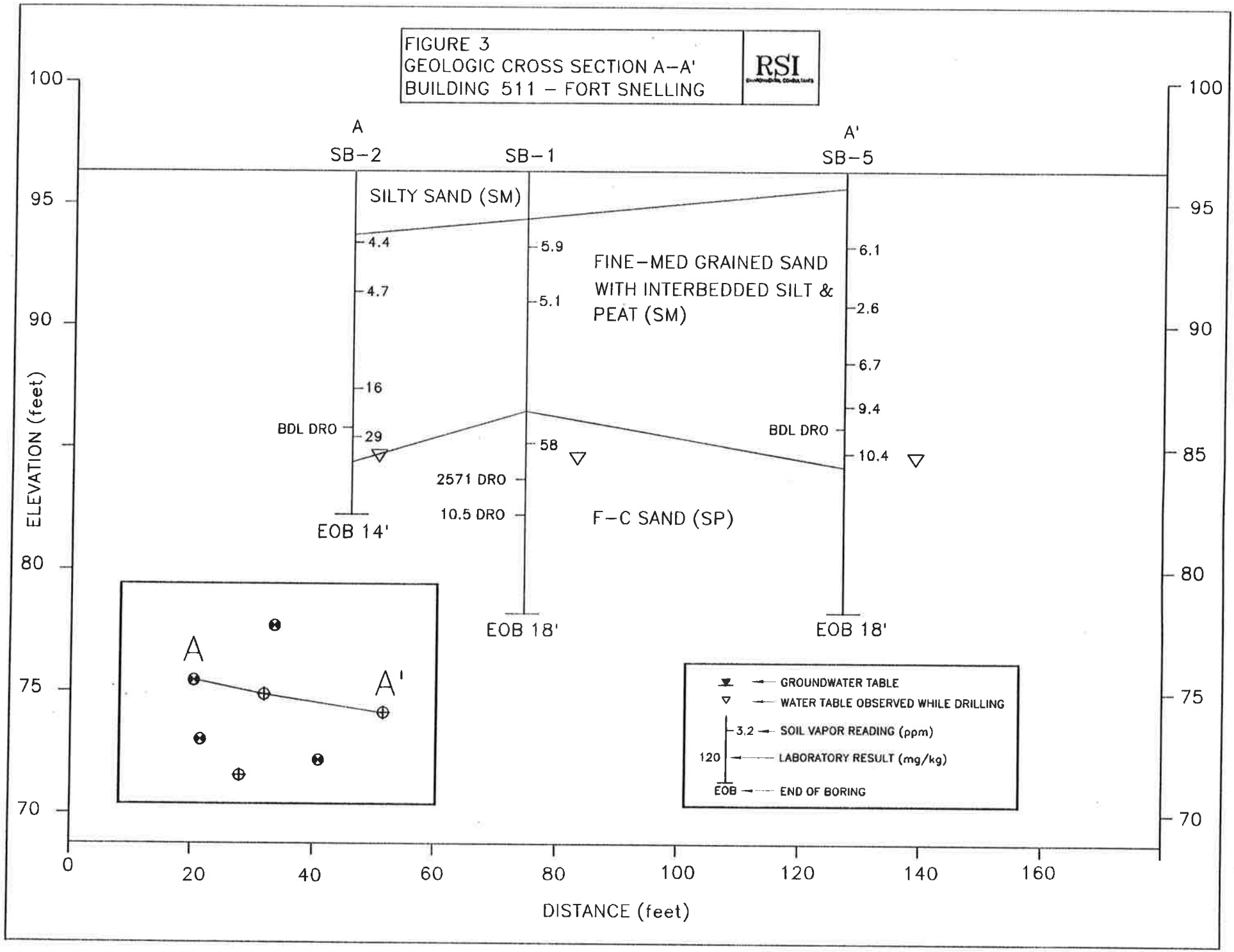
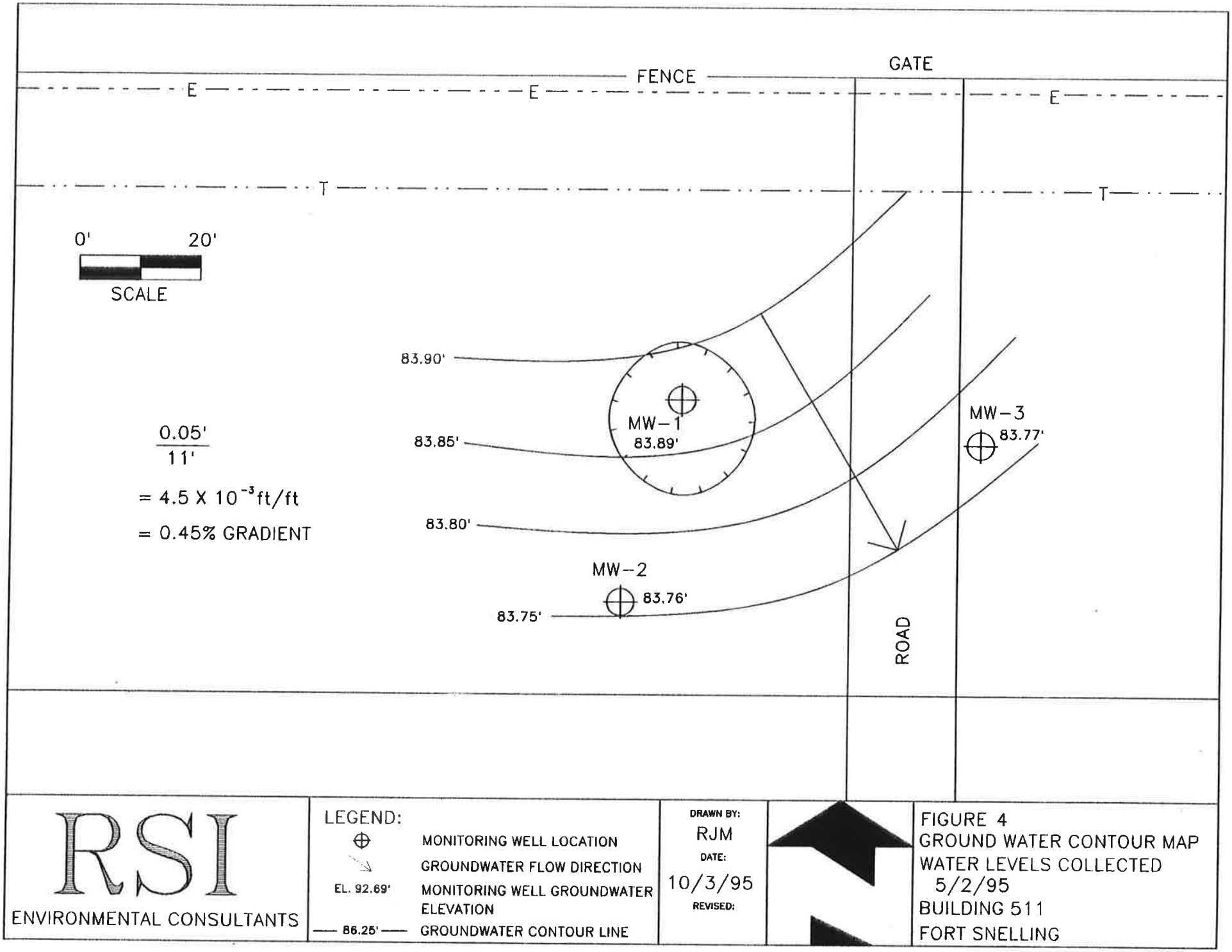


FIGURE 3
GEOLOGIC CROSS SECTION A–A'
BUILDING 511 – FORT SNELLING
RSI
A
A'
SB–2
SB–1
SB–5
SILTY SAND (SM)
FINE–MED GRAINED SAND WITH INTERBEDDED SILT & PEAT (SM)
F–C SAND (SP)
4.4
4.7
16
BDL DRO
29
5.9
5.1
58
2571 DRO
10.5 DRO
6.1
2.6
6.7
9.4
BDL DRO
10.4
EOB 14'
EOB 18'
EOB 18'
ELEVATION (feet)
DISTANCE (feet)
100
95
90
85
80
75
70
0
20
40
60
80
100
120
140
160
GROUNDWATER TABLE
WATER TABLE OBSERVED WHILE DRILLING
3.2 SOIL VAPOR READING (ppm)
120 LABORATORY RESULT (mg/kg)
EOB END OF BORING



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LEGEND:
- ⊕ MONITORING WELL LOCATION
- ↘ GROUNDWATER FLOW DIRECTION
- EL. 92.69' MONITORING WELL GROUNDWATER ELEVATION
- 86.25' GROUNDWATER CONTOUR LINE

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DATE: 10/3/95
REVISED:

FIGURE 4
GROUND WATER CONTOUR MAP
WATER LEVELS COLLECTED
5/2/95
BUILDING 511
FORT SNELLING

TABLE 1

Soil Vapor Screening Results
Fort Snelling, Building 511

Photoionization (PID) data in parts per million (ppm)

Depth (ft)	SB-1/MW-1	SB-2	SB-3	SB-4/MW-2	SB-5/MW-3	SB-6	SB-7
2-4	5.9	4.4	1.9	5.9	6.1	1.7	1.4
4-6	5.1	4.7	1.6	6.3	2.6	2.1	1.6
6-8	2		2.7		6.7	2.4	2.0
8-10		16	1.8	6.4	9.4	2.5	
10-12	58	29 *	1.9 *	10.3*	10.4*	2.9*	2.6*
12-14		EOB					
14-16	*		EOB			EOB	EOB
16-18							
18-20	EOB *			EOB	EOB		

EOB: END OF BORING
* : laboratory sample collected

Laboratory Analysis
Fort Snelling, Building 511

All analytical data in parts per million (ppm)

	SB-1/ MW-1	SB-1	SB-2	SB-3	SB-4	SB-5	SB-6	SB-7
Depth (ft)	14-16	18-20	10-12	10-12	10-12	10-12	10-12	10-12
DRO	2571	10.5	BDL	BDL	BDL	BDL	BDL	BDL
MEK	0.144	BDL					.0069	.0072
Toluene	.091	.0014	.0013	.0015	.004	.0015	.0016	.0012
Benzene	BDL	BDL	BDL	BDL	.0032			
Ethylbenzene	.616	BDL	BDL		.0067			
m & p xylene	3.89	BDL	BDL		.0090	.0046	.0059	.0053
o-xylene	1.281	BDL	BDL					.0045
Isopropylbenzene	1.57	BDL	BDL					
n-Propylbenzene	1.44	.0041	BDL					
1,3,5-Trimethylbenzene	2.84	BDL	BDL					
TERT-BUTYL BENZENE	0.621	BDL	BDL					
1,2,4-Trimethylbenzene	9.16	BDL	BDL					
sec-Butylbenzene	1.98	BDL	BDL					
p-Isopropyl toluene	1.06	BDL	BDL					
n-Butyl Benzene	4.92	BDL	BDL					
Naphthalene	1.86	.0076	.0048	.0043	.0060	.0045	.0067	.0054

BDL : Below Detection Levels

TABLE 3

Ft. Snelling, Building 511
Well and water Elevations

Monitoring Well	MW-1	MW-2	MW-3
Riser elevation	100.22	100.21	100.25
Top of screen	89.72	89.71	89.75
Screen bottom	79.72	79.71	79.75
water: 12/19/94	84.50	84.39	84.43
water: 12/20/94	84.48	84.36	84.40
water: 05/02/95	83.89	83.76	83.77
water: 08/29/95	85.10	84.96	84.98

APPENDIX A

TABLE 4

Water Analysis
Fort Snelling, Building 511
In (ppb)

		MW-1			MW-2			MW-3		
Date collected/ Parameter	MDH RAL**	1/6/95	5/2/95	8/29/95	1/6/95	5/2/95	8/29/95	1/6/95	5/2/95	8/29/95
DRO		6900	4600	3300	BDL	200	BDL	BDL	200	BDL
Toluene	1000	2.6	BDL	BDL	0.7	BDL	BDL	0.6	0.6	BDL
Ethylbenzene	700	30.3	5.3	BDL	1.9	BDL	BDL	BDL	BDL	BDL
m-p Xylenes	10000	279	46.6	BDL	1.9	BDL	BDL	BDL	BDL	BDL
O-xylene	10000	66.7	11.4	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Naphthalene	30	80.8	27.7	27.4	BDL	BDL	BDL	1.3	1.3	BDL
Tetrahydrofuran	100	12.8	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Benzene	10	1.6	2.6	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Trichloroethene		BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.5*	BDL
2-Chlorotoluene		BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.5*	BDL
Bromobenzene		BDL	BDL	BDL	BDL	BDL	BDL	BDL	1.5*	BDL
Bromoform	40	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1.6*	BDL
Methyl ethyl ketone	300	BDL	8.4	17.4	BDL	BDL	BDL	BDL	BDL	BDL
Methyl isobutyl ketone	300	3.1	3.1	20.0	BDL	BDL	BDL	BDL	BDL	BDL
Isopropyl Benzene	300	11.8	26.9	BDL	BDL	BDL	BDL	BDL	BDL	BDL
n-Propyl Benzene		32.3	100.1	17.3	BDL	BDL	BDL	BDL	BDL	BDL
1,3,5-Trimethylbenzene		85.8	29.8	24.5	BDL	BDL	BDL	BDL	BDL	BDL
tert-ButylBenzene		BDL	3.6	BDL	BDL	BDL	BDL	BDL	BDL	BDL
sec-Butyl Benzene		BDL	43.9	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1,2,4-Trimethylbenzene		293	90.4	56.5	BDL	BDL	BDL	BDL	BDL	BDL
p-Isopropyltoluene		9.8	21.9	0.6	BDL	BDL	BDL	BDL	BDL	BDL
n-Butyl Benzene		54.4	27.5	14.5	BDL	BDL	BDL	BDL	BDL	BDL
sec-Butyl Benzene				7.7			BDL			BDL

* contaminant found in trip and/or baller blank
** MDH RAL: Minnesota Department of Health, Recommended Allowable Limits

DRAFT
PRELIMINARY RESULTS
UNDERGROUND STORAGE TANK REMOVAL AND ASSESSMENT
U.S.A.R.C. PROPERTY
FORT SNELLING, BUILDING 511 (WASTE OIL)
MINNEAPOLIS, MINNESOTA

Prepared for:

Mr. Kurt Brownell
Environmental Management Division
ATTN: AFZR-DE-E
2160 South J Street
Fort McCoy, Wisconsin 54656-5162

April 6, 1994

Project Number 3089

Prepared By:

AGASSIZ ENVIROMNENTAL SYSTEMS, INC.
Route 1, Box 119
Hancock, MN 56244

Executive Summary

On October 4, 1993 two (2) underground storage tanks (USTs) were removed from the United States Army Reserve Center (U.S.A.R.C.) Building 511 (waste oil) Fort Snelling, Minneapolis, Minnesota by Crude Oil Inc. dba Petro Tank Service (Petro Tank) of St. Paul, Minnesota; Agassiz Environmental Systems, Inc. (Agassiz) of Hancock, Minnesota provided environmental consulting services. The current operator/owner of the property is the Department of the Army, Real Property Branch, Fort McCoy, Wisconsin.

Evidence of petroleum hydrocarbon contamination was found in the excavation cavity as determined by visual/olfactory observation and headspace analysis of soil samples. The MPCA assigned leak number 00005614.

Approximately 90 cubic yards of petroleum hydrocarbon contaminated soils were excavated from the basin and have been transported to the Tom Maiers land farming site for land treatment. Groundwater was encountered during the excavation activities at approximately 15' below grade.

Results of the investigation indicate that significant petroleum hydrocarbon contamination remains in the soils beneath the former UST basins; groundwater appears to be in contact with these soils.

A low level of PCBs (Aroclors) were detected in the stock-piled soil samples.

Concentrations of arsenic, barium, cadmium, chromium, lead and selenium were detected in the soil samples at levels within those expected for natural soils. Since the MPCA does not have soil standard clean-up guidelines for metals, those developed by the New Jersey Department of Environmental Protection and Energy were used for comparison.

The horizontal and vertical extent of soil contamination has not been fully delineated, nor has the impact to groundwater been assessed.

Agassiz recommends that a remedial investigation (RI) be conducted to fully delineate the extent and magnitude of subsurface contamination, including both soils and groundwater.

The RI work plan should include a series of soil borings to define the horizontal and vertical extent of subsurface contamination. A minimum of three soil borings should be converted into monitoring wells; the selection of monitoring well locations should be based on field observations made during completion of the soil borings, site history and groundwater contouring/gradient requirements.

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1.0 INTRODUCTION

On October 4, 1993 two (2) underground storage tanks (USTs) were removed from the United States Army Reserve Center (U.S.A.R.C.) Building 511(waste oil), Fort Snelling, Minneapolis, Minnesota by Petro Tank of St. Paul, Minnesota; Agassiz of Hancock, Minnesota provided environmental consulting services. The current operator/owner of the property is the Department of Army, Real Property Branch, Fort McCoy, Wisconsin. The USTs included two 250 gallon bare steel tanks. The age of the tanks is unknown.

2.0 BACKGROUND

The site is located in Section 20, Township 28north, Range 23west in Hennipen County, Fort Snelling, Minnesota (Figure 1). The latitude and longitude for the site is 44° 53' and 93° 20', respectively.

The USTs were located north of building 511, west of the P.O.V. parking lot (Figure 2). Both USTs were used to store waste oil.

3.0 EXCAVATION RESULTS

On October 4, 1993 two (2) underground storage tanks (USTs) were removed from the United States Army Reserve Center (U.S.A.R.C.), Fort Snelling, Building 511 (waste oil) property by Agassiz; the excavating contractor was Petro Tank of St. Paul, Minnesota.

The subsurface soils are characterized by brown sand underlying top soil, rock was present at 15' below grade.

Since the tanks were positioned side by side, one excavation measuring 25' by 24' and approximately 15' below grade was created. The tanks were found to be in poor condition upon removal; holes and pitting was visible. The dimensions of each tank was 4' 10" by 31".

Soil samples collected from the excavation cavity were screened for the presence of organic vapors using a organic vapor analyzer utilizing a hydrogen flame ionization detector (FID). The FID readings represent a qualitative indicator of contamination by compounds which are ionized or "burned" in a flame. The soil samples were screened for volatile organic compounds (VOCs) in accordance with the MPCA document "Jar Headspace Analytical Screening Procedures."

Evidence of petroleum hydrocarbon contamination was found in the excavation cavity as determined by visual/olfactory observation and headspace analysis of soil samples. Results for soil vapor from samples collected in the basin ranged from 3 ppm to 320 ppm (Table 1).

Approximately 90 cubic yards of petroleum hydrocarbon contaminated soils were excavated and stock-piled on-site. The soils have been transported to the Tom Maiers land farming site. Final approval is pending from MPCA to spread soils on said site. Groundwater was encountered during the excavation activities; approximately 15' below grade.

No free product was observed, although it appears that groundwater may be in contact with the contaminated soils. The MPCA was notified on October 5, 1993 at 9:25 a.m.. The site has been assigned Leak number 00005614 by the MPCA.

Samples for laboratory analysis were selected based on field observations and headspace results. Five (5) soil sample (SS-1, SS-3, SS-5, SS-6 and SS-7) were collected from the bottom and sidewalls of the excavation cavity.

1.0 INTRODUCTION

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The USTs were located north of building 511, west of the P.O.V. parking lot (Figure 2). Both USTs were used to store waste oil.

3.0 EXCAVATION RESULTS

On October 4, 1993 two (2) underground storage tanks (USTs) were removed from the United States Army Reserve Center (U.S.A.R.C.), Fort Snelling, Building 511 (waste oil) property by Agassiz; the excavating contractor was Petro Tank of St. Paul, Minnesota.

The subsurface soils are characterized by brown sand underlying top soil, rock was present at 15' below grade.

Since the tanks were positioned side by side, one excavation measuring 25' by 24' and approximately 15' below grade was created. The tanks were found to be in poor condition upon removal; holes and pitting was visible. The dimensions of each tank was 4' 10" by 31".

Soil samples collected from the excavation cavity were screened for the presence of organic vapors using a organic vapor analyzer utilizing a hydrogen flame ionization detector (FID). The FID readings represent a qualitative indicator of contamination by compounds which are ionized or "burned" in a flame. The soil samples were screened for volatile organic compounds (VOCs) in accordance with the MPCA document "Jar Headspace Analytical Screening Procedures."

Evidence of petroleum hydrocarbon contamination was found in the excavation cavity as determined by visual/olfactory observation and headspace analysis of soil samples. Results for soil vapor from samples collected in the basin ranged from 3 ppm to 320 ppm (Table 1).

Approximately 90 cubic yards of petroleum hydrocarbon contaminated soils were excavated and stock-piled on-site. The soils have been transported to the Tom Maiers land farming site. Final approval is pending from MPCA to spread soils on said site. Groundwater was encountered during the excavation activities; approximately 15' below grade.

No free product was observed, although it appears that groundwater may be in contact with the contaminated soils. The MPCA was notified on October 5, 1993 at 9:25 a.m.. The site has been assigned Leak number 00005614 by the MPCA.

Samples for laboratory analysis were selected based on field observations and headspace results. Five (5) soil sample (SS-1, SS-3, SS-5, SS-6 and SS-7) were collected from the bottom and sidewalls of the excavation cavity.

The following parameters, via corresponding methods, were preformed on soil samples submitted for laboratory analysis:

o Total Petroleum Hydrocarbon as Fuel Oil (DRO)	Method Modified 8020
o Aroclor (PCBs)	Method SW846 8080
o RCRA Metals	Method SW846
o VOCs	Method MDH 465-D

Soil samples were submitted to Midwest Analytical Services of Cambridge, Minnesota for analysis. The results are presented on Table 2. The laboratories' analytical report is contained in Appendix C.

Concentrations of DRO ranged from below quantifiable limits to 4,900 ppm, Aroclor (including isomers 1016, 1221, 1232, 1242, 1248, 1254 and 1260) was below quantifiable limits for all samples. Concentrations of BTEX for samples SS-3 and SS-7 were below quantifiable limits. Concentrations of BTEX for sample SS-1 was 0.128 ppm, 0.831 ppm, 3.82 ppm and 22.82 ppm, respectively; for sample SS-5 the concentration of xylenes was 0.428 ppm, benzene, toluene and ethyl benzene were below quantifiable limits; for sample SS-6 benzene was below quantifiable limits, while concentrations of toluene, ethyl benzene and xylenes were 0.013 ppm, 0.026 ppm and 2.98 ppm, respectively.

No volatile organic compounds (VOCs) were detected in SS-3, while numerous VOCs were detected in the other samples. The total volatile organic compound (TVOC) concentrations, excluding the BTEX consitutents, for SS-1, SS-5, SS-6 and SS-7 are 46.96 ppm, 11.73 ppm, 45.99 ppm and 0.089 ppm, respectively.

With the exception of mercury and silver, concentrations of RCRA metals were detected in the soil samples.

A low level (8.1 ppm) of PCBs (Aroclors) were detected in the stock-piled soil sample. Stock-pile soils were sampled twice, on October 4, 1993 and November 30, 1993 and analyzed on October 13, 1993 and December 3, 1993, respectively. The concentration of Aroclor below quantifiable limits for the first round of sampling and 56.7 ppm for the second round; consequently, the second sample was reanalyzed and a value of 8.1 was obtained.

The results of the excavation are contained in the MPCA document "Excavation Report For Petroleum Release Sites" attached as Appendix A.

4.0 DISCUSSION/CONCLUSIONS

Results of the investigation indicate that significant petroleum hydrocarbon contamination remains in the soils beneath the former UST basins; groundwater appears to be in contact with these soils.

A low level of PCBs (Aroclors) were detected in the post-excavation or stock-piled soil samples.

Concentrations of arsenic, barium, cadmium, chromium, lead and selenium were detected in the soil samples at levels within those expected for natural soils. Since the MPCA does not have standard soil clean-up guidelines for metals, those developed by the New Jersey Department of Environmental Protection and Energy are presented in Table 3 for comparison.

The horizontal and vertical extent of soil contamination has not been fully delineated, nor has the impact to groundwater been assessed.

5.0 RECOMMENDATIONS

Agassiz recommends that a remedial investigation (RI) be conducted to fully delineate the extent and magnitude of subsurface contamination, including both soils and groundwater.

The RI work plan should include a series of soil borings to define the horizontal and vertical extent of subsurface contamination. A minimum of three soil borings should be converted into monitoring wells; the selection of monitoring well locations should be based on field observations made during completion of the soil borings, site history and groundwater contouring/gradient requirements.

Agassiz recommends that the Department of Army, Environmental Management Division comply with the release reporting requirements of the MPCA by completing a petroleum tank release report (PTR).

The MPCA requires that you complete and submit a Petroleum Tank Release Report (PTR) if you are the responsible party (RP) in the release from a petroleum underground storage tank (UST). The PTR is actually comprised of several documents, the site specific factors determine which of the reports are included in the PTR. The possible reports include:

- Excavation Report: If there has been no contamination of groundwater or surface water and the release can be cleaned up by excavating the contaminated soil this report is submitted alone, no further reports are usually required. Excavation reports which indicate that a RI is necessary will not be reviewed by the MPCA until the RI has been completed.

- Remedial Investigation Report: If further investigation is needed, this report is submitted to document all RI activities, show that the objectives of the investigation have been met, and give recommendations for corrective actions that should be taken to clean up soil and/or groundwater contamination, if necessary. The excavation report is an attachment to the RI report.

- Corrective Action Design Report: If the investigation finds remaining soil or groundwater contamination that must be corrected a CAD should be submitted with the RI report.

- Progress Report: If additional monitoring, cleanup or testing is needed after the RI or excavation is completed, periodic progress reports will be required.

TABLES

TABLE 1

Summary of Soil Vapor Results from Excavation Cavity

Site: Army Project (Building 511 (Waste Oil))
Project # 3089
Date: October 4, 1993

VAPOR #	DEPTH	LOCATION	READING
SV-1		Surface	205
SV-2	15'	Bottom	310
SV-3	12'	Bottom	320
SV-4	10.5'	Sidewall	46
SV-5		Stock Pile	100
SV-6	12.5'	Sidewall	100
SV-7	10.5'	Sidewall	3
SV-8	14'	Sidewall	160
SV-9	15'	Bottom	185

Explanations: SV = Soil Vapor

The head space of each soil sample was screened for petroleum hydrocarbon content using a Heath Detecto-Pak III flame-ionization detector in accordance with the MPCA protocol for "Jar Soil Headspace Screening Procedures" (Guidance Document #7)

TABLE 2

Summary of Laboratory Soil Analysis from Excavation

Site: Army Project (Building 511 (Waste Oil))
Project # 3089
Date: October 4, 1993

Parameters (mg/kg)	SS-1	SS-3	SS-5	SS-6	SS-7
Benzene	0.128	BQL	BQL	BQL	BQL
Toluene	0.831	BQL	BQL	0.013	BQL
Ethyl Benzene	3.82	BQL	BQL	0.026	BQL
Xylenes	22.82	BQL	0.428	2.98	BQL
TPH as DRO	4900	BQL	4350	3670	332
Total Aroclor	BQL	BQL	BQL	BQL	BQL
Arsenic	<0.25	<0.25	0.71	0.44	<0.25
Barium	15.5	22.2	33.4	26.9	35.4
Cadmium	<0.75	<0.75	1.49	1.23	<0.75
Chromium	<1.9	3.33	25.2	20.2	4.7
Lead	4.48	1.92	5.08	24.8	2.21
Mercury	<0.10	<0.10	<0.10	<0.10	<0.10
Selenium	0.3	<0.25	<0.25	<0.25	<0.25
Silver	<1.5	<1.5	<1.5	<1.5	<1.5
Isopropyl Benzene	2.88	BQL	0.603	3.83	BQL
N-Propyl Benzene	2.95	BQL	4.59	15.7	0.036
1,3,5-Trimethyl Benzene	6.27	BQL	0.236	1.91	BQL
Tert-Butly Benzene	0.826	BQL	0.398	BQL	BQL
1,2,4-Trimethyl Benzene	22.6	BQL	BQL	BQL	0.014
Sec-Butly Benzene	BQL	BQL	4.295	17.1	0.019
P-Isopropyl Toluene	BQL	BQL	0.834	3.19	BQL
N-Butyl Benzene	6.71	BQL	0.493	0.809	0.02
Naphthalene	4.6	BQL	0.263	0.412	BQL

Explanations: SS = Soil Sample
BQL = Below Quantifiable Levels

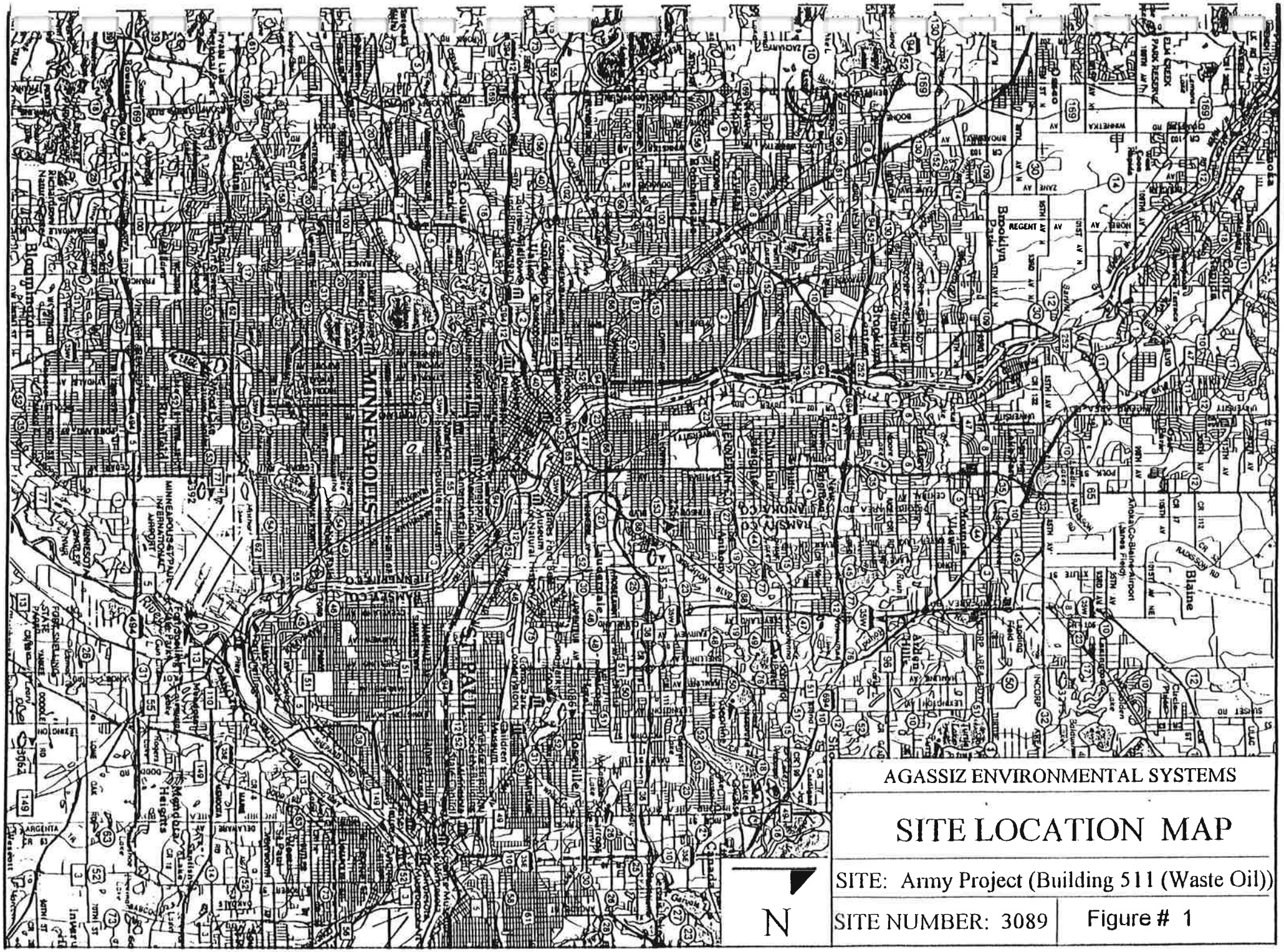
TABLE 3

Suggested Soil Metal Evaluation Levels

Site: Army Project (Building 511 (Waste Oil))
Project # 3089
Date: October 4, 1993

Element	New Jersey DEPE Soil Action Levels (ppm)	*Common Range (ppm)
Arsenic	20	1-50
Barium	400	100-3,000
Cadmium	3	0.07-0.7
Chromium	100	1-1,000
Lead	100	2-200
Mercury	1	0.01-0.3
Silver	4	0.01-4
Selenium	5	0.1-2

FIGURES

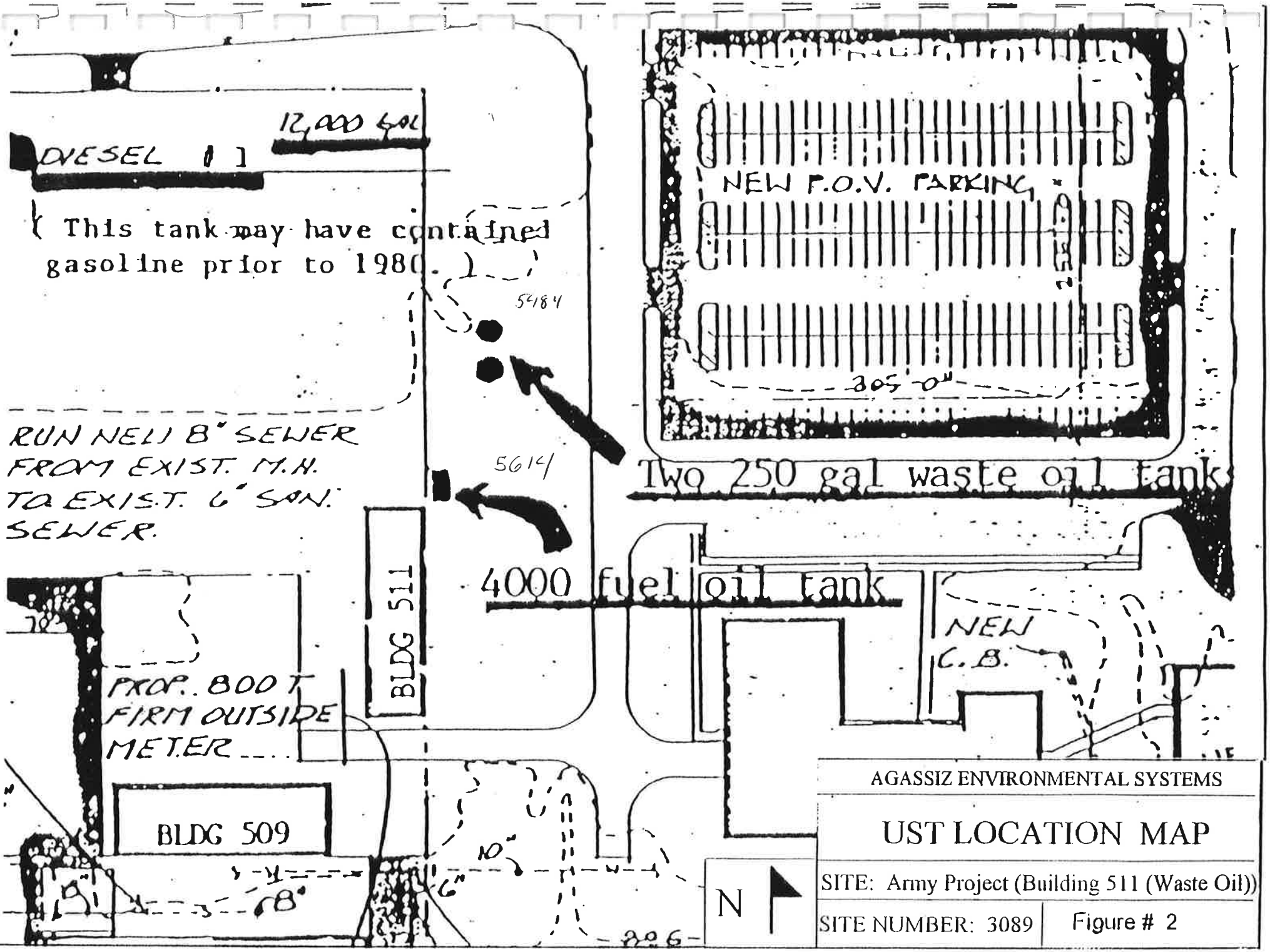


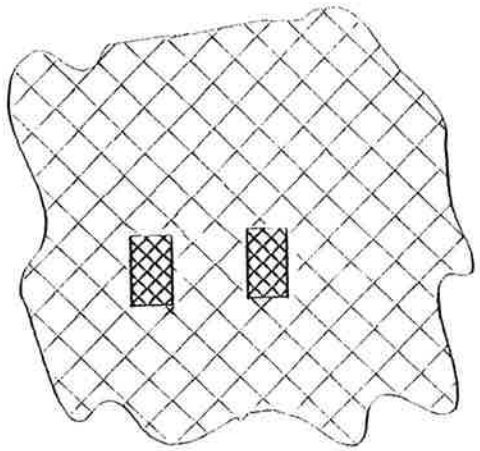
AGASSIZ ENVIRONMENTAL SYSTEMS

SITE LOCATION MAP

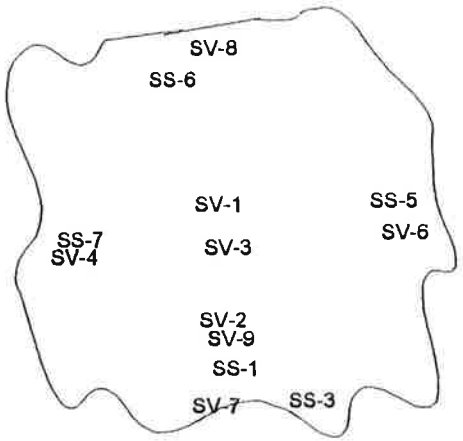
SITE: Army Project (Building 511 (Waste Oil))

SITE NUMBER: 3089 | Figure # 1


12,000 gal
DIESEL # 1
(This tank may have contained gasoline prior to 1980.)
5484
NEW P.O.V. PARKING
305'-0"
RUN NEW 8" SEWER FROM EXIST. M.H. TO EXIST. 6" SAN. SEWER.
5614
Two 250 gal waste oil tank
4000 fuel oil tank
BLDG 511
NEW C.B.
PROP. 800 T FIRM OUTSIDE METER
BLDG 509
10"
6"
68'
206
N
AGASSIZ ENVIRONMENTAL SYSTEMS
UST LOCATION MAP
SITE: Army Project (Building 511 (Waste Oil))
SITE NUMBER: 3089
Figure # 2



Scale	AGASSIZ ENVIRONMENTAL SYSTEMS	Legend
15' N	UST LOCATION MAP Figure #: 2A	= Excavation Area
	Project: Army Project (Bldg 511 (Waste Oil))	= Tanks
	Project #: 3089 Leak #: 5614 Date: 2-10-94	= Fence



Scale

15'

N

AGASSIZ ENVIRONMENTAL SYSTEMS

SV/SS LOCATION MAP Figure #: 3

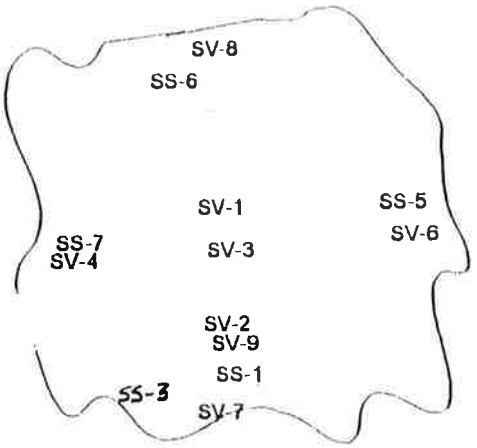
Project: Army Project (Bldg 511 (Waste Oil))

Project #: 3089 Leak #: 5614 Date: 2-10-94

Legend

SV = Soil Vapor

SS = Soil Sample



Scale	AGASSIZ ENVIRONMENTAL SYSTEMS	Legend
15' N	SV/SS LOCATION MAP Figure #: 3	SV = Soil Vapor
	Project: Army Project (Bldg 511 (Waste Oil))	SS = Soil Sample
	Project #: 3089 Leak #: 5614 Date: 2-10-94	

APPENDIX A

EXCAVATION REPORT FOR PETROLEUM RELEASE SITES

Excavation Report Worksheet For Petroleum Release Sites

Fact Sheet #4
Minnesota Pollution control Agency
LUST Cleanup Program
April 1193

Complete the information below and submit to the Minnesota Pollution Control Agency (MPCA) Tanks and Spills Section to document excavation and treatment of petroleum contaminated soil. Conduct excavations in accordance with "Excavation of Petroleum Contaminated Soil" (fact sheet #13). Please attach any available preliminary site investigation reports to this excavation report. Attach additional pages if necessary. Please type or print clearly.

The excavation reporting deadline is 10 months from the date of receipt of the standard letter. A shorter deadline may be established by the MPCA Staff for high priority sites.

I. BACKGROUND

A. Site: **U.S.A.R.C. Fort Snelling**
Street: **Building 511 (Waste Oil)**
City, Zip: **Fort Snelling, MN 55111-4092**
County: **Hennepin**
MPCA LEAK # **5614**

B. Tank Owner/Operator: **Department of Army**
Real Property Branch
Street/Box:
City, Zip: **Fort McCoy, Wisconsin**
Telephone: **(608) 388-4789**

C. Excavating Contractor: **Petro Tank Services**
Contact: **Dana Nelson**
Telephone: **(612) 659-0086**
Certification Number: **0013**

D. Consultant: **Agassiz Environmental Systems, Inc.**
Contact: **John Landwehr**
Street/Box: **Route 1 Box 119**
City, Zip: **Hancock, MN 56244**
Telephone: **(612) 795-2200**

E. Other on site during site work: **Kurt Brownell, U.S.A.R.C.**

Note: If person other than tank owner and/or operator is conducting the cleanup, provide name, address, and relationship to site on a separate attached sheet.

II. DATES

A. Date release was reported to the MPCA: **October 5, 1993**
B. Dates site was work was performed:

Work Performed	Date
Removed two (2) 250 Gallon USTs	**October 4, 1993**

III. RELEASE INFORMATION

A. Provide the following information for all removed tanks:

Tank #1
- Capacity: **250**
- Type: **Bare Steel**
- Age: **Unknown**
- Condition: **The UST was in poor condition upon removal. The UST was leaking from a perforation on one end.**
- Product History: **Waste Oil**
- Approximate quantity of petroleum released, if known: **Unknown**
- Cause of release: **Perforation in tank**

Tank #2
- Capacity: **250**
- Type: **Bare Steel**
- Age: **Unknown**
- Condition: **The UST was in poor condition with multiple perforations.**
- Product History: **Waste Oil**
- Approximate quantity of petroleum released, if known: **Unknown**
- Cause of release: **Perforations in tank**

B. Provide the following information for all existing tanks: **Unknown**

C. If the release was associated with the lines or dispensers, briefly describe the problem:
N/A

D. If the release was a surface spill, briefly describe the problem:
N/A

IV. EXCAVATION

A. Dimensions of excavation: **25' X 24' X 15'below grade**

B. Original tank backfill material (sand, gravel, etc.): **Sand**

C. Native soil type (clay, sand, etc.): **0-6" gravel; 6" - 2' top soil; 2' - 15' fine sand-brown; rock at 15'**

D. Quantity of contaminated soil removed: **90 Cubic Yards**
(Note: if more than 400 cubic yards removed, please attach copy of written approval from the MPCA)

E. Was ground water encountered or was there evidence of a seasonally high ground water table?
Ground water was encountered in the tank basin at approximately 15'.

F. If a soil boring was required (see fact sheet #12, "Excavation of Petroleum Contaminated Soil," Part IV Additional Investigation) describe the soil screening analytical results. Attach the boring logs and laboratory results to this report: **See summary**

G. If no soil boring was required, explain:
See summary

H. If ground water was encountered or if a soil boring was conducted, was there evidence of ground water contamination?

No free product visible, groundwater does appear to be in contact with contaminated soils.

I. Was bedrock encountered in the excavation?

Bedrock was encountered in the tank basin, approximately 15' below grade.

J. Were other unique conditions associated with this site?

There were no unique conditions associated with this site.

V. SAMPLING

A. Briefly describe the field screening methods used to distinguish contaminated from uncontaminated soils:

Initial observations of each sample's appearance was recorded. Soil samples were then field screened for petroleum hydrocarbons content using a Heath Detecto-Pak III flame-ionization detector. The detector, sensitive to a range of volatile organic compounds (VOCs) and calibrated to methane, measured the concentration of certain VOCs by flame-ionization. The head space of each soil sample was screened for petroleum hydrocarbon content in accordance with the Minnesota Pollution Control Agency protocol for "Jar Soil Headspace Screening Procedures," dated May, 1992, Guidance Document 7. The instrument yielded a reading proportional to the concentration of VOCs.

B. List soil vapor headspace analysis results.

See Table 1 (Summary of Soil Vapor Results from Excavation Cavity)

C. Briefly describe the soil analytical sampling and handling procedures used:

Soil samples collected for analytical laboratory analysis were packed in clean, laboratory supplied 2 ounce glass jars equipped with nylon septums. Approximately 25 grams of soil was placed in each jar. Samples were kept in a cooler on site and during transit to the laboratory. Samples analyzed for diesel range organics (DRO) were preserved in the laboratory. Proper sample chain of custody was maintained.

D. List below the soil sample analytical results from bottom and sidewall samples:

See Table 2 (Summary of Laboratory Soil Analysis from Excavation)

VI. FIGURES

A. Attach the following figures to this report:

1. Site location map.
2. Site map(s) drawn to scale illustrating the following:
   a. Location (or former location) of all present and former tanks, lines, and dispensers;
   b. Location of other structures (buildings, canopies, etc.);
   c. Adjacent city, township, or county roadways;
   d. Final extent and depth of excavation;
   e. Location of soil screening samples (e.g. R-1), soil analytical samples (e.g., S-1 or B-1), and soil borings (e.g. SB-1). Also, attach all boring logs.
   f. North arrow, bar scale and map legend.

VII. SUMMARY

Briefly summarize evidence indicating whether additional investigation is necessary at the site, as discussed in part VI of "Excavation of Petroleum Contaminated Soil" (fact sheet #13). If no further action is recommended, the MPCA staff will review this report following notification of soil treatment.

Results of the investigation indicate that significant petroleum hydrocarbon contamination remains in the soils beneath the former UST basin; groundwater appears to be in contact with these soils.

The PCB (Aroclors) analysis were below quantifiable limits for all post-excavation soil samples.

Concentration of arsenic, barium, cadmium, chromium, lead and selenium were detected in the soil samples at levels within those expected for natural soils. Since the MPCA does not have soil standard clean-up guidelines for metals, those developed by the New Jersey Department of Environmental Protection and Energy are presented in Tank 3 for comparison.

The horizontal and vertical extent of soil contamination has not been fully delineated, nor has the impact to groundwater been assessed.

Agassiz recommends that a remedial investigation (RI) be conducted to fully delineate the extent and magnitude of subsurface contamination, including both soils and groundwater.

The RI work plan should include a series of soil borings to define the horizontal and vertical extent of subsurface contamination. A minimum of three soil borings should be converted into monitoring wells; the selection of monitoring well locations should be based on field observations made during completion of the soil borings, site history and groundwater contouring/gradient requirements.

VIII. SOIL TREATMENT INFORMATION

A. Soil treatment method used (thermal, land application, other). If you choose "other" specify treatment method: **Land Application**

B. Location of treatment site/facility: **Tom Maiers Land Farming Site**

C. Date MPCA approved soil treatment (if thermal treatment was used after May 1, 1991, indicate date that the MPCA permitted thermal treatment facility agreed to accept soil):
Tom Maiers Land Farming Site

D. Identify the location of stockpiled contaminated soil:

IX. CONSULTANT (OR OTHER) PREPARING THIS REPORT

Company Name:	**Agassiz Environmental Systems**
Street/Box:	**Route 1 Box 119**
City, Zip:	**Hancock, Minnesota 56244**
Telephone:	**(612) 795-2200**
Contact:	**John Landwehr**

Signature
Date: February 22, 1994

If additional investigation is not required at the site, please mail this form and all necessary attachments to:

Ms. Dawn Dunkinson
Minnesota Pollution Control Agency
Hazardous Waste Division
Tanks and Spills Section
520 Lafayette Road North
St. Paul, Minnesota 55155-4194

If additional investigation is required at this site, include this form as an appendix to the Remedial Investigation/Corrective Action Design report. Excavation reports indicating a remedial investigation (RI) is necessary will not be reviewed by the MPCA staff until the RI has been completed.

LOG OF BORING

PROJECT:	FORT SNELLING	SITE:	BUILDING 511
OWNER:	FORT McCOY	BORING #:	SB– 1/MW–1

DEPTH, FEET	SAMPLE NUMBER AND TYPE	STRATA CHANGE (FEET)	DESCRIPTION OF MATERIAL	TEST RESULTS (PID)	N-VALUE (BLOWS/FT)	WATER LEVEL
			SURFACE ELEVATION: ▼			
1			BROWN SANDY SILT (SM)			
2		2				
3			INTERBEDDED BLACK AND BROWN SILTS; BROWN F–C SANDS AND PEA GRAVEL; PEAT (SP–ML–PT)	5.9	3	
4						
5				5.1	3	
6						
7					2	
8						
9						
10		10			5	
11			BROWN SANDS F–C AND GRAVEL, BEDDED; ODOR AND STAINING; WATER BEARING	58	3	▽
12						
13						
14					3	
15		15				
16			BROWN F–C SAND WITH GRAVEL; POSSIBLE LOW WATER LINE @ 15'		7	
17						
18					14	
19						
20					15	
21			EOB 20' WELL SET @ 18'			
22						
23						

STANDARD PENETRATION (BLOWS/FOOT): 10 20 30 40 50

WATER LEVEL OBSERVATIONS	
W.L.	12'
W.L.	
W.L.	

RSI
ENVIRONMENTAL CONSULTANTS

BORING STARTED:	11/28/95		
BORING COMPLETED:	11/28/95		
RIG:	CME 55	DRILLER:	C.A.
DRAWN:	TMH	APPROVED:	RJM
		SHEET 1 OF 1	

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES; IN SITU, THE TRANSITION MAY BE GRADUAL

LOG OF BORING

PROJECT:	FORT SNELLING	SITE:	BUILDING 511
OWNER:	FORT McCOY	BORING #:	SB–2

DEPTH, FEET	SAMPLE NUMBER AND TYPE	STRATA CHANGE (FEET)	DESCRIPTION OF MATERIAL	TEST RESULTS (PID)	N–VALUE (BLOWS/FT)	WATER LEVEL	STANDARD PENETRATION (BLOWS/FOOT) 10 20 30 40 50
			SURFACE ELEVATION: ▼				
1		.5	BLACK AND BROWN SILTY SAND: TOPSOIL				
			BROWN SILTY SAND				
2		2					
3		2.5	BLACK & BROWN SILTY SAND; TOPSOIL				
			BROWN SAND F–M (SP)	4.4	9		⊗
4							
5				4.7	9		⊗
6		6					
7			FINE BROWN SAND (SP) VARVES BEDDING		14		⊗
8							
9							
10				16	7		⊗
11			SILT INTERBEDDED	29	13		⊗
12		12				▽	
13			BROWN F–C SAND & FINE GRAVEL (SP) WATER BEARING		14		⊗
14							
15			EOB 14'				
16							
17							
18							
19							
20							
21							
22							
23							

WATER LEVEL OBSERVATIONS	
W.L.	12'
W.L.	
W.L.	

RSI
ENVIRONMENTAL CONSULTANTS

BORING STARTED:	11/28/95		
BORING COMPLETED:	11/28/95		
RIG:	CME 55	DRILLER:	C.A.
DRAWN:	TMH	APPROVED:	RJM
		SHEET 1 OF 1	

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES; IN SITU, THE TRANSITION MAY BE GRADUAL

LOG OF BORING

PROJECT:	FORT SNELLING	SITE:	BUILDING 511
OWNER:	FORT McCOY	BORING #:	SB–3

DEPTH, FEET	SAMPLE NUMBER AND TYPE	STRATA CHANGE (FEET)	DESCRIPTION OF MATERIAL	TEST RESULTS (PID)	N-VALUE (BLOWS/FT)	WATER LEVEL	STANDARD PENETRATION (BLOWS/FOOT)
			SURFACE ELEVATION: →				10 20 30 40 50
1		.5	BLACK SILTY SAND; TOPSOIL				
			BROWN F–C SAND W/GRAVEL				
2							
3				1.9	11		
4							
5				1.6	10		
6							
7				2.7	6		
8							
9				1.8	7		
10							
11		11	VARVES AND BEDS OF FINE GRAVEL				
12			BROWN FINE TO COARSE SAND AND GRAVEL BEDDED	1.9	11	▽	
13							
14					10		
15							
16					6		
17			EOB 16'				
18							
19							
20							
21							
22							
23							

WATER LEVEL OBSERVATIONS	
W.L.	12'
W.L.	
W.L.	

RSI
ENVIRONMENTAL CONSULTANTS

BORING STARTED:	11/28/95		
BORING COMPLETED:	11/28/95		
RIG:	CME 55	DRILLER:	C.A.
DRAWN:	TMH	APPROVED:	RJM
		SHEET 1 OF 1	

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES; IN SITU, THE TRANSITION MAY BE GRADUAL

LOG OF BORING

PROJECT:	FORT SNELLING	SITE:	BUILDING 511
OWNER:	FORT McCOY	BORING #:	SB-4/MW-2

DEPTH, FEET	SAMPLE NUMBER AND TYPE	STRATA CHANGE (FEET)	DESCRIPTION OF MATERIAL	TEST RESULTS (PID)	N-VALUE (BLOWS/FT)	WATER LEVEL	STANDARD PENETRATION (BLOWS/FOOT)
			SURFACE ELEVATION: ▼				10 20 30 40 50
1			BLACK TO BROWN SANDY SILT				
2							
3		2.5	BROWN FINE TO MEDIUM SAND WITH GRAVEL (SP)	5.9	10		
4							
5				6.3	9		
6							
7							
8					12		
9			BEDDING AND VARVES				
10		10		6.4	7	▽	
11			BROWN FINE TO COARSE SAND AND GRAVEL	10.3	13		
12							
13							
14					27		
15							
16					23		
17							
18							
19			EOB 18'				
20							
21							
22							
23							

WATER LEVEL OBSERVATIONS	
W.L.	10'
W.L.	
W.L.	

RSI
ENVIRONMENTAL CONSULTANTS

BORING STARTED:	11/29/95		
BORING COMPLETED:	11/29/95		
RIG:	CME 55	DRILLER:	C.A.
DRAWN:	TMH	APPROVED:	RJM
		SHEET 1 OF 1	

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES; IN SITU, THE TRANSITION MAY BE GRADUAL

LOG OF BORING

PROJECT:	FORT SNELLING	SITE:	BUILDING 511
OWNER:	FORT McCOY	BORING #:	SB–5/MW–3

DEPTH, FEET	SAMPLE NUMBER AND TYPE	STRATA CHANGE (FEET)	DESCRIPTION OF MATERIAL	TEST RESULTS (PID)	N–VALUE (BLOWS/FT)	WATER LEVEL	STANDARD PENETRATION (BLOWS/FOOT)
			SURFACE ELEVATION: ▼				10 20 30 40 50
		.5	BLACK TO BROWN SANDY SILT				
1			BROWN FINE – MEDIUM SAND				
2							
3				6.1	9		
4							
5				2.6	8		
6							
7				6.7	10		
8							
9				9.4	11		
10							
11				10.4	9		
12		12				▽	
			FINE TO COARSE SAND AND GRAVEL		27		
13							
14							
15					10		
16							
17							
18					16		
19			EOB 18'				
20							
21							
22							
23							

WATER LEVEL OBSERVATIONS	
W.L.	12'
W.L.	
W.L.	

RSI
ENVIRONMENTAL CONSULTANTS

BORING STARTED:	11/29/95
BORING COMPLETED:	11/29/95
RIG: CME 55	DRILLER: C.A.
DRAWN: TMH	APPROVED: RJM
	SHEET 1 OF 1

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES; IN SITU, THE TRANSITION MAY BE GRADUAL

LOG OF BORING

PROJECT:	FORT SNELLING	SITE:	BUILDING 511
OWNER:	FORT McCOY	BORING #:	SB–7

DEPTH, FEET	SAMPLE NUMBER AND TYPE	STRATA CHANGE (FEET)	DESCRIPTION OF MATERIAL	TEST RESULTS (PID)	N-VALUE (BLOWS/FT)	WATER LEVEL	STANDARD PENETRATION (BLOWS/FOOT)
			SURFACE ELEVATION: ▼				10 20 30 40 50
1			BLACK TO BROWN SANDY SILT (TOPSOIL)				
2		2					
3			BROWN FINE SAND	1.4	13		
4							
5							
6				1.6	10		
7			BEDDING AND PEA GRAVEL				
8				2.0	16		
9							
10				2.1	14		
11		10	BROWN FINE TO COARSE SAND & GRAVEL BEDDED				
12				2.6	24	▽	
13							
14					24		
15							
16					16		
17			EOB 16'				
18							
19							
20							
21							
22							
23							

WATER LEVEL OBSERVATIONS	
W.L.	12'
W.L.	
W.L.	

RSI
ENVIRONMENTAL CONSULTANTS

BORING STARTED:	11/30/95		
BORING COMPLETED:	11/30/95		
RIG:	CME 55	DRILLER:	C.A.
DRAWN:	TMH	APPROVED:	RJM
		SHEET 1 OF 1	

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES; IN SITU, THE TRANSITION MAY BE GRADUAL

LOG OF BORING

PROJECT:	FORT SNELLING	SITE:	BUILDING 511
OWNER:	FORT McCOY	BORING #:	SB-6

DEPTH, FEET	SAMPLE NUMBER AND TYPE	STRATA CHANGE (FEET)	DESCRIPTION OF MATERIAL	TEST RESULTS (PID)	N-VALUE (BLOWS/FT)	WATER LEVEL	STANDARD PENETRATION (BLOWS/FOOT)
			SURFACE ELEVATION: ▼				10 20 30 40 50
1			BLACK SILTY SAND & GRAVEL (TOPSOIL)				
2		1.5	BROWN SILT				
3		3		1.7	6		
4			BROWN SAND F-M				
5				2.1	13		
6		6					
7			BROWN FINE SAND AND GRAVEL	2.4	9		
8							
9				2.5	9		
10		10					
11		11	BROWN F-C SAND	2.9	15		
12			BROWN F-C SAND & GRAVEL BEDDING & VARVES			▽	
13					9		
14							
15							
16					11		
17			EOB 16'				
18							
19							
20							
21							
22							
23							

WATER LEVEL OBSERVATIONS	
W.L.	12'
W.L.	
W.L.	

RSI
ENVIRONMENTAL CONSULTANTS

BORING STARTED:	11/30/95
BORING COMPLETED:	11/30/95
RIG: CME 55	DRILLER: C.A.
DRAWN: TMH	APPROVED: RJM
	SHEET 1 OF 1

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES; IN SITU, THE TRANSITION MAY BE GRADUAL