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Operable Unit 2
Final Remedial Investigation Report
Fort Wainwright, Alaska

Volume I

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LIST OF ACRONYMS

AAL	Arctic Aeromedical Laboratory
ACWEAS	Alaskan Cold Weather Environmental Airfield Station
ADEC	Alaska Department of Environmental Conservation
AEC	Airways Engineering Corporation
AEHA	U.S. Army Environmental Hygiene Agency
AFCEE	Air Force Center for Environmental Excellence
AI/SVE	Air injection/soil vapor extraction
AKNHP	Alaska Natural Heritage Program
Alta	Alta Analytical Laboratory, Inc.
ARARs	Applicable or relevant and appropriate requirements
ARDL	Applied Research and Development Laboratory, Inc.
ASTM	American Society for Testing and Materials
ATI	Analytical Technologies, Inc.
Atm-m^3/mol	Atmospheric cubic meters per mole
BCF	Bioconcentration factor
BHC	Benzene hexachloride
BTEX	Benzene, toluene, ethylbenzene, and xylenes
BTOC	Below top of casing
C&T	Curtis and Tompkins, Ltd.
CAS	Columbia Analytical Services
CEAA	Chelation extraction atomic absorption
CEC	Cation exchange capacities
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfm	Cubic feet per minute
cfs	Cubic feet per second
cm/s	Centimeters per second
COC	Chemical of concern
CQAR	Chemical Quality Assurance Report
CRREL	Cold Regions Research Engineering Laboratory
CT&E	Commercial Testing & Engineering Co., Environmental Laboratory Services
CVAA	Cold vapor atomic absorption
DCA	1,1-dichloroethane
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethene
DDT	Dichlorodiphenyltrichloroethane
DO	Dissolved oxygen
DOD	Department of Defense
DPW	Directorate of Public Works
DRMO	Defense Reutilization Marketing Office
DRO	Diesel-range organics
E&E	Ecology & Environment, Inc.
EM	Electromagnetic profiling
EPA	U.S. Environmental Protection Agency
EPN	0-ethyl-o, p-nitrophenyl phenylphosphorothioate
FFA	Federal Facility Agreement
FIQ	Fuel identification and quantification
ft/yr	Feet per year
GAC	Granular activated carbon
GC	Gas chromatography
GFAA	Graphite furnace atomic absorption
GPR	Ground-penetrating radar
GRO	Gasoline-range organics
HLA	Harding Lawson Associates
HpCDD	Heptachlorodibenzodioxin
HpCDF	Heptachlorodibenzofuran
HQ	Hazard quotient
HRA	Human health risk assessment
ICP	Inductively coupled plasma
ID	Inside diameter
KHz	Kilohertz
LAAF	Ladd Army Airfield
LAFB	Ladd Air Force Base
LCS	Laboratory control spike
m^2/s	Square meters per second
MCL	Maximum contaminant level
meq	Milliequivalent
µg/kg	Micrograms per kilogram
µg/L	Micrograms per liter
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
MRL	Method reporting limit
MS	Mass spectrometry
MS	Matrix spike
MSD	Matrix spike duplicate
MSL	Mean sea level
NAPL	Nonaqueous-phase liquid
NCP	National Contingency Plan
NET	National Environmental Testing Laboratories, Inc.
NOAA	National Oceanic Atmospheric Administration
NPD	North Pacific Division
NPDWR	National Primary Drinking Water Regulations
NPL	National Priorities List
NSDWR	National Secondary Drinking Water Regulations
NTU	Nephelometric turbidity unit

LIST OF ACRONYMS

^{o}C	Degrees Celsius
OCDD	Octachlorodibenzodioxin
OCDF	Octachlorodibenzofuran
OCP	Organochlorine pesticide
OD	Outside diameter
OPP	Organophosphorous pesticide
OU	Operable Unit
PAHs	Polynuclear aromatic hydrocarbons
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene
PeCDF	Pentachlorodibenzofuran
PeCDD	Pentachlorodibenzodioxin
pg/g	Picograms per gram
pg/L	Picograms per liter
PID	Photoionization detector
POL	Petroleum, oils, and lubricants
ppm	Parts per million
PSE	Preliminary source evaluation
PVC	Polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
RA	Risk assessment
RBC	Risk-based concentration
RCRA	Resource Conservation and Recovery Act
REDOX	Oxidation-reduction potential
RI/FS	Remedial investigation/feasibility study
RPM	Remedial project manager
SARA	Superfund Amendments and Reauthorization Act
SAS	Sound Analytical Services, Inc.
SOP	Standard operating procedures
SVOCs	Semivolatile organic compounds
SWLO	Southwest Laboratory of Oklahoma, Inc.
TCA	1,1,1-trichloroethane
TCDD	Tetrachlorodibenzo-p-dioxin
TCDF	Tetrachlorodibenzofuran
TCE	Trichloroethene
TEQ	Toxicity equivalent
TIC	Tentatively identified compound
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons
Triangle	Triangle Laboratories of RTP, Inc.
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	Underground Storage Tank
VES	Vapor extraction system
VOCs	Volatile organic compounds

1.0 INTRODUCTION

This report presents the findings of the remedial investigation (RI) of Operable Unit 2 (OU 2) at the U.S. Department of the Army's (Army's) Fort Wainwright facility in Fairbanks, Alaska. The RI was performed by Harding Lawson Associates (HLA) for the U.S. Army Corps of Engineers (USACE) under Delivery Order No. 002 of Indefinite Architect-Engineer Services Contract No. DACA85-94-D-0008.

Fort Wainwright is located within the Fairbanks North Star Borough in central Alaska, and covers approximately 918,000 acres on the eastern side of the City of Fairbanks (Figure 1-1). The OU 2 portion of Fort Wainwright contains three source areas defined in a Federal Facility Agreement (FFA) as the Defense Reutilization Marketing Office (DRMO) yard, Building 1168, and the North Post (Figure 1-2).

1.1 Federal Facility Agreement

In August 1990, Fort Wainwright was placed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List (NPL). As a result, current environmental assessment and remediation activities at Fort Wainwright are being performed to comply with the CERCLA, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986. These activities are also being performed to comply with an FFA effected in March of 1992 between the U.S. Environmental Protection Agency (EPA), the Department of Defense (DOD), and the Alaska Department of Environmental Conservation (ADEC). The FFA identifies the authorities and responsibilities of these parties, and integrates CERCLA requirements with pertinent aspects of other federal and state remedial programs such as the Resource Conservation and Recovery Act (RCRA) and Alaska's Underground Storage Tank (UST) Program.

The general purposes of the FFA, as defined in Section III of the agreement, are to (EPA, 1991):

- Ensure that the environmental impacts associated with past and present activities at the Site are thoroughly investigated and appropriate removal and/or remedial action(s) is taken as necessary to protect the public health, welfare, and the environment;
- Establish a procedural framework and schedule for developing, implementing, and monitoring appropriate response actions at the Site in accordance with CERCLA, the National Contingency Plan (NCP), national Superfund guidance and policy, RCRA, national RCRA guidance and policy, and applicable state law; and
- Facilitate cooperation, exchange of information, and participation of the Parties in such actions.

1.2 Remedial Investigation Report Purpose and Overview

This RI report was prepared according to the format for RI reports included in the document *Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA* (EPA, 1988a), with minor modifications. Background information on Fort Wainwright and OU 2, investigation methods, results, and the significance of findings are described within the report as follows:

- Section 1 presents historical background data on Fort Wainwright and OU 2, including the results of previous investigations.
- Section 2 presents the physical characteristics of Fort Wainwright.
- Section 3 summarizes field operation and sample collection information.
- Section 4 summarizes the lithology and hydrology of each source area.

- Section 5 summarizes laboratory analytical programs and results of the quality assurance/quality control (QA/QC) program.
- Section 6 describes analytical results and the nature of contamination of each source area.
- Section 7 presents applicable or relevant and appropriate requirements (ARARs) and laboratory background contaminants eliminated from further consideration.
- Section 8 describes chemical fate and transport, and presents the significance of results regarding site characterization.
- Section 9 presents recommendations based on OU 2 RI results.
- Appendixes A through L include supporting documentation.

1.3 Fort Wainwright Background

The Fort Wainwright main post cantonment area is a 4,473-acre expanse east of downtown Fairbanks, partly within the city limits (Figure 1-2). Fort Wainwright also includes 8,825 acres of ranges and 898,306 acres of military maneuver areas.

On March 31, 1937, Executive Order No. 7596 established 2,684.01 acres representing the airfield and the bulk of the original Fort Wainwright cantonment area as the Alaskan Cold Weather Environmental Airfield Station (ACWEAS). The ACWEAS was established specifically for military purposes, to include cold weather testing, training, and operational preparedness. On December 1, 1939, the ACWEAS was officially designated Ladd Army Airfield (LAAF). During World War II, LAAF served as a transfer point in the lend-lease program. Between 1942 and 1945, almost 8,000 combat and transport aircraft were transferred to Soviet aircrews at LAAF. In 1947, the newly formed U.S. Air Force assumed control of LAAF, which was redesignated as Ladd Air Force Base (LAFB).

LAFB served as a resupply and maintenance base for remote distant early warning sites and experimental ice stations in the Arctic Ocean. During the Korean conflict, LAFB served as part of the defense network and was the site of the first Nike Hercules Missile launch from a tactical missile site in December 1959.

On January 1, 1961, the Army resumed control of LAFB and renamed it Fort Wainwright. The primary mission of Fort Wainwright is to train infantry soldiers in the arctic environment; to prepare troops to defend the Pacific Rim in case of war; and to rapidly deploy troops worldwide. Industrial operations at Fort Wainwright include maintaining fixed-wing aircraft, helicopters, and support vehicles.

1.4 Defense Reutilization and Marketing Office Yard Source Area Background

The DRMO yard source area is located along Badger Road, northwest of the intersection of Badger Road and the Richardson Highway, as shown on Figure 1-2. The earliest reference to the DRMO yard was found in the 1958 LAFB Master Plan, which identifies the area as a vehicle maintenance shop compound (AEC, 1958). At that time, the compound included the area directly west of the DRMO yard source area. The 1958 Master Plan site maps show numerous Quonset huts, temporary buildings, and some permanent buildings equipped with full utilities that included underground sewer lines to carry wastewater offsite (AEC, 1958). The Quonset huts and temporary buildings shown on the 1958 Master Plan site maps are no longer at the DRMO yard source area. When or why the Quonset huts were demolished is not known.

The following buildings were previously in use at the DRMO yard source area and were also demolished:

- Building 5004, constructed in 1945, was used for vehicle storage. It was demolished in 1990, although the concrete foundation remains.
- Building 5006, constructed in 1945, was used for general storage, and was demolished in 1991.

Currently, the DRMO yard source area is a fenced compound of approximately 25 acres containing the following buildings:

- Building 5001, constructed in 1945, is used for administrative offices and storage.
- Building 5002, constructed in 1958, is a scale house with a concrete floor and metal walls.
- Building 5003 constructed in 1978, is used for covered storage.
- Building 5007, constructed in 1985, is used for flammable materials storage.
- Building 5008, constructed in 1985, is used for general storage and some hazardous materials storage.
- Buildings Y and Z, constructed in 1979 as part of an Army readiness training exercise, are used to store hazardous materials.

In addition to the buildings at the DRMO yard source area, other site features include numerous aisles of surplus appliances, tires, transformers, wire, etc. A railroad spur, currently abandoned and in deteriorating condition, enters a gate on the south side of the yard and extends to a loading ramp west of Building 5007.

The DRMO yard serves as the hazardous materials transfer point for several federal installations including Fort Wainwright, Fort Greely, and Eielson AFB. Its function is to store obsolete, surplus, and unserviceable equipment and supplies for transfer to another authorized user, for public auctions, or to destroy/dispose of unwanted materials. The DRMO yard is presently used to handle and store hazardous materials in accordance with the Fort Wainwright RCRA Part B Permit. Most of the hazardous materials are stored in Buildings 5008, Y, and Z. Building Y is used to store corrosive chemicals. Building Z is used to store oxidizers or reactive chemicals. Hazardous materials handled at the DRMO yard are strictly classified and accounted for (E&E, 1993).

1.4.1 DRMO Yard Past Practices

In 1961 when LAFB became Fort Wainwright, the vehicle maintenance shop was converted into the salvage yard currently known as the DRMO yard. Approximately 200 feet east of the DRMO yard source area is the Arctic Surplus site, also a CERCLA NPL site. Many items such as petroleum products, pesticides and herbicides, tar and asphalt, transformers, and drums of transformer oil containing polychlorinated biphenyls (PCBs), appliances, vehicles, and paint products reportedly stored at the DRMO yard were sold to Arctic Surplus (HLA, 1993b). Complete records of DRMO yard activities were not maintained, and information about past salvage and resale procedures is incomplete.

The central to southwestern portion of the DRMO yard source area previously contained a burn pit, and was used to store drums of waste oil and asphalt, and electrical transformers (some of which may have contained PCBs). The drums containing waste oil were also suspected to contain solvents and/or vehicle fluid such as antifreeze and hydraulic fluid. Reportedly, many of the drums in storage leaked, especially in the southwestern corner of the yard where leaking asphalt had reportedly accumulated on the ground to a depth of 4 to 6 inches (HLA, 1993b).

Items customarily burned in the DRMO yard source area included mattresses and wood furniture, although plastics also may have been burned. During the early 1980s, an estimated 3,000 to 8,000 gallons of diesel fuel No. 1 was spilled near Building 5001. Cleanup included spreading the contaminated soil throughout the yard. Waste oil was used to control dust on roads in the DRMO yard source area during the 1970s and early 1980s (HLA, 1993b).

1.4.2 DRMO Yard Source Area Previous Investigations

The USACE installed groundwater monitoring wells outside the eastern boundaries of the DRMO yard source area as part of an investigation at the Arctic Surplus site (S&W, 1993). Studies of the Arctic Surplus site were conducted from 1990 through 1993. Results of the Arctic Surplus site investigations described below are included in this report, because the site is adjacent to the DRMO yard source area. Many of the

chemicals associated with the Arctic Surplus site were also detected at the DRMO yard source area, and the same ecological receptors may be exposed to chemicals from both sites.

Arctic Surplus Site

In 1990, nine monitoring wells downgradient of the Arctic Surplus site were installed at the DRMO yard source area (USACE, 1991b). In September and October 1992 and March 1993, Shannon & Wilson Inc. conducted additional investigative work at the Arctic Surplus site (1993). Five new monitoring wells were installed to further characterize the extent of contamination from the southwestern corner and the west-central part of the site. These monitoring wells, two existing water-supply wells, and six nearby residential wells were sampled twice a year in 1990, 1991, 1992, and 1993. Samples from the studies were analyzed for semivolatile organic compounds (SVOCs), pesticides/PCBs, volatile organic compounds (VOCs), dioxins/furans, petroleum hydrocarbons, metals, and organophosphorus pesticides (OPP). Trichloroethene (TCE) was detected in Monitoring Well AP-5627 at 18 micrograms per liter (µg/L) in 1993. TCE was also detected in Monitoring Wells AP-5625 (1 µg/L), AP-5810 (2 µg/L), and AP-5809 (1 µg/L), but at concentrations below 5 µg/L. Summaries of these monitoring data are presented in Appendix F of the final management plan for OU 2 (HLA, 1994b). A summary of 1993 groundwater data is presented in Table 1-1. Well locations are shown on Figure 1-3.

In addition to groundwater, Shannon & Wilson Inc. investigated soil at the Arctic Surplus site (1993). Dioxins/furans and PCBs were found in soil at several locations within the northwest area of the site. Sample locations and results are shown on Figure 1-4 and in Table 1-2, respectively.

DRMO Yard Source Area

In July 1992, 12 borings were drilled and 2 monitoring wells were installed by the USACE in the area directly north of Building 5001 at the DRMO yard source area to investigate the area for placing a building foundation (HLA, 1993a). Petroleum hydrocarbons were detected in several borings at concentrations exceeding ADEC soil cleanup levels. Groundwater samples collected from Monitoring Well AP-5764 contained 8.6 µg/L TCE and 6.7 µg/L trichlorofluoromethane.

At the request of the USACE, HLA conducted an OU 2, preliminary source evaluation (PSE) 2, phase 2 investigation at the DRMO yard source area in September 1992 to assess the presence of contamination in soil and groundwater. The area north of Building 5001 was not included in the phase 2 investigation and is associated with a spill from a UST that is being addressed under a separate two-party agreement between the DOD and the ADEC. The results of HLA's 1992 investigation are contained in HLA's report titled *Final Report, Operable Unit 2, Preliminary Source Evaluation 2, Phase 2, Defense Reutilization Marketing Office, Fort Wainwright, Alaska* (1993b). To identify likely boring locations, 20 screening samples were collected from shallow borings and field analyzed for PCBs, chlorinated solvents, and petroleum hydrocarbon content. Twelve soil borings were drilled to 6.5 feet, and four borings were drilled to approximately 15 feet and completed as groundwater monitoring wells. Monitoring well and soil boring locations are shown on Figures 1-3 and 1-4.

Based on soil analytical results, fuel contamination consisting of petroleum hydrocarbons and associated VOCs was identified in soil samples from each of the previous transformer storage areas and the previous asphalt drum storage area identified in the PSE 2 report (HLA, 1993b).

Table 1-1. March 1993 Arctic Surplus Site Groundwater Data

Analyte	Number of Wells Sampled	Number of Wells with Detectable Concentrations	Wells with Highest Concentrations	Concentrations (Micrograms per Liter)
Volatile Organic Compounds				
Trichloroethene	15	5	AP-5627	1 to 18
Semivolatile Organic Compounds				
bis(2-Ethylhexyl)phthalate	7	2	AP-5622, AP-5620	2
Polychlorinated Biphenyls and Pesticides	6	0		None in groundwater
Fuels				
Bunker oil	6	1	AP-5807	980

Table 1-2. Summary of Dioxin/Furan Analyses in Soil at the Arctic Surplus Site

Sample Number	2,3,7,8-TCDD Equivalency Concentration (picograms per gram)
DI1-100	33.7
DI5-101	1420.0
DI2-102	4.74
DI2-103	4.0
DI3-104	2.82
DI4-105	2.55

2,3,7,8-TCDD 2,3,7,8-dioxin (tetrachlorodibenzo-p-dioxin)

Note: These results are presented to identify other sources of contamination near the Defense Reutilization Marketing Office yard source area.

Source: Shannon & Wilson, Inc., 1993.

Diesel-range organics (DRO) detected in soil samples from the northeast section of the yard exceeded the ADEC action level of 100 milligrams per kilogram (mg/kg). Gasoline-range organics (GRO) and DRO that exceeded ADEC action levels were in soil samples from the southwest corner of the yard. DRO results from borings in the previous transfer storage areas ranged from 15 mg/kg to as high as 8,200 mg/kg. In Boring AP-5818 within the asphalt drum storage area, sample results for DRO ranged from 59 to 338 mg/kg. One soil sample from Boring AP-5815 from the previous burn pit area and one soil sample from Boring AP-5818 in the previous asphalt drum storage area contained dioxins and furans.

The results of PCB and pesticide analyses ranged from 0.01 to 0.7 mg/kg. The highest PCB concentration (0.7 mg/kg) was detected in a sample from Boring AP-5822 within the previous waste oil drum storage area. PCBs were not detected in soil samples from the transformer storage areas in the northeast corner of the DRMO yard.

HLA's 1992 groundwater results for the DRMO yard source area (1993b) show a maximum concentration of 330 µg/L of naphthalene in Monitoring Well AP-5825. Dioxins and furans were also detected in monitoring wells in the asphalt drum storage area (AP-5824) and in the central transformer storage area (AP-5825). Disulfoton was detected in Monitoring Well AP-5826 at a maximum concentration of 3.4 µg/L (HLA, 1993b).

The highest concentration of lead was found in Monitoring Well AP-5826 at 54 µg/L. Manganese was detected at 201 µg/L in Monitoring Well AP-5824, 8,500 µg/L in Monitoring Well AP-5825, 1,210 µg/L in Monitoring Well AP-5823, and 5,610 µg/L in Monitoring Well AP-5826. Concentration ranges, frequencies, and sample locations for soil and groundwater samples are summarized in Tables 1-3 and 1-4, respectively.

Groundwater flow beneath the DRMO yard source area is interpreted to be in a westerly direction toward Channel B based on data from HLA's PSE 2 investigation (1993b). Shannon & Wilson Inc.'s Arctic Surplus site investigation interpreted groundwater flow to be in a west/northwest direction (1993). The direction of regional groundwater flow south of the Chena River is approximately to the west/northwest. The uncertainty regarding local groundwater flow direction was attributed to the margin for error in interpreting limited data from two separate but nearby sites, local variations in groundwater flow direction at the two sites, or temporal variations of groundwater flow direction.

Table 1-3. DRMO Yard Source Area September 1992 Preliminary Source Evaluation 2 Soil Analytical Results

Analyte	Number of Samples Collected	Number of Samples with Detectable Concentrations	Location Well AP-58__	Units	Concentrations
Metals					
Aluminum	8	8	12,14,17,25,26	mg/kg	3,370 to 7,000
Arsenic	8	8	12,14,17,25,26	mg/kg	1.0 to 4.0
Barium	8	8	12,14,17,25,26	mg/kg	40 to 84
Chromium	8	8	12,14,17,25,26	mg/kg	7.0 to 14
Copper	8	8	12,14,17,25,26	mg/kg	10.0 to 22
Iron	8	8	12,14,17,25,26	mg/kg	6,810 to 12,200
Lead	8	8	12,14,17,25,26	mg/kg	3.0 to 19
Manganese	8	8	12,14,17,25,26	mg/kg	127 to 374
Nickel	8	8	12,14,17,25,26	mg/kg	12.0 to 18
Vanadium	8	8	12,14,17,25,26	mg/kg	12.0 to 24
Zinc	8	8	12,14,17,25,26	mg/kg	18.0 to 51
Petroleum Hydrocarbons					
DRO	18	5	11,12,13,14	mg/kg	15 to 8,200
GRO	18	1	17	mg/kg	68
Other	18	3	12,13,18	mg/kg	45 to 873
Polychlorinated Biphenyls/Pesticides					
4,4'-Dichlorodiphenyldichloroethene	26	1	18	mg/kg	0.01
4,4'-Dichlorodiphenyltrichloroethane	26	3	11,17,18	mg/kg	.02 to 0.11
Methoxychlor	26	7	13,14,15,16	mg/kg	0.02
Toxaphene	26	7	13,14,15,16	mg/kg	0.3
Chlordane	26	7	13,14,15,16	mg/kg	0.1
Aroclor 1221	26	4	14,15,16	mg/kg	0.1
Aroclor 1232	26	4	14,15,16	mg/kg	0.1
Aroclor 1242	26	4	14,15,16	mg/kg	0.1
Aroclor 1248	26	4	14,15,16	mg/kg	0.1
Aroclor 1254	26	4	14,15,16	mg/kg	0.1
Aroclor 1260	26	2	22	mg/kg	0.5 to 0.7
Volatile Organic Compounds					
Methylene chloride	21	10	13,16,18,22,25,26	µg/kg	15 to 41
Xylenes	21	1	25	µg/kg	1,200
1,3,5-Trimethylbenzene	21	3	25,26	µg/kg	230 to 9,100
1,2,4-Trimethylbenzene	21	1	25	µg/kg	17,000
4-Isopropyltoluene	21	1	25	µg/kg	110

Table 1-3. DRMO Yard Source Area September 1992 Preliminary Source Evaluation 2 Soil Analytical Results (continued)

Analyte	Number of Samples Collected	Number of Samples with Detectable Concentrations	Location Well AP-58__	Units	Concentrations
Volatile Organic Compounds (continued)					
1,2-Dibromo 3-chloropropene (DBCP)	21	1	25	µg/kg	350
1,2,3-Trichlorobenzene	21	1	25	µg/kg	210
Naphthalene	21	4	25,26	µg/kg	350 to 12,000
Semivolatile Organics					
Naphthalene	5	2	25,26	mg/kg	3.0 to 7.0
2-Methylnaphthalene	5	1	25	mg/kg	19
Dioxins/Furans					
2,3,7,8-TCDD	3	1	18	pg/g	1.2
Total TCDD	3	1	18	pg/g	6.5
1,2,3,7,8-PeCDD	3	1	18	pg/g	6
Total PeCDD	3	1	18	pg/g	49
1,2,3,4,7,8-HxCDD	3	1	18	pg/g	8.4
1,2,3,6,7,8-HxCDD	3	1	18	pg/g	15
1,2,3,7,8,9-HxCDD	3	1	18	pg/g	15
Total HxCdd	3	1	18	pg/g	220
1,2,3,4,6,7,8-HpCDD	3	3	15,18	pg/g	1.2 to 320
Total HpCDD	3	3	15,18	pg/g	2.3 to 570
OCDD	3	3	15,18	pg/g	4.3 to 740
2,3,7,8-TCDF	3	1	18	pg/g	1.1
Total TCDF	3	1	18	pg/g	22
2,3,4,7,8-PeCDF	3	1	18	pg/g	2.1
Total PeCDF	3	1	18	pg/g	14
1,2,3,4,7,8-HxCDF	3	1	18	pg/g	1.9
1,2,3,6,7,8-HxCDF	3	1	18	pg/g	2.6
Total HxCDF	3	2	15,18	pg/g	1.5 to 48
1,2,3,4,6,7,8-HpCDF	3	2	15,18	pg/g	5.5 to 35
1,2,3,4,7,8,9-HpCDF	3	1	18	pg/g	2.4
Total HpCDF	3	2	15,18	pg/g	5.5 to 130
OCDF	3	2	15,18	pg/g	3.2 to 91

DRO Diesel-range organics
DRMO Defense Reutilization and Marketing Office
GRO Gasoline-range organics
mg/kg Milligrams per kilogram
pg/g Picograms per gram
µg/kg Micrograms per kilogram

Table 1-4. DRMO Yard Source Area September 1992 Preliminary Source Evaluation 2 Groundwater Analytical Results

Analyte	Number of Locations Sampled	Number of Locations with Detectable Concentrations	Location Well AP-58__	Units	Concentrations
Metals					
Aluminum	4	4	23,24,25,26	µg/L	800 to 21,800
Arsenic	4	3	23,25,26	µg/L	7 to 37
Barium	4	4	23,24,25,26	µg/L	136 to 584
Chromium	4	1	26	µg/L	41
Copper	4	4	23,25,26	µg/L	18 to 162
Iron	4	4	23,24,25,26	µg/L	1,470 to 62,900
Lead	4	3	23,25,26	µg/L	4 to 54
Manganese	4	4	23,24,25,26	µg/L	201 to 8,500
Nickel	4	1	26	µg/L	60
Vanadium	4	1	26	µg/L	70
Zinc	4	4	23,24,25,26	µg/L	13 to 151
Petroleum Hydrocarbons					
DRO	4	4	23,24,25,26	µg/L	144 to 85,000
GRO	4	0	--	µg/L	--
Other	4	1	25	µg/L	910
Extractable petroleum hydrocarbons	4	4	23,24,25,26	µg/L	169 to 82,000
Pesticides					
Organophosphorous disulfoton	4	1	26	µg/L	3.4
Volatile Organic Compounds					
Xylenes	4	1	25	µg/L	180
1,3,5-Trimethylbenzene	4	2	25, 26	µg/L	14 to 140
1,2,4-Trimethylbenzene	4	2	25, 26	µg/L	7.4 to 290
4-Isopropyltoluene	4	1	25	µg/L	23
Trichloroethene	4	1	23	µg/L	0.6
Ethylbenzene	4	1	25	µg/L	4.7
Naphthalene	4	2	25, 26	µg/L	13 to 330
Toluene	4	1	25	µg/L	1

Table 1-4. DRMO Yard Source Area September 1992 Preliminary Source Evaluation 2 Groundwater Analytical Results (continued)

Analyte	Number of Locations Sampled	Number of Locations with Detectable Concentrations	Location Well AP-58__	Units	Concentrations
Volatile Organic Compounds (continued)					
n-Propylbenzene	4	2	25, 26	µg/L	3 to 15
Isopropylbenzene	4	2	25, 26	µg/L	1.6 to 16
n-Butylbenzene	4	2	25, 26	µg/L	6.1 to 15
Semivolatile Organic Compounds					
Naphthalene	4	1	25	µg/L	330
2-Methylnaphthalene	4	1	25	µg/L	26 to 190
Dioxins/Furans					
Total HxCdd	4	1	24	pg/L	8.9
1,2,3,4,6,7,8-HpCDD	4	2	24, 25	pg/L	7.8 to 8.1
Total HpCDD	4	2	24, 25	pg/L	14
OCDD*	4	4	23,24,25,26	pg/L	34 to 67
2,3,7,8-TCDF	4	1	24	pg/L	7.6
Total TCDF	4	1	24	pg/L	60
2,3,4,7,8-PeCDF	4	1	24	pg/L	11
1,2,3,7,8-PeCDF	4	1	24	pg/L	8.9
Total PeCDF	4	1	24	pg/L	85
1,2,3,4,7,8-HxCDF	4	1	24	pg/L	9.5
1,2,3,6,7,8-HxCDF	4	1	24	pg/L	6.3
2,3,4,6,7,8-HxCDF	4	1	24	pg/L	7.9
1,2,3,7,8,9-HxCDF	4	1	24	pg/L	2.2
Total HxCDF	4	1	24	pg/L	48
1,2,3,4,6,7,8-HpCDF	4	2	24, 25	pg/L	4.5 to 11
1,2,3,4,7,8,9-HpCDF	4	1	24	pg/L	2
Total HpCDF	4	2	24, 25	pg/L	7 to 18
OCDF	4	2	24, 25	pg/L	4.5 to 5.4

-- None given
DRMO Defense Reutilization and Marketing Office
DRO Diesel-range organics
GRO Gasoline-range organics
µg/L Micrograms per liter
pg/L Picograms per liter

* OCDD concentrations were below method calibration limits and were also detected in laboratory blanks.

1.5 Building 1168 Source Area Background

The Building 1168 source area is located on the north side of Trainor Road, adjacent to the Trainor gate entrance of Fort Wainwright (Figures 1-5 and 1-6). This single-story building is occupied by A Company, 706th Main Support Battalion. The Building 1168 source area is surrounded by fenced storage yards on the north and east, and by unrestricted parking lots on the south and west. A Fairbanks public school is within 1,000 feet northwest of the source area, and the 801 military housing area is approximately 300 feet south. Surface water near the site includes the Chena River (approximately 1,800 feet east), and sloughs, drainage ditches, and associated wetland systems within approximately 1,500 feet north of the site. Past practices previous investigations, and the Building 1168 treatability study are discussed below.

1.5.1 Building 1168 Past Practices

According to Directorate of Public Works (DPW) Real Property Records, Building 1168 was constructed in 1949. The building was identified as a Lube Oil and Vehicle Storage Facility on As-Built Drawing No. 78-08-03 dated November 1953. According to the drawing, building dimensions were 66 feet by 95 feet with a concrete foundation, a floor, and walls. The as-built drawing shows a 10,000-gallon, aboveground, lube-oil storage tank and dispenser located inside the southeast corner of the building. Four floor drains in the western half of the building are shown draining into an oil/water separator. The oil/water separator is shown with a 3-inch waste line that empties into a 250-gallon UST, and a 4-inch waste line that terminates at a leach well. Oil, fuel, and water mixtures that entered the floor drains presumably flowed to the oil/water separator. Oil and fuel passed through the 3-inch waste line into the UST. Water passed through the 4-inch waste line into the leach well. Contaminants suspected to have entered the floor drains include oil from engines and transmissions, gasoline, diesel, jet fuel, solvents, hydraulic fluid, and engine coolants. The building is shown equipped with a 2000-gallon heating oil tank and a septic system for sanitary waste.

The 1958 Master Plan listed Building 1168 as a permanent, reinforced concrete building in excellent, usable condition, and the site was identified as Storage-Lube (AEC, 1958). As-built drawings from May 1962 (File No. 300-001-0562) detail the conversion of the tank room into a petroleum, oils, and lubricants (POL) laboratory. The 10,000-gallon, lube-oil storage tank and dispenser were removed, and a new floor was installed with an additional floor drain plumbed into the existing oil/water separator and leach well system.

In 1985, the post utility maintenance group replaced the waste line from Building 1168 to the leach well. Workers reportedly did not notice stained soil or strong odors at the building connection or along the waste line. However, they reported feeling light-headed when working near the connection to the leach well (HLA, 1993a).

One spill report concerning the Building 1168 source area is on file at the ADEC Northern Regional Office. Five gallons of No. 2 heating oil was reported spilled on April 9, 1991, from a boiler leak. Absorbents were reportedly used to clean up the spill and were disposed of at the power plant. According to the report, "A small quantity may have gone down [the] drain" (ADEC, 1990).

1.5.2 Building 1168 Source Area Previous Investigations

In 1985, the City of Fairbanks began supplying potable water to Building 1168. The building was originally serviced by a water-supply well located in its northeast corner. The water well reportedly contained petroleum hydrocarbons (HLA, 1993a); however, no petroleum constituents were detected in a water sample collected from the well by the USACE in January 1992 (USACE, 1992).

In 1990, the U.S. Army Environmental Hygiene Agency (AEHA) conducted a groundwater quality survey (No. 38-26-7026-90). The report designated the oil/water separator and leach well system as Site FWA-009.

In 1990, the ADEC conducted a RCRA facility assessment at Fort Wainwright. The ADEC's report mentioned the oil/water separator and leach well, and recommended that an investigation be initiated based on the high potential for releases via the leach well or storage tank (1990).

In June 1992, HLA completed a limited field investigation of the area surrounding the oil/water separator and leach well as part of a PSE investigation. The results of the 1992 investigation are presented in HLA's report titled *Final Report, Operable Unit 2, Preliminary Source Evaluation 2, Phase 1, Fort Wainwright, Alaska* (1993a). During the 1992 investigation, HLA installed four borings (AP-5748, AP-5749, AP-5750, and AP-5751) around the leach well. One additional boring (AP-5747) was installed upgradient of the leach well and one was installed downgradient (AP-5752), based on local groundwater flow directions. Two borings (AP-5753 and AP-5754) were installed along the waste line piping run to verify information obtained during the 1985 pipe replacement project.

Four of the eight borings (AP-5747, AP-5751, AP-5752, and AP-5754) were converted into monitoring wells. Soil and groundwater samples were collected and analyzed for the following: petroleum hydrocarbons, VOCs, SVOCs, PCBs, and RCRA metals. Petroleum hydrocarbons and VOCs were detected in soil samples at concentrations exceeding ADEC action levels of 100 mg/kg for DRO and 10 mg/kg for benzene, toluene, ethylbenzene, and xylenes (BTEX) constituents.

TCE was detected in Monitoring Well AP-5751 at a concentration of 34 µg/L, and benzene was detected at concentrations of 12 µg/L in Boring AP-5751 and 27 µg/L in Boring AP-5752. Ethylbenzene was detected in Boring AP-5751 at a concentration of 960 µg/L, and total xylenes were detected in Borings AP-5751 and AP-5752 at concentrations of 4,800 µg/L and 1200 µg/L, respectively. In general, the highest analyte concentrations in soil and groundwater were from samples closest to the leach well. Complete results of the PSE 2 are presented in HLA's final report (1993a).

In August and September 1993, HLA completed additional support work for the PSE 2 investigation to obtain information regarding the extent of contamination at the site (HLA, 1994a). HLA collected groundwater samples from 26 microwells (groundwater probes) installed by the Cold Regions Research Engineering Laboratory (CRREL). HLA drilled borings and completed them as groundwater monitoring wells (AP-6332, AP-6333, and AP-6334). Samples were collected from both soil and groundwater.

Monitoring Well AP-6332 located near the leach well east of Monitoring Well AP-5751 had DRO at 435 mg/kg detected in soil at the 15- to 16.5-foot-depth sampling interval, which exceeds the ADEC soil cleanup level of 100 mg/kg. GRO was detected at 2,000 mg/kg in soil at the same depth, which exceeds the ADEC cleanup level of 50 mg/kg.

Soil sample results were consistent with 1992 investigation findings (HLA, 1993a). HLA's draft report titled *OU 2, PSE 2 Support Work, Building 1168* (1994a) concluded that:

> The significant concentrations of petroleum hydrocarbons detected adjacent to the leach well are likely the result of petroleum products entering the leach well, saturating the soil from the leach well bottom to the water table, and migrating laterally at the water table surface. Based on the lack of measurable free product in monitoring wells surrounding the leach well, the extent of product-saturated soil is apparently limited to the immediate vicinity of the leach well. Based on analytical soil samples, field-screening results, and observations from CRREL ground-truth borings, the zone of contaminated soil extends approximately 50 feet radially

from the leach well location. The thickness of the contaminated zone is approximately 4 to 5 feet, which is thought to correspond with the seasonal range of water table fluctuation.

The highest levels of contaminants in groundwater were concentrated in Monitoring Wells AP-5751 and AP-5752. Table 1-5 summarizes the maximum contaminant concentrations detected in groundwater samples during HLA's 1993 investigation.

The contaminated soil around the leach well appeared to be the source of detected petroleum hydrocarbons and VOCs in groundwater. Contaminants dissolved in groundwater were believed to be migrating from the zone of contaminated soil in the direction of the groundwater gradient.

A figure from the draft report (HLA, 1994a) is reproduced as Figure 1-7 to illustrate isoconcentration contours for the petroleum hydrocarbon plume in groundwater. GRO and DRO (petroleum) sample results were summed to generate the contours. As shown on Figure 1-7, the highest petroleum concentrations were detected adjacent to the leach well. Concentrations diminished with increased distance from the well. Separate concentration peaks within the plume were attributed to possible individual disposal events (HLA, 1994a). Microwell data were used along with monitoring well data to generate the contours. Although contour maps were not generated for benzene and TCE, the occurrence of these contaminants in groundwater followed similar patterns (Figure 1-6).

The microwells and monitoring wells were also used to estimate the plume's thickness. The plume was located in a zone between approximately 20 to 50 feet below ground surface. Groundwater sample results indicated that plume concentrations decreased to near regulatory levels at a distance of 400 feet from the leach well, possibly due to dispersion and dilution. Tables 1-6 and 1-7 summarize data for contaminants found in soil and groundwater, respectively, from all of the above-referenced investigations for the Building 1168 source area.

CRREL conducted a geophysical survey at several sites at Fort Wainwright during the spring of 1993. Building 1168 was included in a survey presented in the report titled *Preliminary Geophysical Investigations of Toxic Waste Sites within Operating Unit #1, Fairbanks, Alaska* (CRREL, 1993). As part of the conclusions, CRREL reported several locations indicative of permafrost at Building 1168.

In response to CRREL's geophysical survey, HLA included a ground-truth investigation during the 1993 PSE 2 support work to evaluate whether permafrost was present near Building 1168. HLA drilled eight borings (AP-6335 through AP-6342) in the areas identified by CRREL (Figure 1-5). Samples from the ground-truth borings did not indicate the presence of permafrost.

1.5.3 Building 1168 Source Area Treatability Study

HLA is currently performing an ongoing treatability study via a pilot air injection/soil vapor extraction (AI/SVE) system constructed at the Building 1168 source area. System installation, operation, maintenance, and monitoring results from the treatability study are documented in HLA's report titled *Interim Report, Building 1168 Treatability Study, Fort Wainwright, Alaska* (1995a), and letter report titled *Monitoring Report, Building 1168 Treatability Study, Fort Wainwright, Alaska* (1995b).

The AI/SVE system is expected to increase oxygen concentrations in the soil, thus stimulating the growth of indigenous aerobic microorganisms capable of degrading hydrocarbons. The estimated lateral extent of BTEX in groundwater at the Building 1168 source area is illustrated on Figure 1-8. HLA tests the AI system to assess the injection airflow characteristics and zone of influence of the AI well. SVE tests are conducted to estimate air conductivity and radius of influence in the vadose zone.

The effect of AI in the saturated zone is monitored monthly and quarterly by analyzing groundwater samples, monitoring dissolved oxygen (DO) in the groundwater during respiration tests, and recording groundwater levels. The

Table 1-5. Summary of Maximum Contaminant Concentrations in Micrograms per Liter Detected in Groundwater During the 1993 Building 1168 Investigation

Analyte	Maximum Detected Concentration
Benzene	17
Bromodichloromethane	1.3
Chloroform	3.0
Ethylbenzene	960
Isopropylbenzene	35
Lead	92
Manganese	3,290
Naphthalene	220
Toluene	1,600
Xylenes	5,000

Source: HLA, 1994a

Table 1-6. Soil Analytical Results in Milligrams per Kilogram from Previous Investigations at the Building 1168 Source Area

Analyte	Number of Samples Collected	Number of Saples with Detectable Concentrations	Location Boring AP-___	Concentrations
Petroleum Hydrocarbons				
Diesel n-C_{10} to n-C_{28}	43	24	5747, 5754, 6332, 6333 Background	4.8 to 1,100
Jet fuel	33	2	5750, 5751	114 to 286
Semivolatile Organic Compounds				
2-Methylnaphthalene	43	3	5748, 5751, 6332	0.85 to 3.0
Fluorene	33	2	5748, 5750	0.081 to 0.140
Naphthalene	43	3	5748, 5750, 6332	1.0 to 1.6
Volatile Organic Compounds				
Benzene	33	1	5749	0.01
1,2,3-Trichloropropane	10	2	6332	0.020 to 0.041
2-Butanone (MEK)	10	5	6333	0.012 to 0.073
Acetone	33	13	5747 through 5754	0.005 to 0.067
Ethylbenzene	33	2	5748, 5749	0.09 to 0.15
Methylene chloride	33	14	5747 through 5754	0.004 to 0.045
Toluene	10	2	5749, 6332	0.08 to 1.5
Xylene	33	2	5748, 5749	0.74 to 12

Table 1-7. Water Analytical Results in Micrograms per Liter from Previous Investigations of the Building 1168 Source Area

Analyte	Number of Samples Collected	Number of Samples with Detectable Concentrations	Location Monitoring Well AP-__	Concentrations
Petroleum Hydrocarbons				
Diesel n-C_{10} to n-C_{28}	17	14	5747, 5751, 5752, 5754, 5790, 6332, 6333, 6334	0.36 to 25,400
Gasoline	13	10	5747, 5751, 5752, 6332, 6333	64.0 to 26,000
Pesticides				
4,4'-Dichlorodiphenyltrichloroethane	11	1	5752	0.11
Volatile Organic Compounds				
1,2,4-Trimethylbenzene	13	4	5751, 5752, 6332	880 to 680
1,3,5-Trimethylbenzene	13	5	5747, 5751, 5752, 6332	31.0 to 210
4-Isopropyltoluene	13	1	5747	7
Acetone	13	7	5747, 5751, 5752, 5754, 5781	2.0 to 430
Benzene	17	6	5751, 5752, 6333, 6334	1.1 to 27
Bromodichloromethane	13	1	5747	1.3
Chloroform	13	3	5781, 6333	1.1 to 3.0
Dichlorodifluoromethane (Freon 12)	13	3	5781, 6333	0.8 to 1.0
Ethylbenzene	17	8	5747, 5751, 5752, 6332	18 to 960
Isopropylbenzene	13	2	5747, 5752	28 to 35
Methylene chloride	4	1	5754	3
Naphthalene	13	3	5747, 5751, 5752	23 to 220
Toluene	17	7	5747, 5751, 5752, 6332	0.7 to 1,600
Total xylenes	17	8	5747, 5751, 5752, 6332	39.0 to 5,000
Trichloroethene	4	1	5751	34
Trichlorofluoromethane (Freon 11)	13	4	5754, 5781, 6333	0.6 to 44
cis-1,2-Dichloroethene	13	3	6333, 6334	0.9 to 1.0
n-Butylbenzene	13	1	5747	8
n-Propylbenzene	13	2	5747, 5752	33 to 37
sec-Butylbenzene	13	1	5747	8
tert-Butylbenzene	13	1	5747	150
Semivolatile Organic Compounds				
2-Methylnaphthalene	17	6	5747, 5751, 5752, 6332	8.0 to 120
Naphthalene	17	7	5747, 5751, 5752, 6332	7.0 to 120
bis (2-Ethylhexyl) phthalate	4	1	5754	3

mode and rate of hydrocarbon removal in the vadose zone is evaluated by conducting vadose zone microbial respiration tests, collecting vapor samples from the SVE system sampling ports for field-screening and/or laboratory analyses, and monitoring vadose zone soil temperatures.

Based on system startup and preliminary monitoring results, the pilot-scale system is increasing DO in groundwater. Reduced concentrations of DRO, GRO, benzene, and TCE at the site are attributed to enhanced volatilization and biodegradation as a result of AI and the stimulated growth of aerobic microorganisms capable of degrading hydrocarbons (HLA, 1995b). HLA has recommended continued operation and monitoring of the system. Additional testing may be necessary to further evaluate operational parameters and design criteria for full-scale operation (HLA, 1995a).

1.6 North Post Source Area Background

The North Post source area at Fort Wainwright is located northeast of the main cantonment area on an oxbow of the Chena River. The site is a relatively flat floodplain for which the Chena River forms the north and west boundaries (Figure 1-9). The North Post source area contains approximately 45 acres, and has been the subject of proposals for military housing projects for many years. While conducting a geotechnical investigation in 1985 for construction of a proposed 45-acre, 150-unit family housing development at the North Post source area, USACE drill crews noticed strong petroleum and solvent odors in soil borings on the west side of the oxbow area, which is vacant. Drill crew helpers who handled the soil experienced a burning sensation to skin and headaches (E&E, 1990). In 1987, 58 family housing units were constructed on the east side of the oxbow.

1.6.1 North Post Past Practices

In 1947, the Arctic Aeromedical Laboratory (AAL), comprised of four research sections (biology, arctic aviation medicine, physiology, and psychology) became operational on the northwest portion of the area currently identified as North Post source area Site 2. A river laboratory was constructed for use as a staging area for field experiments and as a center for work on large mammals. The river laboratory facilities consisted of a Quonset hut, an incinerator, and a wood-framed structure on skids containing animal cages. The laboratory conducted cold adaptation and acclimatization experiments for 20 years. When the AAL constructed new headquarters in 1955, smaller laboratories, except for the river laboratory, were closed.

In 1967, the entire facility was closed. In addition to the AAL's extensive use of the site, several temporary buildings and a radio transmitter were located in the vicinity. The transmitter was in the area currently identified as North Post source area Site 4. The transmitter was most likely a base radio station, or may have been a line-of-sight link to the Fairbanks, Alaska, Communications System facility.

An 8-inch-diameter POL pipeline, constructed in the 1940s, crossed the North Post source area in the section currently identified as North Post source area Site 3. The pipeline transported aviation gasoline from the Birch Hill UST tank farm until the 1950s. The pipeline was then used to transport diesel fuel until the 1960s. When the Birch Hill UST tank farm and the hydrant refueling system on the north taxiway were closed in the 1960s, the pipeline was abandoned in place.

Limited information was available about two documented pipeline spills (E&E, 1990). The first spill occurred on the north side of the Chena River in the late 1950s; the second spill occurred in the southwestern portion of the proposed housing site. Spill volumes and the date of the second spill were not found in available background information. In 1980, petroleum was observed seeping from the North Post source area into the Chena River. Extensive backhoe excavations were conducted by base personnel, but a source for the petroleum was not found. The location of the seep is not known.

Review of historical photographs and drawings showed that a slough of the Chena River, formerly located north of Dogwood Street, separated the North Post source area from the main post. Photographs indicated that the southern arm of the slough was progressively filled during the 1940s and early 1950s (E&E, 1990). Historical photographs also indicated that 55-gallon drums were stored north of the southern end of the slough. Subsequent field investigations confirmed drum disposal had occurred in this area.

1.6.2 North Post Source Area Previous Investigations

Because obvious contamination was encountered during its geotechnical investigation, the USACE initiated an environmental investigation and sampling program to verify the presence of possible hazardous contaminants (E&E, 1988).

In September 1985, eight soil borings and piezometer wells were drilled in areas where contamination was encountered during the geotechnical investigation. Sample analytical results confirmed that soil and groundwater had been contaminated with petroleum hydrocarbons and solvents; however, the extents and specific types of contamination were not identified. Additional field studies conducted in the former slough area of the North Post source area (E&E, 1988) indicated the debris used for fill material included wood, scrap metal, pipe, brick, and raw coal mixed with ash and slag.

The USACE conducted additional sampling in 1986 to investigate specific areas of potential contamination identified from historical building records and land use data. The sample analytical results indicated that areas of the North Post source area were contaminated with VOCs, SVOCs, and the pesticide dichlorodiphenyltrichloroethane (DDT). In addition, 55-gallon drums with little or no contents were removed from an area near the center of the planned housing area (E&E, 1988).

In 1986 and 1987, URS, Inc., examined and summarized existing sample results, and prepared an endangerment assessment to evaluate whether hazardous wastes were present on the site, and whether any of the detected chemicals presented a threat to human health (E&E, 1990). The assessment evaluated the potential health risks to construction workers and future residents of the proposed family housing project. The report concluded that most of the site was free of hazardous waste and suitable for family housing. However, the study documented that hazardous wastes were found along the western and southern boundaries of the North Post source area. The report emphasized that the conclusions were general because site plans and construction details were not available. The URS, Inc., report also indicated that the 17-acre area containing the 58 housing units was free of hazardous materials. The site was later expanded to 19 acres to include a softball field (E&E, 1990).

In 1988, a break in the 8-inch-diameter POL pipeline (Site 3) was discovered on the western side of the North Post source area. Excavation activities were conducted to remediate three areas of concern as follows: contaminated soil at the pipeline break area was excavated and removed from the site; an aircraft buried in the northeast portion of the oxbow was excavated for proper disposal; and fly ash used as fill material in the slough area was further defined and excavated for proper disposal. Soil samples collected following removal of the fly ash indicated that metals did not leach from the ash into surrounding soil. Test pits were excavated at locations across the site and were sampled. In addition, water samples were collected from existing piezometers and monitoring wells. Results from 1985 through 1988 sampling events are summarized in Appendix F of the final management plan for OU 2 (HLA, 1994b).

A total of 47 chemicals from five general classes were identified on the entire 45-acre North Post source area during 1985 through 1988 sampling events. The five classes of chemicals included VOCs, SVOCs, pesticides, metals, and petroleum hydrocarbons (E&E, 1990).

In 1988, Ecology & Environment, Inc. (E&E) conducted a risk assessment (RA) according to EPA standards and guidelines in effect at that time.

The RA identified several areas of concern at the site. The areas of greatest concern were designated as Sites 1, 2, 3, and 4 by the USACE (Figure 1-9). In May 1990, E&E prepared a report that presented cleanup alternatives for the North Post source area and summarized data from previous investigations (1990). Analytical data from previous investigations in the E&E report for the North Post source area are provided in Appendix F of the final management plan (HLA, 1994b).

Site 1 is an area immediately north of Buildings 1038 and 1039. During the USACE's 1986 sampling event, DDT was detected at a concentration of 0.1 mg/kg in a surface-soil sample from Boring B-7 (Figure 1-9). In 1989, the USACE collected additional surface-soil samples to define the extent of DDT contamination. Soil samples were collected within a radius of approximately 25 feet of the Boring B-7 location (E&E, 1990), but specific sampling locations are not known. DDT was detected at 0.58 micrograms per kilogram (µg/kg) in one of the five samples collected. The sampling results are summarized in Appendix F of the final management plan (HLA, 1994b). No further action was recommended for Site 1.

Site 2, a former burn pit area located on a small bluff in the southern portion of the former river laboratory site at the north end of the oxbow, is in the center of a 100-foot-diameter, circular trench that was apparently excavated as a firebreak. During the USACE's 1986 investigation, SVOCs thought to be products of incomplete combustion were detected in Boring B-2 at the center of the burn area (Figure 1-9). SVOCs detected were benzo(a)anthracene (1,800 µg/kg); benzo(g,h,i)perylene (2,900 µg/kg); benzo(k)-fluoranthene (4,700 µg/kg); benzo(a)pyrene (2,700 µg/kg); chrysene (3,900 µg/kg); dibenzo(a,h)anthracene (1,300 µg/kg); and indeno 1,2,3-(c,d)pyrene (2,800 µg/kg). In a 1989 effort to estimate the extent of SVOC contamination, the USACE drilled six borings (DH-1, DH-2, DH-3, DH-4, DH-5, and DH-6, as shown on Figure 1-9) within a radius of 15 to 30 feet of the burn pit location, and collected soil samples from each boring (E&E, 1990). Because specific location information was unavailable, the boring locations shown on Figure 1-9 are approximate. The sampling results are summarized in Appendix F of the final management plan (HLA, 1994b). With one exception, previously identified SVOCs were not detected in the boring samples. The single exception was the detection of benzo(a)-pyrene (380 µg/kg) in a surface-soil sample from Boring DH-6, located approximately 30 feet away from the burn area center.

Soil contaminated with petroleum hydrocarbons in the vicinity of the POL pipeline break was designated as Site 3. To evaluate the adequacy of the 1988 remediation (soil removal) and to assess the extent of petroleum hydrocarbon-contaminated soil and groundwater from the pipeline break, the USACE installed three borings (AP-5551, AP-5552, and AP-5553) (completed as monitoring wells) in 1989. Petroleum hydrocarbons were detected in soil and groundwater samples at concentrations indicating that the 1988 remediation was incomplete (E&E, 1990). In 1993, Laidlaw Environmental excavated and removed additional contaminated soil at Site 3. Verification sampling preliminary results reported for the removal activities indicated that the contaminated soil was removed. Because it was determined that additional Site 3 remediation activities would be addressed under the two-party compliance agreement between the Army and the ADEC, the Site 3 pipeline break is not considered further in this RI.

Site 4 is the northern portion of the oxbow at the transmitter site, where strong petroleum odors were detected during the 1985 geotechnical investigation. Groundwater samples collected from Site 4 between 1985 and 1986 contained petroleum hydrocarbon contamination. Additional sampling in 1988 confirmed the presence of hydrocarbons in groundwater and revealed the presence of naphthalene at a concentration of 770 µg/L.

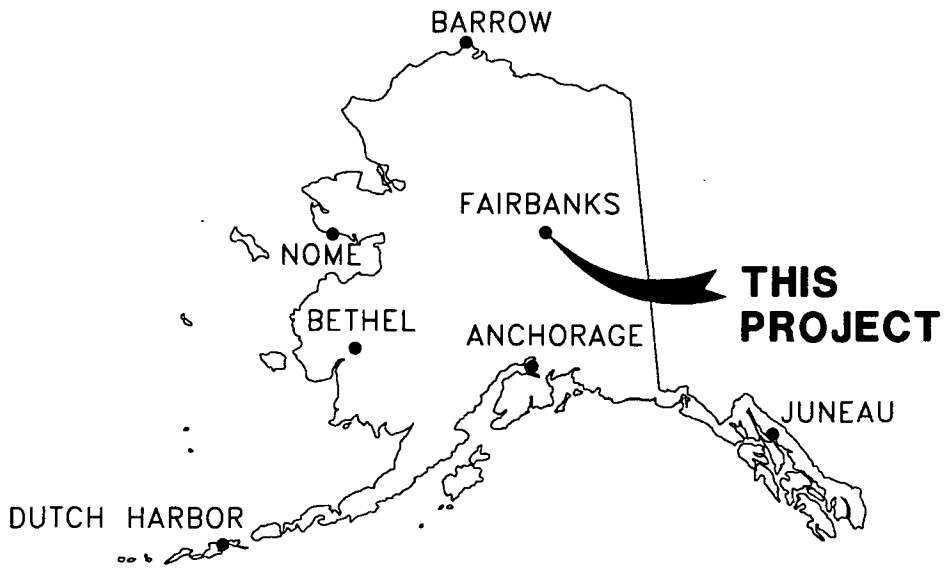
During the 1989 USACE investigation, Site 4 was surveyed using a metal detector for indications of subsurface contamination sources such as buried tanks; nothing was detected. Five borings were drilled, and soil samples were collected from each boring. Four of the borings were completed as monitoring wells (AP-5546, AP-5547, AP-5548,

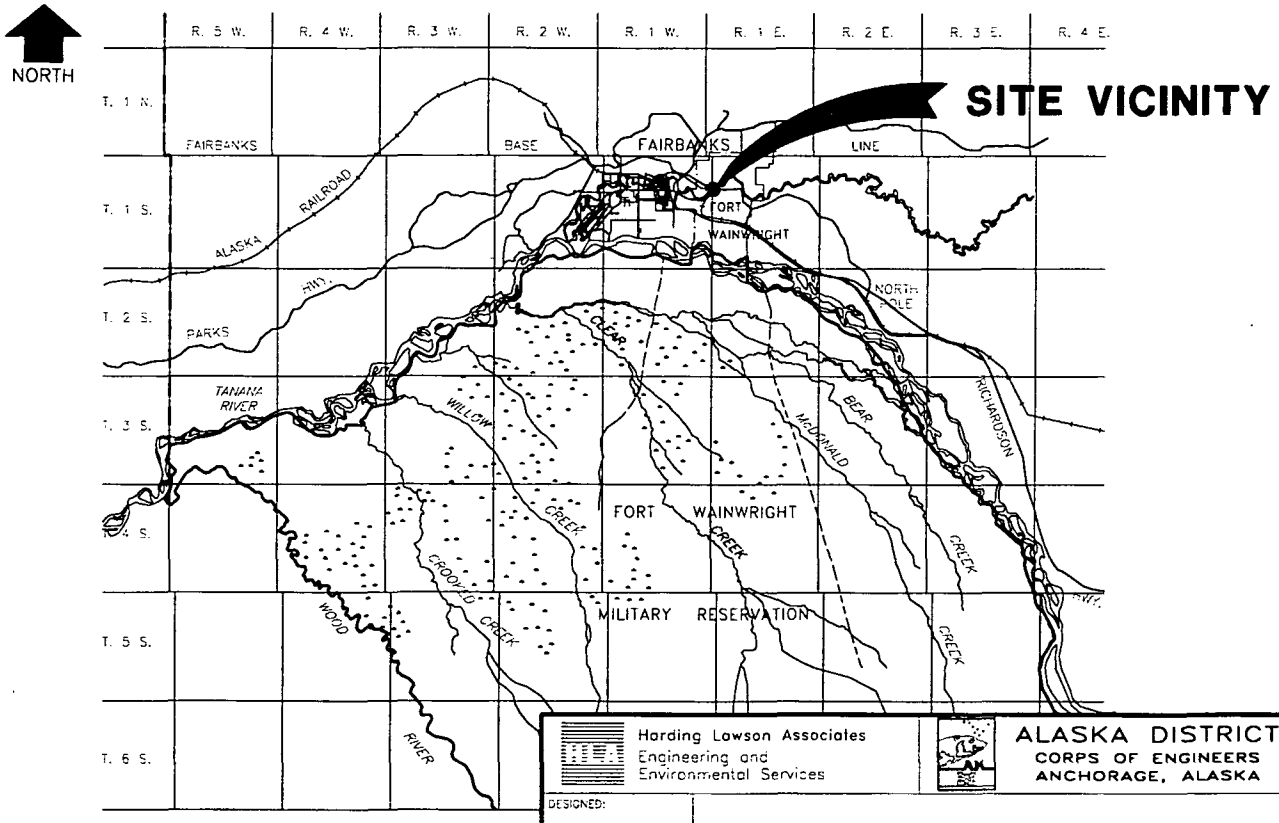
and AP-5549, as shown on Figure 1-9) and groundwater samples were collected (E&E, 1990). Sampling results are summarized in Appendix F of the final management plan (HLA, 1994b). Petroleum hydrocarbons were detected in soil and groundwater samples collected, with the exception of samples from Monitoring Well AP-5549. Benzene was detected in groundwater samples from Monitoring Wells AP-5546, AP-5547, and AP-5548 at concentrations exceeding 5 μg/L. Benzene was detected at a maximum concentration of 47 μg/L in a groundwater sample collected from Monitoring Well AP-5546. Dichlorobenzene was detected at concentrations of 300 μg/L in Monitoring Well AP-5546 and 190 μg/L in Monitoring Well AP-5548. The sampling results indicated that the extent of contamination was greater than previously estimated (E&E, 1990).

In 1993, Laidlaw Environmental excavated approximately 2,700 cubic yards from Site 4. Soil samples were collected from the excavation sidewalls to evaluate remediation. Samples were analyzed for DRO, GRO, total petroleum hydrocarbons (TPH), VOCs, SVOCs, PCB/pesticides, and metals. Analytes were not detected, or were detected at concentrations below ADEC soil cleanup levels. Analytes detected in soil samples from the Site 4 excavation sidewalls are summarized in Table 1-8.

Table 1-8. 1993 Soil Analytical Results in Milligrams per Kilogram from North Post Source Area Site 4 Excavation Sidewalls

Analyte	Number of Samples Collected	Samples with Detectable Concentrations	Range of Concentrations
Petroleum Hydrocarbons			
Diesel	7	1	40
Gasoline	7	2	15 to 31
Total Petroleum Hydrocarbons	7	1	17
Metals			
Arsenic	7	7	1 to 4
Barium	7	7	34 to 68
Chromium	7	7	7 to 14
Semivolatile Organic Compound			
di-n-Butyl Phthalate	7	6	19 to 23





0 4 8 16
SCALE IN MILES

Harding Lawson Associates
Engineering and Environmental Services

ALASKA DISTRICT
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED:	
DRAWN:	JP
TRACED:	
CHECKED:	
SUBMITTED	
CHIEF, ARCHITECTURAL SECTION	

Vicinity Map

OU 2 Remedial Investigation
Fort Wainwright, Alaska

RECOMMENDED:	APPROVED:	DATE: 10/95
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH	CHIEF, ENGINEERING DIVISION	
	SCALE: NOTED	SPEC. NO.
	FIGURE 1-1	

151b

NORTH POST SOURCE AREA

BUILDING 1168 SOURCE AREA

DRMO YARD SOURCE AREA

TRAINOR ROAD

FAIRBANKS

CHENA RIVER

MONTEREY LAKE

SOUTH GATE HOUSE

RICHARDSON HWY

BADGER ROAD

ARCTIC SURPLUS

DENNIS MANOR SUBDIVISION

NORTH

0 1250 2500 5000

SCALE IN FEET

LEGEND

- ROADS AND PARKING, PAVED
- ROADS AND PARKING, UNPAVED
- RESERVATION BOUNDARY
- RAILROAD
- STREAM
- SHORELINE
- TRAIL
- BRIDGE

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ALASKA DISTRICT
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ANCHORAGE, ALASKA

DESIGNED:
DRAWN: JP
TRACED:
CHECKED:
SUBMITTED:
CHIEF, ARCHITECTURAL SECTION

Site Map

OU 2 Remedial Investigation
Fort Wainwright, Alaska

RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH

APPROVED:
CHIEF, ENGINEERING DIVISION

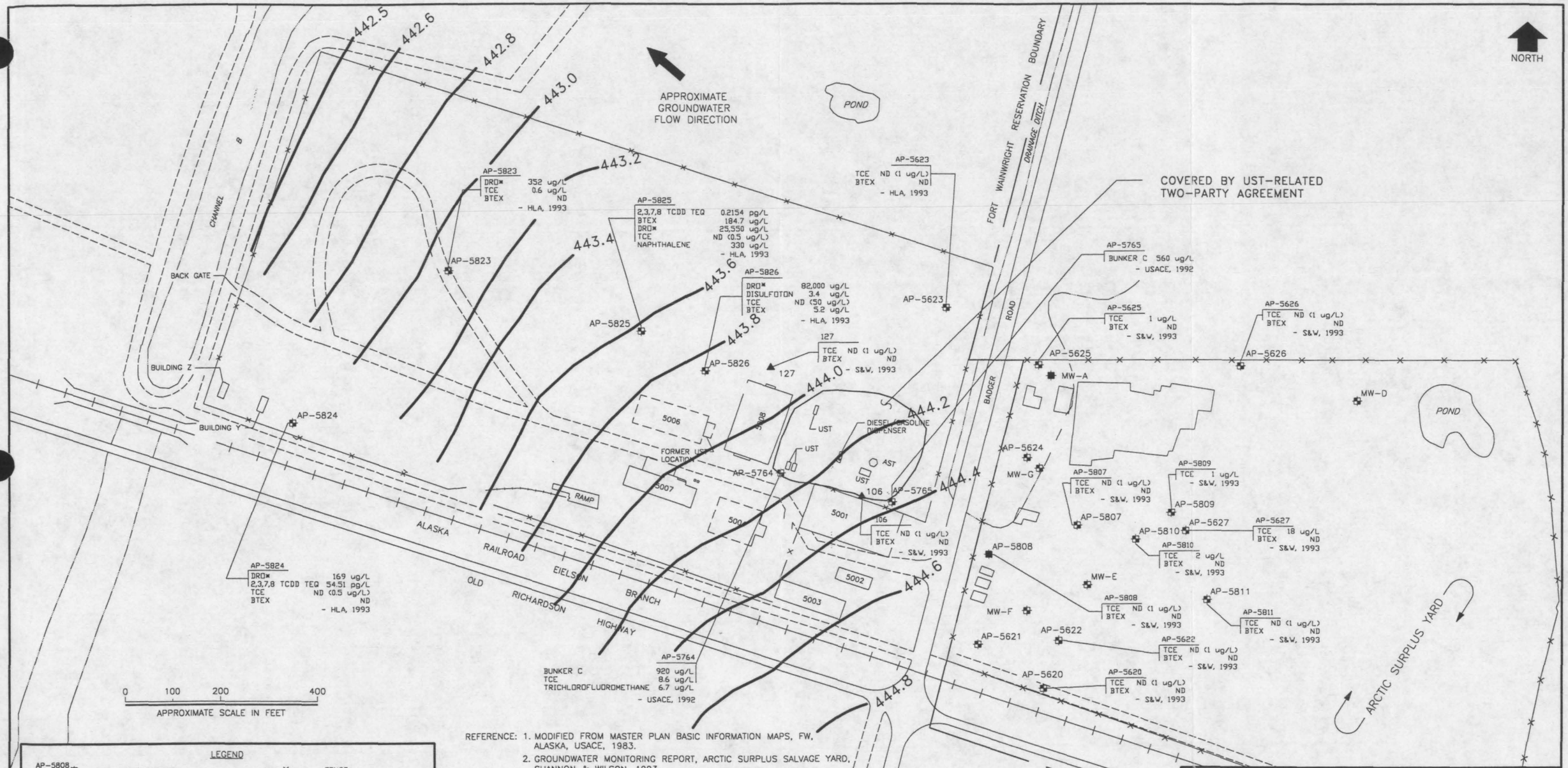
DATE: 10/95

SCALE: NOTED

SPEC. NO.

FIGURE
1-2

151b



LEGEND

AP-5808	DEEP MONITORING WELL	— X —	FENCE
AP-5823	SHALLOW MONITORING WELL LOCATION		BUILDING LOCATION
106 ▲	EXISTING SUPPLY WELL		FORMER BUILDING LOCATION
– HLA, 1993	DATA REPORTED IN HLA's OPERABLE UNIT (OU) 2, PRELIMINARY SOURCE EVALUATION (PSE) 2, PHASE 2 REPORT FOR DEFENSE REUTILIZATION MARKETING OFFICE (DRMO), JULY 20, 1993.	442.50	GROUNDWATER ELEVATION (SEPTEMBER 1994)
– S&W, 1993	DATA REPORTED IN SHANNON & WILSON's GROUNDWATER MONITORING REPORT, ARCTIC SURPLUS SALVAGE YARD, JULY 1993.		
– USACE, 1992	DATA REPORTED IN SUMMARY OF FIELD ACTIVITIES AND LABORATORY DATA FOR DLA COVERED STORAGE, FORT WAINWRIGHT, ALASKA, MEMO FOR CENPA-EN-TE-DM, DECEMBER 8, 1992.		

REFERENCE: 1. MODIFIED FROM MASTER PLAN BASIC INFORMATION MAPS, FW, ALASKA, USACE, 1983.
2. GROUNDWATER MONITORING REPORT, ARCTIC SURPLUS SALVAGE YARD, SHANNON & WILSON, 1993.

TEQ	TOXICITY EQUIVALENT CONCENTRATION OF ALL DIOXINS AND FURANS DETECTED EXPRESSED AS 2,3,7,8 TETRA-CHLORODIBENZO-P-DIOXIN (2,3,7,8 TCDD) PER U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA) 625/3-89/016, MARCH 1989.
DRO *	DIESEL-RANGE ORGANICS ANALYSIS PERFORMED AS EXTRACTABLE PETROLEUM HYDROCARBONS BY EPA METHOD 8100M.
AST	ABOVEGROUND STORAGE TANK
BTEX	BENZENE, TOLUENE, ETHYLBENZENE, XYLENES
ND	NOT DETECTED AT OR ABOVE METHOD REPORTING LIMIT IN PARENTHESES
pg/L	PICOGRAMS PER LITER
TCE	TRICHLOROETHENE
ug/L	MICROGRAMS PER LITER
USACE	U.S. ARMY CORPS OF ENGINEERS
UST	UNDERGROUND STORAGE TANK

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Engineering and Environmental Services

ALASKA DISTRICT
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

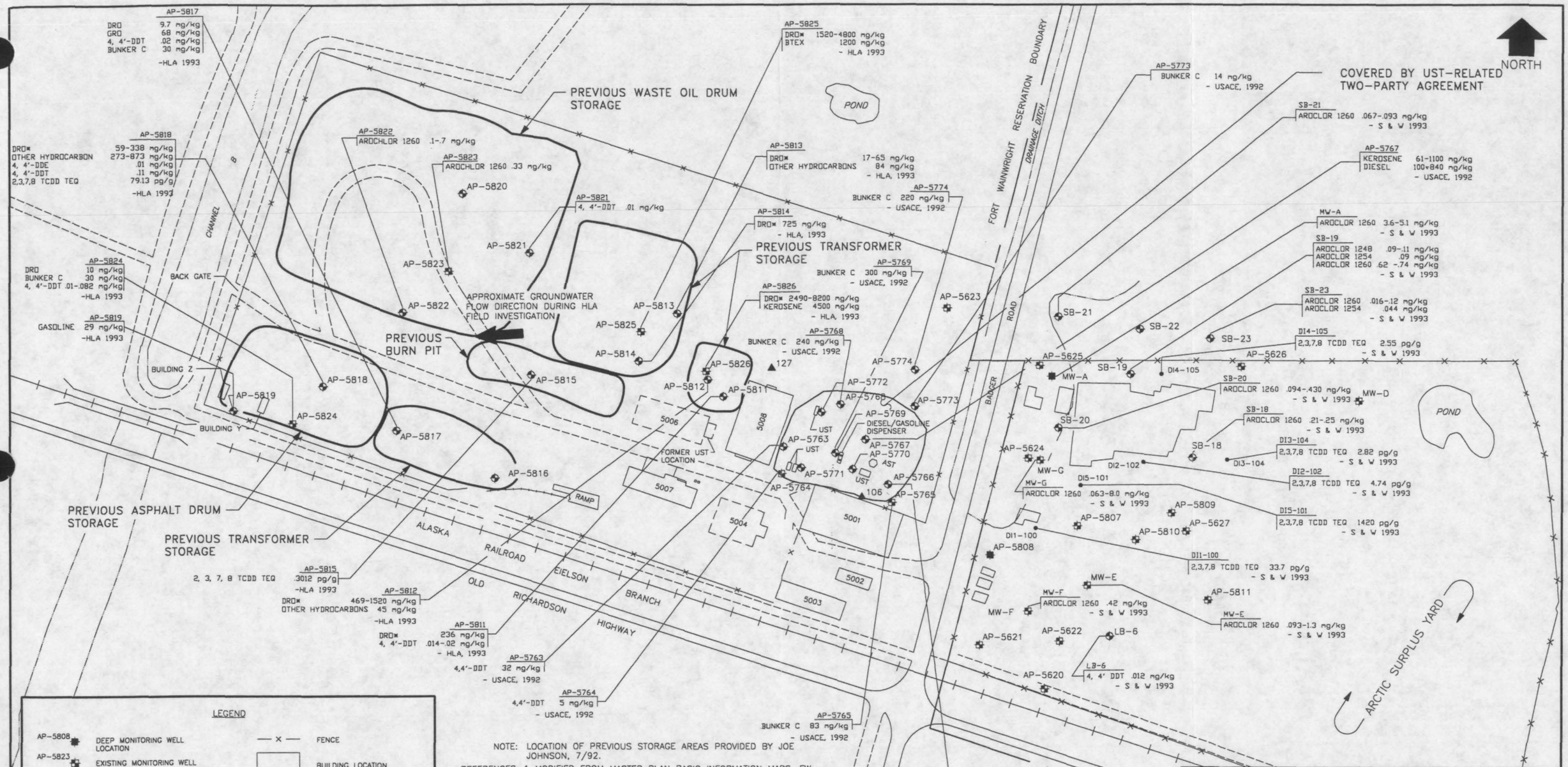
DESIGNED:
DRAWN: PB
TRACED:
CHECKED:
SUBMITTED:
CHIEF, ARCHITECTURAL SECTION
RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH
APPROVED:
CHIEF, ENGINEERING DIVISION
DATE: 10/95
SCALE: NOTED
SPEC. NO.

DRMO Yard Source Area Site Plan, Groundwater

OU 2 Remedial Investigation
Fort Wainwright, Alaska

FIGURE 1-3

156b



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Engineering and Environmental Services

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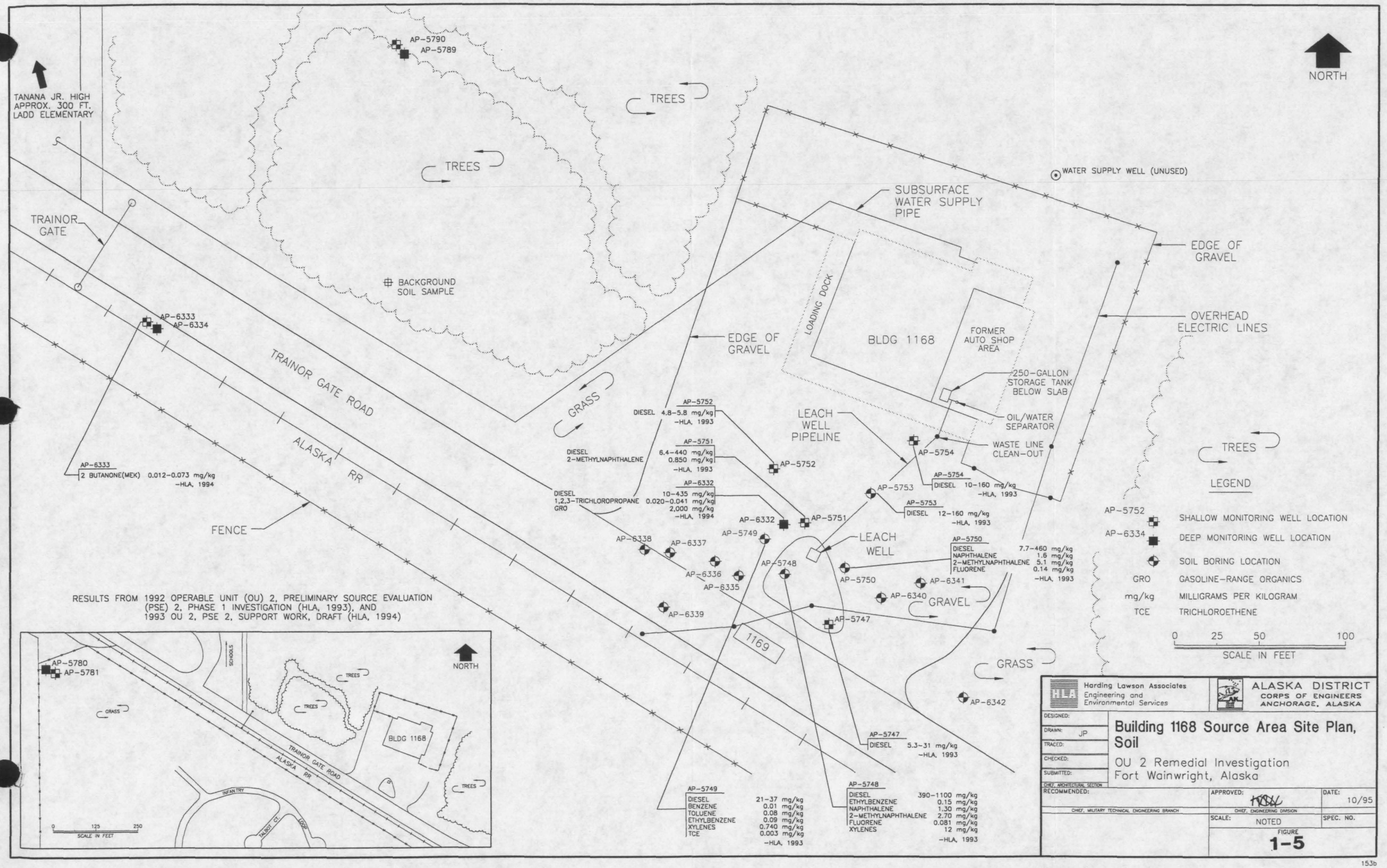
DESIGNED:
DRAWN: PB
TRACED:
CHECKED:
SUBMITTED:
CHIEF, ARCHITECTURAL SECTION
RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH
APPROVED:
CHIEF, ENGINEERING DIVISION
DATE: 10/95
SCALE: NOTED
SPEC. NO.

DRMO Yard Source Area Site Plan, Soil

OU 2 Remedial Investigation
Fort Wainwright, Alaska

FIGURE 1-4

155b

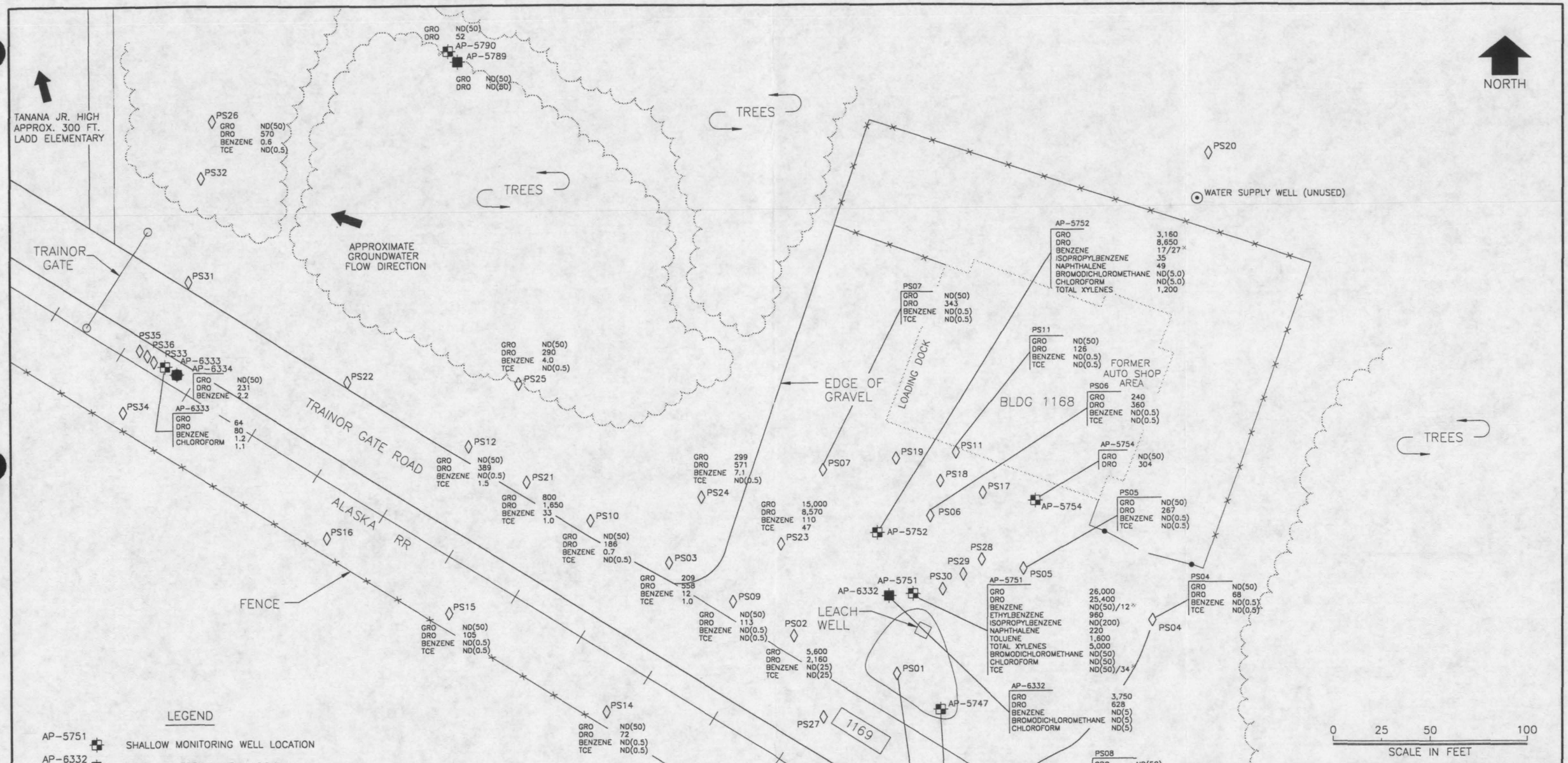


RESULTS FROM 1992 OPERABLE UNIT (OU) 2, PRELIMINARY SOURCE EVALUATION (PSE) 2, PHASE 1 INVESTIGATION (HLA, 1993), AND 1993 OU 2, PSE 2, SUPPORT WORK, DRAFT (HLA, 1994)

Building 1168 Source Area Site Plan, Soil

OU 2 Remedial Investigation
Fort Wainwright, Alaska

153b



LEGEND

AP-5751 — SHALLOW MONITORING WELL LOCATION

AP-6332 — DEEP MONITORING WELL LOCATION

PS20 — MICROWELL LOCATION

* — RESULTS FROM 1992 OPERABLE UNIT (OU) 2, PRELIMINARY SOURCE EVALUATION (PSE) 2, PHASE 1 INVESTIGATION (HLA, 1993) ALL OTHER RESULTS FROM 1993 OU 2, PSE 2 SUPPORT WORK DRAFT (HLA, 1994)

GRO — GASOLINE-RANGE ORGANICS, µg/L

DRO — DIESEL-RANGE ORGANICS, µg/L

TCE — TRICHLOROETHENE, µg/L

ND — NOT DETECTED AT OR ABOVE THE METHOD REPORTING LIMIT IN PARENTHESES

NOTE: ALL UNITS ARE MICROGRAMS PER LITER (µg/L)

Harding Lawson Associates
Engineering and Environmental Services

ALASKA DISTRICT
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED:
DRAWN: JP
TRACED:
CHECKED:
SUBMITTED:
CHIEF, ARCHITECTURAL SECTION
RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH
APPROVED:
CHIEF, ENGINEERING DIVISION

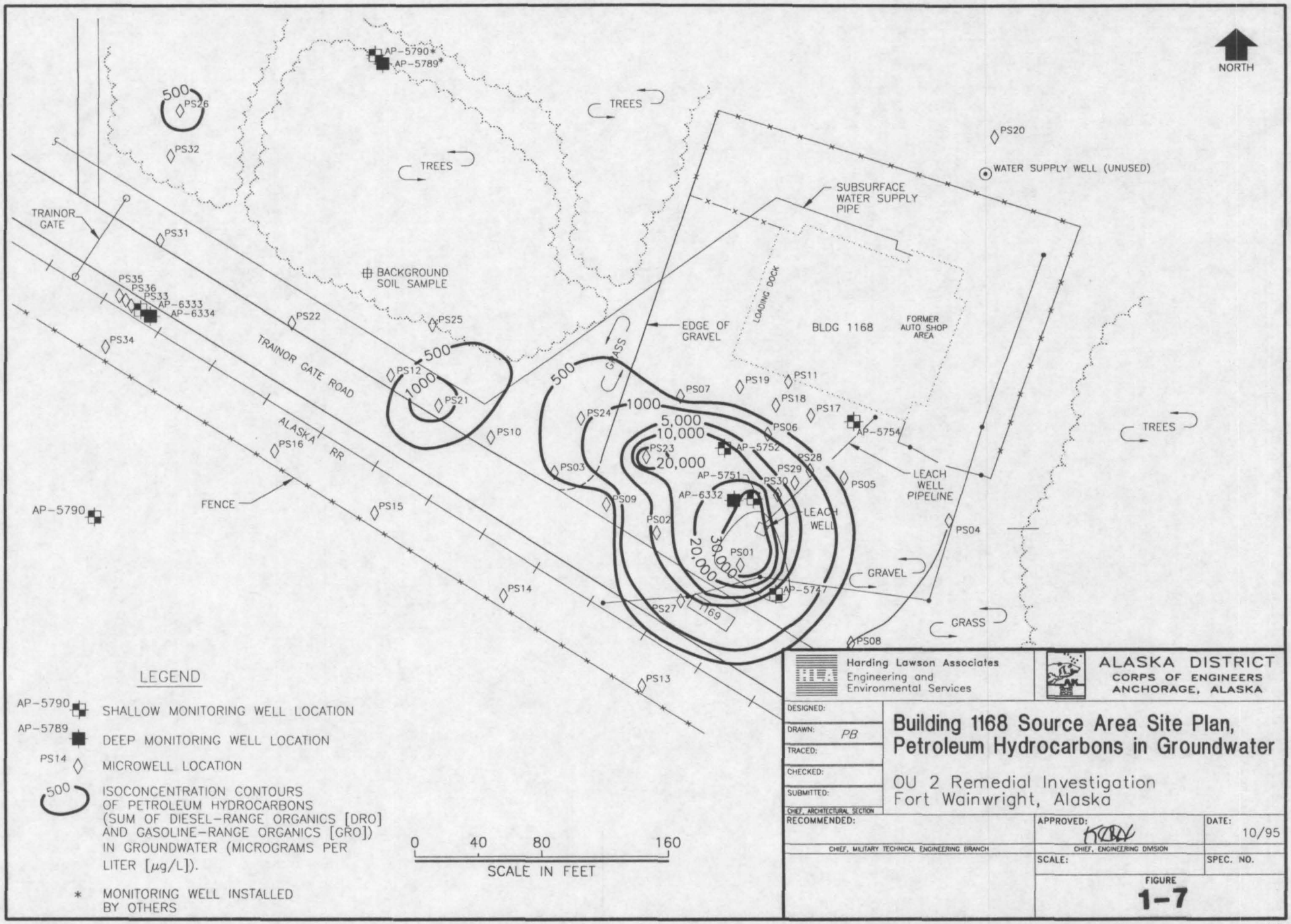
Building 1168 Source Area Site Plan, Groundwater

OU 2 Remedial Investigation
Fort Wainwright, Alaska

DATE: 10/95
SCALE: NOTED
SPEC. NO.

FIGURE
1-6

154b



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Engineering and Environmental Services

ALASKA DISTRICT
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED:
DRAWN: PB
TRACED:
CHECKED:
SUBMITTED:
CHIEF, ARCHITECTURAL SECTION

Building 1168 Source Area Site Plan, Petroleum Hydrocarbons in Groundwater

OU 2 Remedial Investigation
Fort Wainwright, Alaska

RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH

APPROVED:
CHIEF, ENGINEERING DIVISION

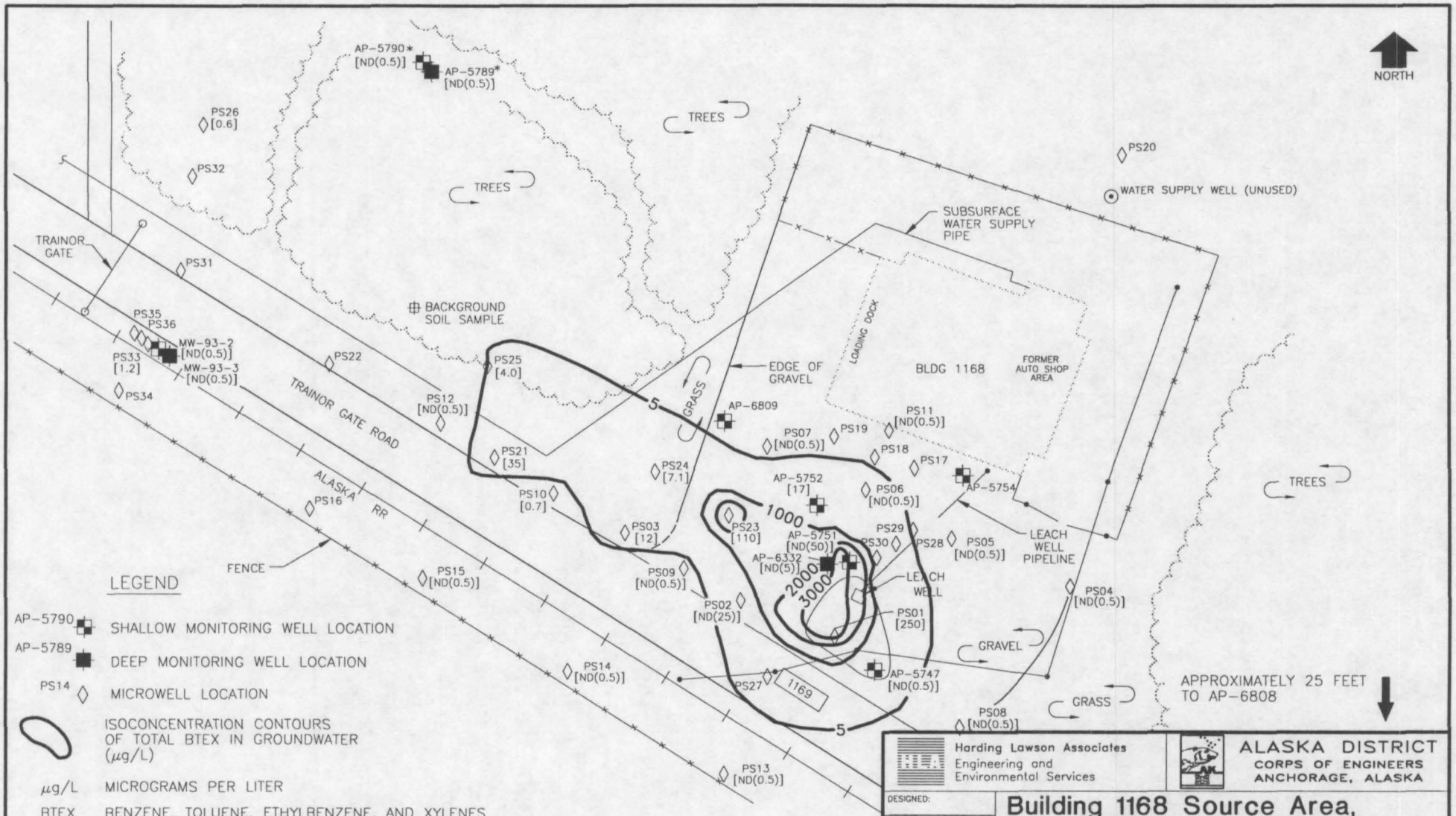
DATE: 10/95

SCALE:

SPEC. NO.

FIGURE
1-7

157b



LEGEND

AP-5790	SHALLOW MONITORING WELL LOCATION
AP-5789	DEEP MONITORING WELL LOCATION
PS14	MICROWELL LOCATION
	ISOCONCENTRATION CONTOURS OF TOTAL BTEX IN GROUNDWATER (µg/L)
µg/L	MICROGRAMS PER LITER
BTEX	BENZENE, TOLUENE, ETHYLBENZENE, AND XYLENES
[250]	BENZENE CONCENTRATIONS REPORTED IN MICROGRAMS PER LITER
ND	NOT DETECTED AT OR ABOVE METHOD REPORTING LIMIT SHOWN IN PARENTHESES
*	MONITORING WELL INSTALLED BY OTHERS

0 40 80 160
SCALE IN FEET

FIGURE DEVELOPED FROM DATA COLLECTED DURING HLA's 1994 OU 2, PRELIMINARY SOURCE EVALUATION 2 SUPPORT WORK, BUILDING 1168.

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Engineering and Environmental Services

ALASKA DISTRICT
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED:
DRAWN: BJ
TRACED:
CHECKED:
SUBMITTED:
CHIEF, ARCHITECTURAL SECTION

Building 1168 Source Area, Total BTEX in Groundwater, Contour Map

OU 2 Remedial Investigation
Fort Wainwright, Alaska

RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH

APPROVED:
CHIEF, ENGINEERING DIVISION

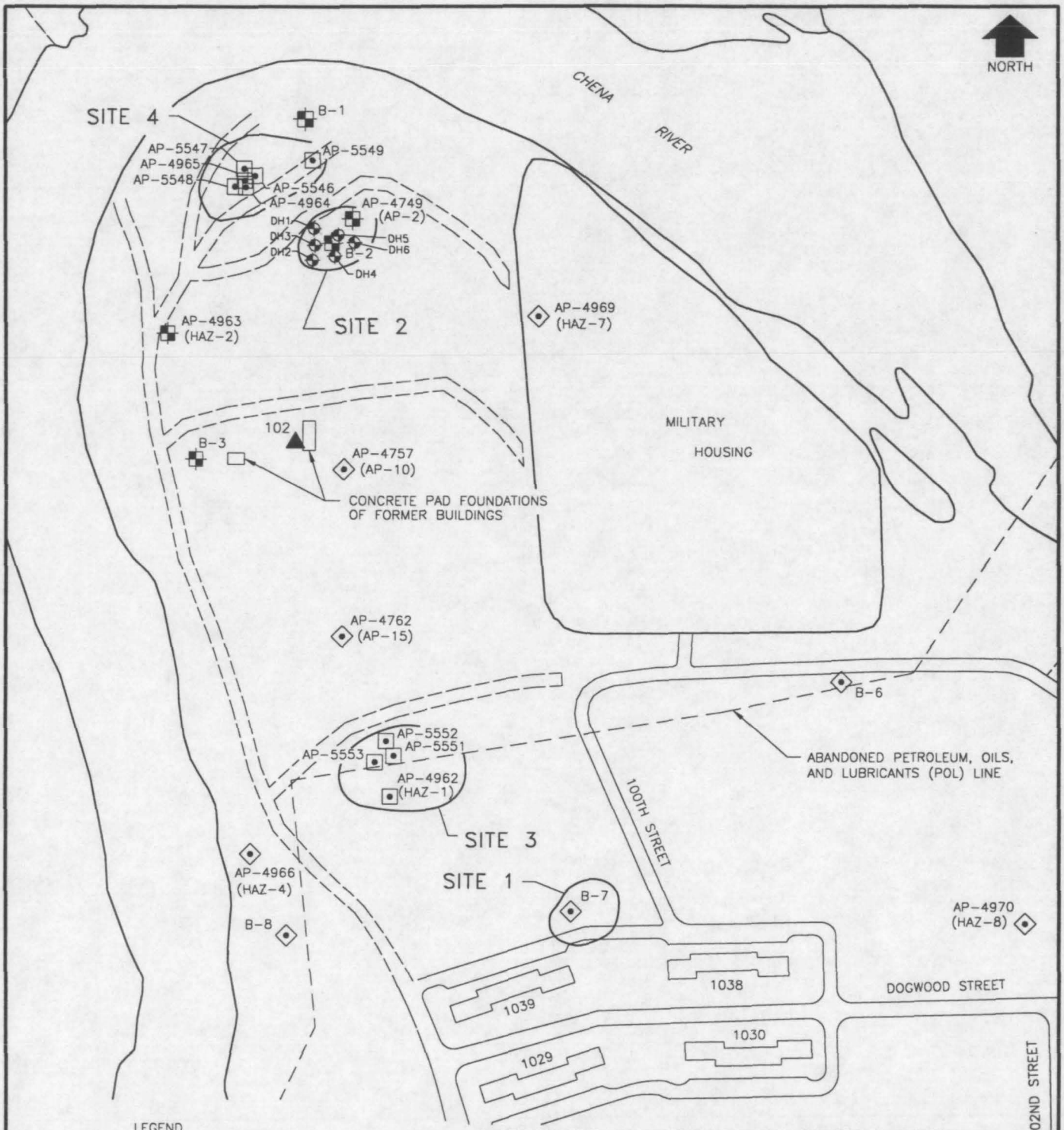
DATE: 10/95

SCALE:

SPEC. NO.

FIGURE 1-8

412b



REFERENCE: FORT WAINWRIGHT ENVIRONMENTAL MONITORING NETWORK REPORT, USACE, 1992.

LEGEND

- B-3 — EXISTING MONITORING WELL LOCATION
- AP-4962 (HAZ-1) — ABANDONED WELL LOCATION
- 102 — SUPPLY WELL
- AP-4970 — REPORTED LOCATION OF MONITORING WELLS NOT FOUND DURING 1993 WELL SURVEY.
- DH1 — APPROXIMATE LOCATIONS OF U.S. ARMY CORPS OF ENGINEERS BORINGS (1989)

0 125 250 500
SCALE IN FEET

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Engineering and Environmental Services

ALASKA DISTRICT
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED:
DRAWN: PB
TRACED:
CHECKED:
SUBMITTED:
CHIEF, ARCHITECTURAL SECTION

North Post Source Area Site Plan

OU 2 Remedial Investigation
Fort Wainwright, Alaska

RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH

APPROVED:
CHIEF, ENGINEERING DIVISION

DATE: 10/95

SCALE: NOTED

SPEC. NO.

FIGURE
1-9

158b

2.0 PHYSICAL CHARACTERISTICS OF THE STUDY AREA

This section describes physiography of the Fort Wainwright main post cantonment area, and surface water, climate, regional geology, regional hydrogeology, and groundwater quality.

2.1 Physiographic Setting

The Fairbanks area consists of two geographic regions: the Yukon-Tanana Upland and the Tanana-Kuskokwim Lowland. The Yukon-Tanana Upland is a northwest-trending highland between the Yukon and Tanana rivers. The Yukon-Tanana Upland is characterized by rolling hills with elevations typically between 500 and 3,000 feet above mean sea level (MSL). South of the Yukon-Tanana Upland is the Tanana-Kuskokwim Lowland, a sediment-filled trough between the upland on the north and the Alaska Range on the south. The Fort Wainwright cantonment area is located on the north side of the Tanana River valley within the Tanana-Kuskokwim Lowland. This region is characterized by flat lowlands and gently rolling hills with elevations ranging from 350 to 950 feet above MSL. Bottomland forests and wetlands are typical in this area (University of Alaska, 1976).

2.2 Climate

Fort Wainwright is located in the continental climate zone of interior Alaska. In general, this zone is characterized by extreme summer and winter temperatures and light precipitation. Surface winds are generally light (University of Alaska, 1976). Precipitation and temperature data are summarized in Tables 2-1 and 2-2, respectively.

Monthly mean temperatures historically range from -10.3 degrees Fahrenheit (°F) to 61.2°F. With an overall mean annual precipitation of 11.15 inches (NOAA, 1991), the region is characterized as semiarid. Approximately 64 percent of the annual precipitation falls from May through September as rain. The remaining precipitation is from snow and ice, with a mean annual snowfall of 54 inches.

During most of the year, the prevailing wind direction is from the north at an average of 5.15 miles per hour (mph). However, in June and July the wind direction is typically from the southwest at an average of 6.9 mph (E&E, 1993). The strongest winds occur in May and June with mean speeds of 7.7 and 7.2 mph, respectively. Because of generally low wind speeds, moderate to heavy ice fog is prevalent in the Fairbanks area during cold weather.

2.3 Surface Water

Fort Wainwright lies within the Tanana and Chena river drainage basins. The Tanana River, approximately 3 miles south of Fort Wainwright, generally flows in a westerly direction. The river is a silt-laden, highly braided, glacial stream that joins the Yukon River approximately 130 miles west of Fort Wainwright. The Chena River flows through the northern portion of the Fort Wainwright main cantonment area and joins the Tanana River approximately 8 miles west-southwest of Fort Wainwright. The Chena River drains an area of approximately 2,000 square miles.

Based on U.S. Geological Survey (USGS) records, the average discharge for the Chena River at Fairbanks over a 42-year recording period was 1,371 cubic feet per second (cfs) with a daily mean discharge of 1,292 cfs. The average discharge for the Tanana River at Fairbanks over a 17-year recording period was 19,970 cfs (E&E, 1993).

Prior to flow regulation, the Chena River had a history of rapidly fluctuating flow rates during the flood season. At normal and low stages during the winter when precipitation is stored as ice and snow, the Chena River appears to be an influent system, with groundwater flowing into it. Conversely, at high stages during the spring months when rainfall is augmented by melting snow and ice, the river is presumed to be

Table 2-1. Monthly Precipitation Averages for Fort Wainwright[a]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Record Mean	0.68	0.45	0.42	0.28	0.65	1.38	1.85	2.14	1.03	0.88	0.70	0.69	11.15

a. Precipitation in inches

Source: NOAA, 1991

Table 2-2. Monthly Average Temperature for Fort Wainwright[a]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Record Mean	-10.3	-3.5	9.9	30.3	48.0	59.2	61.2	55.6	44.7	25.6	2.9	-7.9	26.4
Maximum	-1.4	7.7	23.3	41.4	59.1	70.4	71.8	65.7	54.2	33.1	11.1	0.4	36.4
Minimum	-19.2	-14.6	-3.5	19.2	36.8	48.0	50.6	45.6	35.2	18.2	-5.3	-16.1	16.3

a. Average temperature measured in degrees Fahrenheit.

Source: NOAA, 1991.

Note: Record period is 1962 through 1991.

effluent, discharging into groundwater and producing changes in local groundwater flow direction, water-table levels, and velocities (University of Alaska, 1976).

Chemical analysis of Chena River water shows that trace metals are normally within acceptable and typical concentrations. Iron is the only element that may occasionally exceed the EPA-recommended concentration of 300 μg/L for drinking water. High iron content is prevalent in the lower elevations of the river and may result from the reducing conditions of marshy areas (E&E, 1993). According to USGS unpublished data, the average concentrations of iron and manganese during the past 20 years in the portion of the Chena River from the vicinity of North Pole to Fort Wainwright are approximately 286 μg/L and 48 μg/L dissolved, respectively. Because the Chena River is not fed by glaciers, the concentrations of suspended solids are relatively low.

Surface-water runoff from each of the Fort Wainwright OU 2 source areas eventually drains to the Chena River. Groundwater beneath OU 2 source areas may also recharge the Chena River or its tributaries.

2.4 Regional Geology

The Yukon-Tanana Upland is a complex terrain of Precambrian and Paleozoic metamorphic rocks that have been extensively intruded by igneous rocks of Mesozoic to Tertiary age. The metamorphic assemblage extends southward beneath the Tanana-Kuskokwim Lowland to the Denali fault system in the Alaska Range, and northward to the Yukon flats and the Tintina fault zone. The Tintina and Denali faults separate the metamorphic rocks of the Yukon-Tanana Upland from relatively unmetamorphosed rocks to the north and south, respectively (Foster, et al, 1987).

In the Tanana-Kuskokwim Lowland, the metamorphic basement is overlain by several hundred feet of unconsolidated Quaternary sediment consisting primarily of glacial outwash and fluvial deposits. Although this part of Alaska was not covered by ice sheets during the Pleistocene epoch, alpine glaciers occupied the Alaska Range and the high peaks of the Yukon-Tanana Upland. Substantial quantities of outwash were deposited in the valleys and reworked by streams and wind (Foster, et al, 1987).

In the uplands north of the Chena River, metamorphic bedrock is at or near the ground surface. Principal rock types include well-foliated gneiss and schist, weathered to varying depths. Observations made in rock cuts, quarries, and well logs indicate that fracture spacing and orientation are highly variable.

Most of Fort Wainwright, including the main cantonment area, lies within the lowlands of the river basin, where a surficial layer of fine-grained soil overlies deeper alluvial deposits. The surficial-soil layer is generally less than 5 feet thick. The alluvial floodplain deposits beneath the surficial soil consist of varying proportions of sand and gravel, which are commonly layered. Silt is generally found intermixed with the alluvium at percentages up to approximately 10 percent.

The Fort Wainwright area is underlain by discontinuous permafrost of generally low ice content in nonorganic soil. The ice is typically restricted to pore spaces and thin ice seams in silt and clay. The depth to permafrost, when present, ranges from 2 to 40 feet below ground surface. The greater depths are found on cleared and developed land surfaces where thermal degradation of underlying permafrost is occurring. The thicknesses of the permafrost intervals vary from approximately 5 to 275 feet. The seasonal frost layer (or active layer) also varies in thickness and is typically between 2 to 12 feet (E&E, 1993). A map showing surficial geology and permafrost locations for Fort Wainwright is presented on Figure 2-1 (USGS, 1975).

2.5 Regional Hydrogeology

The main aquifer in the Fort Wainwright area is the Tanana basin alluvium. The aquifer ranges from a few feet thick at the base of Birch Hill to at least 300 feet thick under the main cantonment area, and may reach thicknesses to 700 feet in the Tanana River valley (E&E, 1993). The aquifer is considered unconfined in permafrost-free areas.

The water table is generally encountered within 10 to 20 feet below ground surface and reportedly flows west-northwest, similar to the flow direction of the Chena and Tanana rivers (USACE, 1991a). A regional groundwater flow map for Fort Wainwright is presented on Figure 2-2. According to the USACE's Groundwater Monitoring Network report (1991a), the hydraulic gradient across the post on the south side of the Chena River ranges from about 0.0015 to 0.0005 foot per foot during periods of normal summer flow, and values of hydraulic conductivity on the order of 1×10^{-1} centimeters per second or greater are common.

Where present, permafrost forms discontinuous confining layers that influence groundwater movement and distribution. The presence of near-surface permafrost usually restricts groundwater movement within the shallow subsurface. Groundwater flow on the north side of the Chena River appears to be highly influenced by permafrost bodies (USACE, 1991a).

2.6 Groundwater Quality

Naturally occurring chemical concentrations in Fairbanks and Fort Wainwright area groundwater are generally below the maximum contaminant levels (MCLs) established by the National Primary Drinking Water Regulations (NPDWR) and the National Secondary Drinking Water Regulations (NSDWR). However, naturally occurring levels of metals including iron and arsenic above MCLs are not uncommon.

In a study performed by the USGS, water samples from domestic and observation wells located upgradient (east-southeast) of Fort Wainwright were characterized for chemical constituents. The samples were analyzed for iron, hardness, arsenic, nitrate, chloride, phosphorus, sulfate, and fecal coliform. Iron was found at concentrations exceeding the NSDWR MCL of 0.3 milligrams per liter (mg/L). Iron concentrations ranged from 0.07 mg/L to 73 mg/L, with an average of 8.37 mg/L (Krumhardt, 1982).

Elevated arsenic levels in groundwater are prevalent in upland areas around Fairbanks. During a well sampling survey performed by the USGS in the Chena Hot Springs Road, Steele Creek Road, and Gilmore Trail areas located north-northwest of Fort Wainwright, arsenic concentrations were found to range from 0 to 5,100 µg/L. Arsenic concentrations in ground-water from 13 percent of the sampled wells exceeded the 50 µg/L NPDWR MCL (Krumhardt, 1982).

Barium and chromium are reportedly naturally present in Fairbanks groundwater (EMCON, 1994). Background lead concentrations in Fort Wainwright groundwater are also believed to result from natural processes (USACE, 1994).

Geologic explanations have been formulated for naturally occurring concentrations of arsenic, barium, and lead in groundwater. Those metals have been found, along with cadmium and chromium, in rock samples taken from a quarry near Fort Wainwright (USACE, 1994).

The USACE began systematically sampling Fort Wainwright monitoring wells in 1989. The majority of the wells were in developed areas south of the Chena River. The USACE's Groundwater Monitoring Network report (1993) includes the following findings:

- Groundwater from 15 wells contained concentrations of various metals at levels exceeding NPDWR MCLs. Lead, chromium, arsenic, and barium were the predominant metals found above MCLs.
- Groundwater from 11 wells contained significant amounts of VOCs (particularly BTEX). Gasoline, diesel, jet fuel, and solvents were present in the groundwater samples from some wells.

In addition, the USACE's 1994 Groundwater Monitoring Network Report (EMCON, 1994) provides details on the following findings:

- Petroleum hydrocarbons in water samples from wells at OUs 1, 2, and 3, and from wells at several UST sites on Fort Wainwright.
- VOC concentrations above NPDWR MCLs in groundwater samples from OUs 1, 2, and 3, and UST sites.

- Naphthalene, 2-methylnaphthalene, fluorene, acenaphthalene, and phenanthrene in groundwater samples from OUs 1, 2, and 3, and UST sites. (These compounds are fuel-related and are typically detected when other fuel-related compounds are present.)
- Bis-(2-Ethylhexyl)phthalate exceeding the 6 µg/L NPDWR MCL in samples from wells at OU 3 and UST sites, and from the picket wells installed to monitor groundwater at the northwest boundary of Fort Wainwright in 1992.
- A chlorinated herbicide in groundwater from one well at OU 1.
- Metal concentrations above the limits established by the NPDWR and the NSDWR in samples from wells at OUs 1, 2, 3, and the UST sites, and from the picket wells.
- The absence of PCBs and OPP in groundwater samples from the wells included in the report.

2.7 Ecological Setting

Fort Wainwright lies within the boreal forest ecosystem typical of the broad geographic lowland that covers interior Alaska. Vegetation and wildlife that characterize the boreal forest ecosystem of Fort Wainwright are discussed below.

2.7.1 Vegetation

Vegetation distribution within the boreal forest is determined by several factors including slope, aspect, past fire history or other disturbance, and the hydrologic regime including presence or absence of permafrost. This section discusses the main vegetation types expected to occur within the boreal forest of Fort Wainwright under the two general categories of upland and wetland. This section also discusses potential sensitive plant species that may be present, and provides a plant species list for Fort Wainwright.

Upland Vegetation

The following description of upland vegetation is based on observations made during the OU 2 RI and references that discuss plant community structure in interior Alaska (Viereck, et al, 1972 and 1986; Hulten, 1968) or in the Fairbanks area (Spindler, 1976).

Upland vegetation of the boreal forest is characterized by spruce-hardwood stands that occur on warm, dry, south-facing hillsides and adjacent to rivers where permafrost is absent. Dominant tree species are white spruce (*Picea glauca*) and paper birch (*Betula papyrifera*); common shrubs include prickley rose (*Rosa acicularis*), labrador tea (*Ledum groenlandicum*), buffaloberry (*Shepherdia canadensis*), high bush cranberry (*Viburnum edule*), and several species of willow (*Salix* spp.). As a result of fires or other disturbances, the spruce-hardwood forest may be characterized by other dominant tree species under various stages of forest succession. Quaking aspen (*Populus tremuloides*) appeared in upland areas on south-facing slopes following fire and an initial willow stage. Paper birch is the common invading tree after disturbance on east- and west-facing slopes and occasionally on north slopes and flat areas. Balsam poplar (*P. balsamifera*) invades sandbars on floodplains and glacial outwashes.

Wetland Vegetation

Wetland vegetation in the Fort Wainwright area is described below on the basis of field observations made during the August 1994 field survey; references describing plant community structure in interior Alaska and the Fairbanks area (Viereck, et al, 1972); USACE wetland boundary maps (1986); U.S. Fish and Wildlife Service (USFWS) National Wetland Inventory maps (1992); and *Classification of Wetlands and Deepwater Habitats of the United States* (USFWS, 1979).

The five main types of wetlands present at Fort Wainwright are black spruce forest, black spruce scrub, willow-alder thicket, tussock low shrub bog, and persistent emergent. These five wetland types, which are labeled on the basis of vegetation dominants by which they are locally characterized, correspond to the broader wetland classifications used by the USFWS (1979; 1991) and the USACE (1986) of 1) palustrine forested needle-leaved evergreen saturated (PFO4B);

2) palustrine scrub-shrub needle-leaved evergreen saturated (PSS4B); 3) palustrine scrub-shrub broad-leaved deciduous seasonally flooded (PSS1C); 4) palustrine scrub-shrub broad-leaved deciduous/emergent narrow-leaved persistent saturated (PSS1/EM5B); and 5) palustrine emergent narrow-leaved persistent saturated (EM5B).

On north-facing slopes and poorly drained lowlands, forest succession leads to open stands of black spruce trees (greater than 20 feet in height) that are usually underlain by permafrost. The black spruce are slow growing and seldom exceed 8 inches in diameter. A thick moss mat, often of peat moss (*Sphagnum* spp.), sedge, grass, and ericaceous shrub such as bog cranberry (*Oxycoccos microcarpus*) and dwarf blueberry (*V. caespitosum*) make up the understory of the black spruce stands. Tamarack (*Larix larcina*), another slow-growing tree species, is often associated with black spruce in the wet bottomlands.

The black spruce scrub wetland is dominated by stunted black spruce trees that typically do not exceed 20 feet in height. The black spruce scrub wetland occurs in areas underlain by permafrost that are wetter than the areas that support black spruce forests. Subordinate plants include dwarf birch (*Betula nana*), cottongrass (*Eriophorum vaginatum*), bog blueberry (*Vaccinium uliginosum*), labrador tea, and peat moss. This wetland type is commonly referred to as muskeg.

Willow-alder thickets typically occur on alluvial deposits along streams and rivers and in other locations that are periodically flooded. Willow-alder thickets in the vicinity of Fort Wainwright are dominated by several species of willow and alder including bebb willow (*Salix bebbiana*), park willow (*S. monticola*), tall blueberry willow (*S. novae-angliae*), diamondleaf willow (*S. planifolia* ssp. *pulchra*), thinleaf alder (*Alnus tenuifolia*), sitka alder (*A. sinuata*), and American green alder (*A. crispa*).

Tussock low shrub bogs in the vicinity of Fort Wainwright are locally characterized by cottongrass, which forms into humps or tussocks as high as 3 feet in some locations. Stunted paper birch, thinleaf alder, black spruce, shrub birch (*Betula glandulosa*), diamond-leaf willow, little tree willow (*S. arbusculoides*), and barren-ground willow (*S. brachycarpa* subsp. *niphoclada*) are the most common stunted trees or tall shrubs interspersed throughout this wetland type. Lower shrubs include dwarf birch, lingonberry (*Vaccinium vitis-idaeas*), bog blueberry, and labrador tea. Sedge marsh may also be present within these bogs.

The persistent emergent wetland is dominated by grasslike species that normally remain standing at least until the beginning of the next growing season. Locally, sedges including *Carex aquatilis*, *C. rostrata*, and others dominate the persistent emergent wetlands that occur along the rivers and channels in seasonally and semipermanently flooded locations, and in saturated areas.

Sensitive Plant Species

The Alaska Natural Heritage Program (AKNHP) was contacted to identify the potential presence of sensitive plant species at or near OU 2 source areas. The AKNHP maintains a database inventory that contains specimen collection and sighting locations of sensitive plant (and animal) species statewide. Sensitive plant species include federally listed threatened and endangered species, candidate species for threatened or endangered listing, and species that do not have regulatory status but are considered of special concern by the state or scientific community. A search of the AKNHP database showed that no records of federally listed threatened, endangered, or candidate plants are on file for the Fairbanks area.

The USFWS Northern Ecological Services office in Fairbanks was also contacted regarding federally threatened, endangered, and candidate plants. They concurred with the AKNHP that no sensitive plant species are known to be present in the Fairbanks area.

2.7.2 Wildlife

Upland vegetation provides terrestrial habitat for large numbers of birds and mammals. Rivers, channels, and ponds provide aquatic habitat for various fish species, waterfowl, and benthic

organisms. This section discusses common terrestrial and aquatic wildlife known to occur at Fort Wainwright, as well as sensitive animal species that are potentially present.

Terrestrial Wildlife

Terrestrial wildlife species that occur at Fort Wainwright include a variety of mammals and birds. Of the 36 species of mammals listed by Kerns (1993) as potentially occurring at Fort Wainwright, 17 are indicated as common inhabitants. Moose (*Alces alces*) are probably the most abundant and widespread large mammal in the area, feeding primarily on willows and other shrubs. Although black bear (*Ursus americanus*) and grizzly bear (*U. arctos*) have been sighted on base, their occurrence is considered rare to very rare. The red fox (*Vulpes vulpes*) is the most common of the canids; grey wolf (*Canis lupus*) and coyote (*C. latrans*) are considered rare to uncommon. Other mammals that commonly occur at Fort Wainwright include shrews (*Sorex* spp.), pine martens (*Martes americanas*), woodchuck (*Marmota monax*), red squirrel (*Tamiasciurus hudsonicus*), beaver (*Castor canadensis*), deer mouse (*Peromyscus maniculatus*), lemming (*Lemmus trimucronatus*), and snowshoe hare (*Lepus americanus*). Several species of vole (*Microtus* spp.) inhabit the area; the northern red-backed vole (*Clethrionomys rutilus*) is considered the most common small mammal at Fort Wainwright (Kerns, 1993).

More than 150 bird species including waterfowl, raptors, game birds, perching birds, and others are known to migrate through or reside in the Fairbanks area (Kerns, 1993; Spindler, 1976). Breeding waterfowl species include mallard (*Anas platyrhynchos*), pintail (*A. acuta*), green-winged teal (*A. crecca*), American widgeon (*A. americana*), northern shoveler (*Anas clypeata*), red-necked and horned grebes (*Podiceps grisegena and P. auritus*), lesser scaup (*Aythya affinis*), and bufflehead (*Bucephala albeola*). The only resident hawk is the northern goshawk (*Accipiter gentilis*), but several others including sharp-shinned (*A. striatus*), red-tailed (*Buteo jamaicensis*), and marsh hawk (*Circus cyaneus*) nest and breed in the area. Bald eagle (*Haliateetus leucocephalus*) nesting sites are known to occur along the Tanana River.

Spruce grouse (*Canachites canadensis*), ruffed grouse (*Bonasa umbellus*), and willow and rock ptarmigan (*Lagopus lagopus and L. mutus*) are regional residents that survive the winters by feeding on willow, birch, and spruce buds, and berries left from the past summer. Other common resident birds include the rock dove (*Columba livia*); great-horned, boreal, and hawk owls (*Bubo virginianus, Aegolius funereus*, and *Surnia ulula*); hairy and downy woodpeckers (*Picoides villosus* and *P. pubescens*); the gray jay (*Perisoreus canadensis*); black-capped and boreal chickadees (*Parus atricapillus* and *P. hudsonicus*); the northern shrike (*Lanius excubitor*); and the pine grosbeak (*Pinicola enucleator*).

Reptiles are absent from interior Alaska, and amphibians are rare because few have adapted to the long, harsh winters and dry summers. While several species of salamanders, newts, toads, and frogs inhabit southeast Alaska, only the wood frog (*Rana sylvatica*) is known to occur throughout most of the state including the Fairbanks area (Hodge, 1976).

Terrestrial invertebrates regionally present include mosquitoes, flies, ants, bees, wasps, beetles, spiders, mites, and nematodes. Much of the diversity of birds in summer depends on the abundance of insects, spiders, and mites for food. Saw flies, which feed on willows, are one of the most numerous insects in Alaska (University of Alaska, 1976).

Aquatic Wildlife

The Chena River is an important aquatic habitat and sport fishery in the region. Unlike the glacial-fed Tanana River for which it is a tributary, the Chena River is clear, supporting numerous fish species including arctic grayling (*Thymallus arcticus*), burbot (*Lota lota*), humpback whitefish (*Coregonus pidschian*), sheefish (*Stenodus leucichthys*), lake chub (*Couesius plumbeus*), least cisco (*Coregonus sardinella*), longnose sucker (*Catostomus catostomus*), northern pike (*Esox lucius*), round whitefish (*Prosopium*

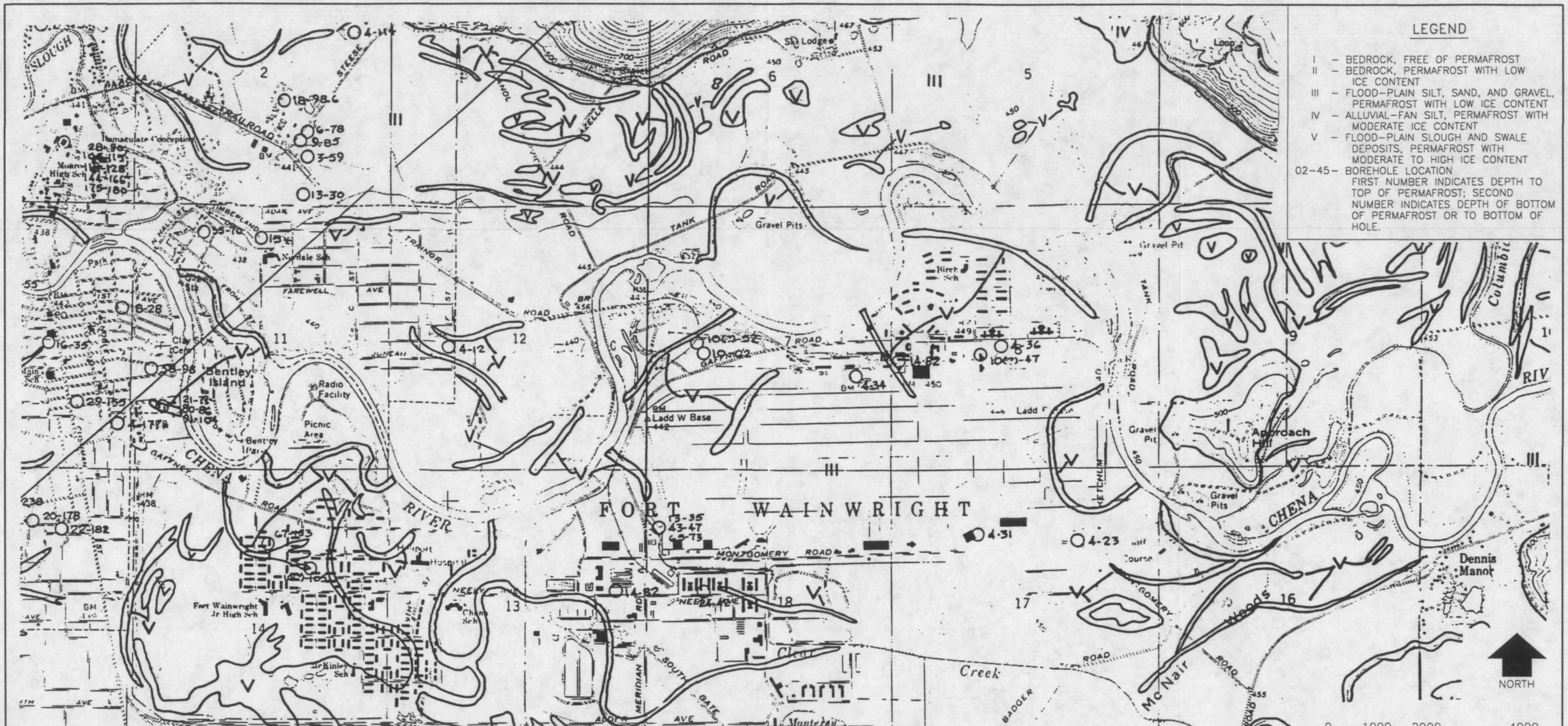
cylindraceum), slimy sculpin (*Cottus cognatus*), and arctic lamprey (*Lampetra japonica*). Anadromous species that migrate upstream from the ocean to spawn in the clear waters of the Chena include chum salmon (*Oncorhynchus keta*), silver salmon (*O. kisutch*), and the largest of all salmons, the king salmon (*O. tshawytscha*).

Sensitive Animal Species

The AKNHP and the USFWS Northern Ecological Services offices were contacted regarding the potential presence of federally listed threatened, endangered, or candidate animal species in the Fairbanks area. The AKNHP indicated the potential presence of the federally endangered peregrine falcon (*Falco peregrinus*), the federally threatened arctic peregrine falcon (*F. columbarius*), and four species that are Category 2 candidates for listing as federally threatened or endangered species: North American lynx (*Felis lynx canadensis*), harlequin duck (*Histrionicus histrionicus*), northern goshawk, and olive-sided flycatcher (*Contopus borealis*). Category 2 candidates are taxa for which there is some evidence of vulnerability, but for which there are not enough data to support listing proposals (USFWS, 1991).

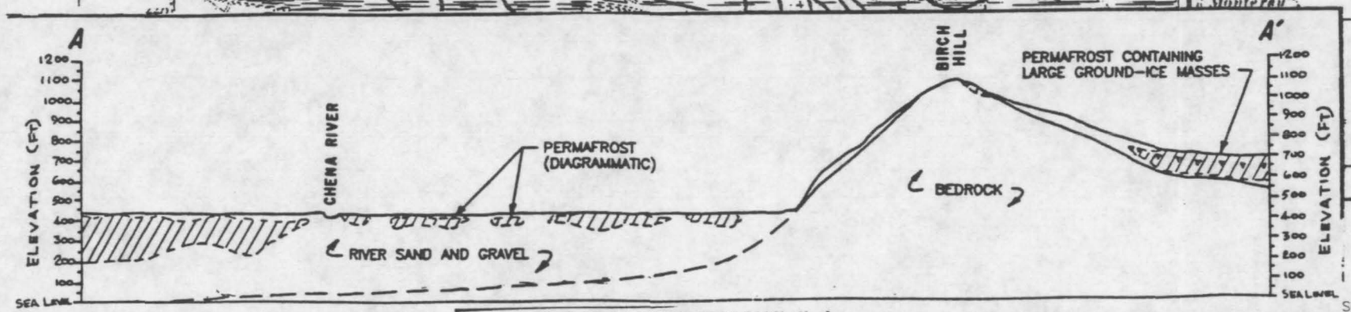
The USFWS indicated that the peregrine falcon has several nesting sites along the Tanana River, but the arctic peregrine falcon is present in the general area only during migration. The North American lynx is a candidate for listing because populations are declining in the lower 48 states; however, its populations in Alaska are stable. The harlequin duck is a coastal species that is not expected to occur near Fairbanks. The northern goshawk is a resident species in the Fairbanks area. The olive-sided flycatcher is a breeding species in Fairbanks that nests in open woods or clearings near woodlands. Neither the northern goshawk or the olive-sided flycatcher is considered particularly vulnerable in the Fairbanks area. The USFWS also indicated that the bald eagle, which is protected in Alaska under the Eagle Protection Act, has several nesting sites along the Tanana River near Fairbanks.

The State of Alaska Department of Fish and Game was contacted to identify any state-listed threatened or endangered species, or special concern species that potentially inhabit the Fairbanks area. The state-listed endangered species in Alaska include three whales and two birds, all coastal or off-shore species. An administrative list of state species of special concern was established to compliment the Alaska endangered species list. This list includes any species or subspecies of fish or wildlife native to Alaska that have entered a long-term decline due to low numbers, restricted distribution, dependence on limited habitat resources, or sensitivity to environmental disturbance. Three birds that occur in the Fairbanks area and possibly at Fort Wainwright that are on the state species of special concern list include the olive-sided flycatcher, the gray-cheeked thrush (*Catharus minimus*), and the Townsends warbler (*Dendroica townsendii*).



LEGEND

I – BEDROCK, FREE OF PERMAFROST
II – BEDROCK, PERMAFROST WITH LOW ICE CONTENT
III – FLOOD-PLAIN SILT, SAND, AND GRAVEL, PERMAFROST WITH LOW ICE CONTENT
IV – ALLUVIAL-FAN SILT, PERMAFROST WITH MODERATE ICE CONTENT
V – FLOOD-PLAIN SLOUGH AND SWALE DEPOSITS, PERMAFROST WITH MODERATE TO HIGH ICE CONTENT
02-45 – BOREHOLE LOCATION FIRST NUMBER INDICATES DEPTH TO TOP OF PERMAFROST; SECOND NUMBER INDICATES DEPTH OF BOTTOM OF PERMAFROST OR TO BOTTOM OF HOLE.



VERTICAL EXAGGERATION X 4

GENERALIZED CROSS SECTION

SOURCE: U.S. GEOLOGICAL SURVEY MAP SHOWING DISTRIBUTION OF PERMAFROST IN THE FAIRBANKS D-2 SE QUADRANGLE, ALASKA 1975-0-690-036/58

Harding Lawson Associates
Engineering and Environmental Services

ALASKA DISTRICT
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

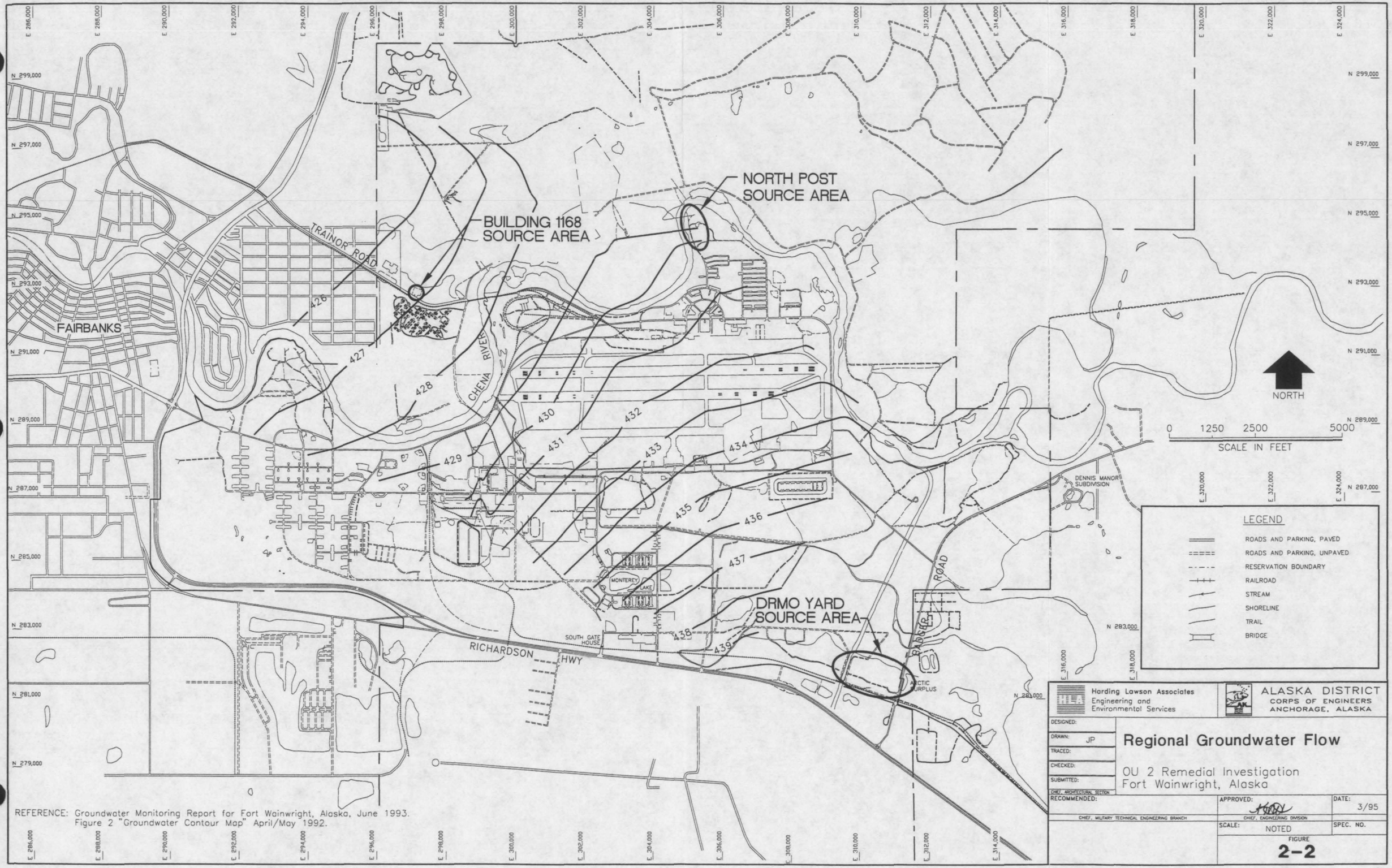
DESIGNED:	
DRAWN: JP	
TRACED:	
CHECKED:	
SUBMITTED:	
CHIEF, ARCHITECTURAL SECTION	
RECOMMENDED:	APPROVED: DATE: 3/95
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH	CHIEF, ENGINEERING DIVISION
	SCALE: NOTED / SPEC. NO.

Surficial Geology Map

OU 2 Remedial Investigation
Fort Wainwright, Alaska

FIGURE 2-1

152b



Regional Groundwater Flow

OU 2 Remedial Investigation
Fort Wainwright, Alaska

REFERENCE: Groundwater Monitoring Report for Fort Wainwright, Alaska, June 1993. Figure 2 "Groundwater Contour Map" April/May 1992.

3.0 STUDY AREA INVESTIGATION

Field operations in support of the RI were performed in accordance with HLA's OU 2 RI/FS management plan (1994b).

3.1 Objectives of the Field Investigation

The objectives of the field portion of the RI were as follows:

- Assess the nature and extent of surface- and subsurface-soil contamination at each source area within OU 2.
- Evaluate groundwater flow direction and hydraulic characteristics.
- Assess the nature and extent of groundwater contamination.
- Assess the nature and extent of sediment and surface-water contamination.
- Evaluate groundwater/surface-water interaction as they impact each site.
- Collect sufficient data to evaluate remedial action alternatives and implement interim remedial actions.
- Collect sufficient data to assess human health and ecological risks.

3.2 Sampling Strategy

The sampling strategy for the field investigation was to:

- Conduct a geophysical survey to assess the burn pit areas at DRMO yard and North Post Site 2 source areas.
- Collect surface- and subsurface-soil samples in areas of known and suspected contamination at DRMO yard and North Post source areas.
- Install groundwater probes and monitoring wells, and collect groundwater samples to assess areas of impacted groundwater at DRMO yard and North Post source areas.
- Collect sediment and surface-water samples in drainages adjacent to areas of known and suspected contamination at the DRMO yard source area.
- Estimate hydraulic characteristics of impacted acquifer(s) at DRMO yard, Building 1168, and North Post source areas.
- Evaluate physical parameters of site surface and subsurface soil at DRMO yard, Building 1168, and North Post source areas.
- Sample soil and groundwater at DRMO yard, Building 1168, and North Post source areas for laboratory testing for treatability parameters.
- Collect background soil and groundwater samples from DRMO yard, Building 1168, and North Post source areas.

The potential contaminants of concern at the three sites included DRO, GRO, VOCs, SVOCs, dioxins/furans, metals, PCBs and pesticides.

3.3 Analytical Methods

Media sampled during the OU 2 RI included surface and subsurface soil, groundwater, surface water, and sediment. The following analytical methods were used:

- DRO was analyzed by gas chromatography (GC) using the ADEC's modification of EPA Method SW-8100.
- GRO was analyzed by GC using the ADEC's modification of EPA Method SW-8015.
- VOCs were analyzed by GC/mass spectrometry (MS) using EPA Method SW-8260.
- SVOCs were analyzed by GC/MS using EPA Method SW-8270.
- Dioxins and furans were analyzed by GC/MS using EPA Method SW-8290.

- PCBs/organochlorine pesticides (OCP) were analyzed by GC using EPA Method SW-8080.
- OPPs were analyzed by GC/MS using EPA Method SW-8140.
- Metals were extracted (acid digestion) by EPA Methods SW-3010 and SW-3050. Arsenic was analyzed by graphite furnace atomic absorption (GFAA) using EPA Method SW-7060. Hexavalent chromium was analyzed by chelation extraction atomic absorption (CEAA) using EPA Method SW-7197. Mercury was analyzed by cold vapor atomic absorption (CVAA) using EPA Method SW-7470. Selenium was analyzed by GFAA using EPA Method SW-7740. Lead was analyzed by GFAA using EPA Method SW-7421. Barium, cadmium, chromium, thallium, and silver were analyzed by inductively coupled plasma (ICP) using EPA Method SW-6010.
- Total organic carbon (TOC) was analyzed using a modification of American Society for Testing and Materials (ASTM) Method D 4129-82M.
- Grain size distribution was measured using ASTM Methods D 421 and D 422. The specific gravities of soil solids were measured using ASTM Method D 854. Moisture contents were measured using ASTM Method D 2216.

3.4 Geophysical Survey

Surface geophysical surveys were conducted at all groundwater probe and soil boring locations, at the burn pit areas at the DRMO yard, and at Site 2 of the North Post source area. The purpose of the surveys were to clear boring/probe locations for buried utilities or other obstructions at the OU 2 source areas, and to locate the former fire burn pits at the DRMO yard and North Post source areas. Geophysical methods used included ground-penetrating radar (GPR), electromagnetic profiling (EM), and use of a buried pipe and cable locator. General geophysical procedures were as follows:

- Equipment was checked and calibrated to local site conditions.
- A grid of perpendicular survey transects was established over the investigation area. Two perpendicular transects crossed at the boring location for boring clearance.
- If utilities were exposed in the vicinity, the buried pipe and cable locator was used to trace them.
- Subsurface conditions along the survey transects were investigated using GPR and EM.
- Pertinent information was recorded and documented in a field notebook.

The results of geophysical survey data generated during the OU 2 RI are discussed in section 8.5 and presented in Appendix E.

3.4.1 Ground-Penetrating Radar

GPR, which uses radar technology to obtain a continuous high-resolution profile of the subsurface, consists of a pulse generator, a transmitting and receiving antenna, and a graphic recorder. GPR transmits a signal that is coupled to the earth by the antenna. When a subsurface signal encounters a boundary between media with different electrical properties (e.g., soil and drums), a portion of the wave energy is reflected back to the surface, detected by the antenna, amplified, and printed on a graphic recorder.

During the investigation, the recorder was positioned in a support vehicle. The antenna was attached to the recorder by a 100-foot cord and manually pulled over the ground surface.

3.4.2 Electromagnetic Profiling

EM profiling involves transmitting a primary signal that is inductively coupled to the earth. Secondary signals are generated in the ground, and both the primary and secondary fields are detected by the EM receiver. The EM instrument is an inductive terrain conductivity meter that is sensitive to buried metal objects such as drums and cables. Metal objects are electrically conductive compared to native soil and, therefore,

produce anomalous readings in measured conductivity values. EM profiling does not give specific information about the depth to buried objects, but is effective in defining horizontal position.

3.4.3 Buried Pipe and Cable Detection

A buried pipe and cable locator was used during the investigation. The locator comprised a hand-carried receiver that detects EM signals rising from the electric current flow on buried linear conductors. Two types of signals can be passively detected by the locator: those resulting from power lines and those associated with metal pipes that reradiate ambient radio signals. In the active mode, a transmitter unit can generate an 8- or 33-kilohertz (KHz) signal that can be inductively coupled to subsurface pipes or cables, or directly connected to pipes that extend to the surface. The resulting signals are traced on the surface with a receiver.

3.5 Surface-Soil Investigations

3.5.1 Sampling Methodology

Surface-soil samples were collected as grab samples from an interval of approximately 0 to 6 inches. The samples were collected using a stainless steel hand trowel, and were homogenized in decontaminated stainless steel bowls before being placed into sample jars. Any observations made during sampling, such as odor or sheen, were recorded in the field log. Surface-soil samples from the 0- to 2-foot depth interval were also collected from each soil boring (section 3.7.1).

3.5.2 Surface-Soil Sample Locations by Source Area

DRMO Yard Source Area

Surface-soil grab samples (0 to 6 inches) were collected from randomly selected locations at the DRMO yard source area. A grid consisting of 100 node points evenly spaced across the area was established. Five random numbers were generated and surface-soil grab samples were collected at the corresponding node points (001 through 005). A total of 78 surface-soil samples (0 to 2 feet below ground surface) were also collected from soil borings (AP-6730 through AP-6799 and AP-6801), and from monitoring wells (AP-6799, AP-6800, and AP-6802 through AP-6807) at the DRMO yard source area. A summary of surface-soil samples collected is presented in Table 3-1. Surface-soil sample locations are shown on Figure 3-1.

Building 1168 Source Area

One surface-soil sample (0 to 2 feet below ground surface) was collected from one soil boring (AP-6808) at the Building 1168 source area. Boring AP-6809 was completed as a groundwater level monitoring well under the direction of CRREL. The surface-soil sample collected at the Building 1168 source area is presented in Table 3-1. The surface-soil sample location is shown on Figure 3-2.

North Post Source Area

Surface-soil grab samples (0 to 6 inches) were collected at North Post source area Site 2 from five locations (001 through 005) to evaluate the lateral extent of contamination at the fire burn pit. Based on quick turnaround laboratory analytical results, additional surface-soil grab samples were collected from 20 locations (006 through 025) to further assess the extent of contamination at the fire burn pit. Surface-soil samples (0 to 2 feet below ground surface) were also collected from four soil borings (AP-6810 through AP-6813), and from seven groundwater monitoring wells (AP-6814 through AP-6820). A summary of surface-soil samples collected at the North Post source area is presented in Table 3-1. Surface-soil sample locations are shown on Figure 3-3.

3.6 Surface-Water and Sediment Investigation

3.6.1 Sampling Methodology

Surface Water

Field measurements of pH, specific conductance, and temperature were recorded prior to sampling. Surface-water samples were collected as grab samples by fully immersing sample containers in

Table 3-1. Surface-Soil Sample Summary for DRMO Yard, Building 1168, and North Post Source Areas

Source Area	Location Number	Sample Number	Depth	Sample Type
DRMO Yard	001	94FW10001SS	0 - 6 inches	Project
	002	94FW10002SS	0 - 6 inches	Project
	002	94FW10004SS	0 - 6 inches	QC
	002	94FW1003SS	0 - 6 inches	QA
	003	94FW10005SS	0 - 6 inches	Project
	004	94FW10006SS	0 - 6 inches	Project
	005	94FW10007SS	0 - 6 inches	Project
	AP-6730	94FW1012SL	0 - 2 feet	Project
	AP-6731	94FW1031SL	0 - 2 feet	Project
	AP-6732	94FW1053SL	0 - 2 feet	Project
	AP-6733	94FW1057SL	0 - 2 feet	Project
	AP-6734	94FW1098SL	0 - 2 feet	Project
	AP-6735	94FW1104SL	0 - 2 feet	Project
	AP-6737	94FW1250SL	0 - 2 feet	Project
	AP-6738	94FW1254SL	0 - 2 feet	Project
	AP-6739	94FW1273SL	0 - 2 feet	Project
	AP-6740	94FW1277SL	0 - 2 feet	Project
	AP-6741	94FW1205SL	0 - 2 feet	Project
	AP-6743	94FW1113SL	0 - 2 feet	Project
	AP-6744	94FW1117SL	0 - 2 feet	Project
	AP-6745	94FW1094SL	0 - 2 feet	Project
	AP-6746	94FW1090SL	0 - 2 feet	Project
	AP-6747	94FW1063SL	0 - 2 feet	Project
	AP-6748	94FW1036SL	0 - 2 feet	Project
	AP-6749	94FW1026SL	0 - 2 feet	Project
	AP-6751	94FW1018SL	0 - 2 feet	Project
	AP-6752	94FW1040SL	0 - 2 feet	Project
	AP-6754	94FW1067SL	0 - 2 feet	Project
	AP-6756	94FW1123SL	0 - 2 feet	Project
	AP-6757	94FW1127SL	0 - 2 feet	Project
	AP-6758	94FW1217SL	0 - 2 feet	Project
	AP-6759	94FW1211SL	0 - 2 feet	Project
	AP-6760	94FW1263SL	0 - 2 feet	Project
	AP-6761	94FW1269SL	0 - 2 feet	Project
	AP-6762	94FW1244SL	0 - 2 feet	Project
	AP-6763	94FW11221SL	0 - 2 feet	Project
	AP-6764	94FW1184SL	0 - 2 feet	Project
	AP-6765	94FW1131SL	0 - 2 feet	Project
	AP-6766	94FW1081SL	0 - 2 feet	Project
	AP-6767	94FW1075SL	0 - 2 feet	Project
	AP-6768	94FW1071SL	0 - 2 feet	Project
	AP-6769	94FW1044SL	0 - 2 feet	Project
	AP-6770	94FW1022SL	0 - 2 feet	Project

Table 3-1. Surface-Soil Sample Summary for DRMO Yard, Building 1168, and North Post Source Areas (continued)

Source Area	Location Number	Sample Number	Depth	Sample Type
	AP-6771	94FW1006SL	0 - 2 feet	Project
	AP-6772	94FW1135SL	0 - 2 feet	Project
	AP-6773	94FW1155SL	0 - 2 feet	Project
	AP-6774	94FW1180SL	0 - 2 feet	Project
	AP-6776	94FW11235SL	0 - 2 feet	Project
	AP-6778	94FW11231SL	0 - 2 feet	Project
	AP-6779	94FW1193SL	0 - 2 feet	Project
	AP-6780	94FW1174SL	0 - 2 feet	Project
	AP-6781	94FW1164SL	0 - 2 feet	Project
	AP-6782	94FW1151SL	0 - 2 feet	Project
	AP-6783	94FW1139SL	0 - 2 feet	Project
	AP-6784	94FW1145SL	0 - 2 feet	Project
	AP-6786	94FW1170SL	0 - 2 feet	Project
	AP-6787	94FW1197SL	0 - 2 feet	Project
	AP-6788	94FW1201SL	0 - 2 feet	Project
	AP-6789	94FW11227SL	0 - 2 feet	Project
	AP-6790	94FW1294SL	0 - 2 feet	Project
	AP-6792	94FW1305SL	0 - 2 feet	Project
	AP-6793	94FW1332SL	0 - 2 feet	Project
	AP-6795	94FW1341SL	0 - 2 feet	Project
	AP-6799	94FW1281SL	0 - 2 feet	Project
	AP-6801	94FW1287SL	0 - 2 feet	Project
	AP-6802	94FW1291SL	0 - 2 feet	Project
	AP-6803	94FW1309SL	0 - 2 feet	Project
	AP-6804	94FW1313SL	0 - 2 feet	Project
	AP-6805	94FW1319SL	0 - 2 feet	Project
	AP-6807	94FW1328SL	0 - 2 feet	Project
Building 1168	AP-6809	94FWT509SL	0 - 2 feet	Project
North Post	001	94FW30001SS	0 - 6 inches	Project
	002	94FW30002SS	0 - 6 inches	Project
	003	94FW30003SS	0 - 6 inches	Project
	004	94FW30004SS	0 - 6 inches	Project
	005	94FW30005SS	0 - 6 inches	Project
	005	94FW30006SS	0 - 6 inches	QA
	005	94FW30007SS	0 - 6 inches	QC
	006	94FW3008SS	0 - 6 inches	Project
	007	94FW3009SS	0 - 6 inches	Project
	008	94FW3010SS	0 - 6 inches	Project
	009	94FW3011SS	0 - 6 inches	Project
	010	94FW3012SS	0 - 6 inches	Project
	011	94FW3013SS	0 - 6 inches	Project

Table 3-1. Surface-Soil Sample Summary for DRMO Yard, Building 1168, and North Post Source Areas (continued)

Source Area	Location Number	Sample Number	Depth	Sample Type
	012	94FW3014SS	0 - 6 inches	Project
	013	94FW3015SS	0 - 6 inches	Project
	014	94FW3016SS	0 - 6 inches	Project
	015	94FW3017SS	0 - 6 inches	Project
	016	94FW3018SS	0 - 6 inches	Project
	017	94FW3019SS	0 - 6 inches	Project
	017	94FW3020SS	0 - 6 inches	QA
	017	94FW30221SS	0 - 6 inches	QC
	018	94FW3022SS	0 - 6 inches	Project
	019	94FW3023SS	0 - 6 inches	Project
	020	94FW3024SS	0 - 6 inches	Project
	020	94FW3025SS	0 - 6 inches	QA
	020	94FW3026SS	0 - 6 inches	QC
	021	94FW3027SS	0 - 6 inches	Project
	022	94FW3028SS	0 - 6 inches	Project
	023	94FW3029SS	0 - 6 inches	Project
	024	94FW3030SS	0 - 6 inches	Project
	025	94FW3031SS	0 - 6 inches	Project

QA Quality assurance
QC Quality control

the water, taking care to minimize aeration. Unless otherwise noted, surface-water samples were collocated with sediment samples and preserved as described in the OU 2 RI/FS management plan (HLA, 1994b). Downstream samples were collected first to minimize disturbance to upstream sample locations. Vials for volatile fractions were filled first. Any observations made during sampling, such as odor or sheen, were recorded in the field logbook.

Sediment

Sediment samples were collected as grab samples from 6 inches below the sediment surface in shallow water using a hand trowel. Samples were retrieved and placed in appropriate sample containers in a manner that minimized aeration of the samples. Sediment samples were collected after surface-water samples had been collected. Samples were collected from the stream bank or by wading carefully into the stream to minimize disturbance to the stream bed. Downstream samples were collected first to minimize disturbance to upstream sample locations. Any observations made during sampling, such as odor or sheen, were recorded in the field logbook.

3.6.2 Surface-Water and Sediment Locations by Source Area

DRMO Yard Source Area

Surface-water and sediment samples were collected from Channel B at locations downgradient (001), adjacent to (002), and upgradient from (003) the DRMO yard source area. Drainage ditches located adjacent to the east side of the DRMO yard source area and approximately 500 feet north did not contain water during the field investigation. Therefore, only sediment samples were collected at these locations (004 through 008). Surface-water and sediment samples collected at the DRMO yard source area are summarized in Table 3-2. Surface-water and sediment sample locations are shown on Figure 3-1.

Building 1168 Yard Source Area

Surface-water and sediment samples were not collected as part of the Building 1168 source area investigation.

North Post Source Area

Surface-water and sediment samples were collected from the Chena River at locations upgradient (001) and downgradient (002) of the North Post source area. A North Post source area surface-water and sediment sample summary is presented in Table 3-2. Surface-water and sediment sample locations are shown on Figure 3-3.

3.7 Soil Boring and Logging Procedures

3.7.1 Soil Boring Methodology

Soil borings were completed to enable logging soil conditions and collecting subsurface-soil samples. A complete log of conditions encountered during drilling was maintained by the engineer or geologist supervising the operation. A boring log form was used to record observations. Soil boring logs and associated laboratory geotechnical data generated during the OU 2 RI are presented in Appendix A. Boring logs were prepared in accordance with ASTM Method D 2488 (ASTM, 1984), the Unified Soil Classification System (USCS), and the USACE Soil Frost Classification System, as shown on Figures A-1 through A-3 included in Appendix A.

Borings were drilled with a truck-mounted drilling rig using hollow-stem auger drilling methods. Borings were drilled to depths of approximately 10 feet below the water table. Borings not converted to monitoring wells were backfilled with rough-cut bentonite.

Subsurface-soil samples were collected from borings for soil description or chemical analyses. Photographs of each sample were taken. Samples collected to provide soil descriptions were obtained by using a split-barrel drive sampler or by collecting cuttings from the hollow-stem auger. Samples for geotechnical analyses were collected using a split-barrel drive sampler and

Table 3-2. Surface-Water and Sediment Sample Summary for DRMO Yard and North Post Source Areas

Source Area	Location Number	Sample Number	Sample Type
DRMO Yard	001	94FW10001SD	Project
	001	94FW10001SW	Project
	002	94FW10002SD	Project
	002	94FW10002SW	Project
	002	94FW10004SD	QC
	002	94FW10004SW	QC
	002	94FW1003SD	QA
	002	94FW1003SW	QA
	003	94FW10005SD	Project
	003	94FW10005SW	Project
	004	94FW1009SD	Project
	005	94FW1010SD	Project
	006	94FW10006SD	Project
	007	94FW10007SD	Project
	008	94FW10008SD	Project
North Post	001	94FW3001SD	Project
	001	94FW3002SD	QA
	001	94FW3003SD	QC
	001	94FW3080WA	Project
	001	94FW3081WA	QA
	001	94FW3082WA	QC
	002	94FW3004SD	Project
	002	94FW3083WA	Project

QA Quality assurance
QC Quality control

then sealed in plastic "geobags." Two samples from each boring were collected for geotechnical analyses: one from the vadose zone and one from below the water table. The geotechnical sample from the vadose zone was collected from a depth interval representative of a single soil horizon. Vadose zone geotechnical samples from subsequent borings were selected from other soil horizons to obtain geotechnical samples from each soil horizon present at a site. The samples were submitted to a soil laboratory for grain-size distribution (ASTM C 117 and C 136) and moisture content (ASTM D 2216) (ASTM, 1980b) tests.

Soil samples to be submitted for chemical analyses were collected with a split-barrel drive sampler driven into undisturbed soil. Samples were collected from the ground surface and at 5-foot depth intervals to a maximum depth of 5 feet below the groundwater table. Sample fractions for laboratory analyses of VOCs and GRO content were retrieved from the split-spoon sampler first to minimize aeration, and were placed in the jars with no headspace. Remaining samples were homogenized in a stainless steel bowl and composited among remaining sample containers. VOC field screening consisted of placing the sealed sample bag in a warm area for 5 to 10 minutes, inserting a photoionization detector (PID) probe into the headspace of the bag, and recording the reading on the field soil boring logs. Observations made during sampling, such as odor or sheen, were recorded in the field logbook and/or boring log. Sampling equipment was decontaminated between sampling locations, then placed on disposable polyethylene plastic or aluminum foil sheeting to prevent cross-contaminating samples.

3.7.2 Boring Locations by Source Area

DRMO Yard Source Area

Seventy soil borings were drilled at the DRMO yard source area with subsurface-soil samples collected from each boring (AP-6730 through AP-6798 and AP-6801). Subsurface-soil samples were also collected during the installation of eight groundwater monitoring wells (AP-6799, AP-6800, and AP-6802 through AP-6807). Initially, the subsurface-soil investigation consisted of 60 soil borings (AP-6730 through AP-6789) drilled within the DRMO yard property boundary. These borings were located according to a statistical grid that yields an approximate 90 percent probability that the initial borings will land within a circular area of contamination with a diameter of 20 feet or greater. Based on quick-turnaround laboratory analytical results, three additional soil borings (AP-6790, AP-6791, and AP-6792) were drilled and sampled to further assess the extent of contamination in the north-central portion of the DRMO yard source area. Six borings (AP-6793 through AP-6798) were drilled and sampled to assess the extent of contamination in the vicinity of the west gate. Boring AP-6801 was intended for a monitoring well installation, but was terminated due to a buried obstruction. Background subsurface-soil samples were collected during the installation of Monitoring Well AP-6802. A summary of subsurface soil samples collected at the DRMO yard source area is presented in Table 3-3. Soil boring and groundwater monitoring well locations are shown on Figure 3-1.

Building 1168 Source Area

Subsurface-soil samples were collected from two soil borings at the Building 1168 source area. Boring AP-6809 was completed as a groundwater level monitoring well under the direction of CRREL. Boring AP-6808 was completed as a groundwater monitoring well and is located at an upgradient background location. A summary of the subsurface-soil samples collected at the Building 1168 source area is presented in Table 3-3. Soil boring locations are shown on Figure 3-2.

North Post Source Area

Four soil borings were drilled at North Post source area Site 2, with subsurface-soil samples collected from each boring (AP-6810 through AP-6813). Subsurface-soil samples were also collected during the installation of seven groundwater monitoring wells (AP-6814 through AP-6816 at Site 2, AP-6817 at concrete pad foundations of former buildings, AP-6818 at the background location, and AP-6819 and

at Site 4). Background subsurface-soil samples were collected during the installation of Monitoring Well AP-6818. A summary of subsurface-soil samples collected at the North Post source area is presented in Table 3-3. Soil boring locations are shown on Figure 3-3.

3.8 Groundwater Probe Installation

3.8.1 Installation Methodology

Groundwater probe surveys were used to explore for the presence of contaminated groundwater and, if found, to investigate the lateral and vertical extents of contamination. Advancing probes in increments and sampling at different depths provided analytical data for characterizing the vertical extent of a contaminant plume. Typical groundwater probe construction and installation details for probes installed during the OU 2 RI are included in Appendix B.

Groundwater probes were installed using a mobile impact drill. The probes consisted of nominal 1/2-inch-diameter, Schedule 40, black iron pipe with a stainless steel drive point, and a stainless steel 0.008-inch vertically slotted screen section. A 3-foot section of blank stainless steel was attached to the bottom of the screened section to trap silt. Pipe sections were welded together to achieve desired depths.

To investigate the uppermost portion of the aquifer, the probe was driven until the midpoint of the screen was approximately at the water table surface (i.e., a penetration of approximately 8 feet into the aquifer). To investigate deeper into the aquifer, the probe was driven until the screen section spanned the desired sampling interval.

Groundwater probe locations were measured from surveyed reference points using a swing-tie survey or an electronic distance measurement (EDM) technique. The accuracy of the groundwater probe location measurements is approximately plus or minus 1.0 foot. All location measurements were recorded in the field logbook.

Groundwater probes left permanently in the ground were completed with flush-mount locking protective casings. All other probes were removed, and the formations were allowed to collapse to fill the probe holes.

Before purging or sampling, measurements were made of the depth to water from the top of the probe, and from the length of probe exposed above the ground surface. Water-level measurements were made using an electronic sounder with a cable permanently marked in 0.01-inch increments. These measurements and the total length of the probe were recorded in the field logbook.

Groundwater-probe purging and sampling was accomplished using an inertial pump consisting of 3/8-inch-diameter Teflon tubing equipped with a foot valve. New tubing and foot valves were used for each sample. The intake end of the sample tubing was placed at approximately the midpoint of the submerged screen section. Samples were collected to measure field parameters of pH, specific conductance, temperature, and turbidity after a minimum of 20 probe volumes were withdrawn. If the turbidity was greater than 200 nephelometric turbidity units (NTUs), an additional 10 probe volumes were removed. Typical development volumes ranged from 8.5 to 10 liters. Ground-water samples were analyzed on a quick-turnaround basis. Purge and decontamination water were collected for granular activated carbon (GAC) treatment and disposal.

3.8.2 Probe Locations by Source Area

DRMO Yard Source Area

Eighty-two groundwater probes were installed and sampled as part of the DRMO yard source area investigation. Initially, 60 groundwater probes (P01 through P60) were installed on a 150-foot by 150-foot grid established within the DRMO yard property boundary. Based on quick-turnaround laboratory analytical results, additional probes were installed to further define the extent of contamination.

Table 3-3. Subsurface-Soil Sample Summary for DRMO Yard, Building 1168, and North Post Source Areas

Source Area	Location Number	Sample Number	Depth (feet)	Sample Type
DRMO Yard	AP-6730	94FW1013SL	2 - 4	Project
	AP-6730	94FW1014SL	5 - 7	Project
	AP-6730	94FW1015SL	10 - 14	Project
	AP-6730	94FW1016SL	10 - 14	QA
	AP-6730	94FW1017SL	10 - 14	QC
	AP-6731	94FW1032SL	2 - 4	Project
	AP-6731	94FW1033SL	5 - 9	PR/QA
	AP-6731	94FW1034SL	5 - 9	QC
	AP-6731	94FW1035SL	10 - 12	Project
	AP-6732	94FW1054SL	2 - 4	Project
	AP-6732	94FW1055SL	5 - 7	Project
	AP-6732	94FW1056SL	10 - 12	Project
	AP-6733	94FW1058SL	3 - 7	Project
	AP-6733	94FW1059SL	3 - 7	QA
	AP-6733	94FW1060SL	3 - 7	QC
	AP-6733	94FW1061SL	6 - 8	Project
	AP-6733	94FW1062SL	10 - 12	Project
	AP-6734	94FW1099SL	2 - 4	Project
	AP-6734	94FW1100SL	5 - 7	Project
	AP-6734	94FW1101SL	10 - 14	Project
	AP-6734	94FW1102SL	10 - 14	QA
	AP-6734	94FW1103SL	10 - 14	QC
	AP-6735	94FW1105SL	2 - 4	Project
	AP-6735	94FW1106SL	5 - 7	Project
	AP-6735	94FW1107SL	10 - 12	Project
	AP-6736	94FW1108SL	0 - 4	Project
	AP-6736	94FW1109SL	0 - 4	QA
	AP-6736	94FW1110SL	0 - 4	QC
	AP-6736	94FW1111SL	5 - 7	Project
	AP-6736	94FW1112SL	10 -12	Project
	AP-6737	94FW1251SL	2 - 4	Project
	AP-6737	94FW1252SL	5 - 7	Project
	AP-6737	94FW1253SL	10 - 12	Project
	AP-6738	94FW1255SL	2 - 4	Project
	AP-6738	94FW1256SL	5 - 7	Project
	AP-6738	94FW1257SL	10 - 12	Project
	AP-6739	94FW1274SL	2 - 4	Project
	AP-6739	94FW1275SL	5 - 7	Project
	AP-6739	94FW1276SL	10 - 12	Project
	AP-6740	94FW1278SL	2 - 4	Project
	AP-6740	94FW1279SL	5 - 7	Project

Table 3-3. Subsurface-Soil Sample Summary for DRMO Yard, Building 1168, and North Post Source Areas (continued)

Source Area	Location Number	Sample Number	Depth (feet)	Sample Type
DRMO Yard (continued)	AP-6740	94FW1280SL	10 - 12	Project
	AP-6741	94FW1206SL	2 - 4	Project
	AP-6741	94FW1207SL	5 - 9	Project
	AP-6741	94FW1208SL	5 - 9	QA
	AP-6741	94FW1209SL	5 - 9	QC
	AP-6741	94FW1210SL	10 - 12	Project
	AP-6742	94FW1258SL	0 - 4	Project
	AP-6742	94FW1259SL	0 - 4	QA
	AP-6742	94FW1260SL	0 - 4	QC
	AP-6742	94FW1261SL	5 - 7	Project
	AP-6742	94FW1262SL	10 - 12	Project
	AP-6743	94FW1114SL	2 - 4	Project
	AP-6743	94FW1115SL	5 - 7	Project
	AP-6743	94FW1116SL	10 - 12	Project
	AP-6744	94FW1118SL	2 - 4	Project
	AP-6744	94FW1119SL	5 - 7	Project
	AP-6744	94FW1120SL	10 - 14	Project
	AP-6744	94FW1121SL	10 - 14	QA
	AP-6744	94FW1122SL	10 - 14	QC
	AP-6745	94FW1095SL	2 - 4	Project
	AP-6745	94FW1096SL	5 - 7	Project
	AP-6745	94FW1097SL	10 - 12	Project
	AP-6746	94FW1091SL	2 - 4	Project
	AP-6746	94FW1092SL	5 - 7	Project
	AP-6746	94FW1093SL	10 - 12	Project
	AP-6747	94FW1064SL	2 - 4	Project
	AP-6747	94FW1065SL	5 - 7	Project
	AP-6747	94FW1066SL	10 - 12	Project
	AP-6748	94FW1037SL	2 - 4	Project
	AP-6748	94FW1038SL	5 - 7	Project
	AP-6748	94FW1039SL	10 - 12	Project
	AP-6749	94FW1027SL	2 - 4	Project
	AP-6749	94FW1028SL	5 - 9	PR/QA
	AP-6749	94FW1029SL	5 - 9	QC
	AP-6749	94FW1030SL	10 - 12	Project
	AP-6750	94FW1001SL	0 - 1.5	Project
	AP-6750	94FW1002SL	1.25 - 2.75	Project
	AP-6750	94FW1003SL	4.75 - 6.75	Project
	AP-6750	94FW1004SL	10 - 12	Project
	AP-6751	94FW1019SL	2 - 4	Project
	AP-6751	94FW1020SL	5 - 7	Project
	AP-6751	94FW1021SL	10 - 12	Project
	AP-6752	94FW1041SL	2 - 4	Project
	AP-6752	94FW1042SL	5 - 8	Project

Table 3-3. Subsurface-Soil Sample Summary for DRMO Yard, Building 1168, and North Post Source Areas (continued)

Source Area	Location Number	Sample Number	Depth (feet)	Sample Type
DRMO Yard (continued)	AP-6752	94FW1043SL	10 - 12	Project
	AP-6753	94FW1048SL	0 - 4	Project
	AP-6753	94FW1049SL	0 - 4	QA
	AP-6753	94FW1050SL	0 - 4	QC
	AP-6753	94FW1051SL	5 - 7	Project
	AP-6753	94FW1052SL	10 - 12	Project
	AP-6754	94FW1068SL	2 - 4	Project
	AP-6754	94FW1069SL	5 - 7	Project
	AP-6754	94FW1070SL	10 - 12	Project
	AP-6755	94FW1085SL	0 - 4	Project
	AP-6755	94FW1086SL	0 - 4	QA
	AP-6755	94FW1087SL	0 - 4	QC
	AP-6755	94FW1088SL	5 - 7	Project
	AP-6755	94FW1089SL	10 - 12	Project
	AP-6756	94FW1124SL	2 - 4	Project
	AP-6756	94FW1125SL	5 - 7	Project
	AP-6756	94FW1126SL	10 - 12	Project
	AP-6757	94FW1128SL	2 - 4	Project
	AP-6757	94FW1129SL	5 - 7	Project
	AP-6757	94FW1130SL	10 - 12	Project
	AP-6758	94FW1218SL	2 - 4	Project
	AP-6758	94FW1219SL	5 - 7	Project
	AP-6758	94FW1220SL	10 - 12	Project
	AP-6759	94FW1212SL	2 - 6	Project
	AP-6759	94FW1213SL	2 - 6	QA
	AP-6759	94FW1214SL	2 - 6	QC
	AP-6759	94FW1215SL	6 - 8	Project
	AP-6759	94FW1216SL	10 - 12	Project
	AP-6760	94FW1264SL	2 - 4	Project
	AP-6760	94FW1265SL	5 - 7	Project
	AP-6760	94FW1266SL	10 - 14	Project
	AP-6760	94FW1267SL	10 - 14	QA
	AP-6760	94FW1268SL	10 - 14	QC
	AP-6761	94FW1270SL	2 - 4	Project
	AP-6761	94FW1271SL	5 - 7	Project
	AP-6761	94FW1272SL	10 - 12	Project
	AP-6762	94FW1245SL	2 - 6	Project
	AP-6762	94FW1246SL	2 - 6	QA
	AP-6762	94FW1247SL	2 - 6	QC
	AP-6762	94FW1248SL	6 - 8	Project
	AP-6762	94FW1249SL	10 - 12	Project

Table 3-3. Subsurface-Soil Sample Summary for DRMO Yard, Building 1168, and North Post Source Areas (continued)

Source Area	Location Number	Sample Number	Depth (feet)	Sample Type
DRMO Yard (continued)	AP-6763	94FW11222SL	2 - 4	Project
	AP-6763	94FW11223SL	5 - 9	Project
	AP-6763	94FW11224SL	5 - 9	QA
	AP-6763	94FW11225SL	5 - 9	QC
	AP-6763	94FW11226SL	10 - 12	Project
	AP-6764	94FW1185SL	2 - 4	Project
	AP-6764	94FW1186SL	5 - 7	Project
	AP-6764	94FW1187SL	10 - 12	Project
	AP-6765	94FW1132SL	2 - 4	Project
	AP-6765	94FW1133SL	5 - 7	Project
	AP-6765	94FW1134SL	10 - 12	Project
	AP-6766	94FW1082SL	2 - 4	Project
	AP-6766	94FW1083SL	5 - 7	Project
	AP-6766	94FW1084SL	10 - 12	Project
	AP-6767	94FW1076SL	2 - 6	Project
	AP-6767	94FW1077SL	2 - 6	QA
	AP-6767	94FW1078SL	2 - 6	QC
	AP-6767	94FW1079SL	6 - 8	Project
	AP-6767	94FW1080SL	10 - 12	Project
	AP-6768	94FW1072SL	2 - 4	Project
	AP-6768	94FW1073SL	5 - 7	Project
	AP-6768	94FW1074SL	10 - 12	Project
	AP-6769	94FW1045SL	2 - 4	Project
	AP-6769	94FW1046SL	5 - 7	Project
	AP-6769	94FW1047SL	10 - 12	Project
	AP-6770	94FW1023SL	2 - 4	Project
	AP-6770	94FW1024SL	5 - 7	Project
	AP-6770	94FW1025SL	10 - 12	Project
	AP-6771	94FW1007SL	2 - 4	Project
	AP-6771	94FW1008SL	5 - 9	Project
	AP-6771	94FW1009SL	5 - 9	QA
	AP-6771	94FW1010SL	5 - 9	QC
	AP-6771	94FW1011SL	10 - 12	Project
	AP-6772	94FW1136SL	2 - 4	Project
	AP-6772	94FW1137SL	5 - 7	Project
	AP-6772	94FW1138SL	10 - 12	Project
	AP-6773	94FW1156SL	2 - 4	Project
	AP-6773	94FW1157SL	5 - 7	Project
	AP-6773	94FW1158SL	10 - 12	Project
	AP-6774	94FW1181SL	2 - 4	Project
	AP-6774	94FW1182SL	5 - 7	Project
	AP-6774	94FW1183SL	10 - 12	Project
	AP-6775	94FW1188SL	0 - 4	Project
	AP-6775	94FW1189SL	0 - 4	QA

Table 3-3. Subsurface-Soil Sample Summary for DRMO Yard, Building 1168, and North Post Source Areas (continued)

Source Area	Location Number	Sample Number	Depth (feet)	Sample Type
DRMO Yard (continued)	AP-6775	94FW1190SL	0 - 4	QC
	AP-6775	94FW1191SL	5 - 7	Project
	AP-6775	94FW1192SL	10 - 12	Project
	AP-6776	94FW11236SL	2 - 4	Project
	AP-6776	94FW11237SL	5 - 7	Project
	AP-6776	94FW11238SL	10 - 12	Project
	AP-6777	94FW1239SL	0 - 4	Project
	AP-6777	94FW1240SL	0 - 4	QA
	AP-6777	94FW1241SL	0 - 4	QC
	AP-6777	94FW1242SL	5 - 7	Project
	AP-6777	94FW1243SL	10 - 12	Project
	AP-6778	94FW11232SL	2 - 4	Project
	AP-6778	94FW11233SL	5 - 7	Project
	AP-6778	94FW11234SL	10 - 12	Project
	AP-6779	94FW1194SL	2 - 4	Project
	AP-6779	94FW1195SL	5 - 7	Project
	AP-6779	94FW1196SL	10 - 12	Project
	AP-6780	94FW1175SL	2 - 4	Project
	AP-6780	94FW1176SL	5 - 9	Project
	AP-6780	94FW1177SL	5 - 9	QA
	AP-6780	94FW1178SL	5 - 9	QC
	AP-6780	94FW1179SL	10 - 12	Project
	AP-6781	94FW1165SL	2 - 6	Project
	AP-6781	94FW1166SL	2 - 6	QA
	AP-6781	94FW1167SL	2 - 6	QC
	AP-6781	94FW1168SL	6 - 8	Project
	AP-6781	94FW1169SL	10 - 12	Project
	AP-6782	94FW1152SL	2 - 4	Project
	AP-6782	94FW1153SL	5 - 7	Project
	AP-6782	94FW1154SL	10 - 12	Project
	AP-6783	94FW1140SL	2 - 6	Project
	AP-6783	94FW1141SL	2 - 6	QA
	AP-6783	94FW1142SL	2 - 6	QC
	AP-6783	94FW1143SL	6 - 8	Project
	AP-6783	94FW1144SL	10 - 12	Project
	AP-6784	94FW1146SL	2 - 6	Project
	AP-6784	94FW1147SL	2 - 6	QA
	AP-6784	94FW1148SL	2 - 6	QC
	AP-6784	94FW1149SL	6 - 8	Project
	AP-6784	94FW1150SL	10 - 12	Project
	AP-6785	94FW1159SL	0 - 4	Project
	AP-6785	94FW1160SL	0 - 4	QA
	AP-6785	94FW1161SL	0 - 4	QC
	AP-6785	94FW1162SL	5 - 7	Project

Table 3-3. Subsurface-Soil Sample Summary, DRMO Yard for Building 1168, and North Post Source Areas (continued)

Source Area	Location Number	Sample Number	Depth (feet)	Sample Type
DRMO Yard (continued)	AP-6785	94FW1163SL	10 - 12	Project
	AP-6786	94FW1171SL	2 - 4	Project
	AP-6786	94FW1172SL	5 - 7	Project
	AP-6786	94FW1173SL	10 - 12	Project
	AP-6787	94FW1198SL	2 - 4	Project
	AP-6787	94FW1199SL	5 - 7	Project
	AP-6787	94FW1200SL	10 - 12	Project
	AP-6788	94FW1202SL	2 - 4	Project
	AP-6788	94FW1203SL	5 - 7	Project
	AP-6788	94FW1204SL	10 - 12	Project
	AP-6789	94FW11228SL	2 - 4	Project
	AP-6789	94FW11229SL	5 - 7	Project
	AP-6789	94FW11230SL	10 - 12	Project
	AP-6790	94FW1295SL	2 - 4	Project
	AP-6790	94FW1296SL	5 - 9	Project
	AP-6790	94FW1297SL	5 - 9	QA
	AP-6790	94FW1298SL	5 - 9	QC
	AP-6790	94FW1299SL	10 - 12	Project
	AP-6791	94FW1300SL	0 - 4	Project
	AP-6791	94FW1301SL	0 - 4	QA
	AP-6791	94FW1302SL	0 - 4	QC
	AP-6791	94FW1303SL	5 - 7	Project
	AP-6791	94FW1304SL	10 - 12	Project
	AP-6792	94FW1306SL	2 - 4	Project
	AP-6792	94FW1307SL	5 - 7	Project
	AP-6792	94FW1308SL	10 - 12	Project
	AP-6793	94FW1333SL	2 - 4	Project
	AP-6793	94FW1334SL	5 - 7	Project
	AP-6793	94FW1335SL	10 - 12	Project
	AP-6794	94FW1336SL	0 - 4	Project
	AP-6794	94FW1337SL	0 - 4	QA
	AP-6794	94FW1338SL	0 - 4	QC
	AP-6794	94FW1339SL	5 - 7	Project
	AP-6794	94FW1340SL	10 - 12	Project
	AP-6795	94FW1342SL	2 - 4	Project
	AP-6795	94FW1343SL	5 - 9	Project
	AP-6795	94FW1344SL	5 - 9	QA
	AP-6795	94FW1345SL	5 - 9	QC
	AP-6795	94FW1346SL	10 - 12	Project
	AP-6796	94FW1347SL	2 - 4	Project
	AP-6796	94FW1348SL	5 - 7	Project
	AP-6796	94FW1349SL	10 - 12	Project
	AP-6797	94FW1350SL	2 - 4	Project
	AP-6797	94FW1351SL	5 - 7	Project

Table 3-3. Subsurface-Soil Sample Summary for DRMO Yard, Building 1168, and North Post Source Areas (continued)

Source Area	Location Number	Sample Number	Depth (feet)	Sample Type
DRMO Yard (continued)	AP-6797	94FW1352SL	10 - 12	Project
	AP-6798	94FW1353SL	2 - 4	Project
	AP-6798	94FW1354SL	5 - 7	Project
	AP-6798	94FW1355SL	10 - 12	Project
	AP-6799	94FW1282SL	2 - 4	Project
	AP-6799	94FW1283SL	5 - 7	Project
	AP-6799	94FW1284SL	9 - 13	Project
	AP-6799	94FW1285SL	9 - 13	QA
	AP-6799	94FW1286SL	9 - 13	QC
	AP-6801	94FW1288SL	2 - 5	Project
	AP-6801	94FW1289SL	5 - 7	Project
	AP-6801	94FW1290SL	10 - 12	Project
	AP-6802	94FW1292SL	5 - 7	Project
	AP-6802	94FW1293SL	10 - 12	Project
	AP-6803	94FW1310SL	2 - 4	Project
	AP-6803	94FW1311SL	5 - 7	Project
	AP-6803	94FW1312SL	10 - 12	Project
	AP-6804	94FW1314SL	2 - 6	Project
	AP-6804	94FW1315SL	2 - 6	QA
	AP-6804	94FW1316SL	2 - 6	QC
	AP-6804	94FW1317SL	6 - 8	Project
	AP-6804	94FW1318SL	10 - 12	Project
	AP-6805	94FW1320SL	2 - 4	Project
	AP-6805	94FW1321SL	5 - 7	Project
	AP-6805	94FW1322SL	10 - 12	Project
	AP-6806	94FW1323SL	0 - 4	Project
	AP-6806	94FW1324SL	0 - 4	QA
	AP-6806	94FW1325SL	0 - 4	QC
	AP-6806	94FW1326SL	5 - 7	Project
	AP-6806	94FW1327SL	10 - 12	Project
	AP-6807	94FW1329SL	2 - 4	Project
	AP-6807	94FW1330SL	5 - 7	Project
	AP-6807	94FW1331SL	10 - 12	Project
Building 1168	AP-6808	94FW2001SL	1.5 - 3.5	Project
	AP-6808	94FW2002SL	5 - 7	Project
	AP-6808	94FW2003SL	9 - 13	Project
	AP-6808	94FW2004SL	9 - 13	QA
	AP-6808	94FW2005SL	9 - 13	QC
	AP-6808	94FW2006SL	15 - 17	Project
	AP-6809	94FWTS09SL	0 - 2	Project
	AP-6809	94FWTS10SL	5 - 7	Project
	AP-6809	94FWTS11SL	10 - 12	Project
	AP-6809	94FWTS12SL	14 - 18	Project
	AP-6809	94FWTS13SL	14 - 18	QA
	AP-6809	94FWTS14SL	14 - 18	QC
	AP-6809	94FWTS15SL	20 - 22	Project

Table 3-3. Subsurface-Soil Sample Summary for DRMO Yard, Building 1168, and North Post Source Areas (continued)

Source Area	Location Number	Sample Number	Depth (feet)	Sample Type
North Post	AP-6810	94FW3001SL	0 - 2	Project
	AP-6810	94FW3002SL	5 - 7	Project
	AP-6810	94FW3003SL	10 - 12	Project
	AP-6810	94FW3004SL	15 - 17	Project
	AP-6810	94FW3005SL	20 - 22	Project
	AP-6811	94FW3044SL	1 - 3	Project
	AP-6811	94FW3047SL	5 - 7	Project
	AP-6811	94FW3048SL	10 - 12	Project
	AP-6811	94FW3049SL	15 - 17	Project
	AP-6812	94FW3050SL	0 - 2	Project
	AP-6812	94FW3051SL	5 - 7	Project
	AP-6812	94FW3052SL	10 - 12	Project
	AP-6812	94FW3053SL	15 - 17	Project
	AP-6813	94FW3054SL	0 - 2	Project
	AP-6813	94FW3055SL	5 - 7	Project
	AP-6813	94FW3056SL	11 - 13	Project
	AP-6813	94FW3059SL	15 - 17	Project
	AP-6814	94FW3006SL	0 - 1	Project
	AP-6814	94FW3007SL	5 - 7	Project
	AP-6814	94FW3008SL	10 - 12	Project
	AP-6814	94FW3009SL	15 - 17	Project
	AP-6815	94FW3017SL	0 - 2	Project
	AP-6815	94FW3018SL	5 - 7	Project
	AP-6815	94FW3019SL	11 - 13	Project
	AP-6815	94FW3022SL	15 - 17	Project
	AP-6815	94FW3023SL	22.5 - 24.5	Project
	AP-6816	94FW3010SL	0 - 2	Project
	AP-6816	94FW3011SL	5 - 7	Project
	AP-6816	94FW3014SL	10 - 12	Project
	AP-6816	94FW3015SL	15 - 17	Project
	AP-6816	94FW3016SL	20 - 22	Project
	AP-6817	94FW3024SL	0 - 2	Project
	AP-6817	94FW3025SL	5 - 7	Project
	AP-6817	94FW3026SL	10 - 12	Project
	AP-6817	94FW3027SL	15 - 17	Project
	AP-6818	94FW3028SL	0 - 2	Project
	AP-6818	94FW3029SL	5 - 7	Project
	AP-6818	94FW3030SL	10 - 12	Project
	AP-6818	94FW3031SL	15 - 17	Project
	AP-6819	94FW3032SL	0 - 2	Project
	AP-6819	94FW3033SL	6 - 8	Project
	AP-6819	94FW3036SL	10 - 12	Project
	AP-6819	94FW3037SL	15 - 17	Project
	AP-6820	94FW3038SL	0 - 2	Project
	AP-6820	94FW3041SL	5 - 7	Project
	AP-6820	94FW3042SL	10 - 12	Project
	AP-6820	94FW3043SL	15 - 17	Project

QA Quality assurance
QC Quality control

Four additional probes were installed in the north-central portion of the DRMO yard (P68 and P69), and in the area immediately northwest (P61 and P72) to evaluate the lateral and vertical extents of groundwater contamination. Groundwater Probes P61, P68, P69, and P72 were advanced approximately 10 feet into the aquifer and sampled. Each probe was then advanced in equal increments and resampled to assess the vertical migration of contaminants in groundwater. Groundwater samples were collected at depths of 10, 20, 30, 40, 50, and 60 feet below the groundwater surface in Ground-water Probes P68 and P69, at depths of 15, 20, 30, 40, 50, and 60 feet below the groundwater surface in Groundwater Probe 61, and at depths of 15, 25, 35, and 45 feet below the groundwater surface in Groundwater Probe P72.

Thirteen probes (P61, P62, and P70 through P80) were installed in the area northwest of the DRMO yard source area to evaluate the lateral extent of groundwater contamination downgradient. Five probes (P63 through P67) were installed adjacent to the south boundary of the DRMO yard source area to further evaluate the lateral extent of groundwater contamination. Two probes (PSLOUGH1 AND PSLOUGH2) were installed on the west side and downgradient of Channel B.

Groundwater Probes P05, P06, P21, P30, P34, P39, P61, P68, P69, P72 and P76 were selected for permanent installation and were completed with flush-mount, locking protective casings cemented in place. Groundwater probes, probes that were removed, and probes left in place but not completed are identified on Figure 3-1. A summary of groundwater samples collected at the DRMO yard source area is presented in Table 3-4.

Building 1168 Source Area

Groundwater probes were not installed as part of the Building 1168 source area investigation.

North Post Source Area

Seventeen groundwater probes were installed and sampled as part of the North Post source area investigation. Ten groundwater probes (P01 through P10) were installed at locations identified in the OU 2 RI/FS management plan (HLA, 1994b). Based on quick-turnaround laboratory analytical results, additional probes were installed during phase 2 to further define the lateral extent of contamination.

Seven groundwater probes (P11 through P17) were installed and sampled to define the lateral extent of petroleum hydrocarbon contamination downgradient of Sites 2 and 4. All groundwater probes at the North Post source area were removed. A summary of samples collected from groundwater probes at the North Post source area is presented in Table 3-4. Groundwater probe locations are shown on Figure 3-3.

3.9 Monitoring Well Installation

3.9.1 Installation Methodology

Monitoring wells were installed with a truck-mounted drilling rig using hollow-stem auger drilling methods. The auger size was at least 6 inches nominal inside diameter (ID). A geologist or engineer supervised the drilling and well installation, and prepared logs of the borings. Soil samples were collected as described in sections 3.5 and 3.6.

Standard Monitoring Well Construction

A summary of monitoring well installation details for wells installed during the OU 2 RI is presented in Appendix C. Monitoring well casings were constructed of a minimum 2-inch-diameter (2.375-inch outside diameter [OD] by 2.067-inch ID), Schedule 40, flush-joint, threaded polyvinyl chloride (PVC) pipe. Screens were Johnson 2-inch-diameter (3.63-inch OD by 2-inch-ID), 8-slot, PVC Vee-Pack (prepacked screen). All casing and screen sections were coupled with threaded joints; no PVC solvent or metal parts were used. The screen length was selected based on groundwater levels. Unless otherwise noted, approximately 10 feet of screen extends below the water table and approximately 5 feet extends above the water table in each well installed. Finished well depths were sufficient to evaluate

Table 3-4. Groundwater Probe Sample Summary for DRMO Yard and North Post Source Areas

Source Area	Location Number	Sample Number	Sample Type
DRMO Yard	P01	94FW01002WA	Project
	P02	94FW1011WA	Project
	P03	94FW1012WA	Project
	P04	94FW0132WA	Project
	P05	94FW0133WA	Project
	P06	94FW1045WA	Project
	P07	94FW1046WA	Project
	P08	94FW1054WA	Project
	P10	94FW1070WA	Project
	P11	94FW1072WA	Project
	P12	94FW1069WA	Project
	P13	94FW1055WA	Project
	P15	94FW1043WA	Project
	P16	94FW0134WA	Project
	P17	94FW1028WA	Project
	P18	94FW1013WA	Project
	P19	94FW1123WA	Project
	P20	94FW01001WA	Project
	P21	94FW01003WA	Project
	P22	94FW1010WA	Project
	P23	94FW1017WA	QA
	P23	94FW115WA	Project
	P23	94FW116WA	QC
	P24	94FW1027WA	Project
	P25	94FW0135WA	Project
	P26	94FW1044WA	Project
	P27	94FW1049WA	Project
	P28	94FW1056WA	Project
	P29	94FW1068WA	Project
	P30	94FW1071WA	Project
	P31	94FW10074WA	Project
	P31	94FW10075WA	QA
	P31	94FW10076WA	QC
	P32	94FW1067WA	Project
	P33	94FW1057WA	Project
	P34	94FW1050WA	Project
	P35	94FW1110WA	Project
	P36	94FW1037WA	Project
	P37	94FW1024WA	Project
	P38	94FW1018WA	Project
	P39	94FW1009WA	Project
	P41	94FW1005WA	Project
	P42	94FW1008WA	Project
	P43	94FW1019WA	Project

Table 3-4. Groundwater Probe Sample Summary for DRMO Yard and North Post Source Areas (continued)

Source Area	Location Number	Sample Number	Sample Type
DRMO Yard (continued)	P44	94FW1026WA	Project
	P45	94FW1038WA	Project
	P46	94FW1042WA	Project
	P46	94FW1089WA	Project
	P47	94FW1051WA	Project
	P47	94FW1090WA	Project
	P48	94FW1111WA	Project
	P49	94FW1062WA	Project
	P50	94FW10077WA	Project
	P51	94FW10082WA	Project
	P51	94FW10083WA	QA
	P51	94FW10084WA	QC
	P52	94FW1061WA	Project
	P53	94FW1058WA	Project
	P53	94FW1059WA	QA
	P53	94FW1060WA	QC
	P54	94FW1052WA	Project
	P55	94FW1040WA	PR/QA
	P55	94FW1041WA	QC
	P56	94FW1039WA	Project
	P57	94FW1025WA	Project
	P58	94FW1022WA	PR/QA
	P58	94FW1023WA	QC
	P59	94FW1007WA	Project
	P60	94FW1006WA	Project
	P61	94FW1091WA	Project
	P61	94FW1092WA	Project
	P61	94FW1093WA	Project
	P61	94FW1095WA	Project
	P61	94FW1096WA	Project
	P61	94FW1097WA	Project
	P61	94FW1098WA	Project
	P61	94FW1099WA	QC
	P62	94FW1094WA	Project
	P62	94FW1115WA	Project
	P62	94FW1116WA	QA
	P62	94FW1117WA	QC
	P63	94FW1100WA	Project
	P64	94FW1101WA	Project
	P65	94FW1102WA	Project
	P66	94FW1103WA	Project
	P67	94FW1104WA	Project
	P68	94FW1105WA	Project
	P68	94FW1107WA	Project

Table 3-4. Groundwater Probe Sample Summary for DRMO Yard and North Post Source Areas (continued)

Source Area	Location Number	Sample Number	Sample Type
DRMO Yard (continued)	P68	94FW1109WA	Project
	P68	94FW1120WA	Project
	P68	94FW1122WA	Project
	P68	94FW1125WA	Project
	P69	94FW1106WA	Project
	P69	94FW1108WA	Project
	P69	94FW1112WA	Project
	P69	94FW1119WA	Project
	P69	94FW1121WA	Project
	P69	94FW1124WA	Project
	P70	94FW1126WA	Project
	P70	94FW1127WA	QA
	P70	94FW1128WA	QC
	P71	94FW1129WA	Project
	P72	94FW1130WA	Project
	P72	94FW1138WA	Project
	P72	94FW1139WA	QA
	P72	94FW1139WA	QC
	P72	94FW1142WA	Project
	P72	94FW1147WA	Project
	P73	94FW1131WA	Project
	P74	94FW1132WA	Project
	P75	94FW1143WA	Project
	P76	94FW1137WA	Project
	P77	94FW1141WA	Project
	P78	94FW1144WA	Project
	P79	94FW1146WA	Project
	P80	94FW1145WA	Project
	PSLOUGH1	94FW10085WA	Project
	PSLOUGH2	94FW10086WA	Project
North Post	P01	94FW30001WA	Project
	P03	94FW30002WA	Project
	P04	94FW30003WA	Project
	P05	94FW30004WA	Project
	P06	94FW30005WA	Project
	P07	94FW30006WA	Project
	P08	94FW30008WA	Project
	P09	94FW30009WA	Project
	P10	94FW30014WA	Project
	P11	94FW3017WA	Project
	P12	94FW3025WA	Project
	P13	94FW3021WA	Project
	P14	94FW3022WA	Project
	P15	94FW3023WA	Project
	P16	94FW3024WA	Project
	P17	94FW3020WA	Project

QA Quality assurance
QC Quality control

chemical concentrations for most contaminants at each source area.

The formation was allowed to collapse to 2 feet above the screen. The casing and screen assemblies were capped at the bottoms and set by being lowered through the hollow stem of the auger to the proper depth or to the bottom of the boring.

Rough-cut bentonite was placed above the sand pack to the ground surface by adding bentonite as the auger was raised. Installations were completed by embedding a 5-foot-long, 6-inch-diameter steel pipe with a locking cap approximately 2 feet into the bentonite seal and over the well pipe. A 4-foot-diameter, 12-inch-thick gravel pad, sloping away from the well, was placed at the ground surface around the security casing. Locks were installed on all wells. The locks were set to a USACE-defined combination.

Three steel guard posts with a minimum diameter of 2 inches were typically installed 2 feet radially from each well head. The guard posts are 5 feet long and cemented in place. The security casing and guard posts were painted yellow. A marking flag was attached to the security casing to make it easy to find in the winter. The measuring point on the top of the casing was marked with a hacksaw cut or permanent ink. Monitoring well installation details are in Appendix C.

Well Development

Well development generally began no sooner than 48 hours after well construction was completed. Development was done using surge/purge methods for 60 minutes. Surging was accomplished with a surge block, and pumping was done with a pump and/or bailer. The adequacy of well development was evaluated by the field representative using parameters of specific conductance, water temperature, pH, DO, oxidation-reduction potential (REDOX), and turbidity measurements. A minimum of 10 well casing volumes were drawn from the well to assess whether stabilization of field parameters had occurred. Water quality was considered stabilized when all of the following were observed:

- The pH varied less than 0.1 pH unit in three consecutive samples.
- The temperature varied less than 0.1 degrees Celsius (°C) in three consecutive samples.
- The conductivity varied less than 5 percent in three consecutive samples.
- The DO varied less than 10 percent in three consecutive samples.
- The REDOX varied less than 10 percent in three consecutive samples.
- The turbidity was less than 25 NTUs.

After well development was completed, approximately 1 liter of water was collected in a clear jar. The jar was photographed and submitted as part of the project photographic log. Well development information was recorded on a Well Development Data form. Well Development Data Forms for all wells developed during the OU 2 RI are presented in Appendix C.

Water-Level Surveys

Water levels were measured using an electronic sounder (interface probe) and documented on well development and groundwater sampling forms. All monitoring wells at a site were surveyed at the time of groundwater sampling. The following protocols were employed while collecting water-level measurements:

- An electronic interface probe was used to monitor well water-level measurements and to measure the thickness of free product or film.
- The portion of the cable submerged below fluid levels in wells was cleaned according to the decontamination procedure described in the OU 2 RI/FS management plan (HLA, 1994b).
- Sounders were maintained in a clean and functional condition.
- Measurements were taken from a permanent, marked location on the PVC well casing.

Sampling Methodology

Immediately before purging, the static water level below the top of the well PVC casing and the total depth of the well were measured and recorded on the Groundwater Sampling Data Form. Whenever feasible, wells expected to be uncontaminated were sampled first, followed by wells with increasing levels of contamination. Wells were sampled when a minimum of 5 well-casing volumes had been purged from the well using a pump or bailer, and groundwater parameters had stabilized. Field measurements consisted of specific conductance, water temperature, pH, DO, REDOX, and turbidity. Water quality was considered stabilized when the following occurred:

- The pH varied less than 0.1 pH unit in three consecutive samples.
- The temperature varied less than 0.1°C in three consecutive samples.
- The conductivity varied less than 5 percent in three consecutive samples.
- The DO varied less than 10 percent in three consecutive samples.
- The REDOX varied less than 10 percent in three consecutive samples.
- The turbidity was less than 25 NTUs.

Wells that recharged slowly were purged dry, allowed to recharge, and purged again. If more than 4 hours were required to purge 5 well-casing volumes, the amount of fluid purged was measured and recorded, and the well was sampled after sufficient recharge (enough to collect a sample) had occurred. If a pump was used, low flow rates were maintained to minimize volatilization of organic compounds. All sampling equipment was decontaminated between sampling events and placed on disposable polyethylene plastic or aluminum foil sheeting to prevent cross-contaminating samples.

Samples were collected to be analyzed for total metals and dissolved metals. The dissolved metals sample was filtered in the field using a 0.45-micron filter. Any observations made during sampling, such as odor or sheen, were recorded in the field logbook.

3.9.2 Monitoring Well Locations by Source Area

DRMO Yard Source Area

Eight groundwater monitoring wells (AP-6799, AP-6800, and AP-6802 through AP-6807) were installed and sampled, and seven existing groundwater monitoring wells (AP-5623, AP-5764, AP-5765, AP-5823, AP-5824, AP-5825, and AP-5826) were sampled at the DRMO yard source area. Monitoring Well AP-6800 was installed as a deep well (screened from 50 to 60 feet below ground surface) and is located adjacent to the east boundary of the DRMO yard source area. Monitoring Wells AP-6799 and AP-6802 through AP-6807 were installed as shallow wells with approximately 10 feet of screen extending below the water table and 5 feet extending above the water table. Monitoring Well AP-6802 was installed as a background well and is located southeast of the DRMO yard source area. A summary of groundwater samples collected at the DRMO yard source area is presented in Table 3-5. Groundwater monitoring well locations and completion details are shown on Figures 3-1 and 3-4, respectively.

Building 1168 Source Area

Two groundwater monitoring wells (AP-6809 and AP-6808) were installed and sampled, and 11 existing wells (AP-5747, AP-5751, AP-5752, AP-5754, AP-5780, AP-5781, AP-5789, AP-5790, AP-6332, AP-6333, and AP-6334) were sampled at the Building 1168 source area. Monitoring Well AP-6808 was installed as a background well and is located upgradient of the source area. A summary of groundwater samples collected at the Building 1168 source area is presented in Table 3-5. Groundwater monitoring well locations and completion details are shown on Figures 3-2 and 3-5, respectively.

Table 3-5. Groundwater Monitoring Well Sample Summary for DRMO Yard, Building 1168, and North Post Source Areas

Source Area	Location Number	Sample Number	Sample Type
DRMO Yard	127	94FW1165WA	Project
	AP-5623	94FW1161WA	Project
	AP-5764	94FW1159WA	Project
	AP-5765	94FW1160WA	Project
	AP-5823	94FW1151WA	Project
	AP-5824	94FW1150WA	Project
	AP-5825	94FW1152WA	Project
	AP-5826	94FW1156WA	Project
	AP-5826	94FW1157WA	QA
	AP-5826	94FW1158WA	QC
	AP-6799	94FW1174WA	Project
	AP-6800	94FW1176WA	Project
	AP-6802	94FW1188WA	Project
	AP-6803	94FW1169WA	Project
	AP-6803	94FW1170WA	QA
	AP-6803	94FW1171WA	QC
	AP-6804	94FW1179WA	Project
	AP-6805	94FW1177WA	Project
	AP-6806	94FW1183WA	Project
	AP-6806	94FW1184WA	QA
	AP-6806	94FW1185WA	QC
	AP-6807	94FW1178WA	Project
Building 1168	AP-5747	94FW2005WA	Project
	AP-5747	94FW2006WA	QA
	AP-5747	94FW2007WA	QC
	AP-5751	94FW2015WA	Project
	AP-5752	94FW2002WA	Project
	AP-5754	94FW2024WA	Project
	AP-5780	94FW2012WA	Project
	AP-5781	94FW2001WA	Project
	AP-5789	94FW2014WA	Project
	AP-5790	94FW2013WA	Project
	AP-6332	94FW2004WA	Project
	AP-6333	94FW2008WA	Project
	AP-6334	94FW2009WA	Project
	AP-6808	94FW2021WA	Project
	AP-6808	94FW2022WA	QA
	AP-6808	94FW2023WA	QC
North Post	AP-6814	94FW3034WA	Project
	AP-6815	94FW3031WA	Project
	AP-6815	94FW3032WA	QA
	AP-6815	94FW3033WA	QC
	AP-6816	94FW3030WA	Project
	AP-6817	94FW3037WA	Project
	AP-6817	94FW3038WA	QC
	AP-6818	94FW3039WA	Project
	AP-6819	94FW3042WA	Project
	AP-6820	94FW3045WA	Project
	AP-6820	94FW3046WA	QA
	AP-6820	94FW3047WA	QC

QA Quality assurance
QC Quality control

North Post Source Area

Seven groundwater monitoring wells (AP-6814 through AP-6820) were installed and sampled at the North Post source area. All wells were installed as shallow wells with approximately 10 feet of screen extending below the water table and 5 feet extending above the water table. Monitoring Well AP-6818 was installed as a background well and is located upgradient of Sites 2 and 4. A summary of groundwater samples collected at the North Post source area is presented in Table 3-5. Groundwater monitoring well locations and completion details are shown on Figures 3-3 and 3-6, respectively.

3.10 Treatability Testing

Treatability testing was conducted as part of the OU 2 RI to provide design and operational information for use in evaluating the technical feasibility and cost-effectiveness of remedial technologies of interest. Soil-gas permeability and in situ respiration testing were conducted at the DRMO yard source area according to procedures presented in the Air Force Center for Environmental Excellence document on treatability testing (AFCEE, 1992). A pilot-scale treatability study was conducted at the Building 1168 source area. In addition, soil and groundwater samples were collected at both sites for laboratory treatability analyses. A summary of the OU 2 RI treatability testing is presented in the following sections.

3.10.1 DRMO Yard Source Area Treatability Testing

Based on relatively high concentrations of DRO encountered near Monitoring Well AP-6806 at the DRMO yard source area, soil-gas permeability and in situ respiration tests were conducted. The following wells and probes were installed as part of the testing:

- One vapor extraction system (VES) well (VES1) using conventional drilling techniques;
- Four impact-driven soil vapor probes (VP1, VP2, VP3, and VP4).

The vapor probes are constructed of nylon tubing attached to steel drive points equipped with vapor inlet holes. Data collected from the vapor probes were used to evaluate vertical changes in the vapor flow field and vapor chemical concentrations, and to provide an assessment of pressure response as a function of distance.

Well VES1 was constructed of flush-threaded, Schedule 40, 4-inch-diameter PVC well casing with a 10-foot screen section. The well was screened from 3.5 to 13.5 feet below ground surface. Soil samples collected during the installation of Well VES1 were submitted for laboratory treatability analyses including ammonia-nitrogen (EPA Method 305.1), total nitrogen (EPA Method 351), and nitrate-nitrogen (EPA Method 353.2). Vapor probe nest Probes VP1, VP2, and VP3 were installed 5, 10, and 15 feet, respectively, from Well VES1. Each vapor probe nest consists of two vapor probes installed at 3 feet and 6 feet below the ground surface (groundwater was encountered at 7 feet). A single vapor probe (VP4) was installed approximately 100 feet east of Well VES1 to monitor background conditions.

To implement the respiration test, 1 cubic foot per minute (cfm) of air with a 1 percent helium tracer was injected into vapor probe nest Probes VP1, VP2, and VP3. Following injection, the change of oxygen, carbon dioxide, and helium levels in the soil gas were measured over time. Helium was used as an inert tracer gas to assess the extent of soil-gas diffusion within the aerated zone, and to monitor the system for leaks. Before readings were taken, the monitoring point was purged for a few minutes until oxygen, carbon dioxide, and helium readings were constant. During the initial 8 hours of the test, readings were recorded at 2-hour intervals. During the following 16 hours of the test, readings were recorded at 4-hour intervals. Readings were then recorded every 8 to 12 hours for a period of 3 days. Oxygen and carbon dioxide levels were measured using a Landtec GA-90 Gas Analyzer; helium was measured using a Mark Products, Inc., Model 9821 Helium Detector.

To implement the soil-gas permeability test, an EG&G Rotron 10-horsepower regenerative blower, Model DR 8, was connected to Well VES1. An initial flow rate of 25 cfm and a vacuum of 20 inches of water were established at the extraction well, and the starting time was recorded to the nearest second. The dynamic vacuum response was recorded at the deep vapor probe within Probe VP2. Initially, the response was recorded at 5-second intervals. After 1 minute, the interval was extended to 20 seconds. After 2 minutes, the interval was extended to approximately 1 minute. After 5 minutes, the interval was extended to approximately 15 minutes and readings were collected from deep and shallow vapor probes in probe nest Probes VP1, PV2, and VP3, and at background location Probe VP4. After 1 hour, the interval was extended to approximately 1 hour. The test was terminated after approximately 4 ours, and repeated with flow rates of 40 and 60 cfm and vacuums of 32 and 43 inches of water. Field data were recorded on field summary sheets, which are presented in Appendix D.

3.10.2 Building 1168 Source Area Treatability Study

A pilot-scale AI/SVE treatability test system was installed at the Building 1168 source area to evaluate treatment effectiveness under representative field conditions. The pilot-scale system consists of an SVE blower and four extraction wells, an AI blower and one injection well, groundwater monitoring probes, soil-gas monitoring probes, and soil temperature monitoring thermistors. A discussion of the test objectives, and plans for system installation, startup, and monitoring are presented in HLA's December 14, 1994, Building 1168 Treatability Study Work Plan (1994c).

HLA plans to test and monitor the pilot-scale treatment system for approximately 1 year. Testing and monitoring consists of sampling soil, groundwater, and soil/SVE system vapor; testing contaminant respiration, vadose zone air flow permeability and radius of influence, and AI radius of influence, and monitoring dissolved oxygen and soil temperature. Results of startup testing and the first 3 months of monitoring are presented in HLA's Building 1168 Treatability Study Interim Report (1995a) and Monitoring Report (1995b)

3.11 Aquifer Testing

Previous investigations at Fort Wainwright have shown that the alluvial aquifer underlying the area is shallow (approximately 10 to 20 feet below ground), very thick (up to several hundred feet of saturated thickness), and highly transmissive (hydraulic conductivity on the order of 1×10^{-1} centimeters/second).

Hydraulic conductivity may be estimated by a variety of methods including geotechnical testing analytical results (i.e., sieve analysis), pump tests, or slug tests.

Hydraulic conductivity can be estimated from grain size distribution of granular porous media. Based on the grain size diameter (of soil samples collected from below the water table) at which 10 percent by weight of the soil particles are finer and 90 percent are coarser, hydraulic conductivity values at the DRMO Yard range from approximately 70 to 6,000 feet per day. Results of current USGS testing being conducted near the Chena River in the vicinity of the North Post source area indicate hydraulic conductivity values of approximately 100 to 300 feet per day. Determining hydraulic conductivity using geotechnical results may be somewhat limited in accurately depicting subsurface conditions.

Traditional pump tests were not used to estimate hydraulic characteristics at each of the source areas because large quantities of potentially contaminated water would be produced.

HLA used slug tests to evaluate the hydraulic conductivity at the OU2 source areas. To collect data that best represents natural subsurface conditions, the slug tests were performed using 0.008-inch slotted probes in the natural formation. Estimated hydraulic conductivities for each source area at OU2 are presented in sections 4.1.2, 4.2.2, and 4.3.2, and range from 8 to 33 feet/day. Dr. Dan Lawson of CRREL noted that HLA's hydraulic conductivity value (slug test) is

the largest value recorded to date at Fort Wainwright. The HLA slug tests are described in the following section.

3.11.1 Slug Tests

Slug tests were completed following ASTM Test Method D 4044-91, "Field Procedure for Instantaneous Change in Head (Slug Tests) for Determining Hydraulic Properties of Aquifers." The slug test method involved causing a sudden change in head in a test well and measuring the water-level response within the test well.

Slug withdrawal tests at the OU 2 source areas were performed in 0.008-slot screened test probes installed in the natural formation. The top of the screened interval was below the lowest water level achieved during the test. Shallow probes with screened intervals spanning the top of the water table were not used for slug testing.

Prior to starting a slug test, the water levels in the test probe, and in other nearby wells or probes were measured to establish the static water level. A mechanical or pressure-induced "slug" was then used to displace a known volume of water in the test probe, and the water level was allowed to equilibrate to ambient conditions. The slug was then quickly removed (or the pressure released) and the water-level response measured.

Slug test data were analyzed using the methodology developed by Bouwer and Rice for determining the hydraulic conductivity of unconfined aquifers with partially penetrating wells (1976). The locations of slug test probes for DRMO yard, Building 1168, and North Post source areas are shown on Figures 3-1 through 3-3, respectively.

3.12 Surveying

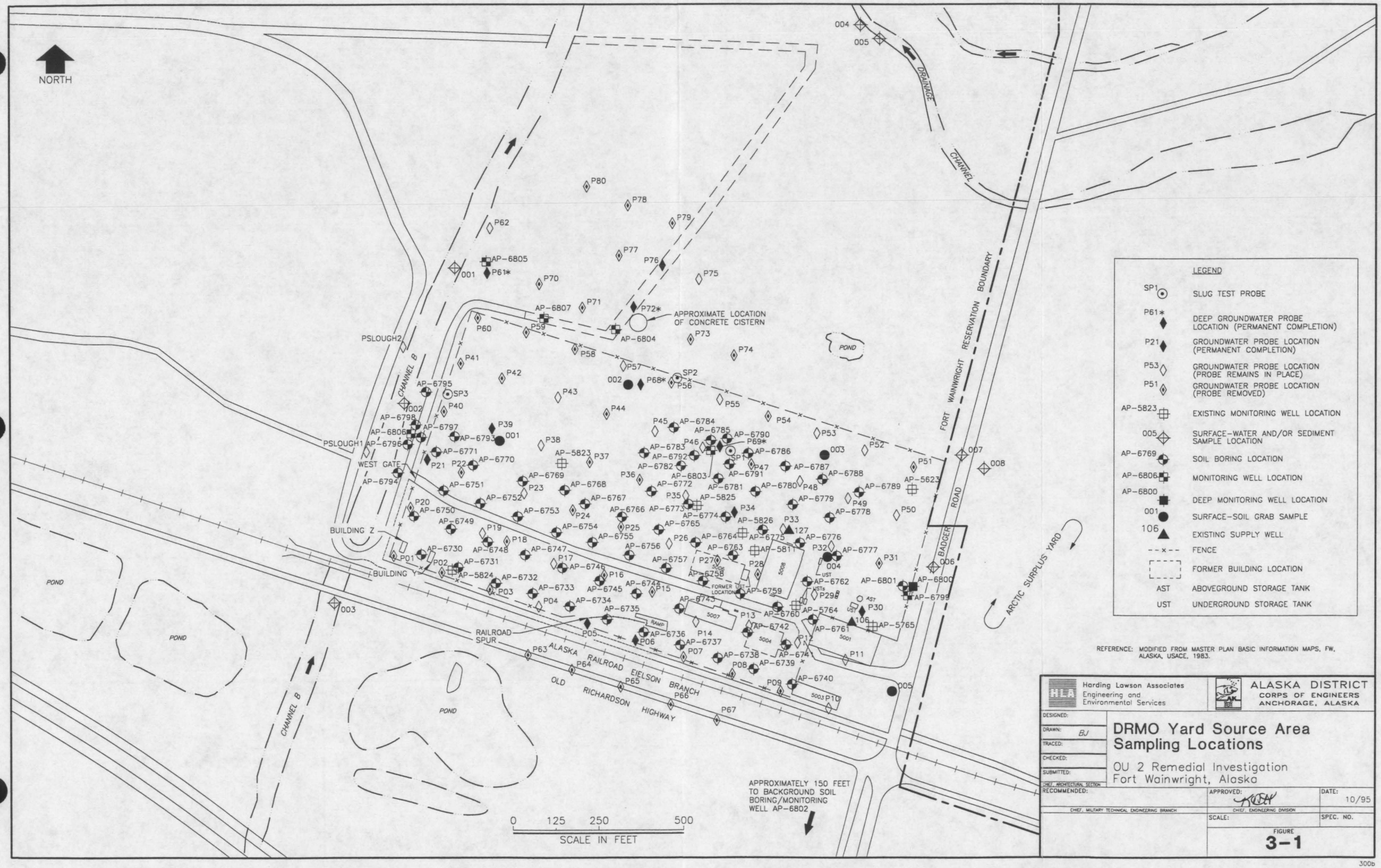
Site surveying was conducted to provide ground elevations and horizontal locations for soil borings, monitoring wells, surface-soil samples, groundwater probes, surface-water and sediment samples, and the elevation of the tops of the PVC monitoring well casings. At the DRMO yard source area, the horizontal and vertical coordinates of selected geophysical grid control points were also surveyed. Elevations were measured to an accuracy of 0.01 foot, and horizontal locations were measured to an accuracy of 1.0 foot. The surveys were referenced to an existing grid system used at Fort Wainwright. Survey data generated during the OU 2 RI is presented in Appendix E.

3.13 Field and System Audits

In accordance with the Quality Assurance Project Plan and HLA's internal QC program, the following field and system audits were performed during the OU2 RI:

- Field Investigation Audit
- Office Operations System Audit
- Quality Assurance Field Audit

Reports of these audits are included in Appendix L.



REFERENCE: MODIFIED FROM MASTER PLAN BASIC INFORMATION MAPS, FW, ALASKA, USACE, 1983.

Harding Lawson Associates
Engineering and Environmental Services

ALASKA DISTRICT
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED:
DRAWN: BJ
TRACED:
CHECKED:
SUBMITTED:
CHIEF, ARCHITECTURAL SECTION
RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH

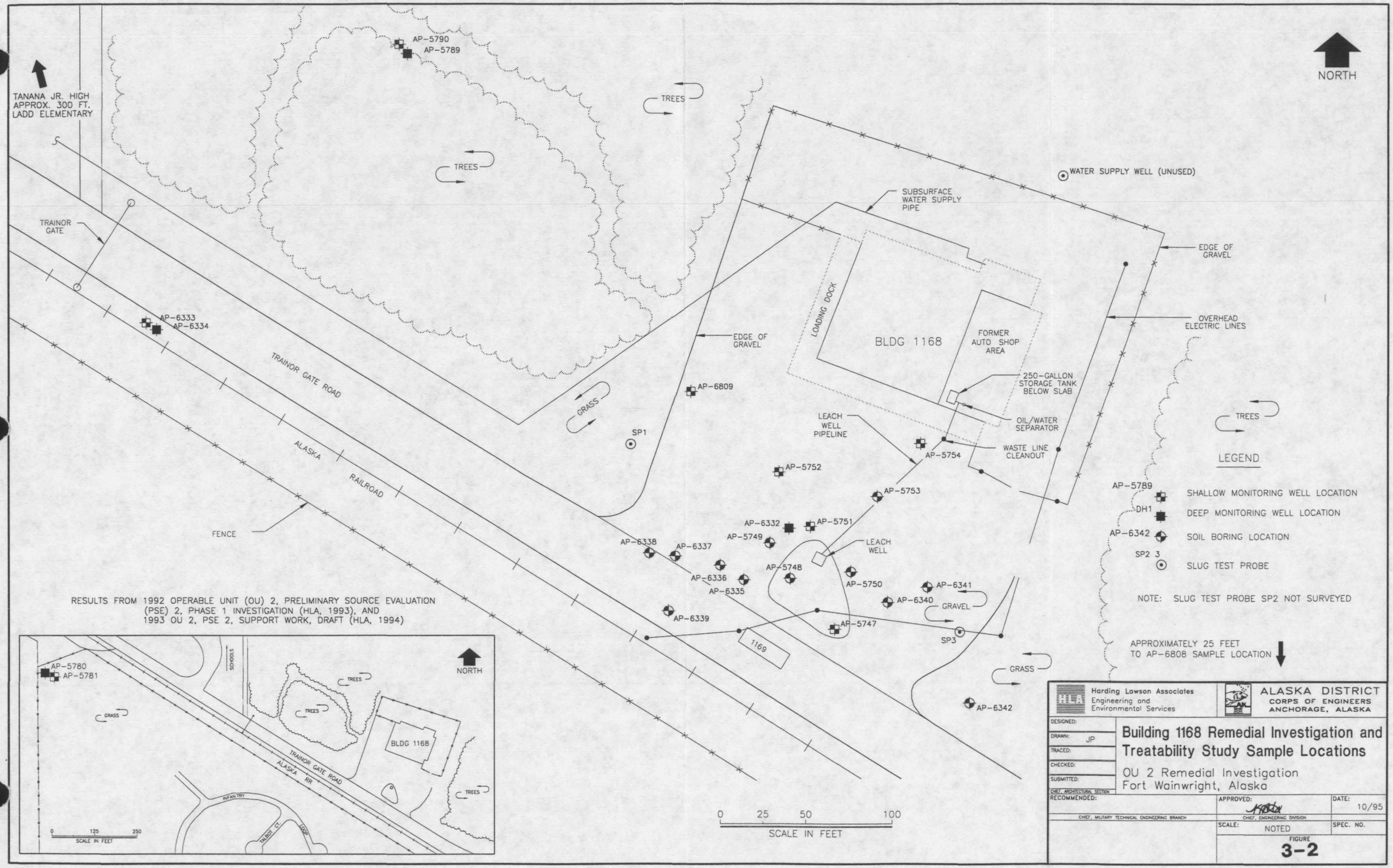
DRMO Yard Source Area Sampling Locations

OU 2 Remedial Investigation
Fort Wainwright, Alaska

APPROVED:
CHIEF, ENGINEERING DIVISION
DATE: 10/95
SCALE:
SPEC. NO.

FIGURE
3-1

300b



Harding Lawson Associates
Engineering and Environmental Services

ALASKA DISTRICT
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED:
DRAWN: JP
TRACED:
CHECKED:
SUBMITTED:
CHIEF, ARCHITECTURAL SECTION
RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH

Building 1168 Remedial Investigation and Treatability Study Sample Locations

OU 2 Remedial Investigation
Fort Wainwright, Alaska

APPROVED:
CHIEF, ENGINEERING DIVISION

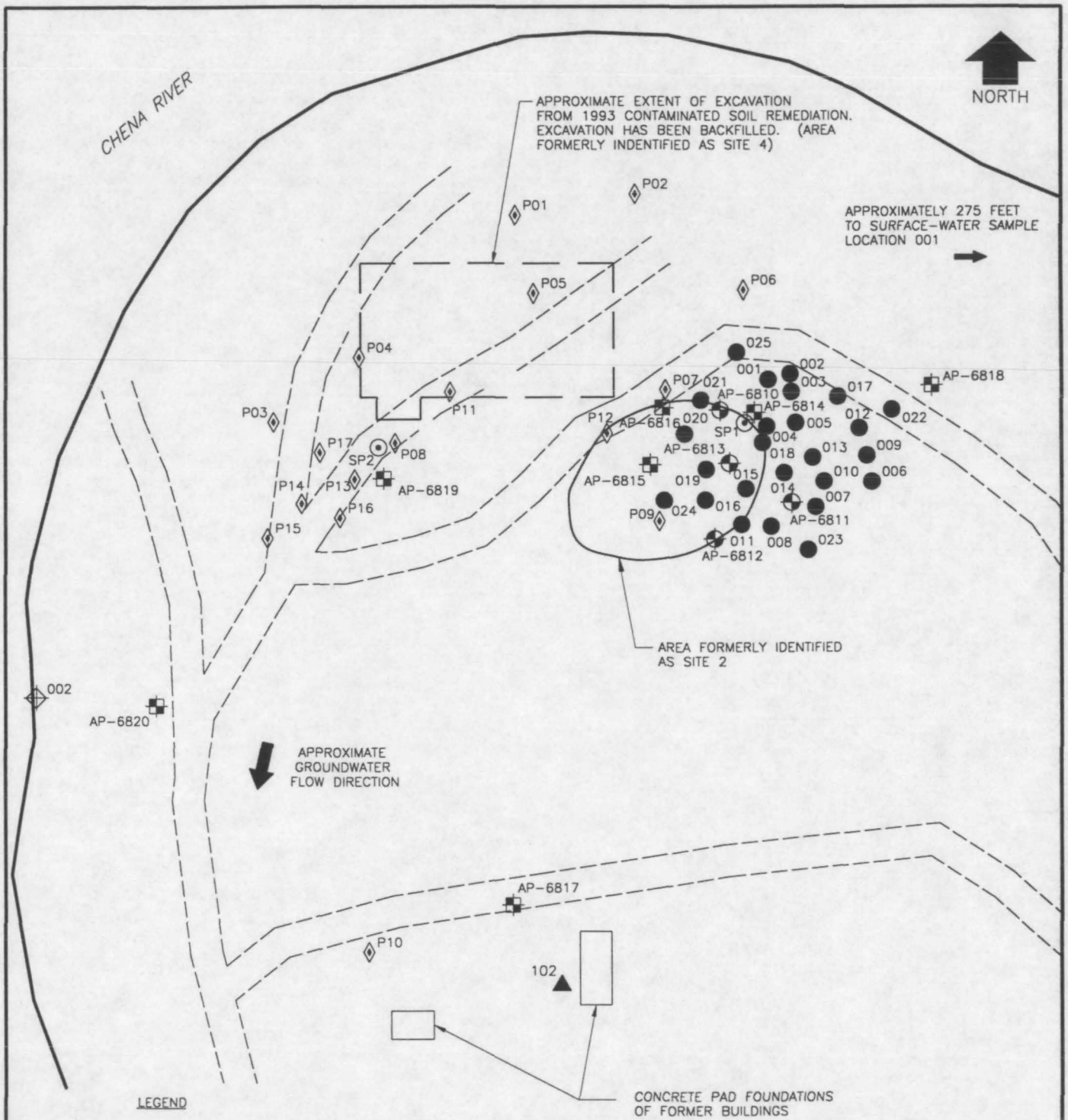
DATE: 10/95

SCALE: NOTED

SPEC. NO.

FIGURE
3-2

312b



LEGEND

- 002 — SURFACE-WATER AND/OR SEDIMENT SAMPLE LOCATION
- SP2 — SLUG TEST PROBE
- P03 — GROUNDWATER PROBE LOCATION (PROBE REMOVED)
- AP-6815 — MONITORING WELL LOCATION
- 001 — SURFACE-SOIL GRAB SAMPLE
- 102 — EXISTING SUPPLY WELL
- AP-6810 — SOIL BORINGS

0 50 100 200
SCALE IN FEET

REFERENCE: FORT WAINWRIGHT ENVIRONMENTAL MONITORING NETWORK REPORT, USACE, 1992.

Harding Lawson Associates
Engineering and Environmental Services

ALASKA DISTRICT
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED:
DRAWN: PB
TRACED:
CHECKED:
SUBMITTED:
CHIEF, ARCHITECTURAL SECTION

North Post Source Area Sampling Locations

OU 2 Remedial Investigation
Fort Wainwright, Alaska

RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH

APPROVED:
CHIEF, ENGINEERING DIVISION

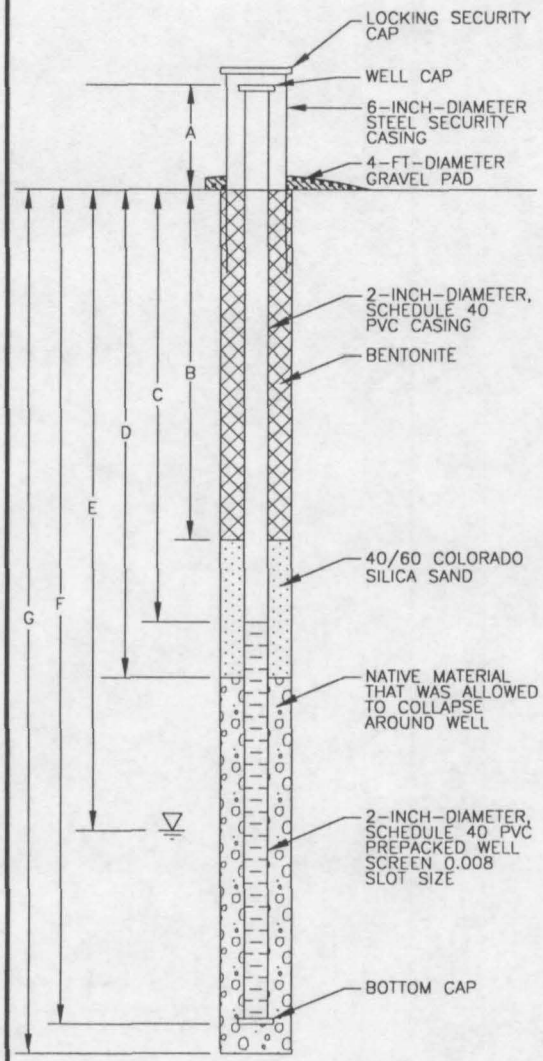
DATE: 10/95

SCALE: NOTED

SPEC. NO.

FIGURE
3-3

303b



WELL NUMBER	DATE OF WATER LEVEL READING	GROUND ELEVATION FT(MSL)	PVC ELEVATION FT(MSL)	A CASING STICK UP FT(AGS)	B DEPTH TO SANDPACK FT(BGS)	C DEPTH TO SCREEN FT(BGS)	D DEPTH TO COLLAPSED FORMATION FT(BGS)	E DEPTH TO GROUNDWATER FT(BTOC)	F WELL DEPTH FT(BTOC)	G BORING DEPTH FT(BGS)
AP-6799	9/14/94	451.7	453.61	1.91	2.0	2.9	5.5	9.26	18.4	19.0
AP-6800	9/21/94	451.7	454.34	2.64	NA	48.0	43.0	10.15	58.5	60.0
AP-6802	9/23/94	451.3	454.04	2.74	2.0	2.6	4.0	8.95	18	18.0
AP-6803	9/14/94	451	453.99	2.99	2.5	3.0	4.0	10.51	18.4	18.5
AP-6804	9/21/94	450.3	453.59	3.29	2.5	3.0	9.0	10.66	18.4	18.5
AP-6805	9/21/94	450.4	453.25	2.85	2.5	3.0	4.5	10.84	18.4	18.5
AP-6806	9/21/94	450.6	453.69	3.09	2.0	2.1	3.0	11.27	17.5	18.0
AP-6807	9/21/94	450	453.02	3.02	2.5	2.6	4.5	10.36	18.0	18.0

BGS – BELOW GROUND SURFACE
BTOC – BELOW TOP OF CASING
TOC – TOP OF CASING
FT – FEET
MSL – MEAN SEA LEVEL
PVC – POLYVINYL CHLORIDE
AGS – ABOVE GROUND SURFACE
NM – NOT MEASURED
NA – NOT APPLICABLE

NOTE: MONITORING WELL AP-6802 WAS INSTALLED AS A BACKGROUND WELL.

NOT TO SCALE

Harding Lawson Associates
Engineering and Environmental Services

ALASKA DISTRICT
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

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TRACED:
CHECKED:
SUBMITTED:
CHIEF, ARCHITECTURAL SECTION

DRMO Yard Source Area Monitoring Well Completion Detail

OU 2 Remedial Investigation
Fort Wainwright, Alaska

RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH

APPROVED:
CHIEF, ENGINEERING DIVISION

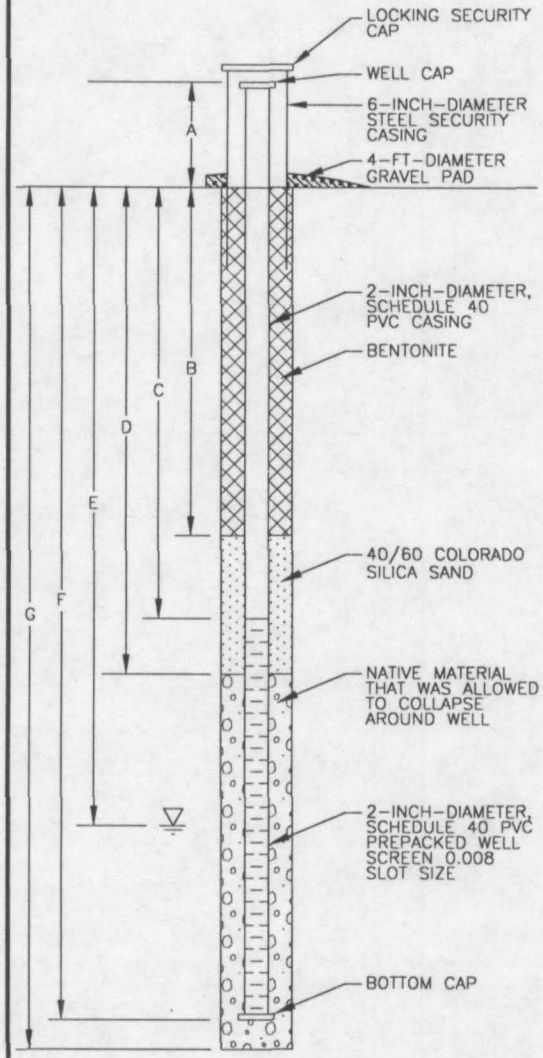
DATE: 10/95

SCALE:

SPEC. NO.

FIGURE
3-4

335b



WELL NUMBER	DATE OF WATER LEVEL READING	GROUND ELEVATION FT(MSL)	PVC ELEVATION FT(MSL)	A CASING STICK UP FT(AGS)	B DEPTH TO SANDPACK FT(BGS)	C DEPTH TO SCREEN FT(BGS)	D DEPTH TO COLLAPSED FORMATION FT(BGS)	E DEPTH TO GROUNDWATER FT(BTOC)	F WELL DEPTH FT(BTOC)	G BORING DEPTH FT(BGS)
AP-6808	9/2/94	442	444.89	2.89	7.0	9.0	9.0	17.16	24.4	25.0
AP-6809	NA	442	444.56	2.56	7.0	9.0	11.0	NM	25.0	25.0

BGS – BELOW GROUND SURFACE
BTOC – BELOW TOP OF CASING
TOC – TOP OF CASING
FT – FEET
MSL – MEAN SEA LEVEL
PVC – POLYVINYL CHLORIDE
AGS – ABOVE GROUND SURFACE
NM – NOT MEASURED
NA – NOT APPLICABLE

NOTE: MONITORING WELL AP-6808 WAS INSTALLED AS A BACKGROUND WELL.
MONITORING WELL AP-6809 WAS INSTALLED AS A PRESSURE TRANSDUCER WELL.

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Building 1168 Source Area Monitoring Well Completion Detail

OU 2 Remedial Investigation
Fort Wainwright, Alaska

RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH

APPROVED:
CHIEF, ENGINEERING DIVISION

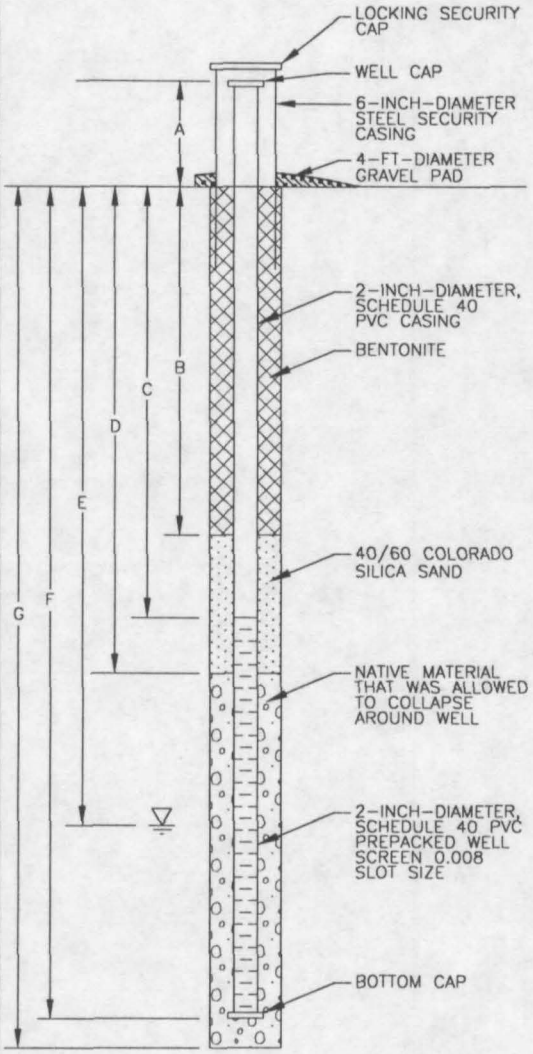
DATE: 10/95

SCALE:

SPEC. NO.

FIGURE
3-5

335b



WELL NUMBER	DATE OF WATER LEVEL READING	GROUND ELEVATION FT(MSL)	PVC ELEVATION FT(MSL)	A CASING STICK UP FT(AGS)	B DEPTH TO SANDPACK FT(BGS)	C DEPTH TO SCREEN FT(BGS)	D DEPTH TO COLLAPSED FORMATION FT(BGS)	E DEPTH TO GROUNDWATER FT(BTOC)	F WELL DEPTH FT(BTOC)	G BORING DEPTH FT(BGS)
AP-6814	9/9/94	446.35	448.48	2.13	9.5	11.5	13.5	18.25	26.8	28.0
AP-6815	9/9/94	446	449.08	3.08	7.5	10.0	11.0	18.84	25.3	28.0
AP-6816	9/9/94	445.9	448.695	2.795	8.0	10.2	13.0	18.45	25.5	28.0
AP-6817	9/10/94	443.1	445.88	2.78	7.0	9.3	9.0	15.69	24.6	25.0
AP-6818	9/10/94	445.2	447.85	2.65	8.0	10.0	10.0	17.59	25.4	25.4
AP-6819	11/15/94	439.89	442.95	3.06	3.0	4.6	5.0	12.86	20.0	20.0
AP-6820	NA	441.45	444.49	3.04	4.0	6.1	5.5	NM	21.5	21.5

BGS – BELOW GROUND SURFACE
BTOC – BELOW TOP OF CASING
TOC – TOP OF CASING
FT – FEET
MSL – MEAN SEA LEVEL
PVC – POLYVINYL CHLORIDE
AGS – ABOVE GROUND SURFACE
NM – NOT MEASURED
NA – NOT APPLICABLE

NOTE: MONITORING WELL AP-6818 WAS INSTALLED AS A BACKGROUND WELL.

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CHIEF, ARCHITECTURAL SECTION

North Post Source Area Monitoring Well Completion Detail

OU 2 Remedial Investigation
Fort Wainwright, Alaska

RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH

APPROVED:
CHIEF, ENGINEERING DIVISION

DATE: 10/95

SCALE:

SPEC. NO.

FIGURE
3-6

335b

4.0 LITHOLOGY AND HYDROLOGY

Data presented in this section describe site-specific soil characteristics and hydrology based on HLA's RI.

4.1 DRMO Yard Source Area

During HLA's 1994 field investigation, 78 soil borings were drilled at the DRMO yard source area to depths ranging from 12.0 to 60.0 feet below ground surface. Eight borings were converted to groundwater monitoring wells with completion depths ranging from 18.0 to 60.0 feet below ground surface. Figure 3-1 presents boring and monitoring well locations at the DRMO yard source area. Lithologic descriptions are presented on the boring logs in Appendix A.

4.1.1 Lithology

Subsurface soil at the DRMO yard source area consists of layers of unconsolidated silty sand, gravel, silt, and alluvial deposits of sand and gravel. A subsurface profile of the DRMO source area is presented on Figures 4-1 and 4-2.

Based on HLA's inspections of aerial photographs of the DRMO yard source area taken during the 1930s, field observations of surrounding marsh lands, and lithologic descriptions of soil borings, surface soil at the site can be categorized as fill material, which is approximately 3 to 6 feet deep.

Silt and silty sand extend to an average depth of 4.5 feet below ground surface in most borings. However, this fine-grained soil ranges in depth from 1.5 feet in Boring AP-6786 to 9.0 feet in Borings AP-6737 and AP-6791. A layer of loose, brown silt ranging from less than 6 inches to 48 inches in thickness is present throughout most of the site. A layer of very loose to loose silty sand and gravel ranging from less than 6 inches to 30 inches in thickness overlies the silt layer. In the south section of the DRMO yard source area (Borings AP-6730 through AP-6750), approximately 3 feet of silt and 2 feet of overburden overlie loose to medium dense, mostly coarse-grained deposits of sand and gravel. In Borings AP-6736 through AP-6739 and AP-6741 through AP-6744, fine-grained sand underlies the silt layer. This sand layer is shallow in the easterly borings and deeper in Boring AP-6744.

Interbedded silty sand occurs more frequently toward the center of the site (Borings AP-6751 through AP-6771). The silt layer is consistent in thickness in the easterly borings; however, it phases out briefly in Borings AP-6758 and AP-6763. The silt layer is exposed at the surface in Borings AP-6756 and AP-6766, and abruptly ends west of Borings AP-6751 and AP-6740. Fine-grained sand deposits continue to appear in borings directly north of Boring AP-6744, with the deepest deposits in Boring AP-6757. Cross sections of the sand unit indicate that a channel may have intersected the site previously (Figures 4-1 and 4-2).

The silt layer is also at the surface in Borings AP-6774 and AP-6779 and in borings surrounding Boring AP-6803 (with the exceptions of Borings AP-6772, AP-6780, and AP-6784). Shallow beds of alternating fine-grained sand and sandy gravel only occur beneath the silt layer in Borings AP-6774, AP-6779, AP-6781, AP-6786, and AP-6787.

Logs for Borings AP-6793 through AP-6798 and AP-6806, which are located near the west gate of the DRMO yard source area, document material in the area as loose to medium-dense silty gravel underlain by sandy gravel. Two borings, AP-6804 and AP-6805, drilled north of the site indicate silty sand overlying sandy gravel. Boring AP-6807, also drilled north of the site, indicates as much as 6 feet of silt over sandy gravel.

Geotechnical analysis verified that sand and gravel at the DRMO yard source area are poorly graded, with a silt content of .03 to 39.8 percent. The moisture content of soil in the vadose zone ranges from 2.7 to 26.7 percent.

4.1.2 Hydrology

Groundwater

Groundwater at the DRMO yard source area is encountered at approximately 7.5 feet below ground surface in an unconfined aquifer consisting of poorly graded, coarse-grained deposits of sand and gravel. Groundwater levels collected during the RI (Table 4-1) indicate groundwater flow in a northwest direction. Based on information presented in CRREL's report (1994), groundwater is recharged by the Tanana River, and ice formation on the Tanana River increases the hydrostatic pressure on the groundwater system resulting in fluctuations of water table elevations. A groundwater contour map presented on Figure 4-3 indicates a horizontal hydraulic gradient across the DRMO yard source area of approximately 0.00124. Slug tests were performed in three probes: Probe SP-1 near Boring AP-6791, Probe SP-2 north of Boring AP-6784, and Probe SP-3 east of Boring AP-6795. Aquifer hydraulic conductivity was measured to be approximately 22 feet per day, based on the average value of measurements in the three slug probes. Slug test field results are in Appendix F. Slug test probe locations are shown on Figure 3-1.

Surface Water

The topography at the DRMO yard source area grades gently to the north and northwest. However, numerous depressions and the presence of silty soil may promote surface-water ponding. Surface-water runoff from portions of the northeastern section of the yard drain east into a drainage ditch adjacent to Badger Road. The ditch conveys flow to the north, eventually to the Chena River. Surface-water runoff from portions of the western section of the yard may enter Channel B, a rip-rapped drainage conveyance that parallels the west boundary and runs north approximately 1 mile to the Chena River. Groundwater flow direction during the RI inclined toward Channel B. Survey data collected on October 3, 1994, indicated the level of surface water in Channel B was slightly lower than groundwater elevations collected from monitoring wells on September 16 and 21, 1994. Groundwater appeared to discharge to Channel B. Seasonal variations of groundwater flow to Channel B due to flooding are unknown.

A shallow stream bed located north of the DRMO yard source area was dry during the RI; however, it may serve as a channel for surface-water runoff to the Chena River during spring breakup and heavy precipitation. A small pond is located approximately 150 feet north of the DRMO yard source area. The pond does not discharge into a well-defined surface drainage system and the relationship of the pond to groundwater is unknown. Areal photographs show a large gravel-pit lake located south of the DRMO yard source area and north of the Richardson Highway.

4.2 Building 1168 Source Area

During the 1994 field investigation, two soil borings were drilled at the Building 1168 source area to depths of 27.0 feet below ground surface. Both borings were converted to groundwater monitoring wells with completion depths of approximately 24.0 feet below ground surface. Figure 3-2 presents the locations of monitoring wells drilled during the RI and borings drilled during past area investigations that are used to interpret groundwater flow direction and subsurface soil at the site. Lithologic descriptions are presented on boring logs in Appendix A.

4.2.1 Lithology

Subsurface soil at the Building 1168 source area consists of unconsolidated lenses of interlayered silt, silty sand, and poorly graded sand and gravel, underlain by sandy gravel. A subsurface profile of the Building 1168 source area is presented on Figures 4-4 and 4-5.

Fine-grained silt deposits appear as shallow lenses within silty sand and sand, and are mostly overlain by silty gravel. Wide variations of these lenses may indicate mechanical disturbance of soil from past excavations. Silty gravely surface soil is predominantly fill material, likely laid down when the Building 1168 parking lot was

Table 4-1. Groundwater Elevation at the DRMO Yard Source Area

Monitoring Well Number	Date of Water Level Reading	Ground Elevation (feet above MSL)	PVC Elevation (feet above MSL)	Depth to Water (feet BTOC)	Water Elevation (feet above MSL)
AP-6799	9/14/94	451.7	453.61	9.26	444.35
AP-6800	9/21/94	451.7	454.34	10.15	444.19
AP-6802	9/23/94	451.3	454.04	8.95	445.09
AP-6803	9/14/94	451	453.98	10.51	443.47
AP-6804	9/21/94	450.3	453.59	10.66	442.93
AP-6805	9/21/94	450.4	453.25	10.84	442.41
AP-6806	9/21/94	450.6	453.69	11.27	442.42
AP-6807	9/21/94	450	453.02	10.36	442.66
AP-5623	9/13/94	NM	452.21	8.08	444.13
AP-5764	9/13/94	452.43	452.73	8.85	443.88
AP-5765	9/13/94	452.75	454.5	11.02	443.48
AP-5823	9/12/94	449.95	451.91	8.85	443.06
AP-5824	9/12/94	451.36	453.8	10.96	442.84
AP-5825	9/12/94	451.21	453.49	9.87	443.62
AP-5826	9/12/94	451.43	453.49	9.78	443.71

BTOC Below top of casing
MSL Mean sea level
NM Not measured
PVC Polyvinyl chloride

constructed. Silty soil also appears east of the parking lot in Boring AP-6808, extending from ground surface to a depth of approximately 11 feet. Groundwater appears below the silt and silty sand in all borings except in Boring AP-6332, where a 1-foot silt lens and 7 feet of silty sand were detected approximately 6 feet below the water table. The moisture content of soil in the vadose zone ranges from approximately 1.9 to 26.8 percent.

Near-surface sand and silt are underlain primarily by poorly graded, loose to medium-dense, saturated, sandy gravel that is highly permeable. Occasional layers of sand are interbedded with the sandy gravel. The silt content of the sand and gravel ranges from 0.7 to 31.1, and generally decreases with depth.

4.2.2 Hydrology

Groundwater

Groundwater at the Building 1168 source area was encountered between 13 and 16 feet below ground surface. No confining layers were detected during the RI. Water level elevations measured during the RI are presented on Table 4-2. A groundwater contour map presented on Figure 4-6 indicates groundwater flow direction during September 1994 was to the northwest with a horizontal hydraulic gradient across the site of approximately 0.00019. Water level elevations measured at the Building 1168 source area in September 1993 were approximately 1 foot higher, and indicated groundwater flow in a more westerly direction, and a hydraulic gradient of 0.0003 (HLA, 1994a). Although additional water level data are being collected by CRREL, sufficient data have not been collected to report groundwater level fluctuations. Seasonal fluctuations in groundwater levels of 5 to 7 feet are expected. Slug tests were performed in three slug test probes, SP-1, SP-2, and SP-3. Aquifer hydraulic conductivity was measured to be approximately 33 feet per day based on the average value of measurements collected from the slug test probes.

Surface Water

The topography at the Building 1168 source area is relatively flat, and defined surface drainage pathways were not observed during the RI. During periods of high precipitation and spring snow melt, surface water may flow overland to low-lying areas north and southeast of the site. The nearest surface water is the Chena River. The overland distance between the Building 1168 source area and the Chena River is approximately 1,800 feet to the east and is heavily vegetated.

4.3 North Post Source Area

During the 1994 field investigation, 11 soil borings were drilled at the North Post source area to depths ranging from 17.0 to 27.0 feet below ground surface. Seven borings were completed as groundwater monitoring wells with depths ranging from 20.0 to 27.0 feet below ground surface. Figure 3-3 presents boring and monitoring well locations at the North Post source area. Lithologic descriptions are presented on boring logs in Appendix A.

4.3.1 Lithology

Subsurface soil encountered at the North Post source area is representative of floodplain deposits, and consists of unconsolidated lenses of interbedded silt, silty sand, and poorly graded sand underlain by sandy gravel. Wide variations of these lenses may indicate mechanical disturbances to the soil from past excavations and landfill practices. A subsurface profile of the North Post source area is presented on Figures 4-7 and 4-8.

A silt layer overlying coarse-grained deposits present in eight borings ranged in thickness from approximately 0.5 feet in Boring AP-6740 to 8.0 feet in Boring AP-6815. The silt was mostly interbedded and overlain with poorly graded sand and silty sand; however, the silt layer was also apparent at the ground surface in Borings AP-6815 and AP-6816. Silt extended to a depth of 12.5 feet in Boring AP-6816 and was highly interbedded with sand having a low silt content. The silt layer was absent in Borings AP-6818,

Table 4-2. Groundwater Elevation at the Building 1168 Source Area[a]

Monitoring Well Number	Date of Water Level Reading	Ground Elevation (feet above MSL)	PVC Elevation (feet above MSL)	Depth to Water (feet BTOC)	Water Elevation (feet above MSL)
AP-6808	9/2/94	442	444.89	17.16	427.73
AP-5747	9/2/94	443.1	444.89	17.22	427.67
AP-5751	9/2/94	442.3	444.73	17.06	427.67
AP-5752	9/2/94	442.3	441.77	14.1	427.67
AP-5754	9/2/94	443.3	445.57	17.88	427.69
AP-5780[b]	9/2/94	338.8	NM	16.58	NM
AP-5781[b]	9/2/94	441.4	442.73	15.18	427.55
AP-5789	9/2/94	441.8	444.91	17.3	427.61
AP-5790	9/2/94	441.6	444.03	16.4	427.63
AP-6632	9/2/94	442.3	441.46	13.79	427.67
AP-6633	9/2/94	443.5	443.17	15.55	427.62
AP-6634	9/2/94	443.5	443.16	15.55	427.61

BTOC Below top of casing
MSL Mean sea level
NM Not measured
PVC Polyvinyl chloride

a. Survey data from HLA, 1994a
b. Existing survey data from USACE, 1993

AP-6811, and AP-6812; however, silty sand was present to depths of 3.5 and 8.5 feet. The moisture content of near-surface soil ranged from 1.5 percent to 24.6 percent and the water table was encountered below the silt layer.

Groundwater occurs in material that is predominately poorly graded, loose to medium-dense, saturated, sandy gravel with occasionally interbedded sand. These deposits are highly permeable and have a silt content ranging from 0.8 percent to 4.2 percent that generally decreases with depth. Gravel was observed at the surface in Boring AP-6820, underlain by a layer of silt.

4.3.2 Hydrology

Groundwater

Groundwater at the North Post source area was encountered in a shallow unconfined aquifer approximately 15.0 feet below ground surface in all borings except Boring AP-6819 and AP-6820, where groundwater was encountered at 10.0 feet below ground surface. Based on data presented in CRREL's report (1994), water table elevations may fluctuate by 5 feet depending on the changing stage of the Chena River.

Water level elevations collected during the RI are presented in Table 4-3. A groundwater contour map presented on Figure 4-9 indicates groundwater flow to the southwest and a horizontal hydraulic gradient across the site of approximately 0.00031. Slug tests were performed in two probes, SP-1 and SP-2, located adjacent to Borings AP-6814 and AP-6819, respectively. Aquifer hydraulic conductivity was measured to be approximately 8 feet per day based on the average value of measurements collected from both slug test probes.

Based on data collected from north of the Chena River and west of the North Post source area, as presented in CRREL's report (1994), dramatic changes occur in groundwater flow direction and gradient with changing stages of the Chena River. During low-stage winter months, groundwater flow discharges to the Chena River.

During high-stage events corresponding to spring breakup and flooding, the Chena River appears to recharge groundwater at the site. Because the North Post source area lies within an oxbow on the south side of the Chena River, groundwater flow beneath the site appears to be consistently to the southwest, recharging from the upstream side and discharging to the downstream side of the oxbow peninsula. Variations in groundwater flow direction were not observed during the RI.

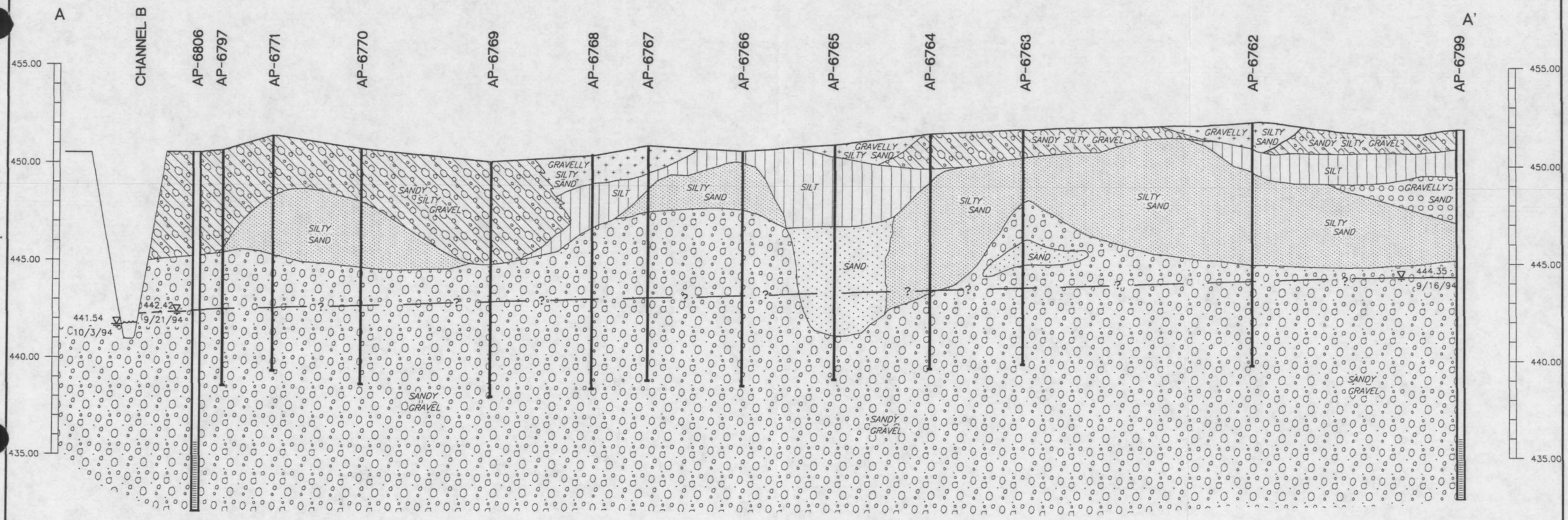
Surface Water

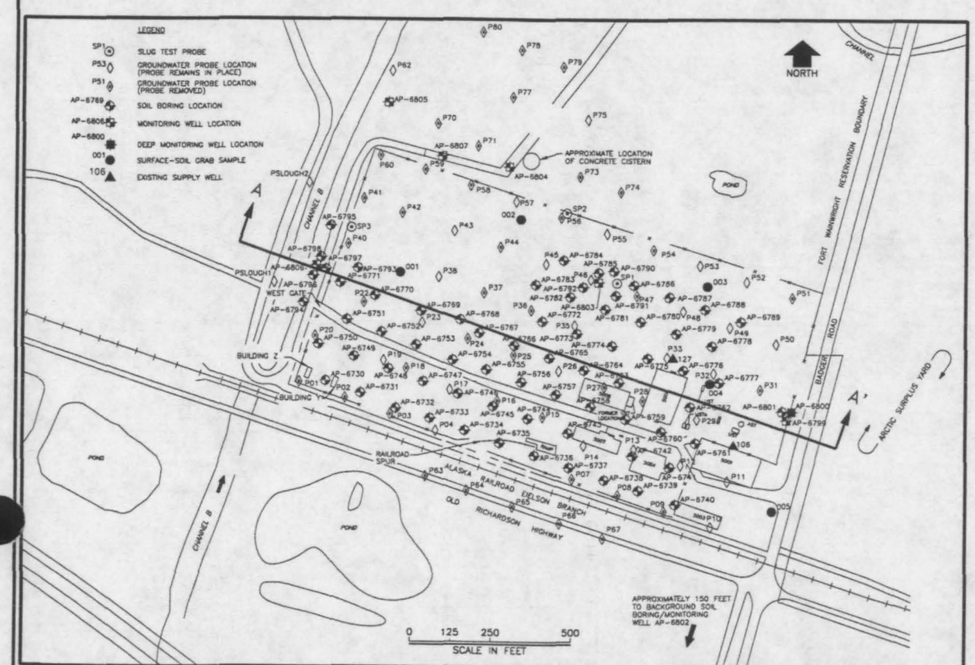
The North Post source area lies on a floodplain bordered by the Chena River on the north and west. The topography at the North Post source area is relatively flat at Site 2. Elevations drop sharply north of Boring AP-6816 and west toward Boring AP-6820, and level off at Site 4 (Figures 4-7 and 4-8). During periods of high precipitation and spring snow melt, surface water may drain overland northwest to the Chena River; however, defined surface drainage pathways were not observed during the RI. The overland distance between the Chena River and Site 2 is approximately 250 to 300 feet, and is heavily vegetated in some areas.

Table 4-3. Groundwater Elevation at the North Post Source Area

Monitoring Well Number	Date of Water Level Reading	Ground Elevation (feet above MSL)	PVC Elevation (feet above MSL)	Depth to Water (feet BTOC)	Water Elevation (feet above MSL)
AP-6814	9/9/94	446.35	448.48	18.25	430.23
AP-6815	9/9/94	446.00	449.08	18.84	430.24
AP-6816	9/9/94	445.90	448.70	18.45	430.25
AP-6817	9/10/94	443.10	445.88	15.69	430.19
AP-6818	9/10/94	445.20	447.85	17.59	430.26
AP-6819	11/15/94	439.89	442.95	12.86	430.09
AP-6820	NM	441.45	444.49	NM	NM

BTOC Below top of casing
MSL Mean sea level
NM Not measured
PVC Polyvinyl chloride





LEGEND

- SANDY SILTY GRAVEL
- GRAVELLY SILTY SAND
- SILTY SAND
- SILT
- SAND
- SANDY GRAVEL
- GRAVELLY SAND

- APPROXIMATE GROUNDWATER ELEVATION ENCOUNTERED DURING DRILLING
- SOIL BORING
- MONITORING WELL

SCALE: HORIZONTAL 1" = 120'
VERTICAL 1" = 5'

NOTE: THE LINES DESIGNATING THE INTERFACE BETWEEN SOIL AND ROCK MATERIALS ON THE SUBSURFACE PROFILES ARE INTERPOLATED AND ARE THEREFORE APPROXIMATIONS. THE TRANSITION BETWEEN THE MATERIALS MAY BE ABRUPT OR GRADUAL. THE PROFILES SHOULD BE CONSIDERED AS REASONABLY ACCURATE ONLY AT THE BORING LOCATIONS, AND THEN ONLY TO THE DEGREE IMPLIED BY THE NOTES ON THE BORING LOGS. DETAILED STRATIGRAPHIC INFORMATION SHOULD BE OBTAINED FROM THE SOIL BORING LOGS.

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CHIEF, ARCHITECTURAL SECTION

DRMO Yard Source Area Geologic Cross-Section A-A'

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Fort Wainwright, Alaska

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CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH

APPROVED:
CHIEF, ENGINEERING DIVISION

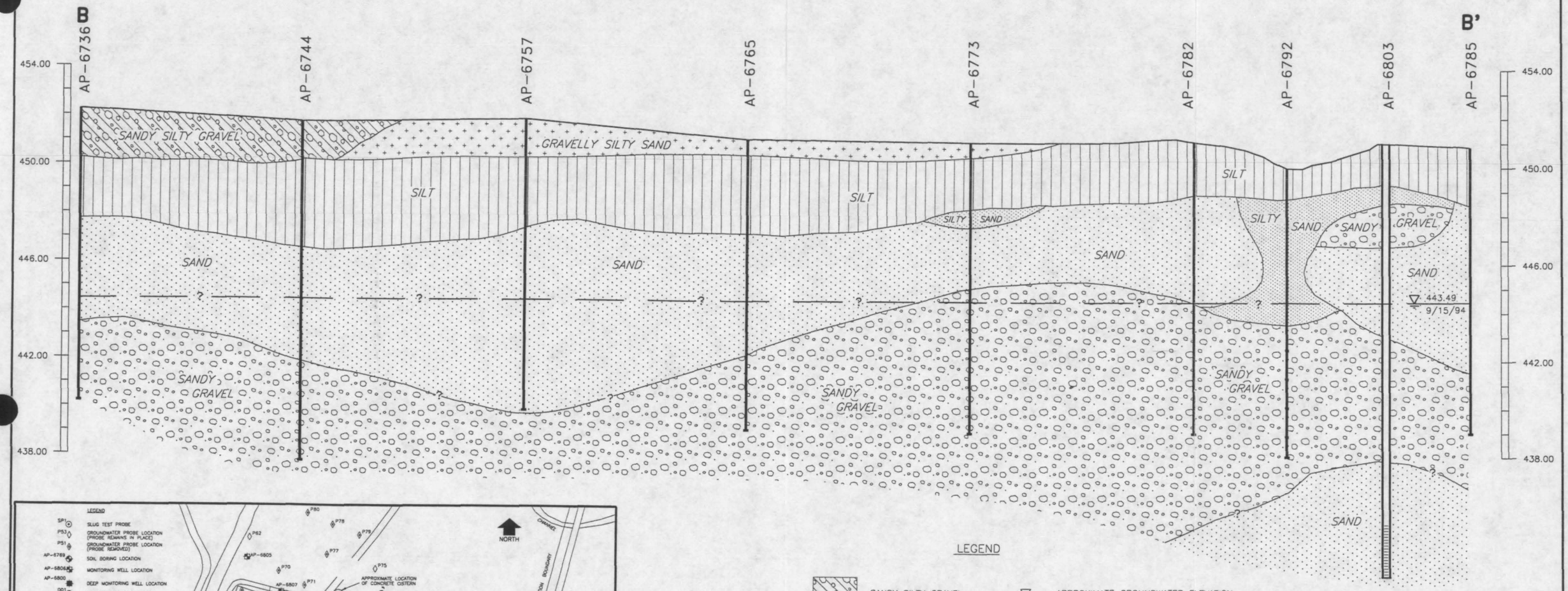
DATE: 10/95

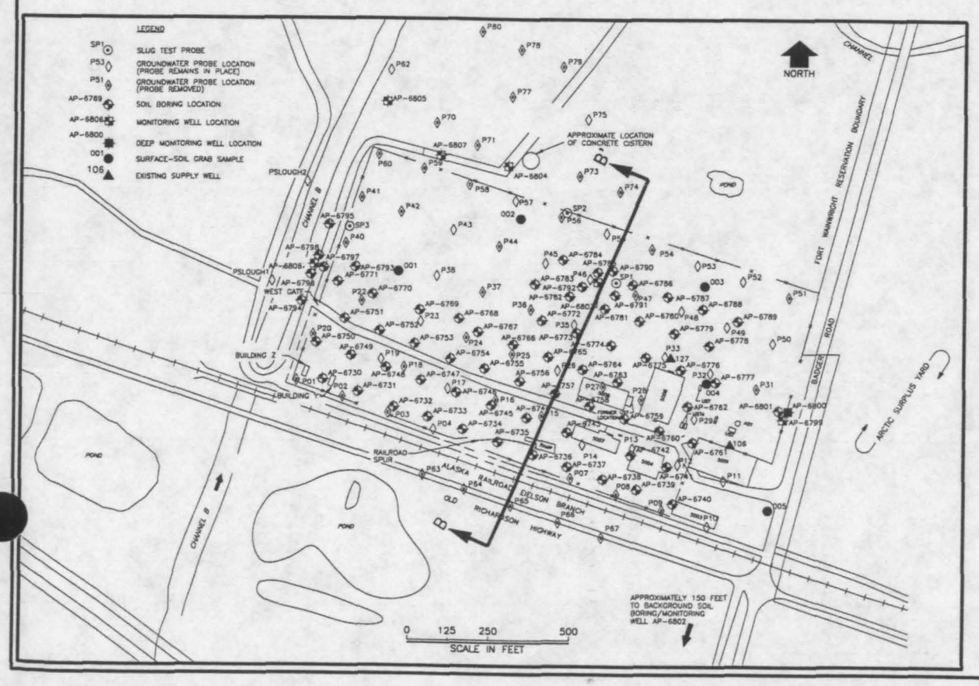
SCALE:

SPEC. NO.

FIGURE
4-1

467da





LEGEND

- SANDY SILTY GRAVEL
- GRAVELLY SILTY SAND
- SILTY SAND
- SILT
- SAND
- SANDY GRAVEL
- APPROXIMATE GROUNDWATER ELEVATION ENCOUNTERED DURING DRILLING
- SOIL BORING
- MONITORING WELL

SCALE: HORIZONTAL 1" = 50'
VERTICAL 1" = 4'

NOTE: THE LINES DESIGNATING THE INTERFACE BETWEEN SOIL AND ROCK MATERIALS ON THE SUBSURFACE PROFILES ARE INTERPOLATED AND ARE THEREFORE APPROXIMATIONS. THE TRANSITION BETWEEN THE MATERIALS MAY BE ABRUPT OR GRADUAL. THE PROFILES SHOULD BE CONSIDERED AS REASONABLY ACCURATE ONLY AT THE BORING LOCATIONS, AND THEN ONLY TO THE DEGREE IMPLIED BY THE NOTES ON THE BORING LOGS. DETAILED STRATIGRAPHIC INFORMATION SHOULD BE OBTAINED FROM THE SOIL BORING LOGS.

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CHIEF, ARCHITECTURAL SECTION

DRMO Yard Source Area Geologic Cross-Section B-B'

OU 2 Remedial Investigation
Fort Wainwright, Alaska

RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH

APPROVED:
CHIEF, ENGINEERING DIVISION

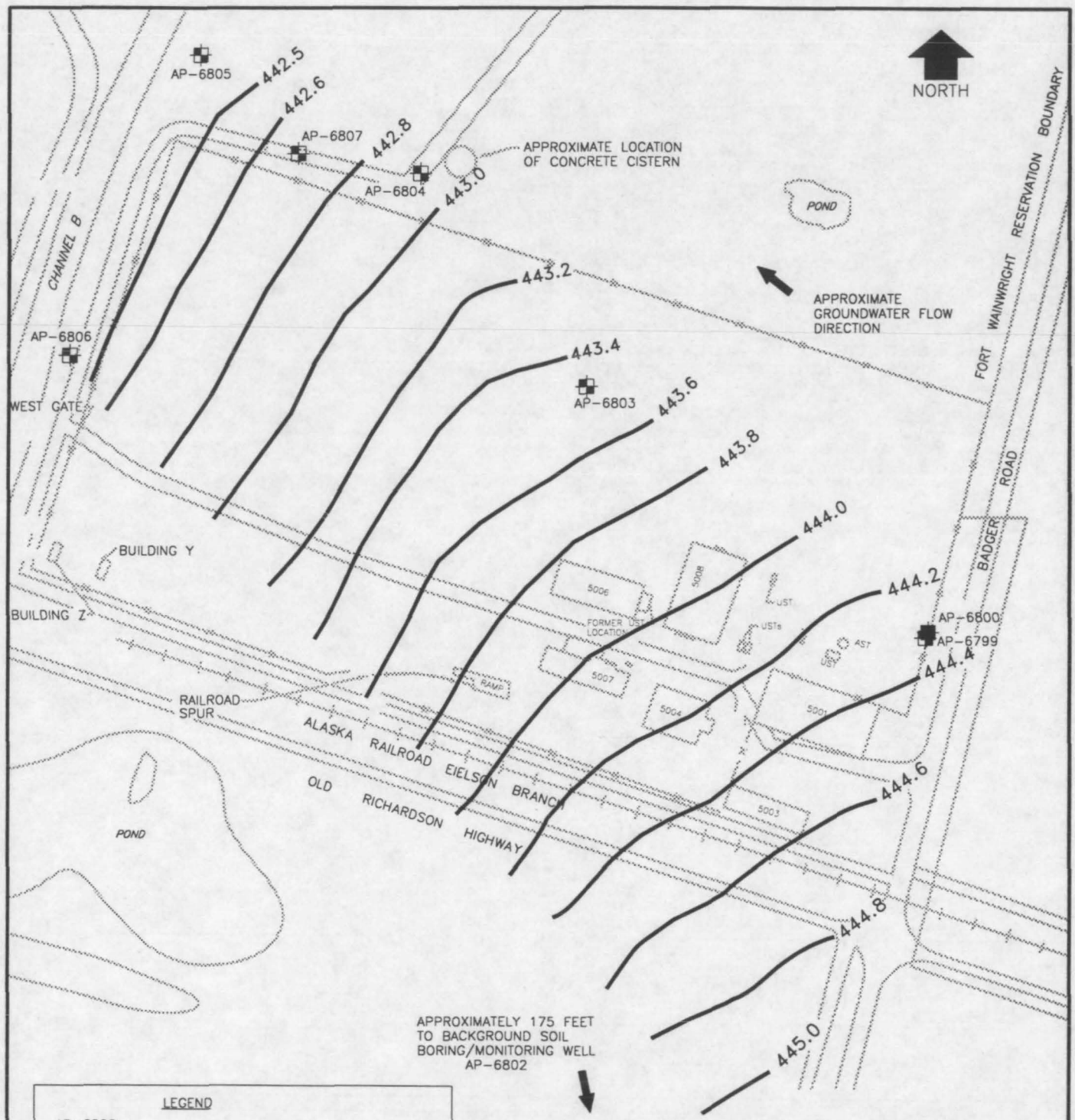
DATE: 10/95

SCALE:

SPEC. NO.

FIGURE
4-2

466d



LEGEND

AP-6806	MONITORING WELL LOCATION
AP-6800	DEEP MONITORING WELL LOCATION
443.8	GROUNDWATER CONTOUR
AST	ABOVEGROUND STORAGE TANK
UST	UNDERGROUND STORAGE TANK
	FENCE
	FORMER BUILDING LOCATION

NOTE: GROUNDWATER LEVELS MEASURED IN SEPTEMBER 1994.

0 125 250 500
SCALE IN FEET

REFERENCE: MODIFIED FROM MASTER PLAN BASIC INFORMATION MAPS, FW, ALASKA, USACE, 1983.

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DRMO Yard Source Area Groundwater Contour Map

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Fort Wainwright, Alaska

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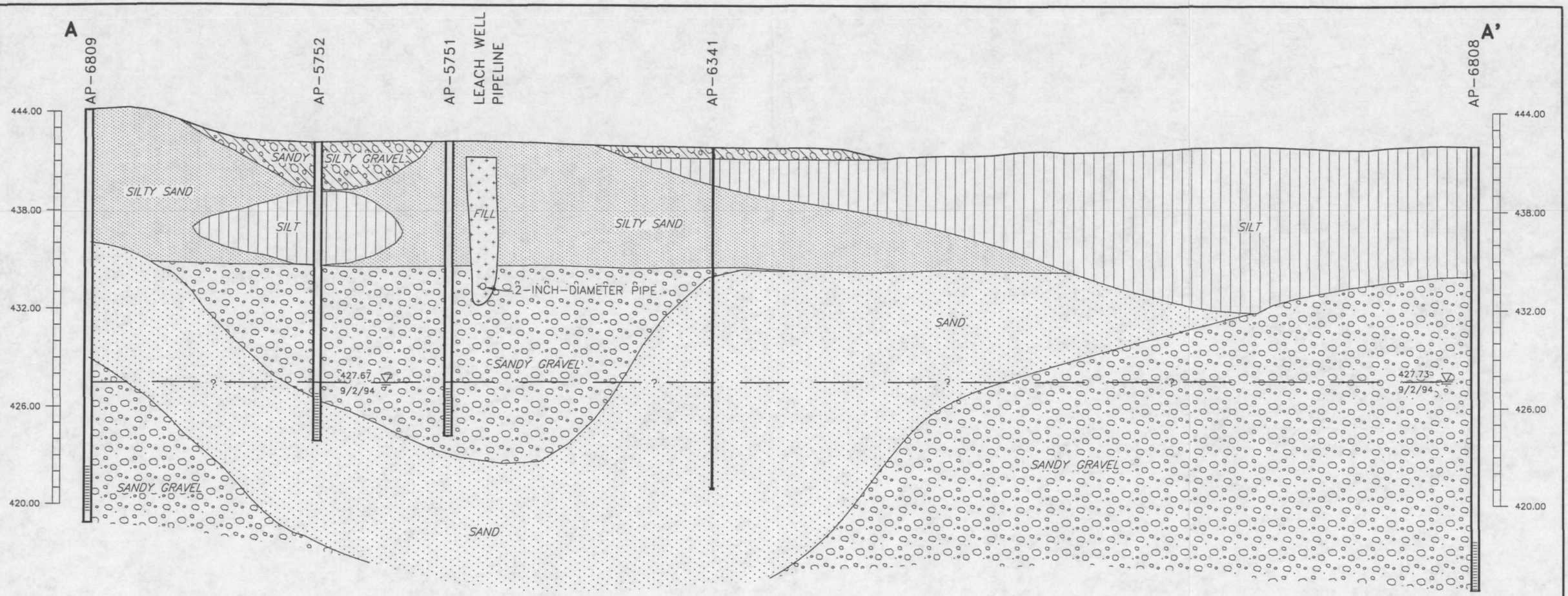
DATE: 10/95

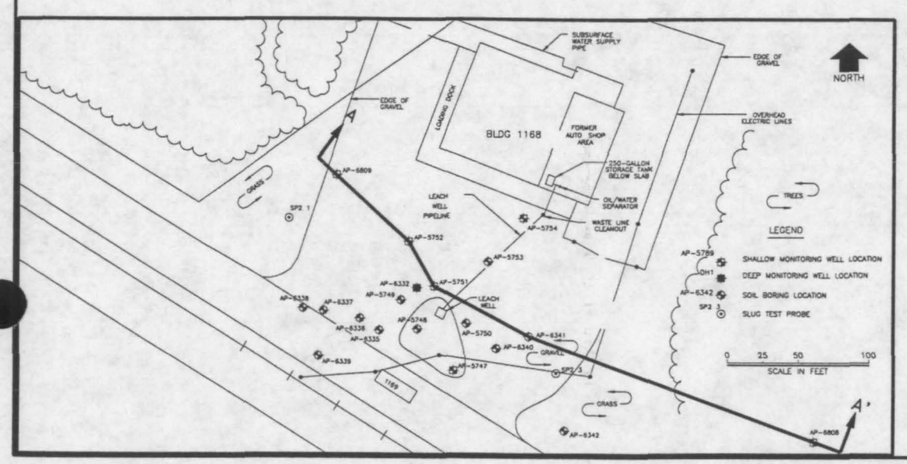
SCALE:

SPEC. NO.

FIGURE
4-3

314b





LEGEND

- SANDY SILTY GRAVEL
- GRAVELLY SILTY SAND (FILL)
- SILTY SAND
- SILT
- SAND
- APPROXIMATE GROUNDWATER ELEVATION ENCOUNTERED DURING DRILLING
- SOIL BORING
- MONITORING WELL
- SANDY GRAVEL

NOTE: THE LINES DESIGNATING THE INTERFACE BETWEEN SOIL AND ROCK MATERIALS ON THE SUBSURFACE PROFILES ARE INTERPOLATED AND ARE THEREFORE APPROXIMATIONS. THE TRANSITION BETWEEN THE MATERIALS MAY BE ABRUPT OR GRADUAL. THE PROFILES SHOULD BE CONSIDERED AS REASONABLY ACCURATE ONLY AT THE BORING LOCATIONS, AND THEN ONLY TO THE DEGREE IMPLIED BY THE NOTES ON THE BORING LOGS. DETAILED STRATIGRAPHIC INFORMATION SHOULD BE OBTAINED FROM THE SOIL BORING LOGS.

SCALE: HORIZONTAL 1" = 30'
VERTICAL 1" = 6'

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Building 1168 Source Area Geologic Cross-Section A-A'

OU 2 Remedial Investigation
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CHIEF, ENGINEERING DIVISION

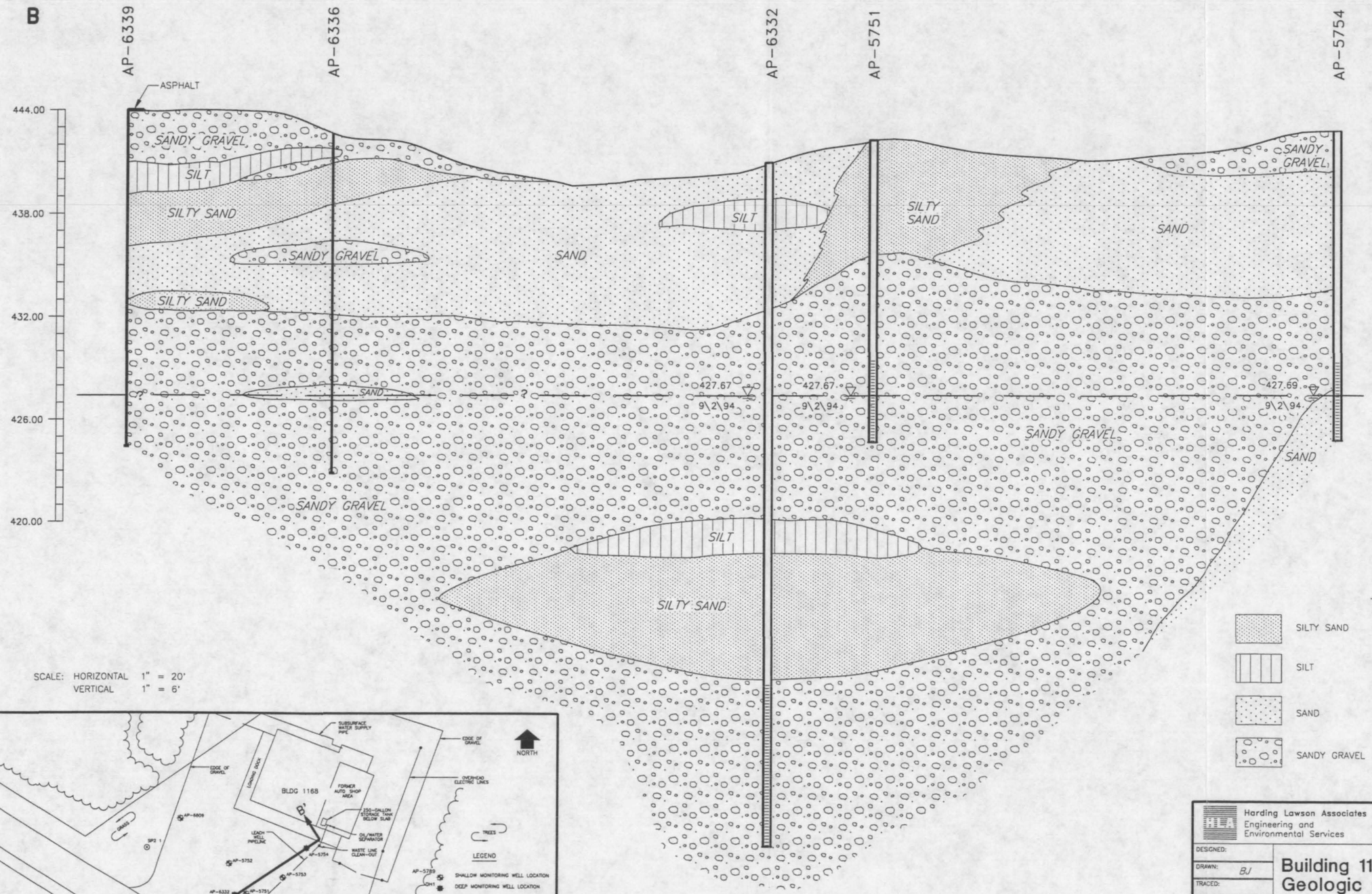
DATE: 10/95

SCALE:

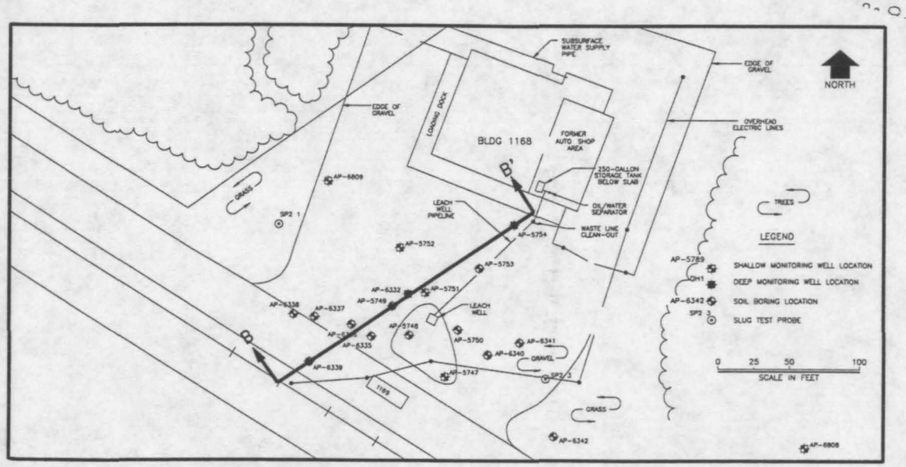
SPEC. NO.

FIGURE
4-4

317b



SCALE: HORIZONTAL 1" = 20'
VERTICAL 1" = 6'



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LEGEND

- SILTY SAND
- SILT
- SAND
- SANDY GRAVEL
- APPROXIMATE GROUNDWATER ELEVATION ENCOUNTERED DURING DRILLING
- SOIL BORING
- MONITORING WELL

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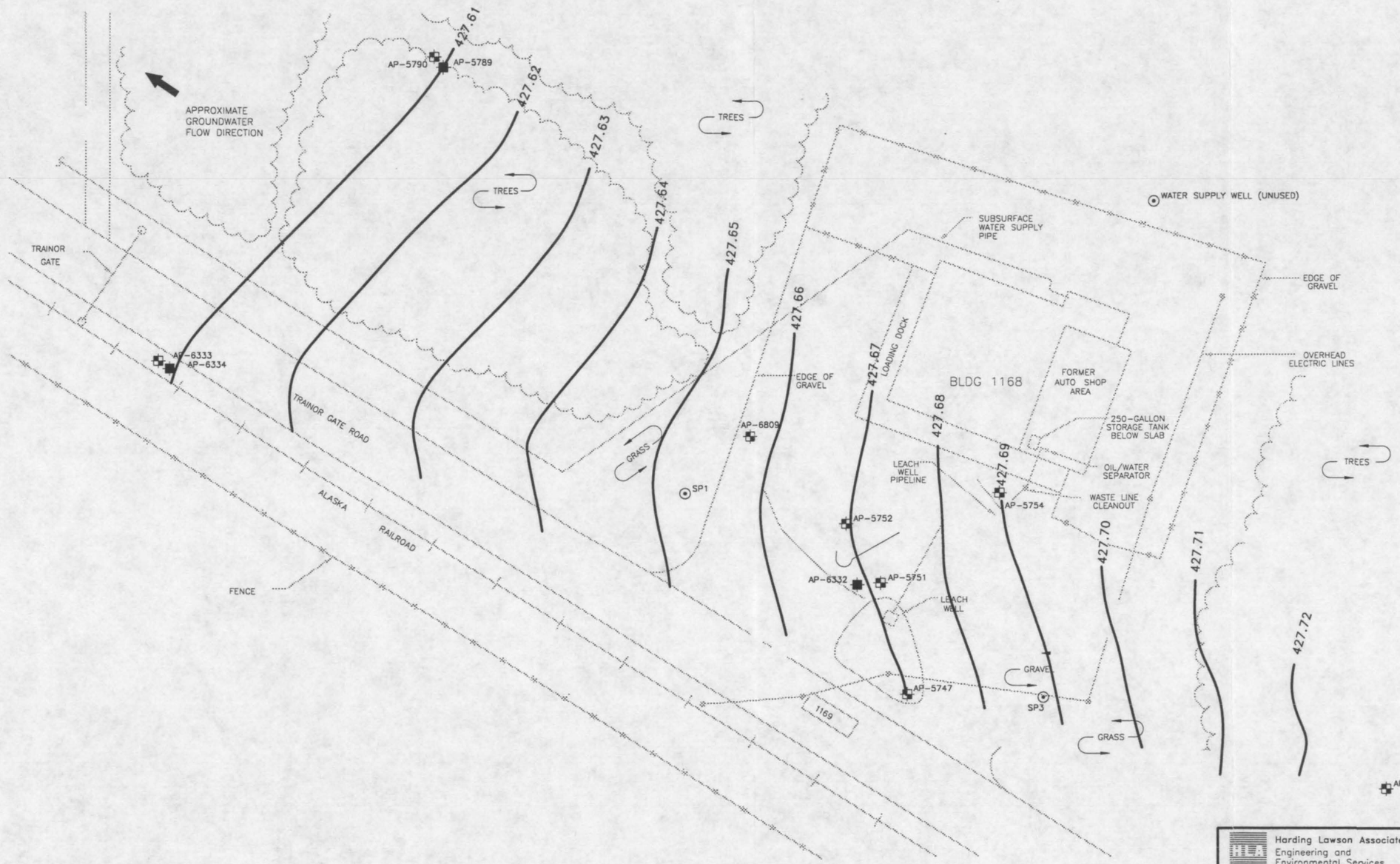
Building 1168 Source Area
Geologic Cross-Section B-B'

OU 2 Remedial Investigation
Fort Wainwright, Alaska

RECOMMENDED: CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION
DATE: 10/95
SCALE:
SPEC. NO.
FIGURE
4-5

318b



LEGEND

AP-5789 SHALLOW MONITORING WELL LOCATION

DH1 DEEP MONITORING WELL LOCATION

SP3 SLUG TEST PROBE

NOTE: SLUG TEST PROBE SP2 WAS NOT SURVEYED.

0 30 60 120
SCALE IN FEET

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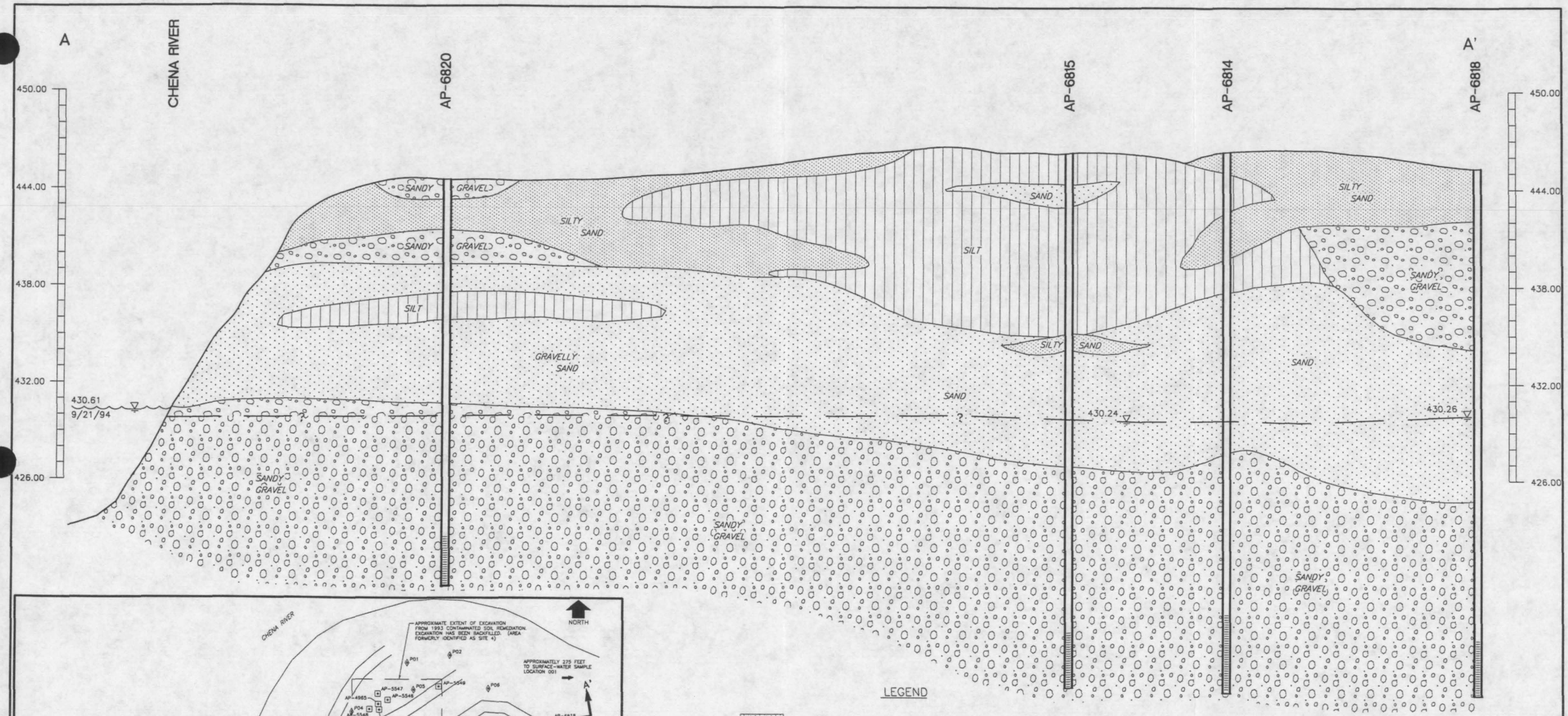
RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH
APPROVED:
CHIEF, ENGINEERING DIVISION
DATE: 10/95
SCALE:
SPEC. NO.

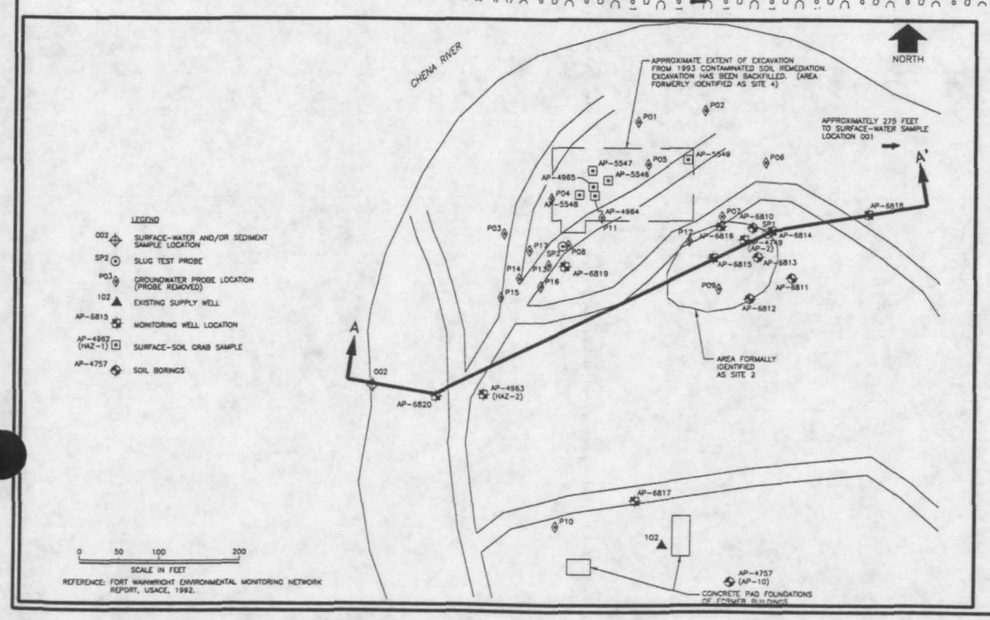
Building 1168 Source Area Groundwater Contours

OU 2 Remedial Investigation
Fort Wainwright, Alaska

FIGURE
4-6

316b





LEGEND

- SILTY SAND
- SILT
- SAND
- SANDY GRAVEL
- APPROXIMATE GROUNDWATER ELEVATION ENCOUNTERED DURING DRILLING
- SOIL BORING
- MONITORING WELL

SCALE: HORIZONTAL 1" = 50'
VERTICAL 1" = 6'

NOTE: THE LINES DESIGNATING THE INTERFACE BETWEEN SOIL AND ROCK MATERIALS ON THE SUBSURFACE PROFILES ARE INTERPOLATED AND ARE THEREFORE APPROXIMATIONS. THE TRANSITION BETWEEN THE MATERIALS MAY BE ABRUPT OR GRADUAL. THE PROFILES SHOULD BE CONSIDERED AS REASONABLY ACCURATE ONLY AT THE BORING LOCATIONS, AND THEN ONLY TO THE DEGREE IMPLIED BY THE NOTES ON THE BORING LOGS. DETAILED STRATIGRAPHIC INFORMATION SHOULD BE OBTAINED FROM THE SOIL BORING LOGS.

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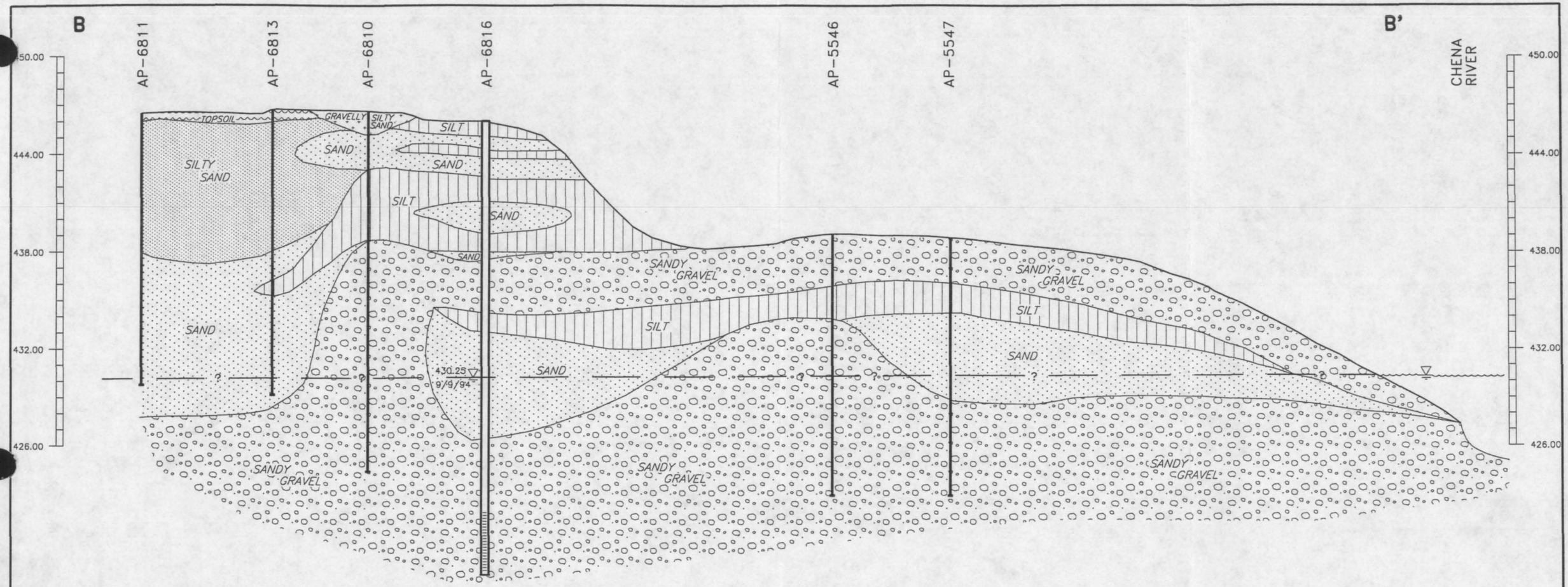
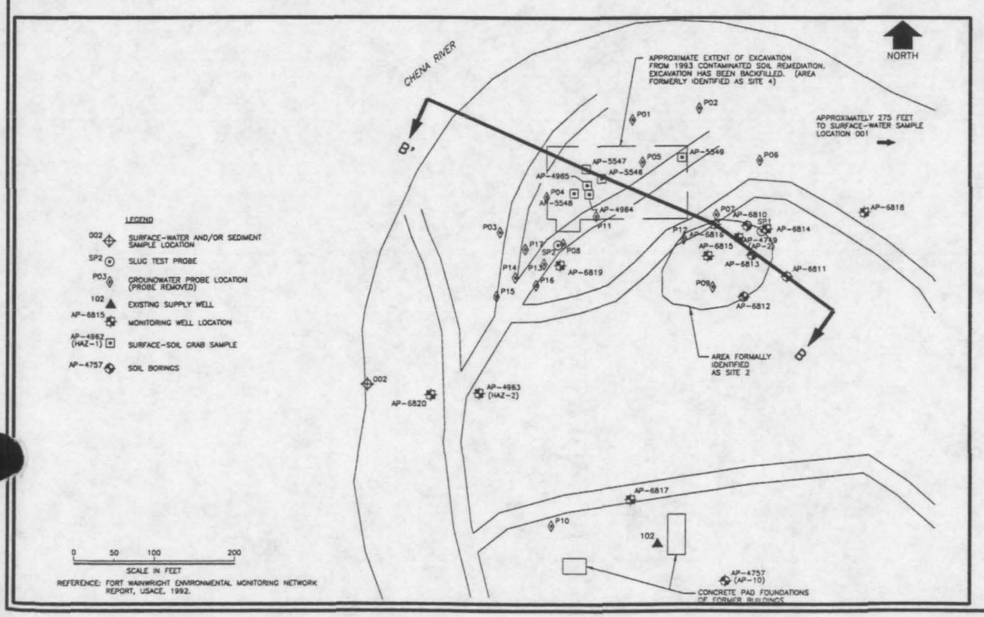
North Post Source Area Geologic Cross-Section A-A'

OU 2 Remedial Investigation
Fort Wainwright, Alaska

APPROVED:
CHIEF, ENGINEERING DIVISION
DATE: 10/95
SCALE:
SPEC. NO.
FIGURE
4-7

313b





LEGEND

- TOPSOIL
- SANDY SILTY GRAVEL
- SILTY SAND
- SILT
- SAND
- SANDY GRAVEL
- GRAVELLY SILTY SAND
- WATER
- SOIL BORING
- MONITORING WELL

NOTE: THE LINES DESIGNATING THE INTERFACE BETWEEN SOIL AND ROCK MATERIALS ON THE SUBSURFACE PROFILES ARE INTERPOLATED AND ARE THEREFORE APPROXIMATIONS. THE TRANSITION BETWEEN THE MATERIALS MAY BE ABRUPT OR GRADUAL. THE PROFILES SHOULD BE CONSIDERED AS REASONABLY ACCURATE ONLY AT THE BORING LOCATIONS, AND THEN ONLY TO THE DEGREE IMPLIED BY THE NOTES ON THE BORING LOGS. DETAILED STRATIGRAPHIC INFORMATION SHOULD BE OBTAINED FROM THE SOIL BORING LOGS.

SCALE: HORIZONTAL 1" = 30'
VERTICAL 1" = 6'

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North Post Source Area Geologic Cross-Section B-B'

OU 2 Remedial Investigation
Fort Wainwright, Alaska

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APPROVED:
CHIEF, ENGINEERING DIVISION

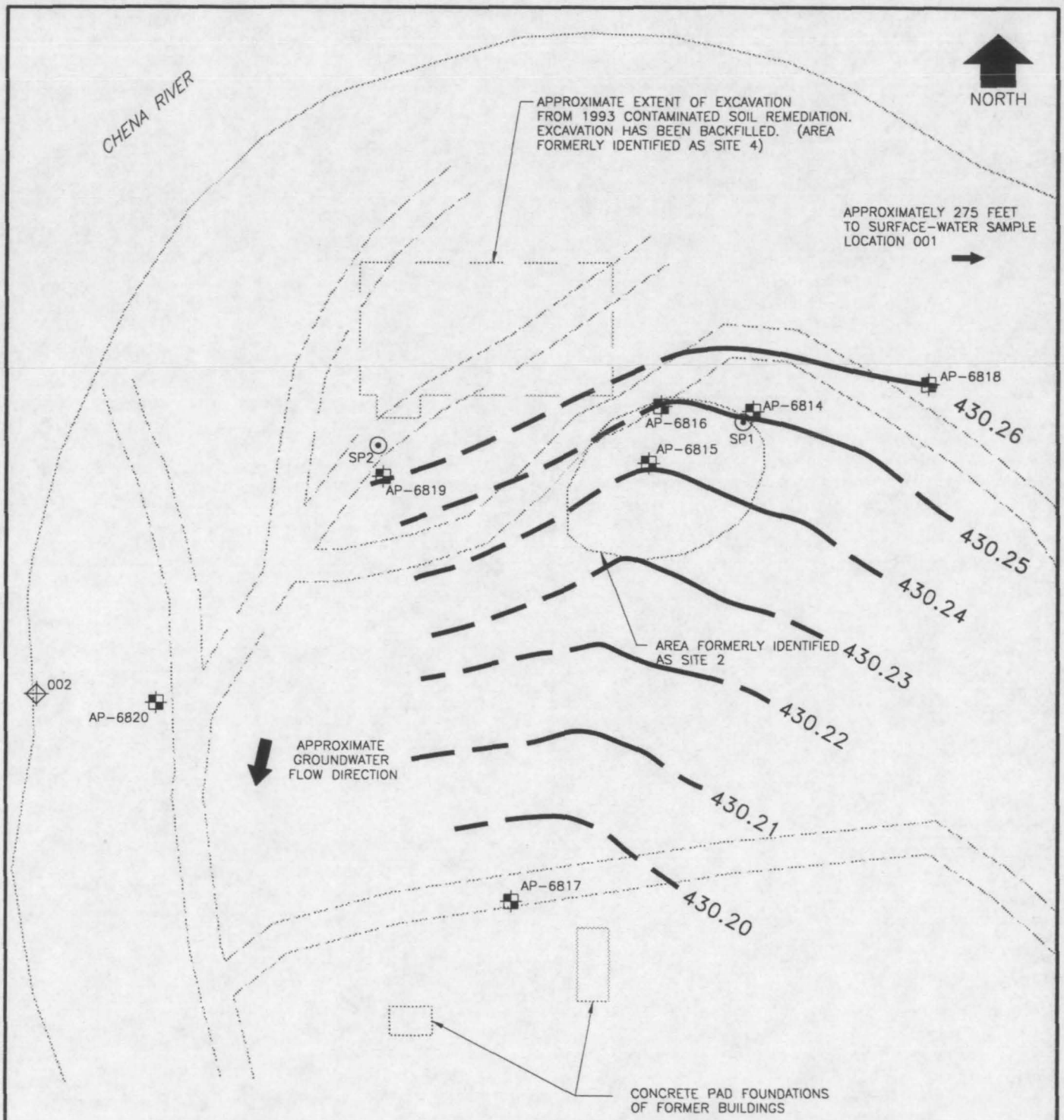
DATE: 10/95

SCALE:

SPEC. NO.

FIGURE
4-8

315b



REFERENCE: FORT WAINWRIGHT ENVIRONMENTAL MONITORING NETWORK REPORT, USACE, 1992.

LEGEND

002	SURFACE-WATER AND/OR SEDIMENT SAMPLE LOCATION
AP-6815	MONITORING WELL LOCATION
SP2	SLUG TEST PROBE
430.20	GROUNDWATER CONTOUR

0 50 100 200
SCALE IN FEET

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CHIEF, ARCHITECTURAL SECTION

North Post Source Area Groundwater Contour Map

OU 2 Remedial Investigation
Fort Wainwright, Alaska

RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH

APPROVED:
CHIEF, ENGINEERING DIVISION

DATE: 10/95

SCALE: NOTED

SPEC. NO.

FIGURE
4-9

331b

5.0 ANALYTICAL PROGRAM

5.1 Program Structure

The OU 2 RI analytical program was organized into 11 tasks divided between the three source areas to allow project laboratories to accommodate the volume of samples, and to provide the rapid turnaround times required to complete the field investigation as scheduled. The 11 analytical program tasks are listed below:

- DRMO Yard Source Area
  - Groundwater probe investigation
  - Subsurface-soil investigation
  - Soil investigation
  - Monitoring investigation
  - Surface-water and sediment investigation
- Building 1168 Source Area
  - Soil and water investigation
- North Post Source Area
  - Groundwater probe investigation
  - Subsurface-soil investigation
  - Surface-soil investigation
  - Monitoring well investigation
  - Surface-water and sediment investigation

5.2 Analytical Laboratories

The USACE's NPD Laboratory assigned a project and a QA laboratory for each program. The laboratories and their locations are listed below:

- Alta Analytical Laboratory, Inc. (Alta) of Eldorado Hills, California;
- Applied Research and Development Laboratory, Inc. (ARDL) of Mount Vernon, Illinois;
- Analytical Technologies, Inc. (ATI) of San Diego, California;
- Columbia Analytical Services, Inc. (CAS) of Kelso, Washington, and Anchorage, Alaska;
- Commercial Testing & Engineering Co., Environmental Laboratory Services (CT&E) of Anchorage, Alaska;
- Curtis and Tompkins, Ltd., Analytical Laboratories (C&T) of Berkeley, California;
- National Environmental Testing Laboratories, Inc. (NET) of Santa Rosa, California;
- USACE, NPD Laboratory of Troutdale, Oregon;
- Pace, Inc. (Pace) of Novato, California;
- Sound Analytical Services, Inc. (SAS) of Tacoma, Washington;
- Southwest Laboratory of Oklahoma, Inc. (SWLO) of Broken Arrow, Oklahoma;
- Triangle Laboratories of RTP, Inc., (Triangle) Research Triangle Park, North Carolina;
- Quanterra Environmental Services (Quanterra), of Sacramento, California.

A Quanterra field laboratory was contracted by HLA for a separate USACE project at Fort Wainwright, and was used periodically during the OU 2 RI for field-screening analytical support. Table 5-1 presents the laboratories used for each program.

5.3 Project and Quality Assurance/Quality Control Samples and Analytical Methods

The project QA program included collecting several types of samples to be used for site characterization and data quality assessment as follows:

- Project samples were collected and analyzed to ascertain analyte levels in the media being sampled (soil, water, sediment).

Table 5-1. Laboratories Used During OU 2 Remedial Investigation by Analytical Task, Fort Wainwright, Alaska

Source Area/Analytical Task	Laboratory												
	ARDL	NET	SAS	CAS	Quanterra	Triangle	Alta	SWLO	C&T	CT&E	NPD	Pace	ATI
DRMO Yard													
- Groundwater Probe Investigation	QA	PR		PR(7196A)	Field	PR(8290)	QA(8290)			QA(7196A)	QA		
- Subsurface-Soil Investigation	PR				QA(8290)	PR(8290)			QA		PR/QA		
- Soil Investigation		QA	PR			QA(8290)		PR(8290)			PR/QA	QA	
- Monitoring Well Investigation	QA	PR				PR(8290)	QA(8290)				QA		QA
- Surface-Water and Sediment Investigation	QA			PR		QA(8290)	PR(8290)			QA(7196A)	PR/QA		
Building 1168													
- Soil and Water Investigation			PR	QA							PR/QA		
North Post													
- Groundwater Probe Investigation	PR			PR(7196A)	Field				QA	QA(7196A)			
- Surface-Soil Investigation	PR	QA			QA(8290)	PR(8290)	QA(8290)		QA		PR		
- Subsurface-Soil Investigation		PR		QA		PR(8290)	QA(8290)				PR/QA	QA	
- Monitoring Well Investigation	PR	PR		QA		PR(8290)	QA(8290)						
- Surface-Water and Sediment Investigation		QA		PR		QA(8290)	PR(8290)				PR/QA		

7196A	Laboratory method used to analyze for hexavalent chromium
8290	Laboratory used to analyze for dioxins and furans
Alta	Alta Analytical Laboratory, Inc.
ARDL	Applied Research and Development Laboratory
ATI	Analytical Technologies, Inc.
C&T	Curtis and Tompkins, Ltd.
CAS	Columbia Analytical Services, Inc.
CT&E	Commercial Testing & Engineering Co., Environmental Laboratory Services
DRMO	Defense reutilization and marketing office
Field	Onsite field laboratory
NET	National Environmental Testing, Inc.
NPD	North Pacific Division Laboratory
Pace	Pace, Inc.
PR	Project
PR/QA	NPD laboratory served as the project laboratory for geotechnical analyses and as the quality assurance laboratory for diesel-range organics analyses
QA	Quality assurance
QC	Quality control
Quanterra	Quanterra Environmental Services was the onsite field laboratory at Fort Wainwright
SAS	Sound Analytical Services, Inc.
SWLO	Southwest Laboratory of Oklahoma, Inc.
Triangle	Triangle Laboratories of RTP, Inc.

- Background samples were collected from locations upgradient of suspected sources of potential contamination to assess concentrations of naturally occurring chemicals. The analytical results of background samples are to be used in the USACE's background study.
- QC duplicate samples were collected and analyzed to evaluate intralaboratory and sampling precision. QA duplicate samples were collected and analyzed by the QA laboratory to evaluate the precision of sampling and intralaboratory analytical processes.
- Trip blanks, samples of organic-free water, accompanied each cooler shipment containing samples for VOC analyses, and were analyzed for VOCs and GRO to evaluate cross contamination occurring during shipment.
- Rinsate blanks were samples of rinse water obtained by rinsing decontaminated sampling equipment with organic-free water, and were collected and analyzed to evaluate the completeness of decontamination procedures.
- Equipment blanks were samples of rinse water obtained by rinsing unused sampling equipment with organic-free water, and were collected to analyze for cross contamination from the sampling equipment to the project samples.
- A drilling water sample was collected from potable water injected into a boring. Water injection was required to control flowing sand during installation of a monitoring well. The drilling water sample was analyzed to evaluate the impact of injected water on the groundwater, and on groundwater samples collected from that monitoring well.

Table 5-2 summarizes the numbers and types of samples collected for each analytical task.

The following analytical methods were used during the OU 2 RI:

- DRO was analyzed by GC using EPA Method 8100 modified for calibration of hydrocarbons in the range of C_{10} to C_{28}.
- GRO was analyzed by GC using EPA Method 8015 modified for calibration of hydrocarbons in the range of C_6 to C_{10}.
- VOCs were analyzed by GC/MS using EPA Method 8260.
- SVOCs were analyzed by GC/MS using EPA Method 8270.
- Dioxins and furans were analyzed by GC/MS using EPA Method 8290.
- PCBs and organochlorine pesticides were analyzed by GC using EPA Method 8080.
- Organophosphorous pesticides were analyzed by GC/MS using EPA Method 8140.
- Metals were extracted by EPA Methods 3010 and 3050 (acid digestion).
  - Arsenic was analyzed by GFAA using EPA Method 7060, by gaseous hydride atomic absorption using EPA Method 7061, and by ICP/MS using EPA Method 200.8.
  - Cadmium was analyzed by GFAA using EPA Method 7131, by ICP using EPA Method 6010, and by ICP/MS using EPA Method 200.8.
  - Hexavalent chromium was analyzed by CEAA using EPA Method 7197, and by colorimetric techniques using EPA Method 7196.
  - Mercury was analyzed by CVAA using EPA Methods 7470 and 7471.
  - Selenium was analyzed by GFAA using EPA Method 7740, by gaseous hydride atomic absorption using EPA Method 7741, and by ICP/MS using EPA Method 200.8.
  - Lead was analyzed by GFAA using EPA Method 7421, by ICP using EPA Method 6010, and by ICP/MS using EPA Method 200.8.

Table 5-2. Numbers and Types of Samples by Analytical Task, OU 2 Remedial Investigation, Fort Wainwright, Alaska

Analytical Task	Project Samples	Field-Screening Samples	Blind Duplicates	QA Duplicates	Project Trip Blanks	QA Trip Blanks	Project Rinsate Blanks	QA Rinsate Blanks	Project Equipment Blanks	QA Equipment Blanks	Drilling Water Samples	Background Samples
DRMO Yard												
- Groundwater Probe Investigation	87	40	10	9	16	8	0	0	3	3	1	0
- Monitoring Well Investigation	16	0	2	2	8	3	3	3	0	0	0	1
- Soil Investigation	67	0	9	9	8	5	3	3	0	0	0	3
- Subsurface-Soil Investigation	237	0	24	24	23	20	12	12	0	0	0	0
- Surface-Water and Sediment Investigation	9	0	2	2	5	2	1	1	0	0	0	2
Building 1168												
- Soil and Groundwater Investigation	11	0	4	4	5	3	2	2	0	0	0	10
North Post												
- Groundwater Probe Investigation	16	7	2	2	3	2	1	1	0	0	0	0
- Subsurface-Soil Investigation	43	0	6	6	5	4	3	3	0	0	0	4
- Surface-Soil Investigation	25	0	3	3	0	0	0	0	0	0	0	0
- Surface-Water and Sediment Investigation	2	0	2	2	1	1	0	0	0	0	0	2
- Monitoring Well Investigation	6	0	2	2	2	2	2	2	0	0	0	1

DRMO Defense reutilization and marketing office
QA Quality assurance

- Thallium was analyzed by GFAA using EPA Method 7841, by ICP using EPA Method 6010, and by ICP/MS using EPA Method 200.8.
- Barium, chromium, and silver were analyzed by ICP using EPA Method 6010.

- TOC was analyzed by ASTM Method D 4129-82, EPA Method 415.1, and EPA Method 9060.
- Particle sizes were measured using ASTM Methods D 421 and D 422. The specific gravities of soil solids were measured using ASTM Method D 854. Moisture contents were measured using ASTM Method D 2216.

Table 5-3 summarizes the analyses performed for each analytical task.

Sample record logs summarizing laboratories, analyses performed, sample types, and sample locations are presented by analytical task in Appendix G.

5.4 Data Validation Procedures

5.4.1 HLA Data Validation

Data validation involves assessing the technical utility of reported analytical results with respect to EPA requirements and program-specific method requirements to provide data of known quality. HLA validated 10 percent of the OU 2 RI analytical results. Data validation was performed following the EPA Contract Functional Guidelines for Organic and Inorganic Data Review (EPA, 1994), and was intended to provide a comprehensive review of a subset of OU 2 RI analytical results. HLA selected analytical results for validation from each of the environmental media sampled for every method of analysis performed by each of four project laboratories used during the program: ARDL, SAS, CAS, and NET. Appendix H includes a summary of HLA's data validation results by analytical method, the Data Corrective Action Results report for OCPs and OPPs, and the Technical Memorandum regarding OCP and OPP Data.

5.4.2 Northern Pacific Division Laboratory Data Validation

The NPD Laboratory performed a cursory validation of 100 percent of OU 2 RI analytical results. The NPD laboratory validated the analytical results following procedures described in ER 1110-1-263, Engineering and Design Chemical Data Quality Management for Hazardous Waste Remedial Activities (USACE, 1990), and applicable standard operating procedures (SOPs). The NPD laboratory reported validation results in a series of 18 chemical quality assurance reports (CQARs). Each CQAR describes the quality of analytical results for a selected sample medium, and provide information about the overall results of the laboratory QC sample analyses. Problems experienced during sample analyses were expressed as general qualifying statements. A summary of technical problems observed during data validation is included in Appendix I. Copies of the CQARS are included in Appendix I.

The NPD laboratory did not apply specific EPA standard qualifiers to analytical results to document data technical utility. Consequently, HLA reviewed the CQARs, catalogued the qualifying statements, and converted these statements into qualifiers consistent with respective EPA or other validation guidelines. HLA then applied these qualifiers to affected analytical results for inclusion in the OU 2 RI report. The NPD laboratory's cursory validation effort was limited to reviewing QC summary data packages that generally do not include chromatograms or other raw data necessary to completely reconstruct the method of quantification and the reliability of the reported results. Thus, the results of the NPD laboratory validation may not provide accurate insight into the technical or legal defensibility of 100 percent of the OU 2 RI analytical data.

Table 5-3. Analyses Performed, by Analytical Task, OU 2 Remedial Investigation, Fort Wainwright, Alaska

Source Area/ Analytical Task	Analyses Performed												
	VOCs EPA Method 8010	GRO EPA Method 8015M	BTEX EPA Method 8020	PCBs/Pest EPA Method 8080	DRO EPA Method 8100M	OPP EPA Method 8140	VOCs EPA Method 8260	SVOCs EPA Method 8270	Dioxins/ Furnans EPA Method 8290	TOC*	Metals**	Hex. Cr EPA Method 7196A	Geotechnical***
DRMO													
- Groundwater Probe Investigation	X	X	X	X	X	X	X	X	X		X	X	
- Subsurface-Soil Investigation		X		X	X	X	X	X	X	X	X		X
- Surface-Soil Investigation		X		X	X	X	X	X	X	X	X		X
- Monitoring Well Investigation		X		X	X	X	X	X	X		X		
- Surface-Water and Sediment Investigation		X		X	X	X	X	X	X	X	X	X	X
Building 1168													
- Soil and Groundwater Investigation	X	X	X	X	X	X	X	X	X	X	X		X
North Post													
- Groundwater Probe Investigation		X	X	X	X		X	X			X	X	
- Surface-Soil Investigation				X	X			X	X	X	X		X
- Subsurface-Soil Investigation		X		X	X		X	X	X	X	X		X
- Monitoring Well Investigation		X		X	X		X	X	X		X		
- Surface-Water and Sediment Investigation		X		X	X		X	X	X	X	X		X

* TOC analyses may have been by Method D 4129-82, 415.1, 9060, or modifications of those methods.
** Metals analyses may have been by Methods 200.8, 6010, 6010A, 7060, 7061, 7131, 7421, 7470, 7471, 7740, 7741, or 7831.
*** Geotechnical analyses included particle-size, specific gravity, and moisture content analyses.
BTEX Benzene, toluene, ethylbenzene, and xylenes.
DRMO Defense reutilization and marketing office.
DRO Diesel-range organics.
EPA U.S. Environmental Protection Agency.
GRO Gasoline-range organics.
Hex. Cr Hexavalent chromium.
OPP Organophosphorus pesticides.
PCBs/Pest Polychlorinated biphenyls and organochlorine pesticides.
SVOCs Semivolatile organic compounds.
TOC Total organic carbon.
VOCs Volatile organic compounds.

5.5 Data Useability

5.5.1 Results of the NPD Validation Effort

The problems observed by the NPD laboratory during its data validation included surrogate compound, MS/matrix spike duplicate (MSD), and laboratory control spike (LCS) percent recoveries outside of their respective acceptance criteria. However, in general, the NPD laboratory's data validation indicated that the analytical results are acceptable with the following qualifications: The pesticide/PCB analytical results for two subsurface soil samples from the DRMO yard source area (211SL and 2185SL), and VOC analytical results for a third sample (273SL) were identified by NPD as unacceptable, because of poor surrogate compound recoveries.

5.5.2 Results of HLA Data Validation

HLA validated results from the analyses of water and soil samples for the presence of VOCs, semivolatile organics, organochlorine pesticides/PCBs, organophosphorous pesticides, dioxins/furans, DRO, GRO, and metals. Validation results for each of these analyte groups are summarized in Appendix H. A brief summary is presented in the following section.

VOC analyses were reviewed from five analytical cases provided by three of the four analytical laboratories used during the program. One of the laboratories used during the program did not analyze samples for the presence of VOCs. Deviations from required calibration, surrogate, and MS/MSD performance criteria resulted in qualifying several target analytes as estimated, and identifying blanks containing methylene chloride at or above levels identified in associated samples. The data packages reviewed were found to be complete, with the exception of documentation required to evaluate the sample preparation steps used.

SVOC analyses were reviewed from six analytical cases provided by the four analytical laboratories used during the program. Deviations from the required QC performance criteria resulted in qualifying selected results as estimated. Low response did result in the rejection of the target analyte benzidine in two of the cases reviewed. Method blank artifacts were limited to di-n-butylphthalate and several unknown compounds that were qualified as not detected at or above the method reporting limit (MRL) where appropriate, in accordance with the EPA functional guidelines. Data packages reviewed were found to be complete, with the exception that raw QC sample data were not provided in some of the packages reviewed.

Organochlorine pesticide/PCB, and organophosphorous pesticide analyses from six analytical cases analyzed at each of the four laboratories were reviewed. Minor problems were encountered that resulted in qualifying some results as estimated from three of the four laboratories for which data was reviewed. MRLs were adjusted to reflect the elimination of several low-level calibration standards thought to represent a loss in instrument sensitivity. The most significant problems identified were observed for samples analyzed at NET. HLA's data validation found that sample data packages were incomplete, the appropriate method QC sample analyses had not been run in accordance with the method requirements, and artificial baselines had been created to quantitate and report results for some samples and standards. Chromatograms in these data packages were not legible or to scale, and sample quantitations could not be verified.

Based on the preliminary findings of data validation of NET's OCP and OPP data, HLA recommended that the data be considered unacceptable until the laboratory could implement corrective action and sufficient data could be compiled to evaluate the utility of the data. At the USACE's request, HLA investigated OCP and OPP data deficiencies and assisted NET in designing a corrective action plan. Based on the results of the corrective action, much of the data initially recommended for rejection by HLA was elevated to "acceptable as qualified." However, data in the non-validated portion of the NET-generated OCP and OPP data were still considered unacceptable following the investigation and corrective action

plan. Details regarding the NET data investigation and corrective action plan are in the Data Corrective Action Results Report for OCPs and OPPs, included in Appendix H.

Following HLA's data corrective action results report, a data review was conducted to summarize the affected data and compare them with supporting QA and other acceptable data from related environmental media to evaluate the need to collect additional data or modify the risk assessment (RA). Details of the data review are presented in the "Technical Memorandum to Assess the Impact of OCP and OPP Data Recommended for Rejection on the Fort Wainwright OU 2 Risk Assessment," included in Appendix H. In general, the OCP and OPP data used to prepare the RA were compiled, and detections at or above the method reporting limits (MRL) were summarized and compared with existing QA sample results to evaluate the NET data initially recommended for rejection in the Data Corrective Action Results Report. When sufficient results at or above the MRL for both investigative and QA samples were not available, the concentrations in surrounding media were reviewed. Based on the data assessment, the QA sample results confirm the NET project samples and QC sample results. Although EPA functional guideline criteria required significant qualifications or rejection of NET's OCP and OPP data, the comparisons to QA sample results indicate that these data still are technically usable for screening for the OU 2 RA, when applied with the additional supporting data or information in the technical memorandum. It is HLA's opinion that NET's OCP and OPP data may be applied along with historical site-use information to assess the presence of these compounds at any given location.

As discussed in the Technical Memorandum, with regard to the RA, the impact of the rejected data on the data set as a whole appears to be minimal, and collection of additional data does not appear warranted.

The remaining data packages for OCP/PCB and OPPs were verified, as being complete.

Dioxin analyses from six analytical cases were reviewed from each of two subcontract laboratories (Triangle and SWLO) used by the primary program laboratories. Surrogate and internal standard recoveries were found to be low for selected analytes in all of the cases reviewed, and resulted in qualifying the analyte as estimated. Numerous blank artifacts, particularly in the case performed by SWLO, were identified and associated data were qualified according to the EPA guidelines for validating organics. The data packages reviewed were found to be complete.

DRO and GRO analyses were reviewed from six analytical cases from the four laboratories used during the program. Three results for DRO analyzed by ARDL were initially rejected due to errors in quantitation resulting in false negative and false positive results. Results reported by NET for DRO were incorrectly quantitated, and insufficient data in the data packages preventing making corrections. HLA conducted a data investigation of DRO analysis by NET and ARDL; the laboratories provided proper and adequate documentation to verify the reliability of the DRO results. HLA considers results for DRO acceptable.

Metals data were reviewed from six analytical cases from each of the laboratories used during the program. With the exception of blank contamination identified, the data were found to be acceptable as qualified.

5.5.3 Summary of Data Usability and Recommended Data Reduction

In general, the project laboratories followed method-specified criteria, and the results are considered reliable for use as qualified with several notable exceptions. Based on results of HLA's initial data validation summary, the subsequent Data Corrective Action Results Report, and the Technical Memoranda, the NET-generated OCP and OPP data are recommended to be technically usable as qualified.

Metals results and dioxin data, in particular, may be significantly impacted by the presence of laboratory artifacts. The NPD CQARs also indicate

the presence of a substantial number of blank artifacts in the external or field blanks analyzed during the program.

HLA has generally accepted all investigation-derived data and data quality objectives have been met, except for the exceptions described in section 5.5.2 and in supporting documents in Appendix H.

5.6 Chromium VI Analyses

Initially, groundwater samples were analyzed for the presence of chromium VI. However, MS recoveries were found to be extremely depressed to nonexistent in samples analyzed. Preliminary analyses of impacted water samples for metals and the rust color of most samples indicated the presence of high levels of iron in the groundwater being analyzed for chromium VI. Conductivities measured in the samples were also high, confirming the presence of high levels of dissolved metals in the impacted samples. High iron concentrations are of interest, because iron can interfere with some spectrophotometric methods used to measure chromium VI.

Under direction from HLA, a series of experiments were performed to evaluate the reliability of the analytical method for chromium VI (see Appendix L, Quality Assurance Field Audit Report, page 6). Samples were spiked with chromium VI at a range of concentrations, and were analyzed to evaluate the threshold at which acceptable spike recoveries could be obtained. The results of these experiments indicated that the method was performing adequately; however, the nature of the sample matrix resulted in the instability and loss of the chromium VI being spiked into the samples. Chromium VI was not detected in chemical analyses of 94 groundwater samples from the site, which confirmed the absence of chromium VI at the site and/or the instability of this species of chromium. These facts combined with the belief that activities such as metal plating or processing did not occur at the site resulted in HLA's recommendation to discontinue chromium VI analyses. USACE remedial project managers (RPMs) accepted this recommendation and the decision to terminate chromium VI analysis was approved.

The absence of chromium VI at the site from a theoretical standpoint is not surprising for several other reasons. Chromium VI is a strong oxidizing agent. Even in the presence of low ppm levels of petroleum hydrocarbons, chromium VI will readily reduce to chromium III and hydrocarbons will oxidize to form alcohols and phenols. Similarly, in water containing high TOC, the organics tend to oxidize and chromium VI tends to reduce to chromium III. Given the hydrocarbon concentrations detected throughout much of the site, the presence of chromium VI is considered extremely unlikely.

6.0 NATURE OF CONTAMINATION

A summary of laboratory analyses requested for each soil and groundwater sample collected during the RI field investigation is provided in Appendix G. The geotechnical analyses performed by the USACE's NPD laboratory are described in section 3.3. Tables 6-1 through 6-13, which are referenced throughout the following text, are presented at the end of section 6.

6.1 DRMO Yard Source Area

6.1.1 Soil

Five surface-soil grab sample locations (001 through 005) and 78 soil borings (AP-6730 through AP-6807) were drilled to investigate the nature and extent of contamination associated with the DRMO yard source area. Surface-soil sample and soil boring locations are presented on Figure 3-1. Petroleum hydrocarbons, VOCs, SVOCs, PCBs, chlorinated pesticides, dioxins/furans, and metals were detected. OPP were not detected. Analytical results for soil samples from the DRMO yard source area are presented in Appendix J. Concentration ranges and detection frequencies for analytes detected in soil samples are presented in Table 6-1.

6.1.2 Groundwater

Eighty-two groundwater probes (P01 through P80, PSLOUGH1, and PSLOUGH2) were installed to assess the extent of groundwater contamination associated with the DRMO yard source area. Groundwater probe locations are presented on Figure 3-1. Four groundwater probes (P61, P68, P69, and P72) were driven to approximately 70 feet below the ground surface to vertically profile the extent of groundwater contamination. Petroleum hydrocarbons, VOCs, SVOCs, OPPs, dioxins/furans, and metals were detected. PCBs and OCPs were not detected. Analytical results for groundwater probe samples are presented in Appendix J. Concentration ranges and detection frequencies for analytes detected in groundwater probe samples are summarized in Table 6-2.

Eight groundwater monitoring wells (AP-6799, AP-6800, and AP-6802 through AP-6807) were installed in eight of the soil borings throughout the DRMO yard source area. Groundwater samples were collected from Monitoring Wells AP-6799, AP-6800, and AP-6802 through AP-6807, and from seven existing groundwater monitoring wells (AP-5623, AP-5764, AP-5765, AP-5823, AP-5824, AP-5825, and AP-5826). Groundwater monitoring well locations are presented on Figure 3-1. Petroleum hydrocarbons, VOCs, SVOCs, OPPs, dioxins/furans, and metals were detected. PCBs and OCPs were not detected. Analytical results for groundwater monitoring well samples are presented in Appendix J. Concentration ranges and detection frequencies for analytes detected in groundwater monitoring well samples are summarized in Table 6-3.

6.1.3 Surface Water and Sediment

Eight sediment samples were collected at the locations (001 through 008) shown on Figure 3-1. Petroleum hydrocarbons, VOCs, PCBs, dioxins/furans, and metals were detected. SVOCs, chlorinated pesticides, and organophosphorous pesticides were not detected. Analytical results for sediment samples are presented in Appendix J. Concentration ranges and detection frequencies for analytes detected in sediment samples are presented in Table 6-4.

Three surface-water samples were collected at the locations (001 through 003) shown on Figure 3-1. Petroleum hydrocarbons, VOCs, and metals were detected. SVOCs, PCBs, chlorinated pesticides, dioxins/furans, and organophosphorous pesticides were not detected. Analytical results for surface-water samples are presented in Appendix J. Concentration ranges and detection frequencies for analytes detected in surface-water samples are presented in Table 6-5.

6.2 Building 1168 Source Area

6.2.1 Soil

Two soil borings (AP-6808 and AP-6809) were drilled at the Building 1168 source area. Soil boring locations are presented on Figure 3-2. Metals and OCPs were detected in soil samples. Analytical results for soil samples from the Building 1168 source area are presented in Appendix J. Concentration ranges and detection frequencies for analytes detected in soil samples are presented in Table 6-6.

6.2.2 Groundwater

Two groundwater monitoring wells (AP-6808 and AP-6809) were installed in the two soil borings at the Building 1168 source area. Groundwater samples were collected from Monitoring Well AP-6808, and from 11 existing groundwater monitoring wells (AP-5747, AP-5751, AP-5752, AP-5754, AP-5780, AP-5781, AP-5789, AP-5790, AP-6332, AP-6333, and AP-6334). Groundwater monitoring well locations are presented on Figure 3-2. Petroleum hydrocarbons, VOCs, and metals were detected in groundwater samples. SVOCs, PCBs, OCPs, dioxins/furans, and OPPs pesticides were not detected. Analytical results for groundwater monitoring well samples are presented in Appendix J. Concentration ranges and detection frequencies for analytes in groundwater monitoring well samples are summarized in Table 6-7.

6.3 North Post Source Area

6.3.1 Soil

Twenty-five surface-soil grab sample locations (001 through 025), and 11 soil borings (AP-6810 through AP-6820) were drilled to investigate the nature and extent of contamination associated with the North Post source area. Surface-soil sample and soil boring locations are presented on Figure 3-3. Analytical results for soil samples from the North Post source area are presented in Appendix J. Petroleum hydrocarbons, VOCs, SVOCs, PCBs, chlorinated pesticides, dioxins/furans, and metals were detected. Concentration ranges and detection frequencies for analytes detected in the surface-soil grab samples are presented in Table 6-8. Table 6-9 presents the concentration ranges and detection frequencies for analytes detected in the soil boring samples.

6.3.2 Groundwater

Seventeen groundwater probes (P01 through P17) were installed to assess the extent of groundwater contamination associated with the North Post source area. Groundwater probe locations are presented on Figure 3-3. Analytical results for groundwater samples are presented in Appendix J. Petroleum hydrocarbons, VOCs, SVOCs, chlorinated pesticides, and metals were detected. PCBs were not detected. Concentration ranges and detection frequencies for analytes detected in groundwater probe samples are summarized in Table 6-10.

Seven groundwater monitoring wells (AP-6814 through AP-6820) were installed in seven of the soil borings in the North Post source area (Figure 3-3). Petroleum hydrocarbons, VOCs, SVOCs, dioxins/furans, and metals were detected in groundwater monitoring well samples. PCBs and chlorinated pesticides were not detected. Analytical results for groundwater monitoring well samples are presented in Appendix J. Concentration ranges and detection frequencies for analytes detected in groundwater monitoring well samples are summarized in Table 6-11.

6.3.3 Surface Water and Sediment

Two sediment samples were collected at the locations (001 and 002) shown on Figure 3-3. Analytical results for sediment samples are presented in Appendix J. Petroleum hydrocarbons, dioxins/furans, and metals were detected. PCBs,

VOCs, SVOCs, and chlorinated pesticides were not detected. Concentration ranges and detection frequencies for analytes detected in sediment samples are presented in Table 6-12.

Two surface-water samples were collected at the locations (001 and 002) shown on Figure 3-3. VOCs and metals were detected. Petroleum hydrocarbons, dioxins/furans, PCBs, SVOCs, and chlorinated pesticides were not detected. Analytical results for surface-water samples are presented in Appendix J. Concentration ranges and detection frequencies for analytes detected in surface-water samples are presented in Table 6-13.

Table 6-1. Concentration Ranges and Detection Frequencies of Analytes in DRMO Yard Source Area Soil Samples

Chemical	Units	Detection Frequency	Range of Detected Concentration
Petroleum Hydrocarbons			
Diesel-Range Organics	µg/kg	163/328	3.8 - 9,600,000
Gasoline-Range Organics	mg/kg	66/322	0.25 - 690
Volatile Organic Compounds			
1,2,4-Trimethylbenzene	µg/kg	9/323	4 - 2,800
1,3,5-Trimethylbenzene	µg/kg	18/323	6 - 5,600
Acetone	µg/kg	30/323	17 - 420
Benzene	µg/kg	4/323	6 - 8
Cumene	µg/kg	2/323	9.2 - 16
Ethylbenzene	µg/kg	5/323	3 - 23
m & p-Xylene	µg/kg	7/323	5 - 77
Methylene chloride	µg/kg	212/323	3 - 95
n-Butylbenzene	µg/kg	6/323	6 - 630
n-Propylbenzene	µg/kg	2/323	8.2 - 23
o-Xylene	µg/kg	7/323	2 - 35
p-Isopropyltoluene	µg/kg	13/323	5 - 2,200
sec-Butylbenzene	µg/kg	2/323	11 - 220
tert-Butylbenzene	µg/kg	1/323	3.4
Tetrachloroethene (PCE)	µg/kg	24/323	2.5 - 150
Toluene	µg/kg	11/323	2.4 - 90
Semivolatile Organic Compounds			
2-Methylnaphthalene	µg/kg	8/328	57 - 13,000
Acenaphthene	µg/kg	2/328	130 - 170
Aldrin	µg/kg	1/331	0.65
Anthracene	µg/kg	4/328	50 - 350
Benzo(a)anthracene	µg/kg	7/328	45 - 320
Benzo(a)pyrene	µg/kg	7/328	49 - 350
Benzo(b)fluoranthene	µg/kg	9/328	48 - 350
Benzo(g,h,i)perylene	µg/kg	7/328	46 - 370
Benzo(k)fluoranthene	µg/kg	7/328	52 - 330
Bis(2-ethylhexyl)-phthalate(DEHP)	µg/kg	28/328	29 - 1,600
Butyl benzyl phthalate	µg/kg	7/328	150 - 710
Chrysene	µg/kg	8/328	46 - 390
di-n-butyl phthalate	µg/kg	133/327	24 - 2,600
Dibenzo(a,h)anthracene	µg/kg	2/328	52 - 84
Fluoranthene	µg/kg	11/328	58 - 660
Fluorene	µg/kg	4/328	230 - 1,000
Indeno(1,2,3-cd)pyrene	µg/kg	5/328	52 - 200
Naphthalene	µg/kg	10/651	3.9 - 4,700

Table 6-1. Concentration Ranges and Detection Frequencies of Analytes in DRMO Yard Source Area Soil Samples (continued)

Chemical	Units	Detection Frequency	Range of Detected Concentration
Phenanthrene	µg/kg	16/328	59 - 950
Pyrene	µg/kg	9/328	91 - 640
Other Organic Compounds			
Total Organic Carbon	mg/kg	331/331	290 - 40,300
PCBs and Organochlorine Pesticides			
4,4'-dichlorodiphenyldichloroethane (DDD)	µg/kg	31/331	2.4 - 39
4,4'-dichlorodiphenyldichloroethene (DDE)	µg/kg	38/331	1.6 - 59
4,4'-dichlorodiphenyltrichloroethane (DDT)	µg/kg	119/331	1.3 - 1,100
Aroclor 1254	µg/kg	2/331	26 - 430
Aroclor 1260	µg/kg	55/331	17 - 1,300
beta-BHC	µg/kg	4/331	0.57 - 1.6
Dieldrin	µg/kg	4/331	12 - 1,000
Endosulfan I	µg/kg	1/331	16
Endosulfan II	µg/kg	5/331	0.78 - 16
Endrin	µg/kg	3/331	9.7 - 14
Endrin aldehyde	µg/kg	1/331	8.6
Endrin ketone	µg/kg	5/331	1.5 - 27
gamma-BHC(Lindane)	µg/kg	6/331	4.2 - 130
Heptachlor epoxide	µg/kg	1/331	19
Methoxychlor	µg/kg	1/331	4.8
Metals			
Arsenic	mg/kg	318/332	0.79 - 72.4
Barium	mg/kg	331/331	18 - 381
Cadmium	mg/kg	84/331	0.48 - 8.1
Chromium	mg/kg	330/331	2.7 - 46.1
Lead	mg/kg	332/336	1.7 - 996
Manganese	mg/kg	330/331	29.1 - 2,420
Mercury	mg/kg	22/331	0.07 - 2.3
Selenium	mg/kg	214/331	0.051 - 4.1
Silver	mg/kg	12/331	0.55 - 5.3
Thallium	mg/kg	6/331	0.13 - 9.8
Dioxins/Furans			
2,3,7,8-TCDD TEQ	pg/g	244/267	0.0008 - 97.356

mg/kg Milligrams per kilogram
PCBs Polychlorinated biphenyls
pg/g Picograms per gram
TCDD Tetrachlorodibenzo-p-dioxin
TEQ Toxicity equivalency
µg/kg Micrograms per kilogram

Table 6-2. Concentration Ranges and Detection Frequencies of Analytes in DRMO Yard Source Area Groundwater Probe Samples

Chemical	Units	Detection Frequency	Range of Detected Concentrations
Petroleum Hydrocarbons			
Diesel-Range Organics	mg/L	65/94	0.12 - 41
Gasoline-Range Organics	mg/L	19/89	0.07 - 28
Volatile Organic Compounds			
1,2,4-Trimethylbenzene	µg/L	11/93	1.3 - 340
1,2-Dichlorobenzene	µg/L	2/161	19 - 38
1,2-Dichloroethane	µg/L	1/93	1.5
1,3,5-Trimethylbenzene	µg/L	10/93	1.3 - 130
1,3-Dichlorobenzene	µg/L	1/161	1.5
1,4-Dichlorobenzene	µg/L	2/161	6 - 12
Acetone	µg/L	7/93	3.1 - 79
Benzene	µg/L	6/93	1.4 - 7.5
Chlorobenzene	µg/L	1/93	2.6
Chloroform	µg/L	27/93	1.1 - 8
cis-1,2-dichloroethene	µg/L	3/93	1.2 - 2.3
Cumene	µg/L	10/93	1.4 - 14
Dichlorodifluoromethane	µg/L	2/93	1.7 - 18
Ethylbenzene	µg/L	7/93	1.3 - 6
m & p-Xylene	µg/L	8/93	1.6 - 87
Methyl ethyl ketone (MEK)	µg/L	21/93	2 - 110
Methylene chloride	µg/L	26/93	1 - 8.8
n-Butylbenzene	µg/L	1/93	30
n-Propylbenzene	µg/L	8/93	1.6 - 32
o-Xylene	µg/L	7/93	1.2 - 150
p-Isopropyltoluene	µg/L	10/93	1.5 - 200
sec-Butylbenzene	µg/L	7/93	1.2 - 25
Styrene	µg/L	2/93	1.7 - 69
Tetrachloroethene (PCE)	µg/L	20/93	1.1 - 65
Toluene	µg/L	5/93	1.5 - 3.7
trans-1,2-dichloroethene	µg/L	6/93	1.3 - 4.4
Trichloroethene (TCE)	µg/L	19/93	1.4 - 9.1
Trichlorofluoromethane	µg/L	2/93	1.6 - 4.1
Semivolatile Organic Compounds			
2-Methylnaphthalene	µg/L	9/68	1 - 240
Dibenzofuran	µg/L	1/68	2
Diethyl phthalate	µg/L	1/68	10
Fluorene	µg/L	2/68	4 - 6
Naphthalene	µg/L	20/161	1.6 - 410
Phenanthrene	µg/L	1/68	4

Table 6-2. Concentration Ranges and Detection Frequencies of Analytes in DRMO Yard Source Area Groundwater Probe Samples (continued)

Chemical	Units	Detection Frequency	Range of Detected Concentrations
Organophosphorus Pesticides			
Diazinon	µg/L	1/68	0.27
Disulfoton	µg/L	2/68	0.11 - 0.53
Naled	µg/L	2/68	0.18 - 0.87
Ronnel	mg/L	1/68	1.1
Metals			
Arsenic (Dissolved)	mg/L	34/67	0.005 - 0.039
Arsenic (Total)	mg/L	35/68	0.006 - 0.043
Barium (Dissolved)	mg/L	64/67	0.03 - 0.42
Barium (Total)	mg/L	65/68	0.03 - 1.2
Chromium (Total)	mg/L	8/64	0.02 - 0.51
Lead (Dissolved)	mg/L	3/67	0.003 - 0.005
Lead (Total)	mg/L	10/68	0.002 - 0.017
Manganese (Dissolved)	mg/L	63/67	0.02 - 6.1
Manganese (Total)	mg/L	65/68	0.02 - 6.4
Mercury (Dissolved)	mg/L	1/67	0.0008
Dioxins/Furans			
2,3,7,8-TCDD TEQ	pg/L	50/68	.6588 - 0.0159

mg/L Milligrams per liter
pg/L Picograms per liter
TCDD Tetrachlorodibenzo-p-dioxin
TEQ Toxicity equivalency
µg/L Micrograms per liter

Table 6-3. Concentration Ranges and Detection Frequencies of Analytes in DRMO Yard Source Area Groundwater Monitoring Well Samples

Chemical	Units	Detection Frequency	Range of Detected Concentrations
Petroleum Hydrocarbons			
Diesel-Range Organics	mg/L	16/23	0.13 - 23
Gasoline-Range Organics	mg/L	8/31	0.05 - 0.94
Volatile Organic Compounds			
1,2,4-Trimethylbenzene	µg/L	5/31	2.9 - 460
1,3,5-Trimethylbenzene	µg/L	5/31	3.7 - 130
Chloroform	µg/L	1/31	1.9
cis-1,2-dichloroethene	µg/L	1/31	7.3
Cumene	µg/L	5/31	1.6 - 14
Ethylbenzene	µg/L	3/31	2.6 - 3.7
m & p-Xylene	µg/L	3/31	3.2 - 92
Methyl ethyl ketone (MEK)	µg/L	2/31	6.4 - 12
Methylene chloride	µg/L	12/31	1 - 1.9
n-Butylbenzene	µg/L	1/31	3.3
n-Propylbenzene	µg/L	5/31	1.7 - 16
Naphthalene	µg/L	6/54	14 - 530
o-Xylene	µg/L	1/31	170
p-Isopropyltoluene	µg/L	2/31	3.5 - 19
sec-Butylbenzene	µg/L	7/31	1.6 - 11
Tetrachloroethene (PCE)	µg/L	6/31	1.3 - 190
trans-1,2-dichloroethene	µg/L	3/31	1.2 - 1.7
Trichloroethene (TCE)	µg/L	5/31	4.8 - 17
Trichlorofluoromethane	µg/L	1/31	6.3
Semivolatile Organic Compounds			
2-Methylnaphthalene	µg/L	5/23	11 - 200
Benzoic acid	µg/L	1/23	19
Fluorene	µg/L	1/23	2
Naphthalene	µg/L	6/54	14 - 530
Organophosphorus Pesticides			
Disulfoton	µg/L	3/23	0.14 - 1.3
Metals			
Arsenic (Dissolved)	mg/L	13/23	0.006 - 0.024
Arsenic (Total)	mg/L	13/23	0.006 - 0.023
Barium (Dissolved)	mg/L	20/23	0.1 - 0.31
Barium (Total)	mg/L	20/23	0.1 - 0.32

Table 6-3. Concentration Ranges and Detection Frequencies of Analytes in DRMO Yard Source Area Groundwater Monitoring Well Samples (continued)

Chemical	Units	Detection Frequency	Range of Detected Concentrations
Lead (Dissolved)	mg/L	1/23	0.006
Manganese (Dissolved)	mg/L	20/23	0.25 - 13
Manganese (Total)	mg/L	20/23	0.27 - 13
Dioxins/Furans			
2,3,7,8-TCDD TEQ	pg/L	19/20	0.33 - 8.4183

µg/L Micrograms per liter
mg/L Milligrams per liter
pg/L Picograms per liter
TCDD Tetrachlorodibenzo-p-dioxin
TEQ Toxicity equivalency

Table 6-4. Concentration Ranges and Detection Frequencies of Analytes in DRMO Yard Source Area Sediment Samples

Chemical	Units	Detection Frequency	Range of Detected Concentrations
Petroleum Hydrocarbons			
Diesel-Range Organics	mg/kg	9/9	63 - 1,000
Volatile Organic Compounds			
Chloroform	µg/kg	1/9	8
Other Organic Compounds			
Total Organic Carbon	percent	7/7	1 - 9.35
PCBs and Organochlorine Pesticides			
Aroclor 1260	mg/kg	3/9	7 - 60
Metals			
Arsenic	mg/kg	9/9	8 - 38
Barium	mg/kg	9/9	139 - 387
Cadmium	mg/kg	4/9	2 - 6
Chromium	mg/kg	9/9	18 - 49
Lead	mg/kg	9/9	10 - 1,390
Manganese	mg/kg	9/9	251 - 5,140
Dioxins/Furans			
2,3,7,8-TCDD TEQ	pg/g	9/9	0.0043 - 71.98

µg/kg Micrograms per kilogram
mg/kg Milligrams per kilogram
pg/g Picograms per gram
TCDD Tetrachlorodibenzo-p-dioxin
TEQ Toxicity equivalency

Table 6-5. Concentration Ranges and Detection Frequencies of Analytes in Micrograms per Liter in DRMO Yard Source Area Surface-Water Samples

Chemical	Detection Frequency	Range of Detected Concentrations
Petroleum Hydrocarbons		
Diesel-Range Organics	1/4	62
Volatile Organic Compounds		
Chloroform	3/4	0.5 - 3.2
Methylene chloride	3/4	1 - 1
Metals		
Barium (Dissolved)	4/4	71 - 74
Barium (Total)	4/4	70 - 74
Manganese (Dissolved)	4/4	479 - 536
Manganese (Total)	4/4	478 - 532

Table 6-6. Concentration Ranges and Detection Frequencies of Analytes in Building 1168 Source Area Soil Samples

Chemical	Units	Detection Frequency	Range of Detected Concentrations
Other Organic Compounds			
Total Organic Carbon	mg/kg	5/5	890 - 26,000
PCBs and Organochlorine Pesticides			
4,4'-dichlorodiphenyltrichloroethane (DDT)	µg/kg	1/5	4.8
Metals			
Arsenic	mg/kg	5/5	1.3 - 5.1
Barium	mg/kg	5/5	29 - 120
Cadmium	mg/kg	5/5	0.73 - 2.2
Chromium	mg/kg	5/5	6.8 - 22
Lead	mg/kg	5/5	2.4 - 7.9
Manganese	mg/kg	5/5	93 - 380
Selenium	mg/kg	1/5	0.22
Silver	mg/kg	4/5	0.98 - 3.7

µg/kg Micrograms per kilogram
mg/kg Milligrams per kilogram
PCBs Polychlorinated biphenyls

Table 6-7. Concentration Ranges and Detection Frequencies of Analytes in Building 1168 Source Area Groundwater Samples

Chemical	Units	Detection Frequency	Range of Detected Concentrations
Petroleum Hydrocarbons			
Diesel-Range Organics	mg/L	9/15	0.077 - 34
Gasoline-Range Organics	mg/L	7/20	0.011 - 18
Volatile Organic Compounds			
1,2,4-Trimethylbenzene	µg/L	4/20	49 - 350
1,3,5-Trimethylbenzene	µg/L	4/20	18 - 150
Acetone	µg/L	1/20	41
Benzene	µg/L	1/20	5.1
Cumene	µg/L	4/20	18 - 59
Ethylbenzene	µg/L	4/20	26 - 310
m & p-Xylene	µg/L	4/20	44 - 620
n-Butylbenzene	µg/L	3/20	13 - 16
n-Propylbenzene	µg/L	4/20	21 - 71
Naphthalene	µg/L	8/35	5 - 130
o-Xylene	µg/L	4/20	3 - 1,000
p-Isopropyltoluene	µg/L	4/20	10 - 30
sec-Butylbenzene	µg/L	4/20	4.4 - 11
Toluene	µg/L	1/20	770
Trichloroethene (TCE)	µg/L	1/20	23
Trichlorofluoromethane	µg/L	3/20	5.1 - 26
Semivolatile Organic Compounds			
2-Methylnaphthalene	µg/L	4/15	5 - 59
Naphthalene	µg/L	8/35	5 - 130
Metals			
Arsenic (Dissolved)	µg/L	7/15	1.2 - 27
Arsenic (Total)	µg/L	6/16	1.8 - 25
Barium (Dissolved)	µg/L	14/15	62 - 350
Barium (Total)	µg/L	14/16	48 - 330
Cadmium (Dissolved)	µg/L	1/15	4.9
Chromium (Total)	µg/L	2/16	8 - 48
Lead (Dissolved)	µg/L	2/15	1.6 - 5.4
Lead (Total)	µg/L	14/16	1.1 - 21
Manganese (Dissolved)	µg/L	13/15	82 - 4,400
Manganese (Total)	µg/L	14/16	11 - 4,400
Selenium (Dissolved)	µg/L	2/15	2.4 - 3.1
Selenium (Total)	µg/L	3/16	1.7 - 2.5
Silver (Total)	µg/L	1/16	22

µg/L Micrograms per liter
mg/L Milligrams per liter

Table 6-8. Concentration Ranges and Detection Frequencies of Analytes in North Post Source Area Surface-Soil Grab Samples

Chemical	Units	Detection Frequency	Range of Detected Concentrations
Petroleum Hydrocarbons			
Diesel-Range Organics	µg/kg	28/28	100,000 - 3,600,000
Volatile Organic Compounds			
Naphthalene	µg/kg	17/28	120 - 5,100
Semivolatile Organic Compounds			
2-Methylnaphthalene	µg/kg	12/28	110 - 1,100
Acenaphthene	µg/kg	17/28	1,000 - 6,800
Anthracene	µg/kg	18/28	11,900 - 11,900
Benzo(a)anthracene	µg/kg	22/28	1,000 - 32,200
Benzo(a)pyrene	µg/kg	23/28	1,000 - 31,600
Benzo(b)fluoranthene	µg/kg	23/28	10,100 - 33,800
Benzo(g,h,i)perylene	µg/kg	22/28	10,800 - 16,900
Benzo(k)fluoranthene	µg/kg	23/28	140 - 20,600
Bis(2-ethylhexyl)phthalate(DEHP)	µg/kg	12/28	1,500 - 4,300
Chrysene	µg/kg	22/28	10,000 - 29,700
di-n-butyl phthalate	µg/kg	22/28	100 - 280
Dibenzo(a,h)anthracene	µg/kg	19/28	1,200 - 8,500
Dibenzofuran	µg/kg	12/28	120 - 3,900
Fluoranthene	µg/kg	21/28	11,200 - 45,900
Fluorene	µg/kg	16/28	1,000 - 5,600
Indeno(1,2,3-cd)pyrene	µg/kg	21/28	1,100 - 18,600
Naphthalene	µg/kg	17/28	120 - 5,100
Phenanthrene	µg/kg	19/28	1,000 - 36,600
Pyrene	µg/kg	22/28	1,000 - 41,500
Other Organic Compounds			
Total Organic Carbon	mg/kg	28/28	13,100 - 57,400
PCBs and Organochlorine Pesticides			
4,4'-dichlorodiphenyldichloroethane (DDD)	µg/kg	8/28	110 - 200
4,4'-dichlorodiphenylcichloroethene (DDE)	µg/kg	27/28	12 - 200
4,4'-dichlorodiphenyltrichloroethane (DDT)	µg/kg	27/28	100 - 960
Metals			
Arsenic	mg/kg	28/28	10.2 - 12.4
Barium	mg/kg	28/28	1,080 - 4,570
Chromium	mg/kg	28/28	15 - 46.9

Table 6-8. Concentration Ranges and Detection Frequencies of Analytes in North Post Source Area Surface-Soil Grab Samples (continued)

Chemical	Units	Detection Frequency	Range of Detected Concentrations
Lead	mg/kg	28/28	11.5 - 231
Manganese	mg/kg	28/28	280 - 913
Mercury	mg/kg	2/28	0.13 - 0.2
Selenium	mg/kg	28/28	0.22 - 0.33
Dioxins/Furans			
2,3,7,8-TCDD TEQ	pg/g	28/28	0.0393 - 3.3108

µg/kg Micrograms per kilogram
mg/kg Milligrams per kilogram
PCBs Polychlorinated biphenyls
pg/g Picograms per gram
TCDD Tetrachlorodibenzop-p-dioxin
TEQ Toxicity equivalent

Table 6-9. Concentration Ranges and Detection Frequencies of Analytes in North Post Source Area Soil Boring Samples

Chemical	Units	Detection Concentration	Range of Detected Concentrations
Petroleum Hydrocarbons			
Diesel-Range Organics	mg/kg	28/46	4.3 - 138
Volatile Organic Compounds			
Acetone	µg/kg	5/46	20 - 125
Methylene chloride	µg/kg	28/46	5.2 - 10
Naphthalene	µg/kg	2/92	150 - 364
Semivolatile Organics			
Acenaphthene	µg/kg	2/46	289 - 388
Anthracene	µg/kg	2/46	566 - 752
Benzo(a)anthracene	µg/kg	2/46	2,190 - 2,470
Benzo(a)pyrene	µg/kg	2/46	2,420 - 3,170
Benzo(b)fluoranthene	µg/kg	2/46	2,660 - 3,290
Benzo(g,h,i)perylene	µg/kg	2/46	1,380 - 1,760
Benzo(k)fluoranthene	µg/kg	2/46	1,850 - 2,230
Chrysene	µg/kg	2/22	1,960 - 2,350
di-n-butyl phthalate	µg/kg	3/46	363 - 445
Dibenzo(a,h)anthracene	µg/kg	2/46	624 - 811
Fluoranthene	µg/kg	2/46	3,000 - 3,640
Fluorene	µg/kg	1/46	317
Indeno(1,2,3-cd)pyrene	µg/kg	2/46	1,270 - 1,640
Naphthalene	µg/kg	2/92	150 - 364
Phenanthrene	µg/kg	2/46	1,960 - 2,470
Pyrene	µg/kg	2/46	2,770 - 3,290
Other Organic Compounds			
Total Organic Carbon	mg/kg	49/49	207 - 12,500
PCBs and Organochlorine Pesticides			
4,4'-dichlorodiphenyldichloroethane (DDD)	µg/kg	9/96	2.7 - 17.5
4,4'-dichlorodiphenyldichloroethene (DDE)	µg/kg	22/96	2 - 121
4,4'-dichlorodiphenyltrichloroethane (DDT)	µg/kg	25/96	2 - 518
Aroclor 1016	µg/kg	1/50	73
Aroclor 1221	µg/kg	1/50	58
Aroclor 1260	µg/kg	1/50	1,450
Heptachlor	µg/kg	3/96	0.78 - 3.3

Table 6-9. Concentration Ranges and Detection Frequencies of Analytes in North Post Source Area Soil Boring Samples (continued)

Chemical	Units	Detection Concentration	Range of Detected Concentrations
Metals			
Arsenic	mg/kg	50/50	1.8 - 11
Barium	mg/kg	50/50	41 - 1,530
Cadmium	mg/kg	21/50	0.05 - 1.8
Chromium	mg/kg	50/50	4.7 - 26
Lead	mg/kg	50/50	2.3 - 19
Manganese	mg/kg	28/28	64 - 380
Mercury	mg/kg	1/50	0.4
Thallium	mg/kg	1/50	33
Dioxins/Furans			
2,3,7,8-TCDD TEQ	pg/g	27/28	0.00092 - 0.9868

µg/kg	Micrograms per kilogram
mg/kg	Milligrams per kilograms
pg/g	Picograms per gram
PCBs	Polychlorinated biphenyls
TCDD	Tetrachlorodibenzo-p-dioxin
TEQ	Toxicity equivalency

Table 6-10. Concentration Ranges and Detection Frequencies of Analytes in North Post Source Area Groundwater Probe Samples

Chemical	Units	Detection Frequency	Range of Detected Concentrations
Petroleum Hydrocarbons			
Diesel-Range Organics	µg/L	15/19	120 - 26,000
Gasoline-Range Organics	mg/L	7/22	0.14 - 47
Volatile Organic Compounds			
1,2,4-Trimethylbenzene	µg/L	2/20	380 - 540
1,3,5-Trimethylbenzene	µg/L	3/20	5 - 660
Benzene	µg/L	1/20	8
Bromoform	µg/L	1/20	4
Chloroform	µg/L	2/20	4 - 5
Ethylbenzene	µg/L	3/20	7 - 220
m & p-Xylene	µg/L	3/20	36 - 1,200
Methyl ethyl ketone (MEK)	µg/L	3/20	46 - 100
Naphthalene	µg/L	4/31	9 - 430
o-Xylene	µg/L	2/20	250 - 370
Semivolatile Organic Compounds			
2-Methylnaphthalene	µg/L	1/11	5
3,3'-Dichlorobenzidine	µg/L	1/11	20
Cumene	µg/L	2/20	10 - 43
di-n-butyl phthalate	µg/L	10/11	1 - 12
n-Propylbenzene	µg/L	1/20	6
Naphthalene	µg/L	4/31	9 - 430
p-Isopropyltoluene	µg/L	2/20	63 - 120
sec-Butylbenzene	µg/L	1/20	5
PCBs and Organochlorine Pesticides			
Endrin ketone	µg/L	1/11	0.1
Metals			
Arsenic (Dissolved)	mg/L	10/11	0.009 - 0.27
Arsenic (Total)	mg/L	10/11	0.011 - 0.24
Barium (Dissolved)	mg/L	10/11	0.13 - 0.29
Barium (Total)	mg/L	10/11	0.13 - 0.29
Chromium (Total)	mg/L	4/11	0.01 - 0.11
Lead (Total)	mg/L	1/11	0.0015
Manganese (Dissolved)	mg/L	10/11	0.25 - 1.9
Manganese (Total)	mg/L	10/11	0.31 - 1.9
Mercury (Total)	mg/L	1/11	0.00058
Selenium (Dissolved)	mg/L	2/11	0.00058 - 0.0011
Selenium (Total)	mg/L	2/11	0.00054 - 0.0012
Silver (Total)	mg/L	1/11	0.034

µg/L Micrograms per liter
mg/L Milligrams per liter
PCBs Polychlorinated biphenyls

Table 6-11. Concentration Ranges and Detection Frequencies of Analytes in North Post Source Area Monitoring Well Samples

Chemical	Units	Detection Frequency	Range of Detected Concentrations
Petroleum Hydrocarbons			
Diesel-Range Organics	µg/L	4/12	100 - 10,000
Gasoline-Range Organics	mg/L	1/14	0.73
Volatile Organic Compounds			
1,3,5-Trimethylbenzene	µg/L	1/14	14
1,2,4-Trimethylbenzene	µg/L	1/14	21
2-Methylnaphthalene	µg/L	1/12	8
Benzene	µg/L	1/14	10
Ethylbenzene	µg/L	1/14	9
m & p-Xylene	µg/L	1/14	66
Methyl ethyl ketone (MEK)	µg/L	1/14	14
Methylene chloride	µg/L	3/14	1 - 1.1
n-Propylbenzene	µg/L	1/14	9
Naphthalene	µg/L	3/26	1 - 13
p-Isopropyltoluene	µg/L	1/14	15
sec-Butylbenzene	µg/L	1/14	6
tert-Butylbenzene	µg/L	1/14	4
Semivolatile Organic Compounds			
di-n-butyl phthalate	µg/L	4/12	2 - 7
Cumene	µg/L	1/14	16
Naphthalene	µg/L	3/26	1 - 13
Metals			
Arsenic (Dissolved)	mg/L	10/12	0.008 - 0.042
Arsenic (Total)	mg/L	10/12	0.008 - 0.042
Barium (Dissolved)	mg/L	10/12	0.22 - 0.36
Barium (Total)	mg/L	10/12	0.23 - 0.34
Lead (Dissolved)	mg/L	1/12	0.0015
Lead (Total)	mg/L	3/12	0.0035 - 0.011
Manganese (Dissolved)	mg/L	10/12	1.4 - 3.2
Manganese (Total)	mg/L	10/12	1.3 - 2.9
Dioxins/Furans			
2,3,7,8-TCDD TEQ	pg/L	6/8	0.0115 - 74.499

µg/L Micrograms per liter
mg/L Milligrams per liter
pg/L Picograms per liter
TDCC Tetrachlorodibenzo-p-dioxin
TEQ Toxicity equivalency

Table 6-12. Concentration Ranges and Detection Frequencies of Analytes in North Post Source Area Sediment Samples

Chemical	Units	Detection Frequency	Range of Detected Concentrations
Petroleum Hydrocarbons			
Diesel-Range Organics	mg/kg	3/3	54-159
Other Organic Compounds			
Total Organic Carbon	percent	3/3	1.3 - 5.69
Metals			
Arsenic (Total)	mg/kg	3/3	6 - 9
Barium (Total)	mg/kg	3/3	108 - 108
Chromium (Total)	mg/kg	3/3	10 - 19
Lead (Total)	mg/kg	3/3	4 - 9
Manganese (Total)	mg/kg	3/3	160 - 287
Dioxins/Furans			
2,3,7,8-TCDD TEQ	pg/g	3/3	0.1101 - 2.9043

mg/kg Milligrams per kilogram
pg/g Picograms per gram
TCDD Tetrachlorodibenzo-p-dioxin
TEQ Toxicity equivalency

Table 6-13. Concentration Ranges and Detection Frequencies of Analytes in North Post Source Area Surface-Water Samples

Chemical	Units	Detection Frequency	Range of Detected Concentrations
Volatile Organic Compounds			
Chloroform	µg/L	1/4	0.6
Other Organic Compounds			
Total Organic Carbon	mg/L	3/3	3 - 3.2
Metals			
Barium (Total)	µg/L	3/3	32 - 34
Manganese (Total)	µg/L	3/3	69 - 74

µg/L Micrograms per liter
mg/L Milligrams per liter

7.0 DEVELOPMENT OF POTENTIAL CHEMICAL-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

To evaluate the significance of chemical concentrations detected and the need for additional action at OU 2 source areas, potential chemical-specific ARARs were developed and used as a screening assessment. Potential ARARs included published EPA RBCs and regulatory concentrations such as MCLs, health advisory levels, and ADEC site soil cleanup levels. At the screening level, detected contaminant concentrations that exceeded the potential ARARs are considered significant and are discussed in section 8. Potential action- and location-specific ARARs will be considered in the OU 2 feasibility study (FS).

7.1 Data Quality Validation

According to the *Supplemental Risk Assessment Guidance for Superfund* (EPA, 1989), analytical laboratory data should be evaluated prior to comparison with potential ARARs. The purpose of the evaluation is to eliminate data not representative of contaminant chemical concentrations from further consideration. The USACE's CQARs evaluate and qualify the data based on results from field laboratory QA/QC programs. The CQARs considered data from the OU 2 source areas as usable and valid without qualification, except as noted in the data tables in Appendix J. HLA performed a data validation on approximately 10 percent of the data. HLA considered data from the OU 2 source areas as usable and valid, except as noted in the data tables in Appendix J. Details of the data evaluations are presented in section 5.

In addition to the data validations performed by HLA and the USACE, an evaluation of laboratory contamination, background concentrations, and tentatively identified compounds (TICs) is presented below.

7.1.1 Laboratory Contamination

The EPA considers acetone, 2-butanone, methylene chloride, toluene, and the phthalate esters common laboratory contaminants. If a laboratory blank contains a detectable level of a common laboratory contaminant, the sample result is considered positive only if the sample concentration exceeds 10 times the maximum amount detected in the blank. If the associated laboratory blank contains detectable levels of one or more analytes not considered by the EPA to be common laboratory contaminants, the sample results are considered positive only if the sample concentration exceeds five times the maximum amount detected in the blank (EPA, 1988b). The following analytes were detected in laboratory blanks associated with some of the project samples, were evaluated according to the criteria presented above, and were considered to be the result of laboratory contamination in at least some of the project samples:

- 1,2,3,4,6,7,8-Heptachlorodibenzodioxin (1,2,3,4,6,7,8-HpCDD);
- 1,2,3,4,6,7,8-Heptachlorodibenzofuran (1,2,3,4,6,7,8-HpCDF);
- 1,2,3,4,7,8-Hexachlorodibenzodioxin (1,2,3,4,7,8-HxCDD);
- 1,2,3,4,7,8-Hexachlorodibenzofuran (1,2,3,4,7,8-HxCDF);
- 1,2,3,6,7,8-HxCDD;
- 1,2,3,6,7,8-HxCDF;
- 1,2,3,7,8,9-HxCDF;
- 1,2,3,7,8-Pentachlorodibenzodioxin (1,2,3,7,8-PeCDD);
- 2,3,4,6,7,8-HxCDF;
- 2,3,7,8-Tetrachlorodibenzofuran (2,3,7,8-TCDF);
- Octachlorodibenzodioxin (OCDD);
- Octachlorodibenzofuran (OCDF);
- Total HpCDD;
- Total HpCDF;
- Total HxCDD;

- Total HxCDF;
- Total PeCDD;
- Total pentachlorodibenzofuran (PeCDF);
- Total tetrachlorodibenzodioxin (TCDD);
- Total TCDF;
- 2-Butanone;
- Acetone;
- Barium;
- bis(2-Ethylhexyl)phthalate;
- di-n-Butylphthalate;
- DRO;
- Lead;
- Methylene chloride;
- Naphthalene.

Methylene chloride was characterized as a laboratory contaminant and is not addressed as a chemical of concern (COC) in this report.

Chloroform was characterized as a laboratory contaminant in surface-water and sediment samples at the OU 2 source areas and is not addressed as a COC for these media.

7.1.2 Background Concentrations

Chemicals identified as part of the background were also eliminated from further consideration. The two types of background chemicals are 1) naturally occurring chemicals that have not been influenced by humans, and 2) chemicals that are present due to human (anthropogenic) sources. In general, comparison with naturally occurring levels applies only to inorganic chemicals, because most organic chemicals found at contaminated sites are not naturally occurring. The USACE evaluated and reported on background concentrations for arsenic, barium, cadmium, chromium, and lead in soil and groundwater at Fort Wainwright, and recommended background values that correspond to the 95-percent upper confidence limit of these metals concentrations (USACE, 1994). Table 7-1 presents a summary of the background concentrations obtained from the USACE background study report. Chemicals exceeding naturally occurring background concentrations were considered COCs.

Arsenic, barium, cadmium, chromium, and manganese detected in all media at the OU 2 source areas exceeded the ranges of naturally occurring background concentrations, and are addressed as COCs in this report. However, HLA believes that the metals detected in samples are associated with naturally occurring inorganic chemicals and do not correspond to a separate contaminant source.

Manganese and thallium were not included in the Fort Wainwright background investigation. Background concentrations for these two metals were obtained by collecting soil and groundwater samples from locations upgradient of suspected sources of contamination at the three OU 2 source areas. The highest concentrations detected in manganese and thallium background samples are reported in Table 7-1.

7.1.3 Tentatively Identified Compounds

TICs are compounds, or general classes of compounds, assigned identities based on computer searches of mass spectra and partial matches of the 30 highest peaks on a chromatogram for VOC and SVOC analyses. Both the identity and the reported concentration of a TIC are questionable. TICs at low concentrations do not need to be specifically addressed in the human health screening assessment when other related compounds are present at higher concentrations and can be evaluated using more complete toxicity information. TICs at high concentrations or present in large quantities may need to be further evaluated with fieldwork or different chemical analyses (EPA, 1989). TICs in samples collected from the OU 2 source areas were detected at relatively low concentrations and are not considered further in this report.

Table 7-1. Fort Wainwright Background Levels of Metals South of the Chena River

Analyte	Units	Recommended Level	Maximum Level
Metals - Soil			
Arsenic	mg/kg	14	29
Barium	mg/kg	115	234
Cadmium	mg/kg	1.8	NA
Chromium	mg/kg	19	46
Lead	mg/kg	26	NA
Manganese	mg/kg	NA	318
Thallium	mg/kg	NA	33
Dissolved Metals - Groundwater			
Arsenic	µg/L	20	56
Barium	µg/L	341	520
Cadmium	µg/L	4.8	10
Chromium	µg/L	6	10
Lead	µg/L	9.9	27
Manganese	µg/L	NA	1,900
Total Metals - Groundwater			
Arsenic	µg/L	72	230
Barium	µg/L	988	2,000
Cadmium	µg/L	9	16
Chromium	µg/L	125	390
Lead	µg/L	66	160
Manganese	µg/L	NA	1,900

µg/L Micrograms per liter
mg/kg Milligrams per kilogram
NA Not available

7.2 Applicable Groundwater Standards

Applicable groundwater standards include federal drinking water MCLs promulgated by the EPA, ADEC drinking water MCLs, health advisory levels, and RBCs.

An MCL is the maximum permissible level of a contaminant in water delivered to any user of a public water system (EPA, 1993). Both the federal government and the ADEC promulgate MCLs for drinking water, although, in most cases, ADEC MCLs are identical to federal MCLs. The aquifer in the vicinity of the OU 2 source areas provides potable water for Fort Wainwright and the City of Fairbanks; therefore, MCLs are relevant.

Health advisory levels are published by the EPA in several forms differentiated by the duration of exposure, the receptor age, and uncertainty factors. The 70-kilogram (kg) adult receptor, lifetime exposure category health advisory levels are usually identical to MCLs.

RBCs are concentrations of chemicals in water (and soil) designed to be health-protective of potential onsite receptors, based on standard reasonable maximum exposure assumptions and EPA-established toxicity criteria. EPA Region 10 recommends the use of carcinogenic and noncarcinogenic RBCs developed and published by EPA Region 3 for screening purposes (EPA, 1994). At the direction of the USACE, risk-based screening was performed during the OU 2 RI using a carcinogenic risk level of 10^{-6} and a noncarcinogenic hazard quotient of 1.

7.3 Applicable Soil Standards

The EPA Office of Solid Waste and Emergency Response recommended a screening level for lead in soil of 400 ppm. For the purposes of reviewing OU 2 RI data, the Region 3 RBC for lead (0.0078 mg/kg) was used as a potential ARAR, as directed by the remedial project managers.

The ADEC groups site soil cleanup goals into four levels, A through D, based on a scoring matrix, as described in its *Interim Guidance for Non-UST Contaminated Soil Cleanup Levels* (1991). Depth to groundwater, precipitation, soil type, volume of contaminated soil, and distance to potential receptors are considered when calculating an estimated site soil cleanup level. The most conservative site soil cleanup levels (Level A) of 50 mg/kg GRO, 100 mg/kg DRO, 0.1 mg/kg benzene, and 10 mg/kg total BTEX were used as potential ARARs.

7.4 Potential ARARs Below the Method Reporting Limit

Due to the detection methods and equipment used to analyze the samples and matrix interference difficulties, the MRLs of particular chemicals may be greater than the potential ARARs. Summaries of COCs with MRLs greater than the potential ARARs are reported in Tables 7-2, 7-3, and 7-4. The extent of contamination for a chemical with a detected concentration and an elevated MRL greater than the potential ARAR may not be fully known. The human health effects of chemicals that were not detected, but that have MRLs greater than potential ARARs, may require additional evaluation and will be addressed in the human health risk assessment (HRA).

7.5 Screening Assessment

Tables 7-5 and 7-6 list compounds analyzed for the OU 2 source areas, and their potential ARARs for soil and groundwater. The number of chemicals considered in section 8, and the estimated extent of contamination were reduced by considering only those chemicals exceeding the most conservative potential ARARs. Data for chemicals assumed to be present due to laboratory contamination were discarded. Data that exceeded the most conservative potential ARARs with concentrations less than background concentrations were also discarded. Section 8 presents a discussion of those chemicals that passed the screening assessment.

Table 7-2. Chemicals of Concern Detected at the DRMO Yard Source Area With MRLs Greater Than Potential ARARs

Matrix	Analyte	Units	ARAR	MRLs	Frequency of MRLs>ARARs for ND Analytes
Groundwater	1,4-Dichlorobenzene (EPA 8260)	µg/L	0.44[a]	1.0/5.0	124/124
	1,4-Dichlorobenzene (EPA 8270)	µg/L	0.44[a]	1.0-10.0	90/90
	Arsenic (Dissolved)	mg/L	0.000038[b]	0.005	43/43
	Arsenic (Total)	mg/L	0.000038[b]	0.005	43/43
	Lead (Dissolved)	mg/L	0.0000037[b]	0.002	86/86
	Lead (Total)	mg/L	0.0000037[b]	0.002	81/81
Subsurface Soil	Benzo(a)anthracene	µg/kg	880[a]	3,500	1/65
	Benzo(a)pyrene	µg/kg	88[a]	340-2,300	88/151
	Benzo(b)fluoranthene	µg/kg	880[a]	2,200	1/65
	Dibenzo(a,h)anthracene	µg/kg	88[a]	150-1,600	86/152
	Ideno(1,2,3-cd)pyrene	µg/kg	880[a]	2,100	1/67
	Aroclor 1254	µg/kg	83[a]	100-220	82/155
	Aroclor 1260	µg/kg	83[a]	140-220	76/142
	Lead	mg/kg	0.0078[a]	0.11/4.0	2/2
Surface Soil	Aroclor 1254	µg/kg	83[a]	180-210	6/6
	Aroclor 1260	µg/kg	83[a]	370-430	5/5

ARAR Applicable or relevant and appropriate requirement
EPA U.S. Environmental Protection Agency
MRL Method reporting limit
µg/kg Micrograms per kilogram
µg/L Micrograms per liter
mg/kg Milligrams per kilogram
mg/L Milligrams per liter
ND Not detected
> Greater than

a. Risk-based concentration is 10^{-6} (EPA, 1994)
b. Hazard quotient is equal to 1 (EPA, 1994)

Table 7-3. Chemicals of Concern Detected at the Building 1168 Source Area With MRLs Greater Than Potential ARARs

Matrix	Analyte	Units	ARAR*	MRLs	Frequency of MRLs>ARARs for ND Analytes
Groundwater	1,2,4-Trimethylbenzene	μg/L	3	4.1	2/16
	1,3,5-Trimethylbenzene	μg/L	2.4	3.8	2/16

ARAR Applicable or relevant and appropriate requirement
MRL Method reporting limit
μg/L Micrograms per liter
ND Not detected
> Greater than

* Hazard quotient is equal to 1 (EPA, 1994)

Table 7-4. Chemicals of Concern Detected at the North Post Source Area With MRLs Greater Than Potential ARARs

Matrix	Analyte	Units	ARAR	MRLs	Frequency of MRLs > ARARs for ND Analytes
Groundwater	1,2,4-Trimethylbenzene	μg/L	3[a]	5.0	22/31
	1,3,5-Trimethylbenzene	μg/L	2.4[a]	5.0	21/30
Subsurface Soil	Benzo(a)pyrene	μg/kg	880[b]	338-428	44/47
	Dibenzo(a,h)anthracene	μg/kg	88[b]	338-428	44/47
	Aroclor 1260	μg/kg	83[b]	84/300	2/52
Surface Soil	Benzo(a)pyrene	μg/kg	880[b]	370-470	5/5
	Dibenzo(a,h)anthracene	μg/kg	88[b]	360-470	9/9
	Aroclor 1260	μg/kg	83[b]	120-2,100	28/28

ARAR Applicable or relevant and appropriate requirement
MRL Method reporting limit
μg/kg Micrograms per kilogram
μg/L Micrograms per liter
ND Not detected
> Greater than

a. Hazard quotient is equal to 1 (EPA, 1994)
b. Risk-based concentration is 10^{-6} (EPA, 1994)

Table 7-5. Screening Levels for Analytes in Soil in Milligrams per Kilogram

Chemicals of Potential Concern	10^{-6} RBC	10^{-4} RBC	HQ = 1	ADEC Site Soil Cleanup Level
Volatile Organic Compounds - EPA Method 8260				
1,1-Dichloroethene	1.1	110	200	--
1,1,1-Trichloroethane	NA	NA	7,000	--
1,1,2-Trichloroethane	11	1,100	1,000	--
1,1,2,2-Tetrachloroethane	3.2	320	8,000	--
1,2-Dichloroethane	7	700	NA	--
1,2-Dichloropropane	9.4	940	NA	--
trans-1,3-dichloropropene	4	400	80	--
cis-1,3-dichloropropene	4	400	80	--
2-Hexanone	--	--	--	--
4-Methyl-2-pentanone	--	--	--	--
Acetone	NA	NA	7,800	--
Methyl ethyl ketone (MEK)	NA	NA	4,700	--
Benzene	22	2,200	NA	0.1
Bromobenzene	--	--	--	--
Bromochloromethane	--	--	--	--
Bromodichloromethane	10	1,000	5,000	--
Bromoform	81	8,100	5,000	--
Bromomethane	NA	NA	110	--
n-Butylbenzene	--	--	--	--
sec-Butylbenzene	--	--	780	--
tert-Butylbenzene	--	--	780	--
Carbon disulfide	--	--	7,800	--
Carbon tetrachloride	4.9	490	200	--
Chlorobenzene	NA	NA	1,600	--
Chloroethane	NA	NA	31,000	--
Chloroform	100	10,000	3,000	--
Chloromethane	49	4,900	NA	--
2-Chlorotoluene	--	--	--	--
4-Chlorotoluene	--	--	--	--
Dibromochloromethane	7.6	760	5,000	--
1,2-Dibromo-3-chloropropane	0.046	4.6	--	--
1,2-Dibromoethane	0.0075	0.75	--	--
Dibromomethane	--	--	--	--
1,2-Dichlorobenzene	NA	NA	7,000	--
1,3-Dichlorobenzene	NA	NA	7,000	--
1,4-Dichlorobenzene	27	2,700	NA	--
Dichlorodifluoromethane	--	--	1,600	--
1,1-Dichloroethane	NA	NA	7,800	--
cis-1,2-Dichloroethene	NA	NA	780	--
1,3-Dichloropropane	--	--	--	--
1,1-Dichloropropene	--	--	--	--
2,2-Dichloropropane	--	--	--	--
Ethylbenzene	NA	NA	7,800	10

Table 7-5. Screening Levels for Analytes in Soil in Milligrams per Kilogram (continued)

Chemicals of Potential Concern	10^{-6} RBC	10^{-4} RBC	HQ = 1	ADEC Site Soil Cleanup Level
Volatile Organic Compounds - EPA Method 8260 (continued)				
Hexachlorobutadiene	8.2	820	500	--
Cumene	--	--	3,100	--
p-Isopropyltoluene	--	--	--	--
Methylene chloride	85	8,500	20,000	--
Naphthalene	NA	NA	3,100	--
n-Propylbenzene	--	--	--	--
Styrene	20	2,000	16,000	--
1,1,1,2-Tetrachloroethane	25	2,500	--	--
Tetrachloroethene (PCE)	12	1,200	3,000	--
Toluene	NA	NA	16,000	10
1,2,3-Trichlorobenzene	--	--	--	--
1,2,4-Trichlorobenzene	NA	NA	780	--
Trichlorofluoromethane	--	--	23,000	--
1,2,3-Trichloropropane	0.091	9.1	--	--
1,2,4-Trimethylbenzene	--	--	39	--
1,3,5-Trimethylbenzene	--	--	31	--
Total Xylenes	NA	NA	160,000	10
m- & p-Xylene				10
o-Xylene				10
trans-1,2-dichloroethene	NA	NA	1,600	--
Trichloroethene (TCE)	58	5,800	2,000	--
Vinyl chloride	0.34	34	NA	--
Semivolatile Organic Compounds - EPA Method 8270				
Benzidine	0.0028	0.28	--	--
Benzyl alcohol	NA	NA	23,000	--
bis(2-chloroethyl)ether	0.58	58	NA	--
Phenol	NA	NA	47,000	--
1,2-Dichlorobenzene	NA	NA	7,000	--
1,3-Dichlorobenzene	NA	NA	7,000	--
2-Chlorophenol	NA	NA	390	--
2-Methylphenol	NA	NA	3,900	--
bis(2-chloroisopropyl) ether	9.1	910	10,000	--
4-Methylphenol	NA	NA	390	--
n-Nitrosodi-n-propylamine	0.091	9.1	NA	--
Hexachloroethane	46	4,600	300	--
Nitrobenzene	NA	NA	39	--
Isophorone	670	67,000	50,000	--
2-Nitrophenol	NA	NA	NA	--
2,4-Dimethylphenol	NA	NA	1,600	--
Benzoic acid	NA	NA	310,000	--
bis(2-chloroethoxy)methane	NA	NA	NA	--

Table 7-5. Screening Levels for Analytes in Soil in Milligrams per Kilogram (continued)

Chemicals of Potential Concern	10^{-6} RBC	10^{-4} RBC	HQ = 1	ADEC Site Soil Cleanup Level
Semivolatile Organic Compounds - EPA Method 8270 (continued)				
2,4-Dichlorophenol	NA	NA	240	--
1,2,4-Trichlorobenzene	NA	NA	780	--
Naphthalene	NA	NA	3,100	--
4-Chloroaniline	NA	NA	310	--
Hexachlorobutadiene	8.2	820	500	--
4-Chloro-3-methylphenol	NA	NA	NA	--
2-Methylnaphthalene	NA	NA	NA	--
Hexachlorocyclopentadiene	NA	NA	550	--
2,4,6-Trichlorophenol	5.8	580	--	--
2,4,5-Trichlorophenol	NA	NA	7,800	--
2-Chloronaphthalene	NA	NA	20,000	--
2-Nitroaniline	NA	NA	4.7	--
Dimethyl phthalate	NA	NA	780,000	--
Acenaphthylene	NA	NA	4,700	--
3-Nitroaniline	NA	NA	230	--
Acenaphthene	NA	NA	20,000	--
2,4-Dinitrophenol	NA	NA	160	--
4-Nitrophenol	NA	NA	4,800	--
Dibenzofuran	NA	NA	300	--
2,4-Dinitrotoluene	0.9	90	160	--
2,6-Dinitrotoluene	0.9	90	78	--
Diethyl phthalate	NA	NA	63,000	--
4-Chlorophenyl phenyl ether	NA	NA	NA	--
Fluorene	NA	NA	3,100	--
4-Nitroaniline	NA	NA	230	--
2-Methyl-4,6-dinitrophenol	NA	NA	NA	--
n-Nitrosodiphenylamine	130	13,000	NA	--
4-Bromophenyl phenyl ether	NA	NA	4,500	--
Hexachlorobenzene	0.4	40	200	--
Pentachlorophenol	5.3	530	80,000	--
Phenanthrene	NA	NA	NA	--
Anthracene	NA	NA	23,000	--
di-n-butyl phthalate	NA	NA	30,000	--
Fluoranthene	NA	NA	3,100	--
Pyrene	NA	NA	2,300	--
Butyl benzyl phthalate	NA	NA	16,000	--
3,3'-Dichlorobenzidine	1.4	140	NA	--
Benzo(a)anthracene	0.88	88	NA	--
bis(2-ethylhexyl)phthalate(DEHP)	46	4,600	5,000	--
Chrysene	88	8,800	NA	--
di-n-Octyl phthalate	NA	NA	1,600	--
Benzo(b)fluoranthene	0.88	88	NA	--
Benzo(k)fluoranthene	8.8	880	NA	--

Table 7-5. Screening Levels for Analytes in Soil in Milligrams per Kilogram (continued)

Chemicals of Potential Concern	10^{-6} RBC	10^{-4} RBC	HQ = 1	ADEC Site Soil Cleanup Level
Semivolatile Organic Compounds - EPA Method 8270 (continued)				
Benzo(a)pyrene	0.088	8.8	NA	--
Indeno(1,2,3-cd)pyrene	0.88	88	NA	--
Dibenzo(a,h)anthracene	0.088	8.8	NA	--
Benzo(g,h,i)perylene	NA	NA	NA	--
Polychlorinated biphenyls (PCBs)/ Pesticides - EPA Method 8080				
PCBs (total)	0.083	8.3	NA	--
Aroclor 1016	0.083	8.3	5.5	--
Aroclor 1221	0.083	8.3	--	--
Aroclor 1232	0.083	8.3	--	--
Aroclor 1242	0.083	8.3	--	--
Aroclor 1248	0.083	8.3	--	--
Aroclor 1254	0.083	8.3	--	--
Aroclor 1260	0.083	8.3	--	--
Aldrin	0.038	3.8	8	--
alpha-BHC	0.1	10	NA	--
beta-BHC	0.35	35	NA	--
delta-BHC	NA	NA	NA	--
gamma-BHC(Lindane)	0.49	49	80	--
Chlordane	0.49	49	20	--
4,4'-DDD	2.7	270	NA	--
4,4'-DDE	1.9	190	NA	--
4,4'-DDT	1.9	190	100	--
Dieldrin	0.04	4	10	--
Endosulfan (I, II)	NA	NA	470	--
Endosulfan I				--
Endosulfan II				--
Endosulfan sulfate	NA	NA	NA	--
Endrin	NA	NA	23	--
Endrin aldehyde	--	--	--	--
Endrin ketone	--	--	--	--
Heptachlor	0.14	14	100	--
Heptachlor epoxide	0.07	7	4	--
Methoxychlor	NA	NA	390	--
Toxaphene	0.58	58	NA	--
Pesticides (Organophosphorous) - EPA Method 8140				
Azinphos-methyl	--	--	--	--
Bolstar (Sulprofos)	--	--	--	--
Chlorpyrifos	--	--	230	--
Coumaphos	--	--	--	--

Table 7-5. Screening Levels for Analytes in Soil in Milligrams per Kilogram (continued)

Chemicals of Potential Concern	10^{-6} RBC	10^{-4} RBC	HQ = 1	ADEC Site Soil Cleanup Level
Pesticides (Organophosphorous) - EPA Method 8140 (continued)				
Demeton, -O and -S	--	--	3.1	--
Diazinon	--	--	70	--
Dichlorvos	--	--	2.2	--
Dimethoate	--	--	16	--
Disulfoton	--	--	3.1	--
EPN	--	--	--	--
Ethoprop	--	--	--	--
Ethyl parathion	--	--	--	--
Fensulfothion	--	--	--	--
Fenthion	--	--	--	--
Malathion	--	--	1,600	--
Merphos	--	--	2.3	--
Mevinphos	--	--	--	--
Monocrotophos	--	--	--	--
Naled	--	--	160	--
Methyl parathion	--	--	--	--
Phorate	--	--	16	--
Ronnel	--	--	3,900	--
Sulfotep	--	--	--	--
Tetrachlorvinphos (Stirophos)	27	2,700	--	--
Tetraethyl pyrophosphate	--	--	--	--
Tokuthion (Protothiofos)	--	--	--	--
Trichloronate	--	--	--	--
Metals				
Barium	NA	NA	5,500	--
Cadmium	NA	NA	39	--
Chromium	NA	NA	78,000	--
Silver	NA	NA	390	--
Thallium	NA	NA	20	--
Arsenic	0.37	37	23	--
Lead	NA	NA	0.0078	--
Selenium	NA	NA	390	--
Mercury	NA	NA	23	--
Manganese	--	--	390	--

Table 7-5. Screening Levels for Analytes in Soil in Milligrams per Kilogram (continued)

Chemicals of Potential Concern	10^{-6} RBC	10^{-4} RBC	HQ = 1	ADEC Site Soil Cleanup Level
Other Organics				
2,3,7,8-TCDD (dioxin)	$4.10E^{-06}$	0.000410	--	--
Total Organic Carbon	--	--	--	--
Diesel-Range Organics	--	--	--	100
Gasoline-Range Organics	--	--	--	50

-- Value not established.
ADEC Alaska Department of Environmental Conservation.
BHC Benzene hexachloride.
DDD Dichlorodiphenyldichloroethane.
DDE Dichlorodiphenyldichloroethene.
DDT Dichlorodiphenyltrichloroethane.
EPN o-Ethyl-o,p-nitrophenyl phenylphosphorothioate.
HQ Noncarcinogenic hazard quotient estimated in *Supplemental Risk Assessment Guidance for Superfund*, U.S. Environmental Protection Agency (EPA) Region 3, July 11, 1994.
NA Toxicity value not available; risk-based concentrations cannot be calculated.
RBC Carcinogenic risk-based concentration estimated in *Supplemental Risk Assessment Guidance for Superfund*, EPA Region 3, July 11, 1994.

Table 7-6. Screening Levels for Analytes in Groundwater in Micrograms per Liter

Chemicals of Potential Concern	10^{-6} RBC	10^{-4} RBC	HQ = 1	MCL
Volatile Organic Compounds - EPA Method 8260				
1,1-Dichloroethene	0.044	4.4	300	7
1,1,1-Trichloroethane	NA	NA	1,300	200
1,1,2-Trichloroethane	0.19	19	100	5
1,1,2,2-Tetrachloroethane	0.52	52	1,000	--
1,2-Dichloroethane	0.12	12	NA	5
1,2-Dichloropropane	0.16	16	100	5
trans-1,3-Dichloropropene	0.2	20	9	--
cis-1,3-Dichloropropene	0.2	20	9	--
2-Hexanone	--	--	--	--
4-Methyl-2-Pentanone	--	--	--	--
Acetone	NA	NA	3,700	--
Methyl ethyl ketone (MEK)	NA	NA	22,000	--
Benzene	0.36	36	NA	5
Bromobenzene	--	--	--	--
Bromochloromethane	--	--	--	--
Bromodichloromethane	0.17	17	700	100
Bromoform	2.4	240	700	100
Bromomethane	NA	NA	8.7	--
n-Butylbenzene	--	--	--	--
sec-Butylbenzene	--	--	61	--
tert-Butylbenzene	--	--	61	--
Carbon disulfide	--	--	21	--
Carbon tetrachloride	0.16	16	30	5
Chlorobenzene	NA	NA	39	100
Chloroethane	NA	NA	8,600	
Chloroform	0.15	15	400	100
Chloromethane	1.4	140	NA	--
2-Chlorotoluene	--	--	--	--
4-Chlorotoluene	--	--	--	--
Dibromochloromethane	0.13	13	700	--
1,2-Dibromo-3-chloropropane	0.048	4.8	--	--
1,2-Dibromoethane	0.00075	0.075	--	--
Dibromomethane	--	--	--	--
1,2-Dichlorobenzene	NA	NA	370	600
1,3-Dichlorobenzene	NA	NA	540	--
1,4-Dichlorobenzene	0.44	44	2,000	75
Dichlorodifluoromethane	--	--	390	--
1,1-Dichloroethane	NA	NA	810	--
cis-1,2-dichloroethene	NA	NA	61	70
1,3-Dichloropropane	--	--	--	--
1,1-Dichloropropene	--	--	--	--
2,2-Dichloropropane	--	--	--	--
Ethylbenzene	NA	NA	1,300	700
Hexachlorobutadiene	0.14	14	70	--

Table 7-6. Screening Levels for Analytes in Groundwater in Micrograms per Liter (continued)

Chemicals of Potential Concern	10^{-6} RBC	10^{-4} RBC	HQ = 1	MCL
Volatile Organic Compounds - EPA Method 8260 (continued)				
Cumene	--	--	1500	--
p-Isopropyltoluene	--	--	--	--
Methylene chloride	4.1	410	2,000	5
Naphthalene	NA	NA	1,500	--
n-Propylbenzene	--	--	--	--
Styrene	2	200	1,600	100
1,1,1,2-Tetrachloroethane	0.41	41	--	--
Tetrachloroethene (PCE)	1.1	110	400	5
Toluene	NA	NA	750	1,000
1,2,3-Trichlorobenzene	--	--	--	--
1,2,4-Trichlorobenzene	NA	NA	190	70
Trichlorofluoromethane	--	--	1,300	--
1,2,3-Trichloropropane	0.0015	0.15	--	--
1,2,4-Trimethylbenzene	--	--	3	--
1,3,5-Trimethylbenzene	--	--	2.4	--
Total Xylenes	NA	NA	12,000	10,000
m- & p-Xylene				
o-Xylene				
trans-1,2-dichloroethene	NA	NA	120	100
Trichloroethene (TCE)	1.6	160	200	5
Vinyl chloride	0.019	1.9	NA	2
Semivolatile Organic Compounds - Method 8270				
Benzidine	0.00029	0.029	--	--
Benzyl alcohol	NA	NA	11,000	--
bis(2-chloroethyl)ether	0.0092	0.92	NA	--
Phenol	NA	NA	22,000	--
1,2-Dichlorobenzene	NA	NA	370	600
1,3-Dichlorobenzene	NA	NA	540	--
2-Chlorophenol	NA	NA	180	--
2-Methylphenol	NA	NA	1,800	--
bis(2-chloroisopropyl) ether	0.26	26	1,000	--
4-Methylphenol	NA	NA	180	--
n-Nitrosodi-n-propylamine	0.0096	0.96	NA	--
Hexachloroethane	0.75	75	40	--
Nitrobenzene	NA	NA	3.4	--
Isophorone	71	7,100	7,000	NA
2-Nitrophenol	NA	NA	NA	--
2,4-Dimethylphenol	NA	NA	730	--
Benzoic acid	NA	NA	150,000	--
bis(2-chloroethoxy)methane	NA	NA	NA	--
2,4-Dichlorophenol	NA	NA	110	--

Table 7-6. Screening Levels for Analytes in Groundwater in Micrograms per Liter (continued)

Chemicals of Potential Concern	10^{-6} RBC	10^{-4} RBC	HQ = 1	MCL
Semivolatile Organic Compounds - EPA Method 8270 (continued)				
1,2,4-Trichlorobenzene	NA	NA	190	70
Naphthalene	NA	NA	1,500	--
4-Chloroaniline	NA	NA	150	--
Hexachlorobutadiene	0.14	14	70	--
4-Chloro-3-methylphenol	NA	NA	NA	--
2-Methylnaphthalene	NA	NA	NA	--
Hexachlorocyclopentadiene	NA	NA	0.15	50
2,4,6-Trichlorophenol	1.6	160	NA	--
2,4,5-Trichlorophenol	NA	NA	3,700	--
2-Chloronaphthalene	NA	NA	3,000	--
2-Nitroaniline	NA	NA	2.2	--
Dimethyl phthalate	NA	NA	370,000	--
Acenaphthylene	NA	NA	2,200	--
3-Nitroaniline	NA	NA	110	--
Acenaphthene	NA	NA	2,000	--
2,4-Dinitrophenol	NA	NA	73	--
4-Nitrophenol	NA	NA	2,300	--
Dibenzofuran	NA	NA	40	--
2,4-Dinitrotoluene	0.1	10	73	--
2,6-Dinitrotoluene	0.1	10	37	--
Diethyl phthalate	NA	NA	29,000	--
4-Chlorophenyl phenyl ether	NA	NA	NA	--
Fluorene	NA	NA	1,500	--
4-Nitroaniline	NA	NA	110	--
2-Methyl-4,6-dinitrophenol	NA	NA	NA	--
n-Nitrosodiphenylamine	14	1,400	NA	--
4-Bromophenyl phenyl ether	NA	NA	2,100	--
Hexachlorobenzene	0.0066	0.66	30	1
Pentachlorophenol	0.56	56	1,000	1
Phenanthrene	NA	NA	NA	--
Anthracene	NA	NA	11,000	--
di-n-Butyl phthalate	NA	NA	4,000	--
Fluoranthene	NA	NA	1,500	--
Pyrene	NA	NA	1,100	--
Butyl benzyl phthalate	NA	NA	7,300	100
3,3'-Dichlorobenzidine	0.15	15	NA	--
Benzo(a)anthracene	0.092	9.2	NA	0.1
bis(2-Ethylhexyl)phthalate(DEHP)	4.8	480	700	6
Chrysene	9.2	920	NA	0.2
di-n-Octyl phthalate	NA	NA	730	--
Benzo(b)fluoranthene	0.092	9.2	NA	0.2
Benzo(k)fluoranthene	0.92	92	NA	0.2
Benzo(a)pyrene	0.0092	0.92	NA	0.2

Table 7-6. Screening Levels for Analytes in Groundwater in Micrograms per Liter (continued)

Chemicals of Potential Concern	10^{-6} RBC	10^{-4} RBC	HQ = 1	MCL
Indeno(1,2,3-cd)pyrene	0.092	9.2	NA	0.4
Dibenzo(a,h)anthracene	0.0092	0.92	NA	0.3
Benzo(g,h,i)perylene	NA	NA	NA	--
Polychlorinated biphenyls (PCBs)/Pesticides - EPA Method 8080				
PCBs (total)	0.0087	0.87	NA	0.5
Aroclor 1016	0.0087	0.87	2.6	0.5
Aroclor 1221	0.0087	0.87	--	0.5
Aroclor 1232	0.0087	0.87	--	0.5
Aroclor 1242	0.0087	0.87	--	0.5
Aroclor 1248	0.0087	0.87	--	0.5
Aroclor 1254	0.0087	0.87	--	0.5
Aroclor 1260	0.0087	0.87	--	0.5
Aldrin	0.005	0.5	1	NA
alpha-BHC	0.011	1.1	NA	NA
beta-BHC	0.037	3.7	NA	--
delta-BHC	NA	NA	NA	--
gamma-BHC(Lindane)	0.052	5.2	10	0.2
Chlordane	0.052	5.2	2	2
4,4'-DDD	0.28	28	NA	--
4,4'-DDE	0.2	20	NA	--
4,4'-DDT	0.2	20	20	--
Dieldrin	0.0042	0.42	2	--
Endosulfan (I, II)	NA	NA	220	--
Endosulfan sulfate	NA	NA	NA	--
Endrin	NA	NA	11	2
Endrin aldehyde	--	--	--	--
Endrin ketone	--	--	--	--
Heptachlor	0.0023	0.23	20	0.4
Heptachlor epoxide	0.0012	0.12	0.5	0.2
Methoxychlor	NA	NA	180	40
Toxaphene	0.061	6.1	NA	3
Pesticides (Organophosphorous) - EPA Method 8140				
Azinphos-methyl	--	--	--	--
Bolstar (Sulprofos)	--	--	--	--
Chlorpyrifos	--	--	110	--
Coumaphos	--	--	--	--
Demeton, -O and -S	--	--	1.5	--

Table 7-6. Screening Levels for Analytes in Groundwater in Micrograms per Liter (continued)

Chemicals of Potential Concern	10^{-6} RBC	10^{-4} RBC	HQ = 1	MCL
Pesticides (Organophosphorous) - EPA Method 8140 (continued)				
Diazinon	--	--	33	--
Dichlorvos	--	--	0.23	--
Dimethoate	--	--	7.3	--
Disulfoton	--	--	1.5	--
EPN	--	--	--	--
Ethoprop	--	--	--	--
Ethyl parathion	--	--	--	--
Fensulfothion	--	--	--	--
Fenthion	--	--	--	--
Malathion	--	--	730	--
Merphos	--	--	1.1	--
Mevinphos	--	--	--	--
Naled	--	--	73	--
Methyl parathion	--	--	--	--
Monocrotophos	--	--	--	--
Phorate	--	--	7.3	--
Ronnel	--	--	1800	--
Sulfotep	--	--	--	--
Tetrachlorvinphos (Stirophos)	2.8	280	--	--
Tetraethyl pyrophosphate	--	--	--	--
Tokuthion (Protothiofos)	--	--	--	--
Trichloronate	--	--	--	--
Metals				
Barium (Dissolved)	NA	NA	2,600	2,000
Barium (Total)	NA	NA	2,600	2,000
Cadmium (Dissolved)	NA	NA	18	5
Cadmium (Total)	NA	NA	18	5
Chromium (Dissolved)	NA	NA	37,000	100
Chromium (Total)	NA	NA	37,000	100
Silver (Dissolved)	NA	NA	180	--
Silver (Total)	NA	NA	180	--
Thallium (Dissolved)	NA	NA	3	2
Thallium (Total)	NA	NA	3	2
Arsenic (Dissolved)	0.038	3.8	11	50
Arsenic (Total)	0.038	3.8	11	50
Lead (Dissolved)	NA	NA	0.0037	15[a]
Lead (Total)	NA	NA	0.0037	15[a]
Selenium (Dissolved)	NA	NA	180	50
Selenium (Total)	NA	NA	180	50
Mercury (Dissolved)	NA	NA	11	2
Mercury (Total)	NA	NA	11	2
Manganese (Dissolved)	--	--	180	--
Manganese (Total)	--	--	180	--

Table 7-6. Screening Levels for Analytes in Groundwater in Micrograms per Liter (continued)

Chemicals of Potential Concern	10^{-6} RBC	10^{-4} RBC	HQ = 1	MCL
Other Organics				
2,3,7,8-TCDD (dioxin)	4.30E-10	4.30E-08	--	--
Total Organic Carbon	--	--	--	--
Diesel-Range Organics	--	--	--	--
Gasoline-Range Organics	--	--	--	--

-- Value not established.
a. The U.S. Environmental Protection Agency's (EPA's) action level for lead is applicable in drinking water at the point of use.
ADEC Alaska Department of Environmental Conservation.
BHC Benzene hexachloride.
DDD Dichlorodiphenyldichloroethane.
DDE Dichlorodiphenyldichloroethene.
DDT Dichlorodiphenyltrichloroethane.
EPN o-Ethyl-o,p-nitrophenyl phenylphosphorothioate.
HQ Noncarcinogenic hazard quotient estimated in *Supplemental Risk Assessment Guidance for Superfund*, EPA Region 3, July 11, 1994.
MCL Maximum contaminant levels established by the Federal Safe Drinking Water Act, PL93-523; and the State of Alaska Drinking Water Regulations, Title 18, Chapter 80.
NA Toxicity value not available; risk-based concentration cannot be calculated.
RBC Carcinogenic risk-based concentration estimated in *Supplemental Risk Assessment Guidance for Superfund*, EPA Region 3, July 11, 1994.

8.0 FATE AND TRANSPORT CHARACTERIZATION

Sections 8.1 through 8.4 discuss significant fate and transport processes likely to govern the migration of chemicals from OU 2 source areas.

The objectives of information contained in these sections are to provide the following:

- A description of important physical and chemical processes governing fate and transport of site-related chemicals;
- Physical-chemical data on site-related chemicals to enhance understanding of the mobility and persistence of site-related chemicals and to aid in selecting chemicals of concern (COCs);
- A description of the important biotransformation processes in groundwater;
- An evaluation of the potential importance of chemicals bioconcentration.

8.1 Physical and Chemical Processes Affecting Fate and Transport

Physical processes that affect aqueous and nonaqueous transport include advection, dispersion, molecular diffusion, and nonaqueous-phase liquid (NAPL) transport. Chemical processes include water solubility, sorption/desorption, hydrolysis, oxidation-reduction reactions, and precipitation reactions.

8.1.1 Advection

Advection is the process by which dissolved chemicals are transported by the bulk motion of flowing groundwater (Freeze and Cherry, 1979). As a result of advection, nonreactive, nonsorbing constituents, such as chloride, are transported at an average rate equal to the average linear velocity (hereafter referred to as velocity) of groundwater flow. In flow systems dominated by advection, the chemical front of a compound migrating from a contaminant source generally remains well defined, and the chemical tends to be transported as a slug. The concentration at a point downgradient from the source in this type of domain tends to increase rapidly with time as the chemical front approaches.

In contrast, the chemical front tends to spread out in a system in which dispersion or molecular diffusion is as dominant, or more dominant, than advection. In this case, the concentration at a downgradient location increases more gradually upon arrival of the chemical front. As a result of advection, dissolved nonreactive chemicals, which are chemicals that do not adsorb to or otherwise interact with the geologic matrix or in response to changes in chemical equilibrium, are transported at the same rate as the groundwater flow velocities.

8.1.2 Dispersion

Dispersion in porous media refers to the spreading of a given volume of chemical as it flows through the subsurface as a result of spatial variations in hydraulic conductivity. The type of dispersion that occurs as part of contaminant transport in groundwater is generally referred to as hydrodynamic dispersion. Hydrodynamic dispersion includes mechanical mixing (mechanical dispersion) during fluid advection and molecular diffusion.

The dispersion flux is defined as the product of the dispersion coefficient and the concentration gradient. The dispersion coefficient is defined as the sum of the product of dispersivity times the velocity, plus the coefficient of molecular diffusion.

8.1.3 Molecular Diffusion

Molecular diffusion is the process whereby chemicals move from points of higher concentration to points of lower concentration under the influence of the compound's kinetic activities. The effect of diffusion on chemical transport is a function of the concentration gradient and the diffusion coefficient. Diffusion coefficients for unconsolidated coarse-grained deposits are less

than the coefficients for the chemical species in water, which are approximately 2 x 10^{-9} square meters per second [m^2/s] (Freeze and Cherry, 1979).

Diffusion is a relatively slow process, but may be a significant process on a localized basis in very low-permeability materials where advective transport rates are less than 10^{-3} feet per year (ft/yr).

8.1.4 Nonaqueous-Phase Liquid Transport

Organic chemicals can migrate through porous media either dissolved in water or as a separate organic liquid phase that may be immiscible or have components that are only partly miscible in water. The following discussion addresses immiscible transport or NAPL transport aspects.

One of the most important concerns about NAPL transport is that it is controlled largely by density and viscosity. Organic liquid that is less dense than water (e.g., petroleum hydrocarbon distillates, such as gasoline) has specific gravities of approximately 0.7, and therefore, floats on water. This liquid is called light NAPL (LNAPL). Most halogenated hydrocarbons have specific gravities much greater than 1 and are called dense NAPL (DNAPL), and sink in water. The spread of DNAPL is largely uncoupled from the hydraulic gradient that drives the advective transport of the dissolved contaminants. Movement of DNAPL may have a significant downward component, but the ability of DNAPL to migrate is influenced substantially by its viscosity and surface-wetting capabilities in water (Schwille, 1988).

In addition, organic liquid, such as halogenated aliphatics, are spread by capillary action in an aquifer and leave free-phase liquid behind at 0.3 to 5 percent in pore space volume (Schwille, 1988). DNAPL residuals, though they do not continue to migrate, remain in place in the form of droplets. Over time and with water contact, the residuals provide a long-term source of contamination for the following several possible reasons (Powers, et al, 1991):

- Rate-limiting mass transport between phases;
- Water bypassing droplets and, in essence, going around them and reducing contact;
- Nonuniform flow of aqueous or organic phases;
- Misinterpretation of field data.

8.1.5 Physical Characteristics of Shallow and Deep Aquifer Materials

Lithologic characteristics important to the fate and transport of contaminants include specific gravity, porosity, bulk density, and fraction of organic carbon. Separate evaluations of the mobility and persistence of organic and inorganic site-related chemicals are presented in sections 8.2 and 8.3, respectively.

8.2 Mobility and Persistence of Organic Site-Related Chemicals

Each of the above-referenced processes depends on the physical and chemical properties of the respective organic compounds, and the physical and chemical properties of the soil and water. Physical and chemical factors were compiled for each of the site-related chemicals detected at OU 2 source areas (Table 8-1). The net effect of these factors is a time-dependent redistribution of chemical concentrations in water, soil, and air.

8.2.1 Mobility and Persistence Criteria for Organic Site-Related Chemicals

The mobility of chemicals in groundwater is important in assessing whether and when chemicals may reach receptor locations. Table 8-2 lists chemical property criteria for low, medium, and high mobility in groundwater as proposed by Ney (1990) for water solubility and log octanol-water partition coefficient (K_{OW}), and by Dragun (1988) for organic carbon partition coefficient (K_{OC}).

Table 8-1. Physical-Chemical Properties of Potential Site-Related Organic Chemicals

		Mobility Factors										Persistence Factors	
Chemical	CAS	Water Solubility (@20-25°C) (mg/G)	Water Solubility Comments	Log K_{ow}	Log K_{ow} Comments	K_{oc}	K_{oc} Comments	Vapor Pressure (@20-25°C) (aa Hg)	Vapor Pressure Comments	Henry's Law Constant (atm-m^3/mol)	Henry's Law Comments	Water Half-Life (days)*	Water Half-Life Comments
Volatile Organic Compounds													
Acetone	67641	1.00E+06	aa	-0.24	d	2.19E+00	Calc, b	2.70E+02	d	3.67E-05	e	7-27	ee
Benzene	71432	1.75E+03	h	2.01	i	7.18E+01	i	9.52E+01	j	5.43E-03	j	19-199	aa
Carbon disulfide	75150	2.94E+03	aa	2.00	q	5.40E+01	Calc, b	3.60E+02	aa	1.23E-02	Calc, h	0.008-365	aa
Benzo(a)anthracene	56553	9.40E-03	u	5.61	u	1.38E+06	u	5.00E-09	u	6.60E-06	u	15.2-252	ff
Benzo(a)pyrene	50328	3.80E-03	u	5.81	u	3.98E+05	u	2.40E-09	u	2.40E-06	u	39-694	ff
Benzo(b)fluoranthene	205992	1.20E-03	u	6.57	u	5.49E+05	u	5.00E-07	u	1.20E-05	u	nf	
Bromoform	75252	3.01E-03	u	2.3	u	1.14E+02	u	4.00E+00	u	4.30E-04	u	696	w
Carbon tetrachloride	56235	7.5E+02	aa	2.73	aa	4.39E+02	aa	1.10E+02	aa	2.30E-02	aa	7-365	ff
Chlorobenzene	108907	4.91E+02	g	2.84	g	3.30E+02	n	1.17E+01	aa	3.40E-03	j	136-300	ee
Chloroethane	75003	5.74E+03	d	1.43	aa	1.50E+01	n	1.00E+03	d	2.00E-03	j	14-56	ee
Chloroform	67663	7.22E+03	h	1.97	aa	4.40E+01	aa	1.82E+02	aa	3.75E-03	j	23-178	aa
Cumene	98828	4.83E+01	u	3.51	u	2.81E+03	u	3.20E+00	u	1.47E-02	u	nf	
Dibenzo(a,h)anthracene	53703	5.00E-04	u	5.97	u	1.65E+06	u	1.00E-09	u	7.33E-09	u	18-21	ff
1,1-Dichloroethane	75343	5.50E+03	aa	1.79	aa	3.00E+01	aa	1.51E+02	aa	4.31E-03	aa	154-693	aa
1,2-Dichloroethane	107062	7.99E+03	h	1.45	h	1.40E+01	h	6.10E+01	d	1.09E-03	j	178-693	aa
1,1-Dichloroethene	75354	2.25E+03	aa	2.13	n	6.50E+01	n	6.00E+02	aa	1.31E-01	j	178	aa
cis-1,2-Dichloroethene	156592	3.50E+03	aa	0.70	aa	4.90E+01	aa	2.08E+02	aa	1.50E-02	aa	178-247	aa
trans-1,2-Dichloroethene	156605	6.30E+03	aa	2.09	n	5.90E+01	n	3.24E+02	aa	6.60E-03	j	133-192	aa
1,2-Dichloropropane	78875	2.70E+03	n	2.00	n	5.10E+01	n	4.20E+01	n	1.54E-01	j	334-2592	ee
Ethylbenzene	100414	1.49E+02	g	3.15	aa	2.20E+02	r	7.00E+00	aa	7.90E-03	j	30-192	aa
Ethylene dibromide	106934	4.3E+03	aa	1.96	aa	4.4E+01	aa	1.71E+01	aa	9.83E-04	aa	19-120	aa
Indeno(1,2,3-cd)pyrene	193395	6.20E+01	u	5.97	u	3.10E+07	u	1.01E-10	u	2.96E-20	u	nf	
2-Butanone (MEK)	78933	2.68E+05	aa	0.26	aa	4.51E+00	aa	7.75E+01	aa	5.14E-05	e	7-27	aa
Methylene chloride	75092	1.67E+04	d	1.26	n	8.80E+00	n	3.49E+02	d	2.03E-03	n	29-115	aa
4-Methyl-2-pentanone	108101	1.70E+04	d	1.52	Calc, a	2.06E+01	Calc, a	6.00E+00	d	4.66E-05	Calc, h	7-27	aa
Styrene	100425	1.60E+02	aa	3.16	aa	8.91E+02	aa	6.10E+00	aa	4.00E-03	aa	28-210	ee
Tetrachloroethene (PCE)	127184	4.84E+02	h	2.53	h	3.64E+02	h	1.78E+01	aa	2.27E-02	j	231-347	aa
Toluene	108883	1.55E+03	h	2.69	g	3.00E+02	g	2.81E+01	aa	6.61E-03	j	30-42	aa
1,2,4-Trimethylbenzene	95636	5.70E+01	u	3.78	u	3.71E+03	u	2.03E+00	u	5.70E-03	u	3.5	w
1,3,5- Trimethylbenzene	108678	9.70E+01	u	3.42	u	1.62E+03	u	2.42E+00	u	3.93E-03	u	6.0	w
1,1,1-Trichloroethane	71556	1.33E+03	h	2.47	h	1.52E+02	h	1.23E+02	aa	2.76E-02	j	203-400	aa
Trichloroethene (TCE)	79016	1.47E+03	h	2.42	h	1.26E+02	h	5.79E+01	aa	1.16E-02	j	346-400	aa
Vinyl chloride	75014	2.76E+03	aa	1.38	aa	8.20E+00	aa	2.66E+03	aa	2.32E-02	j	178-2887	aa
Xylenes, total	1330207	1.98E+02	d	2.59	Calc, a	2.38E+02	Calc, b	1.00E+01	d	5.10E-03	cc	30-178	aa

Table 8-1. Physical-Chemical Properties of Potential Site-Related Organic Chemicals (continued)

		Mobility Factors										Persistence Factors	
Chemical	CAS	Water Solubility (@20-25°C) (mg/G)	Water Solubility Comments	Loaa K_{ow}	Log K_{ow} Comments	K_{oc}	K_{oc} Comments	Vapor Pressure (@20-25°C) (aa Hg)	Vapor Pressure Comments	Henry's Law Constants (atm-m^3/mol)	Henry's Law Comments	Water Half-Life (days)*	Water Half-Life Comments
Semivolatile Organic Compounds													
Acenaphthene	83329	3.93E+00	aa	3.92	aa	4.60E+03	aa	2.15E-03	aa	2.40E-04	aa	25-204	ee
Aniline	62533	3.40E+04	f	0.90	g	3.50E+02	aa	3.00E+01	f	1.08E-06	Calc, c	nf	aa
Benzoic acid	65850	2.90E+03	d	1.87	d	5.44E+01	Calc, b	7.05E-03	k	3.92E-07	Calc, c	1-4	aa
Benzyl alcohol	100516	3.50E+04	d	1.01	l	6.31E+00	Calc, a	1.37E-01	f	5.57E-07	Calc, c	nf	
bis(2-Ethylhexyl) phthalate	117817	4.00E-01	m	5.11	n	8.74E+04	o	2.00E-07	n	4.40E-07	m	23-408	ee
Butyl benzyl phthalate	85687	2.00E+00	p	4.47	p	1.70E+04	o	2.12E-05	f	4.35E-06	Calc, c	2-180	ee
Chrysene	218019	2.00E-03	s	5.61	t	2.00E+05	n	6.40E-09	aa	9.60E-07	Calc, c	745-2000	ee
1,2-Dichlorobenzene	95501	1.18E+02	k	3.38	g	1.70E+03	n	1.47E+00	aa	1.90E-03	j	56-365	ee
1,4-Dichlorobenzene	106467	7.38E+01	h	3.39	g	1.70E+03	n	1.18E+00	n	1.60E-03	j	56-365	ee
2,4-Dichlorophenol	120832	4.60+03	aa	3.23	aa	3.8E+02	aa	1.35E-01	aa	6.3E-06	aa	6-43	ee
3,3'-Dichlorobenzidine	91941	3.11E+00	u	3.51	u	1.99E+04	u	4.20E-09	u	4.50E-08	u	nf	
di-h-Octylphthalate	117840	3.4E-01	aa	5.22	aa	1.9E+04	aa	1.4E-04	aa	5.5E-06	aa	14-365	ee
Diethyl phthalate	84662	6.80E+02	p	2.46	p	6.90E+01	o	3.50E-03	n	1.50E-06	Calc, c	6-112	ee
2,4-Dimethylphenol	105679	7.87E+03	h	2.42	h	9.60E+01	h	6.20E-02	n	1.27E-06	Calc, c	8-29	ee
di-h-Butyl phthalate	84742	9.20E+00	p	3.75	p	1.39E+03	o	1.00E-05	n	1.30E-06	m	2-23	ee
Fluorene	86737	1.98E+00	s	4.18	i	7.30E+03	n	6.00E-04	aa	8.40E-05	j	64-120	ee
Fluoranthene	206440	2.60E-01	aa	5.33	aa	3.8E+04	aa	9.2E-06	aa	9.41E-06	aa	280-880	ee
Isophorone	78591	1.20E+04	n	2.26	n	8.70E+01	n	3.80E-01	n	5.76E-06	Calc, c	28-71	ee
2-Methylnaphthalene	91576	2.54E+01	r	4.11	g	7.94E+03	Calc, a	4.50E-02	v	3.31E-04	Calc, c	nf	
2-Methylphenol	95187	3.10E+04	d	1.38	Calc, a	1.48E+01	Calc, b	2.40E-01	d	4.00E-02	d	nf	aa
4-Methylphenol	106445	2.40E+04	d	1.44	Calc, a	1.70E+01	Calc, a	4.00E-02	d	2.37E-07	Calc, c	.08-28	ee
H-nitrosodiphenylamine	86306	3.5E+01	aa	3.13	aa	6.5E+02	aa	6.69E-04	aa	5.00E-06	aa	56-365	ee
Naphthalene	91203	3.10E+01	s	3.33	i	9.40E+02	i	8.2×10^{-2}	y	4.24E-04	j	18-257	ee
Phenanthrene	85018	1.29E+00	s	4.52	i	1.40E+04	n	1.20E-04	aa	5.00E-05	j	32-402	ee
Phenol	108952	9.30E+04	aa	1.48	i	1.42E+01	n	3.41E-01	aa	3.97E-07	bb	1-7	ee
Pyrene	129000	1.35e-01	s	5.18	g	3.80E+04	n	4.50E-06	aa	8.86E-06	Calc, c	420-3796	ee
1,2,4-Trichlorobenzene	120821	4.88E+01	g	4.02	g	9.20E+03	n	2.90E-01	n	1.42E-03	aa	178-693	ee

Table 8-1. Physical-Chemical Properties of Potential Site-Related Organic Chemicals (continued)

		Mobility Factors										Persistence Factors	
Chemical	CAS	Water Solubility (@20-25°C) (mg/G)	Water Solubility Comments	Loaa K_{ow}	Log K_{ow} Comments	K_{oc}	K_{oc} Comments	Vapor Pressure (@20-25°C) (aa Hg)	Vapor Pressure Comments	Henry's Law Constants (atm-m^3/mol)	Henry's Law Comments	Water Half-Life (days)*	Water Half-Life Comments
Pesticides/Polychlorinated Biphenyls													
4,4'-DDD	72548	1.00E-01	aa	5.99	aa	7.7+05	aa	1.89E-06	aa	7.96E-06	aa	70-11461	ee
4,4'-DDE	72559	4.60E-02	aa	5.98	aa	2.43E+.05	aa	6.5E-06	aa	6.8E-05	aa	16-11425	ee
4,4'-DDT	50293	5.00E-03	aa	5.98	u	2.43E+05	v	5.50E-06	aa	8.30E-06	aa	16-11425	ee
Dieldrin	60571	1.95E-01	aa	5.18	aa	1.7E+03	aa	1.78E-07	aa	1.10E-05	aa	1-2190	ee
Endrin	72208	2.00E-01	aa	5.60	aa	1.06E+04	aa	3.00E-06	aa	4.20E-06	aa	nf	
Heptachlor epoxidide	1024573	3.50E-01	aa	2.70	aa	2.2E+02	aa	3.00E-04	aa	3.2E-05	aa	1-1104	ee
PCB-1260	11096825	1.44E-02	n	6.91	aa	6.70E+06	n	1.10E-05	z	2.50E-04	z	nf	
PCB-1254	110976981	5.00E+01	u	5.61	u	2.51E+04	u	6.00E-05	u	1.90E-04	u	nf	
Herbicides													
Dicamba	1918009	4.50E+03	aa	3.67	aa	4.00E-01	aa	3.41E-05	aa		nf	nf	
Dioxins and Furans													
2,3,7,8-TCDD	1746016	3.17E-04	dd	6.15	dd	4.68E+05	dd	3.46E-09	dd	2.10E-06	dd	178-2810	ee

°C	Degrees Celsius
atm-m^3/mol	Atmospheric cubic meters per mole
calc	Calculation
CAA	Chemical abstract service number
K_{oc}	Organic-carbon partition coefficient
K_{ow}	Octanol-water partition coefficient
mg/L	Milligrams per liter
nf	Not found

Table 8-1. Physical-Chemical Properties of Potential Site-Related Organic Chemicals (continued)

		Mobility Factors										Persistence Factors	
Chemical	CAS	Water Solubility (@20-25°C) (mg/G)	Water Solubility Comments	Loaa K_{ow}	Log K_{ow} Comments	K_{oc}	K_{oc} Comments	Vapor Pressure (@20-25°C) (aa Hg)	Vapor Pressure Comments	Henry's Law Constants (atm-m^3/mol)	Henry's Law Comments	Water Half-Life (days)*	Water Half-Life Comments

* These water half-lives may over-estimate the degradation rates of chemicals when lower groundwater temperatures characteristic of Alaska are considered. Recent numerical modeling work at Ft. Wainwright indicates the half-lives presented here may be optimistic and that a slower degradation rate may occur possibly due to low groundwater temperatures (personal communication Diane Soderlund, 1995). Recent groundwater and TCE degradation modeling conducted for Elmendorf AFB in Anchorage, Alaska, used a half-life of 987 days for TCE (USAF, December 16, 1994).

a Log K_{oc} = 0.937 Log K_{ow} - 0.006, From Lyman and others, 1982
b Log K_{oc} = -0.55 Log L + 3.64 (L in mg/L); as referenced in Lyman and others, 1982
c Calculated using Henry's Law Constant = VP/WSol, where VP = Vapor Pressure in atm and WSol = Water Solubility in moles/m^3
d (@30°C) (T=40°) Verschueren, 1983
e Rathbun and others, 1982
f Dawson and others, 1980
g Chiou and others, 1983
h Banerjee and others, 1980
i Hansch and others, 1979
j Dawson and others, 1980
k Suntio and others, 1988
l Fujita and others, 1964
m Wolfe and others, 1980
n Mabey and others, 1982
o Russell and others, 1986
p McDuffie and others, 1984
q Peyton and others, 1976
r Lee and others, 1981
s Average of three values from: Hodson and Williams, 1988; Vowles and Mantoura, 1987; Chiou and others, 1983
t Radding and others, 1976
u Montgomery, 1991
v Lyman and others, 1982
w Dragun, 1988
x Riser-Roberts, 1992
y Mackay and others, 1977
z Murphy and others, 1987
aa HLA, 1992
bb Hine and others, 1975
cc Lingaard-Joergensen and others, 1986
dd (T=30.1°C) Schroy and others, 1985
ee Howard, 1991

Table 8-2. Mobility and Persistence Factor Classes of Potential Organic Site-Related Chemicals

	Mobility Factors					Persistence Factors
Class	Water Solubility (mg/L)[a]	Log K_{ow}[b]	Log K_{oc}[b]	Vapor Pressure (mm Hg)[c]	Henry's Law Constant (atm-m^3/mol)[d]	Water Half-Life (days)[e]
Low	<10	>3	>500	<1.00 E-07	<3.00E-7	<30
Medium	10 - 1000	2.7 to 3	50 to 500	1.00E-07 to 0.01	3.0E-7 to 0.001	30 to 90
High	>1000	<2.7	<50	>0.01	>0.001	>90

>	Greater than
<	Less than
atm-m^3/mol	Atmospheric cubic meters per mole
mg/L	Milligrams per liter
mm Hg	Millimeters of mercury

a. Ney, 1981, at 20 to 25 degrees Celsius (°C)
b. Ney, 1981
c. Dragun, 1988
d. Lyman, et al., 1982
e. Howard, 1991

K_{OW} is the equilibrium partition coefficient between octanol and water, and is useful in predicting the behavior of organic chemicals, particularly the affinity of a chemical for sorption onto organic matter and bioconcentration into biota. K_{OC} is the equilibrium partition coefficient between organic carbon and water, and is useful in predicting sorption onto aquifer materials when the percent organic matter is known or can be estimated. Mobility in water is proportional to water solubility and inversely proportional to K_{OW} and K_{OC}. The lower the K_{OW} and K_{OC}, the higher the chemical mobility.

Table 8-2 also presents chemical property criteria for evaluating volatilization potential from water (e.g., volatilization from groundwater through the vadose zone and from surface water). Volatilization potential is important to several exposure pathways (e.g., inhalation of chemicals in indoor and outdoor air, and during showering).

To evaluate volatilization potential, vapor pressure criteria from Dragun (1988) and Henry's Law Constant criteria from Lyman (1982) were used. Vapor pressure is the pressure at which equilibrium exists between a pure liquid, a chemical, and air. Henry's Law Constant is the ratio of solute vapor pressure to aqueous solubility; hence, this constant estimates the tendency of a dissolved organic chemical to volatilize from water to air. The greater the Henry's Law Constant, the more volatile the chemical. Volatilization is highly temperature dependent; low ambient temperatures in the subsurface would be expected to limit the number of chemicals for which volatilization would be important.

Some variation in physical-chemical properties is encountered in the literature, especially in measuring water solubility, K_{OW}, or K_{OC} for hydrophobic organic compounds.

Table 8-2 also provides chemical persistence criteria for groundwater (Ney, 1990). These criteria are commonly presented in days for the concentration to be degraded by abiotic (e.g., hydrolysis) or biotic processes to one-half of the original concentration. This unit is referred to as the half-life ($t_{1/2}$). Persistence criteria were adopted from Ney (1990).

8.2.2 Mobility and Persistence Results for Organic Site-Related Chemicals

HLA applied the mobility and persistence criteria from Table 8-2 to site-related organic chemicals listed in Table 8-1. Each chemical was rated as low, medium, or high for groundwater mobility, volatilization potential, and persistence in groundwater. Table 8-3 presents the results of this evaluation.

Organic chemicals that have high groundwater mobility and persistence include nearly all of the chlorinated VOCs (Table 8-3). Chemicals rating medium to high in mobility and persistence encompassed alkylbenzenes, toluene, ethylbenzene, xylenes, naphthalene, and diethyl phthalate. Chemicals with low to medium mobility and persistence are less likely to migrate and more readily degrade in the environment, and thus, are considered less likely to be exposed to human receptors. Examples of chemicals in this class include fluorene and di-n-butyl phthalate.

Highly persistent compounds, such as bis(2-ethylhexyl)phthalate, 4,4-dichlorodiphenyltrichloroethane (DDT), and others listed in Table 8-3, are not expected to reach offsite receptor locations within 500 years because of the effects of retardation and decay. Dioxins and furans, as represented by 2,3,7,8-TCDD in the rating, are rated low in mobility and high in persistence.

In summary, chemicals with high to medium mobility and persistence, such as chlorinated VOCs, are important chemicals from a fate and transport perspective, because they are less likely to migrate and result in exposure. Chemicals with low to medium mobility and persistence are less likely to result in significant chemical exposures to receptor populations and are considered to be even less important in chemical migration evaluations.

Table 8-3. Groundwater Mobility Versus Persistence in Groundwater and Persistence Ranking

Persistence	Low Mobility	Medium Mobility	High Mobility
High	bis(2-Ethylhexyl)phthalate Butyl benzyl phthalate Chrysene 1,2-Dichlorobenzene 1,4-Dichlorobenzene Phenanthrene PCB 1260 4,4'-DDT 1,2,4-Trichlorobenzene Pyrene 2,3,7,8-TCDD Fluoranthene N-nitrosodiphenylamine Dieldrin Endrin 4,4'-DDD 4,4'-DDE di-n-Octylphthalate Benzo(a)pyrene	Chlorobenzene Tetrachloroethene Heptachlor expoxide	1,1-Dichloroethane 1,2-Dichloroethane 1,2-Dichloropropene 1,1,1-Trichloroethane Trichloroethene cis-1,2-Dichloroethene trans-1,2-Dichloroethene Vinyl chloride Bromoform
Medium	Styrene Acenaphthene 2,4,5-T 2,4,5-TP Benzo(a)anthracene	Xylenes Naphthalene Diethyl phthalate Carbon tetrachloride 2,4-D	Chloroform Methylene chloride Toluene Isophorone Ethylene dibromide
Low	Di-n-butyl phthalate Dibenzo(a,h)anthracene	Dicamba 1,3,5-Trimethylbenzene	Acetone Chloroethane MEK MIBK Benzoic acid 2,4-Dimethylphenol 2-Methylphenol 4-Methylphenol Phenol 2,4-Dichlorophenol

2,4-D	2,4-Dichlorophenoxyacetic acid
2,4,5-T	2,4,5-Trichlorophenoxyacetic acid
2,4,5-TP	2,4,5-Trichlorophenoxypropionic acid (silvex)
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethene
MEK	Methyl ethyl ketone
MIBK	Methyl isobutyl ketone
PCB	Polychlorinated biphenyl
TCDD	Tetrachlorodibenzo-p-dioxin

8.2.3 Biotic Processes

Biological processes that influence the fate and transport of chemicals in the subsurface environment consist of microbial-mediated biodegradation or biotransformation. A biotransformed chemical is changed, normally into a smaller molecular weight chemical.

Environmental Conditions

Aquifer conditions that may affect the rate of biodegradation include pH, REDOX, temperature, chemical concentrations, and the presence of nutrients, such as nitrogen and phosphorous (McCarty, et al, 1991).

Additional environmental conditions that tend to govern microbial biodegradation include the concentration of the chemical and the amount of organic carbon present. Laboratory studies reported in the literature have been performed with varying amounts, from less than 0.1 percent to several percent, of organic carbon. The greater the percent organic carbon, the more favorable the condition for biodegradation.

Perhaps the most important environmental condition governing biodegradation is the oxidation-reduction state. Unlike abiotic processes, biotic processes are oxidation or reduction reactions and require external electron acceptors and donors.

Microorganisms obtain energy from a variety of electron donors and acceptors under different REDOX conditions. Aerobic metabolism predominates where sufficient oxygen is present. As oxygen becomes depleted, nitrate, sulfate, and carbon dioxide, in order of preference, are used by microbes as electron acceptors. Differences in available electron acceptors and REDOX conditions appear to affect the potential pathways for transformation of different halogenated aliphatic compounds.

As chemicals move downgradient, REDOX conditions would be expected to change into sulfate-reducing (also anoxic) conditions, then denitrifying (aerobic) conditions, then finally, to fully aerobic conditions. This continuum may influence biotransformation processes, locations, and rates of biotransformation that are expected to occur onsite and that may be expected to occur at offsite locations in the future.

Microbial Biotransformation Processes for Chlorinated Volatile Organic Compounds

As described previously, REDOX conditions have an important effect 1) on the type of transformation processes expected, and 2) on the rate of biotransformation reactions. The following discussion applies to anaerobic conditions in groundwater.

Under anaerobic conditions, microorganisms reduce carbon dioxide to methane via reductive biotransformations. Microorganisms also reduce chlorinated ethanes and ethenes by dechlorination. Reductive dehalogenation (hydrogenolysis) of halogenated aliphatics has been established by numerous researchers for the following transformations:

Reducing Reaction	Reference
Tetrachloroethene (PCE) to TCE	(Roberts and others, 1982)
TCE to cis/trans-1,2-dichloroethene (c/t-DCE)	(Roberts and others, 1982)
c/t-DCE to vinyl chloride (VC)	(Barrio-Lage and others, 1986)
1,1-DCE to VC	(Barrio-Lage and others, 1986)
VC to Ethylene, Ethanol	(Barrio-Lage and others, 1990)
1,1,1-Trichloroethane (TCA) to 1,1-Dichloroethane (DCA)	(Vogel and others, 1985; 1987)
DCA to Chloroethane (CA)	(Vogel and others, 1987a; Klecka and others, 1990a)
1,2-DCA to CA	(Vogel and others, 1987)
CA to Ethanol	(Vogel and others, 1987)

Several of the metabolites shown above are equally, and in some cases, more toxic than the parent compounds. This fact is an important feature of anaerobic biotransformations of chlorinated aliphatics.

Table 8-4 summarizes literature values for abiotic and biotransformation rates per day (k) associated with reductive dehalogenation under anaerobic conditions. Literature biotransformation rates have been preferred over the treatability studies and laboratory biodegradation rates, because literature values, in general, are more conservative. Laboratory (microcosm) conditions often promote faster biotransformation rates than field conditions, because of more favorable temperature control and other conditions. Where only half-lives were provided, k was estimated from $k = 0.693/t_{1/2}$ assuming first-order kinetics (Olsen, et al, 1990a and 1990b).

Literature values may reflect a microorganism's metabolism while in the growth phase under favorable environmental conditions. Because the biotransformation rates in Table 8-4 were selected from the lowest rates under field conditions reported in the literature (where available), the uncertainty associated with the rates presented in Table 8-4 is significantly reduced.

Microbial Biotransformation Processes for Alkylbenzenes, Ketones, and Selected Semivolatile Organic Compounds

Wilson et al. (1986) studied the biotransformation of alkylbenzenes, benzene, toluene, ethylbenzene, and o-xylene in microcosms containing actively methanogenic aquifer material. All alkylbenzenes were biotransformed, and all chemicals except for toluene required long biotransformation periods. Alkylbenzenes were found to more rapidly degrade in aerobic subsurface environments. Table 8-5 presents biotransformation rates for alkylbenzenes and other organic compounds. As indicated in Table 8-5, aerobic biotransformation rates are generally between 2 and 10 times greater than anaerobic rates.

In another biotransformation study, Chiang et al. (1989) showed that aerobic biotransformations require greater than or equal to 2.0 ppm dissolved oxygen to serve as an electron accepter. The results of the study suggested that nitrate may also serve as an electron acceptor in the denitrification process and may account for chemical biotransformation where insufficient oxygen is present to serve as an electron acceptor for large alkylbenzene concentrations (Chiang, et al., 1989).

Klecka and others (1990b) studied the biotransformation of cresols and naphthalene at the Cliffs-Dow Superfund site in Michigan. Cresols (methylphenols) are structurally similar to 2,4-dimethylphenol and therefore would be expected to biotransform at similar rates. Wastes at the Cliffs-Dow site were disposed of from 1954 through the mid-1960s, yet current concentrations decreased to below detectable limits within 100 meters of the fill area. The authors found that dispersion and sorption of chemicals could not account for the chemical concentration decrease over time.

Laboratory microcosms containing site aquifer material from the Cliffs-Dow site were incubated under aerobic and anaerobic conditions. The results shown in Table 8-5 indicate rapid aerobic biotransformation rates. Although the study did not show appreciable anaerobic biotransformation at longer study periods, other investigations have shown anaerobic biotransformation at longer study periods (Howard, 1991). The study also evaluated the effects of dispersion and adsorption, and found those factors to be less significant than biodegradation in attenuating contaminant concentrations.

Toxic metabolites are not expected from the biotransformation of alkylbenzenes. Oxidative dealkylation or aromatic hydroxylation produces carboxylic acids and ring cleavage (Lyman, 1982). These byproducts are then easily degraded to carbon dioxide and water.

The ketones acetone, methyl ethyl ketone (MEK) or 2-butanone, and methyl isobutyl ketone (MIBK) or 4-methyl-2-pentanone all degrade readily in aerobic sewage inoculums and river

Table 8-4. Anaerobic and Aerobic Biotransformation Rates for Chlorinated Volatile Organic Chemicals

Anaerobic Conditions			Aerobic Conditions (Howard, 1991)	
Chemical Biotransformation	(k) Rate (/day)*	Reference	Chemical Biotransformation	(k) Rate* (/day)
PCE > TCE	0.003	Roberts, 1982	PCE > TCE	0.0020
TCA > acetic acid	0.00055	Vogel, 1987	TCA > acetic acid	0.0025
TCA > DCA	0.0034	Klecka, 1990	TCA > DCA	NA
TCA > cis-1,2-DCE	0.0034	Klecka, 1990	TCA > cis-1,2-DCE	NA
TCA > DCE	0.00011	Vogel, 1987	TCA > DCE	NA
TCE > cis-1,2-DCE	0.003	Roberts, 1982	TCE > cis-1,2-DCE	0.002
TCE > trans-1,2-DCE	0.003	Roberts, 1982	TCE > trans-1,2-DCE	NA
TCE > DCE	0.003	Roberts, 1982	TCE > DCE	NA
DCA > CA	0.001	Howard, 1991	DCA > CA	0.0045
cis-1,2-DCE > CA	0.0028	Barrio-Lage, 1986	cis-1,2-DCE > CA	0.0039
cis-1,2-DCE > VC	0.0028	Barrio-Lage, 1986	cis-1,2-DCE > VC	NA
trans-1,2-DCE > VC	0.0052	Barrio-Lage, 1986	trans-1,2-DCE > VC	0.0039
DCE > VC	0.004	Barrio-Lage, 1986	DCE > VC	0.0039
VC > CO_2	0.00024	Howard, 1991	VC > CO_2	0.0039
1,2-DCA > ethene	0.001	Howard, 1991	1,2-DCA > ethene	0.0039
CF > MC	0.030	Roberts, 1982	CF > MC	0.0039
MC > CM	0.006	Howard, 1991	MC > CM	0.024

>	Degrades to	MC	Methylene chloride
CA	Chloroethane	NA	Data not available
cis-1,2-DCE	cis-1,2-Dichloroethene	PCE	Tetrachloroethane
CF	Chloroform	trans-1,2-DCE	trans-1,2-Dichloroethene
CM	Chloromethane	TCA	1,1,1-trichloroethane
CO_2	Carbon dioxide	TCE	Trichloroethene
DCA	1,2-Dichloroethane	VC	Vinyl chloride
K	Biotransformation		

* From literature sources or calculated as first order rate constants from $k = 0.693/t_{1/2}$

Table 8-5. Biotransformation Rates for Alkylbenzenes, Ketones, and Semivolatile Chemicals of Potential Concern

	Anaerobic Rate (/day)	Aerobic Rate (/day)
Alkylbenzene and Polycyclic Aromatics		
Benzene	0.0035[a]	0.035[b]
Toluene	0.0164[a]	0.023[c]
Ethylbenzene	0.0036[a]	0.023[c]
2,4-Dimethylphenol	0.0240	0.086[d]
Naphthalene	0.0027	0.039[d]
Ketones		
Acetone	0.099	0.025
2-Butanone (MEK)	0.099	0.025
4-Methyl-2-pentanone (MIBK)	0.099	0.025
Semivolatiles		
bis(2-Ethylhexyl)phthalate	0.0017	0.030
Isophorone	0.0098	0.025
Dioxin/furans[e]	0.0003	0.001
1,2,4-Trichlorobenzene	0.0039	0.001
PCB-1260[f]	0.003	0.001

/day = per day

PCB Polychlorinated biphenyl

a. Wilson, et al., 1986
b. Major, et al., 1988
c. Chiang, et al., 1989
d. Klecka, et al., 1990b
e. 2,3,7,8-Tetrachlorodibenzo-p-dioxin
f. Assumed to equal dioxin/furans

Source: Howard, et al., 1991, unless otherwise noted

die-away tests showing a 50-percent reduction in biochemical oxygen demand in 5 to 10 days. Toxic metabolites are not expected from the biotransformation of ketones.

Other SVOCs include the heavily chlorinated compounds 1,2,4-trichlorobenzene and TCDD, and the nonchlorinated bis(2-ethylhexyl)-phthalate. Each of the chlorinated compounds is very resistant to biotransformation. In field studies, trichlorobenzene mineralized very slowly (0.18 micrograms per day [μg/day]) at a concentration of 50 micrograms per gram (μg/g) in soil, and did not degrade in groundwater. Trichlorobenzene was found to be reductively dechlorinated to monochlorobenzene via 1,4-dichlorobenzene in anaerobic sediment (HSDB, 1991).

Biotransformation of 2,3,7,8-TCDD is relatively uncommon in the environment, and little information exists (HSDB, 1991). On the basis of molecular structure, biotransformation of dioxins in the subsurface is expected to be on the order of years.

8.3 Mobility and Persistence of Inorganic Site-Related Chemicals

Chemical attenuation of site-related inorganic chemicals can be classified into the following two major types of reactions:

- Precipitation/dissolution (including oxidation/reduction conditions);
- Adsorption/desorption and ion exchange.

Understanding the nature of the chemical form or aqueous speciation of each chemical/compound is important to evaluate the potential for either type of attenuation reaction. Speciation may be in the form of a monomolecular-charged species or some complex formation. Speciation can significantly affect the mobility of metals and radionuclides, because they generally reduce the free metal ion concentration and associated properties. These effects consist of changing the aqueous solubility, the modification of surface properties of solids, and the sorption potential of inorganic chemicals in solution.

8.3.1 Precipitation/Dissolution of Mineral Phases

The major mineral controlling precipitation of inorganic minerals from solution is calcite or calcium carbonate. The solubility of this mineral is affected by carbonate equilibria, including the partial pressure of carbon dioxide, the pH of the solution, and the concentration of calcium presented. The solubility of calcite expressed as calcium at the partial pressure of carbon dioxide in air (0.0003 atmospheres) is about 20 mg/L (Hem, 1985). In natural and agricultural soil, the partial pressures of carbon dioxide may be 100 times or more the level of the atmosphere (Bolt and Breggenwert, 1978). In areas of high degradation of organic material (e.g., from sulfate reduction), the partial pressures of carbon dioxide can also be very high.

Another aspect of calcite solubility relates to the pH of the solution. In situations where hydrogen ions are produced from other than the dissociation of dissolved carbon dioxide species (e.g., oxidation of sulfur or sulfides), calcium may be found in solution at much greater than its stoichiometric equivalent of bicarbonate. Under these circumstances, the solubility of gypsum (calcium sulfate) may control or increase calcium solubility.

Metals might also precipitate or coprecipitate (a minor component precipitating with another more major component) and become retarded by this process. Many species of metal ions have been shown to incorporate themselves into coatings on grains by coprecipitation effects, specifically with calcite. Coprecipitation with other mineral phases, such as ferric oxyhydroxides, has also been postulated (Hem, 1985). Aluminum, iron, and manganese are known for forming amorphous precipitates of oxides and hydroxides that can form the basis for sorption sites for other metals.

Other issues related to the attenuation of metals from solution include oxidation-reduction reactions. Most relevant is the potential for reduction, because reduced forms (lower valence state) of elements in solution tend to be less soluble and hence, less mobile, than oxidized forms. Mineral

coatings are good indications of past conditions, but do not necessarily determine whether changes are happening because of kinetic effects. A reducing environment in the source area would result in conditions favorable for precipitation or coprecipitation of metals, hence attenuating or limiting the migration of inorganics.

8.3.2 Sorption/Desorption and Ion Exchange

Sorption occurs when an ion or molecule becomes attached to the surface of a preexisting solid substrate. Metals are known to sorb to oxides and oxyhydroxides of aluminum, iron, and manganese in the subsurface. In systems with hydrous oxides, it is often difficult to differentiate between coprecipitation, sorption, and ion exchange.

In general, little sorption of inorganic constituents occurs at low pHs, whereas, nearly all cations are strongly sorbed. Clays and oxides have high sorption capacities. One way of evaluating the potential of a soil to remove trace components from a solution is to measure the exchange capacity of the soil. Although soil has an amphoteric character, in general it carries a net negative charge and therefore, the exchange is mainly cationic. Cation exchange capacities (CEC) for common geologic materials are from 3 to 150 milliequivalent (meq)/100 g for clays with vermiculite and smectite the highest, and feldspar and quartz the lowest at less than 1 meq/100 g (Dragun, 1988). Natural organic material in soil has a CEC of 100 to 350 meq/100 g (Dragun, 1988).

8.4 Bioconcentration of Site-Related Chemicals

Bioconcentration is a fate process that describes the tendency for chemicals to concentrate or accumulate in plant or animal tissues relative to their environmental medium.

The bioconcentration factor (BCF) is defined as a chemical concentration in an organism or tissue divided by its concentration in water (for aquatic organisms) or in food (for terrestrial organisms) (Travis and Arms, 1988). For organic chemicals, BCFs have been shown to correlate with log K_{ow} and log K_{oc}, and to inversely correlate with water solubility (Lyman, et al., 1982).

The log K_{ow} was used to predict bioconcentration of chemicals in beef and livestock (Kenaga, 1980; Travis and Arms, 1988). Travis and Arms described the relationship between log K_{ow} and beef biotransfer factor B_b (analogous to BCF except that it includes intake from feed and water) as:

$$\log B_b = -7.735 + 1.033 \log K_{ow} \quad (5\text{-}6)$$

Beef and other terrestrial animal BCFs are several orders of magnitude lower than the more widely reported fish BCFs, because fish are exposed by immersion in a water medium (Kenaga, 1980).

8.5 Geophysical Survey Results

An EM survey was performed at the DRMO yard and North Post source areas to locate former burn pits. The nine anomalies (Appendix E, Plate 3) identified at the DRMO yard source area were not representative of a previous burn pit and are probably due to the presence of metal mixed in with the subsurface soil. The EM survey at the North Post source area did not reveal any subsurface anomalies that identified the location of a former burn pit. Due to limited access, the GPR survey was not performed at the North Post source area and the location of a former burn pit was not identified. The results of the geophysical survey data generated during the OU 2 RI are in Appendix E.

8.6 OU 2 Source Areas Extent of Contamination

This section presents the nature and extent of contaminants at DRMO yard and North Post source areas. Based on analytical data and conceptual site models, the DRMO yard and North Post source areas were divided into sub-areas for the purposes of this report. Each sub-area represents a separate contaminant source (or sources), and/or physical migration pathways. Chemical concentrations that exceeded potential chemical-specific ARARs are summarized for each sub-area as COCs. Chemical concentrations that did not

exceed potential chemical-specific ARARs may be included in this section to provide additional site characterization data.

This section does not address the nature and extent of contamination at the Building 1168 source area. The extent of contamination at Building 1168 was characterized and results are presented in HLA's 1993 PSE 2 report (1993a). During the OU 2 RI, HLA collected samples from a boring and a groundwater monitoring well completed at a background location upgradient of known contamination at the Building 1168 source area. HLA also installed a groundwater monitoring well (AP-6809) under the direction of CRREL (soil samples were collected at this location). Analytical results generated from samples collected at the Building 1168 source area are included in this section. HLA is currently conducting a treatability test at the Building 1168 source area, and anticipates presenting the results in a report to the USACE in November 1995.

8.6.1 DRMO Yard Source Area

The DRMO yard source area was divided into the following sub-areas:

- Sub-area DRMO1, which includes Buildings 5006 and 5008, the central- and north-central portions of the DRMO yard, and the area north of the DRMO yard. Previous waste oil drum and transformer storage areas are within this sub-area (HLA, 1993b).
- Sub-area DRMO2, which includes Building 5001 and the eastern quarter of the DRMO yard.
- Sub-area DRMO3, which includes Buildings 5004 and 5007, and a portion of the Alaska Railroad rail line and the Old Richardson Highway immediately south of the DRMO yard.
- Sub-area DRMO4, which includes the Alaska Railroad rail spur that enters the DRMO yard, the associated loading ramp, the southwest portion of the DRMO yard, and the portion of the Alaska Railroad rail line and Old Richardson Highway immediately south. Previous transformer and asphalt drum storage areas are located within this sub-area (HLA, 1993b).
- Sub-area DRMO5, which includes the west-central portion and west gate area of the DRMO yard, the area immediately west of the DRMO yard, and the adjacent portion of Channel B. A portion of the previous waste oil drum storage area is located in this sub-area. The previous fire burn pit is located in the eastern portion of this sub-area (HLA, 1993b).
- Sub-area DRMO6, which includes all surface-water and sediment sample locations.
- Dioxins/furans detected at the DRMO yard source area are presented in 8.6.1.7. Dioxins/furans are not presented by sub-area due to the scattered nature of detections at low concentrations.

Sub-areas DRMO1 through 5, and surface-water and sediment sample locations are presented on Figure 8-1. The nature and extent of contamination detected in each of the DRMO yard source area sub-areas are described in the following sections.

8.6.1.1 Sub-Area DRMO1

Twenty-one of the initial 60 soil borings, 22 of the initial 60 groundwater probes, and surface-soil sample Location 002 are within this sub-area. Petroleum hydrocarbons and chlorinated VOCs detected at the initial sampling locations resulted in the installation of an additional 3 soil borings and 15 groundwater probes to further assess the extent of contamination. In addition, soil analytical results from six borings drilled during a PSE 2 investigation in 1992 (HLA, 1993b) were used to more accurately assess the extent of contamination. COCs detected in soil and groundwater in Sub-area DRMO1 are presented in Tables 8-6 and 8-7 and on Figures 8-2 and 8-3. The extent of contamination in Sub-area DRMO1 is described in the following sections.

Table 8-6. Chemicals of Concern Detected in Soil That Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO1

			Boring Location	AP-6757	AP-6758	AP-6758	AP-6760	AP-6763	AP-6763	A-6763	AP-6763	AP-6764
			Sample Number	94FW1127SL	94FW1217SL	94FW1219SL	94FW1263SL	94FW11221SL	94FW11223SL	94FW11225SL	94FW11226SL	94FW1184SL
			Depth (feet)	0 - 2	0 - 2	5 - 7	0 - 2	0 - 2	5 - 9	5 - 9	10 - 12	0 - 2
			Associated Quality Control Duplicate Sample						94FW11225SL	94FW11223SL		
			Date Sampled	8/6/94	8/13/94	8/13/94	8/17/94	8/15/94	8/15/94	8/15/94	8/15/94	8/11/94
Analyte	Cleanup Level[a]	RBC	Units									
Diesel-Range Organics	100,000	--	µg/kg	<	<	<	<	<	990,000 J	2,900,000 J	1,800,000 J	<
Gasoline-Range Organics	50	--	mg/kg	<	<	<	<	<	<	170 J	91 J	<
Semivolatile Organic Compounds												
Benzo(a)anthracene	--	880[b]	µg/kg	<	<	<	<	<	ND(1,700) RQ	ND(1,700)	<	<
Benzo(a)pyrene	--	88[b]	µg/kg	ND(340)	350 J	ND(340)	ND(350)	ND(380)	ND(1,700) RQ	ND(1,700)	ND(420)	190 J
Benzo(b)fluoranthene	--	880[b]	µg/kg	<	<	<	<	<	ND(1,700) RQ	ND(1,700)	<	<
Dibenzo(a,h)anthracene	--	88[b]	µg/kg	ND(340)	<	ND(340)	ND(350)	ND(380)	ND(1,700) RQ	ND(1,700)	ND(420)	ND(360)
Indeno(1,2,3-cd)pyrene	--	880[b]	µg/kg	<	<	<	<	<	ND(1,700) RQ	ND(1,700)	<	<
Polychlorinated Biphenyls												
Aroclor 1254	--	83[b]	µg/kg	ND(160)	ND(180)	ND(170)	ND(170)	ND(180)	ND(170) RQ	ND(170)	ND(210)	ND(170) J
Aroclor 1260	--	83[b]	µg/kg	85	<	ND(170)	89	290	ND(170) RQ	ND(170)	ND(210)	140 J
Metals												
Lead	--	0.0078[c]	mg/kg	22.8	39.9	6.3	32.8	13.8	5.3	3.9	<	33.3
Manganese	--	390[c]	mg/kg	<	<	415 J	<	<	<	<	<	<

			Boring Location	AP-6765	AP-6765	AP-6772	AP-6772	AP-6773	AP-6773	AP-6774	AP-6774	AP-6774
			Sample Number	94FW1131SL	94FW1132SL	94FW1135SL	94FW1137SL	94FW1156SL	94FW1157SL	94FW1180SL	94FW1181SL	94FW1182SL
			Depth (feet)	0 - 2	2 - 4	0 - 2	5 - 7	2 - 4	5 - 7	0 - 2	2 - 4	5 - 7
			Date Sampled	8/8/94	8/8/94	8/8/94	8/8/94	8/9/94	8/9/94	8/11/94	8/11/94	8/11/94
Analyte	Cleanup Level[a]	RBC	Units									
Diesel-Range Organics	100,000	--	µg/kg	<	<	<	<	110,000	4,200,000	<	<	1,800,000 J
Gasoline-Range Organics	50	--	mg/kg	<	<	<	<	<	690	<	<	<
Semivolatile Organic Compounds												
Benzo(a)anthracene	--	880 b	µg/kg	<	<	<	<	<	<	<	<	<
Benzo(a)pyrene	--	88[b]	µg/kg	ND(420)	ND(340)	ND(350)	ND(380)	ND(350)	ND(340)	ND(340)	ND(340)	ND(340)
Benzo(b)fluoranthene	--	880 b	µg/kg	<	<	<	<	<	<	<	<	<
Dibenzo(a,h)anthracene	--	88[b]	µg/kg	ND(420)	ND(340)	ND(350)	ND(380)	ND(350)	ND(340)	ND(340)	ND(340)	ND(340)
Indeno(1,2,3-cd)pyrene	--	880[b]	µg/kg	<	<	<	<	<	<	<	<	<
Polychlorinated Biphenyls												
Aroclor 1254	--	83[b]	µg/kg	ND(200)	ND(160)	ND(170)	ND(190)	ND(170)	ND(170)	ND(160) J	ND(160) J	ND(160) J
Aroclor 1260	--	83[b]	µg/kg	220	<	110	ND(190)	93 J	ND(170)	1,100 J	120 J	ND(160) J
Metals												
Lead	--	0.0078[c]	mg/kg	27.2	10.2	17.7	5.9	10.3	4.3	46.4	10.6	5.9
Manganese	--	390[c]	mg/kg	406	688	434	399	<	<	<	<	548 J

Table 8-6. Chemicals of Concern Detected in Soil That Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO1 (continued)

			Boring Location	AP-6780	AP-6780	AP-6780	AP-6780	AP-6781	AP-6782	AP-6782	AP-6782
			Sample Number	94FW1174SL	94FW1176SL	94FW1178SL	94FW1179SL	94FW1164SL	94FW1151SL	94FW1152SL	94FW1153SL
			Depth (feet)	0 - 2	5 - 9	5 - 9	10 - 12	0 - 2	0 - 2	2 - 4	5 - 7
			Associated Quality Control Duplicate Sample		94FW1178SL	94FW1176SL					
			Date Sampled	8/11/94	8/11/94	8/11/94	8/11/94	8/10/94	8/9/94	8/9/94	8/9/94
Analyte	Cleanup Level[a]	RBC	Units								
Diesel-Range Organics	100,000	--	µg/kg	<	130,000 J	210,000 J	570,000 J	<	<	<	160,000
Gasoline-Range Organics	50	--	mg/kg	<	<	<	<	<	<	74	<
Semivolatile Organic Compounds											
Benzo(a)pyrene	--	88[b]	µg/kg	210 J	ND(340)	ND(340)	ND(410)	ND(340)	ND(360)	ND(360)	ND(360)
Polychlorinated Biphenyls											
Aroclor 1260	--	83[b]	µg/kg	150 J	ND(160) J	ND(160) J	ND(200) J	250	130 J	ND(160)	ND(160)
Metals											
Arsenic	--	23[c]	mg/kg	<	<	<	<	<	<	<	<
Manganese	--	390[c]	mg/kg	<	<	<	<	<	432	<	<

			Boring Location	AP-6783	AP-6783	AP-6783	AP-6783	AP-6785	AP-6785	AP-6786	AP-6786
			Sample Number	94FW1139SL	94FW1140SL	94FW1142SL	94FW1143SL	94FW1159SL	94FW1161SL	94FW1170SL	94FW1171SL
			Depth (feet)	0 - 2	2 - 6	2 - 6	6 - 8	0 - 4	0 - 4	0 - 2	2 - 4
			Associated Quality Control Duplicate Sample		94FW1142SL	94FW1140SL		94FW1161SL	94FW1159SL		
			Date Sampled	8/8/94	8/8/94	8/8/94	8/8/94	8/10/94	8/10/94	8/10/94	8/10/94
Analyte	Cleanup Level[a]	RBC	Units								
Diesel-Range Organics	100,000	--	µg/kg	<	<	<	<	<	<	<	<
Gasoline-Range Organics	50	--	mg/kg	<	<	<	<	<	<	<	<
Semivolatile Organic Compounds											
Benzo(a)pyrene	--	88[b]	µg/kg	ND(370)	ND(390)	ND(420)	ND(340)	ND(370)	ND(360)	230 J	ND(420)
Polychlorinated Biphenyls											
Aroclor 1260	--	83[b]	µg/kg	ND(180)	ND(190)	ND(200)	ND(170)	370	380	370	ND(200)
Metals											
Arsenic	--	23[c]	mg/kg	<	<	70.5	<	<	<	<	<
Manganese	--	390[c]	mg/kg	432	<	<	2,420	<	<	396	398

Table 8-6. Chemicals of Concern Detected in Soil That Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO1 (continued)

			Sample Location	AP-6790	AP-6790	AP-6791	AP-6791	AP-6792	AP-6803
			Sample Number	94FW1294SL	94FW1295SL	94FW1300SL	94FW1302SL	94FW1305SL	94FW1310SL
			Depth (feet)	0 - 2	2 - 4	0 - 4	0 - 4	0 - 2	2 - 4
			Associated Quality Control Duplicate Sample			94FW1302SL	94FW1300SL		
			Date Sampled	9/8/94	9/8/94	9/9/94	9/9/94	9/9/94	9/9/94
Analyte	Cleanup Level[a]	RBC	Units						
Semivolatile Organic Compounds									
Benzo(a)pyrene	--	88[b]	µg/kg	<	<	<	98	<	<
Polychlorinated Biphenyls									
Aroclor 1260	--	83[b]	µg/kg	160	240	250	360	220	120

			Sample Location	002	002
			Sample Number	94FW10002SS	94FW10004SS
			Depth (feet)	0 - 0.5	0 - 0.5
			Associated Quality Control Duplicate Sample	94FW10004SS	94FW10002SS
			Date Sampled	8/10/94	8/10/94
Analyte	Cleanup Level[a]	RBC	Units		
Diesel-Range Organics	100	--	mg/kg	170	110
Metals					
Lead	--	0.0078[b]	mg/kg	830 RQ	53

<	Analyte was detected at a concentration less than the ARAR, or was not detected (associated method reporting limit less than the ARAR)
--	Applicable regulatory criteria not available
ARAR	Applicable or relevant and appropriate requirement
µg/kg	Micrograms per kilogram
mg/kg	Milligrams per kilogram
ND	Not detected at or above the method reporting limit listed in parentheses
RBC	Risk-based concentration

a. Alaska Department of Environmental Conservation, 1991, and Title 18, Alaska Administrative Code, Chapter 78, Underground Storage Tanks, as amended through August 21, 1991.
b. RBC is 10^{-6} (U.S. Environmental Protection Agency [EPA] Region 3, 1994).
c. Hazard quotient is equal to 1 (EPA Region 3, 1994).

Project Laboratory Qualifiers

J	Value is estimated.
RQ	Qualified until replaced with other data.

Table 8-7. Chemicals of Concern Detected in Water That Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO1

			Probe Location	P26	P27	P28	P33	P34	P35	P36
			Sample Number	94FW1044WA	94FW1049WA	94FW1056WA	94FW1057WA	94FW1050WA	94FW1110WA	94FW1037WA
			Associated Quality Control Duplicate Sample							
			Date Sampled	7/28/94	7/29/94	7/30/94	7/30/94	7/29/94	8/26/94	7/28/94
Analyte	MCL	RBC	Units							
Diesel-Range Organics	--	--	mg/L	0.34	25	ND(0.1)	0.35	41	35	0.41
Gasoline-Range Organics	--	--	mg/L	ND(0.05)	9.7	ND(0.05)	ND(0.05)	28	2.9 J	ND(0.05)
Volatile Organic Compounds										
1,2,4-Trimethylbenzene	--	3[a]	µg/L	<	63 FC	<	<	160 DD	340 DD	<
1,3,5-Trimethylbenzene	--	2.4[a]	µg/L	<	18	<	<	61 DD	130	<
Benzene	5	0.36[b]	µg/L	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(5)	ND(1)
Chloroform	100	0.15[b]	µg/L	ND(1)	ND(1)	2.2 J	1.6	1.7	ND(5)	ND(1)
Styrene	100	1.6[a]	µg/L	<	<	<	<	<	ND(5)	<
Tetrachloroethene (PCE)	5	1.1[b]	µg/L	<	<	<	<	<	ND(5)	<
Trichloroethene (TCE)	5	1.6[b]	µg/L	<	<	<	<	<	ND(5)	<
Metals										
Manganese (Dissolved)	--	0.18[a]	mg/L	0.58	3.6	1.6	1.4	3	6.1	0.66
Manganese (Total)	--	0.18[a]	mg/L	0.56	3.7	1.6	1.4	3	6.4	0.6

			Probe Location	P41	P42	P43	P44	P45	P46	P47
			Sample Number	94FW1005WA	94FW1008WA	94FW1019WA	94FW1026WA	94FW1038WA	94FW1042WA	94FW1051WA
			Associated Quality Control Duplicate Sample							
			Date Sampled	7/22/94	7/22/94	7/25/94	7/26/94	7/28/94	7/28/94	7/29/94
Analyte	MCL	RBC	Units							
Diesel-Range Organics	--	--	mg/L	0.26	1	1.1	15	6.5	2.8	0.62
Gasoline-Range Organics	--	--	mg/L	ND(0.05)	ND(0.05)	ND(0.05)	0.42	0.6	0.41	ND(0.05)
Volatile Organic Compounds										
1,2,4-Trimethylbenzene	--	3[a]	µg/L	<	<	<	48 FC	<	<	<
1,3,5-Trimethylbenzene	--	2.4[a]	µg/L	<	<	<	31	<	<	<
Benzene	5	0.36[b]	µg/L	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
Chloroform	100	0.15[b]	µg/L	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
Styrene	100	1.6[a]	µg/L	<	<	<	<	<	<	<
Tetrachloroethene (PCE)	5	1.1[b]	µg/L	2.1	1.4	3.9	4.4	32	65 FC	28
Trichloroethene (TCE)	5	1.6[b]	µg/L	5	3.9	8.1	3	5.2	2	<
Metals										
Manganese (Dissolved)	--	0.18[a]	mg/L	0.19	2.6	2.8	2.5	1.3	3.8	1.2
Manganese (Total)	--	0.18[a]	mg/L	0.19	2.8	2.9	2.5	1.3	3.9	1.3

Table 8-7. Chemicals of Concern Detected in Water That Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO1 (continued)

			Probe Location	P54	P55	P55	P56	P57	P58	P58
			Sample Number	94FW1052WA	94FW1040WA	94FW1041WA	94FW1039WA	94FW1025WA	94FW1022WA	94FW1023WA
			Associated Quality Control Duplicate Sample		94FW1041WA	94FW1040WA			94FW1023WA	94FW1022WA
			Date Sampled	7/29/94	7/28/94	7/28/94	7/28/94	7/26/94	7/26/94	7/26/94
Analyte	MCL	RBC	Units							
Diesel-Range Organics	--	--	mg/L	ND(0.1)	0.44	0.32	ND(0.1)	38	1.6	1.7
Gasoline-Range Organics	--	--	mg/L	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	0.51	ND(0.05)	ND(0.05)
Volatile Organic Compounds										
1,2,4-Trimethylbenzene	--	3[a]	µg/L	<	<	<	<	40	<	<
1,3,5-Trimethylbenzene	--	2.4[a]	µg/L	<	<	<	<	23	<	<
Benzene	5	0.36[b]	µg/L	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
Chloroform	100	0.15[b]	µg/L	2.4	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
Styrene	100	1.6[a]	µg/L	<	<	<	<	<	<	<
Tetrachloroethene (PCE)	5	1.1[b]	µg/L	<	16	14	22	16	21	20
Trichloroethene (TCE)	5	1.6[b]	µg/L	<	<	<	2.6	8.8	7.9	7.8
Metals										
Manganese (Dissolved)	--	0.18[a]	mg/L	<	<	<	0.63	3	<	<
Manganese (Total)	--	0.18[a]	mg/L	<	<	<	0.65	4.1	<	<

			Probe Location	P59	P60	P61	P61	P61	P62	P62
			Sample Number	94FW1007WA	94FW1006WA	94FW1091WA	94FW1095WA	94FW1098WA	94FW1115WA	94FW1117WA
			Associated Quality Control Duplicate Sample						94FW1117WA	94FW1115WA
			Date Sampled	7/22/94	7/22/94	8/25/94	8/25/94	8/26/94	8/26/94	8/26/94
Analyte	MCL	RBC	Units							
Diesel-Range Organics	--	--	mg/L	0.94	0.5	0.4 J	ND(0.1)	<	<	<
Gasoline-Range Organics	--	--	mg/L	ND(0.05)	ND(0.05)	<	<	<	<	<
Volatile Organic Compounds										
1,2,4-Trimethylbenzene	--	3[a]	µg/L	<	<	<	<	<	<	<
1,3,5-Trimethylbenzene	--	2.4[a]	µg/L	<	<	<	<	<	<	<
Benzene	5	0.36[b]	µg/L	ND(1)	ND(1)	<	<	5.7	ND(1)	ND(1)
Chloroform	100	0.15[b]	µg/L	ND(1)	ND(1)	<	<	<	<	<
Styrene	100	1.6[a]	µg/L	<	<	<	<	69 FB	<	<
Tetrachloroethene (PCE)	5	1.1[b]	µg/L	3.1	2.5	<	<	<	<	<
Trichloroethene (TCE)	5	1.6[b]	µg/L	9.1	4.6	<	<	<	<	<
Metals										
Manganese (Dissolved)	--	0.18[a]	mg/L	2.3	<	<	<	<	<	<
Manganese (Total)	--	0.18[a]	mg/L	2.3	<	<	<	<	<	<

Table 8-7. Chemicals of Concern Detected in Water That Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO1 (continued)

			Probe Location	P68	P69	P70	P70	P71	P72	P72
			Sample Number	94FW1105WA	94FW1106WA	94FW1126WA	94FW1128WA	94FW1129WA	94FW1130WA	94FW1138WA
			Associated Quality Control Duplicate Sample			94FW1128WA	94FW1126WA			94FW1140WA
			Date Sampled	8/26/94	8/26/94	8/27/94	8/27/94	8/27/94	8/27/94	9/1/94
Analyte	MCL	RBC	Units							
Diesel-Range Organics	--	--	mg/L	2.5	1.1	0.17	0.16	0.33	0.22	0.14
Gasoline-Range Organics	--	--	mg/L	<	<	<	<	<	<	<
Volatile Organic Compounds										
1,2,4-Trimethylbenzene	--	3[a]	µg/L	<	<	<	<	<	<	<
1,3,5-Trimethylbenzene	--	2.4[a]	µg/L	<	<	<	<	<	<	<
Benzene	5	0.36[b]	µg/L	<	<	<	<	<	<	ND(1)
Chloroform	100	0.15[b]	µg/L	<	<	<	<	<	<	ND(1)
Styrene	100	1.6[a]	µg/L	<	<	<	<	<	<	<
Tetrachloroethene (PCE)	5	1.1[b]	µg/L	<	<	<	<	<	<	<
Trichloroethene (TCE)	5	1.6[b]	µg/L	<	<	<	<	<	<	<
Metals										
Manganese (Dissolved)	--	0.18[a]	mg/L	<	<	<	<	<	<	<
Manganese (Total)	--	0.18[a]	mg/L	<	<	<	<	<	<	<

			Probe Location	P72	P72	P72	P73	P74	P75
			Sample Number	94FW1140WA	94FW1142WA	94FW1147WA	94FW1131WA	94FW1132WA	94FW1143WA
			Associated Quality Control Duplicate Sample	94FW1138WA					
			Date Sampled	9/1/94	9/1/94	9/1/94	8/27/94	8/27/94	9/1/94
Analyte	MCL	RBC	Units						
Diesel-Range Organics	--	--	mg/L	<	0.14	0.13	ND(0.1)	2.5	0.15
Gasoline-Range Organics	--	--	mg/L	<	<	<	<	<	<
Volatile Organic Compounds									
1,2,4-Trimethylbenzene	--	3[a]	µg/L	<	<	<	<	<	<
1,3,5-Trimethylbenzene	--	2.4[a]	µg/L	<	<	<	<	<	<
Benzene	5	0.36[b]	µg/L	ND(1)	ND(1)	ND(1)	<	<	<
Chloroform	100	0.15[b]	µg/L	ND(1)	ND(1)	ND(1)	<	<	<
Styrene	100	1.6[a]	µg/L	<	<	<	<	<	<
Tetrachloroethene (PCE)	5	1.1[b]	µg/L	<	<	<	<	<	<
Trichloroethene (TCE)	5	1.6[b]	µg/L	<	<	<	<	<	<
Metals									
Manganese (Dissolved)	--	0.18[a]	mg/L	<	<	<	<	<	<
Manganese (Total)	--	0.18[a]	mg/L	<	<	<	<	<	<

Table 8-7. Chemicals of Concern Detected in Water That Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO1 (continued)

			Probe Location	P76	P77	P78	P79	P80
			Sample Number	94FW1137WA	94FW1141WA	94FW1144WA	94FW1146WA	94FW1145WA
			Date Sampled	9/1/94	9/1/94	9/1/94	9/1/94	9/1/94
Analyte	MCL	RBC	Units					
Diesel-Range Organics	--	--	mg/L	0.15	0.22	0.13	0.32	0.39
Gasoline-Range Organics	--	--	mg/L	<	<	<	<	<
Volatile Organic Compounds								
1,2,4-Trimethylbenzene	--	3[a]	µg/L	<	<	<	<	<
1,3,5-Trimethylbenzene	--	2.4[a]	µg/L	<	<	<	<	<
Benzene	5	0.36[b]	µg/L	ND(1)	ND(1)	<	<	<
Chloroform	100	0.15[b]	µg/L	ND(1)	ND(1)	<	<	<
Styrene	100	1.6[a]	µg/L	<	<	<	<	<
Tetrachloroethene (PCE)	5	1.1[b]	µg/L	<	<	<	<	<
Trichloroethene (TCE)	5	1.6[b]	µg/L	<	3	<	<	<
Metals								
Manganese (Dissolved)	--	0.18[a]	mg/L	<	<	<	<	<
Manganese (Total)	--	0.18[a]	mg/L	<	<	<	<	<

Table 8-7. Chemicals of Concern Detected in Water That Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO1 (continued)

			Well Location	AP-5825	AP-5826	AP-5826	AP-6803	AP-6803	AP-6804	AP-6805	AP-6807
			Sample Number	94FW1152WA	94FW1156WA	94FW1158WA	94FW1169WA	94FW1171WA	94FW1179WA	94FW1177WA	94FW1178WA
			Associated QC Duplicate Sample		94FW1158WA	94FW1156WA	94FW1171WA	94FW1169WA			
			Date Sampled	9/12/94	9/13/94	9/13/94	9/15/94	9/15/94	9/21/94	9/21/94	9/21/94
Analyte	MCL	RBC	Units								
Diesel-Range Organics	--	--	mg/L	23	0.67	1.3	2.6	2.9	0.23	0.14	0.73
Gasoline-Range Organics	--	--	mg/L	0.94 GH	0.17	0.17	0.09	0.1	ND(0.05)	ND(0.05)	ND(0.05)
Volatile Organic Compounds											
1,2,4-Trimethylbenzene	--	3[a]	µg/L	460 FF	<	<	<	<	<	<	<
1,3,5-Trimethylbenzene	--	2.4[a]	µg/L	130 FC	4.1	3.7	<	<	<	<	<
Tetrachloroethene (PCE)	5	1.1[b]	µg/L	<	<	<	140 FC	190 FC	26	<	13
Trichloroethene (TCE)	5	1.6[b]	µg/L	<	<	<	4.8	5	17	<	7.9
Metals											
Manganese (Dissolved)	--	0.18[a]	mg/L	13	1.5	1.4	2.4	2.7	1.4	0.42	1.6
Manganese (Total)	--	0.18[a]	mg/L	13	1.4	1.5	2.4	2.4	1.4	0.42	1.6

< Analyte was detected at a concentration less than the ARAR, or was not detected (associated method reporting limit less than the ARAR)
-- Applicable regulatory criteria not available
ARAR Applicable or relevant and appropriate requirement
MCL Maximum contaminant level
µg/L Micrograms per liter
mg/L Milligrams per liter
ND Not detected at or above the method reporting limit listed in parentheses
RBC Risk-based concentration

a. Hazard quotient is equal to 1 (U.S. Environmental Protection Agency [EPA] Region 3,1994).
b. RBC is 10^{-6} (EPA Region 3, 1994).

Project Qualifiers

B Contaminant detected in associated laboratory blank.
DD Compound quantitated at different dilution.
FB Compound quantitated at 5x dilution.
FC Compound quantitated at 10x dilution.
FF Compound quantitated at 100x dilution.
GH The positive result appears to be a heavier hydrocarbon than gasoline.
J Value is estimated.

Nature and Extent of Contamination in Sub-Area DRMO1

Petroleum Hydrocarbons in Soil

DRO and GRO were detected in soil at concentrations that exceeded potential chemical-specific ARARs (ADEC soil cleanup levels of 100 mg/kg for DRO and 50 mg/kg for GRO). Two USTs (UST 316 and an unnumbered UST) are the suspected sources of petroleum hydrocarbons detected in samples from Sub-area DRMO1. UST 316, a 3,000-gallon single-wall steel tank used to store diesel, was located adjacent to the east end of former Building 5006 (Figure 8-1). Petroleum releases from UST 316 were documented during the UST closure site assessment, with 1,200 mg/kg of DRO detected in a soil sample from the UST excavation sidewall (Quest, 1993).

An unnumbered UST is suspected to have been located near the northwest corner of Building 5008. A construction design drawing for covered storage Buildings 5007 and 5008 (USACE, 1985) indicates that a UST was to be removed during construction. No records were found to confirm the existence and removal of the unnumbered UST.

Petroleum released from the USTs is believed to have migrated through the soil to the water table, where it migrated laterally from the UST locations, primarily in the direction of groundwater flow (northwest).

Subsurface-soil profiles showing sampling locations, DRO and GRO results, and the estimated lateral extent of petroleum hydrocarbons in soil at concentrations exceeding the estimated ADEC soil cleanup level are presented on Figures 8-4 and 8-5. With the exception of samples from Borings AP-6773 and AP-5812, samples collected from the surface to a depth of 4 feet contained DRO at concentrations below the ADEC soil cleanup level. DRO was detected at concentrations exceeding the ADEC soil cleanup level at a depth of approximately 3 feet in Borings AP-6773 (110 mg/kg) and AP-5812 (460 mg/kg). DRO was detected at concentrations ranging from 14 mg/kg to 8,500 mg/kg in samples collected from depths between 6 and 11 feet below ground surface, the expected zone of water table fluctuation (smear zone).

GRO was detected at concentrations exceeding the ADEC soil cleanup level in samples from Borings AP-6763 (170 mg/kg at 7 feet below ground surface, and 91 mg/kg at 11 feet below ground surface); AP-6773 (690 mg/kg at 6 feet below ground surface); and AP-6782 (74 mg/kg at 3 feet below ground surface). Based on a review of chromatograms associated with the sample results, HLA believes GRO detected in soil samples corresponds to light-end hydrocarbons associated with the detected DRO, not to a separate petroleum source. Typical chromatograms for DRO and GRO samples are included for comparison purposes in Appendix K.

Petroleum-related VOCs (BTEX compounds) were not detected in Sub-area DRMO1 soil at concentrations exceeding ADEC soil cleanup levels.

PCBs in Soil

PCBs were detected at concentrations exceeding ARARs in surface soil throughout Sub-area DRMO1. Concentrations ranged from 85 µg/kg in Boring AP-6760 to 1,100 µg/kg in Boring AP-6774.

Petroleum Hydrocarbons in Groundwater

Petroleum hydrocarbons detected in groundwater samples from Sub-area DRMO1 likely resulted from petroleum hydrocarbons in soil. DRO was detected in groundwater at concentrations ranging from 0.13 mg/L to 41 mg/L, with the maximum concentration detected in Groundwater Probe P34, which is within the area of detected soil contamination. The estimated lateral extent of DRO in groundwater is illustrated on Figure 8-6. As shown on the figure, dissolved petroleum hydrocarbons migrated north and northwest from the suspected source area to beyond the northwest corner of the DRMO yard. DRO was detected at concentrations of 0.13 mg/L to 0.39 mg/L in Groundwater Probes P78, P79, and P80, which represent the downgradient extent of sample locations (Figure 8-6). The MRL for DRO in groundwater is 0.1 mg/L.

GRO was detected at concentrations ranging from 0.10 mg/L to 28 mg/L. In general, samples in which GRO was detected also contained DRO at concentrations an order of magnitude greater. As with petroleum hydrocarbons detected in soil, the GRO fraction appears to be associated with the detected DRO.

Petroleum-related VOCs in Sub-area DRMO1 groundwater samples detected at concentrations exceeding potential chemical-specific ARAR concentrations included benzene, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene.

Chlorinated VOCs in Soil

Chlorinated VOCs PCE and TCE were detected in soil samples from Sub-area DRMO1, but at concentrations below respective EPA Region 3 RBCs (12,000 µg/kg PCE, and 58,000 µg/kg TCE). The extent of chlorinated VOCs in soil is discussed in this section to document the suspected secondary source of chlorinated VOCs in groundwater. The primary source of chlorinated VOCs in Sub-area DRMO1 soil has likely not been identified based on the high concentrations of PCE and TCE in groundwater (see next section). Chlorinated VOCs may have been released during drum storage activities to migrate through the soil to the water table.

Subsurface-soil profiles showing sampling locations, PCE results, and the lateral extent of PCE in soil are presented on Figure 8-7. With the exception of Borings AP-6773 and AP-6784, PCE was detected in the surface-soil sample from each of the borings, which is consistent with a surface-spill scenario. Concentrations of PCE in surface-soil samples ranged from 150 µg/kg in Boring AP-6803 (the maximum detected PCE concentration) to 3.3 µg/kg in Boring AP-6792. PCE was detected in subsurface-soil samples with concentrations generally decreasing with depth. The maximum PCE concentration in Boring AP-6784 (51 µg/kg) was detected at 11 feet, approximately 4 feet below the water table level during drilling. PCE was also detected in soil samples from below the water table in Borings AP-6790 and AP-6794. TCE was detected at a concentration of 800 µg/kg in Boring AP-6763 (11 feet below ground surface) and 26 µg/kg in Boring AP-6773 (6 feet below ground surface).

Chlorinated VOCs in Groundwater

Chlorinated VOCs detected in groundwater in Sub-area DRMO1 may have resulted from PCE in the soil. PCE was detected in groundwater at concentrations ranging from 1.4 µg/L to 190 µg/L, with the maximum concentration detected in Monitoring Well AP-6803, which is within the area of detected PCE soil contamination. The lateral extent of chlorinated VOCs in groundwater is illustrated on Figure 8-8. As shown on the figure, dissolved PCE migrated northwest from the suspected source area in the direction of groundwater flow, to beyond the boundary of the DRMO yard. PCE concentrations above the MCL (5 mg/L) for PCE are not expected to have migrated west of Channel B or north of Groundwater Probes P62 and P76. PCE was not detected in project samples from Monitoring Well AP-6805 or Groundwater Probes P62 and P76 at an MRL of 1 µg/L. However, PCE was detected in a field-screening sample (EPA Method 8010 run by Quanterra) from Groundwater Probe P80 at a concentration of 4.8 µg/L.

TCE was detected in groundwater at concentrations ranging from 1.1 µg/L to 17 µg/L, with the maximum concentration detected in Monitoring Well AP-6804 near the concrete cistern. Samples containing TCE also contained PCE. With some exceptions, the TCE detected in groundwater is likely a chemical and biological degradation product of the PCE detected. TCE was detected in Groundwater Probe P35 at a concentration of 5 µg/L. Groundwater Probe P35 is adjacent to Boring AP-6773, one of the two borings with detected concentrations of TCE.

HLA used field-screening laboratory data to profile the vertical extent of chlorinated VOCs in groundwater in Sub-area DRMO1. Groundwater Probes P61, P68, P69, and P72 were driven and sampled at successive 10-foot intervals, as

described in section 3.8.2. The water table level was approximately 7 to 8 feet below ground surface during sampling. The field-screening results of vertical profiling are presented in Table 8-8. The concentration of PCE in field-screening samples from Groundwater Probe P69 decreased with depth from 890 μg/L at 10 feet below ground surface, to 2.5 μg/L at 30 feet below ground surface, and was below the MRL of 1 μg/L at a depth of 40 feet below ground surface. PCE was detected at the same depths in Groundwater Probe P68 (Table 8-8), but the maximum PCE concentration (78 μg/L) was detected in the sample from 20 feet below ground surface. PCE was detected at 15 feet below ground surface in Groundwater Probe P72 (7.1 μg/L), but was not detected at deeper sampling intervals. In Groundwater Probe P61 (Table 8-8), PCE was not analyzed for in samples from the 15-, 20-, and 30-foot depths, and was not detected at 40 and 50 feet below ground surface. The results of vertical profiling suggest that the PCE plume has a vertical thickness of approximately 30 feet, and extends from approximately 7 feet below ground surface (water table surface) to a depth of between 30 to 40 feet below ground surface.

8.6.1.2 Sub-Area DRMO2

Eight of the initial 60 soil borings, 13 of the initial 60 groundwater probes, two groundwater monitoring wells, and three surface-soil samples locations are within Sub-area DRMO2. Based on review of quick-turnaround laboratory analytical results, no additional samples were collected from the area. COCs detected surface soil, subsurface soil, and groundwater in Sub-area DRMO2 are presented in Tables 8-9 and 8-10 and on Figures 8-9 and 8-10. In addition, laboratory analytical results generated from 10 borings and two monitoring wells installed within Sub-area DRMO2 by the USACE in 1992 were reviewed to more accurately assess the extent of contamination (USACE, 1992). The extent of contamination in Sub-area DRMO2 is described in the following section.

Nature and Extent of Contamination in Sub-Area DRMO2

Petroleum Hydrocarbons in Soil

DRO and GRO were detected in soil samples from Sub-area DRMO2 at concentrations exceeding the ADEC soil cleanup levels. Two diesel USTs (identification numbers are not known) are suspected to be the source of petroleum hydrocarbons detected in samples from Sub-area DRMO2. One UST was located adjacent to the north side of former Building 5001. Petroleum releases from the UST were documented during the UST closure site assessment (Quest, 1993).

The other UST was located adjacent to the east end of the former Building 5008. Petroleum releases from the UST were documented during the UST closure site assessment (Quest, 1993).

HLA believes that petroleum released from the USTs migrated down through the soil to the water table, and then laterally from the UST locations, primarily in the direction of groundwater flow (northwest).

DRO and GRO were detected in soil samples from three of the 10 borings drilled during the RI. DRO was detected in Boring AP-6761 (surface sample) at a concentration of 200 mg/kg. GRO was detected in Boring AP-6778 (6 feet below ground surface) at a concentration of 71 mg/kg, and in Boring AP-6789 (6 feet and 11 feet below ground surface) at concentrations of 56 and 58 mg/kg. DRO and GRO were not detected, or were detected at concentrations below the estimated ADEC soil cleanup level in all remaining samples collected from within this sub-area during the OU 2 RI.

Petroleum hydrocarbons were detected in samples from Borings AP-5766 and AP-5767 drilled by the USACE in 1992 (USACE, 1992). The borings were drilled in the vicinity of the UST adjacent to the north side of Building 5001. DRO was detected in Boring AP-5766 at concentrations of 2,100 mg/kg in the surface-soil sample and 1,700 mg/kg at 10 feet below ground surface. DRO concentrations of 840 mg/kg at the surface in Boring

Table 8-8. DRMO Yard Source Area Groundwater Probe Vertical Profile Results in Parts per Billion

Groundwater Probe	Bottom of Screen Depth (feet)	Trichloroethene (TCE)	Tetrachloroethene (PCE)
P61	15	2.5	NA
	20	ND (1.0)	NA
	30	2.6	NA
	40	ND (1.0)	ND (1.0)
	50	ND (1.0)	ND (1.0)
	60	ND (1.0)	ND(1.0)
P68	10	1.1	10
	20	42	78
	30	28	40
	40	ND (1.0)	ND (1.0)
	50	ND (1.0)	ND (1.0)
	60	ND (1.0)	ND (1.0)
P69	10	ND (1.0)	840
	20	2.9	22
	30	ND (1.0)	2.5
	40	ND (1.0)	ND (1.0)
	50	ND (1.0)	ND (1.0)
	60	ND (1.0)	ND (1.0)
P72	15	19	7.1
	25	ND (1.0)	ND (1.0)
	35	ND (1.0)	ND (1.0)
	45	ND (1.0)	ND (1.0)

NA Not analyzed
ND Not detected at or above the method reporting limit in parentheses

Table 8-9. Chemicals of Concern Detected in Soil That Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO2

			Sample Location Sample Number Depth (feet) Date Sampled	003 94FW10005SS 0 - 0.5 8/10/94
Analyte	Cleanup Level[a]	RBC	Units	
Metals				
Lead	--	0.0078[b]	mg/kg	290

			Sample Location Sample Number Depth (feet) Date Sampled	AP-6801 94FW1287SL 0 - 2 8/24/94	AP-6801 94FW1290SL 10 - 12 8/24/94
Analyte	Cleanup Level[a]	RBC	Units		
Metals					
Lead	--	0.0078[b]	mg/kg	41	8
Manganese	--	390[b]	mg/kg	<	760 J

Table 8-9. Chemicals of Concern Detected in Soil That Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO2 (continued)

			Boring Location	AP-6740	AP-6740	AP-6761	AP-6777
			Sample Number	94FW1278SL	94FW1280SL	94FW1269SL	94FW1239SL
			Depth (feet)	2 - 4	10 - 12	0 - 2	0 - 4
			Associated Quality Control Duplicate Sample				94FW1241SL
			Date Sampled	8/17/94	8/17/94	8/17/94	8/16/94
Analyte	Cleanup Level[a]	RBC	Units				
Diesel-Range Organics	100,000	--	µg/kg	<	<	200,000 J	<
Gasoline-Range Organics	50	--	mg/kg	<	<	<	<
Metals							
Lead	--	0.0078[b]	mg/kg	11.5	4.1	54.5	30.3
Manganese	--	390[b]	mg/kg	396 J	451 J	<	440 J

			Boring Location	AP-6778	AP-6789	AP-6789	AP-6789
			Sample Number	94FW11233SL	94FW11228SL	94FW11229SL	94FW11230SL
			Depth (feet)	5 - 7	2 - 4	5 - 7	10 - 12
			Associated Quality Control Duplicate Sample				
			Date Sampled	8/15/94	8/15/94	8/15/94	8/15/94
Analyte	Cleanup Level[a]	RBC	Units				
Diesel-Range Organics	100,000	--	µg/kg	<	<	<	<
Gasoline-Range Organics	50	--	mg/kg	71	<	56	58
Metals							
Lead	--	0.0078[b]	mg/kg	4.6	10.4	5.9	<
Manganese	--	390[b]	mg/kg	<	393 J	<	<

< Analyte was detected at a concentration less than the ARAR, or was not detected (associated method reporting limit less than ARAR)

-- Applicable regulatory criteria not available

ARAR Applicable or relevant and appropriate requirement

µg/kg Micrograms per kilogram

mg/kg Milligrams per kilogram

ND Not detected at or above the method reporting limit listed in parentheses

RBC Risk-based concentration

a. Alaska Department of Environmental Conservation, 1991, and Title 18, Alaska Administrative Code, Chapter 78, Underground Storage Tanks, as amended through August 21, 1991.

b. Hazard quotient is equal to 1 (U.S. Environmental Protection Agency, Region 3, 1994).

Project Laboratory Qualifiers

J Value is estimated.

Table 8-10. Chemicals of Concern Detected in Water That Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO2

			Probe Location	P10	P11	P12	P29	P30
			Sample Number	94FW1070WA	94FW1072WA	94FW1069WA	94FW1068WA	94FW1071WA
			Date Sampled	8/2/94	8/2/94	8/2/94	8/2/94	8/2/94
Analyte	MCL	RBC	Units					
Diesel-Range Organics	--	--	mg/L	ND(0.1)	ND(0.1)	ND(0.1)	1.2	4.2
Gasoline-Range Organics	--	--	mg/L	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	2.6
Volatile Organic Compounds								
1,2,4-Trimethylbenzene	--	3[a]	µg/L	<	<	<	<	43 J
1,3,5-Trimethylbenzene	--	2.4[a]	µg/L	<	<	<	<	66 J
Chloroform	100	0.15[b]	µg/L	4.8	5.9	6.4	4.3	5.3 J
Trichloroethene (TCE)	5	1.6 [b]	µg/L	<	<	<	1.8	<
Metals								
Manganese (Dissolved)	--	0.18[a]	mg/L	0.28	0.34	1.1	2.9	2.3
Manganese (Total)	--	0.18[a]	mg/L	0.22	0.32	1.1	2.9	2.3

			Probe Location	P31	P31	P32	P49	P50
			Sample Number	94FW10074WA	94FW10076WA	94FW1067WA	94FW1062WA	94FW10077WA
			Associated Quality Control Duplicate Sample	94FW10076WA	94FW10074WA			
			Date Sampled	8/3/94	8/3/94	8/2/94	8/1/94	8/3/94
Analyte	MCL	RBC	Units					
Diesel-Range Organics	--	--	mg/L	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	0.57
Gasoline-Range Organics	--	--	mg/L	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)
Volatile Organic Compounds								
1,2,4-Trimethylbenzene	--	3[a]	µg/L	<	<	<	<	<
1,3,5-Trimethylbenzene	--	2.4[a]	µg/L	<	<	<	<	<
Chloroform	100	0.15[b]	µg/L	2.3	5.1	2.2	4.3	3.3
Trichloroethene (TCE)	5	1.6 [b]	µg/L	<	<	<	<	<
Metals								
Manganese (Dissolved)	--	0.18[a]	mg/L	1.2	1.1	2.3	1.3	2.3
Manganese (Total)	--	0.18[a]	mg/L	1.2	1.2	2.2	1.3	2.5

Table 8-10. Chemicals of Concern Detected in Water That Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO2 (continued)

			Probe Location	P51	P51	P52	P53	P53
			Sample Number	94FW10082WA	94FW10084WA	94FW1061WA	94FW1058WA	94FW1060WA
			Associated Quality Control Duplicate Sample	94FW10084WA	94FW10082WA		94FW1060WA	94FW1058WA
			Date Sampled	8/4/94	8/4/94	8/1/94	8/1/94	8/1/94
Analyte	MCL	RBC	Units					
Diesel-Range Organics	--	--	mg/L	0.25	0.23	ND(0.1)	ND(0.1)	ND(0.1)
Gasoline-Range Organics	--	--	mg/L	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)
Volatile Organic Compounds								
1,2,4-Trimethylbenzene	--	3[a]	µg/L	<	<	<	<	<
1,3,5-Trimethylbenzene	--	2.4[a]	µg/L	<	<	<	<	<
Chloroform	100	0.15[b]	µg/L	ND(1) J	4.1	2.3	2.9	7.2
Trichloroethene (TCE)	5	1.6 [b]	µg/L	<	<	<	<	<
Metals								
Manganese (Dissolved)	--	0.18[a]	mg/L	2.2	2.2	0.98	1.4	1.3
Manganese (Total)	--	0.18[a]	mg/L	2.3	2.4	0.92	1.3	1.3

			Well Location	AP-5764	AP-5765	AP-5623	AP-6799	AP-6800
			Sample Number	94FW1159WA	94FW1160WA	94FW1161WA	94FW1174WA	94FW1176WA
			Date Sampled	9/13/94	9/13/94	9/13/94	9/16/94	9/21/94
Analyte	MCL	RBC	Units					
Diesel-Range Organics	--	--	mg/L	0.48	ND(0.1)	0.21	0.13	0.14
Gasoline-Range Organics	--	--	mg/L	ND(0.05)	ND(0.05)	ND(0.05)	0.05	ND(0.05)
Volatile Organic Compounds								
Tetrachloroethene (PCE)	5	1.1[a]	µg/L	1.3	4.5	<	<	<
Trichloroethene (TCE)	5	1.6[a]	µg/L	10	<	<	<	<
Metals								
Manganese (Total)	--	0.18[b]	mg/L	0.34	0.56	1.9	1.3	1

< Analyte was detected at a concentration less than the ARAR, or was not detected (associated method reporting limit less than the ARAR)
-- Applicable regulatory criteria not available
ARAR Applicable or relevant and appropriate requirement
MCL Maximum contaminant level
µg/L Micrograms per liter
mg/L Milligrams per liter
ND Not detected at or above the method reporting limit listed in parentheses
RBC Risk-based concentration

a. Hazard quotient is equal to 1 (U.S. Environmental Protection Agency [EPA] Region 3,1994).
b. RBC is 10^{-6} (EPA region 3, 1994).

Project Laboratory Qualifiers

B Contaminant detected in associated laboratory blank.
J Value is estimated.

AP-5767, and 100 mg/kg at 10 feet below ground surface were detected. The samples were analyzed using USACE-modified EPA Method 8015 for fuel identification and quantitation (FIQ). The concentrations of DRO detected by the FIQ method may not be comparable to DRO results generated during the RI. Petroleum hydrocarbons were not detected in Borings AP-5765 and AP-5770, which are also in the UST area.

Under the direction of the remedial project managers, petroleum hydrocarbon (DRO and GRO) contamination at Sub-Area DRMO2 will be addressed under a two-party agreement, and is not, therefore, addressed in the OU 2 RI report.

Petroleum-related VOCs (BTEX compounds) and PCBs were not detected in Sub-area DRMO2 soil at concentrations exceeding potential ARARs.

Petroleum Hydrocarbons in Groundwater

Petroleum hydrocarbons detected in Sub-area DRMO2 groundwater resulted from petroleum hydrocarbons in soil. The extent of petroleum hydrocarbons in groundwater is illustrated on Figure 8-6. DRO was detected in groundwater at concentrations ranging from 0.23 mg/L to 4.2 mg/L, with the maximum concentration detected in Groundwater Probe P30 within the area of known soil contamination. The dissolved DRO migrated northwest from the suspected source area to beyond the location of Groundwater Probe P29. As shown on Figure 8-6, DRO was also detected in the wells and probes located along the eastern fence line (AP-5623, P50, P51, AP-6800, and AP-6799). The concentrations of DRO in samples collected from these wells and probes ranged from 0.13 mg/L to 0.57 mg/L, and may represent the downgradient edge of a DRO plume from the Arctic Surplus yard, an upgradient source.

Volatile petroleum hydrocarbons were detected in Groundwater Probe P30. GRO was detected at a concentration of 2.6 mg/L, and 1,2,4-trimethylbenzene and 1,3,5-trimethylbenzene were detected at concentrations of 43 μg/L and 66 μg/L, respectively. The volatile petroleum fraction is likely associated with detected DRO and does not represent a separate source (i.e., gasoline UST or other gasoline source). Volatile petroleum hydrocarbons were not detected at other groundwater sampling locations in Sub-area DRMO2.

Chlorinated VOCs In Groundwater

PCE was detected in groundwater samples from Monitoring Wells AP-5764 and AP-5765 at concentrations of 1.3 μg/L and 4.5 μg/L, respectively. The extent of PCE in groundwater is illustrated on Figure 8-8. As shown on the figure, PCE in groundwater appears to have localized around the wells in which it was detected. TCE was detected in Monitoring Well AP-5764 at a concentration of 10 μg/L, and in Groundwater Probe P29 at a concentration of 1.8 μg/L. However, PCE and TCE were not detected in soil samples collected in Sub-area DRMO2 during the OU 2 RI or USACE investigation.

8.6.1.3 Sub-Area DRMO3

Five of the initial 60 soil borings and 3 of the initial 60 groundwater probes installed during the RI are located within this sub-area. Based on quick-turnaround laboratory analytical results, five additional probes (P63 through P67) were installed upgradient to further assess the extent of contamination. COCs detected in soil and groundwater in Sub-area DRMO3 are presented in Tables 8-11 and 8-12 and on Figures 8-11 and 8-12. The extent of contamination in Sub-area DRMO3 is described in the following section.

Nature and Extent of Contamination in Sub-Area DRMO3

Contaminants in Soil

Petroleum hydrocarbons were detected in soil samples collected from Boring AP-6738 at concentrations that exceeded potential chemical-specific ARARs. DRO was detected at concentrations of 2,000 mg/kg at the surface (0- to 2-foot depths), 490 mg/kg at 6 feet, and 9,600 mg/kg at 11 feet. GRO was detected at concentrations of 250 mg/kg at 3 feet, 220 mg/kg at 6 feet, and 260 mg/kg at 11 feet. Based on a review of the chromatograms associated with the sample results,

Table 8-11. Chemicals of Concern Detected in Soil That Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO3

			Boring Location	AP-6737	AP-6738	AP-6738	AP-6738	AP-6738	AP-6739	AP-6743
			Sample Number	94FW1250SL	94FW1254SL	94FW1255SL	94FW1256SL	94FW1257SL	94FW1273SL	94FW1114SL
			Depth (feet)	0 - 2	0 - 2	2 - 4	5 - 7	10 - 12	0 - 2	2 - 4
			Date Sampled	8/16/94	8/16/94	8/16/94	8/16/94	8/16/94	8/17/94	8/5/94
Analyte	Cleanup Level[a]	RBC	Units							
Diesel-Range Organics	100,000	--	µg/kg	<	2,000,000 J	2,000,000 J	490,000 J	9,600,000 J	970,000 J	<
Gasoline-Range Organics	50	--	mg/kg	<	<	250 J	220 J	260 J	130 J	<
Metals										
Lead	--	0.0078[b]	mg/kg	38.1	41.6	15.7	8.5	3.9	211	10.4
Manganese	--	390[b]	mg/kg	<	<	<	<	<	<	450

< Analyte was detected at a concentration less than the ARAR, or was not detected (associated method reporting limit less than the ARAR)

-- Applicable regulatory criteria not available

ARAR Applicable or relevant and appropriate requirement

µg/kg Micrograms per kilogram

mg/kg Milligrams per kilogram

RBC Risk-based concentration

a. Alaska Department of Environmental Conservation, 1991, and Title 18, Alaska Administrative Code, Chapter 78, Underground Storage Tanks, as amended through August 21, 1991.

b. Hazard quotient is equal to 1 (U.S. Environmental Protection Agency, Region 3, 1994).

Project Laboratory Qualifiers

J Value is estimated.

Table 8-12. Chemicals of Concern Detected in Water That Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO3

			Probe Location	P07	P08	P13	P67
			Sample Number	94FW1046WA	94FW1054WA	94FW1055WA	94FW1104WA
			Date Sampled	7/28/94	7/30/94	7/30/94	8/26/94
Analyte	MCL	RBC	Units				
Diesel-Range Organics	--	--	mg/L	1.2	ND(0.1)	3.6 J	0.16
Gasoline-Range Organics	--	--	mg/L	ND(0.05)	ND(0.05)	0.59 GH	ND(0.05)
Volatile Organic Compounds							
1,2-Dichloroethane	5	0.12[a]	µg/L	ND(1)	ND(1)	1.5	<
Benzene	5	0.36[a]	µg/L	ND(1)	ND(1)	3.1	<
Chloroform	100	0.15[a]	µg/L	1.4	1.3	ND(1)	<
Metals							
Manganese (Dissolved)	--	0.18[b]	mg/L	4.8	2.1	3.2	<
Manganese (Total)	--	0.18[b]	mg/L	4.9	2.1	3.1	<

< Analyte was detected at a concentration less than the ARAR, or was not detected (associated method reporting limit less than the ARAR)

-- Applicable regulatory criteria not available

ARAR Applicable or relevant and appropriate requirement

MCL Maximum contaminant level

µg/L Micrograms per liter

mg/L Milligrams per liter

ND Not detected at or above the method reporting limit listed in parentheses

RBC Risk-based concentration

a. RBC is 10^{-6} (U.S. Environmental Protection Agency [EPA] Region 3, 1994).

b. Hazard quotient is equal to 1 (EPA Region 3,1994).

Project Laboratory Qualifiers

GH The positive result appears to be a heavier hydrocarbon than gasoline.

J Value is estimated.

HLA believes GRO detected in samples corresponds to the light-end hydrocarbons associated with the detected DRO, not to a separate hydrocarbon source. Typical chromatograms for DRO and GRO samples are included for comparison purposes in Appendix K.

DRO was detected at a concentration of 970 mg/kg in a surface-soil sample collected from Boring AP-6739. DRO concentrations did not exceed the potential chemical-specific ARAR of 100 mg/kg in subsurface soil at Boring AP-6739, nor in the remaining borings within Sub-area DRMO3. No soil borings are located south of Boring AP-6738, and the extent of DRO in soil south of Borings AP-6738 and AP-6739 is not known. Unidentified USTs possibly located between Buildings 5004 and 5007 and the south property boundary of the DRMO yard source area are suspected sources of DRO in soil. Possible sources may also exist in the vicinity of the rail line immediately south of the sub-area.

Contaminants in Groundwater

DRO was detected in Groundwater Probes P07 and P13 at concentrations of 1.2 and 3.6 mg/L. Upgradient Groundwater Probe P67 contained DRO at a concentration of 0.16 mg/L. The source of DRO in Groundwater Probe P67 has not been identified. The estimated lateral extent of DRO in groundwater is shown on Figure 8-6.

8.6.1.4 Sub-Area DRMO4

Seven of the initial 60 soil borings and 6 of the initial 60 groundwater probes installed during the RI are located within this sub-area. Based on quick-turnaround laboratory analytical results, five additional probes (P63 through P67) were installed to further assess the extent of contamination. Groundwater Probes P63, P64, and P65 are located in Sub-area DRMO4. COCs detected in soil and groundwater in Sub-area DRMO4 are presented in Tables 8-13 and 8-14 and on Figures 8-13 and 8-14. The extent of contamination in Sub-area DRMO4 is described in the following section.

Nature and Extent of Contamination in Sub-Area DRMO4

Contaminants in Soil

Contamination detected in Sub-area DRMO4 is in the vicinity of the railroad spur. Concentrations of DRO in Borings AP-6735 (180 mg/kg at 11 feet) and AP-6736 (200 mg/kg at 11 feet) exceeded potential chemical-specific ARARs. However, samples collected from the surface to a depth of 7 feet in these borings did not contain DRO at concentrations greater than 39 mg/kg. DRO was not detected at concentrations that exceeded potential chemical-specific ARARs in borings located east (AP-6737), north (AP-6743 through AP-6746), or west (AP-6734) of Borings AP-6735 and AP-6736. The source of DRO in Borings AP-6735 and AP-6736 has not been identified. Contaminants in this area may have resulted from miscellaneous releases associated with the railroad spur. However, high concentrations of DRO and GRO several feet below the water table and relatively low to nondetectable concentrations in surface and near-surface soil may suggest a subsurface release of petroleum hydrocarbons (i.e., from an unidentified UST or fuel line). Another potential source may be an undetected surface release adjacent to this area. Other analytes detected in soil at concentrations that exceeded potential ARARs included lead. Chlorinated VOCs were not detected in soil samples collected from Sub-area DRMO4. Subsurface-soil profiles showing sampling locations and DRO results for Sub-area DRMO4 are presented on Figures 8-15 and 8-16.

Contaminants in Groundwater

Samples collected from Groundwater Probes P04, P05, and P06 had DRO at concentrations of 0.22, 0.28, and 0.66 μg/L. Samples collected from Groundwater Probes P63 through P66, which are located on the former Old Richardson Highway south of Sub-area DRMO4, did not contain DRO.

Benzene, PCE, and TCE were detected in Groundwater Probe P05 at concentrations that exceeded potential chemical-specific ARARs.

Table 8-13. Chemicals of Concern Detected in Soil That Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO4

			Boring Location	AP-6730	AP-6731	AP-6731	AP-6731	AP-6733	AP-6734	AP-6735	AP-6735	AP-6735	AP-6736	AP-6736
			Sample Number	94FW1012SL	94FW1032SL	94FW1033SL	94FW1034SL	94FW1057SL	94FW1099SL	94FW1104SL	94FW1105SL	94FW1107SL	94FW1111SL	94FW1112SL
			Depth (feet)	0 - 2	2 - 4	5 - 9	5 - 9	0 - 2	2 - 4	0 - 2	2 - 4	10 - 12	5 - 7	10 - 12
			Associated QC Duplicate Sample			94FW1034SL	94FW1033SL							
			Date Sampled	7/25/94	7/28/94	7/28/94	7/28/94	8/1/94	8/4/94	8/5/94	8/5/94	8/5/94	8/5/94	8/5/94
Analyte	Cleanup Level[a]	RBC	Units											
Diesel-Range Organics	100,000	- -	µg/kg	<	<	<	<	<	<	110,000	<	180,000	<	200,000
Gasoline-Range Organics	50	- -	mg/kg	<	<	<	<	<	<	<	<	410 J	<	<
Semivolatile Organic Compounds														
Benzo(a)pyrene	- -	88[b]	µg/kg	160 J	ND(410)	ND(350)	ND(350)	ND(360)	ND(420)	ND(340)	ND(410)	ND(350)	ND(350)	ND(380)
Polychlorinated Biphenyls														
Aroclor 1254	- -	83[b]	µg/kg	430	ND(200)	ND(170)	ND(170)	ND(170)	ND(200)	ND(170)	ND(200)	ND(170)	ND(170)	ND(180)
Metals														
Lead	- -	0.0078[c]	mg/kg	21.3 J	15.8	5.2	6	17	12.2	996	27	4.6	7.4	3.5
Manganese	- -	390[c]	mg/kg	<	396	746	562	409	440 J	<	404	<	418	<

< Analyte was detected at a concentration less than the ARAR, or was not detected (associated method reporting limit less than the ARAR)
- - Applicable regulatory criteria not available
ARAR Applicable or relevant and appropriate requirement
µg/kg Micrograms per kilogram
mg/kg Milligrams per kilogram
ND Not detected at or above the method reporting limit listed in parentheses
RBC Risk-based concentration

a. ADEC, 1991, and Title 18, Alaska Administrative Code, Chapter 78, Underground Storage Tanks, as amended through August 21 1991.
b. RBC is 10^{-6} (U.S. Environmental Protection Agency [EPA] Region 3, 1994).
c. Hazard quotient is equal to 1 (EPA Region 3, 1994).

Project Laboratory Qualifiers

J Value is an estimate.

Table 8-14. Chemicals of Concern Detected in Water That Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO4

			Probe Location	P01	P04	P05	P06
			Sample Number	94FW01002WA	94FW0132WA	94FW0133WA	94FW1045WA
			Date Sampled	7/21/94	7/27/94	7/27/94	7/28/94
Analyte	MCL	RBC	Units				
Diesel-Range Organics	--	--	mg/L	0.19	0.22	0.28	0.66
Gasoline-Range Organics	--	--	mg/L	ND(0.05)	0.21	0.26	2.4
Volatile Organic Compounds							
1,2,4-Trimethylbenzene	--	3[a]	μg/L	<	<	<	91 FC,J
1,3,5-Trimethylbenzene	--	2.4[a]	μg/L	<	<	<	57 FC,J
Benzene	5	0.36[b]	μg/L	ND(1)	5.9	7.5	ND(1)
Tetrachloroethene (PCE)	5	1.1[b]	μg/L	<	2.6	51 FC	<
Trichloroethene (TCE)	5	1.6[b]	μg/L	<	3.6	3.8	<

< Analyte was detected at a concentration less than the ARAR, or was not detected (associated method reporting limit less than the ARAR)
-- Applicable regulatory criteria not available
ARAR Applicable or relevant and appropriate requirement
MCL Maximum contaminant level
μg/L Micrograms per liter
mg/L Milligrams per liter
ND Not detected at or above the method reporting limit listed in parentheses
RBC Risk-based concentration

a. Hazard quotient is equal to 1 (U.S. Environmental Protection Agency [EPA] Region 3,1994).
b. RBC is 10^{-6} (EPA Region 3, 1994).

Project Laboratory Qualifiers

FC Compound quantitated at 10x dilution.
J Value is estimated.

These contaminants may have originated from a common source in the vicinity of Groundwater Probe P05 and the gate where the railroad spur enters the DRMO yard. Samples in which TCE was detected also contained PCE at concentrations an order of magnitude greater. HLA believes that TCE detected in groundwater in Sub-area DRMO4 is a chemical and biological degradation product of the PCE detected. Benzene, PCE, and TCE were not detected in Groundwater Probes P63 through P67, which are located approximately 125 feet upgradient (south). Benzene, PCE, and TCE were not detected in soil samples collected from adjacent Borings AP-6733 through AP-6736. Soil samples were not collected in the immediate vicinity of Groundwater Probe P05. Groundwater contaminants in Sub-area DRMO4 may have resulted from miscellaneous releases associated with the railroad spur. Isoconcentration contours for PCE and benzene in groundwater at the DRMO yard source area are presented on Figures 8-8 and 8-17, respectively.

8.6.1.5 Sub-Area DRMO5

Eleven of the initial 60 soil borings and 12 of the initial 60 groundwater probes installed during the RI are located within this area. Based on quick-turnaround analytical results, six additional soil borings (AP-6793 through AP-6798) were drilled in the vicinity of Monitoring Well AP-6806 to further assess the extent of contamination in this area. COCs detected in soil and groundwater at Sub-area DRMO5 are presented in Tables 8-15 and 8-16 and on Figures 8-18 and 8-19. The extent of contamination in Sub-area DRMO5 is described in the following section.

Nature and Extent of Contamination in Sub-Area DRMO5

Contaminants in Soil

DRO and GRO were detected in soil from the western and eastern portions of Sub-area DRMO5 at concentrations that exceeded potential chemical-specific ARARs. Relatively high concentrations of petroleum hydrocarbons were detected in soil in the vicinity of Monitoring Well AP-6806. DRO was detected at a concentration of 2,500 mg/kg in surface soil from Monitoring Well AP-6806. Soil samples collected from 3 feet below ground surface in surrounding Borings AP-6796, AP-6797, and AP-6798 contained DRO at concentrations of 12 mg/kg, 14 mg/kg, and 81 mg/kg, respectively (surface-soil samples were not collected from these borings). Samples collected from 6 feet below ground surface in Borings AP-6796, AP-6797, AP-6798, and AP-6806 contained DRO ranging in concentrations from 1,100 mg/kg to 7,300 mg/kg. GRO was detected in Borings AP-6796, AP-6797, AP-6798, and AP-6806 at concentrations ranging from not detected to 57 mg/kg. Based on a review of chromatograms associated with the sample results, the GRO detected in samples likely corresponds to light-end hydrocarbons associated with the detected DRO, not to a separate petroleum source. Typical chromatograms for DRO and GRO samples are included for comparison purposes in Appendix K.

DRO and GRO were not detected in subsurface-soil samples collected from Borings AP-6770, AP-6794, and AP-6795. The extent of contamination in the vicinity of Monitoring Well AP-6806 suggests a surface or near-surface release of petroleum hydrocarbons.

During the 1994 OU 2 field investigation, PCBs were detected in surface soil at scattered locations throughout Sub-area DRMO5. Dieldrin was detected at a concentration of 1,000 µg/kg at a depth of 2 feet in Boring AP-6794. Aroclor 1260 was detected at concentrations ranging from 130 mg/kg in Boring AP-6753 to 810 mg/kg in Boring AP-6769. In August 1995, HLA collected additional surface-soil samples to further estimate the extent of dieldrin in the vicinity of Boring AP-6794. Five samples (including one QC duplicate) were collected from locations 5 feet north, south, east, and west of Boring AP-6794. The concentrations of dieldrin in these samples ranged from not detected to 22.7 μg/kg and did not exceed the 10^{-6} RBC of 40 μg/kg.

Table 8-15. Chemicals of Concern Detected in Soil That Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO5

			Boring Location	AP-6744	AP-6744	AP-6746	AP-6746	AP-6747	AP-6747
			Sample Number	94FW1117SL	94FW1118SL	94FW1090SL	94FW1092SL	94FW1063SL	94FW1064SL
			Depth (feet)	0 - 2	2 - 4	0 - 2	5 - 7	0 - 2	2 - 4
			Date Sampled	8/6/94	8/6/94	8/4/94	8/4/94	8/2/94	8/2/94
Analyte	Cleanup Level[a]	RBC	Units						
PCBs/OCPs									
Aroclor 1260	--	83[b]	µg/kg	<	ND(220)	ND(160)	ND(210)	ND(180)	ND(200)
Metals									
Arsenic	--	23[c]	mg/kg	<	<	<	<	<	<
Lead	--	0.0078[c]	mg/kg	27.8	15.1	31.7	8.1	104	32.2
Manganese	--	390[c]	mg/kg	<	425	<	396 J	<	<

			Boring Location	AP-6747	AP-6750	AP-6751	AP-6753	AP-6754	AP-6755
			Sample Number	94FW1065SL	94FW1001SL	94FW1019SL	94FW1050SL	94FW1069SL	94FW1087SL
			Depth (feet)	5 - 7	0 - 1.5	2 - 4	0 - 4	5 - 7	0 - 4
			Associated Quality Control Duplicate Sample				94FW1048SL		94FW1085SL
			Date Sampled	8/2/94	7/23/94	7/26/94	7/30/94	8/2/94	8/3/94
Analyte	Cleanup Level[a]	RBC	Units						
PCBs/OCPs									
Aroclor 1260	--	83[b]	µg/kg	ND(170)	ND(170)	ND(200)	130	ND(190)	ND(180) J
Metals									
Arsenic	--	23[c]	mg/kg	<	72.4	<	<	<	<
Lead	--	0.0078[c]	mg/kg	6.8	21.8	11.1	11	7.8	12.5 J
Manganese	--	390[c]	mg/kg	625 J	<	429	<	508 J	424

Table 8-15. Chemicals of Concern Detected in Soil That Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO5 (continued)

			Boring Location	AP-6766	AP-6767	AP-6767	AP-6767	AP-6768	AP-6768
			Sample Number	94FW1083SL	94FW1075SL	94FW1076SL	94FW1079SL	94FW1073SL	94FW1074SL
			Depth (feet)	5 - 7	0 - 2	2 - 6	6 - 8	5 - 7	10 - 12
			Associated Quality Control Duplicate Sample			94FW1078SL			
			Date Sampled	8/3/94	8/3/94	8/3/94	8/3/94	8/2/94	8/2/94
Analyte	Cleanup Level[a]	RBC	Units						
Diesel-Range Organics	100,000	--	µg/kg	<	<	<	110,000	480,000 J	510,000 J
Gasoline-Range Organics	50	--	mg/kg	<	<	<	<	<	270
PCBs/OCPs									
Aroclor 1260	--	83[b]	µg/kg	ND(170) J	ND(180) J	ND(170) J	ND(170) J	ND(160)	ND(200)
Metals									
Lead	--	0.0078[c]	mg/kg	5.1 J	33 J	8.9 J	3.9 J	7	5.5
Manganese	--	390[c]	mg/kg	1,360	<	1,050	<	<	<

			Boring Location	AP-6769	AP-6769	AP-6771	AP-6771	AP-6771	AP-6771
			Sample Number	94FW1044SL	94FW1045SL	94FW1007SL	94FW1008SL	94FW1010SL	94FW1011SL
			Depth (feet)	0 - 2	2 - 4	2 - 4	5 - 9	5 - 9	10 - 12
			Associated Quality Control Duplicate Sample				94FW1010SL	94FW1008SL	
			Date Sampled	7/29/94	7/29/94	7/25/94	7/25/94	7/25/94	7/25/94
Analyte	Cleanup Level[a]	RBC	Units						
Diesel-Range Organics	100,000	--	µg/kg	<	<	<	1,000,000 J	1,200,000 J	400,000 J
Gasoline-Range Organics	50	--	mg/kg	<	<	<	<	<	114
PCBs/OCPs									
Aroclor 1260	--	83[b]	µg/kg	810	590	ND(180)	ND(160)	ND(160)	ND(200)
Metals									
Lead	--	0.0078[c]	mg/kg	20.2	20	7.4 J	4.3 J	4.6 J	<
Manganese	--	390[c]	mg/kg	<	<	412	<	<	<

Table 8-15. Chemicals of Concern Detected in Soil That Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO5 (continued)

			Sample Location	AP-6793	AP-6794	AP-6794	AP-6795	AP-6796	AP-6796
			Sample Number	94FW1333SL	94FW1336SL	94FW1338SL	94FW1341SL	94FW1348SL	94FW1349SL
			Depth (feet)	2 - 4	0 - 4	0 - 4	0 - 2	5 - 7	10 - 12
			Associated Quality Control Duplicate Sample		94FW1338SL	94FW1336SL			
			Date Sampled	9/15/94	9/15/94	9/15/94	9/15/94	9/16/94	9/16/94
Analyte	Cleanup Level[a]	RBC	Units						
Diesel-Range Organics	100	--	mg/kg	<	120	<	190	7,300	2,100
Gasoline-Range Organics	50	--	mg/kg	<	<	<	<	57	<
PCBs/OCPs									
Dieldrin	--	40[b]	µg/kg	<	1,000[d]	890[d]	<	<	<
Metals									
Lead	--	0.0078[c]	mg/kg	130	34	36	13	3.5	2.7

			Sample Location	AP-6797	AP-6798	AP-6806	AP-6806	AP-6806	AP-6806
			Sample Number	94FW1351SL	94FW1354SL	94FW1323SL	94FW1325SL	94FW1326SL	94FW1327SL
			Depth (feet)	5 - 7	5 - 7	0 - 4	0 - 4	5 - 7	10 - 12
			Associated Quality Control Duplicate Sample			94FW1325SL	94FW1323SL		
			Date Sampled	9/16/94	9/16/94	9/13/94	9/13/94	9/13/94	9/13/94
Analyte	Cleanup Level[a]	RBC	Units						
Diesel-Range Organics	100	--	mg/kg	1,500	1,100	2,500	1,600	3,400	1,900
Gasoline-Range Organics	50	--	mg/kg	<	<	<	<	<	<
PCBs/OCPs									
Dieldrin	--	40[b]	µg/kg	<	<	<	<	<	<
Metals									
Lead	--	0.0078[c]	mg/kg	2.8	4.8	18	21	5.3	4.1

<	Analyte was detected at a concentration less than the ARAR, or was not detected (associated method reporting limit less than the ARAR)
--	Applicable regulatory criteria not available
ARAR	Applicable or relevant and appropriate requirement
µg/kg	Micrograms per kilogram
mg/kg	Milligrams per kilogram
ND	Not detected at or above the method reporting limit listed in parentheses
PCBs/OCPs	Polychlorinated biphenyls and organochlorine pesticides
RBC	Risk-based concentration

a. Alaska Department of Environmental Conservation, 1991, and Title 18, Alaska Administrative Code, Chapter 78, Underground Storage Tanks, as amended through August 21, 1991.
b. RBC is 10^{-6} (U.S. Environmental Protection Agency [EPA] Region 3, 1994).
c. Hazard quotient is equal to 1 (EPA Region 3, 1994).
d. Area resampled. See Section 8.6.1.5.

Project Laboratory Qualifiers

J Value is estimated.

Table 8-16. Chemicals of Concern Detected in Water That Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO5

			Probe Location	P15	P17	P18	P19	P20	P21	P22
			Sample Number	94FW1043WA	94FW1028WA	94FW1013WA	94FW1123WA	94FW01001WA	94FW0134WA	94FW1010WA
			Associated Quality Control Duplicate Sample							
			Date Sampled	7/28/94	7/26/94	7/23/94	8/27/94	7/21/94	7/27/94	7/22/94
Analyte	MCL	RBC	Units							
Diesel-Range Organics	--	--	mg/L	1.3	0.25	ND(0.1)	0.19	0.2	0.22	13
Gasoline-Range Organics	--	--	mg/L	0.12	0.28	0.11	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.5)
Volatile Organic Compounds										
1,2,4-Trimethylbenzene	--	3[a]	µg/L	8.6	<	<	<	<	<	<
1,3,5-Trimethylbenzene	--	2.4[a]	µg/L	<	<	<	<	<	<	<
1,4-Dichlorobenzene	--	0.44[b]	µg/L	12	ND(1)	ND(1)	<	ND(1)	ND(1)	ND(1)
Benzene	5	0.36[b]	µg/L	ND(1)	4.4	1.4	<	ND(1)	ND(1)	ND(1)
Chloroform	100	0.15[b]	µg/L	ND(1)	ND(1)	ND(1)	<	ND(1)	ND(1)	ND(1)
Tetrachloroethene (PCE)	5	1.1[b]	µg/L	<	6.5*	2.2	<	<	<	<
Trichloroethene (TCE)	5	1.6[b]	µg/L	3.3	4.9	<	<	<	<	<
Semivolatile Organic Compounds			µg/L							
1,4-Dichlorobenzene	--	0.44[b]	µg/L	6 J	ND(10)	ND(10)	<	ND(10)	ND(10)	ND(10)
Metals										
Arsenic (Dissolved)	--	0.000038[b]	mg/L	0.009	0.012	0.01	<	ND(0.005)	0.013	0.01
Arsenic (Total)	--	0.000038[b]	mg/L	0.01	0.011	0.009	<	ND(0.005)	0.015	0.012
Lead (Dissolved)	--	0.0000037[a]	mg/L	ND(0.002)	ND(0.002)	ND(0.002)	<	ND(0.002)	ND(0.002)	ND(0.002)
Lead (Total)	--	0.0000037[a]	mg/L	ND(0.002)	ND(0.002)	ND(0.002)	<	0.002	0.014	ND(0.002)
Manganese (Dissolved)	--	0.18[a]	mg/L	1.6	1	2.4	<	<	0.89	3.1
Manganese (Total)	--	0.18[a]	mg/L	1.6	1	2.4	<	<	1	3.1

Table 8-16. Chemicals of Concern Detected in Water That Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO5 (continued)

			Probe Location	P23	P23	P24	P37	P38	P39	P41	PSLOUGH1	PSLOUGH2
			Sample Number	94FW115WA	94FW116WA	94FW1027WA	94FW1024WA	94FW1018WA	94FW1009WA	94FW0135WA	94FW10085WA	94FW10086WA
			Associated Quality Control Duplicate Sample	94FW116WA	94FW115WA							
			Date Sampled	7/25/94	7/25/94	7/26/94	7/26/94	7/25/94	7/22/94	7/27/94	8/4/94	8/4/94
Analyte	MCL	RBC	Units									
Diesel-Range Organics	--	--	mg/L	1.4	1.4	0.7	0.44	0.28	13	0.14	ND(0.1)	ND(0.1)
Gasoline-Range Organics	--	--	mg/L	ND(0.05)	ND(0.05)	0.07	ND(0.05)	ND(0.05)	0.18	ND(0.05)	ND(0.05)	ND(0.05)
Volatile Organic Compounds												
1,2,4-Trimethylbenzene	--	3[a]	µg/L	<	<	<	<	<	<	<	<	<
1,3,5-Trimethylbenzene	--	2.4[a]	µg/L	<	<	<	<	<	4.4	<	<	<
1,4-Dichlorobenzene	--	0.44[b]	µg/L	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
Benzene	5	0.36[b]	µg/L	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
Chloroform	100	0.15[b]	µg/L	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	2.1	2.9
Tetrachloroethene (PCE)	5	1.1[b]	µg/L	<	<	<	<	<	<	<	<	<
Trichloroethene (TCE)	5	1.6[b]	µg/L	<	<	<	<	<	<	<	<	<
Semivolatile Organic Compounds												
1,4-Dichlorobenzene	--	0.44[b]	µg/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
Metals												
Arsenic (Dissolved)	--	0.000038[b]	mg/L	0.017	0.017 RQ	0.011	0.007	ND(0.005)	0.039	0.01	ND(0.005)	ND(0.005)
Arsenic (Total)	--	0.000038[b]	mg/L	0.017	0.017 RQ	0.011	0.007	ND(0.005)	0.043	0.01	ND(0.005)	ND(0.005)
Lead (Dissolved)	--	0.0000037[a]	mg/L	ND(0.002)	0.005 RQ	ND(0.002)	ND(0.002)	ND(0.002)	ND(0.002)	ND(0.002)	ND(0.002)	ND(0.002)
Lead (Total)	--	0.0000037[a]	mg/L	ND(0.002)	ND(0.002) RQ	ND(0.002)	ND(0.002)	ND(0.002)	0.006	ND(0.002)	ND(0.002)	ND(0.002)
Manganese (Dissolved)	--	0.18[a]	mg/L	1.6	1.6 RQ	1.2	0.5	<	3.9	1.3	<	<
Manganese (Total)	--	0.18[a]	mg/L	1.6	1.6 RQ	1.2	0.5	<	4	1.4	<	<

Table 8-16. Chemicals of Concern Detected in Water That Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO5 (continued)

			Well Location	AP-5823	AP-6806	AP-6806
			Sample Number	94FW1151WA	94FW1183WA	94FW1185WA
			Associated Quality Control Duplicate Sample		94FW1185WA	94FW1183WA
			Date Sampled	9/12/94	9/22/94	9/22/94
Analyte	Maximum Contaminant Level	Risk-Based Concentration	Units			
Diesel-Range Organics	--	--	mg/L	0.48 J	4.2	3.9
Gasoline-Range Organics	--	--	mg/L	ND(0.05)	0.17 J	0.23
Volatile Organic Compounds						
1,2,4-Trimethylbenzene	--	3[a]	µg/L	<	22	26
1,3,5-Trimethylbenzene	--	2.4[a]	µg/L	<	5.8	7.8
Metals						
Manganese (Dissolved)	--	0.18[a]	mg/L	1	2.5	2.5
Manganese (Total)	--	0.18[a]	mg/L	0.93	2.5	2.4

< Analyte was detected at a concentration or was not detected at a method reporting limit less than the ARAR
-- Applicable regulatory criteria not available
ARAR Applicable or relevant and appropriate requirement
MCL Maximum contaminant level
mg/L Milligrams per liter
ND Not detected at or above the method reporting limit listed in parentheses
RBC Risk-based concentration
µg/L Micrograms per liter

* The contaminant associated with the tetrachloroethene (PCE) plume is addressed in section 8.6.1.4.
a. Hazard quotient is equal to 1 (U.S. Environmental Protection Agency [EPA] Region 3,1994).
b. RBC is 10^{-6} (EPA Region 3, 1994).

Project Laboratory Qualifiers

J Value is estimated.
RQ Qualified until replaced with other data.

In the eastern portion of the sub-area, subsurface soil collected from depths greater than 7 feet in Boring AP-6768 contained DRO and GRO at concentrations that exceeded potential chemical-specific ARARs. DRO was detected in Boring AP-6768 at concentrations ranging from 13 mg/kg at the surface to 510 mg/kg at a depth of 11 feet. GRO was detected in Boring AP-6768 at concentrations of 8.9 mg/kg at 6 feet below ground surface and 270 mg/kg at 11 feet below ground surface. DRO and GRO were detected at relatively low concentrations ranging from not detected to 21 mg/kg in borings located east, south, and west of Boring AP-6768. Samples were not collected from north of Boring AP-6768. The source of contamination at Boring AP-6768 has not been identified. Similar to GRO detected in the western portion of Sub-area DRMO5, GRO detected in samples from the eastern portion of the sub-area is believed to correspond to light-end hydrocarbons associated with the detected DRO, not to a separate petroleum source. Previous drum storage in the area suggests that subsurface-soil contamination may be the result of contaminant migration from a surface release of petroleum hydrocarbons. However, DRO was not detected in surface soil above potential ARARs. High concentrations of hydrocarbons several feet below the water table, and relatively low to nondetected concentrations in surface and near-surface soil suggest a subsurface release of petroleum hydrocarbons occurred (i.e., from a UST or fuel line) in the immediate vicinity of Boring AP-6768. No other analytes were detected in this area at concentrations that exceeded established ARARs. Subsurface-soil profiles showing sampling locations and DRO results are presented on Figures 8-20 and 8-21.

Contaminants in Groundwater

Petroleum hydrocarbons are present in groundwater throughout most of Sub-area DRMO5, likely due to petroleum hydrocarbons in soil. DRO was detected in Groundwater Probes P01, P23, P40, P42, P43, and AP-6806 at concentrations ranging from 1.4 to 4.2 μg/L. DRO was detected at 13 μg/L in Groundwater Probes P22 and P39. Petroleum hydrocarbons were not detected in Groundwater Probes PSLOUGH1 and PSLOUGH2, which are located on the west side of Channel B. GRO was detected in Groundwater Probes P21, P39, and AP-6806 at concentrations of 0.08 μg/L, 0.18 μg/L, and 0.17 μg/L, respectively. As with petroleum hydrocarbons detected in soil, the GRO fraction appears to be associated with DRO detected. Petroleum-related VOCs 1,2,4-trimethylbenzene and 1,3,5-trimethylbenzene were detected in Monitoring Well AP-6806 at concentrations of 26 μg/L and 7.8 μg/L, respectively. The lateral extent of DRO in groundwater is shown on Figure 8-6.

8.6.1.6 Sub-Area DRMO6

Surface-water and sediment samples were collected from Channel B (Locations 001, 002, and 003), the drainage ditch adjacent to Badger Road (Locations 006, 007, and 008), and the drainage channel north of the DRMO yard (Locations 004 and 005). Sample locations are shown on Figure 8-1. Chemicals detected in surface water and sediment are presented in Tables 8-17 and 8-18, respectively, and on Figure 8-22. Chemical-specific ARARs have not been identified for surface-water and sediment samples.

The upgradient surface-water samples collected from Channel B contained DRO at concentrations of 62 µg/L. DRO in downgradient surface-water samples was not detected. Sediment samples collected from Channel B contained DRO at concentrations of 68 mg/kg (upgradient location), 67 mg/kg (location adjacent to the DRMO yard), and 94 mg/kg (downgradient location). Sediment samples collected from the drainages east and north of the DRMO yard source area contained DRO (63 to 1,000 mg/kg), Aroclor 1260 (7 mg/kg to 60 mg/kg), and dioxins/furans (0.0043 to 71.98 picograms per gram [pg/g] based on 2,3,7,8-TCDD toxicity equivalency [TEQ]). Badger Road in the vicinity of the Old Richardson Highway was reconstructed during September and October 1994. Large volumes of soil were excavated during this reconstruction, and sediment sample locations adjacent to Badger Road may have been disturbed. Migration of DRMO yard source area contaminants to surface water and sediment has not been evaluated.

Table 8-17. Chemicals of Concern Detected in Surface Water at the DRMO Yard Source Area, Sub-Area DRMO 6

Location		001	002	002	003
Sample Number		94FW10001SW	94FW10002SW	94FW10004SW	94FW10005SW
Associated Quality Control Duplicate Sample			94FW10004SW	94FW10002SW	
Date Collected		8/8/94	8/8/94	8/8/94	8/9/94
Analyte	EPA Method				
Diesel-Range Organics	8100M	ND(50) J	ND(50) J	ND(50) J	62 a
Metals					
Barium (Dissolved)	6010A	74	71	72	73
Barium (Total)	6010A	72	74	70	74
Manganese (Dissolved)	6010A	536	479	488	518 J
Manganese (Total)	6010A	532	506	478	520

EPA U.S. Environmental Protection Agency
ND Not detected at or above the method detection limit listed in parentheses

Project Laboratory Qualifiers

a Quantified as diesel. The sample contained components that eluted in the diesel range, but the chromatogram did not match the typical diesel fingerprint.
B Contaminant detected in associated laboratory blank.
J Value is an estimate.

Table 8-18. Chemicals of Concern Detected in Sediment at the DRMO Yard Source Area, Sub-Area DRMO 6

		Location	001	002	002	003	004	005	006	007	008
		Sample Number	94FW10001SD	94FW10002SD	94FW10004SD	94FW10005SD	94FW1009SD	94FW1010SD	94FW10006SD	94FW10007SD	94FW10008SD
		Assoviated QC Duplicate Sample		94FW10004SD	94FW10002SD						
		Date Collected	8/8/94	8/8/94	8/8/94	8/9/94	9/23/94	9/23/94	8/9/94	8/9/94	8/9/94
Analyte	EPA Method	Units									
Diesel Range Organics	8100M	mg/kg	94 a,J	67 a,J	63 a,J	68 b,c	165 a	227 a	850 b,c	1,000 b,c	490 b,c
Polychlorinated Biphenyls											
Aroclor 1260	8080	mg/kg	ND (0.1)	ND (0.1)	ND (0.1)	ND (0.1)	ND (0.1)	ND (0.1)	14 f	60 f	7 g
Metals											
Arsenic	7060	mg/kg	38	36	35	22	8	11	12	19	10
Barium	6010A	mg/kg	387	251	320	225	185	254	172	365	139
Cadmium	6010A	mg/kg	ND (1)	ND (1)	ND (1)	ND (1)	2	ND (1)	2	6	2
Chromium	6010A	mg/kg	31	24	22	18	29	37	29	49	20
Lead	7421	mg/kg	13	10	10	--	--	--	--	--	--
Lead	6010A	mg/kg	--	--	--	10	144	30	1280	1390	198
Manganese	6010A	mg/kg	4,600	3,020	5,140	3,320 J	251 J	492 J	457 J	383 J	426 J
Total Organic Carbon	D4129-82M	Percent	1.2	1	1.58	1.05			1.73	9.35	3.32

-- Not analyzed
ug/kg Micrograms per kilogram
mg/kg Milligrams per kilogram
ND Not detected at or above the method detection limit
QC Quality control

Project Laboratory Qualifiers

a. Quantified as diesel. The samples contained components that eluted in the diesel range, but the chromatogram did not match the typical diesel fingerprint.
b. Quantified as diesel. The samples contained an oil component that partially eluted in the diesel range.
c. Result is from the analysis of a diluted sample, dilution factor: 1:10.
d. Method reporting limits are elevated because of the low percent solids in the samples as received.
e. Sample was analyzed 4 days past the end of the recommended maximum holding time. Initial analysis, performed within the recommended maximum holding time, failed Columbia Analytical Services (CAS) QC criteria; the reanalysis met our QC criteria. It is the opinion of CAS that the quality of the sample data has not been significantly affected.
f. Result is from the analysis of a diluted sample performed on 8/29/94. Dilution factor: 25.
g. Result is from the analysis of a diluted sample performed on 8/29/94. Dilution factor: 10.
B Contaminant detected in associated laboratory blank.
J Value is an estimate.

8.6.1.7 DRMO Yard Source Area Dioxins/Furans

A fire burn pit previously located in the west-central portion of the DRMO yard source area (Figure 1-3) was identified as a potential source of dioxins/furans (HLA, 1993a). During the OU 2 RI, HLA conducted a geophysical investigation at the suspected location of the fire burn pit in an attempt to define the pit's boundaries (section 3-4). The results of the investigation were inconclusive (Appendix E). Soil and water samples collected throughout the DRMO yard source area during the RI contained low concentrations of dioxins/furans at scattered locations. The soil results suggest that 1) over time surface soil from the previous fire burn pit was distributed randomly throughout the DRMO yard via daily operating activities (e.g., plowing, regrading, moving large piles of debris, etc.), or 2) low concentrations of dioxins/furans were detected throughout the source area. The source of dioxin in groundwater has not been identified. Dioxins/furans (2,3,7,8-TCDD TEQs) detected in sediment, soil, and groundwater at concentrations that exceed potential ARARs are presented in Tables 8-19 through 8-21, respectively.

8.6.2 Chemicals Detected in Samples Collected at the Building 1168 Source Area

The chemicals detected in soil at the Building 1168 source area did not exceed potential chemical-specific ARARs. COCs detected in groundwater at the background location (AP-6808), the CRREL groundwater flow well location (AP-6809), and existing monitoring wells are presented in Table 8-22 and on Figure 8-23.

Figure 8-24 illustrates groundwater sampling points and associated benzene concentrations in groundwater (HLA, 1994). Benzene isocontours for groundwater are not shown on Figure 8-24. HLA attempted to model the extent of benzene in groundwater at the Building 1168 source area and, based on site experience, obtained unrealistic isocontour plots. This is attributable to benzene concentrations below detection limits in samples collected from Microwell PS02 and Monitoring Well AP-6332, which are in the zone of relatively high concentrations of groundwater contaminants. Benzene was not detected at these locations because of sample dilution and elevated MRLs.

8.6.3 North Post Source Area

The North Post source area was divided into the following sub-areas:

- Sub-area NP1, which includes Site 2 and the former burn pit;
- Sub-area NP2, which includes Site 4;
- Sub-area NP3, which includes the concrete foundations from the former experimental laboratory located south of Sub-areas NP1 and NP2;
- Sub-area NP4, which includes surface-water and sediment sample locations.

Sub-areas NP1 through NP3, surface-water, and sediment sample locations (NP4) are shown on Figure 8-25. A description of the nature and extent of contamination detected in each of the North Post sub-areas is presented in the following sections.

8.6.3.1 Sub-Area NP1

Initial sampling locations in Sub-area NP1 included four soil borings (AP-6810, AP-6814, AP-6815, and AP-6816), three groundwater monitoring wells (Borings AP-6814 through AP-6816 were completed as monitoring wells), three groundwater probes (P06, P07, and P12), and five surface locations (001 through 005). Based on quick-turnaround laboratory analytical results, 3 soil borings (AP-6811, AP-6812, and AP-6813) were drilled and 20 surface locations (006 through 025) were sampled to further assess the extent of contamination. The extent of contamination in Sub-area NP1 is described in the following section.

Table 8-19. DRMO Yard Source Area Sediment Samples with Dioxins/Furans in Picograms per Gram

Sample Number	94FW10001SD	94FW10002SD	94FW10004SD	94FW10005SD	94FW10006SD	94FW10007SD	94FW10008SD	94FW1009SD	94FW1010SD
Location	001	002	002	003	006	007	008	004	005
Duplicate Sample		94FW10004SD	94FW10002SD						
Analyte									
2,3,7,8-TCDD TEQ	0.0558	0.0451	0.0043	0.3034	71.98	129.28	14.952	0.2983	0.5684

DRMO Defense reutilization and marketing office
2,3,7,8-TCDD TEQ 2,3,7,8-Tetrachlorodibenzo-p-dioxin toxicity equivalent

Table 8-20. DRMO Yard Source Area Soil Samples with Dioxins/Furans in Picograms per Gram Exceeding EPA Region 3 RBCs

Sample Number	Location	Depth (feet)	Sample Type	Analyte	Concentration	Qualifier	RBC
94FW10007SS	005	NA	PR	2,3,7,8-TCDD TEQ	17.491393	B	4.1
94FW1098SL	AP-6734	1	PR	2,3,7,8-TCDD TEQ	97.356		4.1
94FW1099SL	AP-6734	3	PR	2,3,7,8-TCDD TEQ	5.4244		4.1
94FW1133SL	AP-6765	6	PR	2,3,7,8-TCDD TEQ	15.8564		4.1
94FW1135SL	AP-6772	1	PR	2,3,7,8-TCDD TEQ	5.9747	B	4.1
94FW1204SL	AP-6788	11	PR	2,3,7,8-TCDD TEQ	17.2987		4.1

2,3,7,8-TCDD TEQ	2,3,7,8-Tetrachlorodibenzo-p-dioxin toxicity equivalent
DRMO	Defense reutilization marketing office
EPA	U.S. Environmental Protection Agency
NA	Not applicable
PR	Project
RBC	Risk-based concentration

Project Laboratory Qualifier

B Contaminant detected in associated laboratory blank.

Table 8-21. DRMO Yard Source Area Groundwater Samples with Dioxins/Furans in Picograms per Liter Exceeding EPA Region 3 RBCs

Sample Number	Location	Sample Type	Analyte	Concentration	Qualifier	RBC
94FW01002WA	P01	PR	2,3,7,8-TCDD TEQ	0.5045		0.43
94FW1005WA	P41	PR	2,3,7,8-TCDD TEQ	0.7488	B	0.43
94FW1006WA	P60	PR	2,3,7,8-TCDD TEQ	0.493	B	0.43
94FW1007WA	P59	PR	2,3,7,8-TCDD TEQ	0.57	B	0.43
94FW1008WA	P42	PR	2,3,7,8-TCDD TEQ	0.63	B	0.43
94FW1009WA	P39	PR	2,3,7,8-TCDD TEQ	0.83	B	0.43
94FW1010WA	P22	PR	2,3,7,8-TCDD TEQ	0.66	B	0.43
94FW1013WA	P18	PR	2,3,7,8-TCDD TEQ	0.46	B	0.43
94FW1018WA	P38	PR	2,3,7,8-TCDD TEQ	0.9875	B	0.43
94FW1025WA	P57	PR	2,3,7,8-TCDD TEQ	0.53		0.43
94FW0132WA	P04	PR	2,3,7,8-TCDD TEQ	0.5	B	0.43
94FW0133WA	P05	PR	2,3,7,8-TCDD TEQ	1.3223	B	0.43
94FW0134WA	P16	PR	2,3,7,8-TCDD TEQ	0.51	B	0.43
94FW0135WA	P25	PR	2,3,7,8-TCDD TEQ	8.6588	B	0.43
94FW1039WA	P56	PR	2,3,7,8-TCDD TEQ	0.46	B	0.43
94FW1041WA	P55	QC	2,3,7,8-TCDD TEQ	0.5937	B	0.43
94FW1043WA	P15	PR	2,3,7,8-TCDD TEQ	3.64	B	0.43
94FW1046WA	P07	PR	2,3,7,8-TCDD TEQ	0.5366	B	0.43
94FW1055WA	P13	PR	2,3,7,8-TCDD TEQ	0.47		0.43
94FW1060WA	P53	QC	2,3,7,8-TCDD TEQ	0.726	B	0.43
94FW1061WA	P52	PR	2,3,7,8-TCDD TEQ	0.43		0.43
94FW1062WA	P49	PR	2,3,7,8-TCDD TEQ	5.7		0.43
94FW1069WA	P12	PR	2,3,7,8-TCDD TEQ	1.224		0.43
94FW10082WA	P51	PR	2,3,7,8-TCDD TEQ	0.46		0.43
94FW10084WA	P51	QC	2,3,7,8-TCDD TEQ	2.8779		0.43
94FW10086WA	PSLOUGH2	PR	2,3,7,8-TCDD TEQ	0.44		0.43
94FW1152WA	AP-5825	PR	2,3,7,8-TCDD TEQ	0.48	B	0.43
94FW1156WA	AP-5826	PR	2,3,7,8-TCDD TEQ	0.44	B	0.43
94FW1160WA	AP-5765	PR	2,3,7,8-TCDD TEQ	8.4183	B	0.43
94FW1169WA	AP-6803	PR	2,3,7,8-TCDD TEQ	1.2352	B	0.43
94FW1174WA	AP-6799	PR	2,3,7,8-TCDD TEQ	1.3777	B	0.43
94FW1185WA	AP-6806	QC	2,3,7,8-TCDD TEQ	3.7207	B	0.43
94FW1188WA	AP-6802	PR	2,3,7,8-TCDD TEQ	0.4485	B	0.43

2,3,7,8-TCDD TEQ	2,3,7,8-Tetrachlorodibenzo-p-dioxin toxicity equivalent
DRMO	Defense reutilization marketing office
EPA	U.S. Environmental Protection Agency
PR	Project
QC	Quality control sample
RBC	Risk-based concentration

Project Laboratory Qualifier

B Contaminant detected in associated laboratory blank.

Table 8-22. Chemicals of Concern Detected in Water That Exceed Potential ARARs for the Building 1168 Source Area

			Well Location	AP-5747	AP-5747	AP-5751	AP-5752	AP-5754	AP-5781	AP-6332	AP-6333	AP-6334
			Sample Number	94FW2005WA	94FW2007WA	94FW2015WA	94FW2002WA	94FW2024WA	94FW2001WA	94FW2004WA	94FW2008WA	94FW2009WA
			Associated QC Duplicate Sample	94FW2007WA	94FW2005WA							
			Date Sampled	8/30/94	8/30/94	8/31/94	8/29/94	9/1/94	8/29/94	8/30/94	8/30/94	8/30/94
Analyte	MCL	RBC	Units									
Diesel-Range Organics	--	--	mg/L	0.19	0.5	34	2.1	0.15	0.087	0.14	0.077	0.23
Gasoline-Range Organics	--	--	mg/L	1.8	1.8	18	1.8	0.015	<	0.21	<	0.011
Volatile Organic Compounds												
1,2,4-Trimethylbenzene	--	3[a]	µg/L	75	69	350	49	<	<	<	<	<
1,3,5-Trimethylbenzene	--	2.4[a]	µg/L	21	18	150	31	<	<	<	<	<
Benzene	5	0.36[a]	µg/L	<	<	<	5.1	<	<	<	<	<
Toluene	1,000	750[a]	µg/L	<	<	770	<	<	<	<	<	<
Trichloroethene (TCE)	5	1.6[b]	µg/L	<	<	23	<	<	<	<	<	<
Metals												
Manganese (Dissolved)	--	180[a]	µg/L	840	860	4,400	2,300	<	<	750	240	1,300
Manganese (Total)	--	180[a]	µg/L	800	800	4,400	2,000	260	<	750	240	1,300

< Analyte was detected at a concentration less than the ARAR, or was not detected (associated method reporting limit less than the ARAR)
-- Applicable regulatory criteria not available
ARAR Applicable or relevant and appropriate requirement
MCL Maximum contaminant level
µg/L Micrograms per liter
mg/L Milligrams per liter
RBC Risk-based concentration

a. Hazard quotient is equal to 1 (U.S. Environmental Protection Agency [EPA] Region 3,1994).
b. RBC is 10^{-6} (EPA Region 3, 1994).

Nature and Extent of Contamination in Sub-Area NP1

Contamination in Soil

Manganese, dioxins/furans, and several polynuclear aromatic hydrocarbons (PAHs), including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene, were detected in surface soil at concentrations that exceeded potential chemical-specific ARARs. PAHs were detected in 18 of 25 surface-soil grab samples (0- to 6-inch depth) and surface-soil samples (0- to 2-foot depth) collected from Borings AP-6810 and AP-6814 at concentrations ranging from 150 to 33,800 µg/kg. DRO was detected in 14 of the 25 surface-soil grab samples at concentrations ranging from 100 to 3,600 mg/kg, and in Boring AP-6814 (0- to 2-foot depth) at a concentration of 138 mg/kg. Concentrations of 2,3,7,8-TCDD TEQ above potential ARARs were found at Locations 016 and 017 at 12.54 and 14.88 pg/g, respectively. The estimated lateral extent of PAHs in surface soil is presented on Figure 8-26. Analytes were not detected in subsurface soil (soil deeper than 2 feet) at concentrations that exceeded potential chemical-specific ARARs. Table 8-23 and Figure 8-27 present analytes detected in soil that exceed potential ARARs.

Contamination in Groundwater

Dioxins and furans were detected in one groundwater sample collected during the 1994 RI. The 2,3,7,8-TCDD TEQ concentration in Monitoring Well AP-6814 of 74.49 pg/L exceeded the 10^{-6} RBC of 0.43 pg/L. The 2,3,7,8-TCDD TEQ concentration in Monitoring Wells AP-6815 and AP-6816 did not exceed the potential ARAR. DRO was detected in Groundwater Probes P06 and P09 at concentrations of 130 and 120 µg/L, respectively. On September 6, 1995, HLA resampled Monitoring Wells AP-6814, AP-6815, and AP-6816, collecting filtered and non-filtered groundwater samples for dioxin/furan analysis. The 2,3,7,8-TCDD TEQ concentrations in these samples ranged from 0.01 to 1.06 pg/L (parts per quadrillion). However, dioxin/furan congeners were detected in project samples and associated laboratory blanks at approximately the same concentrations; in several instances, the concentration of a congener detected in a project sample was lower than the concentration detected in the associated laboratory blank. The concentrations of dioxins/furans detected in project samples did not exceed 5 times the concentrations detected in associated blanks. Therefore, dioxin/furans detected in groundwater samples collected at Sub-area NP1 are attributable to laboratory contamination and not contamination at Sub-area NP1.

8.6.3.2 Sub-Area NP2

Groundwater Probes P01, P03, P04, P05, and P08 were initially located in Sub-area NP2. Based on quick-turnaround laboratory analytical results, two soil borings were drilled and converted to groundwater monitoring wells (AP-6819 and AP-6826), and six groundwater probes (P11 and P13 through P17) were installed to further assess the extent of contamination. The extent of contamination in Sub-area NP2 is described in the following section.

Nature and Extent of Contamination in Sub-Area NP2

Contamination in Soil

Analytes were not detected in surface and subsurface soil at concentrations that exceeded potential chemical-specific ARARs, with the exception of Aroclor 1260. Aroclor 1260 was detected at a concentration of 1,450 µg/kg at a depth of 10 to 12 feet in Boring AP-6820. The source of Aroclor 1260 in this sample is not known.

Contamination in Groundwater

Benzene, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene were detected in groundwater at concentrations that exceeded potential chemical-specific ARARs. DRO was detected in groundwater at concentrations ranging from 100 µg/L to 26,000 µg/L. GRO was detected in groundwater at concentrations ranging from 0.14 to 47 µg/L. Petroleum hydrocarbons detected in Sub-area NP2 groundwater likely resulted from

Table 8-23. Chemicals of Concern Detected in Soil That Exceed Potential ARARs for North Post Source Area Sub-Area NP1

			Surface-Soil Sample Location	001	002	003	004	005	005
			Sample Number	94FW30001SS	94FW30002SS	94FW30003SS	94FW30004SS	94FW30005SS	94FW30007SS
			Associated Quality Control Duplicate Sample					94FW30007SS	94FW30005SS
			Date Sampled	8/10/94	8/10/94	8/10/94	8/10/94	8/10/94	8/10/94
Analyte	Cleanup Levels[a]	RBC	Units						
Diesel-Range Organics	100,000	--	µg/kg	<	280,000 J	<	380,000 J	240,000 J	350,000
Semivolatile Organic Compounds									
Benzo(a)anthracene	--	880[b]	µg/kg	9,700 D,J	4,500 J	1,400 J	<	1,400 J	6,000 J
Benzo(a)pyrene	--	88 b	µg/kg	12,000 D,J	4,300 J	1,800 J	ND(400) J	1,800 J	6,700 J
Benzo(b)fluoranthene	--	880[b]	µg/kg	14,000 D,J	5,700 J	2,300 J	<	2,100 J	8,700 D,J
Benzo(k)fluoranthene	--	8800[b]	µg/kg	<	<	<	<	<	<
Dibenzo(a,h)anthracene	--	88[b]	µg/kg	1,300 J	790 J	270 J	ND(400) J	270 J	1,200 J
Indeno(1,2,3-cd)pyrene	--	880[b]	µg/kg	2,800 J	1,300 J	<	<	<	2,000 J
Metals									
Manganese	--	390[c]	mg/kg	668	510	816	569	437	475
2,3,7,8-TCDD TEQ	--	4.1	pg/g	<	<	<	<	<	<

			Surface-Soil Sample Location	006	007	008	009	010	011
			Sample Number	94FW3008SS	94FW3009SS	94FW3010SS	94FW3011SS	94FW3012SS	94FW3013SS
			Associated Quality Control Duplicate Sample						
			Date Sampled	9/18/94	9/18/94	9/18/94	9/18/94	9/18/94	9/18/94
Analyte	Cleanup Levels[a]	RBC	Units						
Diesel-Range Organics	100,000	--	µg/kg	210,000 J	<	<	430,000 J	3,600,000 J	100,000 J
Semivolatile Organic Compounds									
Benzo(a)anthracene	--	880[b]	µg/kg	<	<	<	20,600 D	7,900 D	<
Benzo(a)pyrene	--	88[b]	µg/kg	ND(390)	270 J	<	24,600 D	9,500 D	ND(400)
Benzo(b)fluoranthene	--	880[b]	µg/kg	<	<	<	27,800 D	9,800 D	<
Benzo(k)fluoranthene	--	8800[b]	µg/kg	<	<	<	14,200 D	<	<
Dibenzo(a,h)anthracene	--	88[b]	µg/kg	ND(390)	<	ND(400)	5,500 D	1,800	ND(400)
Indeno(1,2,3-cd)pyrene	--	880[b]	µg/kg	<	<	<	15,000 D	5,000	<
Metals									
Manganese	--	390[c]	mg/kg	448	502	913	432	469	<
2,3,7,8-TCDD TEQ	--	4.1	pg/g	<	<	<	<	<	<

Table 8-23. Chemicals of Concern Detected in Soil That Exceed Potential ARARs for North Post Source Area Sub-Area NP1 (continued)

Analyte	Cleanup Levels[a]	RBC	Units	012	013	014	015	016	017	017
Surface Soil Sample Location				012	013	014	015	016	017	017
Sample Number				94FW3014SS	94FW3015SS	94FW3016SS	94FW3017SS	94FW3018SS	94FW3019SS	94FW30221SS
Associated Quality Control Duplicate Sample									94FW30221SS	94FW3019SS
Date Sampled				9/18/94	9/18/94	9/18/94	9/18/94	9/18/94	9/18/94	9/18/94
Diesel-Range Organics	100,000	--	µg/kg	130,000 J	<	<	<	1,500,000 J	330,000 J	160,000 J
Semivolatile Organic Compounds										
Benzo(a)anthracene	--	880[b]	µg/kg	2,400	1,000	<	<	32,200 D,R	10,300 D,R	29,500 D
Benzo(a)pyrene	--	88 [b]	µg/kg	2,500	1,200	800	<	31,600 D,R	10,600 D,R	29,400 D
Benzo(b)fluoranthene	--	880[b]	µg/kg	3,900	1,400	880	<	33,800 D,R	12,800 D,R	32,500
Benzo(k)fluoranthene	--	8800[b]	µg/kg	<	<	<	<	19,600 D,R	<	20,600 D
Dibenzo(a,h)anthracene	--	88[b]	µg/kg	430	280 J	150 J	ND(450)	8,500 D,R	2,500 D,R	7,600 D
Indeno(1,2,3-cd)pyrene	--	880[b]	µg/kg	1,100	<	<	<	1,880 D,R	5,800 D,R	18,600 D
Metals										
Manganese	--	390[c]	mg/kg	450	809	474	460	<	445	461
2,3,7,8-TCDD TEQ	--	4.1	pg/g	<	<	<	<	12.54	<	14.88

Analyte	Cleanup Levels[a]	RBC	Units	018	019	020	020	021	022	025
Surface Soil Sample Location				018	019	020	020	021	022	025
Sample Number				94FW3022SS	94FW3023SS	94FW3024SS	94FW3026SS	94FW3027SS	94FW3028SS	94FW3031SS
Associated Quality Control Duplicate Sample						94FW3026SS	94FW3024SS			
Date Sampled				9/18/94	9/18/94	9/18/94	9/18/94	9/18/94	9/18/94	9/18/94
Diesel-Range Organics	100,000	--	µg/kg	480,000 J	1,300,000 J	<	<	<	890,000 J	1,400,000 J
Semivolatile Organic Compounds										
Benzo(a)anthracene	--	880[b]	µg/kg	2,900	<	<	<	<	8,500 D	18,900 D
Benzo(a)pyrene	--	88 [b]	µg/kg	3,600	1,000	ND(470)	160 J	430	10,500 D	21,900 D
Benzo(b)fluoranthene	--	880[b]	µg/kg	6,000	1,300	<	<	<	10,100 D	22,300 D
Benzo(k)fluoranthene	--	8800[b]	µg/kg	<	<	<	<	<	9,800 D	14,800 D
Dibenzo(a,h)anthracene	--	88[b]	µg/kg	820	250 J	ND(470)	ND(470)	<	1,700	5,000
Indeno(1,2,3-cd)pyrene	--	880[b]	µg/kg	1,700	<	<	<	<	4,000	13,300 D
Metals										
Manganese	--	390[c]	mg/kg	NA	NA	NA	NA	<	426	<
2,3,7,8-TCDD TEQ	--	4.1	pg/g	<	<	<	<	<	<	<

Table 8-23. Chemicals of Concern Detected in Soil That Exceed Potential ARARs for North Post Source Area Sub-Area NP1 (continued)

			Boring Location	AP-6814	AP-6810	AP-6811	AP-6813
			Sample Number	94FW3006SL	94FW3001SL	94FW3044SL	94FW3056SL
			Depth (feet)	0-2	0-2	0-4	10-14
			Associated Duplicate Sample			94FW3046SL	94FW3058SL
			Date Sampled	8/18/94	8/18/94	9/17/94	9/17/94
Analyte	Cleanup Levels[a]	Risk-Based Concentration	Units				
Diesel-Range Organics	100	--	mg/kg	138	<	<	<
Semivolatile Organic Compounds							
Benzo(a)anthracene	--	880[b]	µg/kg	2,190	2,470	<	<
Benzo(a)pyrene	--	88[b]	µg/kg	2,420	3,170	ND(349)	ND(348)
Benzo(b)fluoranthene	--	880[b]	µg/kg	2,660	3,290	<	<
Dibenzo(a,h)anthracene	--	88[b]	µg/kg	624	811	ND(349)	ND(348)
Indeno(1,2,3-cd)pyrene	--	880[b]	µg/kg	1,270	1,640	<	<

<	Analyte was detected at a concentration less than the ARAR, or was not detected (associated method reporting limit less than the ARAR)
--	Applicable regulatory criteria not available
ARAR	Applicable or relevant and appropriate requirement
µg/kg	Micrograms per kilogram
mg/kg	Milligrams per kilogram
NA	Not analyzed
ND	Not detected at or above the method reporting limit listed in parentheses
pg/g	Picograms per gram
RBC	Risk-based concentration
2,3,7,8-TCDD TEQ	2,3,7,8-Tetrachlorodibenzo-p-dioxin toxicity equivalent

a. Alaska Department of Environmental Conservation, 1991, and Title 18, Alaska Administrative Code, Chapter 78, Underground Storage Tanks, as amended through August 21, 1991.
b. RBC is 10^{-6} (U.S. Environmental Protection Agency [EPA] Region 3, 1994).
c. Hazard quotient is equal to 1 (EPA Region 3, 1994).

Project Laboratory Qualifiers

D Sample diluted.
J Value is estimated.
R Unacceptable.

petroleum hydrocarbons remaining in the vadose zone within the area. GRO detected in groundwater is likely associated with the DRO detected, not to a separate hydrocarbon source. The lateral extents of DRO and benzene in groundwater are presented on Figure 8-28. Table 8-24 and Figure 8-29 present COCs detected in groundwater with concentrations that exceeded potential chemical-specific ARARs.

8.6.3.3 Sub-Area NP3

One soil boring, which was converted to a groundwater monitoring well (AP-6817), and one groundwater probe (P10) are located within Sub-area NP3, which is shown on Figure 8-25.

Nature and Extent of Contamination in Sub-Area NP3

No analytes were detected in soil at concentrations above potential chemical-specific ARARs at Sub-area NP3. DRO was detected in Groundwater Probe P10 at a concentration of 170 µg/L.

8.6.3.4 Sub-Area NP4

Surface-water and sediment samples from the Chena River at locations upgradient (Location 001) and downgradient (Location 002) of the North Post source area are located within Sub-area NP4. Analyte concentrations were of the same order of magnitude at upgradient and downgradient sample locations. Table 8-25 and Figure 8-30 present the concentrations of analytes detected in surface water.

Sediment samples from upgradient and downgradient locations contained barium, chromium, manganese, arsenic, lead, and DRO. Metals concentrations in sediment collected at the upgradient location exceeded metals concentrations in sediment collected at downgradient locations. DRO was detected at a concentration of 76 mg/kg in the downgradient sediment sample, and at concentrations of 54 and 159 mg/kg in samples collected at the upgradient location. Table 8-26 and Figure 8-30 present the concentration of analytes detected in sediment. The migration of North Post source area contaminants in surface water and sediment has not been evaluated.

8.7 Treatability Testing

The following sections present the results of testing performed to evaluate biodegradation and SVE for use in remedial technologies for the DRMO yard source area. Testing included

- Performing an in situ respiration test;
- Performing an SVE test;
- Collecting soil samples to analyze for chemical parameters considered important for biodegradation to occur.

8.8 Respiration Testing

The growth of indigenous aerobic microorganisms capable of degrading hydrocarbons can be stimulated by increasing oxygen concentrations in the soil. To estimate the rate of hydrocarbon biodegradation, a microbial respiration test was conducted at the DRMO yard source area. The test was performed as discussed in section 3.10.

Data collected during the test were used to calculate the rate of oxygen utilization (percent oxygen depletion per day) and to monitor carbon dioxide production. Respiration test data are in Appendix D, and are presented graphically on Figure 8-31. The slope of the graph of percent oxygen versus time represents the oxygen utilization rate; the slope was calculated by performing a linear regression of the data points.

To estimate biodegradation rates from oxygen utilization rates, a stoichiometric relationship for hydrocarbon oxidation was used. Hexane was used as the representative hydrocarbon, and the stoichiometric relationship used was

$$C_6H_{14} + 9.5O_2 \text{--->} 6CO_2 + 7H_2O$$

Where:
C_6H_{14} = Hexane
O_2 = Oxygen
CO_2 = Carbon dioxide
H_2O = Water

Table 8-24. Chemicals of Concern Detected in Water That Exceed Potential ARARs for North Post Source Area Sub-Area NP2

			Probe Location	P01	P03	P04	P05	P08	P11
			Sample Number	94FW30001WA	94FW30002WA	94FW30003WA	94FW30004WA	94FW30008WA	94FW3017WA
			Associated Quality Control Duplicate Sample						94FW3019WA
			Date Sampled	8/5/94	8/5/94	8/5/94	8/5/94	8/6/94	8/27/94
Analyte	MCL	RBC	Units						
Diesel-Range Organics	--	--	µg/L	170 J	160 J	380 J	380 J	9,500 J	21,000 J
Gasoline-Range Organics	--	--	mg/L	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	1.1	43
Volatile Organic Compounds									
1,2,4-Trimethylbenzene	--	3[a]	µg/L	ND(5)	ND(5)	ND(5)	ND(5)	ND(5)	540
1,3,5-Trimethylbenzene	--	2.4[a]	µg/L	ND(5)	ND(5)	ND(5)	ND(5)	5	660
Benzene	5	0.36[b]	µg/L	ND(5)	ND(5)	ND(5)	ND(5)	8	ND(50)
m- & p-Xylene	10,000	520[a]	µg/L	ND(5)	ND(5)	ND(5)	<	36	1,200

			Probe Location	P11	P13	P14	P15	P16	P17
			Sample Number	94FW3019WA	94FW3021WA	94FW3022WA	94FW3023WA	94FW3024WA	94FW3020WA
			Associated Quality Control Duplicate Sample	94FW3017WA					
			Date Sampled	8/27/94	8/27/94	8/27/94	8/27/94	8/27/94	8/27/94
Analyte	MCL	RBC	Units						
Diesel-Range Organics	--	--	µg/L	26,000 J	890 J	120 J	230 J	1,300 J	220 J
Gasoline-Range Organics	--	--	mg/L	47	0.16	ND(0.1)	ND(0.1)	0.18	ND(0.1)
Volatile Organic Compounds									
1,2,4-Trimethylbenzene	--	3[a]	µg/L	380	ND(5)	ND(5)	ND(5)	<	<
1,3,5-Trimethylbenzene	--	2.4[a]	µg/L	450	ND(5)	ND(5)	ND(5)	<	<
Benzene	5	0.36[b]	µg/L	ND(50)	ND(5)	ND(5)	ND(5)	<	<
m- & p-Xylene	10,000	520[a]	µg/L	920	ND(5)	ND(5)	ND(5)	<	<

Table 8-24. Chemicals of Concern Detected in Water That Exceed Potential ARARs for North Post Source Area Sub-Area NP2 (continued)

			Monitoring Well Location	AP-6819	AP-6820	AP-6820
			Sample Number	94FW3042WA	94FW3045WA	94FW3047WA
			Associated Quality Control Duplicate Sample		94FW3047WA	94FW3045WA
			Date Sampled	11/15/94	11/16/94	11/16/94
Analyte	MCL	RBC	Units			
Diesel-Range Organics	--	--	μg/L	10,000	490	580
Gasoline-Range Organics	--	--	mg/L	0.73	ND(0.5)	ND(0.5)
Volatile Organic Compounds						
1,2,4-Trimethylbenzene	--	3[a]	μg/L	21	ND(5)	ND(5)
1,3,5-Trimethylbenzene	--	2.4[a]	μg/L	14	ND(5)	ND(5)
Benzene	5	0.36[b]	μg/L	10	ND(5)	ND(5)

< Analyte was detected at a concentration less than the ARAR, or was not detected (associated method reporting limit less than the ARAR)
-- Applicable regulatory criteria not available
ARAR Applicable or relevant and appropriate requirement
MCL Maximum contaminant level
μg/L Micrograms per liter
mg/L Milligrams per liter
ND Not detected at or above the method reporting limit listed in parentheses
RBC Risk-based concentration

a. Hazard quotient is equal to 1 (U.S. Environmental Protection Agency [EPA] Region 3,1994).
b. Risk-based concentration is 10^{-6} (EPA Region 3, 1994).

Project Laboratory Qualifiers

J Value is estimated.

Table 8-25. Chemicals of Concern Detected in Surface Water at North Post Source Area Sub-Area NP4

		Location	001	001	002
		Sample Number	94FW3080WA	94FW3082WA	94FW3083WA
		Associated Quality Control Duplicate Sample	94FW3082WA	94FW3080WA	
		Date Collected	9/12/94	9/12/94	9/12/94
Analyte	EPA Method	Units			
Metals					
Barium (Total)	6010A	μg/L	34	32	34
Manganese (Total)	6010A	μg/L	74	69	73
Total Organic Carbon	415.1	mg/L	3	3	3.2

EPA U.S. Environmental Protection Agency
μg/L Micrograms per liter
mg/L Milligrams per liter
ND Not detected at or above the method detection limit listed in parentheses

Table 8-26. Chemicals of Concern Detected in Sediment at North Post Source Area Sub-Area NP4

		Location	001	001	002
		Sample Number	94FW3001SD	94FW3003SD	94FW3004SD
		Associated Quality Control Duplicate Sample	94FW3003SD	94FW3001SD	
		Date Collected	9/12/94	9/12/94	9/12/94
Analyte	EPA Method	Units			
Diesel-Range Organics	8100M	mg/kg	54 a	159 a	76 a
Gasoline-Range Organics	8015	mg/kg	<10 b	<10 b	<10 b
Metals					
Lead (Total)	7421	mg/kg	4 J	4 J	9 J
Arsenic (Total)	7060	mg/kg	7	6	9
Barium (Total)	6010A	mg/kg	58 J	60 J	108 J
Chromium (Total)	6010A	mg/kg	9 J	10 J	19 J
Manganese (Total)	6010A	mg/kg	181 J	160 J	287 J
Total Organic Carbon	D4129-82M	percent	3.61	5.69	1.3

< Less than
EPA U.S. Environmental Protection Agency
mg/kg Milligrams per kilogram

Project Laboratory Qualifiers

a. Method reporting limits are elevated because of the low percent solids in the samples as received.
b. Quantified as diesel. The sample contains an oil component that partially eluted in the diesel range.
J Value is estimated.

Based on the oxygen utilization rate, the biodegradation rate in terms of milligrams of hexane-equivalent per kilogram of soil per day was estimated using the following relationship (AFCEE, 1992):

$$K_B = -K_O \, A \, D_O \, (C/100)$$

Where: K_B = biodegradation rate in mg/kg per day (mg/kg/day);

K_O = oxygen utilization rate in percent per day (%/day);

A = volume of air per unit weight of soil in L/kg;

D_O = density of oxygen gas in mg/L;

C = mass ratio of hydrocarbon to oxygen required for mineralization (unitless).

The oxygen utilization rate (K_O) of -3.6 percent per day was used in the calculations. The volume of air per unit weight of soil (A) was calculated based on a soil bulk density of 1,762 kilograms per cubic meter (kg/m^3) (110 pounds per cubic foot) and a porosity of 0.34 (the air-filled porosity varies with moisture content, soil type, and density). The density of oxygen (D_O) varies with changes in temperature and atmospheric pressure; however, significant variations were not expected within the operating range encountered during the test. An oxygen density of 1,330 mg/L (density of oxygen at atmospheric pressure equals 406.8 inches of water [1 atmosphere] and a temperature of 21.1C [70° Fahrenheit]) was used in the calculations.

Based on the parameters outlined above, the calculated biodegradation rate during the respiration test was 0.51 mg/kg/day. A copy of the calculations is included in Appendix D.

8.8.1 Soil Vapor Extraction Testing

SVE tests were conducted at the DRMO yard source area to estimate air conductivity and radius of influence in the vadose zone. SVE tests consisted of measuring changes in vadose zone air pressure with time, while air was pumped from an SVE test well at a known flow rate. The tests were performed according to procedures outlined in section 3.10.

Air was extracted from each test well using an EG&G Rotron EN404 blower. Extraction flow rates were measured in the manifold upstream of the blower with an Aquamatic FLT #1-050 flow cell (orifice plate) or estimated based on the manufacturer's blower performance curve. Dynamic and steady-state pressure responses (drawdown) were measured at the observation points using three magnehelic differential pressure gauges with ranges of 0 to 1 inch of water, 0 to 10 inches of water, and 0 to 100 inches of water. Dynamic drawdown response was measured by recording observation point pressure once every 5 seconds for the first minute, and once every minute until steady-state conditions were approximated. A single observation point was selected for measuring the dynamic response. Once steady-state conditions were achieved, drawdown was measured at each of the surrounding observation points. The test parameters and results of the SVE tests, each conducted at different flow rates, were recorded on an Air Response Test form (Appendix D).

Air Conductivity

Air conductivity was estimated by evaluating the SVE test transient response data using the software package AQTESOLV (Duffield and Rumbaugh, 1991). The evaluation procedure is described by Massman and Madden (1994) as the modified Hantush analysis. The modified Hantush analysis includes the effects of air leakage from the surface, and was selected because surface material at the DRMO yard source area may provide a conduit for surface leakage.

SVE test data were input into AQTESOLV and aquifer properties were calculated. AQTESOLV uses curve-matching procedures to estimate transmissivity, storage, and the Hantush leakage factor. As an example, data and AQTESOLV results for SVE Test 1 (Vapor Probe VP2 at a flow rate of 40 cfm) are illustrated on Figure 8-32. The

drawdown plotted on Figure 8-32 is in units of feet of air column. The field measurements made in the inches of water column were converted to the feet of air column by multiplying by the ratio of the density of water to the density of air. Transmissivity may be converted to air conductivity by dividing the transmissivity by the thickness of the vadose zone (approximately 7.5 feet during the tests). Estimates of transmissivity, storage, leakage, and air conductivity from the SVE tests are summarized in Table 8-27.

The air conductivity values calculated for the DRMO yard source area range from 0.46 foot per minute to 0.865 foot per minute. These values are consistent for the type of soil underlying the DRMO yard source area, primarily medium-dense sandy gravel and gravely sand with silt.

Radius of Influence

The radius of influence of pumped SVE wells is the distance from the extraction well to the edge of an area within which induced airflow (soil vapor) results in the desired treatment effect. The effective radius of influence is a function of the chemical properties of the contaminant, the properties of the soil, and the desired cleanup time.

Radius of influence increases with increasing flow rate and extraction well pressure. During the SVE tests performed, pressure response measurements were recorded at monitoring points 6, 31, and 119 feet from the blower well. A pressure response was noted at 31 feet from the blower well. Pressure response was not noted at a distance of 119 feet.

8.8.2 Inorganic Soil Nutrient Evaluation

Adding solutions containing inorganic nutrients, such as soluble nitrogen and phosphorus, often enhances the ability of microorganisms to degrade organic compounds into carbon dioxide and water. These nutrients may already be present in contaminated soil, but may not be readily available or may not be present in adequate quantities (Sims, 1984).

Generally, acceptable concentrations of key inorganic nutrients necessary to sustain microbial metabolism are as follows:

- Nitrogen as nitrate or ammonia - 20 mg per 100 mg hydrocarbon.

Soil samples were collected from Boring VES1 at the DRMO yard source area and were analyzed for ammonia, total nitrogen, and nitrate. The analytical results for total nitrogen indicated that site soil contains concentrations of total nitrogen ranging from 133 to 298 mg/kg. However, water soluble forms (i.e., nitrogen as ammonia and nitrate) with concentrations ranging from less than 1.0 to 10.9 mg/kg were less than the total nitrogen, were low relative to the requirements outlined above, and may limit the potential for microbial degradation of hydrocarbons. Analyses for total nitrogen were performed using a strict acid extraction procedure, and may represent forms of nitrogen not readily available to microorganisms (Smallbeck, personal communication, 1994).

Many microorganisms have limited tolerance for acidic conditions; consequently, the soil pH often determines which microorganisms will effectively degrade hydrocarbons. Additionally, studies conducted by Van Loocke, et al. (1975) have revealed that the overall rate of hydrocarbon biodegradation is higher under slightly alkaline rather than acidic soil conditions. Generally, a pH range of 6.5 to 8.5 is optimal for microbial degradation of petroleum hydrocarbons. The pH of samples from the DRMO yard source area ranged from 6.9 to 8.3, and was within the optimal range.

Soil contains organic material in varying stages of decomposition. Approximately 65 to 75 percent of the organic material usually consists of humic substances, such as humic acid, fulvic acid, and humin, which have large surface areas and high cation exchange capacities (Schnitzer, 1978). Organic matter is important to the microbial ecology and activity of soil (Sims, 1984). Its high cation-exchange capacity and high density of reactive functional groups help to bind organic and inorganic compounds that may be added to

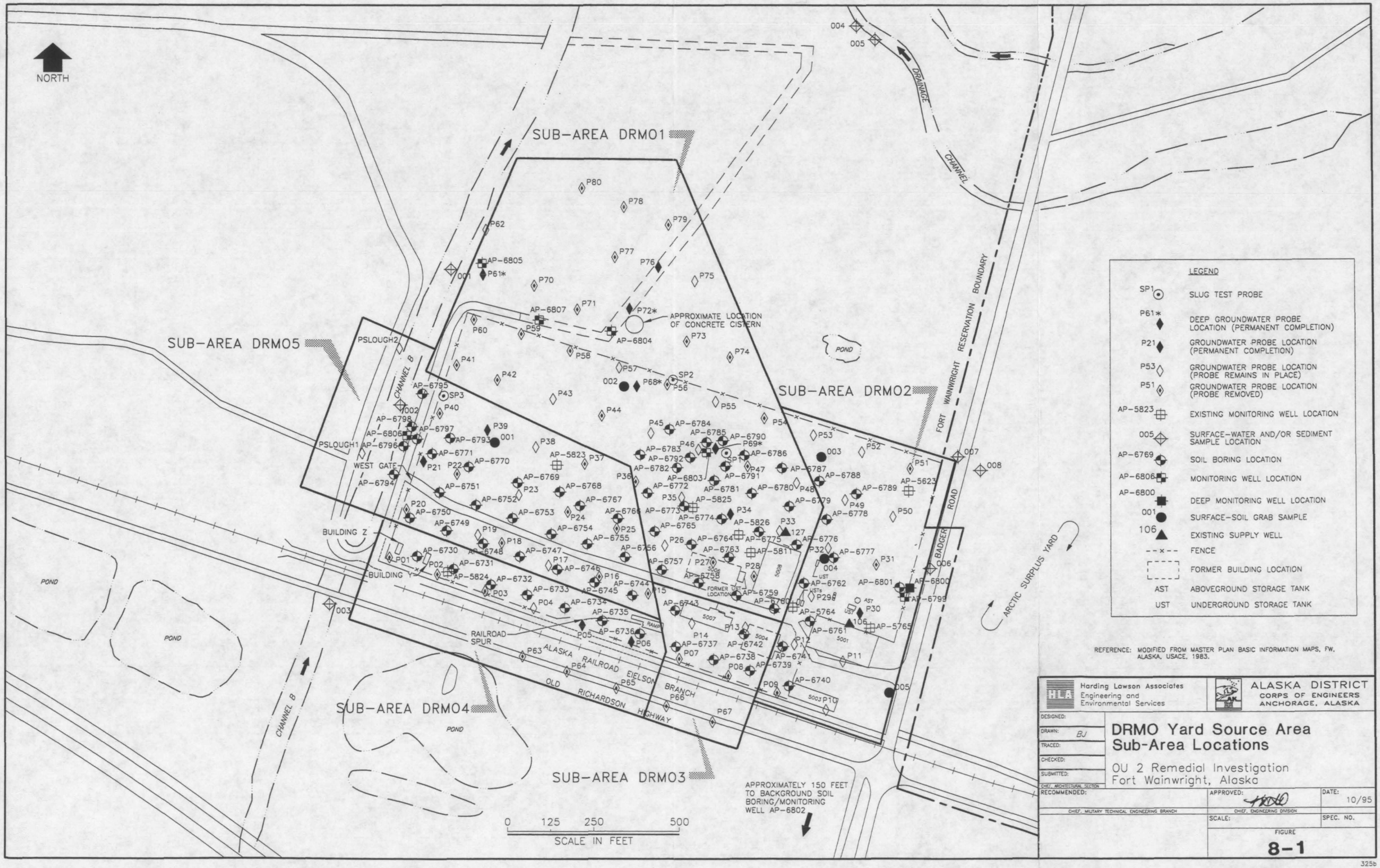
Table 8-27. Summary of Transmissivity, Storage, Leakage, and Air Conductivity Results from Analyses of Soil Vapor Extraction Test Data by AQTESOLV

Test Run Number	Test Well Number	Air Extraction Rate (cfm)	Transmissivity (feet^2/minute)	Storage (no units)	Leakage (feet)	Air Conductivity (K_{air}) (feet/minute)
1	P2	25	0.06	1.77E-4	11	0.49
2	P2	40	0.11	1.42E-4	24	0.86
3	P2	60	0.06	1.37E-4	14	0.46

AQTESOLV Aquifer tests design and analysis computer software
cfm Cubic feet per minute
K Intrinsic permeability
K_{air} Air conductivity

the soil. These properties also help to retain soil bacteria, which can then attack the bound chemicals. The TOC content in soil samples from the DRMO yard source area ranged from 290 to 40,300 mg/kg.

Based on the results of treatability testing conducted at the DRMO yard source area, remedial technologies that employ biodegradation and in situ vapor extraction may be feasible.



REFERENCE: MODIFIED FROM MASTER PLAN BASIC INFORMATION MAPS, FW, ALASKA, USACE, 1983.

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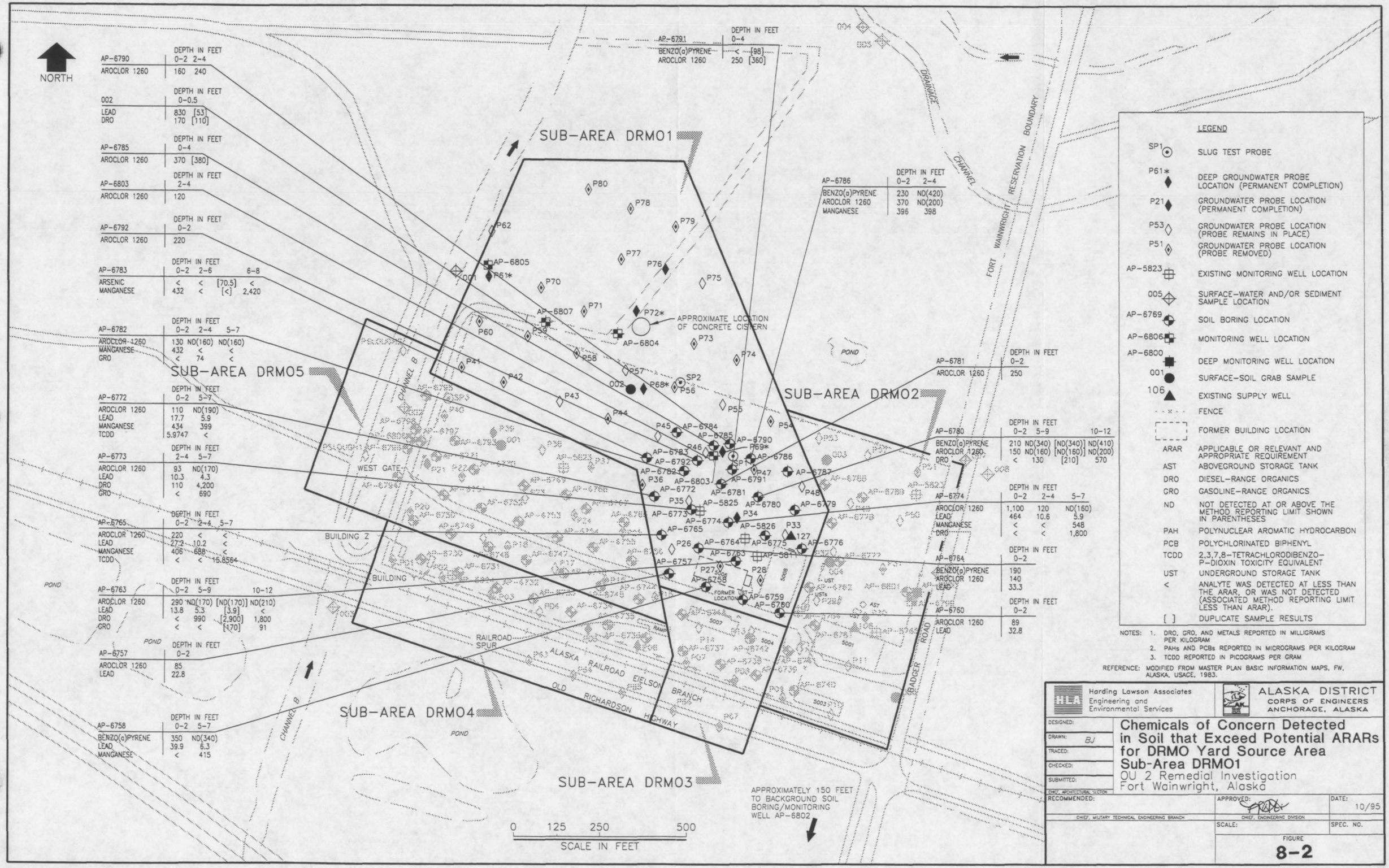
DRMO Yard Source Area Sub-Area Locations

OU 2 Remedial Investigation
Fort Wainwright, Alaska

FIGURE
8-1

325b



AP-6790	DEPTH IN FEET 0-2	2-4
AROCLOR 1260	160	240

002	DEPTH IN FEET 0-0.5
LEAD	830 [53]
DRO	170 [110]

AP-6785	DEPTH IN FEET 0-4
AROCLOR 1260	370 [380]

AP-6803	DEPTH IN FEET 2-4
AROCLOR 1260	120

AP-6792	DEPTH IN FEET 0-2
AROCLOR 1260	220

AP-6783	DEPTH IN FEET 0-2	2-6	6-8
ARSENIC	<	< [70.5]	<
MANGANESE	432	< [<]	2,420

AP-6782	DEPTH IN FEET 0-2	2-4	5-7
AROCLOR 1260	130	ND(160)	ND(160)
MANGANESE	432	<	<
GRO	<	74	<

AP-6772	DEPTH IN FEET 0-2	5-7
AROCLOR 1260	110	ND(190)
LEAD	17.7	5.9
MANGANESE	434	399
TCDD	5.9747	<

AP-6773	DEPTH IN FEET 2-4	5-7
AROCLOR 1260	93	ND(170)
LEAD	10.3	4.3
DRO	110	4,200
GRO	<	690

AP-6765	DEPTH IN FEET 0-2	2-4	5-7
AROCLOR 1260	220	<	<
LEAD	27.2	10.2	<
MANGANESE	406	688	<
TCDD	<	<	15.8564

AP-6763	DEPTH IN FEET 0-2	5-9	10-12
AROCLOR 1260	290	ND(170) [ND(170)]	ND(210)
LEAD	13.8	5.3 [3.9]	<
DRO	<	990 [2,900]	1,800
GRO	<	< [170]	91

AP-6757	DEPTH IN FEET 0-2
AROCLOR 1260	85
LEAD	22.8

AP-6758	DEPTH IN FEET 0-2	5-7
BENZO(a)PYRENE	350	ND(340)
LEAD	39.9	6.3
MANGANESE	<	415

AP-6791	DEPTH IN FEET 0-4
BENZO(a)PYRENE	< [98]
AROCLOR 1260	250 [360]

AP-6786	DEPTH IN FEET 0-2	2-4
BENZO(a)PYRENE	230	ND(420)
AROCLOR 1260	370	ND(200)
MANGANESE	396	398

AP-6781	DEPTH IN FEET 0-2
AROCLOR 1260	250

AP-6780	DEPTH IN FEET 0-2	5-9	10-12
BENZO(a)PYRENE	210	ND(340) [ND(340)]	ND(410)
AROCLOR 1260	150	ND(160) [ND(160)]	ND(200)
DRO	<	130 [210]	570

AP-6774	DEPTH IN FEET 0-2	2-4	5-7
AROCLOR 1260	1,100	120	ND(160)
LEAD	464	10.6	5.9
MANGANESE	<	<	548
DRO	<	<	1,800

AP-6764	DEPTH IN FEET 0-2
BENZO(a)PYRENE	190
AROCLOR 1260	140
LEAD	33.3

AP-6760	DEPTH IN FEET 0-2
AROCLOR 1260	89
LEAD	32.8

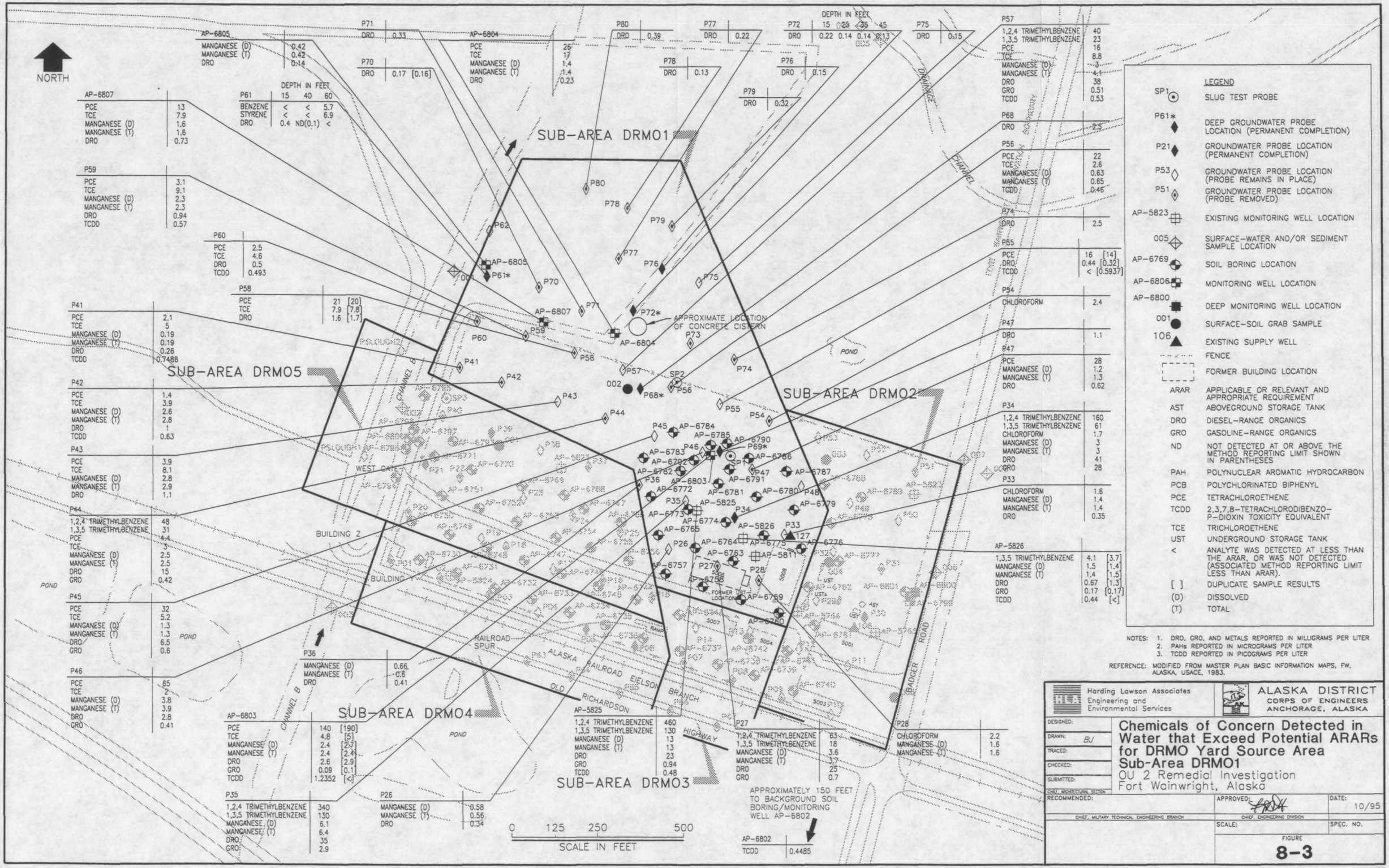

NORTH
SUB-AREA DRMO1
SUB-AREA DRMO2
SUB-AREA DRMO3
SUB-AREA DRMO4
SUB-AREA DRMO5
APPROXIMATE LOCATION OF CONCRETE CISTERN
FORMER UST LOCATION
WEST GATE
BUILDING Z
BUILDING Y
POND
CHANNEL B
RAILROAD SPUR
ALASKA RAILROAD
EIELSON BRANCH
OLD RICHARDSON HIGHWAY
BADGER ROAD
DRAINAGE CHANNEL
APPROXIMATELY 150 FEET TO BACKGROUND SOIL BORING/MONITORING WELL AP-6802
0 125 250 500
SCALE IN FEET
AP-6805
MANGANESE (D) 0.42
MANGANESE (T) 0.42
DRO 0.14
AP-6804
PCE 26
TCE 17
MANGANESE (D) 1.4
MANGANESE (T) 1.4
DRO 0.23
P71 DRO 0.33
P70 DRO 0.17 [0.16]
P80 DRO 0.39
P78 DRO 0.13
P77 DRO 0.22
P76 DRO 0.15
P79 DRO 0.32
P72 DEPTH IN FEET 15 25 35 45
DRO 0.22 0.14 0.14 0.13
P75 DRO 0.15
P61 DEPTH IN FEET 15 40 60
BENZENE < < 5.7
STYRENE < < 6.9
DRO 0.4 ND(0.1) <
AP-6807
PCE 13
TCE 7.9
MANGANESE (D) 1.6
MANGANESE (T) 1.6
DRO 0.73
P59
PCE 3.1
TCE 9.1
MANGANESE (D) 2.3
MANGANESE (T) 2.3
DRO 0.94
TCDD 0.57
P60
PCE 2.5
TCE 4.6
DRO 0.5
TCDD 0.493
P58
PCE 21 [20]
TCE 7.9 [7.8]
DRO 1.6 [1.7]
P41
PCE 2.1
TCE 5
MANGANESE (D) 0.19
MANGANESE (T) 0.19
DRO 0.26
TCDD 0.7488
P42
PCE 1.4
TCE 3.9
MANGANESE (D) 2.6
MANGANESE (T) 2.8
DRO 1
TCDD 0.63
P43
PCE 3.9
TCE 8.1
MANGANESE (D) 2.8
MANGANESE (T) 2.9
DRO 1.1
P44
1,2,4 TRIMETHYLBENZENE 48
1,3,5 TRIMETHYLBENZENE 31
PCE 4.4
TCE 3
MANGANESE (D) 2.5
MANGANESE (T) 2.5
DRO 15
GRO 0.42
P45
PCE 32
TCE 5.2
MANGANESE (D) 1.3
MANGANESE (T) 1.3
DRO 6.5
GRO 0.6
P46
PCE 65
TCE 2
MANGANESE (D) 3.8
MANGANESE (T) 3.9
DRO 2.8
GRO 0.41
P36
MANGANESE (D) 0.66
MANGANESE (T) 0.6
DRO 0.41
AP-6803
PCE 140 [190]
TCE 4.8 [5]
MANGANESE (D) 2.4 [2.7]
MANGANESE (T) 2.4 [2.4]
DRO 2.6 [2.9]
GRO 0.09 [0.1]
TCDD 1.2352 [<]
P35
1,2,4 TRIMETHYLBENZENE 340
1,3,5 TRIMETHYLBENZENE 130
MANGANESE (D) 6.1
MANGANESE (T) 6.4
DRO 35
GRO 2.9
P26
MANGANESE (D) 0.58
MANGANESE (T) 0.56
DRO 0.34
AP-5825
1,2,4 TRIMETHYLBENZENE 460
1,3,5 TRIMETHYLBENZENE 130
MANGANESE (D) 13
MANGANESE (T) 13
DRO 23
GRO 0.94
TCDD 0.48
P27
1,2,4 TRIMETHYLBENZENE 63
1,3,5 TRIMETHYLBENZENE 18
MANGANESE (D) 3.6
MANGANESE (T) 3.7
DRO 25
GRO 0.7
P28
CHLOROFORM 2.2
MANGANESE (D) 1.6
MANGANESE (T) 1.6
AP-6802
TCDD 0.4485
P57
1,2,4 TRIMETHYLBENZENE 40
1,3,5 TRIMETHYLBENZENE 23
PCE 16
TCE 8.8
MANGANESE (D) 3
MANGANESE (T) 4.1
DRO 38
GRO 0.51
TCDD 0.53
P68
DRO 2.5
P56
PCE 22
TCE 2.6
MANGANESE (D) 0.63
MANGANESE (T) 0.65
TCDD 0.46
P74
DRO 2.5
P55
PCE 16 [14]
DRO 0.44 [0.32]
TCDD < [0.5937]
P54
CHLOROFORM 2.4
P47
DRO 1.1
P47
PCE 28
MANGANESE (D) 1.2
MANGANESE (T) 1.3
DRO 0.62
P34
1,2,4 TRIMETHYLBENZENE 160
1,3,5 TRIMETHYLBENZENE 61
CHLOROFORM 1.7
MANGANESE (D) 3
MANGANESE (T) 3
DRO 41
GRO 28
P33
CHLOROFORM 1.6
MANGANESE (D) 1.4
MANGANESE (T) 1.4
DRO 0.35
AP-5826
1,3,5 TRIMETHYLBENZENE 4.1 [3.7]
MANGANESE (D) 1.5 [1.4]
MANGANESE (T) 1.4 [1.5]
DRO 0.67 [1.3]
GRO 0.17 [0.17]
TCDD 0.44 [<]
LEGEND
SP1 SLUG TEST PROBE
P61* DEEP GROUNDWATER PROBE LOCATION (PERMANENT COMPLETION)
P21 GROUNDWATER PROBE LOCATION (PERMANENT COMPLETION)
P53 GROUNDWATER PROBE LOCATION (PROBE REMAINS IN PLACE)
P51 GROUNDWATER PROBE LOCATION (PROBE REMOVED)
AP-5823 EXISTING MONITORING WELL LOCATION
005 SURFACE-WATER AND/OR SEDIMENT SAMPLE LOCATION
AP-6769 SOIL BORING LOCATION
AP-6806 MONITORING WELL LOCATION
AP-6800 DEEP MONITORING WELL LOCATION
001 SURFACE-SOIL GRAB SAMPLE
106 EXISTING SUPPLY WELL
FENCE
FORMER BUILDING LOCATION
ARAR APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENT
AST ABOVEGROUND STORAGE TANK
DRO DIESEL-RANGE ORGANICS
GRO GASOLINE-RANGE ORGANICS
ND NOT DETECTED AT OR ABOVE THE METHOD REPORTING LIMIT SHOWN IN PARENTHESES
PAH POLYNUCLEAR AROMATIC HYDROCARBON
PCB POLYCHLORINATED BIPHENYL
PCE TETRACHLOROETHENE
TCDD 2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN TOXICITY EQUIVALENT
TCE TRICHLOROETHENE
UST UNDERGROUND STORAGE TANK
< ANALYTE WAS DETECTED AT LESS THAN THE ARAR, OR WAS NOT DETECTED (ASSOCIATED METHOD REPORTING LIMIT LESS THAN ARAR).
[ ] DUPLICATE SAMPLE RESULTS
(D) DISSOLVED
(T) TOTAL
NOTES: 1. DRO, GRO, AND METALS REPORTED IN MILLIGRAMS PER LITER
2. PAHs REPORTED IN MICROGRAMS PER LITER
3. TCDD REPORTED IN PICOGRAMS PER LITER
REFERENCE: MODIFIED FROM MASTER PLAN BASIC INFORMATION MAPS, FW, ALASKA, USACE, 1983.
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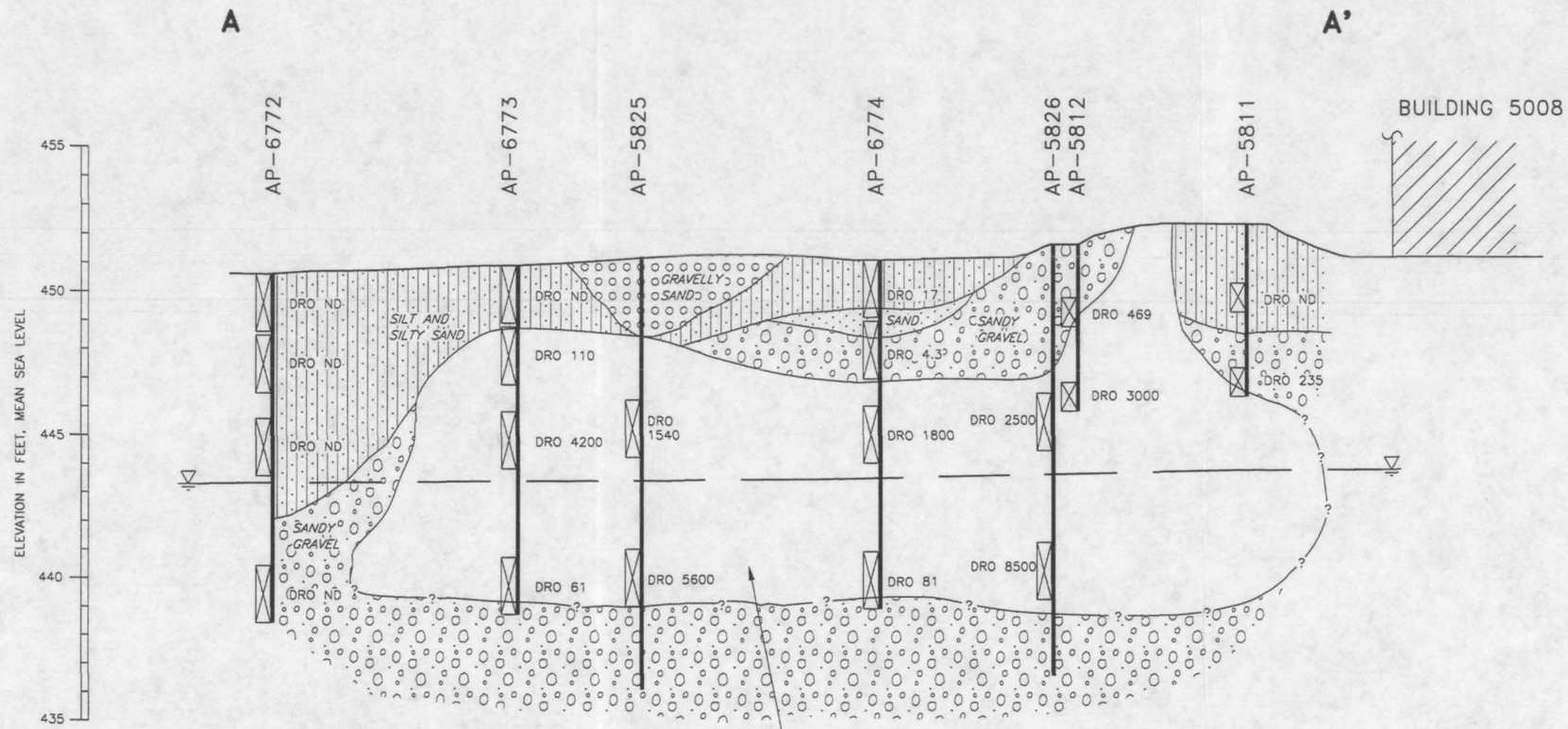
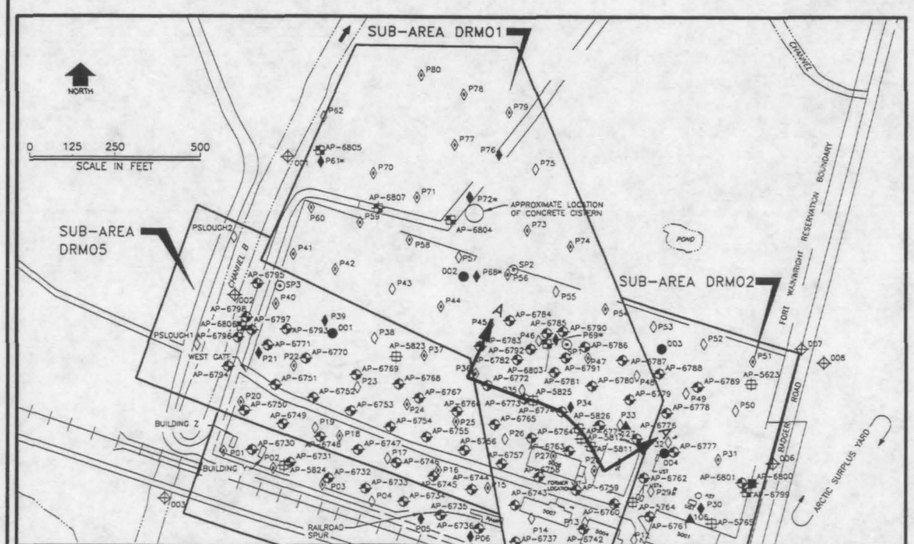
FIGURE
8-3
Chemicals of Concern Detected in Water that Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO1
OU 2 Remedial Investigation
Fort Wainwright, Alaska
4158





LEGEND

AP-6773 — BORING NUMBER

DRO 4200 — DIESEL-RANGE ORGANIC CONCENTRATION IN mg/kg

GROUNDWATER LEVEL BASED ON 1994 REMEDIAL INVESTIGATION SURVEY

mg/kg MILLIGRAMS PER KILOGRAM

ND NOT DETECTED

SCALE: HORIZONTAL 1" = 50'
VERTICAL 1" = 5'

NOTE: THE LINES DESIGNATING THE INTERFACE BETWEEN SOIL AND ROCK MATERIALS ON THE SUBSURFACE PROFILES ARE INTERPOLATED AND ARE THEREFORE APPROXIMATIONS. THE TRANSITION BETWEEN THE MATERIALS MAY BE ABRUPT OR GRADUAL. THE PROFILES SHOULD BE CONSIDERED AS REASONABLY ACCURATE ONLY AT THE BORING LOCATIONS, AND THEN ONLY TO THE DEGREE IMPLIED BY THE NOTES ON THE BORING LOGS. DETAILED STRATIGRAPHIC INFORMATION SHOULD BE OBTAINED FROM THE SOIL BORING LOGS.

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DRMO Yard Source Area
Sub-Area DRMO1
Subsurface-Soil Profile A-A'
OU 2 Remedial Investigation
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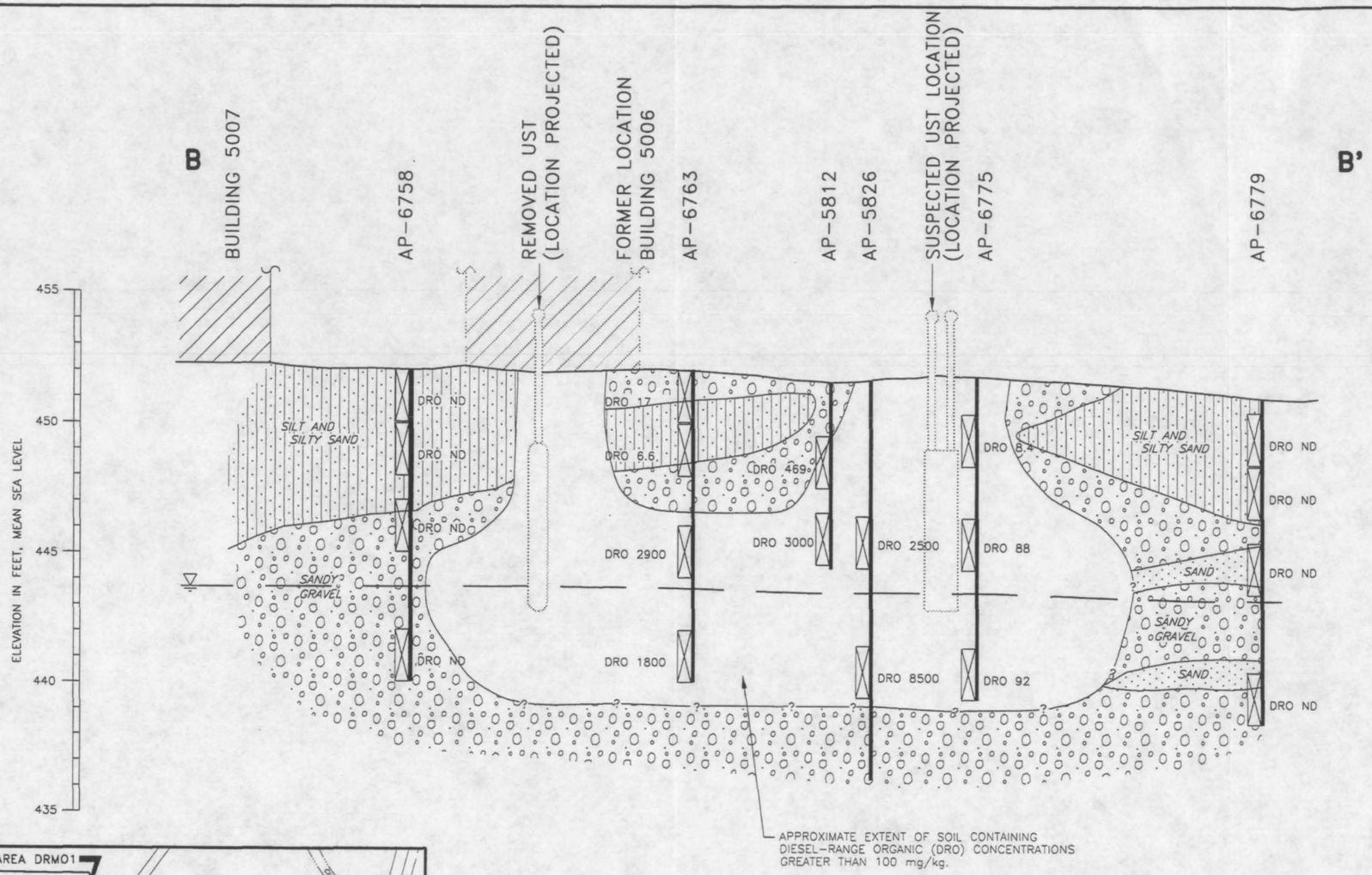
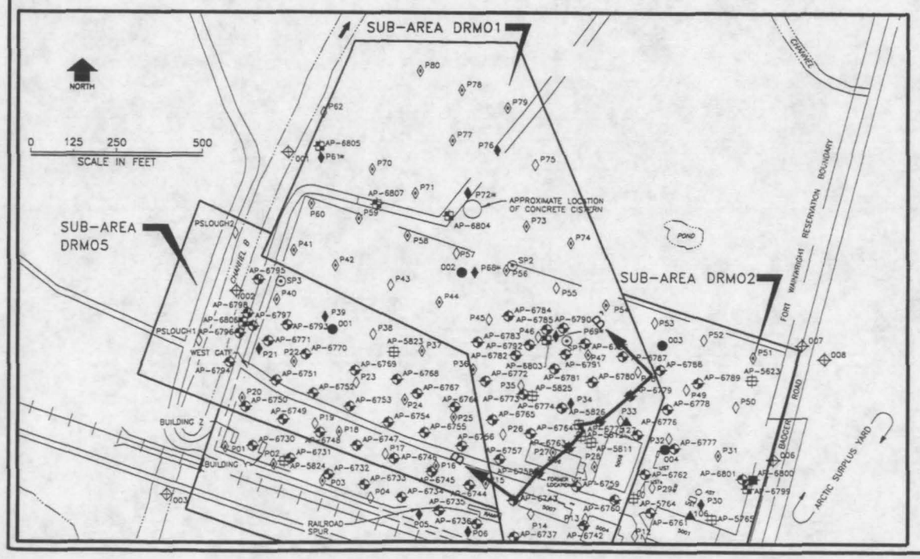
FIGURE
8-4

330b





LEGEND

AP-6775 — BORING NUMBER

DRO 8.4 — DIESEL-RANGE ORGANIC CONCENTRATION IN mg/kg

GROUNDWATER LEVEL BASED ON 1994 REMEDIAL INVESTIGATION SURVEY

mg/kg MILLIGRAMS PER KILOGRAM

ND NOT DETECTED

UST UNDERGROUND STORAGE TANK

SCALE: HORIZONTAL 1" = 50'
VERTICAL 1" = 5'

NOTE: THE LINES DESIGNATING THE INTERFACE BETWEEN SOIL AND ROCK MATERIALS ON THE SUBSURFACE PROFILES ARE INTERPOLATED AND ARE THEREFORE APPROXIMATIONS. THE TRANSITION BETWEEN THE MATERIALS MAY BE ABRUPT OR GRADUAL. THE PROFILES SHOULD BE CONSIDERED AS REASONABLY ACCURATE ONLY AT THE BORING LOCATIONS, AND THEN ONLY TO THE DEGREE IMPLIED BY THE NOTES ON THE BORING LOGS. DETAILED STRATIGRAPHIC INFORMATION SHOULD BE OBTAINED FROM THE SOIL BORING LOGS.

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DRMO Yard Source Area
Sub-Area DRMO1
Subsurface-Soil Profile B-B'

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Fort Wainwright, Alaska

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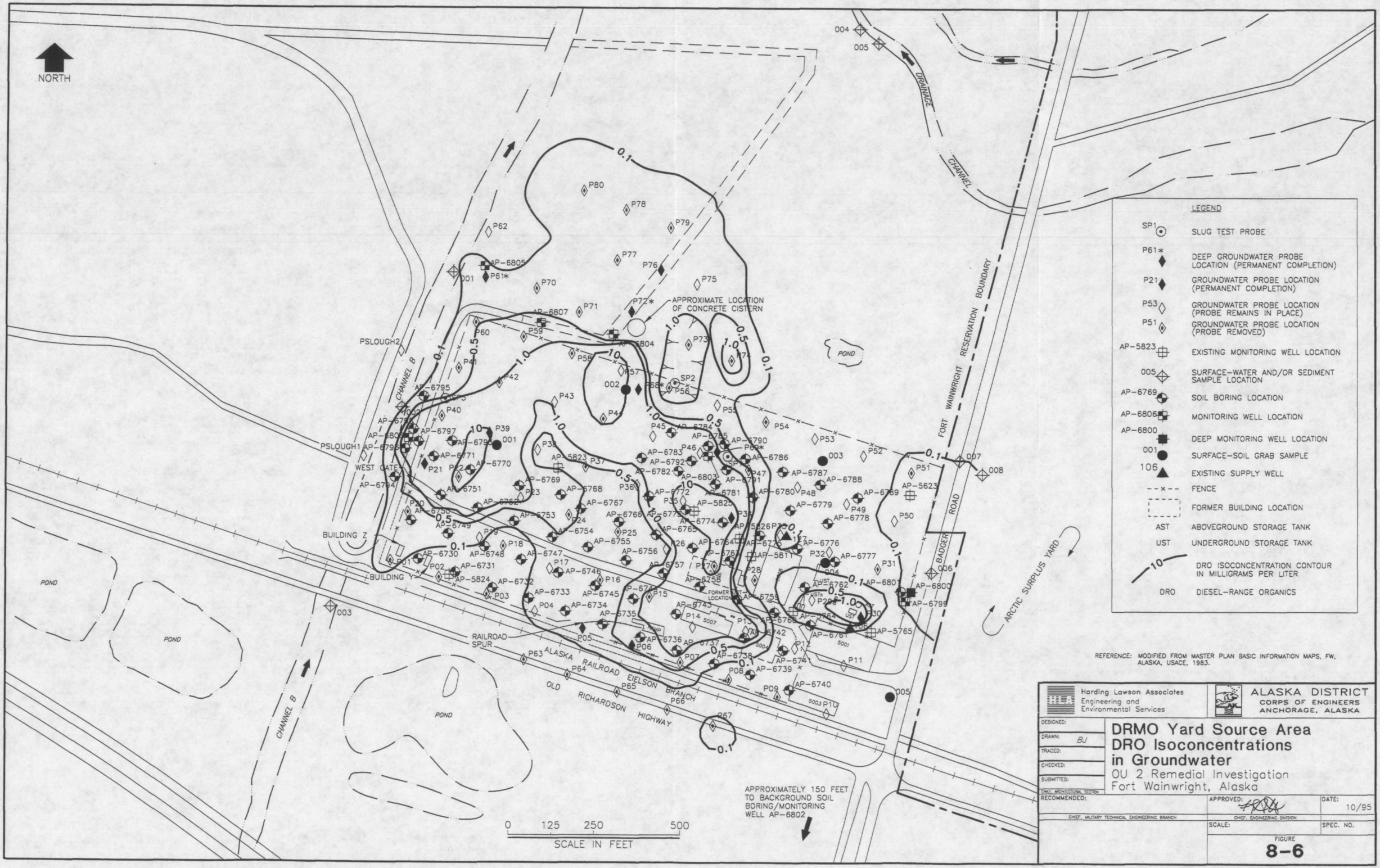
SCALE:

SPEC. NO.

FIGURE
8-5

332b



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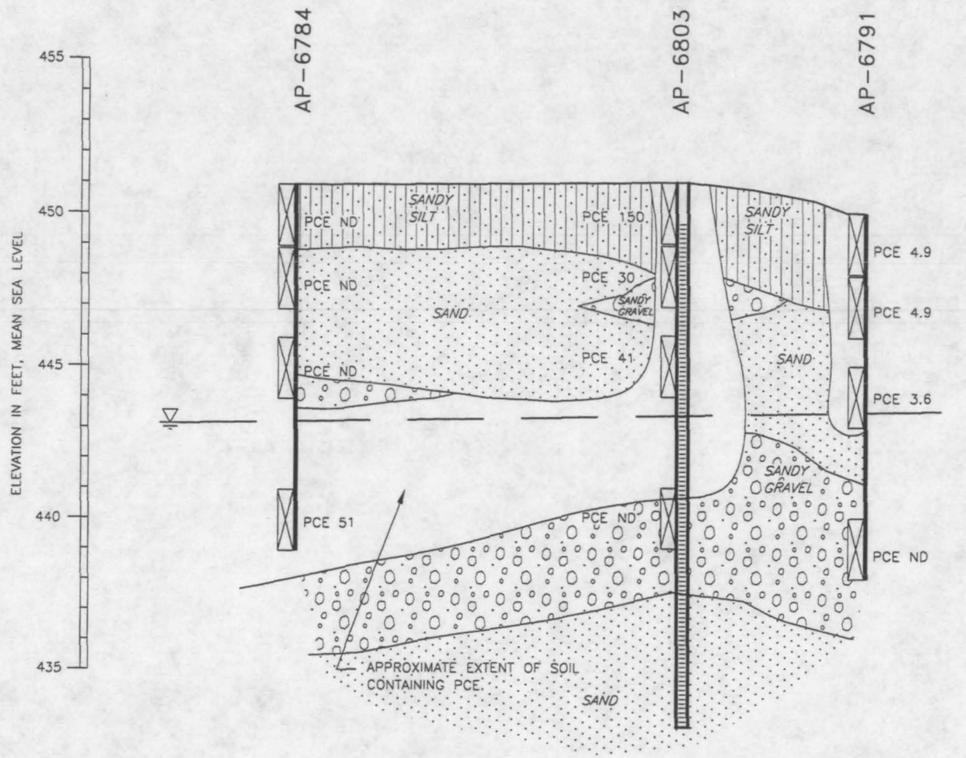
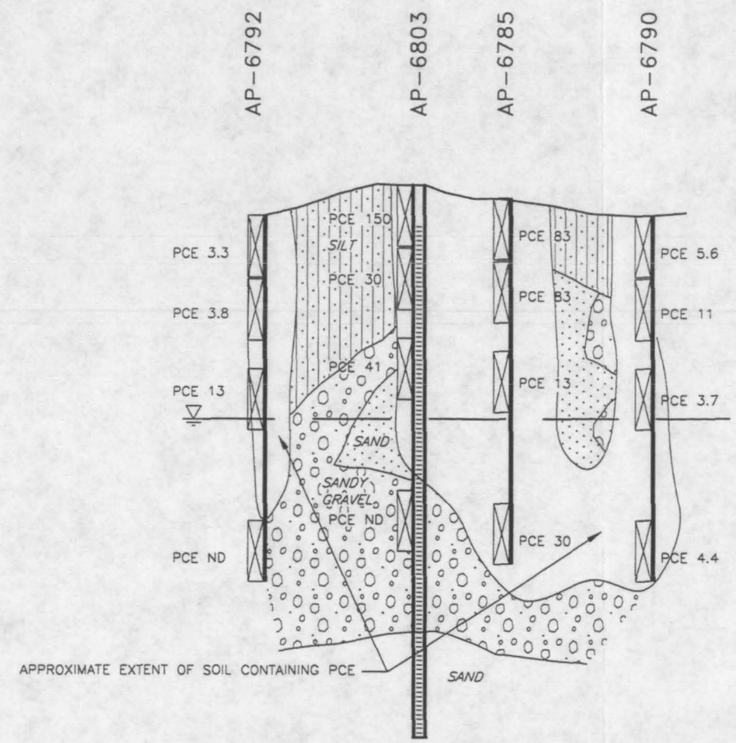
DRMO Yard Source Area DRO Isoconcentrations in Groundwater

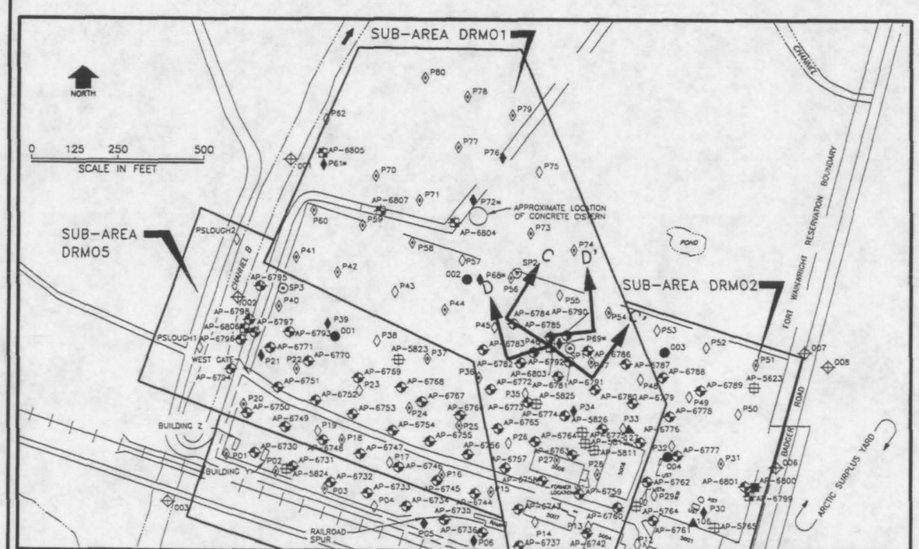
OU 2 Remedial Investigation
Fort Wainwright, Alaska

RECOMMENDED: CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION
DATE: 10/95
SCALE:
SPEC. NO.
FIGURE 8-6

336b







LEGEND

AP-6790 — BORING NUMBER

PCE 11 — PCE CONCENTRATION IN µg/kg

AP-6803 — BORING NUMBER

PCE 30 — PCE CONCENTRATION IN µg/kg (SOIL SAMPLE COLLECTED FROM BORING PRIOR TO MONITORING WELL INSTALLATION)

GROUNDWATER LEVEL BASED ON 1994 REMEDIAL INVESTIGATION SURVEY

PCE TETRACHLOROETHENE

µg/kg MICROGRAMS PER KILOGRAM

ND NOT DETECTED

SCALE: HORIZONTAL 1" = 50'
VERTICAL 1" = 5'

NOTE: THE LINES DESIGNATING THE INTERFACE BETWEEN SOIL AND ROCK MATERIALS ON THE SUBSURFACE PROFILES ARE INTERPOLATED AND ARE THEREFORE APPROXIMATIONS. THE TRANSITION BETWEEN THE MATERIALS MAY BE ABRUPT OR GRADUAL. THE PROFILES SHOULD BE CONSIDERED AS REASONABLY ACCURATE ONLY AT THE BORING LOCATIONS, AND THEN ONLY TO THE DEGREE IMPLIED BY THE NOTES ON THE BORING LOGS. DETAILED STRATIGRAPHIC INFORMATION SHOULD BE OBTAINED FROM THE SOIL BORING LOGS.

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DRMO Yard Source Area
Sub-Area DRMO1
Subsurface-Soil Profiles C-C', D-D'

OU 2 Remedial Investigation
Fort Wainwright, Alaska

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APPROVED:
CHIEF, ENGINEERING DIVISION

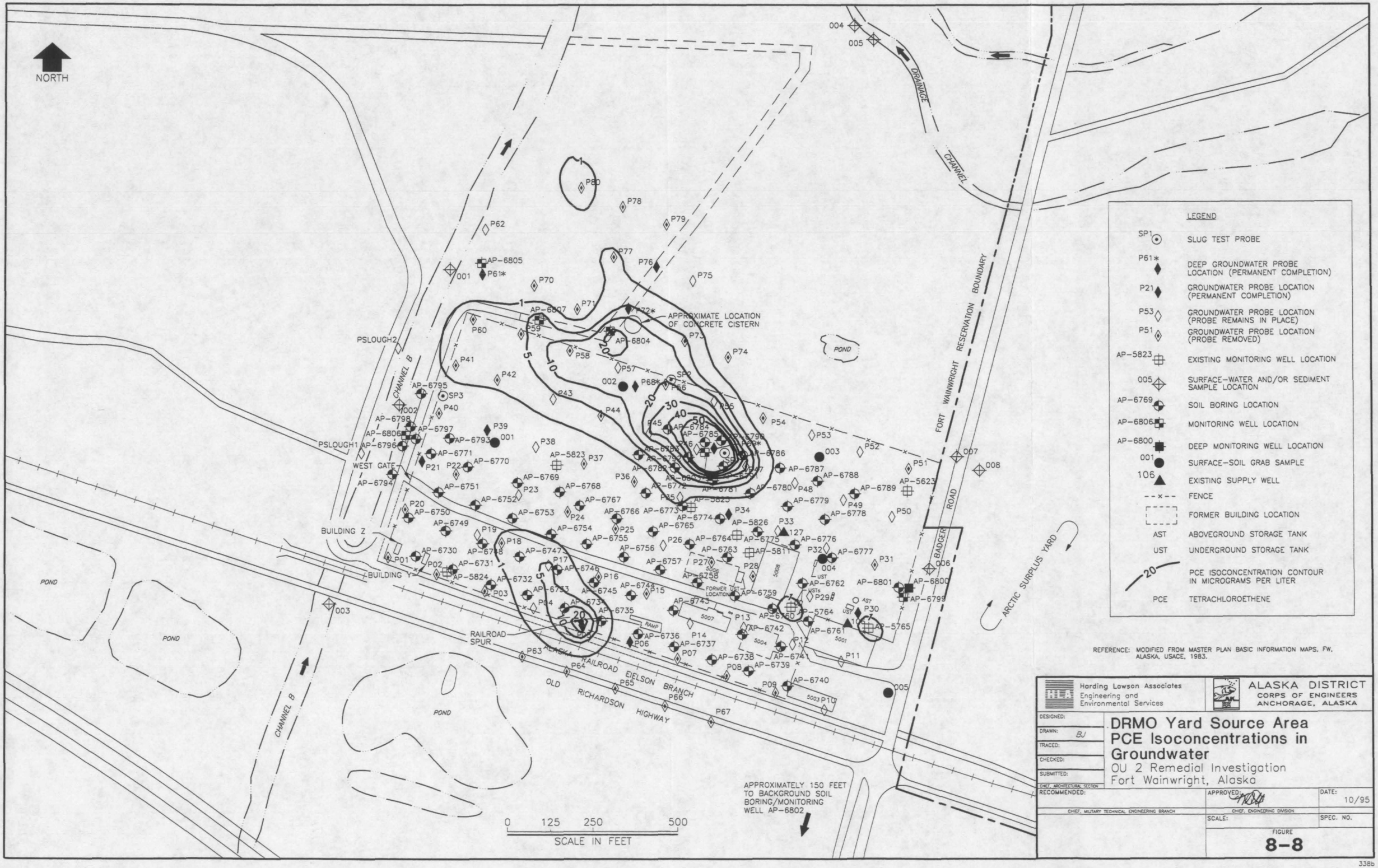
DATE: 10/95

SCALE:

SPEC. NO.

FIGURE
8-7

333b



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DRMO Yard Source Area PCE Isoconcentrations in Groundwater

OU 2 Remedial Investigation
Fort Wainwright, Alaska

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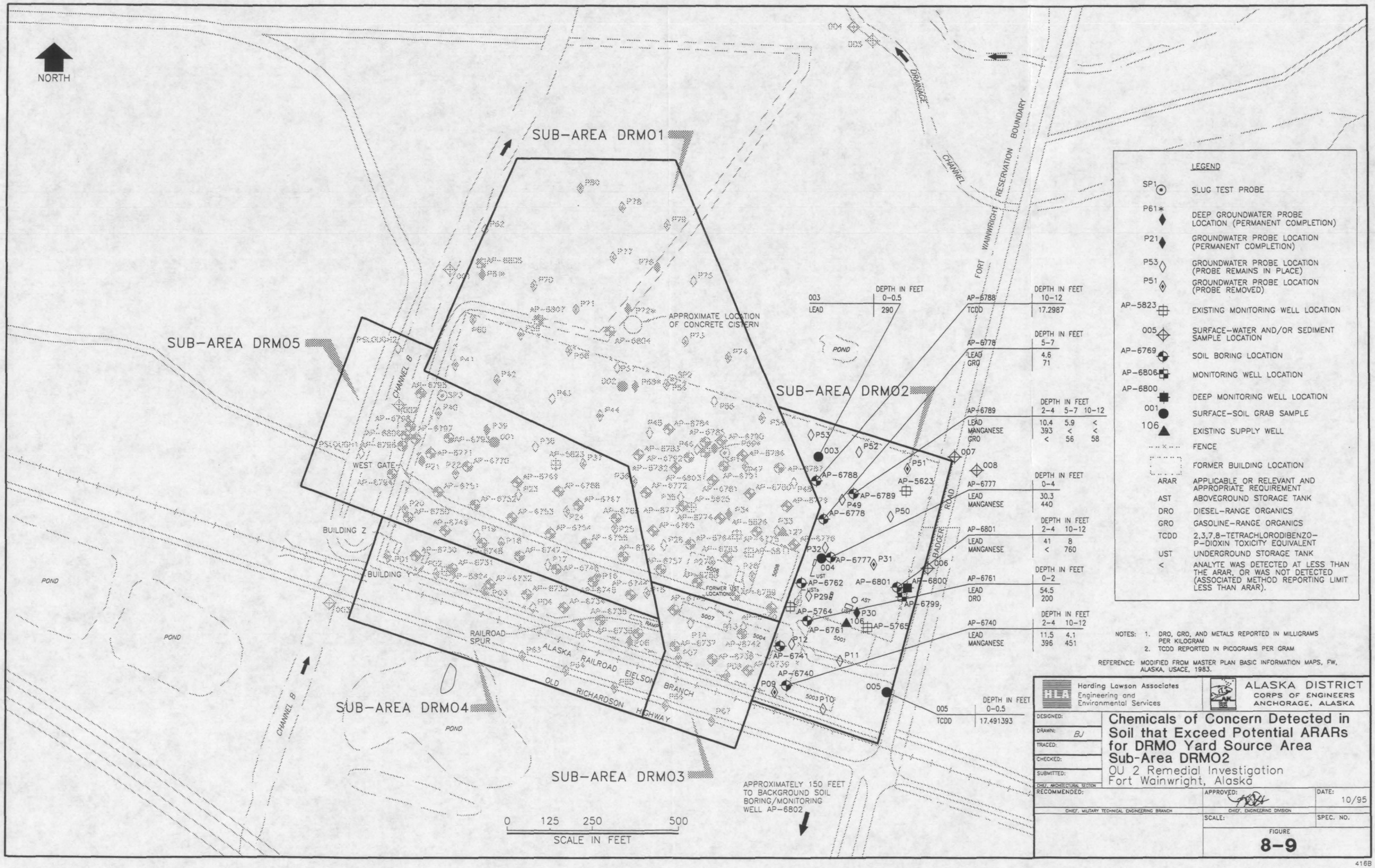
DATE: 10/95

SCALE:

SPEC. NO.

FIGURE
8-8

338b



003	DEPTH IN FEET 0-0.5
LEAD	290

AP-6788	DEPTH IN FEET 10-12
TCDD	17.2987

AP-6778	DEPTH IN FEET 5-7
LEAD	4.6
GRO	71

AP-6789	DEPTH IN FEET 2-4	5-7	10-12
LEAD	10.4	5.9	<
MANGANESE	393	<	<
GRO	<	56	58

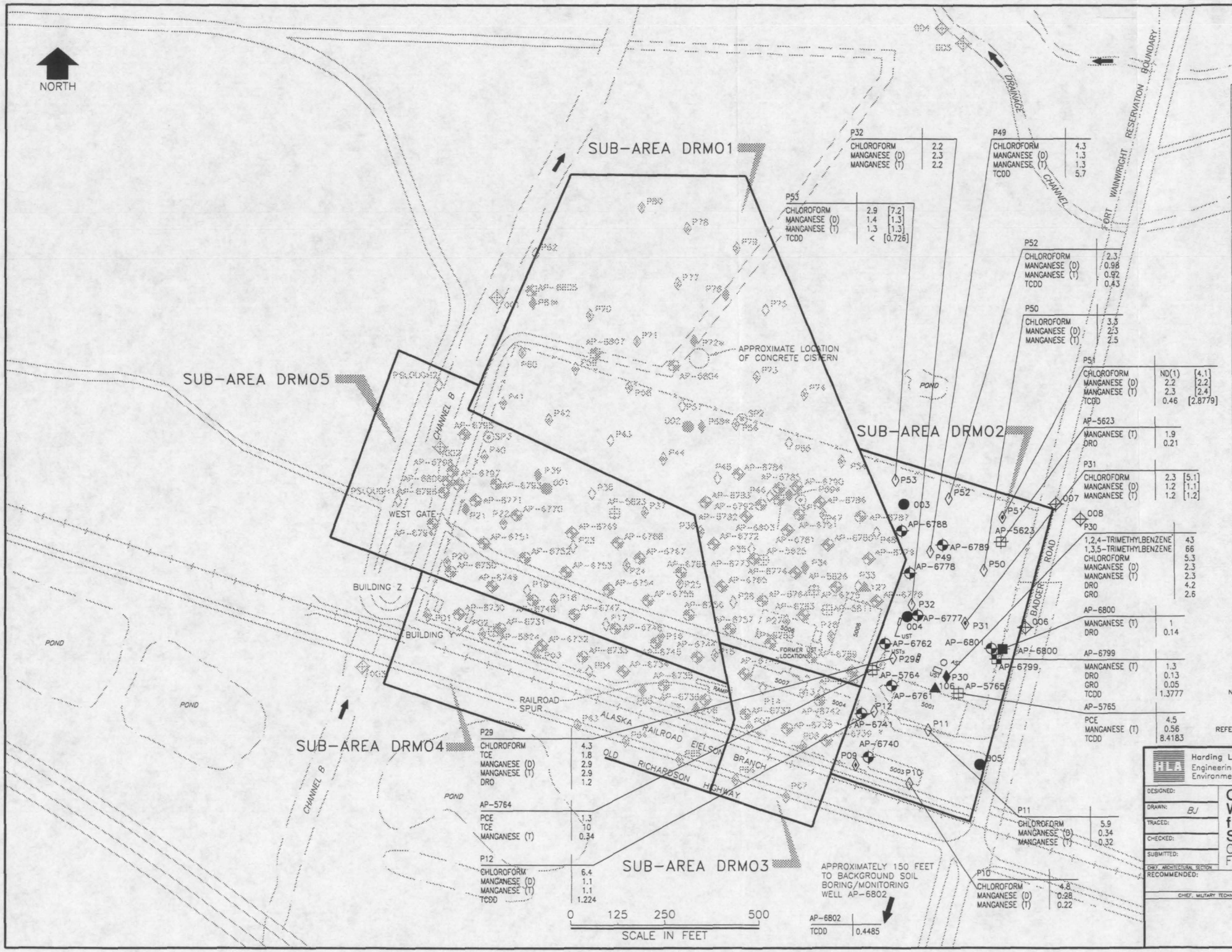
AP-6777	DEPTH IN FEET 0-4
LEAD	30.3
MANGANESE	440

AP-6801	DEPTH IN FEET 2-4	10-12
LEAD	41	8
MANGANESE	<	760

AP-6761	DEPTH IN FEET 0-2
LEAD	54.5
DRO	200

AP-6740	DEPTH IN FEET 2-4	10-12
LEAD	11.5	4.1
MANGANESE	396	451

005	DEPTH IN FEET 0-0.5
TCDD	17.491393



P32

CHLOROFORM	2.2
MANGANESE (D)	2.3
MANGANESE (T)	2.2

P53

CHLOROFORM	2.9	[7.2]
MANGANESE (D)	1.4	[1.3]
MANGANESE (T)	1.3	[1.3]
TCDD	<	[0.726]

P49

CHLOROFORM	4.3
MANGANESE (D)	1.3
MANGANESE (T)	1.3
TCDD	5.7

P52

CHLOROFORM	2.3
MANGANESE (D)	0.98
MANGANESE (T)	0.92
TCDD	0.43

P50

CHLOROFORM	3.3
MANGANESE (D)	2.3
MANGANESE (T)	2.5

P51

CHLOROFORM	ND(1)	[4.1]
MANGANESE (D)	2.2	[2.2]
MANGANESE (T)	2.3	[2.4]
TCDD	0.46	[2.8779]

AP-5623

MANGANESE (T)	1.9
DRO	0.21

P31

CHLOROFORM	2.3	[5.1]
MANGANESE (D)	1.2	[1.1]
MANGANESE (T)	1.2	[1.2]

P30

1,2,4-TRIMETHYLBENZENE	43
1,3,5-TRIMETHYLBENZENE	66
CHLOROFORM	5.3
MANGANESE (D)	2.3
MANGANESE (T)	2.3
DRO	4.2
GRO	2.6

AP-6800

MANGANESE (T)	1
DRO	0.14

AP-6799

MANGANESE (T)	1.3
DRO	0.13
GRO	0.05
TCDD	1.3777

AP-5765

PCE	4.5
MANGANESE (T)	0.56
TCDD	8.4183

P29

CHLOROFORM	4.3
TCE	1.8
MANGANESE (D)	2.9
MANGANESE (T)	2.9
DRO	1.2

AP-5764

PCE	1.3
TCE	10
MANGANESE (T)	0.34

P12

CHLOROFORM	6.4
MANGANESE (D)	1.1
MANGANESE (T)	1.1
TCDD	1.224

P11

CHLOROFORM	5.9
MANGANESE (D)	0.34
MANGANESE (T)	0.32

P10

CHLOROFORM	4.8
MANGANESE (D)	0.28
MANGANESE (T)	0.22

AP-6802

TCDD	0.4485

LEGEND

SP1	SLUG TEST PROBE
P61*	DEEP GROUNDWATER PROBE LOCATION (PERMANENT COMPLETION)
P21	GROUNDWATER PROBE LOCATION (PERMANENT COMPLETION)
P53	GROUNDWATER PROBE LOCATION (PROBE REMAINS IN PLACE)
P51	GROUNDWATER PROBE LOCATION (PROBE REMOVED)
AP-5823	EXISTING MONITORING WELL LOCATION
005	SURFACE-WATER AND/OR SEDIMENT SAMPLE LOCATION
AP-6769	SOIL BORING LOCATION
AP-6806	MONITORING WELL LOCATION
AP-6800	DEEP MONITORING WELL LOCATION
001	SURFACE-SOIL GRAB SAMPLE
106	EXISTING SUPPLY WELL
	FENCE
	FORMER BUILDING LOCATION
ARAR	APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENT
AST	ABOVEGROUND STORAGE TANK
DRO	DIESEL-RANGE ORGANICS
GRO	GASOLINE-RANGE ORGANICS
ND	NOT DETECTED AT OR ABOVE THE METHOD REPORTING LIMIT SHOWN IN PARENTHESES
PAH	POLYNUCLEAR AROMATIC HYDROCARBON
PCB	POLYCHLORINATED BIPHENYL
PCE	TETRACHLOROETHENE
TCDD	2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN TOXICITY EQUIVALENT
TCE	TRICHLOROETHENE
UST	UNDERGROUND STORAGE TANK
<	ANALYTE WAS DETECTED AT LESS THAN THE ARAR, OR WAS NOT DETECTED (ASSOCIATED METHOD REPORTING LIMIT LESS THAN ARAR).
[ ]	DUPLICATE SAMPLE RESULTS
(D)	DISSOLVED
(T)	TOTAL

NOTES:
1. DRO, GRO, AND METALS REPORTED IN MILLIGRAMS PER LITER
2. PAHs REPORTED IN MICROGRAMS PER LITER
2. TCDD REPORTED IN PICOGRAMS PER LITER

REFERENCE: MODIFIED FROM MASTER PLAN BASIC INFORMATION MAPS, FW, ALASKA, USACE, 1983.

Harding Lawson Associates
Engineering and Environmental Services

ALASKA DISTRICT
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED:
DRAWN: BJ
TRACED:
CHECKED:
SUBMITTED:
CHIEF, ARCHITECTURAL SECTION
RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH

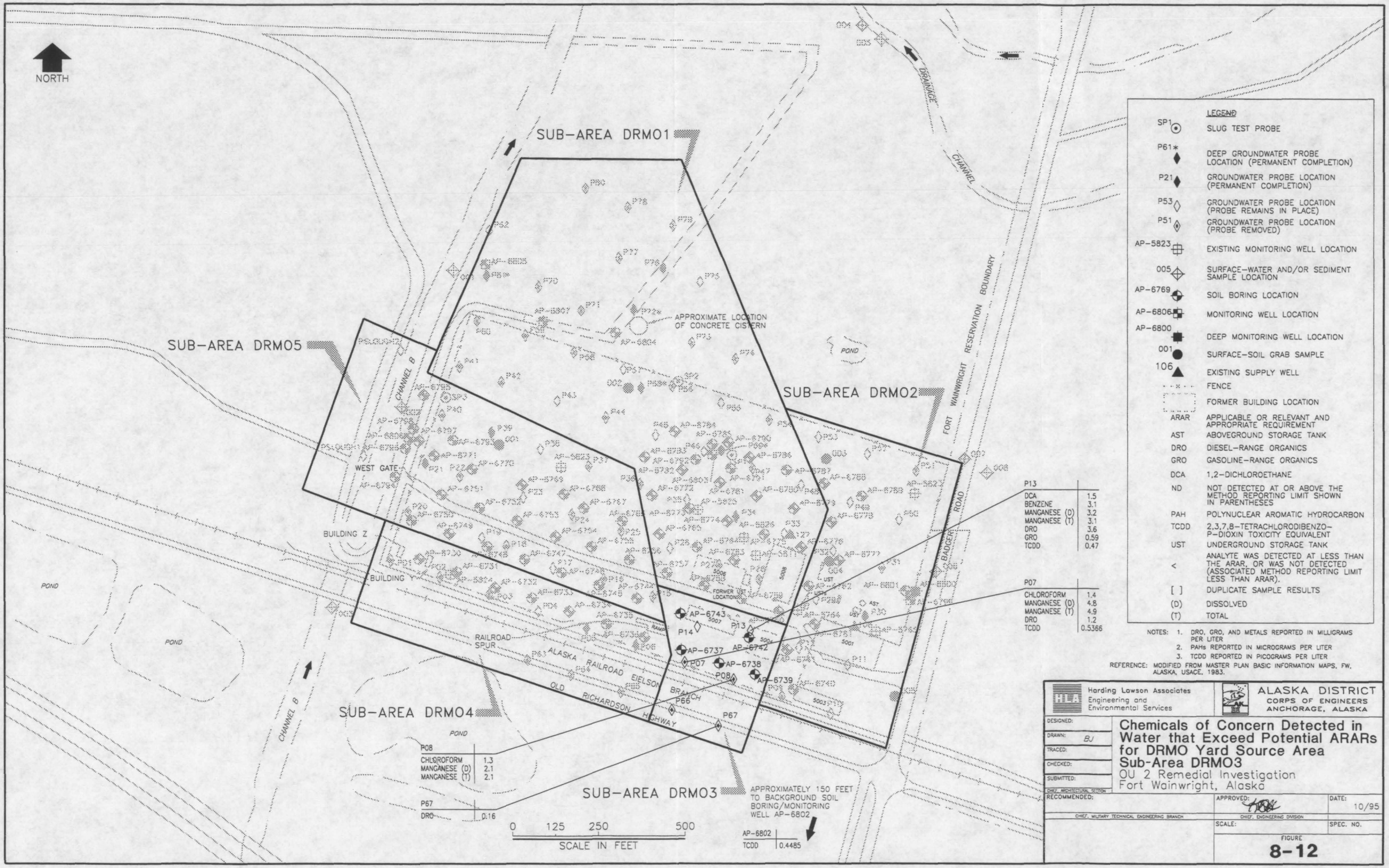
Chemicals of Concern Detected in Water that Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO2

OU 2 Remedial Investigation
Fort Wainwright, Alaska

APPROVED:
CHIEF, ENGINEERING DIVISION
DATE: 10/95
SCALE:
SPEC. NO.

FIGURE
8-10

417B



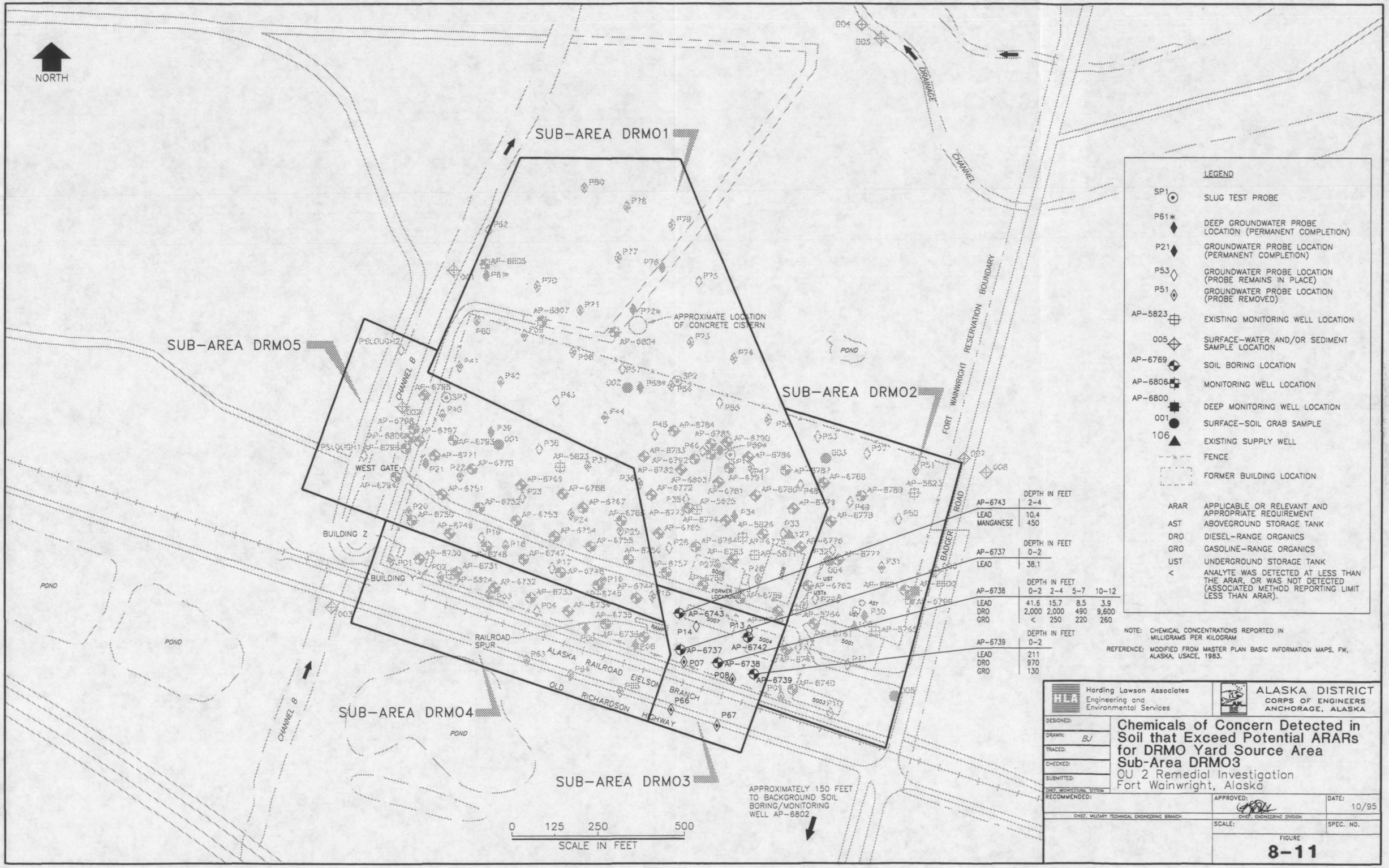
P13	
DCA	1.5
BENZENE	3.1
MANGANESE (D)	3.2
MANGANESE (T)	3.1
DRO	3.6
GRO	0.59
TCDD	0.47

P07	
CHLOROFORM	1.4
MANGANESE (D)	4.8
MANGANESE (T)	4.9
DRO	1.2
TCDD	0.5366

P08	
CHLOROFORM	1.3
MANGANESE (D)	2.1
MANGANESE (T)	2.1

P67	
DRO	0.16

AP-6802	
TCDD	0.4485



AP-6743	DEPTH IN FEET 2-4
LEAD	10.4
MANGANESE	450

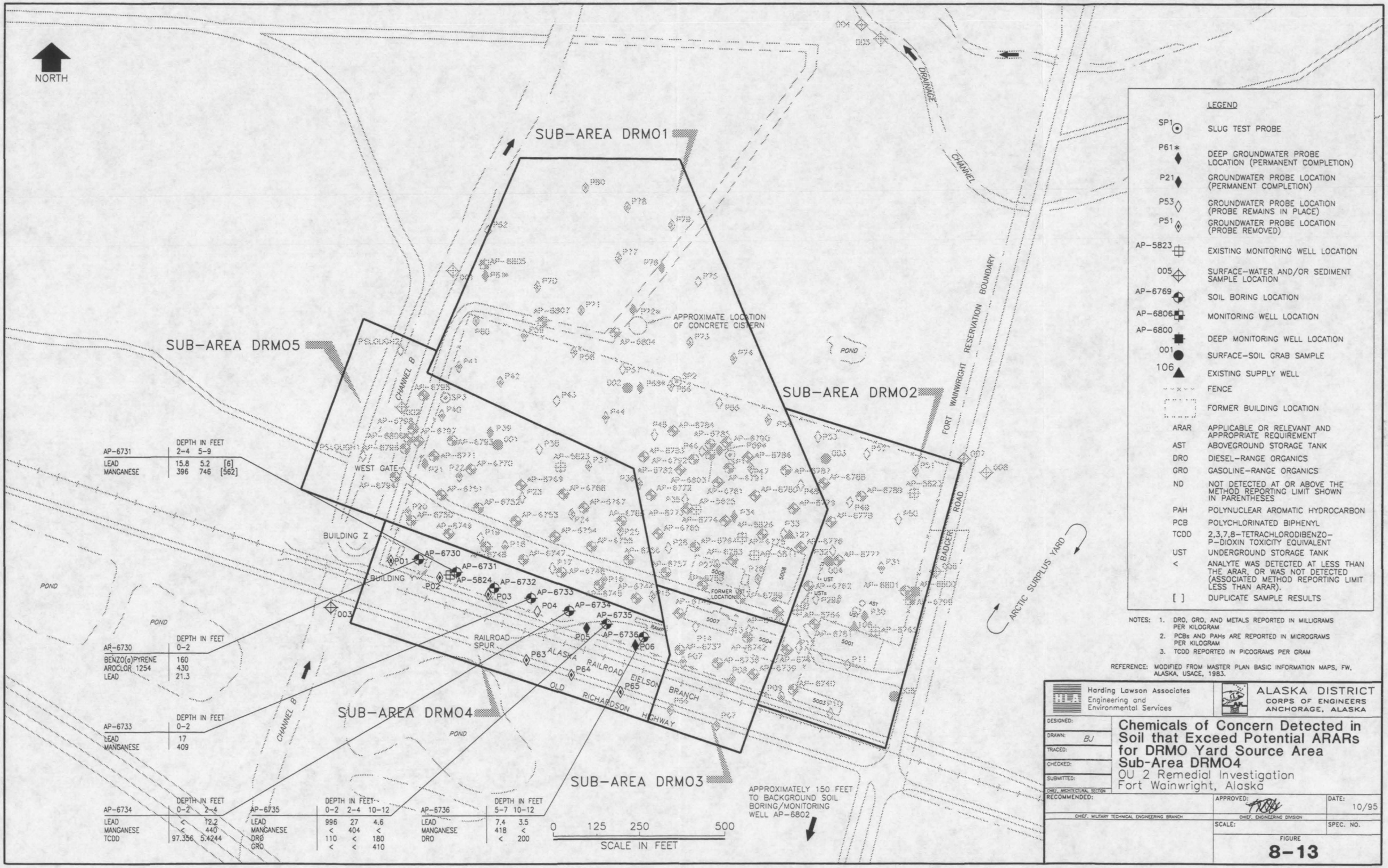
AP-6737	DEPTH IN FEET 0-2
LEAD	38.1

AP-6738	DEPTH IN FEET 0-2	2-4	5-7	10-12
LEAD	41.6	15.7	8.5	3.9
DRO	2,000	2,000	490	9,600
GRO	<	250	220	260

AP-6739	DEPTH IN FEET 0-2
LEAD	211
DRO	970
GRO	130

Chemicals of Concern Detected in Soil that Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO3

OU 2 Remedial Investigation
Fort Wainwright, Alaska



AP-6731	DEPTH IN FEET 2-4	5-9
LEAD	15.8	5.2 [6]
MANGANESE	396	746 [562]

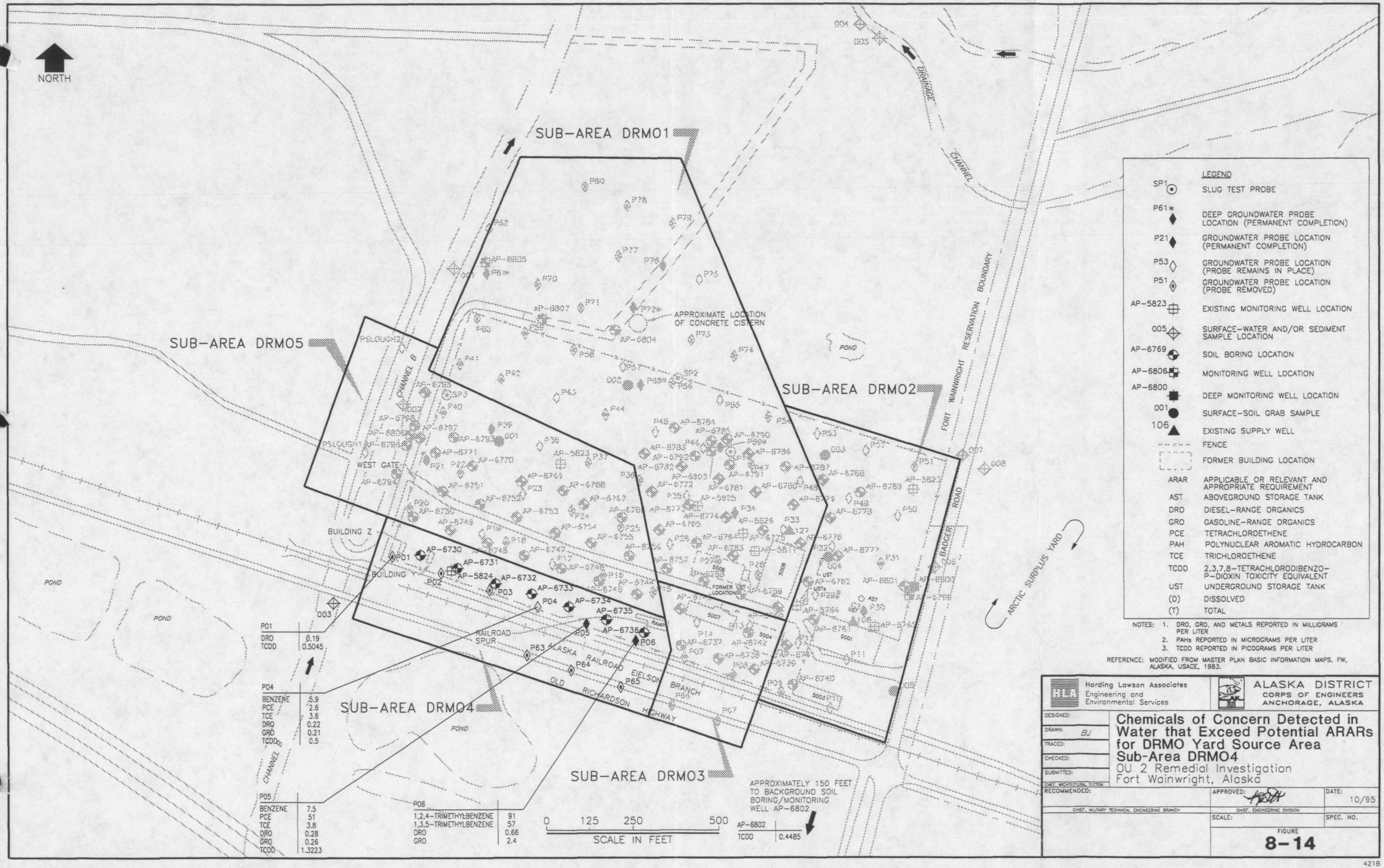
AP-6730	DEPTH IN FEET 0-2
BENZO(a)PYRENE	160
AROCLOR 1254	430
LEAD	21.3

AP-6733	DEPTH IN FEET 0-2
LEAD	17
MANGANESE	409

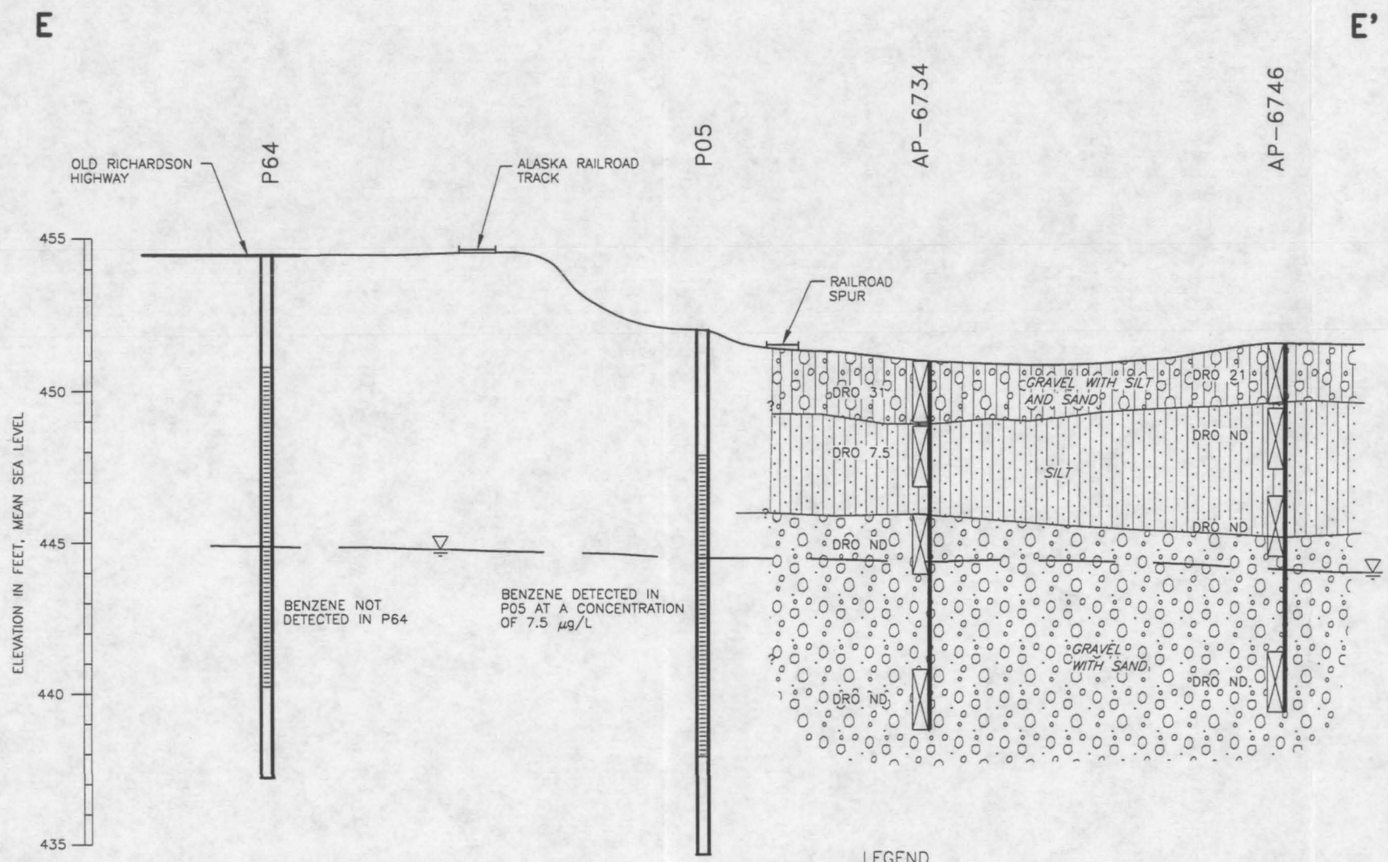
AP-6734	DEPTH IN FEET 0-2	2-4
LEAD	<	12.2
MANGANESE	<	440
TCDD	97.356	5.4244

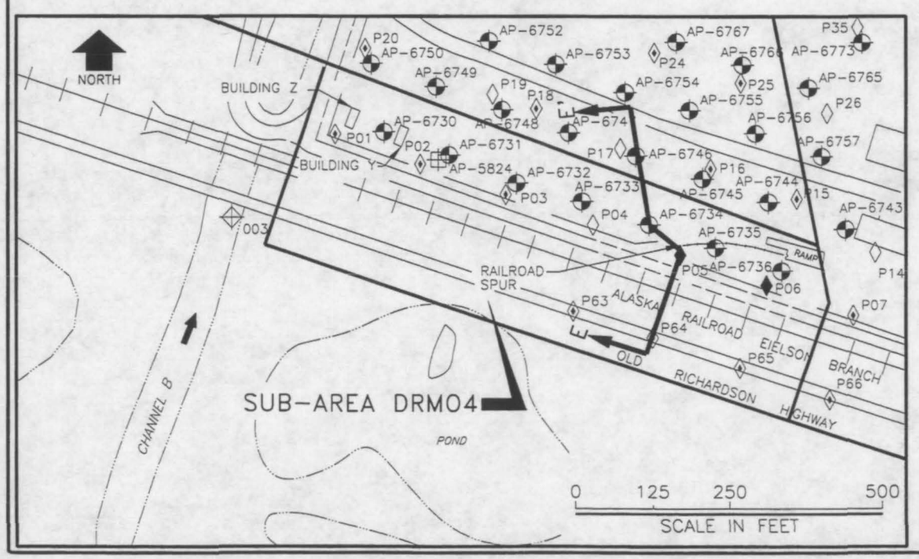
AP-6735	DEPTH IN FEET 0-2	2-4	10-12
LEAD	996	27	4.6
MANGANESE	<	404	<
DRO	110	<	180
GRO	<	<	410

AP-6736	DEPTH IN FEET 5-7	10-12
LEAD	7.4	3.5
MANGANESE	418	<
DRO	<	200


NORTH
SUB-AREA DRMO1
SUB-AREA DRMO2
SUB-AREA DRMO3
SUB-AREA DRMO4
SUB-AREA DRMO5
APPROXIMATE LOCATION OF CONCRETE CISTERN
DRAINAGE CHANNEL
FORT WAINWRIGHT RESERVATION BOUNDARY
BADGER ROAD
ARCTIC SURPLUS YARD
POND
CHANNEL B
WEST GATE
BUILDING Z
BUILDING Y
RAILROAD SPUR
ALASKA RAILROAD EIELSON BRANCH
OLD RICHARDSON HIGHWAY
FORMER UST LOCATIONS
AP-6730
AP-6731
AP-5824
AP-6732
AP-6733
AP-6734
AP-6735
AP-6736
P01
P02
P03
P04
P05
P06
P63
P64
P65
003
P01
DRO 0.19
TCDD 0.5045
P04
BENZENE 5.9
PCE 2.6
TCE 3.6
DRO 0.22
GRO 0.21
TCDD 0.5
P05
BENZENE 7.5
PCE 51
TCE 3.8
DRO 0.28
GRO 0.26
TCDD 1.3223
P06
1,2,4-TRIMETHYLBENZENE 91
1,3,5-TRIMETHYLBENZENE 57
DRO 0.66
GRO 2.4
APPROXIMATELY 150 FEET TO BACKGROUND SOIL BORING/MONITORING WELL AP-6802
AP-6802
TCDD 0.4485
0 125 250 500
SCALE IN FEET
LEGEND
SP1 SLUG TEST PROBE
P61* DEEP GROUNDWATER PROBE LOCATION (PERMANENT COMPLETION)
P21 GROUNDWATER PROBE LOCATION (PERMANENT COMPLETION)
P53 GROUNDWATER PROBE LOCATION (PROBE REMAINS IN PLACE)
P51 GROUNDWATER PROBE LOCATION (PROBE REMOVED)
AP-5823 EXISTING MONITORING WELL LOCATION
005 SURFACE-WATER AND/OR SEDIMENT SAMPLE LOCATION
AP-6769 SOIL BORING LOCATION
AP-6806 MONITORING WELL LOCATION
AP-6800 DEEP MONITORING WELL LOCATION
001 SURFACE-SOIL GRAB SAMPLE
106 EXISTING SUPPLY WELL
FENCE
FORMER BUILDING LOCATION
ARAR APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENT
AST ABOVEGROUND STORAGE TANK
DRO DIESEL-RANGE ORGANICS
GRO GASOLINE-RANGE ORGANICS
PCE TETRACHLOROETHENE
PAH POLYNUCLEAR AROMATIC HYDROCARBON
TCE TRICHLOROETHENE
TCDD 2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN TOXICITY EQUIVALENT
UST UNDERGROUND STORAGE TANK
(D) DISSOLVED
(T) TOTAL
NOTES: 1. DRO, GRO, AND METALS REPORTED IN MILLIGRAMS PER LITER
2. PAHs REPORTED IN MICROGRAMS PER LITER
3. TCDD REPORTED IN PICOGRAMS PER LITER
REFERENCE: MODIFIED FROM MASTER PLAN BASIC INFORMATION MAPS, FW, ALASKA, USACE, 1983.
Harding Lawson Associates
Engineering and Environmental Services
ALASKA DISTRICT
CORPS OF ENGINEERS
ANCHORAGE, ALASKA
DESIGNED:
DRAWN: BJ
TRACED:
CHECKED:
SUBMITTED:
CHIEF, ARCHITECTURAL SECTION
Chemicals of Concern Detected in Water that Exceed Potential ARARs for DRMO Yard Source Area Sub-Area DRMO4
OU 2 Remedial Investigation
Fort Wainwright, Alaska
RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH
APPROVED:
CHIEF, ENGINEERING DIVISION
DATE: 10/95
SCALE:
SPEC. NO.
FIGURE
8-14

421B





LEGEND

AP-6734 — BORING NUMBER

DRO 7.5 — DIESEL-RANGE ORGANIC CONCENTRATION IN mg/kg

P05 — BORING NUMBER

▽	GROUNDWATER LEVEL BASED ON 1994 REMEDIAL INVESTIGATION SURVEY
mg/kg	MILLIGRAMS PER KILOGRAM
µg/L	MICROGRAMS PER LITER
ND	NOT DETECTED
DRO	DIESEL-RANGE ORGANICS

SCALE: HORIZONTAL 1" = 50'
VERTICAL 1" = 5'

NOTES:
1. THE LINES DESIGNATING THE INTERFACE BETWEEN SOIL AND ROCK MATERIALS ON THE SUBSURFACE PROFILES ARE INTERPOLATED AND ARE THEREFORE APPROXIMATIONS. THE TRANSITION BETWEEN THE MATERIALS MAY BE ABRUPT OR GRADUAL. THE PROFILES SHOULD BE CONSIDERED AS REASONABLY ACCURATE ONLY AT THE BORING LOCATIONS, AND THEN ONLY TO THE DEGREE IMPLIED BY THE NOTES ON THE BORING LOGS. DETAILED STRATIGRAPHIC INFORMATION SHOULD BE OBTAINED FROM THE SOIL BORING LOGS.
2. NO STRATIGRAPHIC INFORMATION COLLECTED DURING PROBE INSTALLATION.

Harding Lawson Associates
Engineering and Environmental Services

ALASKA DISTRICT
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

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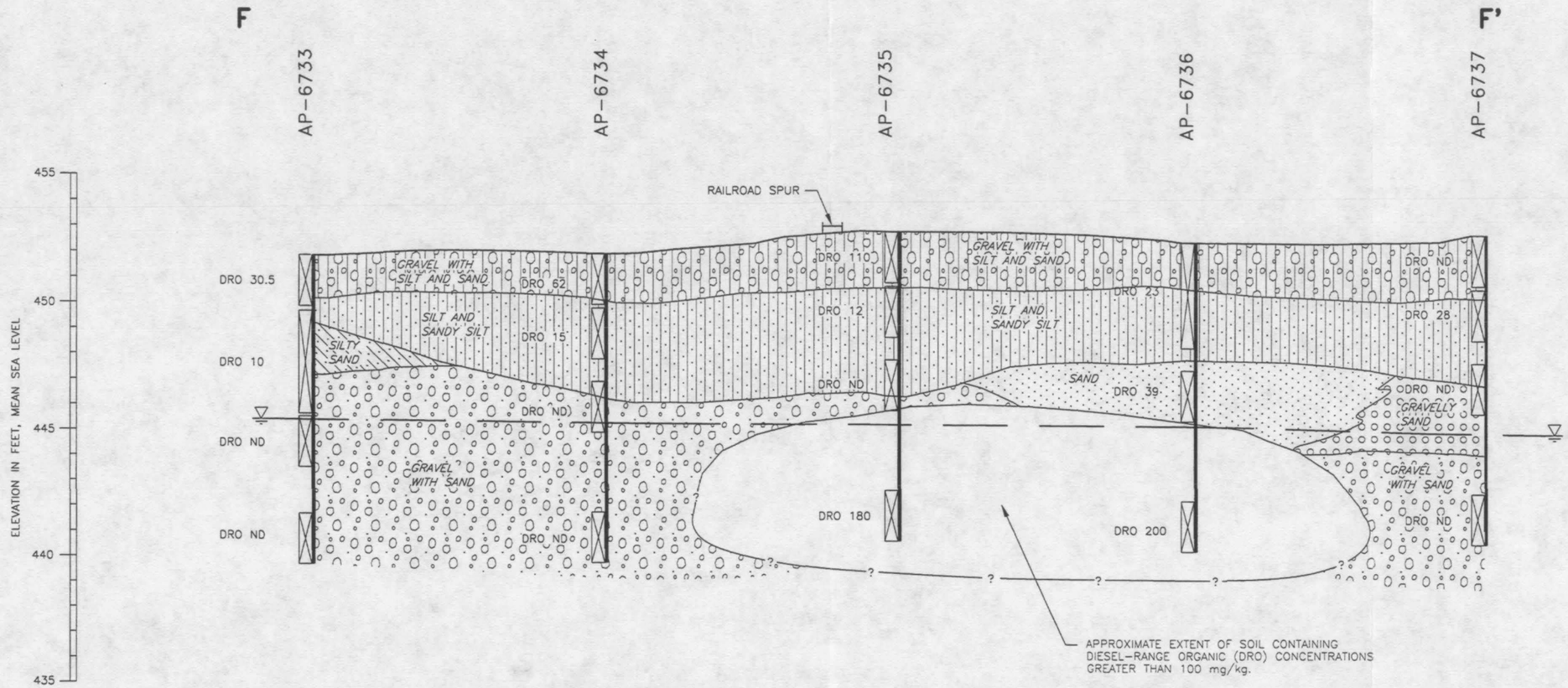
SUBMITTED:
CHIEF, ARCHITECTURAL SECTION
RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH

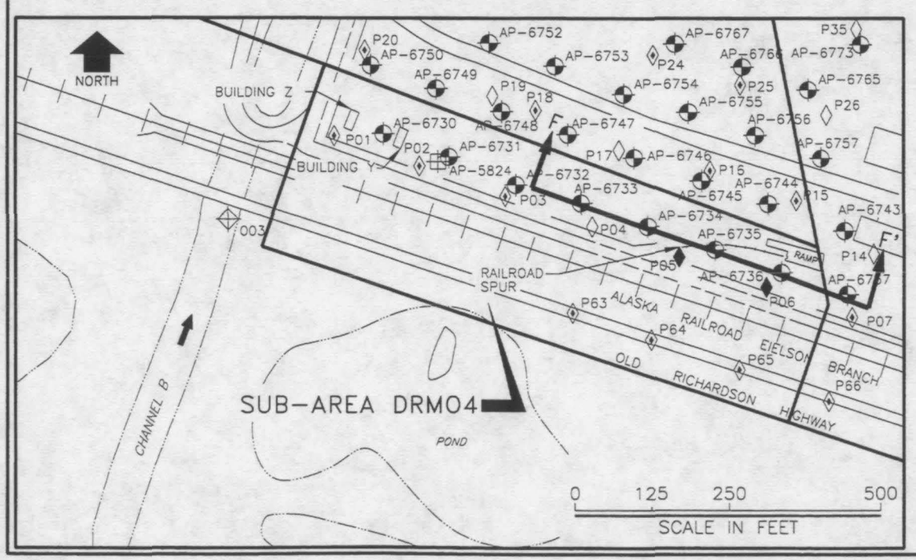
DRMO Yard Source Area
Sub-Area DRMO4
Subsurface-Soil Profile E-E'

OU 2 Remedial Investigation
Fort Wainwright, Alaska

APPROVED:
CHIEF, ENGINEERING DIVISION
DATE: 10/95
SCALE:
SPEC. NO.
FIGURE
8-15

326b





LEGEND

AP-6734 — BORING NUMBER

DRO 7.5 — DIESEL-RANGE ORGANIC CONCENTRATION IN mg/kg

GROUNDWATER LEVEL BASED ON 1994 REMEDIAL INVESTIGATION SURVEY

mg/kg MILLIGRAMS PER KILOGRAM

ND NOT DETECTED

SCALE: HORIZONTAL 1" = 50'
VERTICAL 1" = 5'

NOTE: THE LINES DESIGNATING THE INTERFACE BETWEEN SOIL AND ROCK MATERIALS ON THE SUBSURFACE PROFILES ARE INTERPOLATED AND ARE THEREFORE APPROXIMATIONS. THE TRANSITION BETWEEN THE MATERIALS MAY BE ABRUPT OR GRADUAL. THE PROFILES SHOULD BE CONSIDERED AS REASONABLY ACCURATE ONLY AT THE BORING LOCATIONS, AND THEN ONLY TO THE DEGREE IMPLIED BY THE NOTES ON THE BORING LOGS. DETAILED STRATIGRAPHIC INFORMATION SHOULD BE OBTAINED FROM THE SOIL BORING LOGS.

Harding Lawson Associates
Engineering and Environmental Services

ALASKA DISTRICT
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED:
DRAWN: BJ
TRACED:
CHECKED:
SUBMITTED:
CHIEF, ARCHITECTURAL SECTION

DRMO Yard Source Area
Sub-Area DRMO4
Subsurface-Soil Profile F-F'

OU 2 Remedial Investigation
Fort Wainwright, Alaska

RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH

APPROVED:
CHIEF, ENGINEERING DIVISION

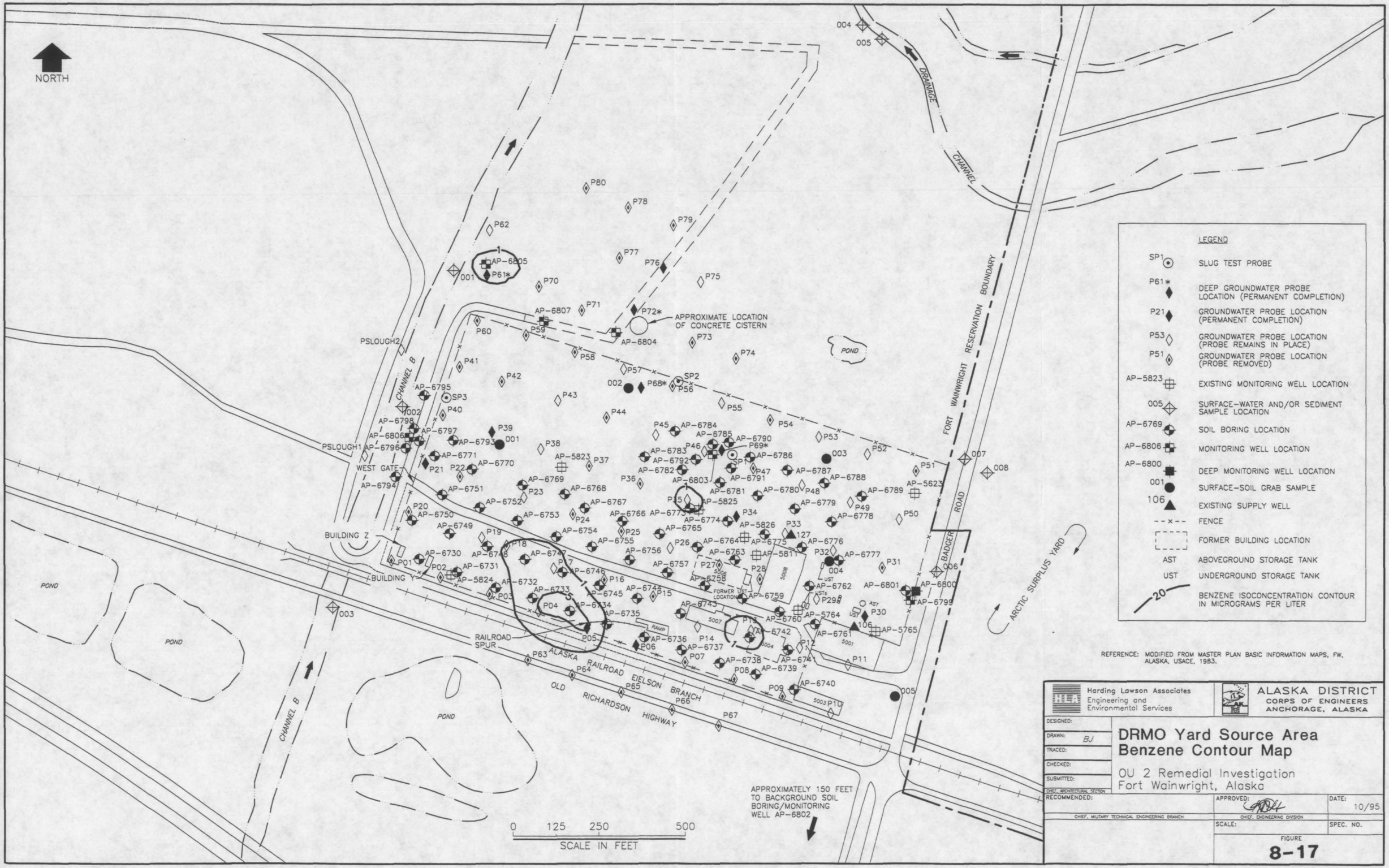
DATE: 10/95

SCALE:

SPEC. NO.

FIGURE
8-16

327b



REFERENCE: MODIFIED FROM MASTER PLAN BASIC INFORMATION MAPS, FW, ALASKA, USACE, 1983.

Harding Lawson Associates
Engineering and Environmental Services

ALASKA DISTRICT
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

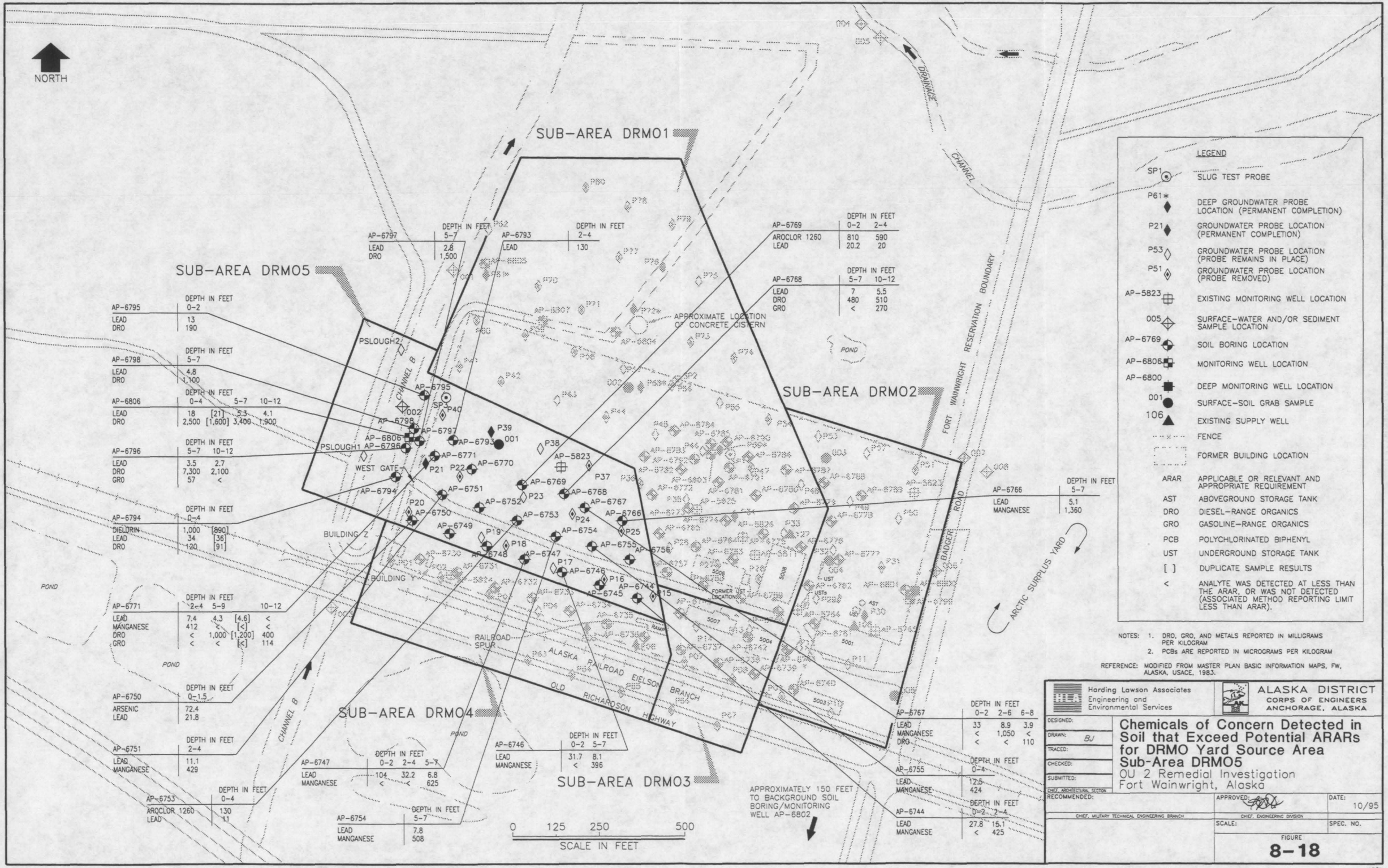
DESIGNED:	
DRAWN:	BJ
TRACED:	
CHECKED:	
SUBMITTED:	
CHIEF, ARCHITECTURAL SECTION	
RECOMMENDED:	
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH	
APPROVED:	
CHIEF, ENGINEERING DIVISION	
DATE:	10/95
SCALE:	
SPEC. NO.	

DRMO Yard Source Area Benzene Contour Map

OU 2 Remedial Investigation
Fort Wainwright, Alaska

FIGURE
8-17

340b



AP-6797	DEPTH IN FEET 5-7
LEAD	2.8
DRO	1,500

AP-6793	DEPTH IN FEET 2-4
LEAD	130

AP-6769	DEPTH IN FEET 0-2	2-4
AROCLOR 1260	810	590
LEAD	20.2	20

AP-6768	DEPTH IN FEET 5-7	10-12
LEAD	7	5.5
DRO	480	510
GRO	<	270

AP-6795	DEPTH IN FEET 0-2
LEAD	13
DRO	190

AP-6798	DEPTH IN FEET 5-7
LEAD	4.8
DRO	1,100

AP-6806	DEPTH IN FEET 0-4	5-7	10-12
LEAD	18	[21]	5.3	4.1
DRO	2,500	[1,600]	3,400	1,900

AP-6796	DEPTH IN FEET 5-7	10-12
LEAD	3.5	2.7
DRO	7,300	2,100
GRO	57	<

AP-6794	DEPTH IN FEET 0-4
DIELDRIN	1,000 [890]
LEAD	34 [36]
DRO	120 [91]

AP-6771	DEPTH IN FEET 2-4	5-9		10-12
LEAD	7.4	4.3	[4.6]	<
MANGANESE	412	<	[<]	<
DRO	<	1,000	[1,200]	400
GRO	<	<	[<]	114

AP-6750	DEPTH IN FEET 0-1.5
ARSENIC	72.4
LEAD	21.8

AP-6751	DEPTH IN FEET 2-4
LEAD	11.1
MANGANESE	429

AP-6753	DEPTH IN FEET 0-4
AROCLOR 1260	130
LEAD	1.1

AP-6754	DEPTH IN FEET 5-7
LEAD	7.8
MANGANESE	508

AP-6747	DEPTH IN FEET 0-2	2-4	5-7
LEAD	104	32.2	6.8
MANGANESE	<	<	625

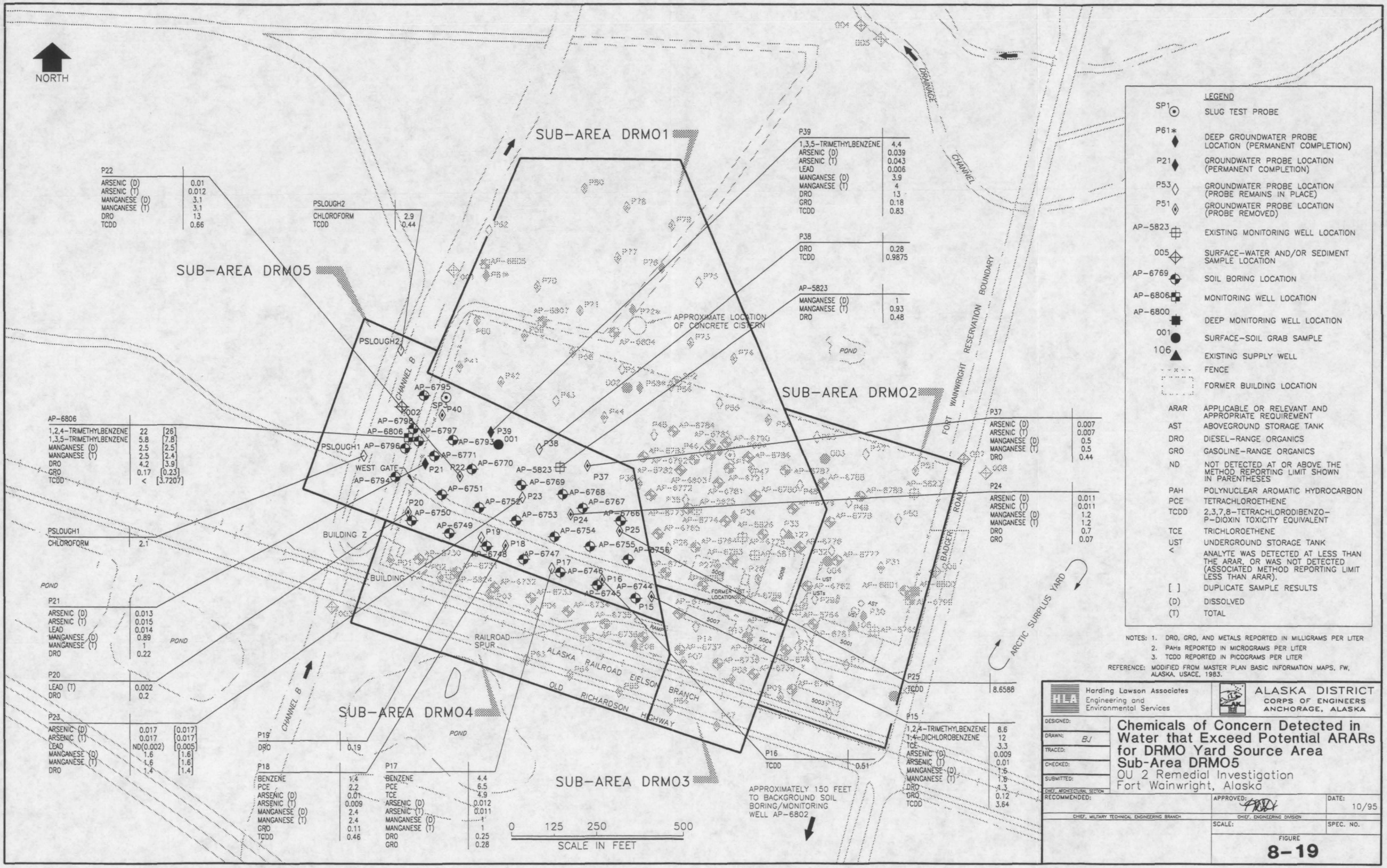
AP-6746	DEPTH IN FEET 0-2	5-7
LEAD	31.7	8.1
MANGANESE	<	396

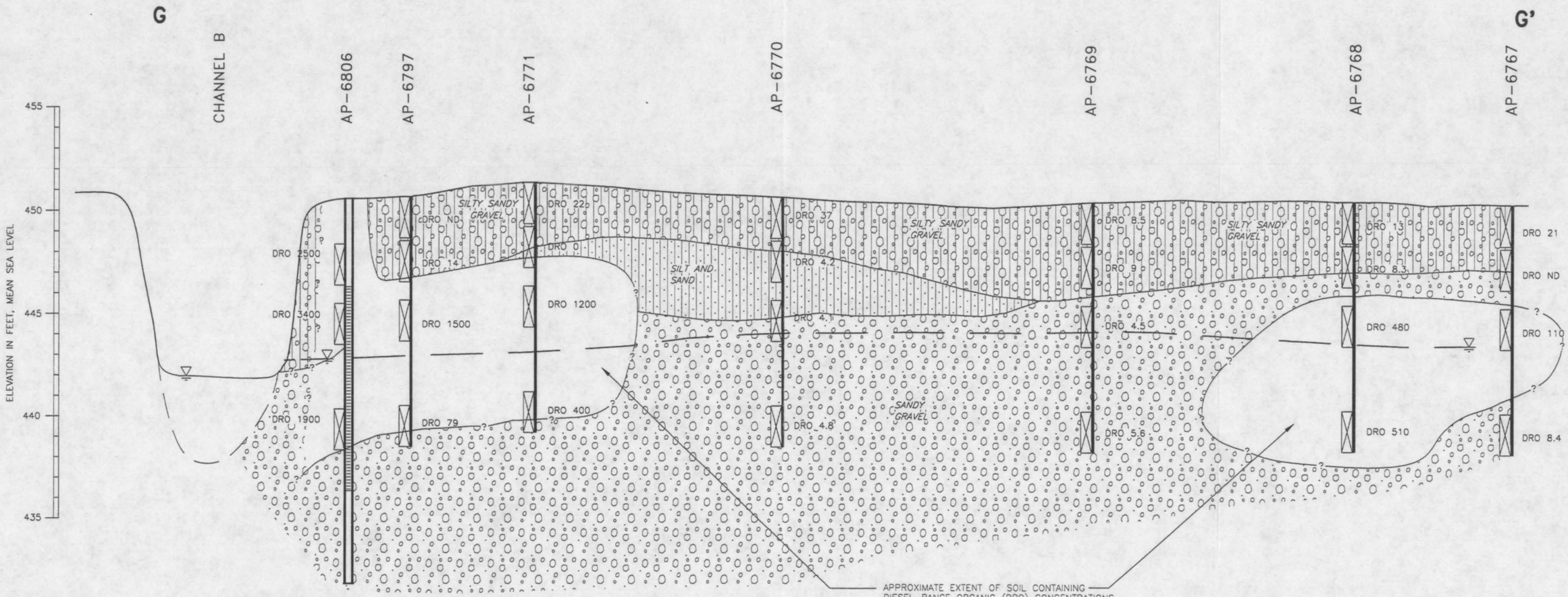
AP-6766	DEPTH IN FEET 5-7
LEAD	5.1
MANGANESE	1,360

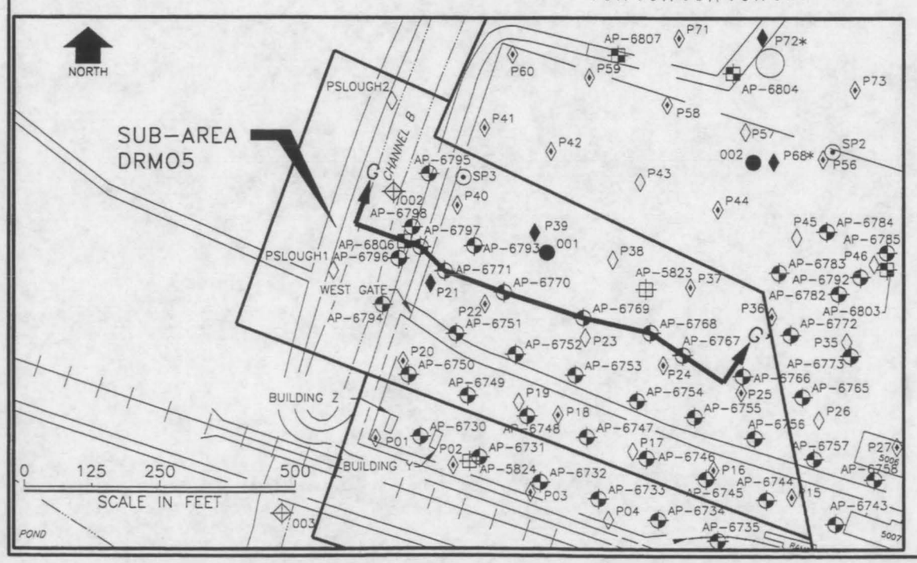
AP-6767	DEPTH IN FEET 0-2	2-6	6-8
LEAD	33	8.9	3.9
MANGANESE	<	1,050	<
DRO	<	<	110

AP-6755	DEPTH IN FEET 0-4
LEAD	12.5
MANGANESE	424

AP-6744	DEPTH IN FEET 0-2	2-4
LEAD	27.8	15.1
MANGANESE	<	425


NORTH
SUB-AREA DRMO1
SUB-AREA DRMO2
SUB-AREA DRMO3
SUB-AREA DRMO4
SUB-AREA DRMO5
P22
ARSENIC (D) 0.01
ARSENIC (T) 0.012
MANGANESE (D) 3.1
MANGANESE (T) 3.1
DRO 13
TCDD 0.66
PSLOUGH2
CHLOROFORM 2.9
TCDD 0.44
P39
1,3,5-TRIMETHYLBENZENE 4.4
ARSENIC (D) 0.039
ARSENIC (T) 0.043
LEAD 0.006
MANGANESE (D) 3.9
MANGANESE (T) 4
DRO 13
GRO 0.18
TCDD 0.83
P38
DRO 0.28
TCDD 0.9875
AP-5823
MANGANESE (D) 1
MANGANESE (T) 0.93
DRO 0.48
APPROXIMATE LOCATION OF CONCRETE CISTERN
POND
DRAINAGE CHANNEL
FORT WAINWRIGHT RESERVATION BOUNDARY
P37
ARSENIC (D) 0.007
ARSENIC (T) 0.007
MANGANESE (D) 0.5
MANGANESE (T) 0.5
DRO 0.44
P24
ARSENIC (D) 0.011
ARSENIC (T) 0.011
MANGANESE (D) 1.2
MANGANESE (T) 1.2
DRO 0.7
GRO 0.07
AP-6806
1,2,4-TRIMETHYLBENZENE 22 [26]
1,3,5-TRIMETHYLBENZENE 5.8 [7.8]
MANGANESE (D) 2.5 [2.5]
MANGANESE (T) 2.5 [2.4]
DRO 4.2 [3.9]
GRO 0.17 [0.23]
TCDD < [3.7207]
PSLOUGH1
CHLOROFORM 2.1
P21
ARSENIC (D) 0.013
ARSENIC (T) 0.015
LEAD 0.014
MANGANESE (D) 0.89
MANGANESE (T) 1
DRO 0.22
P20
LEAD (T) 0.002
DRO 0.2
P23
ARSENIC (D) 0.017 [0.017]
ARSENIC (T) 0.017 [0.017]
LEAD ND(0.002) [0.005]
MANGANESE (D) 1.6 [1.6]
MANGANESE (T) 1.6 [1.6]
DRO 1.4 [1.4]
P19
DRO 0.19
P18
BENZENE 1.4
PCE 2.2
ARSENIC (D) 0.01
ARSENIC (T) 0.009
MANGANESE (D) 2.4
MANGANESE (T) 2.4
GRO 0.11
TCDD 0.46
P17
BENZENE 4.4
PCE 6.5
TCE 4.9
ARSENIC (D) 0.012
ARSENIC (T) 0.011
MANGANESE (D) 1
MANGANESE (T) 1
DRO 0.25
GRO 0.28
P16
TCDD 0.51
P25
TCDD 8.6588
P15
1,2,4-TRIMETHYLBENZENE 8.6
1,4-DICHLOROBENZENE 12
TCE 3.3
ARSENIC (D) 0.009
ARSENIC (T) 0.01
MANGANESE (D) 1.5
MANGANESE (T) 1.6
DRO 4.3
GRO 0.12
TCDD 3.64
APPROXIMATELY 150 FEET TO BACKGROUND SOIL BORING/MONITORING WELL AP-6802
0 125 250 500
SCALE IN FEET
CHANNEL B
RAILROAD SPUR
ALASKA RAILROAD
EIELSON BRANCH
OLD RICHARDSON HIGHWAY
BUILDING Z
BUILDING Y
WEST GATE
FORMER UST LOCATION
BADGER ROAD
ARCTIC SURPLUS YARD
LEGEND
SP1 SLUG TEST PROBE
P61* DEEP GROUNDWATER PROBE LOCATION (PERMANENT COMPLETION)
P21 GROUNDWATER PROBE LOCATION (PERMANENT COMPLETION)
P53 GROUNDWATER PROBE LOCATION (PROBE REMAINS IN PLACE)
P51 GROUNDWATER PROBE LOCATION (PROBE REMOVED)
AP-5823 EXISTING MONITORING WELL LOCATION
005 SURFACE-WATER AND/OR SEDIMENT SAMPLE LOCATION
AP-6769 SOIL BORING LOCATION
AP-6806 MONITORING WELL LOCATION
AP-6800 DEEP MONITORING WELL LOCATION
001 SURFACE-SOIL GRAB SAMPLE
106 EXISTING SUPPLY WELL
FENCE
FORMER BUILDING LOCATION
ARAR APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENT
AST ABOVEGROUND STORAGE TANK
DRO DIESEL-RANGE ORGANICS
GRO GASOLINE-RANGE ORGANICS
ND NOT DETECTED AT OR ABOVE THE METHOD REPORTING LIMIT SHOWN IN PARENTHESES
PAH POLYNUCLEAR AROMATIC HYDROCARBON
PCE TETRACHLOROETHENE
TCDD 2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN TOXICITY EQUIVALENT
TCE TRICHLOROETHENE
UST UNDERGROUND STORAGE TANK
< ANALYTE WAS DETECTED AT LESS THAN THE ARAR, OR WAS NOT DETECTED (ASSOCIATED METHOD REPORTING LIMIT LESS THAN ARAR).
[ ] DUPLICATE SAMPLE RESULTS
(D) DISSOLVED
(T) TOTAL
NOTES: 1. DRO, GRO, AND METALS REPORTED IN MILLIGRAMS PER LITER
2. PAHs REPORTED IN MICROGRAMS PER LITER
3. TCDD REPORTED IN PICOGRAMS PER LITER
REFERENCE: MODIFIED FROM MASTER PLAN BASIC INFORMATION MAPS, FW, ALASKA, USACE, 1983.
Harding Lawson Associates
Engineering and Environmental Services
ALASKA DISTRICT
CORPS OF ENGINEERS
ANCHORAGE, ALASKA
DESIGNED:
DRAWN: BJ
TRACED:
CHECKED:
SUBMITTED:
CHIEF, ARCHITECTURAL SECTION
RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH
APPROVED:
CHIEF, ENGINEERING DIVISION
DATE: 10/95
SCALE:
SPEC. NO.
FIGURE
8-19
442B





LEGEND

AP-6797 — BORING NUMBER

DRO 1500 — DIESEL-RANGE ORGANIC CONCENTRATION IN mg/kg

AP-6806 — BORING NUMBER

DRO 3400 — DIESEL-RANGE ORGANIC CONCENTRATION IN mg/kg (SOIL SAMPLE COLLECTED FROM BORING PRIOR TO MONITORING WELL INSTALLATION)

GROUNDWATER LEVEL BASED ON 1994 REMEDIAL INVESTIGATION SURVEY

mg/kg MILLIGRAMS PER KILOGRAM

ND NOT DETECTED

SCALE: HORIZONTAL 1" = 50'
VERTICAL 1" = 5'

NOTE: THE LINES DESIGNATING THE INTERFACE BETWEEN SOIL AND ROCK MATERIALS ON THE SUBSURFACE PROFILES ARE INTERPOLATED AND ARE THEREFORE APPROXIMATIONS. THE TRANSITION BETWEEN THE MATERIALS MAY BE ABRUPT OR GRADUAL. THE PROFILES SHOULD BE CONSIDERED AS REASONABLY ACCURATE ONLY AT THE BORING LOCATIONS, AND THEN ONLY TO THE DEGREE IMPLIED BY THE NOTES ON THE BORING LOGS. DETAILED STRATIGRAPHIC INFORMATION SHOULD BE OBTAINED FROM THE SOIL BORING LOGS.

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ALASKA DISTRICT
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ANCHORAGE, ALASKA

DESIGNED:
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CHIEF, ARCHITECTURAL SECTION

DRMO Yard Source Area
Sub-Area DRMO5
Subsurface-Soil Profile G-G'

OU 2 Remedial Investigation
Fort Wainwright, Alaska

RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH

APPROVED:
CHIEF, ENGINEERING DIVISION

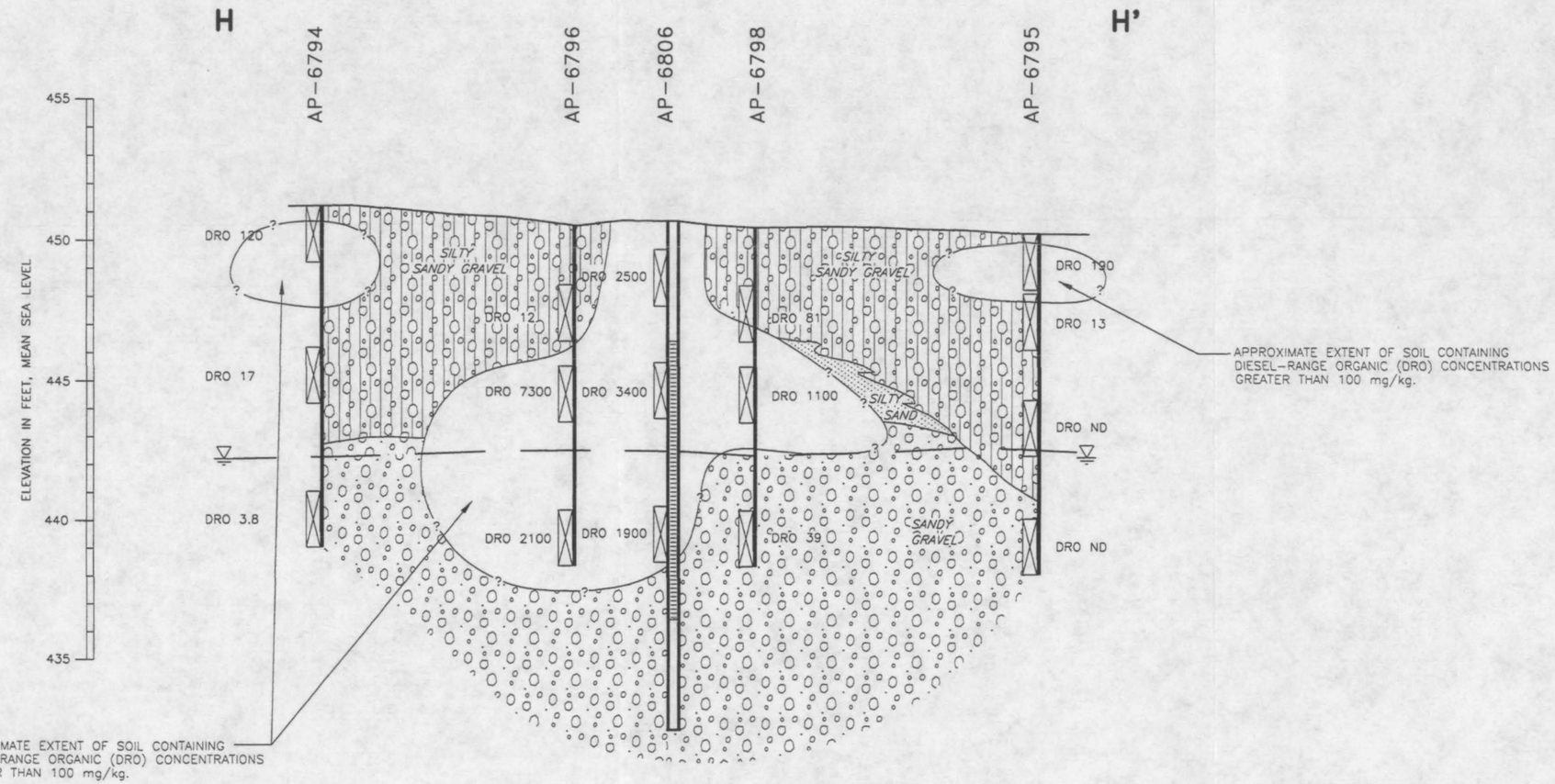
DATE: 10/95

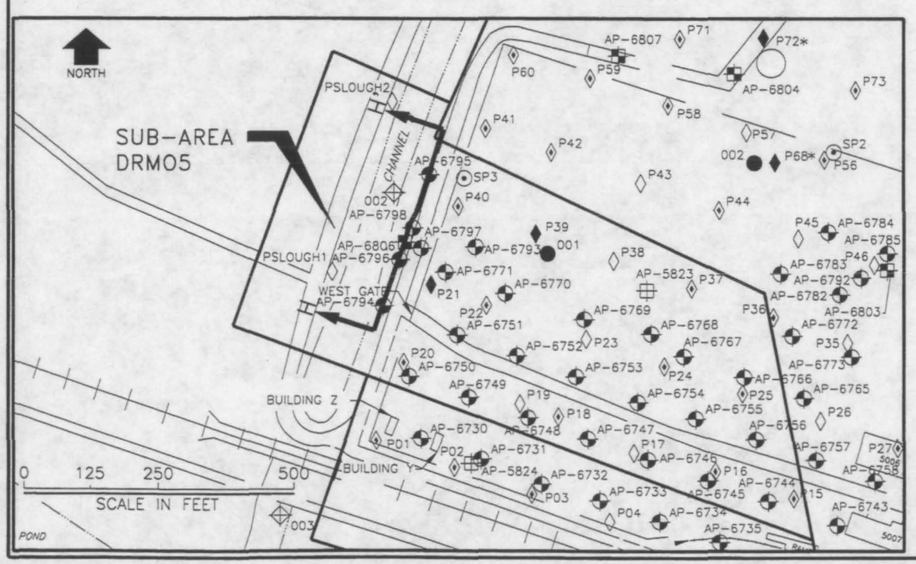
SCALE:

SPEC. NO.

FIGURE
8-20

328b





LEGEND

AP-6794 — BORING NUMBER

DRO 120 — DIESEL-RANGE ORGANIC CONCENTRATION IN mg/kg

AP-6806 — BORING NUMBER

DRO 1900 — DIESEL-RANGE ORGANIC CONCENTRATION IN mg/kg (SOIL SAMPLE COLLECTED FROM BORING PRIOR TO MONITORING WELL INSTALLATION)

GROUNDWATER LEVEL BASED ON 1994 REMEDIAL INVESTIGATION SURVEY

mg/kg MILLIGRAMS PER KILOGRAM

ND NOT DETECTED

SCALE: HORIZONTAL 1" = 50'
VERTICAL 1" = 5'

NOTE: THE LINES DESIGNATING THE INTERFACE BETWEEN SOIL AND ROCK MATERIALS ON THE SUBSURFACE PROFILES ARE INTERPOLATED AND ARE THEREFORE APPROXIMATIONS. THE TRANSITION BETWEEN THE MATERIALS MAY BE ABRUPT OR GRADUAL. THE PROFILES SHOULD BE CONSIDERED AS REASONABLY ACCURATE ONLY AT THE BORING LOCATIONS, AND THEN ONLY TO THE DEGREE IMPLIED BY THE NOTES ON THE BORING LOGS. DETAILED STRATIGRAPHIC INFORMATION SHOULD BE OBTAINED FROM THE SOIL BORING LOGS.

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Engineering and Environmental Services

ALASKA DISTRICT
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

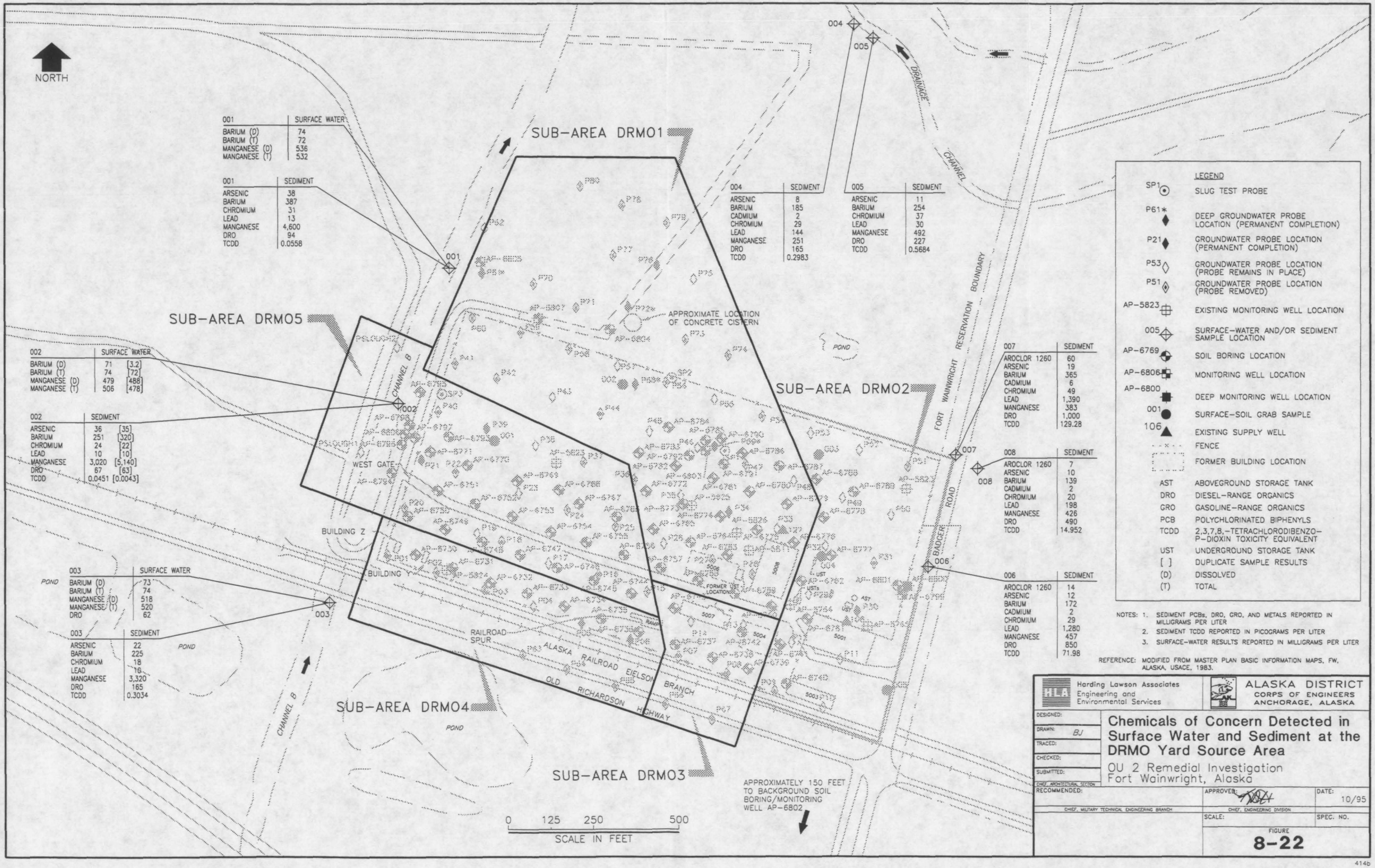
DESIGNED:
DRAWN: BJ
TRACED:
CHECKED:
SUBMITTED:
CHIEF, ARCHITECTURAL SECTION
RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH
APPROVED:
CHIEF, ENGINEERING DIVISION
DATE: 10/95
SCALE:
SPEC. NO.

DRMO Yard Source Area
Sub-Area DRMO5
Subsurface-Soil Profile H-H'

OU 2 Remedial Investigation
Fort Wainwright, Alaska

FIGURE
8-21

329b



001	SURFACE WATER
BARIUM (D)	74
BARIUM (T)	72
MANGANESE (D)	536
MANGANESE (T)	532

001	SEDIMENT
ARSENIC	38
BARIUM	387
CHROMIUM	31
LEAD	13
MANGANESE	4,600
DRO	94
TCDD	0.0558

002	SURFACE WATER	
BARIUM (D)	71	[3.2]
BARIUM (T)	74	[72]
MANGANESE (D)	479	[488]
MANGANESE (T)	506	[478]

002	SEDIMENT	
ARSENIC	36	[35]
BARIUM	251	[320]
CHROMIUM	24	[22]
LEAD	10	[10]
MANGANESE	3,020	[5,140]
DRO	67	[63]
TCDD	0.0451	[0.0043]

003	SURFACE WATER
BARIUM (D)	73
BARIUM (T)	74
MANGANESE (D)	518
MANGANESE (T)	520
DRO	62

003	SEDIMENT
ARSENIC	22
BARIUM	225
CHROMIUM	18
LEAD	16
MANGANESE	3,320
DRO	165
TCDD	0.3034

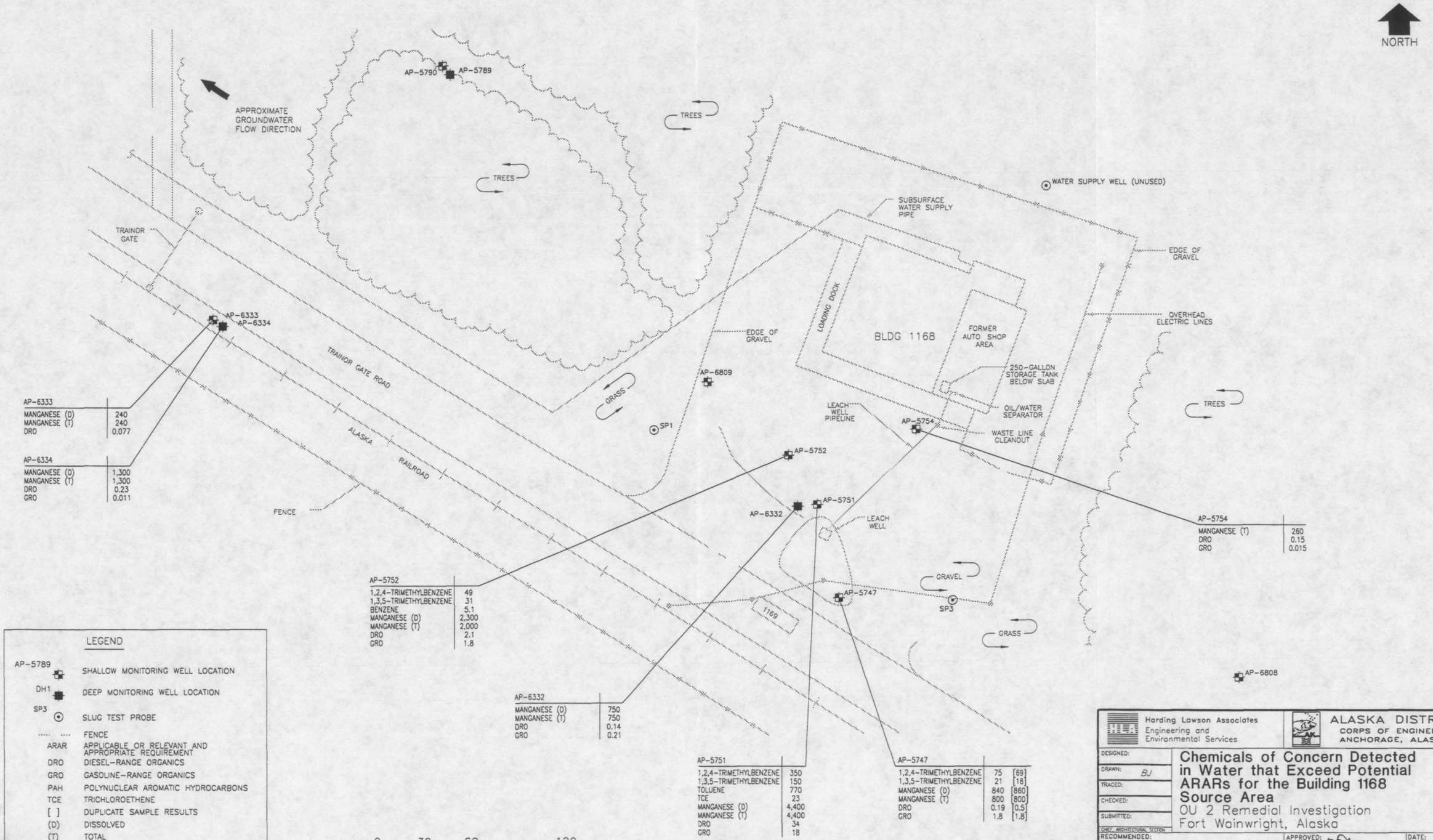
004	SEDIMENT
ARSENIC	8
BARIUM	185
CADMIUM	2
CHROMIUM	29
LEAD	144
MANGANESE	251
DRO	165
TCDD	0.2983

005	SEDIMENT
ARSENIC	11
BARIUM	254
CHROMIUM	37
LEAD	30
MANGANESE	492
DRO	227
TCDD	0.5684

006	SEDIMENT
AROCLOR 1260	14
ARSENIC	12
BARIUM	172
CADMIUM	2
CHROMIUM	29
LEAD	1,280
MANGANESE	457
DRO	850
TCDD	71.98

007	SEDIMENT
AROCLOR 1260	60
ARSENIC	19
BARIUM	365
CADMIUM	6
CHROMIUM	49
LEAD	1,390
MANGANESE	383
DRO	1,000
TCDD	129.28

008	SEDIMENT
AROCLOR 1260	7
ARSENIC	10
BARIUM	139
CADMIUM	2
CHROMIUM	20
LEAD	198
MANGANESE	426
DRO	490
TCDD	14.952



NOTES: 1. DRO, AND GRO REPORTED IN MILLIGRAMS PER LITER
2. METALS AND PAHs REPORTED IN MICROGRAMS PER LITER
3. SLUG TEST PROBE SP2 WAS NOT SURVEYED

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Engineering and Environmental Services

ALASKA DISTRICT
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

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SUBMITTED:
CHIEF, ARCHITECTURAL SECTION

Chemicals of Concern Detected in Water that Exceed Potential ARARs for the Building 1168 Source Area
OU 2 Remedial Investigation
Fort Wainwright, Alaska

RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH
APPROVED:
CHIEF, ENGINEERING DIVISION
DATE: 10/95
SCALE:
SPEC. NO.
FIGURE
8-23

443B

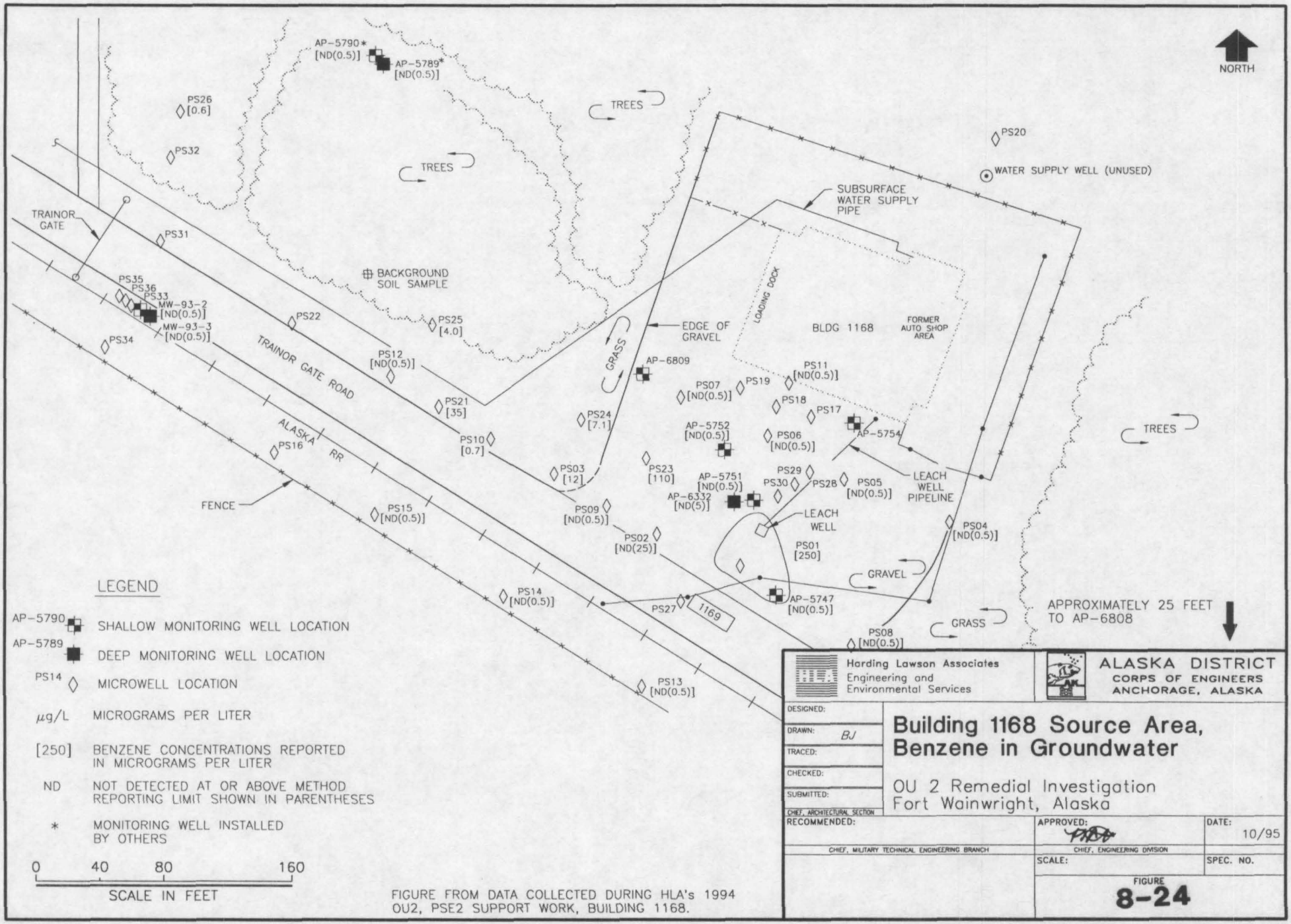

FIGURE FROM DATA COLLECTED DURING HLA's 1994 OU2, PSE2 SUPPORT WORK, BUILDING 1168.

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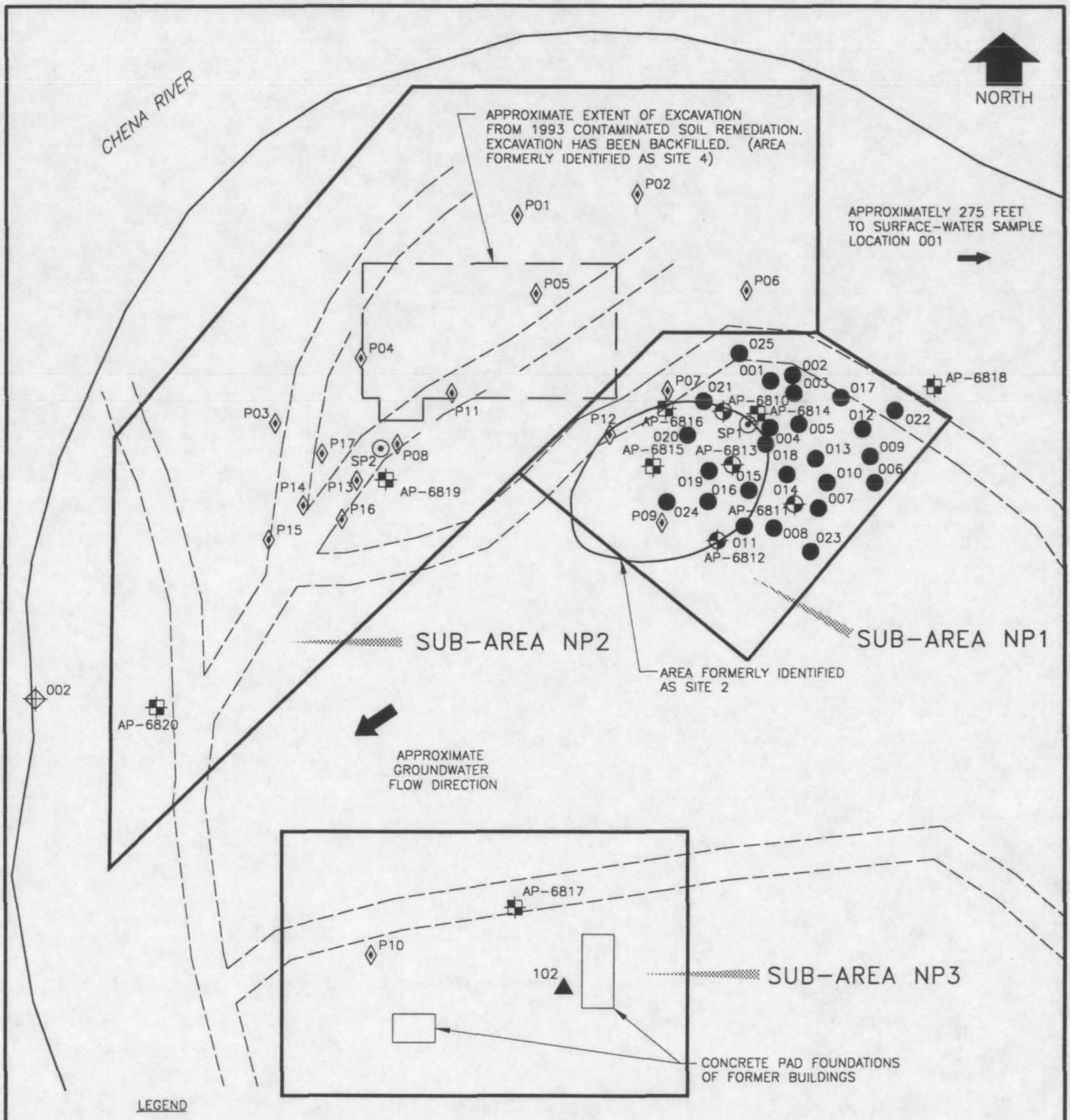
CHIEF, ARCHITECTURAL SECTION
RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH

Building 1168 Source Area, Benzene in Groundwater

OU 2 Remedial Investigation
Fort Wainwright, Alaska

APPROVED:
CHIEF, ENGINEERING DIVISION
DATE: 10/95
SCALE:
SPEC. NO.
FIGURE
8-24

625B



LEGEND

- 002 — SURFACE-WATER AND/OR SEDIMENT SAMPLE LOCATION
- SP2 — SLUG TEST PROBE
- P03 — GROUNDWATER PROBE LOCATION (PROBE REMOVED)
- AP-6815 — MONITORING WELL LOCATION
- 001 — SURFACE-SOIL GRAB SAMPLE
- 102 — EXISTING SUPPLY WELL
- AP-6810 — SOIL BORINGS

0 50 100 200
SCALE IN FEET

REFERENCE: FORT WAINWRIGHT ENVIRONMENTAL MONITORING NETWORK REPORT, USACE, 1992.

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ANCHORAGE, ALASKA

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SUBMITTED:
CHIEF, ARCHITECTURAL SECTION

North Post Source Area Sub-Area Locations

OU 2 Remedial Investigation
Fort Wainwright, Alaska

RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH

APPROVED:
CHIEF, ENGINEERING DIVISION

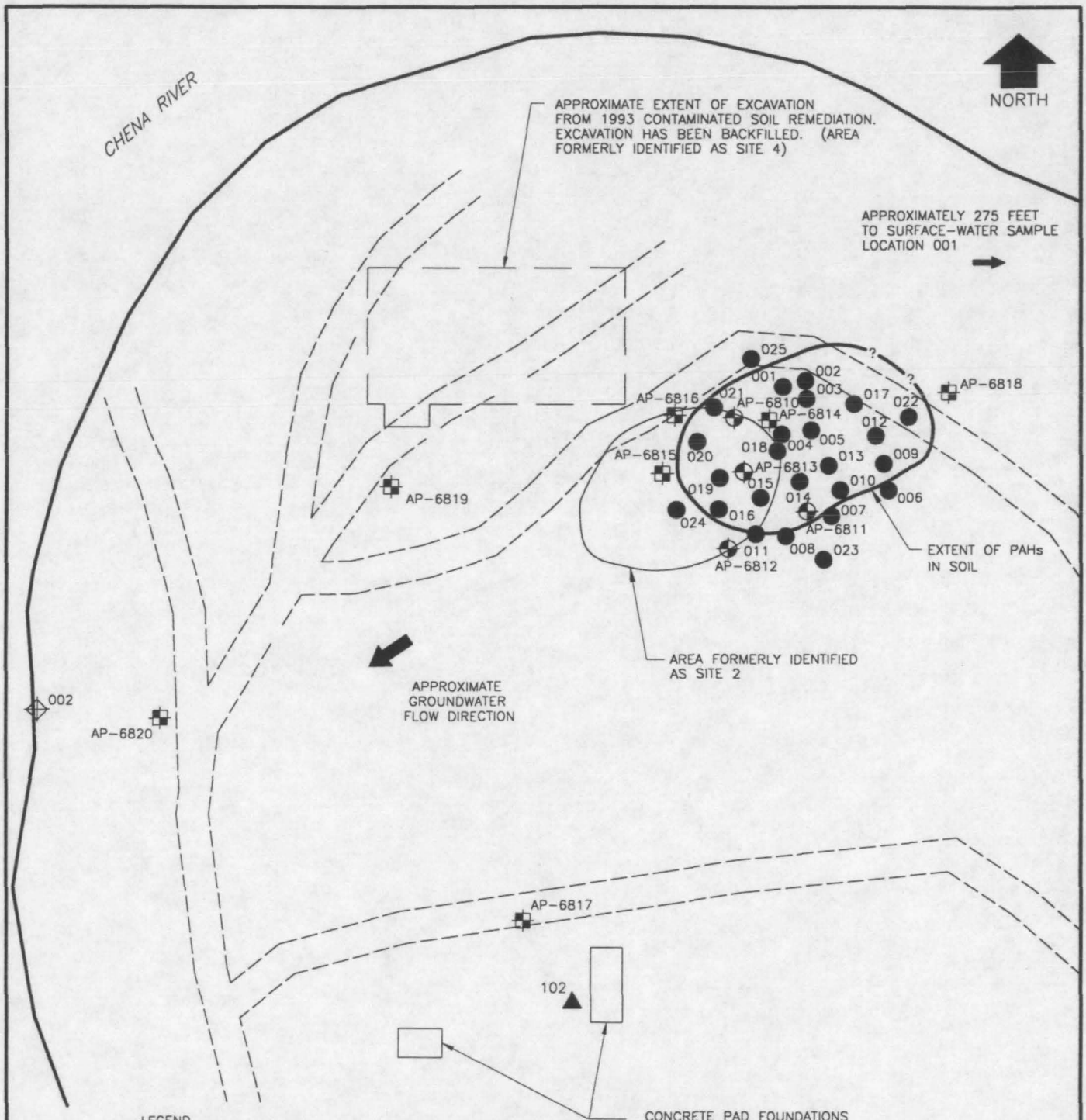
DATE: 10/95

SCALE: NOTED

SPEC. NO.

FIGURE
8-25

334b



LEGEND

002 SURFACE-WATER AND/OR SEDIMENT SAMPLE LOCATION

AP-6815 MONITORING WELL LOCATION

001 SURFACE-SOIL GRAB SAMPLE

102 EXISTING SUPPLY WELL

AP-6810 SOIL BORINGS

PAHs POLYNUCLEAR AROMATIC HYDROCARBONS

0 50 100 200

SCALE IN FEET

REFERENCE: FORT WAINWRIGHT ENVIRONMENTAL MONITORING NETWORK REPORT, USACE, 1992.

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ALASKA DISTRICT
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED:
DRAWN: PB
TRACED:
CHECKED:
SUBMITTED:
CHIEF, ARCHITECTURAL SECTION

North Post Source Area Extent of PAHs in Soil

OU 2 Remedial Investigation
Fort Wainwright, Alaska

RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH

APPROVED: EJ
CHIEF, ENGINEERING DIVISION

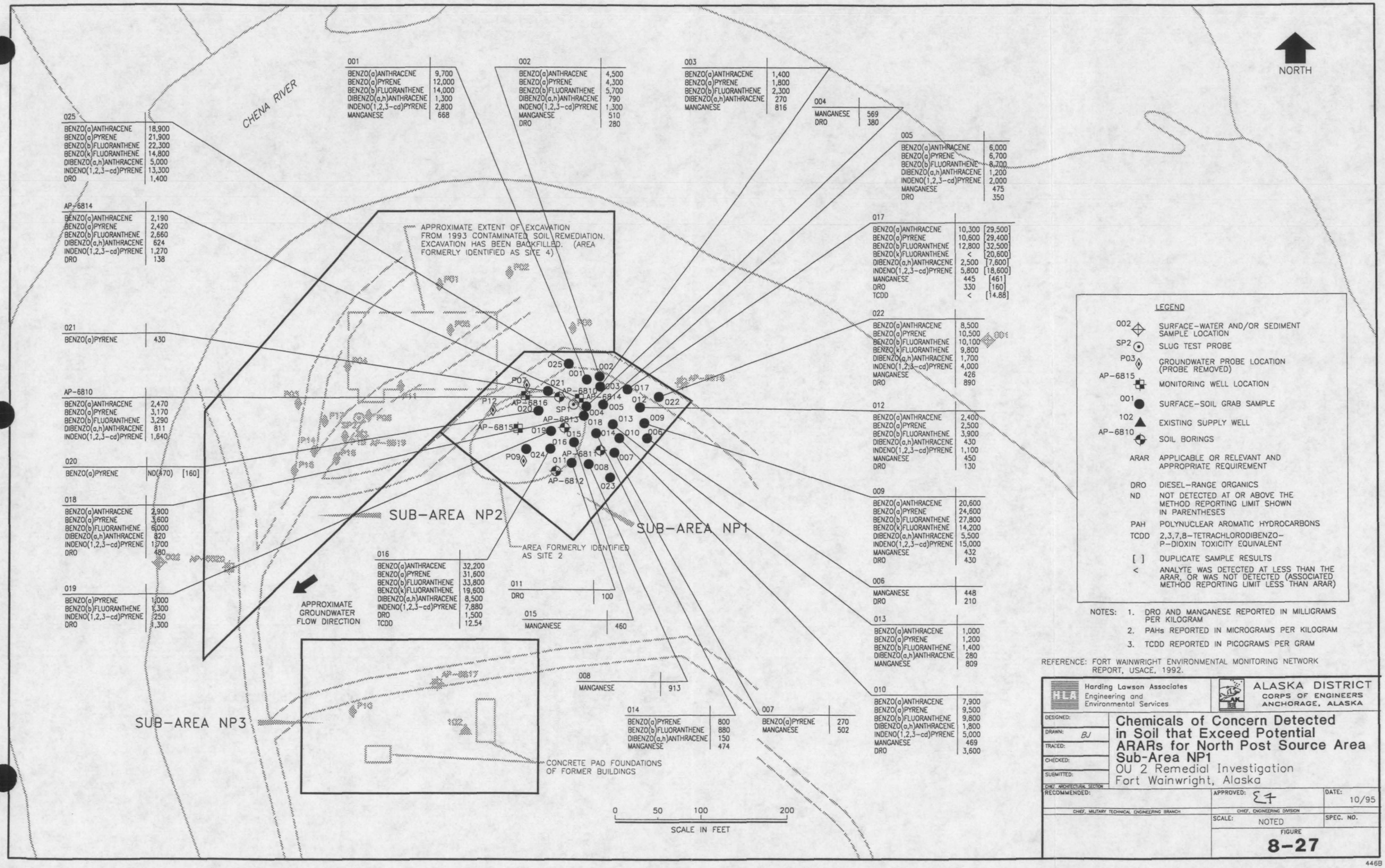
DATE: 10/95

SCALE: NOTED

SPEC. NO.

FIGURE
8-26

343b



Chemicals of Concern Detected in Soil that Exceed Potential ARARs for North Post Source Area Sub-Area NP1

OU 2 Remedial Investigation
Fort Wainwright, Alaska

001	
BENZO(a)ANTHRACENE	9,700
BENZO(a)PYRENE	12,000
BENZO(b)FLUORANTHENE	14,000
DIBENZO(a,h)ANTHRACENE	1,300
INDENO(1,2,3-cd)PYRENE	2,800
MANGANESE	668

002	
BENZO(a)ANTHRACENE	4,500
BENZO(a)PYRENE	4,300
BENZO(b)FLUORANTHENE	5,700
DIBENZO(a,h)ANTHRACENE	790
INDENO(1,2,3-cd)PYRENE	1,300
MANGANESE	510
DRO	280

003	
BENZO(a)ANTHRACENE	1,400
BENZO(a)PYRENE	1,800
BENZO(b)FLUORANTHENE	2,300
DIBENZO(a,h)ANTHRACENE	270
MANGANESE	816

004	
MANGANESE	569
DRO	380

005	
BENZO(a)ANTHRACENE	6,000
BENZO(a)PYRENE	6,700
BENZO(b)FLUORANTHENE	8,700
DIBENZO(a,h)ANTHRACENE	1,200
INDENO(1,2,3-cd)PYRENE	2,000
MANGANESE	475
DRO	350

025	
BENZO(a)ANTHRACENE	18,900
BENZO(a)PYRENE	21,900
BENZO(b)FLUORANTHENE	22,300
BENZO(k)FLUORANTHENE	14,800
DIBENZO(a,h)ANTHRACENE	5,000
INDENO(1,2,3-cd)PYRENE	13,300
DRO	1,400

AP-6814	
BENZO(a)ANTHRACENE	2,190
BENZO(a)PYRENE	2,420
BENZO(b)FLUORANTHENE	2,660
DIBENZO(a,h)ANTHRACENE	624
INDENO(1,2,3-cd)PYRENE	1,270
DRO	138

017		
BENZO(a)ANTHRACENE	10,300	[29,500]
BENZO(a)PYRENE	10,600	[29,400]
BENZO(b)FLUORANTHENE	12,800	[32,500]
BENZO(k)FLUORANTHENE	<	[20,600]
DIBENZO(a,h)ANTHRACENE	2,500	[7,600]
INDENO(1,2,3-cd)PYRENE	5,800	[18,600]
MANGANESE	445	[461]
DRO	330	[160]
TCDD	<	[14.88]

021	
BENZO(a)PYRENE	430

022	
BENZO(a)ANTHRACENE	8,500
BENZO(a)PYRENE	10,500
BENZO(b)FLUORANTHENE	10,100
BENZO(k)FLUORANTHENE	9,800
DIBENZO(a,h)ANTHRACENE	1,700
INDENO(1,2,3-cd)PYRENE	4,000
MANGANESE	426
DRO	890

AP-6810	
BENZO(a)ANTHRACENE	2,470
BENZO(a)PYRENE	3,170
BENZO(b)FLUORANTHENE	3,290
DIBENZO(a,h)ANTHRACENE	811
INDENO(1,2,3-cd)PYRENE	1,640

012	
BENZO(a)ANTHRACENE	2,400
BENZO(a)PYRENE	2,500
BENZO(b)FLUORANTHENE	3,900
DIBENZO(a,h)ANTHRACENE	430
INDENO(1,2,3-cd)PYRENE	1,100
MANGANESE	450
DRO	130

020		
BENZO(a)PYRENE	ND(370)	[160]

018	
BENZO(a)ANTHRACENE	2,900
BENZO(a)PYRENE	3,600
BENZO(b)FLUORANTHENE	6,000
DIBENZO(a,h)ANTHRACENE	820
INDENO(1,2,3-cd)PYRENE	1,700
DRO	480

009	
BENZO(a)ANTHRACENE	20,600
BENZO(a)PYRENE	24,600
BENZO(b)FLUORANTHENE	27,800
BENZO(k)FLUORANTHENE	14,200
DIBENZO(a,h)ANTHRACENE	5,500
INDENO(1,2,3-cd)PYRENE	15,000
MANGANESE	432
DRO	430

016	
BENZO(a)ANTHRACENE	32,200
BENZO(a)PYRENE	31,600
BENZO(b)FLUORANTHENE	33,800
BENZO(k)FLUORANTHENE	19,600
DIBENZO(a,h)ANTHRACENE	8,500
INDENO(1,2,3-cd)PYRENE	7,880
DRO	1,500
TCDD	12.54

011	
DRO	100

015	
MANGANESE	460

006	
MANGANESE	448
DRO	210

019	
BENZO(a)PYRENE	1,000
BENZO(b)FLUORANTHENE	1,300
INDENO(1,2,3-cd)PYRENE	250
DRO	1,300

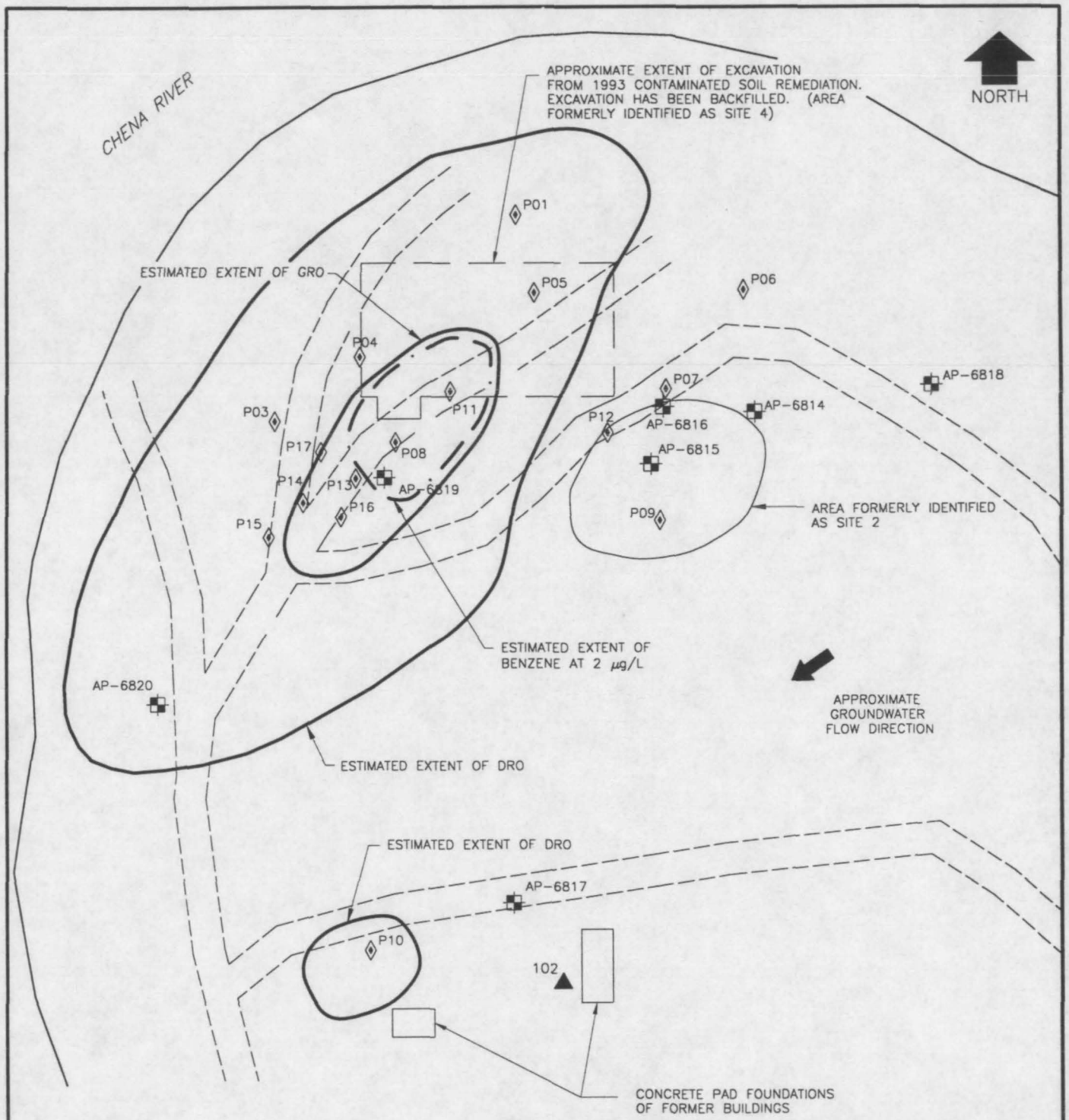
013	
BENZO(a)ANTHRACENE	1,000
BENZO(a)PYRENE	1,200
BENZO(b)FLUORANTHENE	1,400
DIBENZO(a,h)ANTHRACENE	280
MANGANESE	809

008	
MANGANESE	913

014	
BENZO(a)PYRENE	800
BENZO(b)FLUORANTHENE	880
DIBENZO(a,h)ANTHRACENE	150
MANGANESE	474

007	
BENZO(a)PYRENE	270
MANGANESE	502

010	
BENZO(a)ANTHRACENE	7,900
BENZO(a)PYRENE	9,500
BENZO(b)FLUORANTHENE	9,800
DIBENZO(a,h)ANTHRACENE	1,800
INDENO(1,2,3-cd)PYRENE	5,000
MANGANESE	469
DRO	3,600



REFERENCE: FORT WAINWRIGHT ENVIRONMENTAL MONITORING NETWORK REPORT, USACE, 1992.

LEGEND

P03 ◊	GROUNDWATER PROBE LOCATION (PROBE REMOVED)
AP-6815 ✚	MONITORING WELL LOCATION
102 ▲	EXISTING SUPPLY WELL
DRO	DIESEL-RANGE ORGANICS
GRO	GASOLINE-RANGE ORGANICS
μg/L	MICROGRAMS PER LITER

0 50 100 200
SCALE IN FEET

Harding Lawson Associates
Engineering and Environmental Services

ALASKA DISTRICT
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED:
DRAWN: PB
TRACED:
CHECKED:
SUBMITTED:
CHIEF, ARCHITECTURAL SECTION

North Post Source Area Extent of Chemicals Detected in Groundwater

OU 2 Remedial Investigation
Fort Wainwright, Alaska

RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH

APPROVED:
CHIEF, ENGINEERING DIVISION

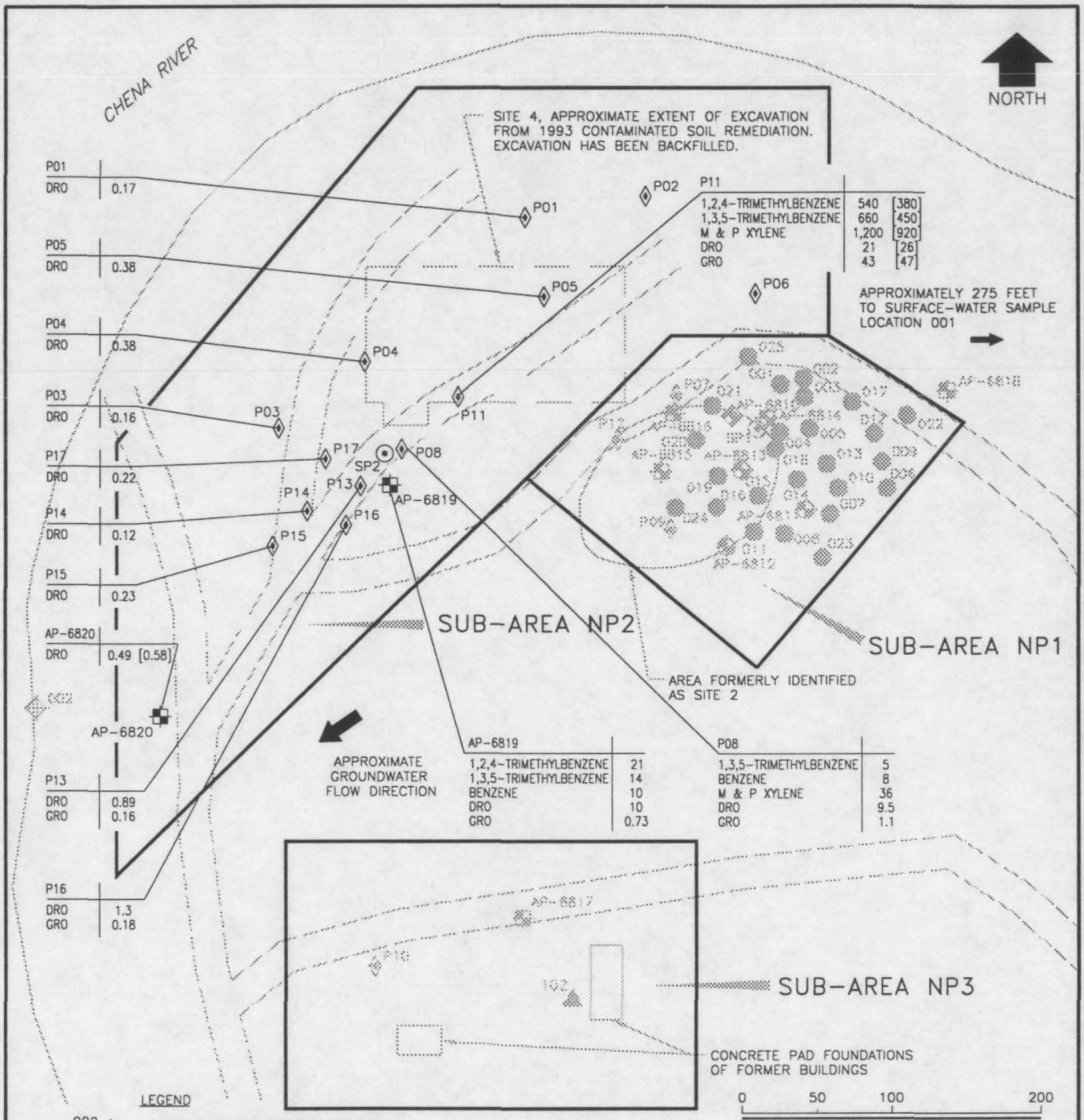
DATE: 10/95

SCALE: NOTED

SPEC. NO.

FIGURE
8-28

344b



LEGEND

- 002 — SURFACE-WATER AND/OR SEDIMENT SAMPLE LOCATION
- SP2 — SLUG TEST PROBE
- P03 — GROUNDWATER PROBE LOCATION (PROBE REMOVED)
- AP-6815 — MONITORING WELL LOCATION
- 001 — SURFACE-SOIL GRAB SAMPLE
- 102 — EXISTING SUPPLY WELL
- AP-6810 — SOIL BORINGS
- ARAR — APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENT
- DRO — DIESEL-RANGE ORGANICS
- GRO — GASOLINE-RANGE ORGANICS
- PAH — POLYNUCLEAR AROMATIC HYDROCARBON
- [ ] — DUPLICATE SAMPLE RESULTS

NOTES:
1. DRO AND GRO REPORTED IN MILLIGRAMS PER LITER
2. PAHs REPORTED IN MICROGRAMS PER LITER

REFERENCE: FORT WAINWRIGHT ENVIRONMENTAL MONITORING NETWORK REPORT, USACE, 1992.

Harding Lawson Associates
Engineering and Environmental Services

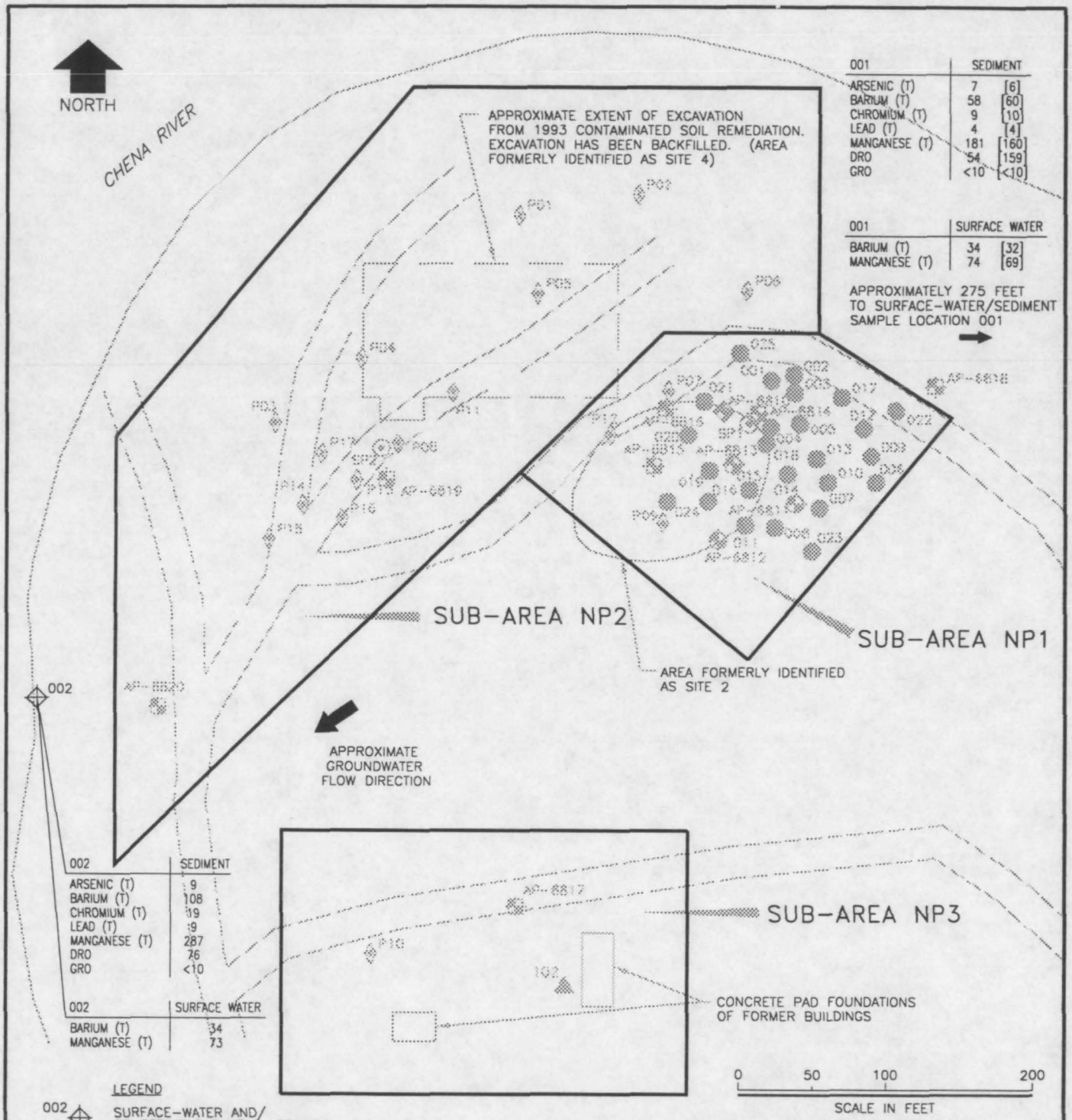
ALASKA DISTRICT
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED:
DRAWN: PB
TRACED:
CHECKED:
SUBMITTED:
CHIEF, ARCHITECTURAL SECTION

Chemicals of Concern Detected in Water that Exceed Potential ARARs for North Post Source Area Sub-Area NP2
OU 2 Remedial Investigation
Fort Wainwright, Alaska

RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH
APPROVED:
CHIEF, ENGINEERING DIVISION
DATE: 10/95
SCALE: NOTED
SPEC. NO.
FIGURE
8-29

444B



001	SEDIMENT	
ARSENIC (T)	7	[6]
BARIUM (T)	58	[60]
CHROMIUM (T)	9	[10]
LEAD (T)	4	[4]
MANGANESE (T)	181	[160]
DRO	54	[159]
GRO	<10	[<10]

001	SURFACE WATER	
BARIUM (T)	34	[32]
MANGANESE (T)	74	[69]

APPROXIMATELY 275 FEET TO SURFACE-WATER/SEDIMENT SAMPLE LOCATION 001

002	SEDIMENT
ARSENIC (T)	9
BARIUM (T)	108
CHROMIUM (T)	19
LEAD (T)	9
MANGANESE (T)	287
DRO	76
GRO	<10

002	SURFACE WATER
BARIUM (T)	34
MANGANESE (T)	73

LEGEND

- 002 — SURFACE-WATER AND/OR SEDIMENT SAMPLE LOCATION
- SP2 — SLUG TEST PROBE
- P03 — GROUNDWATER PROBE LOCATION (PROBE REMOVED)
- AP-6815 — MONITORING WELL LOCATION
- 001 — SURFACE-SOIL GRAB SAMPLE
- 102 — EXISTING SUPPLY WELL
- AP-6810 — SOIL BORINGS
- DRO — DIESEL-RANGE ORGANICS
- GRO — GASOLINE-RANGE ORGANICS
- (T) — TOTAL
- [ ] — DUPLICATE SAMPLE RESULTS

NOTES:
1. SURFACE-WATER RESULTS REPORTED IN MICROGRAMS PER LITER
2. SEDIMENT RESULTS REPORTED IN MILLIGRAMS PER KILOGRAM

REFERENCE: FORT WAINWRIGHT ENVIRONMENTAL MONITORING NETWORK REPORT, USACE, 1992.

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ANCHORAGE, ALASKA

DESIGNED:
DRAWN: BJ
TRACED:
CHECKED:
SUBMITTED:
CHIEF, ARCHITECTURAL SECTION

Chemicals of Concern Detected in Surface Water and Sediment at North Post Source Area

OU 2 Remedial Investigation
Fort Wainwright, Alaska

RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH

APPROVED: EJ
CHIEF, ENGINEERING DIVISION

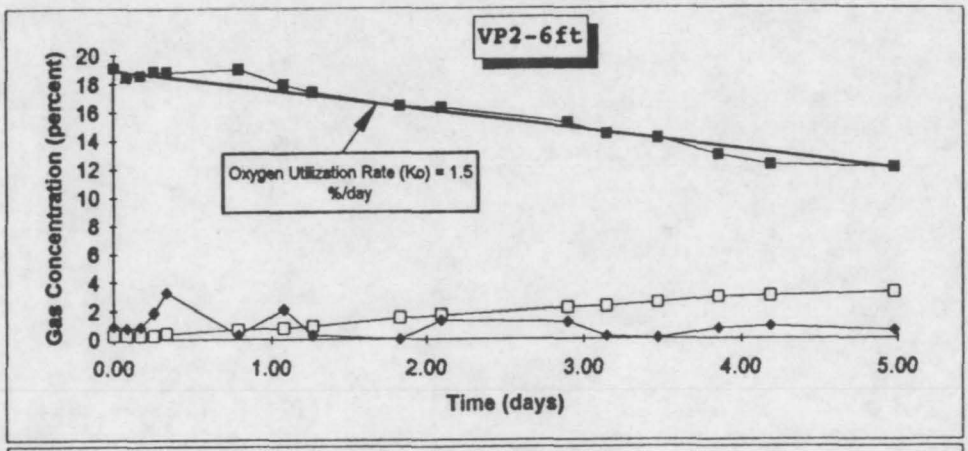
DATE: 10/95

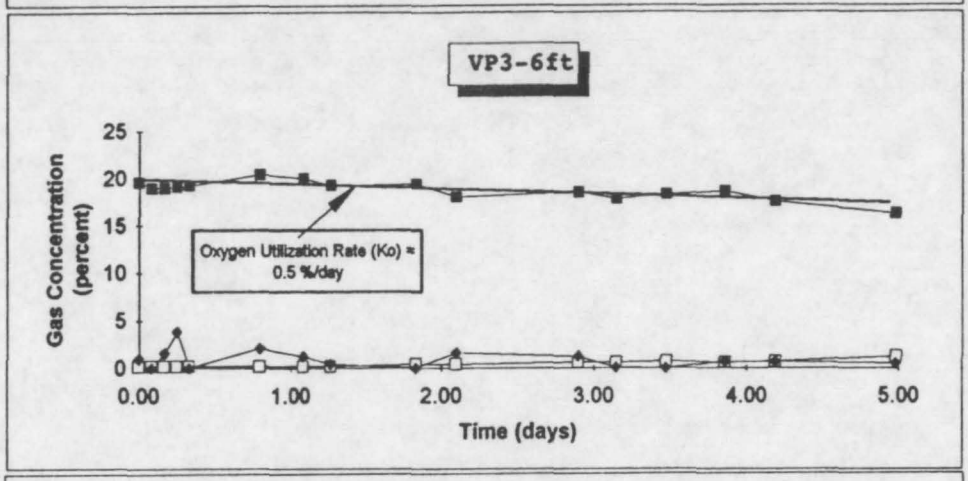
SCALE: NOTED

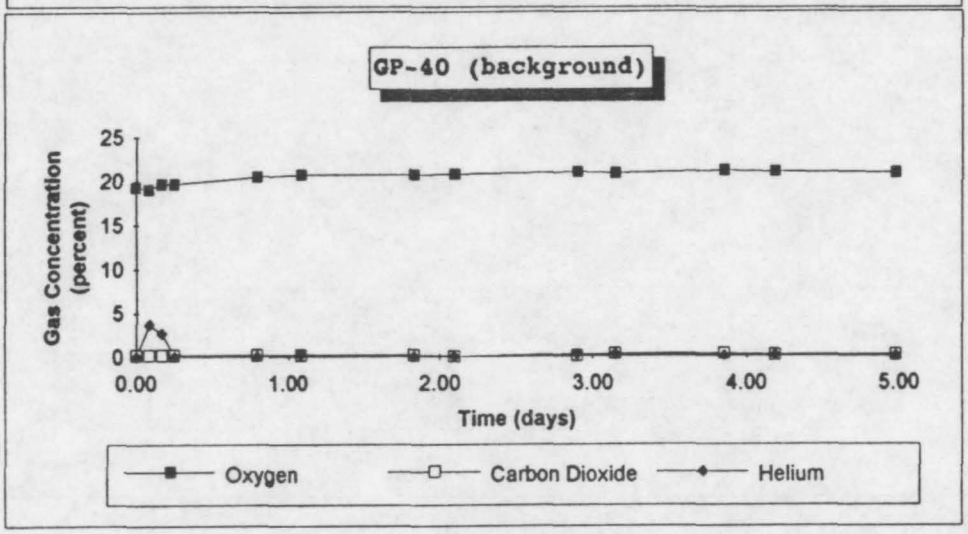
SPEC. NO.

FIGURE
8-30

445B







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DESIGNED:
DRAWN: BJ
TRACED:
CHECKED:
SUBMITTED:
CHIEF, ARCHITECTURAL SECTION

Respiration Test Results

OU 2 Remedial Investigation
Fort Wainwright, Alaska

RECOMMENDED:
CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH

APPROVED:
CHIEF, ENGINEERING DIVISION

DATE: 10/95

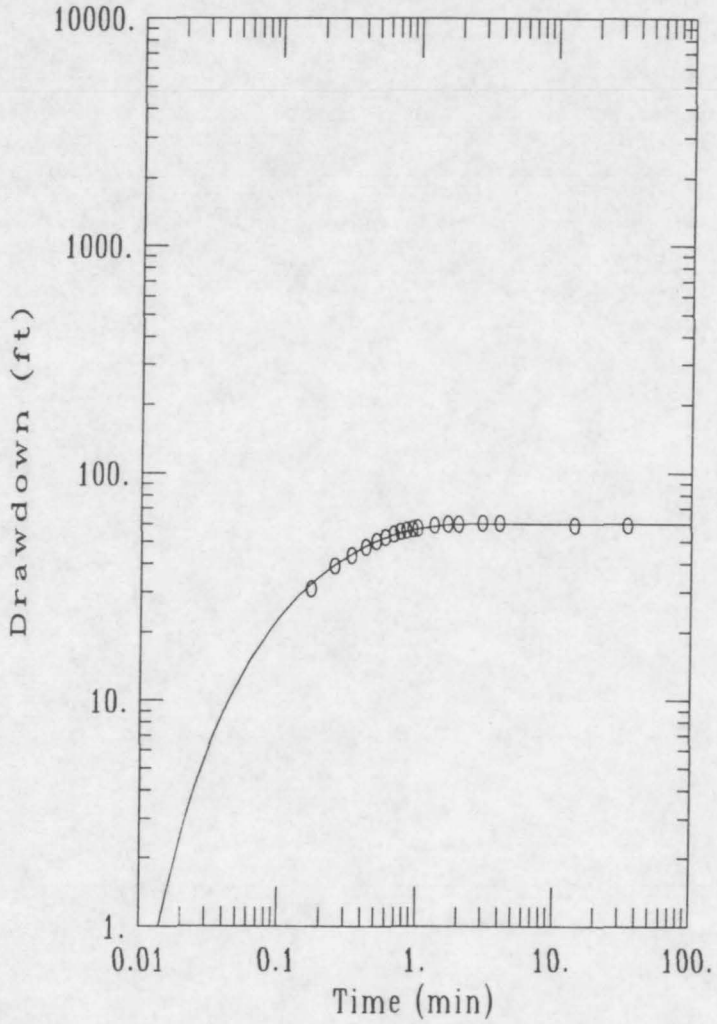
SCALE:

SPEC. NO.

FIGURE
8-31

341b

VES 40 CFM Response at VP2-6



DATA SET:

drmo2.csv

03/15/95

AQUIFER TYPE:

Leaky

SOLUTION METHOD:

Hantush

ESTIMATED PARAMETERS:

T = 0.1148 ft2/min

S = 0.0001418

r/B= 0.4182

TEST DATA:

Q = 40. ft3/min

r = 10. ft

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Engineering and
Environmental Services

ALASKA DISTRICT
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

DESIGNED:

DRAWN: BJ

TRACED:

CHECKED:

SUBMITTED:

CHIEF, ARCHITECTURAL SECTION

SVE Testing Data and AQTESOLV Results

OU 2 Remedial Investigation
Fort Wainwright, Alaska

RECOMMENDED:

CHIEF, MILITARY TECHNICAL ENGINEERING BRANCH

APPROVED:

CHIEF, ENGINEERING DIVISION

DATE: 10/95

SCALE:

SPEC. NO.

FIGURE
8-32

341b

9.0 RECOMMENDATIONS

OU 2 consists of three source areas: the DRMO yard, Building 1168, and North Post. The sub-areas identified within DRMO yard and North Post source areas in section 8 were established based on review of analytical data and refinement of conceptual site models. Contamination at the Building 1168 source area was characterized during the 1993 PSE 2 (HLA, 1993b) and is addressed in section 9.2 of this report. HLA is currently conducting a treatability study at the Building 1168 source area, and will present the results to the USACE in November 1995.

The following sections summarize contamination, identify data gaps, and present recommendations for each of the OU 2 source areas. Additional data gaps could become objectives during source area remediation.

9.1 DRMO Yard Source Area

9.1.1 Sub-Area DRMO1

Contaminants detected in Sub-area DRMO1 include petroleum hydrocarbons (DRO and GRO) and chlorinated VOCs (PCE and TCE) in soil and groundwater. Based on review of the chromatograms associated with the sample results, GRO in soil and groundwater corresponds to the light-end hydrocarbons associated with the detected DRO, not to a separate petroleum source. DRO detected in soil and groundwater is related to diesel USTs previously located adjacent to Building 5008 and former Building 5006. HLA recommends that petroleum hydrocarbon contamination within Sub-area DRMO1 be evaluated under a separate State of Alaska/U.S. Army two-party petroleum agreement.

Based on the relatively high concentrations of PCE and TCE in groundwater and the relatively low concentrations in soil, the primary source of chlorinated VOCs in Sub-area DRMO1 has not been identified. Based on review of the data, TCE detected in soil and groundwater is likely a chemical and biological degradation product of the PCE detected. At the direction of the RPMs, no additional characterization of PCE in soil will be necessary. HLA recommends remedial alternatives for VOC contamination within Sub-area DRMO1 be evaluated under the FS.

9.1.2 Sub-Area DRMO2

Contaminants detected in Sub-area DRMO2 include petroleum hydrocarbons (DRO and GRO) in soil, and petroleum hydrocarbons and chlorinated VOCs (PCE and TCE) in groundwater. Similar to Sub-area DRMO1, GRO detected in soil and groundwater at Sub-area DRMO2 corresponds to the light-end hydrocarbons associated with the detected DRO, not to a separate petroleum source. DRO detected in soil and groundwater is related to diesel USTs located adjacent to Buildings 5001 and 5008. DRO and GRO in soil and groundwater in Sub-area DRMO2 have not been fully characterized. HLA recommends that petroleum hydrocarbon contamination within Sub-Area DRMO2 be evaluated under a separate State of Alaska/U.S. Army two-party petroleum agreement.

PCE and TCE were detected at low concentrations in groundwater at two localized sources (Figure 8-8), and were not detected in soil. HLA recommends that PCE and TCE in groundwater at Sub-area DRMO2 be evaluated in the FS report.

9.1.3 Sub-Area DRMO3

Contaminants detected in Sub-area DRMO3 include petroleum hydrocarbons (DRO and GRO) in soil and DRO in groundwater. GRO detected in soil corresponds to the light-end hydrocarbons associated with the detected DRO, not to a separate hydrocarbon source. Unidentified USTs possibly located in the vicinity of Buildings 5004 and 5007, and the south property boundary of the DRMO yard source area are suspected sources of DRO in soil and groundwater. Additional sources may exist in the vicinity of the rail line immediately south of the sub-area. HLA recommends that petroleum hydrocarbon contamination in soil and groundwater within Sub-area DRMO3 be evaluated under a separate State of Alaska/U.S. Army two-party petroleum agreement.

9.1.4 Sub-Area DRMO4

Contaminants detected in Sub-area DRMO4 soil include DRO and lead. Contaminants detected in groundwater include DRO, benzene, and chlorinated VOCs (PCE and TCE). The sources of DRO contamination in soil, and benzene, PCE, and TCE contamination in groundwater have not been identified. Contaminants in this area may have resulted from miscellaneous releases associated with the railroad spur. Lead was detected in one surface-soil sample collected from adjacent to the railroad spur. HLA recommends that DRO, benzene, chlorinated VOCs (PCE and TCE), and lead contamination within Sub-area DRMO4 be evaluated under the FS.

9.1.5 Sub-Area DRMO5

Petroleum hydrocarbons (DRO and GRO) were detected in subsurface soil in the eastern and western portions of Sub-area DRMO5. The detected GRO is believed to correspond to light-end hydrocarbons associated with the detected DRO, not to a separate petroleum source. In addition, DRO was detected in groundwater throughout Sub-area DRMO5, and PCBs were detected in surface soil at scattered locations.

DRO in soil in the vicinity of Monitoring Well AP-6806 (western portion of the sub-area) has been sufficiently characterized (Figures 8-18, 8-20, and 8-21).

Petroleum hydrocarbons in soil in the eastern portion of Sub-area DRMO5, and PCBs in surface soil at scattered locations throughout the sub-area have not been fully characterized.

HLA recommends that petroleum hydrocarbon contamination within Sub-area DRMO5 be evaluated under a separate State of Alaska/U.S. Army two-party petroleum agreement. PCBs will be evaluated in the FS.

9.1.6 DRMO Yard Source Area Surface Water and Sediment

Contaminants detected in surface water and sediment at the DRMO yard source area have been evaluated under the HRA. Based on the HRA, contaminants detected in surface water and sediment at the DRMO Yard source area do not present a risk to human health.

9.2 Building 1168 Source Area

The Building 1168 source area was characterized during HLA's OU 2 PSE 2 investigations (1993a and 1994a). Contaminants detected in soil included petroleum hydrocarbons (DRO and GRO) and chlorinated VOCs (TCE) (HLA, 1994a). Contaminants detected in groundwater included metals, petroleum hydrocarbons (DRO and GRO), VOCs, and chlorinated VOCs. Results from HLA's ongoing treatability study at the Building 1168 source area have indicated a decrease in DRO, GRO, benzene, and TCE concentrations (1995b). The OU 2 RI included installing one background well (AP-6808) and one pressure transducer well under the direction of the CRREL. Chemicals detected during the OU 2 RI did not exceed potential ARARs. HLA recommends that additional remedial alternatives for the Building 1168 source area be evaluated during the FS.

9.3 North Post Source Area

9.3.1 Sub-Area NP1

Contaminants detected in surface soil at Sub-area NP1 include dioxins/furans, DRO, and PAHs. Contaminants were not detected in groundwater. In September 1995, HLA resampled selected monitoring wells (AP-6814, AP-6815, and AP-6816 for dioxin/furan analysis. As discussed in section 8.6.3.1, dioxin/furans analytical results indicate that detections of dioxin/furans at Sub-area NP1 are attributable to laboratory contamination and are not present in groundwater. The source of DRO and PAHs in surface soil is the fire burn pit. The lateral extent of PAHs in surface soil has not been determined. HLA recommends that DRO and PAH contamination within Sub-area NP1 be evaluated during the FS.

9.3.2 Sub-Area NP2

Analytes were not detected in surface and subsurface soil at concentrations that exceeded potential

chemical-specific ARARs, with the exception of Aroclor 1260 (1,450 µg/kg at 11 feet in Boring AP-6820). Benzene, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene were detected in groundwater at concentrations that exceeded potential chemical-specific ARARs. DRO and GRO were detected in groundwater at concentrations as high as 26,000 µg/L and 47 µg/L, respectively. The suspected source of groundwater contamination is petroleum hydrocarbon-contaminated soil. In the spring of 1993, Laidlaw Environmental excavated 2,700 cubic yards of contaminated soil from Sub-area NP2. High groundwater elevation during the Laidlaw remediation efforts likely resulted in petroleum hydrocarbon contaminated soil being left in place. HLA recommends that contamination in subsurface soil and groundwater within Sub-Area NP2 be evaluated under a separate State of Alaska/U.S. Army two-party petroleum agreement.

9.3.3 Sub-Area NP3

No analytes were detected in soil at concentrations above potential chemical-specific ARARs. DRO was detected in Groundwater Probe P10 at a concentration of 170 µg/L. HLA recommends the DRO contamination within Sub-area NP3 be evaluated in the FS.

9.3.4 Sub-Area NP4

Contaminants detected in surface water sediment have been evaluated under the HRA. Based on the HRA, contaminants detected in surface water and sediment at the North Post source area do not present a risk to human health.

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