OU-B 32113

FINAL
REMEDIAL DESIGN PLAN

OPERABLE UNIT B, POLELINE ROAD DISPOSAL AREA, FORT RICHARDSON, ALASKA

Prepared for
U.S. ARMY CORPS OF ENGINEERS,
ALASKA DISTRICT

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LIST OF ACRONYMS

ADEC	Alaska Department of Environmental Conservation
ARAR	Applicable or Relevant and Appropriate Requirements
bgs	Below Ground Surface
CAIS	chemical agent identification sets
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COEC	Contaminants of Ecological Concern
CRREL	Cold Regions Research and Engineering Laboratory
CWM	Chemical Warfare Material
DNAPLs	Dense Nonaqueous Phase Liquids
DPE	Dual Phase Extraction
DPW	Department of Public Works
DVS	Design Verification Study
ERA	Ecological Risk Assessment
ESE	Environmental Science & Engineering, Inc.
FFA	Federal Facilities Agreement
FS	Feasibility Study
HHRA	Human Health Risk Assessment
HVE	High Vacuum Extraction
IDW	Investigative-Derived Waste
MCLs	Maximum Contaminant Levels
NCP	National Contingency Plan
NPL	National Priority List
O&M	Operation and Maintenance
OHM	Remediation Services, Inc.
OUB	Operable Unit B
PCE	Tetrachloroethene
PID	Photo Ionization Detector
PRDA	Poleline Road Disposal Area
QM	Quotient Method
RA	Remedial Action
RAOs	Remedial Action Objectives
RDP	Remedial Design Plan

LIST OF ACRONYMS

RI	Remedial Investigation
RME	Reasonable Maximum Exposure
ROD	Record of Decision
SVE	Soil Vapor Extraction
TCE	Trichloroethene
TDC	Total Direct Costs
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

Woodward-Clyde was contracted by the United States Army Corps of Engineers (USACE) on behalf of the United States Army, Public Works (Army) to prepare a Remedial Design Plan (RDP) for Operable Unit B (OUB) at Fort Richardson, Alaska. OUB consists of one site, the Poleline Road Disposal Area (PRDA). Fort Richardson is on the United States Environmental Protection Agency (USEPA) National Priority List (NPL), and all work performed for the PRDA was in compliance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). Work was also conducted in compliance with the Federal Facilities Agreement (FFA) negotiated among the U.S. Army, the USEPA, and the Alaska Department of Environmental Conservation (ADEC). The OUB RDP project was assigned Delivery Order Number 021, under terms of USACE contract number DACA85-94-D-005. The scope of work for the RDP was provided by the USACE in a Scope of Work dated January 29, 1997.

OUB is a former Army disposal area for chemical warfare training materials and has been the subject of several environmental investigations, a feasibility study, a treatability study, and a design verification study. The design verification study involved remediation of chlorinated solvents in soil and shallow groundwater by high vacuum soil vapor extraction with six-phase soil heating (Woodward-Clyde, 1997a). High Vacuum Extraction (HVE), without soil heating, combined with site-wide institutional controls and long-term groundwater monitoring, is the remedial alternative selected for the site. Section 2 of this work plan provides more details on site history and previous investigations.

This plan presents a preliminary design for a full scale remedial action at OUB. The plan includes the preliminary design criteria, approach, drawings, and monitoring/maintenance plan for the full scale system. The purpose of the preliminary RDP is to provide an opportunity for review of design concepts by the remedial project managers before completing the detailed final design.

The need for remedial action, described in the following sections, is based on the subsurface conditions prior to initiation of the design verification study (DVS). The remedial effect of the DVS will be documented in a separate report, and is not included here. DVS data are used in this plan to support full scale design assumptions.

The remedial design plan (RDP) is only one document in a process leading up to implementation of a full scale remedial action at OUB. Selection of the Remedial Action contractor will begin as soon as the Final RDP has been submitted (this report). The RA contractor selection process includes, preparing a request for proposal, preparing a cost estimate, negotiating, and awarding. Once the RA contractor has been selected, the RA work plan can be prepared. System installation is scheduled for the spring of 1999.

A dual phase extraction (DPE) treatability study is being conducted at OUB to evaluate the design presented in this plan. The Final RDP is due before the DPE study will be completed, but the DPE study report will recommend changes to this report, if necessary.

This RDP is organized as follows:

- Section 2 - Background
- Section 3 - Design Criteria
- Section 4 - Design Analysis

- Section 5 - System Operations

This section is a summary of information presented in the Remedial Investigation (Woodward-Clyde, 1996), and the Feasibility Study (Woodward-Clyde, 1997). These documents should be reviewed for additional information.

2.1 SITE HISTORY

OUB was identified in 1990 through interviews conducted by the U.S. Army with two ex-soldiers who were stationed at Fort Richardson in the 1950s and who recalled the disposal of chemicals and other materials in the area (ESE 1991a). The disposal location was corroborated by a USACE map dated 1954 showing a "Chemical Disposal Area" at the site, and by 1957 aerial photography showing trenches in the area. A 1965 aerial photograph shows that a portion of the hill west of the site was cut back.

The disposal area was active from approximately 1950 to 1972. At that time, standard military practice was to dispose of suspected chemical weapons in the following manner (OHM Remediation Services, Inc. [OHM] 1993). A layer of "bleach/lime" was laid down in the bottom of the trench, and then the materials contaminated with chemical weapons were placed on a pallet in the trench. Diesel fuel was poured on the agent and then ignited with thermal grenades. After burning was complete, a mixture of either bleach or lime combined with chlorinated solvent carrier (trichloroethene [TCE], tetrachloroethene [PCE], and 1,1,2,2-tetrachloroethane), was poured over the materials.

Information provided by the ex-soldiers indicated that disposed materials may have included solvents and other decontaminants (such as bleach) that were used to neutralize chemical warfare agents, smoke bombs, and Japanese cluster bombs (ESE 1991). Both types of bombs were detonated in pits prior to burial, but there may have been many duds dispersed over the area that were not recovered.

2.2 ENVIRONMENTAL SETTING

2.2.1 Location

OUB is located on Fort Richardson approximately 10 miles northeast of Anchorage, Alaska (Figures 2-1 and 2-2). The site is approximately 1 mile south of the Eagle River and 0.6 miles north of the Anchorage Regional Landfill. Access to the area is by Poleline Road, a major gravel road that runs northeast-southwest along a power line route and the Eklutna Water Line. The site is bisected by Barrs Boulevard, a gravel road extending from the Glenn Highway to Poleline Road.

2.2.2 Site Description

The OUB site is a low-lying, relatively flat area which is bordered by wooded hills to the northwest and southeast (Figure 2-3). The site was cleared of vegetation during a removal action in 1994. The site encompasses four disposal areas, Areas A-1 through A-4, which are discussed in Section 2.3.1. Wetlands are located directly south and southwest of the disposal areas. The remaining area bordering the site is relatively flat and wooded.

2.2.3 Geology

The surficial deposits of the region are fluvially reworked glacial sediments and glacial tills. These deposits appear to be up to 30 feet thick at the site and consist of unstratified to poorly stratified clays, silts, sands, gravels, and boulders. A basal till lies below the surficial deposits and overlies an advance moraine/till complex. Underlying the glacial sediments is bedrock composed of a hard black fissile claystone 120 to 170 feet beneath the site.

The subsurface soils are dense glacial tills and generally silty sands with some gravel. Thin, discontinuous clay lenses were observed rarely. Observations during drilling confirm a typical fluvio-glacial setting — a heterogeneous system of discontinuous, relatively permeable channels with intervening denser, less permeable sediments.

2.2.4 Hydrogeology

Four water-bearing intervals have been identified at OUB (Figure 2-4). The four water-bearing intervals are a perched interval, a shallow interval, an intermediate interval, and a deep aquifer. The detection of contaminants in all four intervals suggests that they are interconnected to some degree. Observations made while drilling indicate that the saturated intervals are separated by [illegible]

The perched interval was observed in borings drilled between Area A-2 and the wetlands, and in Area A-3. The top of the perched interval was encountered at 4 to 10 feet below ground surface (bgs), and the bottom was found at 6 to 12 feet bgs. The average thickness of the perched interval is approximately 5 feet. The perched interval is recharged mainly by surface water from the wetlands, although some recharge also occurs from precipitation. The only well installed in the perched interval is MW-14.

The shallow saturated interval is an average of 10 feet thick; the top was encountered at 20 to 25 feet bgs, and the bottom was found at 28 to 36 feet. Groundwater elevations indicate that shallow groundwater is flowing in a north-northeast direction. There are 15 monitoring wells screened in the shallow interval, including the background well and four wells installed in June 1997. Additional wells and piezometers were installed in the shallow zone during the treatability study as described in Section 2.3. Because of the localized nature of water-bearing zones at this site, it is difficult to tell whether the water-bearing units are hydraulically connected between wells. The shallow interval is recharged by water from the perched interval and by infiltration of precipitation.

The intermediate interval was observed while drilling deep monitoring well MW-16. The saturated portion of the intermediate interval was encountered at approximately 65 to 95 feet bgs in MW-16. The intermediate saturated interval does not correlate with the other deep wells on site, suggesting that it is an isolated lens with limited continuity. There may be several isolated lenses of saturated material within the intermediate interval. Several attempts were made during the June 1997 groundwater characterization study to install additional wells in the intermediate interval, but groundwater was not encountered and wells were installed in the shallow interval only.

The five deep monitoring wells at OUB penetrate the deep aquifer, the top of which was encountered from approximately 80 to 125 feet bgs. The deep aquifer is an advance moraine/till complex with a thickness of between 3 and 40 feet. Groundwater elevations indicate that the flow direction in the deep aquifer is locally to the northeast and regionally to the northwest. The available data indicate that the deep aquifer below the site is not connected with the aquifers used for drinking water in the community of Eagle River (over one mile to the northeast) (Munter et al., 1992).

The deep aquifer overlies a claystone bedrock unit with unknown thickness. Four of the five deep wells at OUB penetrate the bedrock unit and the well screens extend slightly into the bedrock. The top of bedrock was encountered from 120 to 170 feet beneath the site.

Hydraulic conductivities for the various saturated intervals were estimated from several sources: data from slug tests performed by Environmental Science and Engineering, Inc. (ESE 1991); grain size analyses conducted during the remedial investigation (RI) (WC 1996a); literature values documenting hydraulic conductivities in similar hydrogeologic intervals in the Eagle River area (Munter and Allely, 1992); and single well pump tests and laboratory soil permeability testing performed during the treatability study (WC 1997a). Representative values are listed below.

Saturated Interval	Estimated Hydraulic Conductivity
Perched	0.5 feet per day (ft/day)
Shallow	0.5 - 3.4 ft/day
Intermediate	0.05 ft/day
Deep	0.3 ft/day

The ultimate discharge area of the water-bearing intervals at OUB is probably the Eagle River, approximately 1 mile north of the site. The Eagle River flows into the Knik Arm of Cook Inlet approximately 5 miles northwest of OUB. The river is not used as a drinking water supply. In order to provide a conservative evaluation, groundwater modeling performed during the RI assumed that groundwater flows directly from the site to the Eagle River. However, the heterogeneous subsurface geology at the site makes actual flow patterns difficult to estimate. The model, performed using MODFLOW and MT3D, estimated that the solvents would take over 100 years to reach the Eagle River. Details of the groundwater modeling can be found in the RI report (WC 1996a).

2.3 PREVIOUS INVESTIGATIONS AND STUDIES

2.3.1 Initial Investigations and Removal Action

Several investigations and a removal action have been conducted at OUB since its discovery in 1990. ESE conducted site investigations between 1990 and 1992. ESE's investigations included a geophysical survey, soil sampling from 10 borings, a soil gas survey, installation of 11 groundwater monitoring wells, groundwater sampling, a water level study, and aquifer (slug) tests. ESE's investigations are detailed in three documents ESE 1990, ESE 1991, and ESE 1993.

OHM began a removal action in Areas A-3 and A-4 in 1993, and unearthed chemical agent identification sets (CAIS) and other materials related to chemical warfare training activities. Work was halted because no preparations were made to deal with chemical warfare materials.

Additional subsurface information was needed before excavation work could continue, so the Cold Regions Research and Engineering Laboratory (CRREL) performed a geophysical survey in early 1994 (CRREL 1994). The survey identified significant anomalies consistent with trenches and buried waste in the four disposal areas. Areas A-3 and A-4 showed the greatest evidence of buried waste and trenching, including possible stacked canisters or cylinders.

OHM completed the removal action in Areas A-3 and A-4 in October 1994 (OHM 1995). Chemical analyses from ESE's and OHM's sampling confirmed that volatile organic compounds (VOCs) were present in the subsurface. The VOCs detected at the highest concentrations were chlorinated solvents, especially TCE, PCE, and 1,1,2,2-tetrachloroethane. These VOCs were detected in soils and in groundwater samples from the shallow, intermediate and deep intervals. Concentrations of metals were within regional background levels and semivolatile organic compounds were not detected at the site. The only chemical warfare material (CWM) detected in soils was adamsite. Adamsite is an arsenic-based vomiting agent used in aerosol form for riot control. No CWM, CWM breakdown products or explosives were detected in groundwater samples collected by ESE and OHM except for one detection of the explosive hexahydro-1,3,5-trinitro-1,3,5-triazine (commonly known as Research Department Explosives, Royal Demolition Explosives, or RDX) in a groundwater sample from monitoring well MW-5.

Soils excavated during the removal action in Areas A-3 and A-4 were analyzed and compared to the following removal action concentrations:

Chemical	Removal Action Concentration
TCE	600 milligrams/ kilogram (mg/kg)
PCE	100 mg/kg
1,1,2,2-tetrachloroethane	30 mg/kg

The removal action concentrations listed above were established for the three contaminants that were detected at the most elevated concentrations during OHM's removal action. After buried debris was removed, soil sampling was performed on a grid pattern on the bottom and walls of the excavations to confirm that soils exceeding the removal action concentrations had been removed. Soils were excavated to a maximum depth of 14 feet, where water was encountered.

Soils that met the removal action concentrations were mixed with borrow soil and returned to the excavations. No additional soil cover was added to Areas A-3 and A-4. Soils that exceeded the action levels were stockpiled southeast of the site on Barrs Boulevard in lined, plastic-covered piles surrounded by berms and a fence. The stockpiles were treated during summer 1997.

CRREL performed another geophysical survey in June 1995 (CRREL 1995) to determine whether any suspicious material remained in the recently excavated areas and to define more accurately anomalous zones in areas not excavated in 1994. Results of the survey indicated that the buried material had been removed, thereby removing the primary source of subsurface contaminants.

Areas A-1 and A-2 have not been excavated or sampled. Based on the geophysical survey, these areas are expected to contain less significant quantities of buried waste, and therefore less contaminated soil, than found in Areas A-3 and A-4. Information from an ex-soldier indicated that undetonated bomblets from cluster bombs may be buried in Areas A-1 and A-2 (ESE 1991). Approximately 3 feet of soil overlie the apparent disposal horizon (18 inches of soil originally overlying the disposal horizon, plus an 18-inch soil cover added in 1994).

The condition of the wetlands was largely unknown prior to the 1995 RI. Based on the geophysical survey conducted in 1994 by CRREL, the wetlands may contain small dispersed metallic objects.

2.3.2 Remedial Investigation

Woodward-Clyde performed an RI at OUB in August and September of 1995. Procedures and results of the RI are presented in the RI Report (WC 1996a). The RI included the following tasks:

- Field screening for mustard, unexploded ordnance, and chlorinated solvents
- Collection and analysis of soil and groundwater samples
- Installation of 6 groundwater monitoring wells
- Evaluation of the presence of dense nonaqueous phase liquids (DNAPLs)
- Borehole geophysical surveys
- Collection and analysis of wetlands sediment and surface water samples

Metals, explosives, CWM and CWM breakdown products were not detected above applicable or relevant and appropriate requirements (ARARs); however, chlorinated solvents were detected at numerous locations above ARARs. Two contaminants, 1,1,2,2-tetrachloroethane and TCE, were found at concentrations significantly higher than any other chemical detected at the site. The concentrations are high enough that the TCE and 1,1,2,2-tetrachloroethane may occur are DNAPLs at the site. These two contaminants were also detected over the largest area. The table below shows Alaska maximum contaminant levels (MCLs) that were exceeded in groundwater samples. Only those concentrations that exceed MCLs are shown, except for 1,1,2,2-tetrachloroethane where all detections are shown.

Contaminant	Monitoring Well	MCL* (mg/L)	Concentration (mg/L)
Benzene	MW-14	0.005	2.9
Carbon Tetrachloride	MW-14	0.005	2.6
cis-1,2-dichloroethene	MW-4	0.07	1.6
	MW-7		0.28
	MW-14		37
trans-1,2-dichloroethene	MW-4	0.1	0.41
	MW-14		12
tetrachloroethene (PCE)	MW-4	0.005	0.31
	MW-14		11

Contaminant	Monitoring Well	MCL* (mg/L)	Concentration (mg/L)
trichloroethene (TCE)	MW-1	0.005	0.043
	MW-3		0.26
	MW-4		14
	MW-5		4.8
	MW-6		0.13
	MW-7		1.0
	MW-12		0.16
	MW-13		0.0067
	MW-14		220
	MW-15		0.27
1,1,2,2-tetrachloroethane	MW-1	None	0.082
	MW-3		0.54
	MW-4		71
	MW-5		21
	MW-6		0.52
	MW-7		3.1
	MW-12		0.49
	MW-13		0.0011
	MW-14		1,900
	Mw-15		0.0063

NOTES:

*18 Alaska Administrative Code 80
mg/L = Milligrams per liter.

2.3.3 Risk Assessment

Human Health Risk Assessment

A Human Health Risk Assessment (HHRA) was performed as part of the RI in 1995 to evaluate whether existing concentrations of contaminants in media at OUB could pose a threat to human health under conservative (health-protective) exposure assumptions (WC 1996b). The risk assessment was conservative because it was based on long-term residential or occupational exposures, which are not likely at this site, thereby overestimating risk for site-specific exposure scenarios. The most probable future use of the site is continued use for military training.

Soil, Sediment, and Surface Water

The HHRA shows that the relatively low concentrations of contaminants in soils from 0 to 15 feet bgs (the depth of potential direct human exposure) and wetland surface water and sediments do not pose an unacceptable risk to public health under conservative exposure assumptions of long-term residential or industrial use. It therefore follows that exposure to contaminants in soil and the wetland would not pose an unacceptable risk to current authorized personnel and/or other potential receptors such as recreational users or commercial workers, who would be expected to receive much less exposure than that assumed for residents.

- No carcinogens were detected in surface water in the wetland. The low concentrations of VOCs, explosives, and metals in wetland surface water do not pose a threat of noncarcinogenic health effects. Trace levels of explosives in sediments in the wetland do not pose unacceptable risk of cancer or noncancer health effects.
- In Areas A-1 and A-2, exposure to low concentrations of VOCs and metals in soil at depths of 0 to 15 feet bgs do not pose unacceptable risk of cancer and noncancer health effects.
- Lifetime excess cancer risk was 1E-05 (1 in 100,000) and noncarcinogenic hazard index was less than 1 for residential exposure to soil in Areas A-3 and A-4 at depths of 0 to 15 feet bgs. The primary contributors to cancer risk were 1,1,2,2-tetrachloroethane and TCE (exposure point concentrations of 4.6 and 4.1 mg/kg, respectively) via the soil ingestion and soil-to-air inhalation route of exposure. Generally, remediation is not warranted for protection of public health if total lifetime excess cancer risk does not exceed 1E-04 and if noncarcinogenic effects are not a concern (HI < 1).
- The highest concentrations of VOCs in soil were detected in Areas A-3 and A-4 at depths greater than 15 feet bgs, below the depth of potential direct human exposure (e.g., 2,030 mg/kg 1,1,2,2-tetrachloroethane and 0.384 mg/kg TCE were detected at MW-14 at a depth of 16 to 18 feet bgs). Although these contaminants do not pose a threat to human health, they could serve as a continuing contaminant source to groundwater.

Groundwater

Use of groundwater from the shallow interval or deep aquifer at OUB as a drinking water source would pose an unacceptable risk of cancer and noncancer health effects. The physical properties of the shallow saturated interval make its use as a drinking water source highly unlikely; however, to provide a more conservative measure of risk, it was evaluated in the risk assessment as a potential drinking water source. Groundwater at the site or downgradient from it is not currently used in any capacity nor is it expected to be used in the future. Flow rate measured during pump tests conducted on monitoring wells in the shallow aquifer ranged from 0.6 to 1.5 gallons per minute. Groundwater fate and transport modeling indicates that contaminants at OUB do not pose a threat to the Eagle River in the imminent or near future.

- Primary contributors to lifetime excess cancer risk in groundwater at OUB were 1,1,2,2-tetrachloroethane and TCE (exposure point concentrations in the shallow interval of 16.9 and 6.3 mg/L, respectively). Concentrations of carbon tetrachloride, chloroform, cis-1,2-dichloroethene, 1,1-dichloroethene, PCE, and 1,1,2-trichloroethane also exceeded levels of concern for residential exposure to groundwater.
- The highest concentrations of contaminants in groundwater were detected in the perched interval (1,900 mg/L 1,1,2,2-tetrachloroethane and 220 mg/L TCE were detected in MW-14 at a depth of 22 feet bgs). Although these contaminants do not pose a threat to human health

(the perched interval would not be used as a water supply), they are most likely serving as a continuing contaminant source to the shallow interval and deep aquifer.

Based on groundwater fate and transport modeling, it would take 120 years for concentrations of TCE exceeding the drinking water MCL (0.005 mg/L) to reach the Eagle River and 170 years for concentrations of 1,1,2,2-tetrachloroethane exceeding 0.005 mg/L to reach the Eagle River (details of groundwater modeling are provided in Appendix XIII of the RI Report, WC 1996a). These 0.005 mg/L concentrations of 1,1,2,2-tetrachloroethane and TCE do not exceed health-based concentrations of concern for residential drinking water or for ingestion of fish by humans (0.011 mg/L for 1,1,2,2-tetrachloroethane and 0.081 mg/L for TCE).

2.3.4 Ecological Risk Assessment

An ecological risk assessment (ERA) was performed in 1995 in conjunction with the HHRA (WC 1996b). The detected organic chemicals, explosives, and metals were screened against four criteria: frequency of detection; site-specific background data; toxicity based screening; and literature-based background values. The screening was done to assess which of the detected chemicals required further evaluation to assess potential risk to ecological receptors. The results of the screening process indicated that seven VOCs in soil from 0 to 3 feet bgs (the depth of potential direct exposure for ecological receptors) and two explosives in wetland sediment were contaminants of ecological concern (COECs) that required further evaluation of risk to ecological receptors.

The northern red-backed vole and muskrat were selected as representative terrestrial site receptors for the upland and wetland habitats, respectively, based on site-specific exposure pathways and ecological considerations. The potential for adverse effects from COECs on upland and wetland plant communities and aquatic invertebrates were also evaluated. Benchmark toxicity values for the COECs were determined for each receptor. The Quotient Method (QM) was used to quantitatively evaluate potential risk from exposure to COECs in soil and sediment. The QM is based on the comparison of estimated maximum and reasonable maximum exposure (RME) dose concentrations for onsite receptors with protective benchmark toxicity values derived from the toxicological literature.

Based on the risk analysis, COEC concentrations at OUB result in negligible risk to small mammal populations, aquatic invertebrates, emergent wetland vegetation, and upland plant vegetation. The overall potential for valued environmental resources at this site to be adversely affected is considered negligible.

The 0.005 mg/L concentrations of 1,1,2,2-tetrachloroethane and TCE that are estimated to reach Eagle River in 120 and 170 years, respectively, are well below levels of concern for protection of aquatic organisms. These results indicate no imminent or near future threat to Eagle River.

2.3.5 Feasibility Study

Based on the results of the RI, TCE and 1,1,2,2-tetrachloroethane were selected as the chemicals of concern for the feasibility study (FS). Details of the FS can be found in the Feasibility Study Report (WC 1997a). The following Remedial Action Objectives were developed for the FS:

1. Reduce contaminant levels in the groundwater to comply with drinking water standards
2. Prevent the soil from continuing to act as a source of groundwater contamination
3. Prevent the contaminated groundwater from adversely affecting the Eagle River surface water and sediments
4. Minimize degradation of the State of Alaska's groundwater resources at the site as a result of past disposal practices.

After identifying and screening potential process options that may be effective and implementable at the site, the following alternatives were developed:

- Alternative 1 - No Action. The No Action Alternative involves no additional costs or actions at the site. This alternative is required by the National Contingency Plan (NCP).
- Alternative 2 - Natural Attenuation. Interim U.S. Army policy requires the inclusion of "Natural Attenuation" for evaluation as a remedial action alternative through the preparation of the Proposed Plan. Natural attenuation relies on biological, physical, and chemical processes that are occurring in the environment without artificial stimulus. Groundwater monitoring would include intrinsic remediation parameters and VOCs.
- Alternative 3 - Containment. The containment alternative involves a synthetic liner with soil cover as a cap and a bentonite slurry wall to 25 feet bgs as a vertical barrier to prevent recharge of the groundwater from the wetland.
- Alternative 4 - Interception Trench, Air Stripping, and Soil Vapor Extraction. Groundwater is collected in drainage trenches and treated in an air stripper. The treated groundwater is discharged outside the capture zone of the interception trenches and soil vapor extraction is used to remediate contaminated soils above the lowered water table.
- Alternative 5 - Air Sparging and Soil Vapor Extraction of the "Hot Spot" and Natural Attenuation. Groundwater in the "hot spot" area is treated using air sparging, and unsaturated "hot spot" soils are treated with soil vapor extraction. Groundwater is monitored for intrinsic remediation parameters and VOCs.

2.3.6 Treatability Study

A treatability study was completed at OUB during the fall of 1996 (WC 1997b). The study was completed to help reduce the uncertainty involved in the alternatives proposed in the feasibility study. The treatability tests included soil vapor extraction, air sparging, pump tests and groundwater sampling to identify natural attenuation processes.

The soil vapor extraction (SVE) test was run for 5 days. Samples of the extracted soil gas demonstrated that SVE is effective at removing the target contaminants (TCE and 1,1,2,2-tetrachloroethane) from the subsurface. The air sparge test was conducted during the last day of the SVE test. The air sparge well was located 5 feet from the SVE well. Samples of the extracted soil gas indicated that the concentration of TCE extracted from the SVE well increased when the air sparge blower was turned on, but there was little increase in the concentration of 1,1,2,2-tetrachloroethane.

Five single well pump tests were completed in wells screened in the shallow groundwater interval. The hydraulic conductivities calculated from the pump test data ranged from 0.7 to 3.4 ft/day. These values, although slightly higher, generally agree with previously estimated values.

Groundwater samples were collected from seven monitoring wells and analyzed for natural attenuation parameters and volatile organic compounds. The natural attenuation parameters included nutrients needed for bioremediation (nitrate, nitrite, TOC, iron, etc.), degradation byproducts (methane, ethane, ethene, and sulfide), and bacteria counts (sulfate reducing bacteria and heterotrophic plate count). The sampling results indicated that very little if any natural attenuation of the contaminants is occurring.

DNAPLs were observed in one of the SVE monitoring points, MP-2. Approximately 3 inches of a dark liquid were brought to the surface in a bailer. The liquid had a strong solvent odor. This was the only location where DNAPLs have been observed at the site. Attempts to collect additional DNAPL from MP-2, were not successful.

Based on results of the treatability study, an additional alternative was developed:

- Alternative 6 - Soil Vapor Extraction of the "Hot Spot." Soil in the hot spot is treated with soil vapor extraction. Groundwater is extracted via a knockout tank in the SVE system, treated in an air stripper, and discharged to an infiltration system. Dense nonaqueous phase liquids (DNAPLs) are treated with a bubble tube.

2.3.7 Proposed Plan

A Proposed Plan for OUB was developed by Ecology and Environment in January of 1997 (E&E 1997). The Proposed Plan discussed the six remedial alternatives evaluated in the FS and the preferred alternative as selected by the Remedial Project Managers (RPMs). The RPMs are representatives from the Army Public Works, the Alaska Department of Environmental Conservation (ADEC), and the U.S. Environmental Protection Agency (EPA). The preferred alternative was Alternative 6, "High Vacuum Soil Vapor Extraction of the Hot Spot and Site-Wide Institutional Controls with Long Term Groundwater Monitoring". The Proposed Plan was submitted for a 30 day public comment period and no significant comments were received.

2.3.8 Record of Decision

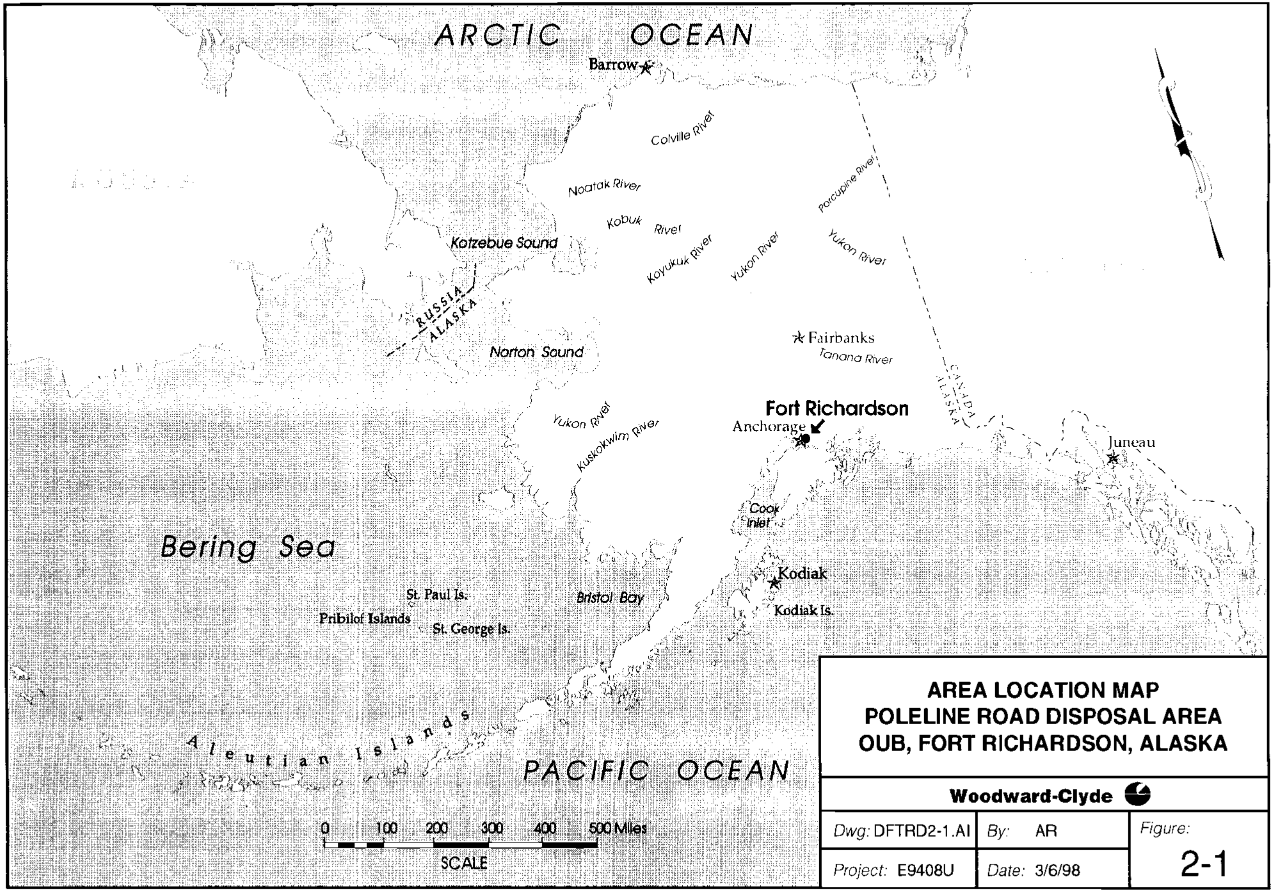
The Record of Decision (ROD) for OUB was signed on September 18, 1997. The ROD presents the selected remedial action for OUB. The ROD lists the remedial action objectives and the major components for the preferred remedy (high vacuum extraction) for OUB.

2.3.9 Design Verification Study

A design verification study was conducted between June and December 1997. Plans for the DVS were documented in the *Work Plan Technical Memorandum, Groundwater Characterization and Design Verification Study* (WC 1997b). The primary objective of the DVS is to evaluate six-phase soil heating (SPSH), an enhancement to SVE, as an applicable in-situ technology for remediating solvent contaminated soils.

SPSH uses common low frequency electricity to heat soil as an enhancement to soil vapor extraction (Bergsman et al., 1993a, 1993b, 1994). The mechanism of heating is resistive dissipation of electrical energy. The SPSH technology uses conventional single-phase transformers to convert standard three-phase electricity into six-phase electricity.

The DVS work plan included sampling DNAPLs in monitoring point MP-2 during the treatability study. Sampling was intended to test for the presence of CWM in the DNAPLs so an appropriate amendment could be developed for the existing health and safety plan prior to initiation of the DVS. However, no DNAPLs were present when MP-2 was sampled in the spring of 1997. The surrounding monitoring points were checked and none contained DNAPLs.

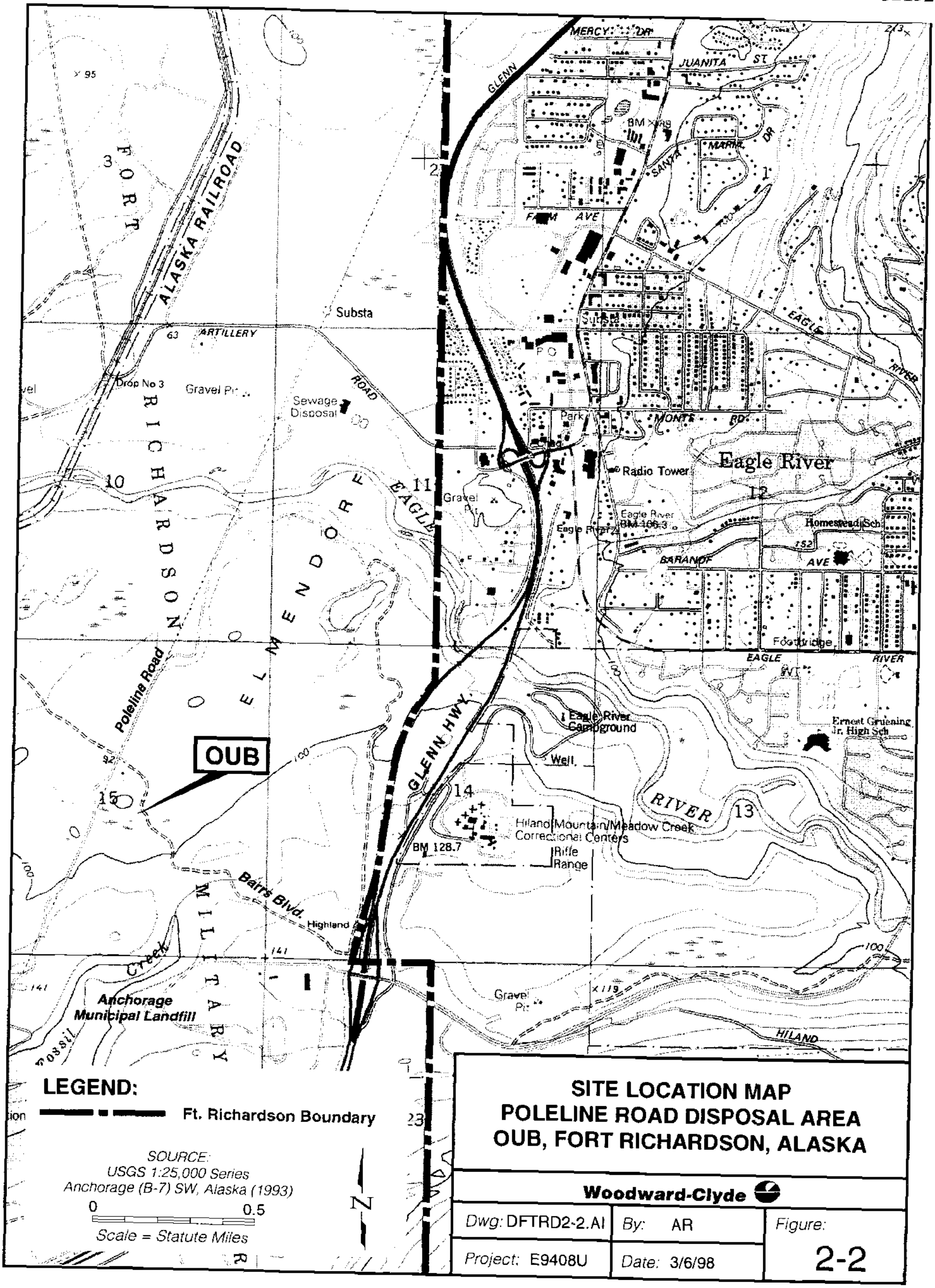


AREA LOCATION MAP
POLELINE ROAD DISPOSAL AREA
OUB, FORT RICHARDSON, ALASKA

Woodward-Clyde

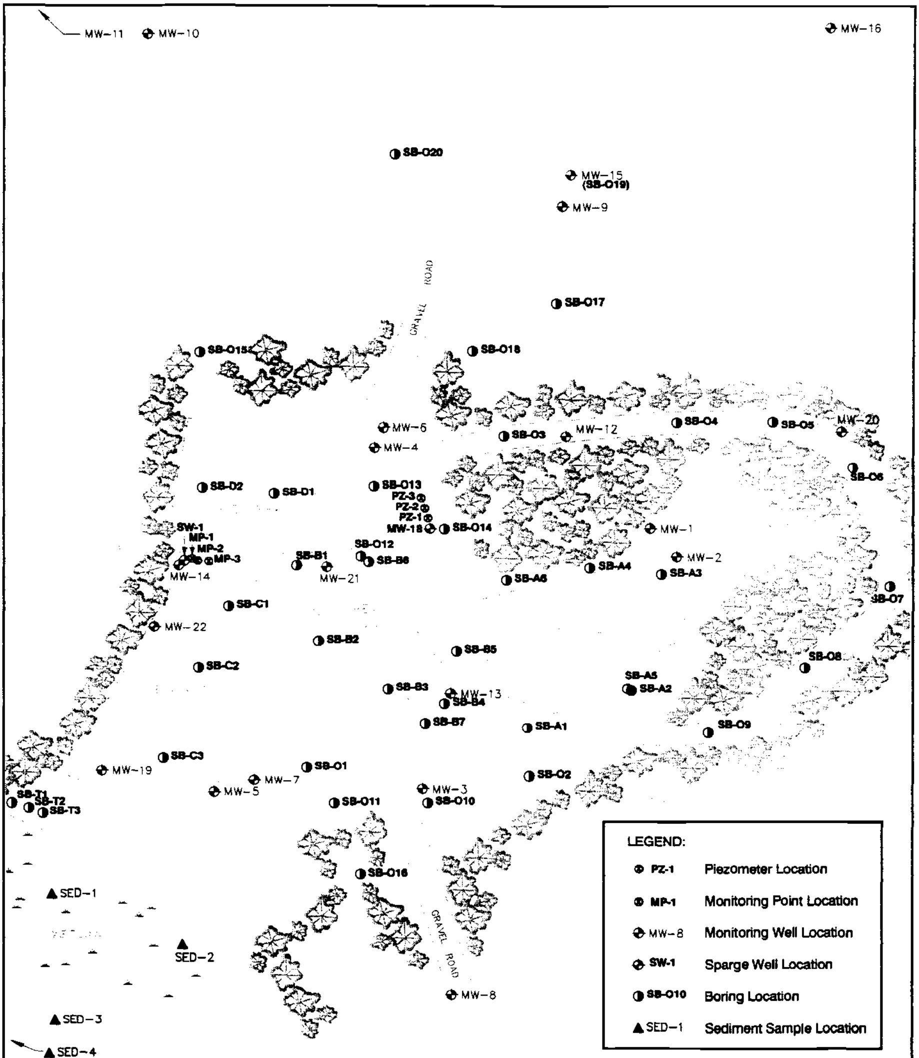
Dwg: DFTRD2-1.AI	*By:* AR	*Figure:* 2-1
Project: E9408U	*Date:* 3/6/98	

OU-B 32131



SITE LOCATION MAP
POLELINE ROAD DISPOSAL AREA
OUB, FORT RICHARDSON, ALASKA

OU-B 32133



MW-17 (background well) is located southwest of the wetlands - See Figure 4-15 of RI Report.

GRAPHIC SCALE

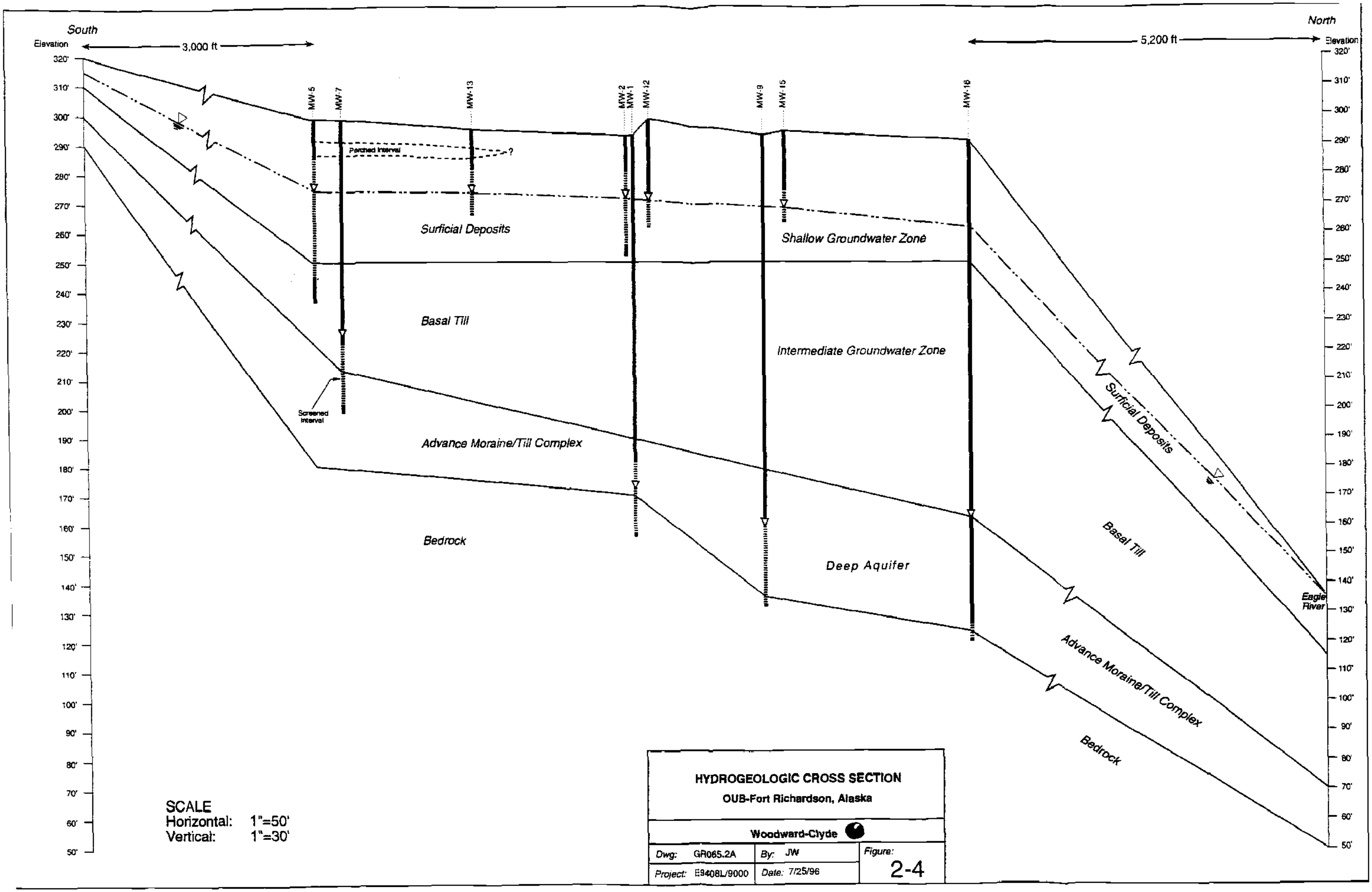
50 0 50 100 200

(IN FEET)
1 inch = 100 ft.

BORING AND MONITORING WELL LOCATIONS
POLELINE ROAD DISPOSAL AREA
OUB, FORT RICHARDSON, ALASKA

Woodward-Clyde

Dwg: DFTRD2_3	By: AR	Figure: 2-3
Project: E9408U	Date: 3-6-98	



HYDROGEOLOGIC CROSS SECTION		
OUB-Fort Richardson, Alaska		
Woodward-Clyde		
Dwg: GR065.2A	By: JW	Figure: 2-4
Project: E9408L/9000	Date: 7/25/96	

This section presents a discussion of the waste characterization, remedial requirements, and treatment processes used for the site. These data are the criteria on which the selected design will be based.

3.1 WASTE CHARACTERIZATION

The waste to be treated consists of soil and groundwater which have been contaminated with chlorinated solvents. Soils at the site can be generally described as a silty sand with some gravel. These three grain sizes (silt, sand and gravel) were observed in nearly every sample at various percentages. Only a few samples were observed with significant amounts of clay. Soils at the site are very dense. Evidenced in the high number of blow counts recorded during split spoon sample collection. Blow counts frequently exceeded 50 blows per 6 inches.

Four water-bearing intervals have been identified at the OUB. The four water-bearing zones are a perched interval, a shallow interval, an intermediate interval, and a deep aquifer. The detection of contaminants in all four intervals suggests that they are interconnected to some degree. Observations made while drilling indicate that the saturated intervals are separated by zones of very dense, slightly moist, low porosity tills.

The soil and groundwater contaminants found at the site are chlorinated solvents consisting of TCE, PCE, and 1,1,2,2-tetrachloroethane. TCE and PCE are halogenated aliphatic organic compounds which, due to their unique properties and solvent effects, have been widely used as industrial cleaning solutions. 1,1,2,2-tetrachloroethane is also an aliphatic organic compound, but it is not widely used because of its hazardous nature. All of the solvents detected at the site have specific gravities greater than water. If a solvent is present at a concentration greater than its solubility limit in water, then a DNAPL will form. Section 2.3.6 has a discussion regarding the presence of DNAPL at the site.

3.1.1 Extent of Soil Contamination

The highest concentrations of chlorinated solvents in soils occur within the boundary of Areas A-3 and A-4. This area is the same location where the solvents were released. Soils located east of Areas A-3 and A-4 also have elevated concentrations of chlorinated solvents, but at much lower levels than inside Area A-3 and A-4. Figure 3-1 shows the area with the highest concentrations of chlorinated solvents in soil.

3.1.2 Extent of Groundwater Contamination

Groundwater with the highest concentrations of chlorinated solvents occurs in Area A-4, A-3 and also east of Areas A-3 and A-4 (Figure 3-2). This area is slightly larger than the area of soil contamination in Figure 3-1. Three groundwater intervals are located in this area, the perched, shallow and deep. The groundwater in the perched and shallow intervals have the highest concentrations of chlorinated solvents.

3.2 REQUIREMENT FOR REMEDIAL ACTION

The requirements for remedial action at OUB are documented in the Record of Decision for Operable Units A and B. Section 8 of the ROD lists the ARARs for OUB. The most significant ARARs considered for OUB are:

- Federal Safe Drinking Water Act (40 Code of Federal Regulations [CFR] 141)
- Alaska Drinking Water Regulations (18 Alaska Administrative Code [AAC] 80)
- Alaska Water Quality Standards (AWQS) (18 ACC 70)

The state and federal MCL and non-zero MCL goals were established under the Safe Drinking Water Act and are relevant and appropriate for groundwater that is a potential drinking water source. For the constituents of concern at OUB, the state and federal MCLs are equal. Many of the constituents of groundwater regulated by AWQS are identical to state and federal MCLs.

As a part of the RI/FS process, remedial action objectives (RAOs) were developed in accordance with the National Contingency Plan and EPA guidance for conducting RI/FS investigations. The purpose of the objectives is to reduce the contamination in the groundwater at OUB to levels that do not pose a threat to human health and the environment. The objectives of the remedial action at OUB are as follows:

- Reduce contamination levels in the groundwater to comply with drinking water standards;
- Prevent contaminated soil from continuing to act as a source of groundwater contamination;
- Prevent the contaminated groundwater from adversely affecting the Eagle River surface water and sediments; and
- Minimize degradation of the State of Alaska's groundwater resources at the site as a result of past disposal practices.

3.3 REMEDIATION STRATEGY

Soil and groundwater hot spots have been identified at OUB. Figure 3-1 shows the estimated boundary of the soil hot spot and Figure 3-2 shows the estimated boundary of the groundwater hot spot. These are updated hot spot delineations based on data collected since the ROD was signed (September 1997). The groundwater hot spot presented in the ROD is included as Figure 3-3.

Active treatment at OUB will be limited to the soils and groundwater inside the soil hot spot, rather than the entire groundwater hot spot. Since the soil hot spot is a subset of the groundwater hot spot, it also represents groundwater with the highest concentrations of chlorinated solvents. Active treatment will be accomplished by installing dual phase extraction (DPE) wells within the soil hot spot. DPE wells are designed to extract both soil gas and groundwater. It is expected that actively treating the soil hot spot will reduce the groundwater solvent concentration in the groundwater hot spot.

3.4 TREATMENT PROCESSES

The following discussion provides a general description of each of the selected treatments and a discussion of the design criteria that each process must meet.

3.4.1 Dual Phase Extraction (DPE)

Soil vapor extraction (SVE) is commonly used to remove volatile organic compounds from contaminated soils . DPE, a variation of SVE, involves extracting soil gas vapors and groundwater from an extraction well via a drop tube (Figure 3-4). The drop tube is placed inside a 4-inch vapor extraction well and acts like a straw to pull both air and liquids from the well.

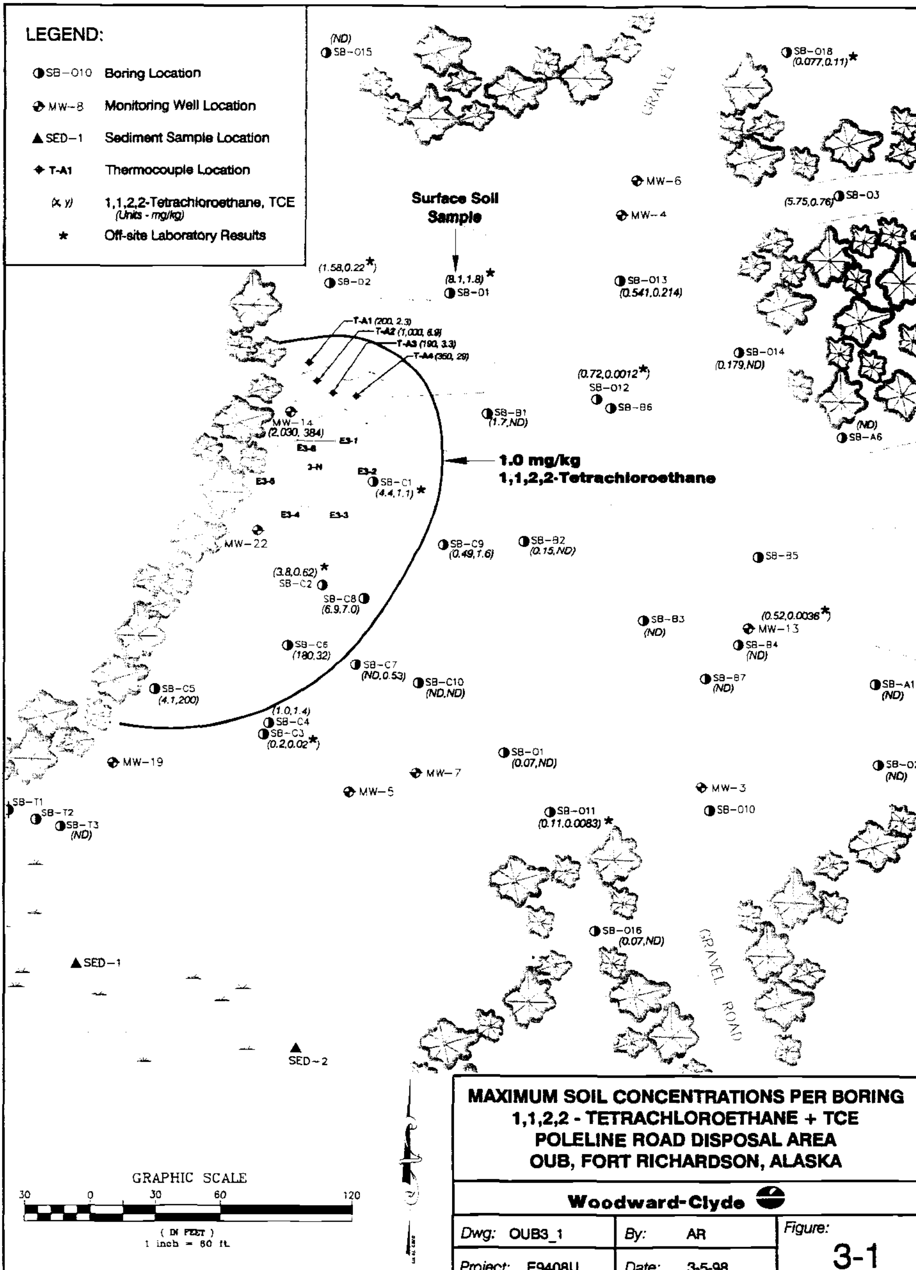
The final design must meet the following design criteria. Air should be extracted through each drop tube at a minimum velocity of 80 scfm. This rate of air flow is necessary to entrain water droplets in the air stream. The drop tube should extend to within 2 feet of the bottom of the extraction well. The concentration of contaminants in water from the moisture separator must be reduced to MCLs before being discharged. Air strippers have been effectively used during previous studies completed at the site. Samples of the treated water will have to be collected to ensure the no contaminants exceed the MCLs. Air extracted from the soil and air exiting the air stripper will not be treated.

3.4.2 Natural Attenuation

Natural attenuation is a collection of physical and biological processes that occur naturally to reduce the concentration or mass of contaminants in the groundwater. The concentration of VOCs in the groundwater can be reduced by physical processes such as: dilution, sorption, and volatilization. The mass of VOCs in the groundwater can be reduced by chemical and biological redox transformations of the contaminants.

Groundwater samples were collected at OUB and analyzed for natural attenuation parameters. The sampling results indicated that very little if any biological processes are reducing the mass of the contaminants. But, the presence of degradation products suggests that chemical transformations are occurring. For example, the large concentrations of TCE are most likely the result of hydrolysis of 1,1,2,2-tetrachloroethane to TCE. The other physical processes, such as dilution, sorption, and volatilization are most likely occurring. The changes in contaminant concentrations over time suggest that these processes are occurring at relatively slow rates.

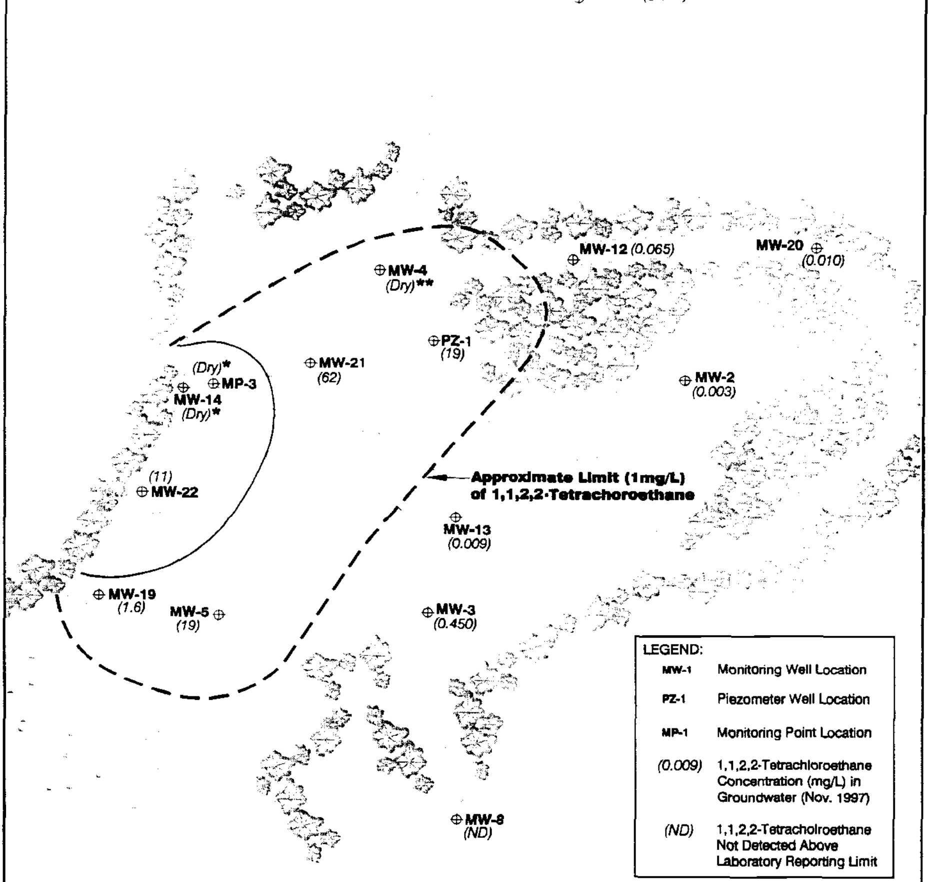
Design criteria can not be developed for the natural attenuation processes. But, criteria can be developed for the monitoring program. A long-term groundwater monitoring program had already been implemented (Woodward-Clyde, 1997c). This program includes eight rounds of groundwater sampling for VOCs by Method 8260B. The first two rounds will include sampling for natural attenuation parameters (Table 5-1). The first round of sampling was conducted November 1997. After the second round, recommendations will be made regarding additional sampling for natural attenuation parameters. These recommendations will define the criteria for the future natural attenuation monitoring.


LEGEND:
SB-010 Boring Location
MW-8 Monitoring Well Location
SED-1 Sediment Sample Location
T-A1 Thermocouple Location
(x, y) 1,1,2,2-Tetrachloroethane, TCE (Units - mg/kg)
* Off-site Laboratory Results
(ND) SB-015
SB-018 (0.077,0.11)*
GRAVEL
MW-6
MW-4
Surface Soil Sample
(5.75,0.76) SB-03
(1.58,0.22*) SB-02
(8.1,1.8)* SB-01
SB-013 (0.541,0.214)
T-A1 (200, 2.3)
T-A2 (1,000, 6.9)
T-A3 (190, 3.3)
T-A4 (350, 29)
SB-014 (0.179,ND)
(0.72,0.0012*) SB-012
SB-B6
SB-B1 (1.7,ND)
(ND) SB-A6
MW-14 (2,030, 384)
E3-1
E3-6
3-N
E3-2
E3-5
SB-C1 (4.4,1.1)*
E3-4
E3-3
1.0 mg/kg 1,1,2,2-Tetrachloroethane
MW-22
SB-C9 (0.49,1.6)
SB-B2 (0.15,ND)
SB-B5
(3.8,0.62)* SB-C2
SB-C8 (6.9,7.0)
SB-B3 (ND)
(0.52,0.0036*) MW-13
SB-B4 (ND)
SB-C6 (180,32)
SB-C7 (ND,0.53)
SB-C10 (ND,ND)
SB-B7 (ND)
SB-A1 (ND)
SB-C5 (4.1,200)
(1.0,1.4) SB-C4
SB-C3 (0.2,0.02*)
SB-01 (0.07,ND)
SB-02 (ND)
MW-19
MW-7
MW-5
MW-3
SB-T1
SB-T2
SB-T3 (ND)
SB-011 (0.11,0.0083)*
SB-010
SB-016 (0.07,ND)
GRAVEL ROAD
SED-1
SED-2
GRAPHIC SCALE
30 0 30 60 120
(IN FEET)
1 inch = 60 ft.
MAXIMUM SOIL CONCENTRATIONS PER BORING
1,1,2,2 - TETRACHLOROETHANE + TCE
POLELINE ROAD DISPOSAL AREA
OUB, FORT RICHARDSON, ALASKA
Woodward-Clyde
Dwg: OUB3_1
By: AR
Figure: 3-1
Project: E9408U
Date: 3-5-98

NOTES

* Design Verification Study underway during Nov. 1997 Sampling is the likely cause for MP-3 and MW-14 being dry. In 1995 the 1,1,2,2-Tetrachloroethane concentration in groundwater from MW-14 was 1900 mg/L

** In 1995 the 1,1,2,2-Tetrachloroethane concentration in groundwater from MW-4 was 71 mg/L This well has been dry when tested subsequently.



MW-17 (ND) is along Poleline Road, southwest of wetland.

GRAPHIC SCALE

50 0 50 100 200

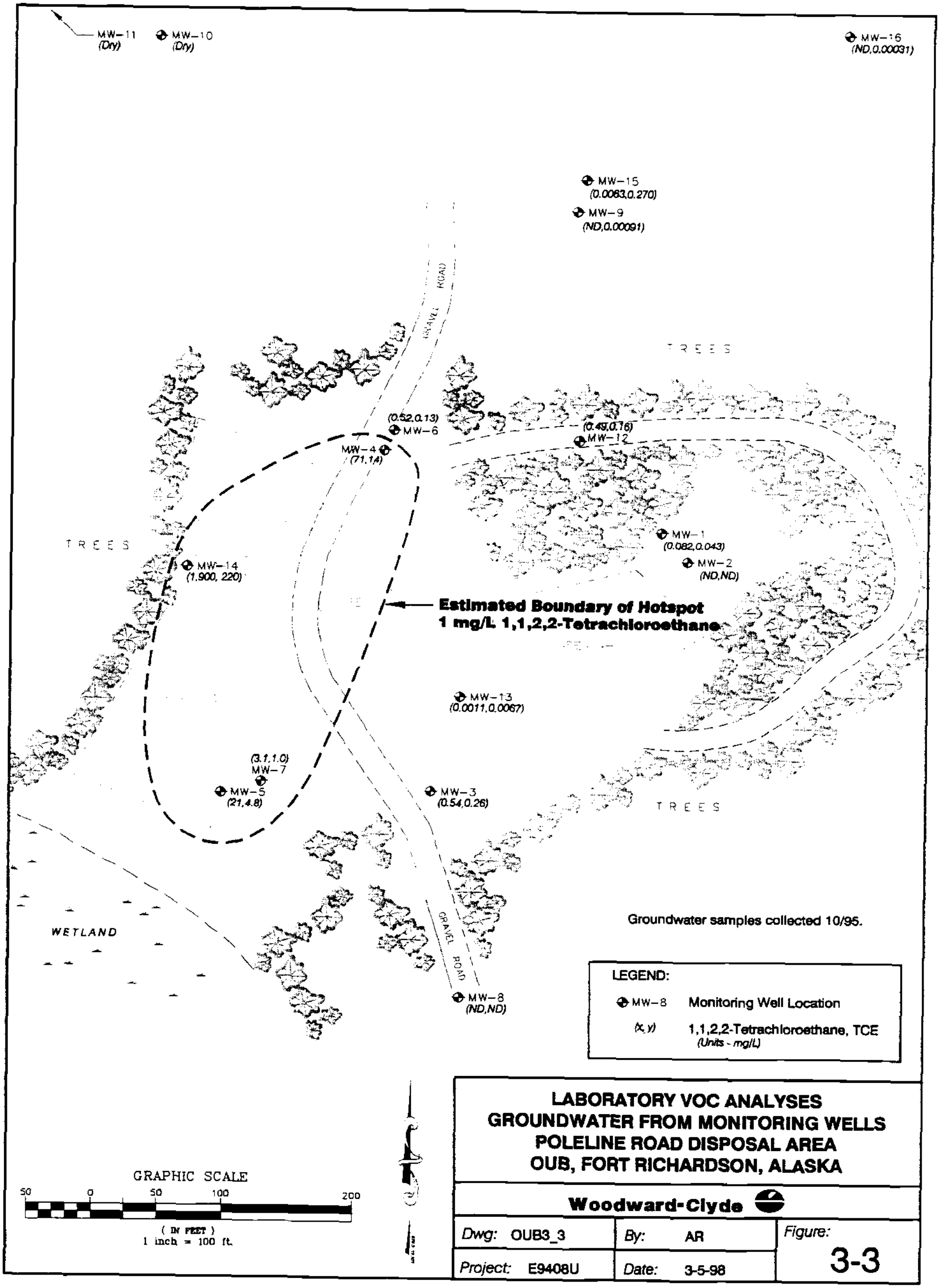
(IN FEET)
1 inch = 100 ft.

1,1,2,2-TETRACHORORETHANE CONCENTRATIONS IN SHALLOW AQUIFER NOVEMBER 1997 OUB, FORT RICHARDSON, ALASKA

Woodward-Clyde

Dwg: OUB3_2	By: AR	Figure: 3-2
Project: E9408U	Date: 3-5-98	

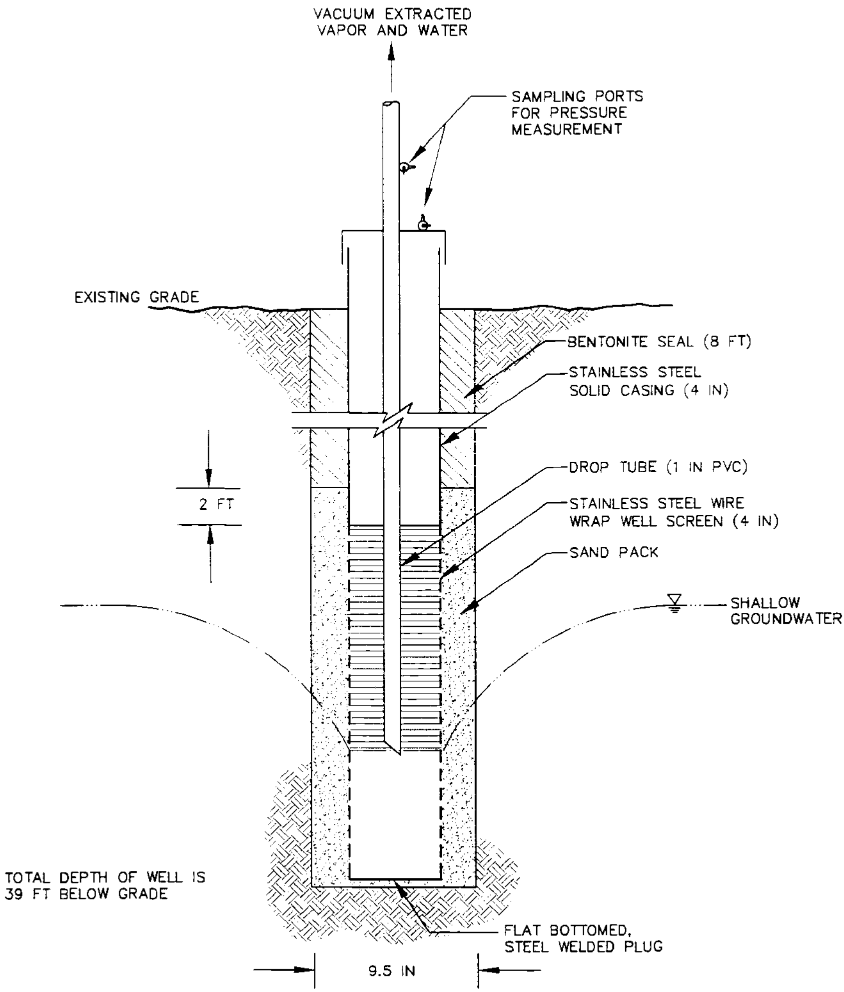
OU-B 32139



LABORATORY VOC ANALYSES
GROUNDWATER FROM MONITORING WELLS
POLELINE ROAD DISPOSAL AREA
OUB, FORT RICHARDSON, ALASKA

Woodward-Clyde

Dwg: OUB3_3	By: AR	Figure:
Project: E9408U	Date: 3-5-98	3-3



NOT TO SCALE

TYPICAL SINGLE-PUMP DPE EXTRACTION WELL
DESIGN VERIFICATION STUDY
POLELINE ROAD DISPOSAL AREA
OUB, FORT RICHARDSON, ALASKA

Woodward-Clyde

Dwg: DFTRD3_4	*By:* AR	*Figure:* 3-4
Project: E9408U	*Date:* 3-6-98	

4.1 DESIGN ASSUMPTIONS

This section presents the assumptions used to develop the treatment system layout. In general. active treatment will be limited to the soil and the groundwater in the source area soil. The DPE system is described below.

4.1.1 Dual Phase Extraction

The DPE system will be installed in the area with the highest levels of soil contamination (Figure 4-1). Portions of this area have been treated during the DVS and will not be treated a second time.

Soil samples were collected before and after treating soils with Six-Phase Soil Heating. These results show that the concentration of solvents in the soil was reduced by 98%. No additional treatment of the previously treated areas is planned, but DPE wells will be placed down gradient of the previously treated area.

A treatability study conducted at the site in 1996 provided information about the performance of standard SVE (WC, 1997b). Measurements were made during the test to allow calculation of the air conductivity and the radius of influence. A 25-foot radius of influence was calculated using the procedures described in the USACE guidance document EM 1110-1-4001.

The most significant finding from the treatability study was that high vacuums were needed to move air from the subsurface. The radius of influence was about 25 feet and the air flow was between 150 and 200 ft^3/min when a vacuum of 100 inches of water was applied at the vacuum extraction well. For comparison, a SVE test conducted at Fort Wainwright in Fairbanks, achieved air extraction rates of 100 ft^3/min and a radius of influence of 50 feet, while applying only 30 inches of water vacuum to the vapor extraction well (HLA, 1997). Based on the treatability study results the following design assumptions will be used:

Vacuum at Vapor Extraction Well:	100 inches of water
Air Extraction Rate:	80 ft^3/min
Radius of Influence:	25 feet
Number of Vapor Extraction Wells:	12

The DPE wells will be constructed of 4-inch PVC and installed to a depth of 40 feet below ground surface. The screened interval will extend from 10 feet to 40 feet below ground surface (BGS). A drop tube will be installed inside the 4-inch PVC casing and screen. The drop tube will extend to within 2 feet of the bottom of the DPE well. All vapors and liquids will be extracted from the well through the drop tube.

The drop tube in each DPE well will be connected to the blower system using 4-inch PVC piping. The blower system will consist of a moisture separator and a set of blowers. For example, three 20 horsepower Suterbilt positive displacement blowers would be required to meet the design assumptions listed above. Wells and blowers will be connected to a manifold. Moisture separators will be placed in-line before each blower. Figure 4-2 is a schematic showing how the VE wells, moisture separator and blowers could be connected. This schematic also includes instrument and sampling port locations.

A significant amount of water was collected by the moisture separator during the 1996 treatability study. Approximately 5 gallons per hour was extracted from the VE well and collected by the moisture separator. The moisture separators will be designed to handle two gallons per minute. Water will have to be automatically transferred from the moisture separators to a batch tank. An automatic shutoff will be installed to prevent water from entering the blowers.

The water will be treated using an air stripper. Previous studies completed at the site show that the concentration of solvents in the extracted water is reduced to below MCLs by pre-heating the water to approximately 140°F. Treated water will be discharged to an infiltration system. The infiltration trench will be 200 feet long, four-inch diameter PVC pipe with 0.5-inch drain holes. The drain holes will be drilled into two sides of the pipe at 1 foot spacing. A bedding of sand and gravel will be placed around the pipe to improve infiltration and to act as a filter. The infiltration system will be placed below the freeze line (8 feet deep).

There is a possibility that DNAPLs will be extracted by the DPE system. Traps will be installed between the moisture separator and the water heater. These traps will limit the amount of DNAPL reaching the air stripper. The traps will be checked and emptied, if necessary, during each site visit.

The DPE system will be operated year-round and will require winterizing. The water handling systems will need to be kept above freezing.

There is currently no permanent electric service at the site. The Fort has recently approached the local electric company about providing permanent electrical supply at the site. Permanent electric service should be installed by the time the full scale DPE system will be installed.

Once the system has been run for several months to several years, the concentration of contaminants in the off-gas will reach an asymptote. Pulsing the system is a strategy often used to increase the concentration of contaminants in the off-gas. Pulsing involves turning the system off for several weeks and the turning the system back on. Pulsing should be considered once the off-gas vapor concentrations level off (i.e., the concentrations reach an asymptote). The water levels will increase in the vent wells while the system is off. The water will have to be removed from each vent well before starting the system. The water can be removed by placing a pump in each well, or by sucking the water out with the drop tube.

4.2 ATTAINMENT OF REMEDIATION GOALS

The remediation goals for subsurface soil and groundwater are presented in the OUB ROD (EPA, 1997). The chemical specific goals listed in the OUB ROD are summarized in Table 4-1. The goals are based on MCLs and RBCs. TCE is not included as a contaminant of concern for the soil because it was not detected above RBCs (58 mg/kg). The following sections evaluate how the remedial goals will be achieved in the source area and the down gradient groundwater plume.

4.2.1 Source Area Soil

The source area soil will be treated with the DPE system. Contaminants will be removed from soil above the vadose zone by volatilization. Since the DPE system also removes groundwater, the water table will be lowered, enlarging the vadose zone.

The criteria for assessing the adequacy of soil treatment will be based on the concentration of solvents detected in the extracted soil gas. Once the concentration of solvents in the extracted soil gas has leveled off, subsurface soil samples should be collected. The subsurface soil sampling results will be used to confirm that treatment goals have been met. Section 5.2.4 presents a more detailed explanation of the shutdown process.

4.2.2 Groundwater

Groundwater remediation goals will be reached by removing and treating groundwater and by removing the source of contaminants to the groundwater. Groundwater inside the soil hot spot will be removed by the DPE system and treated by air stripping. Contaminants in the vadose zone will also be removed by the DPE system, reducing the source of contaminants to the groundwater. Natural attenuation will address groundwater not removed by the DPE system. This includes shallow groundwater outside the area of active treatment and groundwater in the deep aquifer.

A DPE treatability study was started at OUB March 1998. This study was designed to evaluate how groundwater concentrations will change as a result of DPE. Quick reductions in groundwater solvent concentrations are not expected. Groundwater flow rates are quite slow at the site, which will delay the response seen at down gradient monitoring wells. There could also be small pockets of DNAPL that act as continuing sources.

The long term groundwater monitoring program will continue after active treatment has stopped. The results from groundwater sampling results will be used to evaluate the effectiveness of natural attenuation.

4.3 PERMITS

No permits should be needed, but the RA contractor should meet the substantive requirements of permits prior to initiating remedial action.

4.4 REMEDIAL ACTION WORK PLAN

The RA contractor will prepare Draft and Final versions of a RA work plan. This document will cover the following topics:

- system installation
- sampling procedures
- system startup
- operation and maintenance

- remediation monitoring and sampling
- reporting requirements
- system shut down procedures

4.5 INVESTIGATIVE-DERIVED WASTE (IDW)

Personal protective equipment and miscellaneous paper and plastic trash generated during the field work will be collected in garbage bags and disposed in a dumpster at Fort Richardson. Decontamination water, groundwater, and process water will be treated on-site by passing the water through the air stripper. Treated water will be discharged into an infiltration trench.

Soil cuttings, from vapor extraction well installation, will be contained and stored in 55 gallon drums. The drums will be labeled with the project name, drum number, boring number, contents, date and point of contact. Drum deliveries should be coordinated with Kevin Gardner of DPW (384-3175) and ENSR Corporation operator of the disposal facility (561-5700). Drums will be transported to the Environmental Staging Facility at the southeast corner of the intersection of Warehouse Road and the Davis Highway.

4.6 SITE ACCESS

OUB is located in a range area. Access must be coordinated through Range Control.

4.7 COST ESTIMATE

Table 4-2 is an estimate of the cost to install and operate the DPE system at OUB. The capital costs provide an overview of specific items required to install the system. Capital indirect costs are fixed percentages of the total direct costs (TDC). The capital indirect costs represent estimates for contractor overhead and profits, engineering design, design studies, and health and safety work plans and reports. The second portion of the estimated costs describes operation and maintenance (O&M) costs. The first five years of operation of the SVE are expected to require more labor than subsequent years, to allow for equipment malfunctions and increased monitoring. The DPE is scheduled to operate for a total of 12 years while the annual groundwater monitoring is scheduled for 30 years. The O&M costs have not been increased to account for inflation or decreased to represent present worth dollars. Thirty five percent was added to the total capital and O&M costs to account for unexpected contingencies. The last markup is an eight percent increase to account for USACE oversight and administrative services. The total estimated program cost is $4 million.

TABLE 4-1: CHEMICAL-SPECIFIC REMEDIAL ACTION OBJECTIVES
POLELINE ROAD DISPOSAL AREA
FORT RICHARDSON, ALASKA

Remedial Cleanup Objectives for Groundwater			
Contaminant of Concern	Maximum Detected Concentration (mg/L)	Remedial Action Objective (mg/L)	Source of RAO *
Benzene	2.9	0.005	MCL
Carbon Tetrachloride	2.6	0.005	MCL
cis-1,2-Dichloroethene	37	0.07	MCL
trans-1,2-Dichloroethene	12	0.1	MCL
Tetrachloroethene (PCE)	11	0.005	MCL
Trichloroethene (TCE)	220	0.005	MCL
1,1,2,2-Tetrachloroethane	1,900	0.052	RBC

Remedial Action Objectives for Soil			
Contaminant of Concern	Maximum Detected Concentration (mg/Kg)	Remedial Action Objective (mg/Kg)	Source of RAO *
Tetrachloroethene	159	4	RBC
1,1,2,2-Tetrachloroethane	2,030	0.1	RBC

* - source of MCLs are state and federal maximum contaminant levels for drinking water
- source of Risk-based concentration (RBC) for drinking water is based on an increased cancer risk of 1×10^{-4}

source of tables = ROD (EPA, 1997)

TABLE 4-2
ESTIMATED COSTS FOR DPE SYSTEM
OUB, FORT RICHARDSON, ALASKA

ITEM	UNIT COST	UNIT	QUANTITY	COST
I. CAPITAL COSTS				
CAPITAL DIRECT COSTS				
A. Preparation Work/Mob & Demob				
Mobilization & Demobilization	$15,000	LS	1	$15,000
Additional Downgradient Monitoring Well Installations	$40,000	well	2	$80,000
Site Preparation (Clearing & Grubbing)	$2,000	acre	1.4	$2,800
Provide electrical hook-up from high voltage line	$40,000	LS	1.0	$40,000
B. Soil Vapor Extraction				
Extraction Well Installation (PVC, 40' length)	$5,000	well	12	$60,000
IDW Disposal	$15,000	LS	1	$15,000
Blower/Motor System (incl. knockout tank & instrumentation)	$40,000	LS	1	$40,000
Piping (4" PVC)	$14	lf	500	$7,000
Insulation for Piping and Equipment	$3,500	LS	1	$3,500
Pump (from knockout tanks to discharge)	$500	pump	3	$1,500
HDPE Liner	$4	sy	2,100	$8,400
HVE System Installation	$9,000	LS	1	$9,000
Electrical	$5,000	LS	1	$5,000
C. Air Stripper Effluent Treatment				
Equalization Tank	$12,200	tank	1	$12,200
Piping (HDPE)	$3	lf	1,400	$4,200
Water Heating Units	$2,500	each	1	$2,500
Air Stripping Unit (incl. blower)	$18,700	unit	1	$18,700
Treatment Building	$95	sf	200	$19,000
Infiltration System (incl. piping, fittings, filters, emitters)	$14,400	LS	1	$14,400
Infiltration Piping Preparation (punch holes in pipes, install fittings, e	$3,600	LS	1	$3,600
Infiltration Piping Bedding	$21	cy	40	$800
Infiltration Piping Installation	$20	lf	500	$10,000
Groundwater Treatment System Installation	$6,000	LS	1	$6,000
TOTAL DIRECT COSTS (TDC)				**$378,600**
CAPITAL INDIRECT COSTS				
A. Contractor's Overhead and Profit (50% TDC)				$189,300
B. Engineering Design (25% TDC)				$94,650
C. Design Studies (25% TDC)				$94,650
D. Health and Safety (3% TDC)				$11,358
TOTAL INDIRECT COSTS				**$389,958**
TOTAL CAPITAL COSTS (Total Direct Costs + Total Indirect Costs)				**$768,558**
II. ANNUAL O&M COSTS				
A. Treatment System O&M (years 1 to 5)				
Operations Labor (12 hr/wk @ 52 wks)	$60	hr	624	$37,440
Supervision Labor (8 hr/wk @ 52 wks)	$100	hr	416	$41,600
Electrical Power (SVE)	$5,500	LS	1	$5,500
Electrical Power (Treatment Building heating, lighting, etc.)	$1,200	LS	1	$1,200
Sampling Analysis (Extracted Air - VOCs)	$400	sample	12	$4,800
Sampling Analysis (Treated and Untreated Groundwater -VOCs)	$360	sample	12	$4,320
Data Evaluation and Reporting	$85	hr	160	$13,600
Maintenance (20 hr/month @ 12 months)	$100	hr	240	$24,000
Annual O&M Costs (years 1 to 5)				**$132,460**

TABLE 4-2
ESTIMATED COSTS FOR DPE SYSTEM
OUB, FORT RICHARDSON, ALASKA

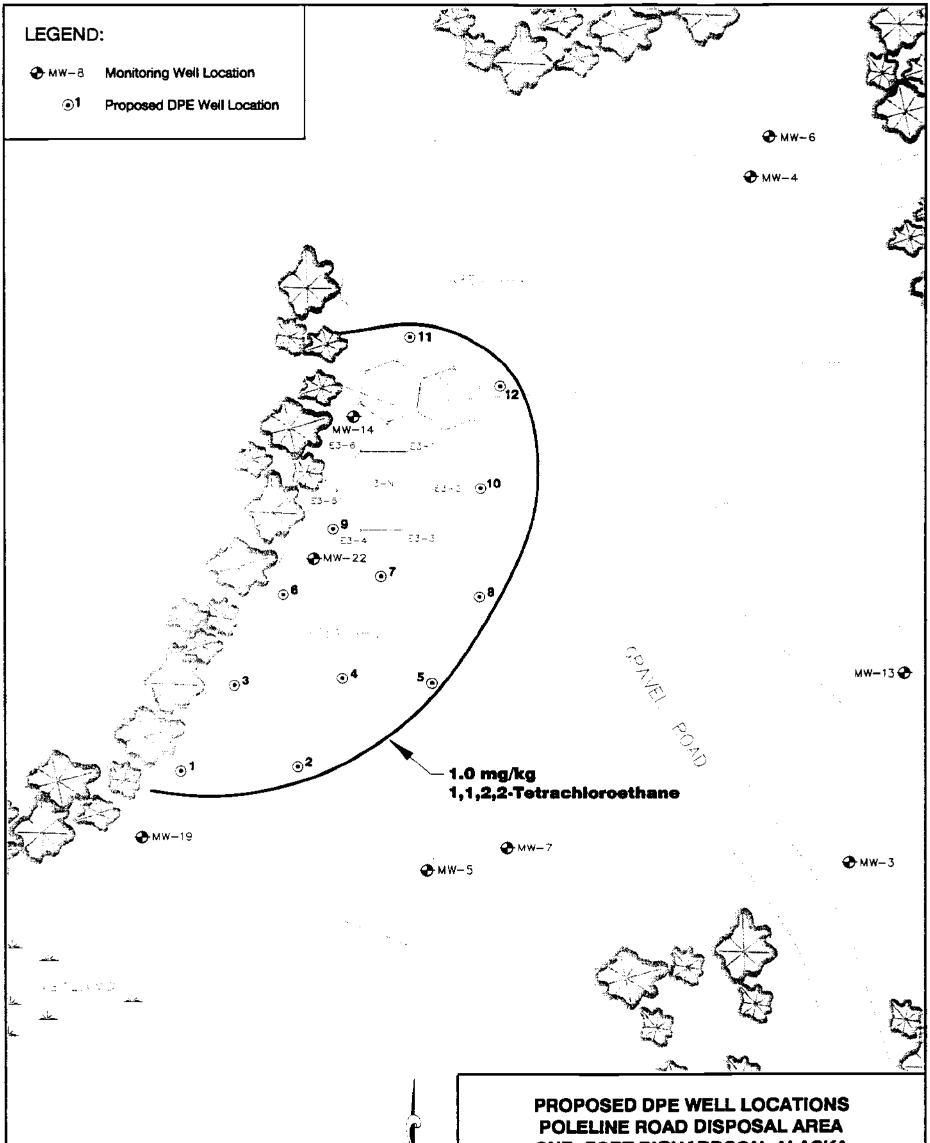
ITEM	UNIT COST	UNIT	QUANTITY	COST
B. Treatment System O&M (years 6 to 12)				
Operations Labor (20 hr/month @ 12 months)	$60	hr	240	$14,400
Supervision Labor (8 hr/month @ 12 months)	$100	hr	96	$9,600
Electrical Power (SVE)	$1,400	LS	1	$1,400
Electrical Power (Treatment Building heating, lighting, etc.)	$1,200	LS	1	$1,200
Sampling Analysis for Extracted Air	$400	sample	4	$1,600
Sampling Analysis for Treated and Untreated Groundwater	$360	sample	4	$1,440
Data Evaluation and Reporting	$85	hr	160	$13,600
Maintenance (20 hr/month @ 12 months)	$100	hr	240	$24,000
Annual O&M Costs (years 6 to 12)				**$67,240**
C. Groundwater Monitoring (30 years)				
Sampling Labor (60 hr * 2 people/year)	$60	hr	120	$7,200
Sampling Analysis - VOCs (17 wells + 10% dupl)	$180	sample	19	$3,420
Sampling Analysis [2] (9 wells + 10% dupl)	$360	sample	10	$3,600
Sampling Analysis [3] (9 wells + 10% dupl)	$145	sample	10	$1,450
Supervision	$100	hr	40	$4,000
Data Evaluation and Reporting	$85	hr	100	$8,500
Supplies and Materials	$600	ls	1	$600
Annual O&M Costs (years 1 to 30)				**$28,770**
TOTAL O&M COSTS (30 years)				**$1,996,080**
TOTAL CAPITAL AND O&M COSTS				**$2,764,638**
CONTINGENCY (35% of Total Capital and O&M Costs)				$967,623
SUBTOTAL (Total Capital and O&M Costs and Contingency)				**$3,732,261**
USACE Fee (8% Total Capital and O&M Costs and Contingency)				$298,581
TOTAL ESTIMATED PROGRAM COSTS [1]				**$4,000,000**

NOTES:

(1) Escalation costs are not included

(2) Analysis for parameters which can indicate biodegradation of chlorinated solvents (e.g., NO_3-nitrogen, NO_2-nitrogen, NH_3-nitrogen, total Kjeldahl nitrogen, total phosphorus, SO4, soluble iron, methane, ethane, ethene, sulfide, TOC, BOD)

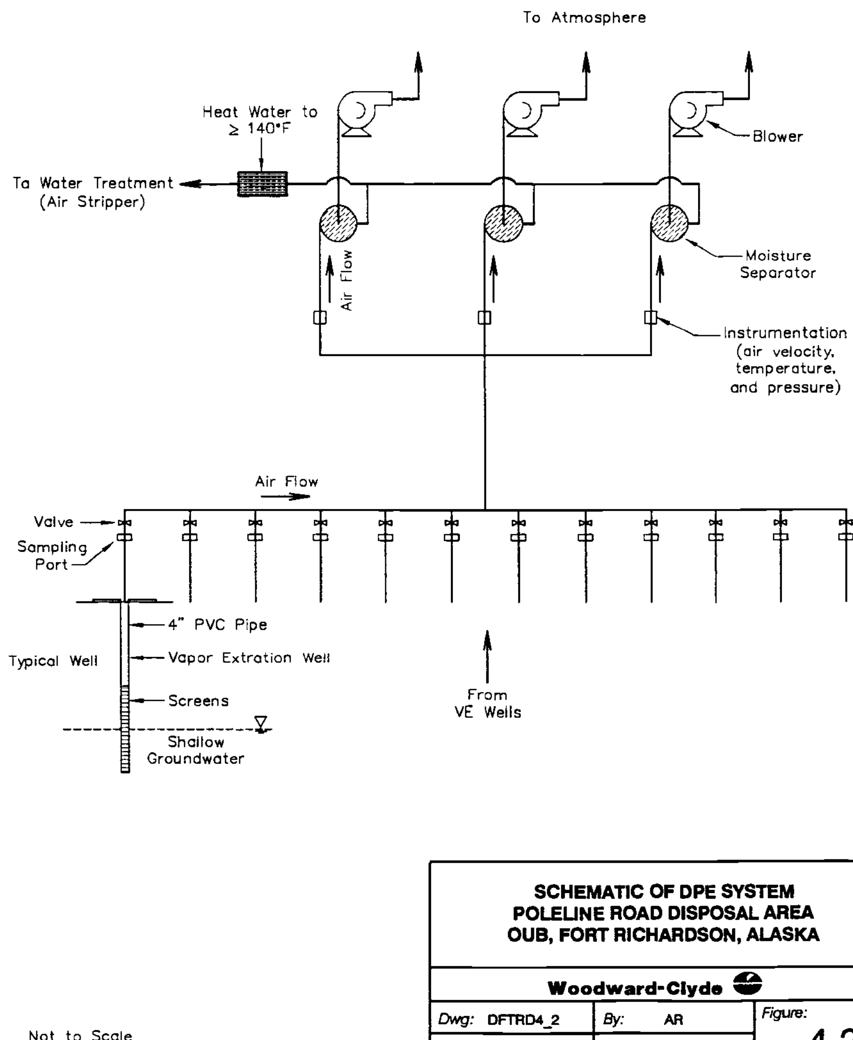
(3) Bacteria enumeration



PROPOSED DPE WELL LOCATIONS
POLELINE ROAD DISPOSAL AREA
OUB, FORT RICHARDSON, ALASKA

Woodward-Clyde

Dwg: DFTRD4_1	*By:* AR	*Figure:* 4-1
Project: E9408U	*Date:* 3-6-98	



SCHEMATIC OF DPE SYSTEM
POLELINE ROAD DISPOSAL AREA
OUB, FORT RICHARDSON, ALASKA

Woodward-Clyde

Dwg: DFTRD4_2	By: AR	Figure: 4-2
Project: E9408U	Date: 3-6-98	

This section outlines how the system will be installed, operated, monitored, and shut down.

5.1 SYSTEM INSTALLATION

An air rotary drill should be used to install the DPE wells described in Section 4.0. Large cobbles often prevented a hollow-stem auger drill from reaching depths greater than 20 feet. The air rotary drill can easily drill through cobbles and reach desired depths. Drillers may be exposed to hazardous vapors while installing the DPE wells. The air rotary drill can reduce the potential for exposure by casing the hole while drilling and minimizing the volume of soil that must be removed.

Soil samples should be collected from several soil borings drilled between the DPE wells. These locations should be marked and surveyed so that adjacent samples can be collected at the end of treatment. Comparison of these before and after samples will help evaluate how effectively the soil was treated.

No additional groundwater monitoring wells should be installed for the purpose of monitoring the effectiveness of the DPE system. The existing monitoring wells are located to allow effective monitoring of groundwater treatment.

5.2 SYSTEM OPERATION

The following sections will describe the general approach or strategy for operating the system, and some of the required day to day monitoring.

5.2.1 Operational Approach

The DPE system is expected to run for 7 to 12 years in order to reduce the concentrations of contaminants in the soils and groundwater to the RAOs stated in the ROD. Natural attenuation will be relied upon to treat groundwater not removed by the DPE system. The time estimate for natural attenuation to reduce the levels of contaminants in the groundwater to the RAOs is 150 years.

The ROD makes provisions for differences between the expected and actual performance of the selected remedy. Once the DPE system is implemented, reviews will be conducted every five years to evaluate the effectiveness of the system and whether the remedy provides adequate protection of human health and the environment. After five years of operation, if the performance of the DPE system indicates that it is not effectively reducing and controlling contamination at the site, then remedial objectives may be re-evaluated. Figure 5-1 is a flow chart of post ROD activities, including the alternatives that may be considered if the expected performance of the system is not realized.

The RA contractor will prepare yearly system performance reports and will recommend changes to the system based on the reported performance. The recommendations made by the RA contractor will likely fall into one of three categories. The first recommendation possible is that little or no changes should be made to the system. This recommendation would be made if sampling data indicated that the system was meeting the RAOs, or was likely to meet the RAOs during the expected operation time.

The second possible recommendation is that the system appears capable of meeting some or all of the RAOs, but not within the originally expected duration. This recommendation would be made when the contaminant removal rate is not high enough to meet the RAOs within a reasonable time frame. The first alternative to consider is making no changes, accepting that a longer treatment time is necessary. The second alternative to consider is to make changes that would improve the system so that the RAOs could be reached within a more reasonable time frame. Other alternatives that could be considered include: adjust the RAOs, implement a new technology, or grant a Technical Impracticability (TI) Waiver to stop treatment. The ROD allows the EPA to grant a TI Waiver if data demonstrate that available remedial technologies cannot attain the RAOs established in the ROD.

The third possible recommendation is that the system is having little or no impact on the concentration of contaminants at the site. This recommendation would be made when the rate of contaminant removal is so low that the system will not meet the RAOs. If this recommendation were made, several responses should be considered. The first response to consider is to make changes that would improve the system so that the RAOs could be reached within a reasonable time frame. The RA contractor should be able to make some recommendations after installing and operating the system for at least one year. The second response to consider is reevaluating the RAOs. If no reasonable changes could be made to the system and other technologies do not appear promising, then adjusting the goals may be an alternative. The last alternative to consider is obtaining a TI Waiver. The TI Waiver could be granted by EPA if data demonstrate that available remedial technologies cannot attain the RAOs established in the ROD.

5.2.2 System Operation Monitoring and Maintenance

System operation monitoring will include collecting system parameter data such as flow rates, pressures, and temperatures. Routine system maintenance will include lubricating the blower, changing blower oil, draining the water knockout tank drum as needed, and general system inspection. Blower maintenance will be conducted as necessary based on manufacturer specifications. System monitoring and maintenance will be conducted on a monthly basis.

5.2.3 Remediation Monitoring

Remediation monitoring will include measuring organic vapor levels (vapor screening), collecting air samples from the DPE system flow stream for laboratory analysis, and groundwater sampling. Screening tests (non-analytical) will be completed monthly, during each site visit. Analytical samples will be collected quarterly.

- A photo ionization detector (PID), with 11.7 eV lamp, will be used to screen vapor from each of the DPE wells.
- The extracted air velocity, line pressure and temperature will be measured at each DPE well. These data will be used to calculate the standard cubic feet per minute of air being removed from each DPE well.

- Air samples will be collected and analyzed for volatile organics by method TO-14 quarterly. This data combined with the volume of air removed can be used to calculate the mass of contaminants removed via the extracted soil gas.
- Groundwater samples will be collected quarterly and analyzed by Method 8021B. These samples will be used to document the active treatment of the groundwater.

5.2.4 System Shutdown And Confirmation Of Cleanup

Procedures for shutting down a vapor extraction system are detailed in the USACE guidance document EM1110-1-4001, Chapter 9. The following is adapted from that document. Actual shutdown of the system, may occur more than ten years after this document was prepared, and the RA contractor should obtain an updated version of EM1110-1-4001.

Once the quarterly sampling data show that extracted vapor concentrations have reached an asymptote, the shutdown plan should be started. Changing the mode of operation should be the first action taken. This will involve pulsing the system in two to four week intervals. The RA contractor should not turn off all the wells, but instead turn off only a portion of the wells. During each site visit, a new set of wells will be turned off, and the others turned back on.

Pulsing the system may continue for up to a year. Pulsing should continue as long as the sampling data show improved extraction rates. Once pulsing no longer shows any improvement, sampling should be conducted to confirm that cleanup criteria have been achieved.

The RA contractor should consider several criteria when determining when to shut off the system:

- Total amount of contamination removed
- Extraction wells vapor concentrations
- Extraction wells vapor composition
- Groundwater concentrations
- Residual soil concentrations

The first four criteria should be evaluated before collecting additional soil samples. The total amount of extracted contamination should be close to estimates made from soil sampling at the beginning of the project. The concentration of solvents extracted from any of the DPE wells should not be elevated. If one or more of the DPE wells still have high vapor concentrations, then the system should be adjusted to only extract from those wells. The composition of the extracted soil gas should change over the course of the test. The ratio of high volatility compounds to lower volatility compounds should be much lower, indicating that the high volatility compounds have been removed. Solvent concentrations in groundwater should also be lower by the time system shut down is considered.

Once the other criteria have been reviewed and the results indicate that target cleanup levels may have been reached, soil samples should be collected. The RA contractor should sample according to the latest USACE sampling guidance. The samples will be collected adjacent to the sampling locations from the start of the RA. The starting and ending solvent concentrations in the soil can be used to estimate starting and ending mass of contaminants in the soil. The difference between the starting and ending mass should be similar to the mass removed in the extracted soil gas.

5.3 LONG-TERM GROUNDWATER MONITORING

Groundwater samples will be collected from monitoring wells yearly. Samples should be analyzed for chlorinated solvents by method 8260B, and various natural attenuation parameters. Table 5-1 is a list of the methods run on groundwater samples from the site to evaluate rate of natural attenuation. Long-term groundwater monitoring will continue after active treatment at the site is completed, so that the rate of natural attenuation can be documented.

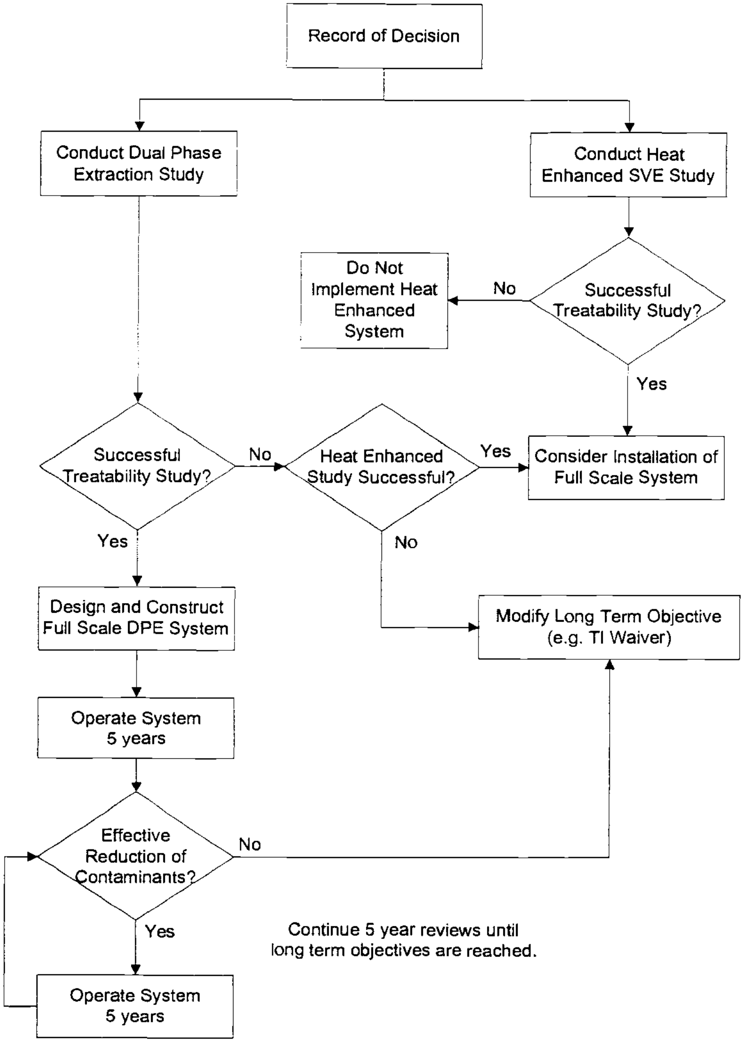
TABLE 5-1

NATURAL ATTENUATION PARAMETERS
OUB, FORT RICHARDSON, ALASKA

PARAMETER	LAB OR FIELD METHOD	LAB METHOD NUMBER
Dissolved oxygen	Field	
Oxidation Reduction Potential	Field	
pH	Field	
Specific Conductance	Field	
Temperature	Field	
Alkalinity	Lab	EPA 310.1
Ammonia	Lab	EPA 350.3
Chloride	Lab	EPA 300.0A
Ferrous Iron	Lab	SM 3500-FeD
Nitrate	Lab	EPA 353.2
Nitrite	Lab	EPA 353.2
Sulfate	Lab	EPA 300.0A
Sulfide	Lab	EPA 376.2
TOC	Lab	EPA 9060

SM = standard methods

Figure 5-1: Remedial Action Strategy



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