FINAL

ENGINEERING EVALUATION/ COST ANALYSIS

Spill Site 7 – Operable Unit 2

F. E. Warren Air Force Base, Wyoming

October 2002

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F. E. Warren Air Force Base, Wyoming

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LIST OF ACRONYMS AND ABBREVIATIONS

ºF	degrees Fahrenheit
µg/L	micrograms per liter
ARAR	applicable or relevant and appropriate requirement
BCY	bank cubic yards
bgs	below ground surface
BMP	best management practice
BRA	Baseline Risk Assessment
BTEX	benzene, toluene, ethylbenzene and xylene
CAMU	corrective action management unit
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
COPC	chemical of potential concern
DAF	dilution-attenuation factor
DCE	dichloroethene
DNAPL	dense non-aqueous phase liquid
ECD	electron capture detector
EE/CA	Engineering Evaluation/Cost Analysis
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
FAR	Field Activity Report
FEW	F.E. Warren Air Force Base
FS	Feasibility Study
GAC	granular activated carbon
HAZWOPER	Hazardous Waste Operations and Emergency Response
HQ	hazard quotient
HRC®	Hydrogen Release Compound®
HSA	hollow-stem auger
ICOC	indicator contaminants of concern
IRA	Interim Removal Action
lbs	pounds
LCY	loose cubic yards
LDR	land disposal restriction
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
MIP	membrane interface probe
NAPL	non-aqueous phase liquid
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
O&M	operation and maintenance
OSHA	Occupational Safety and Health Administration
OU	operable unit

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

PCB	polychlorinated biphenyl
PID	photoionization detector
ppb	parts per billion
ppbv	parts per billion volume
PPE	personal protective equipment
ppm	parts per million
PRB	permeable reactive barrier
PRSC	post-removal site control
PVC	polyvinyl chloride
RAO	remedial action objective
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SSL	soil screening level
SVE	soil vapor extraction
SWRA	Surface Water Risk Assessment
TAT	turn-around time
TBC	to be considered
TCE	tichloroethylene
TCLP	toxicity characteristic leaching procedure
USAF	United States Air Force
VOC	volatile organic compound
WCA	Waste Consolidation Area
WDEQ	Wyoming Department of Environmental Quality
WHWRR	Wyoming Hazardous Waste Rules and Regulations
WWQRR	Wyoming Water Quality Rules and Regulations

1.0 PURPOSE

This Engineering Evaluation and Cost Analysis (EE/CA) addresses contamination in the unsaturated soils at Spill Site 7 in Operable Unit (OU) 2 at F.E. Warren AFB (FEW), Wyoming. The purpose of the EE/CA is to identify the objectives for potential removal action at this site and analyze various alternatives that may satisfy these objectives. The EE/CA also serves as a basis for the Action Memorandum, the primary decision document substantiating the need for a removal response.

This EE/CA addresses the vadose zone soils within Spill Site 7, which are acting as a source area for groundwater contamination. The following criteria were established in the *Draft Final Zone D Source Areas Remedial Investigation (RI) Report* (United States Air Force [USAF] 2002a) to determine whether a source is present in unsaturated soils and whether an interim removal action (IRA) is necessary to reduce risk to human or ecological receptors and to be protective of groundwater and surface water at the site:

1. Direct field observations: Are odors, staining, or elevated headspace readings present?
2. Human or ecological risk: Does contamination of any medium present a risk to human or ecological receptors?
3. Potential leaching of unsaturated soils: Do contamination levels in bulk soil exceed calculated site-specific soil screening levels?
4. Elevated soil gas readings: Do soil gas readings exist at levels indicative of residual free-phase contamination in vadose zone soils (Cohen and Mercer 1993)?
5. Historical groundwater contamination: Do historical groundwater concentrations in the source investigation area increase or remain elevated over long periods of time?

Using these five criteria, Spill Site 7 showed exceedances in four of the five criteria. The only criterion that Spill Site 7 did not exceed was the human and ecological risk criterion. Risk was calculated to be low to moderate. Based on the remaining four criteria, unsaturated soils at Spill Site 7 have been identified as a source area contributing to future groundwater contamination.

The response action does not address groundwater or saturated soil contamination that may exist at this site. Groundwater and saturated soils will be addressed within the Zone D Groundwater RI/Feasibility Study (FS) and/or other response actions.

The response action described in this EE/CA will be conducted pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). This EE/CA has been prepared in accordance with the National Oil and Hazardous Substance Pollution Contingency Plan (NCP) and the U.S. Environmental Protection Agency's (EPA's) *Guidance on Conducting Non-time-critical Removal Actions Under CERCLA* (EPA 1993a) (the EE/CA guidance).

The authority for this response action stems from the NCP as codified in 40 Code of Federal Regulations (CFR) 300.415(b)(1) under which a determination has been made that there is a threat to public health or welfare or the environment posed by the contamination present at Spill Site 7. This determination of whether an IRA is needed is based on the factors set out in 300.415(b)(2), specifically, (iv) "High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface, that may migrate." In the case of Spill Site 7, the contaminants are present throughout the soil column and have the potential to migrate into the groundwater continuously into the future.

Potential remedial alternatives are analyzed using the EE/CA guidance criteria of effectiveness, implementability, and cost. The analysis considers the variability in geological conditions that are encountered within Spill Site 7 and provides pertinent information as to which specific actions would be most appropriate for the conditions encountered at the site. As a further refinement, the EE/CA compares the performance of the response action alternatives relative to each other, using the same EE/CA guidance criteria. The comparative analysis takes into account the specific conditions found at the site in evaluating the relative performance of the different response action alternatives.

The identification and screening of response action alternatives, coupled with the detailed and comparative analyses of these alternatives, result in a full evaluation of the potential response

actions and a determination as to which actions would be most appropriate for the conditions and settings found at Spill Site 7.

This EE/CA is divided into eight sections. Section 1.0 provides an introduction. Section 2.0 presents the site characterization information, including site background, source, nature, and extent of contamination, and risk evaluation. Section 3.0 identifies removal action objectives and discusses compliance with applicable or relevant and appropriate requirements (ARARs). Section 4.0 presents the identification and analysis of removal action alternatives. Section 5.0 is a comparative analysis of the removal action alternatives. Section 6.0 recommends the most appropriate removal action alternative. Section 7.0 provides a scoping of a pilot study. Section 8.0 provides the report references.

2.0 SITE CHARACTERIZATION

2.1 INSTALLATION AND SITE DESCRIPTION

FEW is located on approximately 5,866 acres adjacent to the western city limits of Cheyenne, Wyoming (Figure 2-1). FEW is bordered by agricultural land, ranches, and residential areas of Cheyenne and Laramie County. Most buildings, roads, and human activities are centered in the southern portion of the installation.

Based on the 2000 census, Laramie County had a population of 81,607. The population of Cheyenne itself was reported at 53,011 in 2000. The population appears to be growing in the areas surrounding FEW, and the number of persons residing on base property appears to be increasing. The most current (2000) statistics indicate an on-base population of 4,440, which is up from 3,324 in 1997. According to August 1997 employment data, approximately 8.6 percent of the working population in Laramie County is employed in the military, predominantly at FEW.

FEW has served a number of functions since its activation as a military base in the mid-1800s. United States Army outpost Fort D.A. Russell was established at this location in 1867 to protect railroad workers from Native American attacks. In 1930, the base was renamed for Francis E. Warren, the Wyoming senator who played an important role in the development of the post. During World War II, the size of the installation more than doubled to support new missions, including training of Army personnel.

In 1947, the base was transferred to the newly formed Air Force, under control of the Air Training Command. The Strategic Air Command assumed jurisdiction over the installation in 1958. FEW was the first base selected for deployment of the Atlas D missiles and became the operations center for the Atlas intercontinental ballistic missile in 1960. In 1965, the Atlas missiles were replaced by Minuteman I missiles. Minuteman III missiles replaced Minuteman I missiles in 1975. FEW was assigned to the Air Combat Command in June 1992, and then to the Air Force Space Command in July 1993. In February 1998, the Environmental Restoration Section at FEW became Restoration Management. Regardless of the name change, all Installation Restoration Program efforts remain under the guidance of the Air Force Space

Command. At present, the prime mission of FEW is to provide operational, maintenance, and security support for Peacekeeper missiles, which replaced the Minuteman III missiles in the mid-1990s.

2.1.1 Surrounding Land Use

FEW is bordered by agricultural land, ranches, and residential areas of Cheyenne and Laramie County. Most buildings, roads, and human activities are centered in the southern portion of the installation. Spill Site 7 is located within Zone D in the southern portion of the base, which is bounded by Diamond Creek to the northwest and Crow Creek to the northeast (Figure 2-2). Land use at Spill Site 7 itself is open field. There are no regular activities at the source area or proposed treatment area beyond quarterly environmental sampling.

2.1.2 Climate

The climate of southeastern Wyoming is classified as a steppe climate typical of semiarid grassland prairies (Martner 1986). Average annual precipitation for 1915-2000 in Cheyenne was 15.27 inches (Western Regional Climate Center 2001). Average annual evaporation for 1956-70 was 62.83 inches, based on class-A pan measurements. This results in a net loss of precipitation. Temperatures range from below zero to about 90° Fahrenheit (°F). The average daily mean temperature is 45.47°F (Western Regional Climate Center 2001). Wind velocities are highest during fall and winter and lowest during summer. The average wind velocity is 13.7 miles per hour (Martner 1986).

2.1.3 Geology

The geology at FEW consists primarily of Quaternary terrace deposits that generally do not exceed 25 feet in thickness. These unconsolidated deposits, which are thickest along the streams, consist mainly of clay, silt, sand with some gravel, cobbles, and boulders. The Quaternary deposits are hydraulically connected with the underlying Tertiary Ogallala Formation. The Ogallala Formation consists of a heterogeneous mixture of clay, silt, sand, and gravel, which is up to 300 feet thick in this part of Wyoming. Some layers are well cemented, whereas others tend to be friable and unconsolidated. In general, the upper 130 feet of the

Ogallala Formation consist of silty clay with slightly consolidated sand and gravel layers interbedded with clay and silt. Sandstone and conglomerate beds also are present. The Ogallala Formation dips to the northeast at about 52 feet per mile and has an approximate strike of northwest. The Quaternary deposits and the Ogallala Formation form the High Plains aquifer at FEW.

The Tertiary White River Formation underlies the Ogallala Formation. The White River Formation consists of a pinkish-brown massive siltstone containing beds of sandstone, conglomerate, and volcanic ash. Its thickness is estimated to be about 600 feet in the study area. The White River Formation has approximately the same strike and dip as the Ogallala Formation.

Spill Site 7 is located north of Building 1294 (formerly Building 4000) and approximately 600 feet south and 1,000 feet west of the confluence of Diamond Creek and Crow Creek (Figure 2-3). The Spill Site 7 source area currently consists of an open field. Building 1294 is currently used as a training facility.

Spill Site 7 is located on a gently sloping terrace dropping to the northwest toward Diamond Creek. The investigation found coarse-grained sand within the first 8 feet below ground surface (bgs). Below this layer of sand, finer-grained materials such as silts and clays exist. Refusal occurred between 15 feet and 20 feet bgs at most of the direct-push locations, indicating widespread occurrences of caliche or cemented sand layers. Figure 2-3 shows the locations of two cross-section transects at Spill Site 7 that are shown on Figures 2-4 and 2-5.

2.1.4 Hydrogeology

Sitewide water levels were collected the weeks of November 12 and 21, 2001. Although water levels are typically collected over a shorter period, two contractors obtained these readings as part of two separate projects. No rain events occurred during the 2-week period, so these data are deemed viable.

Groundwater was encountered between 9 and 26 feet bgs. Figure 2-6 shows the November 2001 water elevations and groundwater contours reflecting these measurements. On a base-wide

scale, groundwater flow is to the northeast, somewhat parallel to Diamond Creek and towards Crow Creek. However, at Spill Site 7 the groundwater flow is split, with the majority of groundwater flowing to the north while portions flow to the west. This flow pattern results in flow towards Diamond Creek. The contour lines show a distinct "V" pattern pointing to the southeast, which is centered on the collection drain from a previous treatability study. This drain was installed to a depth of 6 feet below the base of Diamond Creek, which puts it well below the local water table. The flow pattern near this drain indicates it may be acting as a preferential flow path for the shallow groundwater, increasing flow to Diamond Creek. This preferential flow path may have an impact on saturated zone and groundwater remedial actions, which are being addressed by another contractor. Historical groundwater levels at Spill Site 7 were found to fluctuate over 10 feet throughout the historical record as shown on Figure 2-7. This groundwater data can be found in Appendix A. Seasonal lows occur through the fall to early spring, depending on snow melt and rain fall recharge.

2.1.5 Surface Hydrology

Surface water at FEW occurs as stream flow and seeps. Stream flow on the base results from groundwater discharge, rainfall, and snowmelt runoff. Crow Creek is the major perennial tributary that drains most of the southern part of the base and has been characterized as a gaining stream throughout the base (Ebasco 1995). Diamond Creek is an entrenched meandering tributary to Crow Creek that flows just north of Spill Site 7 and meets Crow Creek approximately 1,000 feet west of Spill Site 7 (Figure 2-2).

Stream flow in Diamond Creek was measured during February and June 2000 and reported in the *Final Surface Water Risk Assessment* (SWRA) for FEW (USAF 2002b). Round 1 stream flow gauging was conducted February 14 through 16, 2000, during low flow conditions. Stream discharge on Diamond Creek was measured only at sample location D4 (Figure 2-8). Ice, low flow, and shallow vegetated stream channels hindered discharge measurements at the other Diamond Creek sampling locations (D4-6, D2, D1a, D0, and C0). The flow measured in February at sampling location D4 was 0.44 cubic feet per second.

The Round 2 stream flow gauged during June 2000 in Diamond Creek was lower than that observed during February. The limiting factors affecting stream discharge measurement were stream velocity and, to a lesser extent, depth. Diamond Creek Round 2 stream discharge was too low to be measured at sampling location D4. In addition, flow was too slow or too shallow to be measured upstream of D4 on Diamond Creek.

Stream flow data from Rounds 1 and 2 indicate Diamond Creek and Crow Creek are overall gaining streams near Spill Site 7. Quantitative data obtained during the February and June 2000 sampling events alone do not sufficiently support this; however, qualitative flow observations and historical data generally support this conclusion. In addition, data collected as part of a concurrent remedial investigation addressing the groundwater and surface water interactions in Zone D supports the conclusion that Diamond Creek is a gaining stream near Spill Site 7.

Although the floodplain is shown to encroach toward the Spill Site 7 source area on Figure 2-8, the local topography does not support this depiction. As shown on Figure 2-3, the topographic contours indicate that Diamond Creek has a steep eastern embankment and a much more gentle western bank. This geomorphology is typical of an entrenched, migrating meander, where the embankment is the eroding edge of the meander bend and the interior area is the filled former channel, which exhibits considerably lower relief. The floodplain for the stream is misrepresented at the coarse scale of Figure 2-8, which was generated from the base-wide GIS system. The actual floodplain would more accurately be restricted by the 24-foot-high eastern embankment near Spill Site 7.

In the area of interest at Spill Site 7, during large precipitation events, the surface water flow may occur as sheet flow across the area, which slopes towards Diamond Creek, and as channelized flow in the man-made drainage ditch along the southern portion of the area, which was used by the historic grease trap.

2.1.6 Sensitive Ecosystems

Since the delisting of the peregrine falcon in 1999, there are six species of Federally listed threatened and endangered wildlife species that occasionally or potentially could occur within

southeastern Wyoming (Table 2-1), as described in the FEW fish and wildlife management plan (Rosenlund 1992). The six species are the bald eagle, whooping crane, black-footed ferret, Wyoming toad, Preble's meadow jumping mouse, and greenback cutthroat trout.

The Colorado butterfly plant, a Federally listed threatened species, grows along Crow Creek, Diamond Creek, and the unnamed tributary (USAF 1993). About 30 percent of the known United States population of the Colorado butterfly plant is growing on the base (Marriot 1987). Monitoring of the Colorado butterfly plant, which is a Category I candidate for Federal listing as an endangered species, includes studies by the Nature Conservancy (Marriot 1991) and the University of Colorado (Ebasco 1995).

None of the sensitive ecosystems described above are located within the footprint of the Spill Site 7 source area or treatment zone. Wetlands in Diamond Creek are located approximately 250 feet north-northwest of the planned action. However, their presence or potential presence in and around Diamond Creek makes them of importance to the selection of potential removal alternatives for Spill Site 7 unsaturated soils. Best management practices (BMPs), such as hay bales, berms and silt fences, will be utilized during any removal actions to restrict storm water from flowing into and/or runoff from leaving the site and flowing into areas of sensitive habitat or Diamond Creek.

Big-game species inhabiting the Base year-round include pronghorn (antelope), mule deer, and whitetail deer. The deer use the habitat along the creeks, as do many furbearers such as raccoon, red fox, beaver, and muskrat. Other furbearers known or suspected to inhabit the area include badger, coyote, striped skunk, cottontail, jackrabbits, swift fox, and weasel; non-game animals include mice, shrews, voles, ground squirrels, bats, and snakes. Birds observed include the burrowing owl, mourning doves, and more than 100 other species that are listed in the FEW fish and wildlife management plan (Rosenlund 1992).

Brook trout also live in creeks on the base. Other aquatic resources include 11 species of fish, the tiger salamander, and two species each of frogs and toads. Crow Creek has recently been re-classified to a Class 2AB stream by the Wyoming Department of Environmental Quality

(WDEQ). Class 2AB streams are known to support game fish species and are potential drinking water sources.

2.2 PREVIOUS INVESTIGATIONS

2.2.1 Installation Restoration Program Remedial Investigation

A remedial investigation was conducted at FEW from 1985-1989 to characterize the nature and extent of contamination and to make a preliminary assessment of contamination problems on a site-by-site basis (United States Geological Survey 1991). The original source of the trichloroethene (TCE) contamination at Spill Site 7 was identified as Building 4000 (currently Building 1294), which was used from 1960-66 as a liquid-oxygen production facility for Atlas missiles. TCE was used as a degreaser to prevent the oil and grease from reacting explosively with the pure oxygen. Apparently, TCE was released from Building 4000 through a floor drain leading to a grease trap about 50 yards northeast of the building. The grease trap was designed to separate oil and grease from water by trapping "floaters" while discharging the basal wastewater through a 25-foot long outlet pipe to a man-made surface drainage ditch leading northwest to Diamond Creek. Because of its density, TCE would likely settle to the bottom of the grease trap and be discharged with the water to the surface drainage ditch (USAF 1996a).

In 1987, water was reportedly coming from the air conditioning units in Building 4000, discharging to the grease trap at a rate of 0.5 gallon per minute. This discharge to the grease trap ended in 1988, but an overflow incident occurred in 1989 when a sump pump diverting the water failed and discharge was accidentally allowed. The original discharge lines from the grease trap were plugged so the water overflowed through the trap doors on top of the grease trap. No additional information is available concerning the historic usage of the grease trap or activities at Spill Site 7.

During a 1989 investigation, the grease trap was found to contain three separate phases: "liquid," "organic," and "sludge." The grease trap, its contents, and the surrounding soil within a 15-foot radius centered on the grease trap were removed in 1989 and transported to an EPA-approved disposal facility. Prior to the removal activities, samples of the contents of the trap were collected and four soil borings were advanced around the perimeter of the grease trap. TCE was

detected in the liquid and sludge samples at concentrations of 852,000 and 188,000,000 parts per billion (ppb), respectively. In the organic phase, TCE was reported as 54 percent volume by weight. Elevated levels of barium, cadmium, chromium, and lead were also detected in the sludge.

Approximately 2,500 to 3,000 gallons of liquid waste and 440 gallons of residual sludge were removed from the grease trap. Approximately 285 tons of soil characterized as hazardous waste was transported off-site for disposal. Excavation was terminated within a 15-foot radius. Ten soil samples were collected from the floor of the excavation (six samples at 8 feet bgs and four samples at 12 feet bgs). Analytical results of the soil samples indicated that not all of the impacted soils were removed. A soil sample collected in the southern portion of the excavation following excavation exhibited TCE at 177,000 ppb from 12 feet bgs (Stewart Environmental Consultants, Inc. 1989). The excavation was brought to grade with clean fill.

2.2.2 Operable Unit 1 Remedial Investigation

In the summer and fall of 1992, a remedial investigation addressing soil contamination at Spill Site 7 (OU 1) was conducted to identify physical characteristics, the nature and extent of contamination, and contaminant fate and transport and to conduct a baseline risk assessment (BRA) characterizing the potential risks from direct contact with contaminants in the soil. Investigations during the RI included site reconnaissance, a hydrogeological investigation, a soil chemistry investigation, a groundwater chemistry investigation, an ecological investigation, and a limited population survey.

The site reconnaissance consisted of the assessment of well and soil borehole locations. The hydrogeological investigation consisted of lithologic descriptions of the soil, analysis of soil physical properties, and a study of groundwater movement. A total of eight soil boreholes were advanced, and the soil was logged for lithologic description. Thirty permanent monitoring wells were installed. Groundwater movement was defined using water level and aquifer test data. The soil chemistry investigation consisted of the installation of eight additional boreholes and five monitoring wells and soil sampling and analysis. For the groundwater chemistry investigation, 39 monitoring wells were sampled. Potential ecological impacts were evaluated at two plant

transects measuring 25 meters in length, where frames were set up along the transects to categorize plant material (USAF 1996a).

2.2.3 Operable Unit 2 Remedial Investigation

The OU 2 RI addressed base wide groundwater and surface water contamination. Following the RI, a Focused RI consisting of a treatability study for TCE and its degradation products was conducted at Spill Site 7. A treatment system constructed in 1992 consisted of groundwater collector drains for the contaminated groundwater, an air stripping system, a purge-water transfer system, and an off-gas treatment system, as well as leach drains to allow treated groundwater to percolate back into the subsurface (Figure 2-9). The treatability study was conducted from April 17, 1995, to March 22, 1996. The system was designed to intercept and treat shallow TCE-contaminated groundwater and inject the treated groundwater back into the vadose zone, above the shallow aquifer (USAF 1996a).

The efficiency of the treatment system was monitored with analytical data from groundwater, surface water, and air samples collected at Spill Site 7. During the study, a total of 114.2 pounds (lbs) of TCE and 5.82 lbs of total 1,2-dichloroethene (DCE) were recovered from the groundwater.

The drains were not installed deep enough to intercept groundwater from the deeper zones of the aquifer. The treatment plant did not operate continuously for an extended period because of equipment failures. Overall, the treatment plant incurred much greater operations and maintenance (O&M) expenses than anticipated. Although the system removed a portion of the TCE and its degradation products from the groundwater, the drains intercepted only a small part of the groundwater plume in the shallow zone of the aquifer. Operational problems and design limitations hindered the effectiveness of the system and the evaluation of the study, and the system was shut down in March 1996 (USAF 1996b).

2.2.4 Operable Unit 2 Interim Remedial Action

Following the shutdown of the treatability system, a Record of Decision (ROD) was submitted for an interim remedial action. The ROD was signed in September 1997 (USAF 1997). The

interim remedial action implemented at Spill Site 7 was the installation of an in-situ passive treatment wall to intercept and treat the upper 15 feet of the shallow aquifer beneath the site. The specific objectives for the remedial action were to minimize any future residential population's potential for ingestion, inhalation, and dermal exposure to groundwater indicator contaminants of concern (ICOCs) and to minimize the contaminant loading to Diamond Creek from the Spill Site 7 shallow groundwater by reducing ICOC levels to below maximum contaminant levels (MCLs) in the upper 15 feet of groundwater. The in-situ passive treatment wall, or permeable reactive barrier (PRB), was designed as an iron filings wall, which degrades TCE and its breakdown products as the groundwater moves through the wall. In addition, a number of monitoring wells were installed to monitor the effectiveness of the wall and its ability to meet the stated objectives (USAF 1997). The design documents were finalized in December 1998; construction began in April 1999; and the wall was completed in October 1999. Preliminary indications are that the wall is working as designed.

2.2.5 Zone D Source Area Remedial Investigation

The Zone D Source Areas RI focused on the TCE sources for groundwater contamination at sites within Zone D, including Spill Site 7. The primary objective at Spill Site 7 was to locate and define the extent and magnitude of the TCE source area and to provide data for a quantitative evaluation of risks to human health and the environment. The field sampling activities performed at Spill Site 7 included a soil gas survey, membrane interface probe (MIP) survey, borehole installation and soil sampling, temporary and permanent groundwater well installation, and groundwater sampling. The *Soil Characterization Field Activity Report (FAR)* (USAF 2001b) and *Groundwater Characterization FAR* (USAF 2001c) contain detailed descriptions of field sampling activities performed at Spill Site 7. A total of 24 soil gas points, 7 MIP points, 15 soil borings, 10 temporary wells, and 2 permanent wells were installed during the investigation. Soil samples were collected at 11 of the 15 boreholes. Groundwater samples were collected at the 10 temporary wells and 2 permanent wells. Additional groundwater samples were collected at Spill Site 7 by another contractor as part of the concurrent Zone D Groundwater RI.

2.3 ANALYTICAL DATA/EXTENT OF CONTAMINATION

TCE at Spill Site 7 was routinely released from 1960 to 1966 when the liquid oxygen production plant was in operation. Following this period, several discharges to the drainage ditch helped carry contaminants from the grease trap into the subsurface and/or drive contaminants held in the vadose zone deeper into the subsurface. The following sections summarize the RI findings, which are detailed in the *Draft Final Zone D Source Areas RI Report* (USAF 2002a).

2.3.1 Soil Gas and Membrane Interface Probe Survey

Soil gas and MIP surveys were used to track contamination in the subsurface by detecting volatile contaminants in the vadose zone. Areas that contain volatile contaminants are likely to have volatile organic compounds (VOCs) in the vapor phase within the soil column. Evaluation of the soil gas plume aided in the placement of groundwater wells and soil borings and will be used to focus the IRA.

Twenty-four soil gas points and seven MIP points were sampled at Spill Site 7 during the Zone D Source Areas RI/FS. The soil gas samples were collected on an approximately 50-foot grid, which was oriented parallel to the drainage ditch adjacent to the grease trap in an effort to trace the transport of contaminants from the discharge pipe. Sample locations are shown on Figure 2-3, and the soil gas data are summarized in Table 2-2. Samples were collected at depths ranging from 8 to 22 feet bgs. Soil gas sampling was limited by the presence of caliche layers at depths varying from 10 to 20 feet bgs. Soil gas detections are predominantly TCE and its degradation products, *cis*-1,2-DCE and *trans*-1,2-DCE. All soil gas detections are recorded as parts per billion volume (ppbv).

The MIP provides real-time data at a screening level through the use of three detectors, a flame ionization detector, a photoionization detector (PID), and an electron capture detector (ECD). The ECD is used to identify chlorinated solvents. All detections on the MIP are recorded as microvolts of detector response and can only indicate relative levels of contamination.

Figures 2-4 and 2-5 show soil gas detections and MIP responses in the soil column in two cross sections. The maximum TCE value in soil gas was 3,000,000 ppbv or 3,000 parts per million

(ppm) volume. The elevated level is indicative of the presence of a residual non-aqueous phase liquid (NAPL) in the vadose zone. As stated in *DNAPL Site Evaluation* (Cohen and Mercer 1993), organic vapor concentrations detected in soil gas that exceeds 100-1,000 ppm suggest the presence of dense NAPL (DNAPL). In most cases, the soil gas detections decrease with depth. In some cases, soil gas samples were collected immediately above a caliche layer, where the probe hit refusal. The caliche layer may act as a localized barrier to downward migration.

Maximum soil gas results have been contoured to show greatest concentrations of contamination within the vapor (Figure 2-10). This figure shows concentrations of TCE from approximately 4 to 26 feet deep (the water table ranges from 14 to 26 feet bgs). As shown on Figure 2-10, a proportion of the contamination appears to have migrated along the ditch line as well as to the northeast, which is more consistent with the local groundwater flow direction.

Low-level detections of benzene, toluene, ethylbenzene, and xylene (BTEX) were observed in soil gas. The detections of BTEX are scattered throughout Spill Site 7 and show no real trend. Toluene was detected in several of the associated equipment blanks, suggesting the detections are possible laboratory artifacts. There were five low-level detections of methylene chloride in the samples, ranging from 5.4 to 48 ppbv. There is no direct correlation between the TCE contamination at Spill Site 7 and these low level detections, suggesting the methylene chloride may also be an artifact.

2.3.2 Surface Soil Samples

Ten surface soil samples at Spill Site 7 were obtained from two depth intervals, 0 to 1 foot bgs and 0 to 2 feet bgs. Two inorganic analytes were detected above established site-wide mean background levels, EPA Region III residential risk-based concentrations (RBCs) and soil screening levels (SSLs) (EPA 2001). Table 2-3 summarizes these exceedances and lists toxicity characteristic leaching procedure (TCLP) values. Figure 2-11 shows metal concentrations along the drainage ditch.

Total chromium was evaluated against the residential RBC and SSL for the hexavalent chromium ion (chromium VI), which has the most conservative RBC and SSL values of the

chromium ions. The residential RBC for chromium III is 1.2E+05 milligrams per kilogram (mg/kg) as compared to 2.3E+2 mg/kg for chromium VI (EPA 2001a). The SSL for chromium III is 2.0E+09 mg/kg as compared to 4.2E+1 mg/kg for chromium VI (EPA 2001). Typically chromium III is six times more prevalent than chromium VI. One surface soil sample had a value for total chromium that exceeded the SSL value. Site personnel indicate sodium chromate may have been used at Building 1294/4000. Disassociation of sodium chromate could produce chromium VI. However, during groundwater sampling for the Zone D Source Areas RI (USAF 2002a) chromium was not present in Spill Site 7 groundwater monitoring wells at levels of above RBCs, MCLs, or background.

Arsenic exceeded RBCs and background values in most surface soil samples. This widespread distribution of arsenic at only slightly elevated concentrations may suggest either widespread contamination or naturally high levels at this location. Because other inorganic and organic contaminants associated with the grease trap are not found sitewide, it is believed that these levels are likely to be naturally occurring. Arsenic is known to be naturally occurring in high concentrations in the surface and subsurface soils at FEW.

The presence of higher inorganic concentrations in SS7SS02 might be attributed to deposition of metals in water discharged from the grease trap. Soils found at the surface today may have been subsurface soils in contact with the groundwater, which were brought to the surface through excavation during implementation of various historical remedial actions.

Detections of 2,4-dimethylphenol and trace amounts of Arochlor-1260 (polychlorinated biphenyl [PCB]-1260), heptachlor, acenaphthene, di-n-butyl phthalate, and di-n-octylphthalate were noted in the surface soils at Spill Site 7. None of these compounds exceeded the RBC values for residential soils (Table 2-4).

2.3.3 Subsurface Soil Samples

Thirty-four subsurface soil samples were collected in Spill Site 7 at different sampling intervals. Arsenic had the only inorganic exceedance of both industrial RBCs and mean background values in subsurface soil. Inorganic exceedances in subsurface soil are presented in Table 2-5. Arsenic

exceeded both industrial RBCs and mean background values in 38 percent of the subsurface soil samples. The highest concentration of arsenic detected was 11 mg/kg at sample point SS7SB01 (located near the grease trap) at an interval of 20 to 22 feet bgs. Other arsenic detections do not appear to be localized in a particular area of Spill Site 7. Arsenic was not detected in the samples collected from the grease trap (liquid or sludge) prior to its removal. The detections exhibit no discernable pattern and are therefore not likely to be site-related.

TCE, *cis*-1,2-DCE, naphthalene, toluene, methylene chloride, n-butylbenzene, n-propylbenzene, and 1,2,3-trichlorobenzene were detected in subsurface soil samples (see Table 2-4). However, no organic analytes exceeded industrial RBCs. The highest TCE concentrations were found at SS7SB02 at a depth of 5 to 7 feet bgs (40.4 mg/kg) and at 7 to 8 feet bgs (2.12 mg/kg). The industrial soil RBC value for TCE is 520 mg/kg. Within the area of concern, subsurface soil sampling revealed an area approximately 150 feet long by 25 feet wide to a depth of 12 feet that may be considered characteristically hazardous for TCE based on a comparison to the TCLP criteria using the "20 times rule." This area comprises approximately 2,400 loose cubic yards (LCY).

2.3.3.1 Soil Screening Levels

SSLs are used to aid in the determination of the likelihood of a contaminant migrating through the soil profile into the groundwater. EPA Region III publishes SSLs for unsaturated soils in relation to dilution-attenuation factors (DAFs) of 1 and 20 and the tap water RBC (EPA 2001). This section briefly summarizes the site-specific SSLs, which were derived using a site-specific DAF as detailed in Appendix B. For this evaluation, soil concentrations were first screened against the Region III SSLs with a DAF equal to 20 (EPA 2001). Only unsaturated zone soil results for Spill Site 7 were considered for the SSL screen.

The exceedances of the general EPA Region III SSL criteria (where DAF equals 20) are:

- TCE
- *cis*-1,2-DCE
- Chloroform
- 1,1,2-TCA

- arsenic
- chromium

Concentrations exceeding these initial screening levels were compared to SSLs calculated using site-specific data. The site-specific SSL and DAF equations, assumptions, and input values are found in Appendix H of the *Draft Final Zone D Source Areas RI Report* (USAF 2002a), which is reproduced in this EE/CA as Appendix B.

The exceedances of the site-specific SSLs (where the DAF is equal to 19.3) are shown in the following table with the Region III SSL values and site-specific SSL values:

Analyte	Region III SSL Value[1] (mg/kg)	Site-specific SSL Value (mg/kg)
TCE	0.015	0.0407
cis-1-2-DCE	0.035	0.3687
chromium	4.2	27.45

Note:

[1] SSL values from EPA 2001 (September)

The SSL partitioning equation for migration of constituents to groundwater is derived from equation 10 and the DAF is calculated using equation 11 of the *Soil Screening Guidance: User's Guide* (EPA 1996). Appendix B lists all of the values and equations used for Spill Site 7.

TCE, *cis*-1,2-DCE and chromium exceedances were noted in the area of the ditch and historic grease trap.

2.3.4 Groundwater Samples

Twenty groundwater samples and three field duplicates were collected from permanent and temporary monitoring wells at Spill Site 7 during the Zone D Source Areas RI. Additional groundwater samples were collected by other contractors and have been presented in the Zone D Groundwater RI. Sample locations are shown on Figure 2-3. All samples collected from permanent monitoring wells were analyzed for VOCs and total metals.

Groundwater data for aluminum, iron, and manganese were compared to background concentrations to fully evaluate whether metals exceeded background and standards at Spill

Site 7. Aluminum concentrations fall within the background range in all but one sample collected at Spill Site 7. The ranges of iron and of manganese concentrations fall within the background range of values. The background values for both aluminum and iron exceed the WDEQ standards. Based on this assessment, iron, aluminum, and manganese are not considered to exceed background or standards at Spill Site 7.

Temporary wells were installed to aid in the placement of permanent wells by sampling for screening-level VOC data and to better define the potentiometric surface of the groundwater table. These wells were not developed prior to sampling, and data from these wells are used strictly as screening-level data.

The screening-level data show that the groundwater contamination within the Spill Site 7 source area is centered around SS7TW10, which had a TCE detection of 5,300 micrograms per liter (µg/L). Groundwater elevations for local flow at Spill Site 7 are shown on Figure 2-6 and discussed in Section 2.1.4. It is apparent that the dominant groundwater flow path is to the north with a secondary flow path to the northwest. Figure 2-12 shows TCE detections in the groundwater and relative concentration contours at Spill Site 7. Tables 2-6 and 2-7 present organic and inorganic detections in groundwater compared to RBCs. Tables 2-8 and 2-9 show summary statistics of both groundwater and soil data, respectively.

2.3.5 Surface Water and Sediment

Surface water and sediment in Diamond Creek near Spill Site 7 were evaluated for potential impacts during two SWRA sampling events in 2000 at D2 (upstream), D4.6, and D4 (downstream). Historical surface water data were evaluated from D2, D3 (due west of Spill Site 7), D3.5 (downstream), D3.6 (downstream), and D4. Surface water sampling has been conducted sporadically at Diamond Creek since 1986. Surface water data collected in 2000-2001 associated with the long-term monitoring of the PRB wall only include a shortened list of analytes from surface water sampling sites D3, D3.5, and D3.6. Sediment has been sampled less frequently along Diamond Creek. The sediment sampling points from two SWRA sampling events in 2000 are D2, D4.6, and D4. Historical sediment data exist for D3 and D4 only and include three sampling events in 1993 and 1994. The sediment and surface water sampling

results are presented in detail in the *Final SWRA Report* (USAF 2002b) and are summarized briefly in the following paragraphs.

TCE and its associated breakdown products are the main contaminants of concern along Diamond Creek related to potential impacts at Spill Site 7. The most recent TCE value detected at D4 (farthest downgradient sampling location) was 19.8 µg/L in November 2000. TCE was previously identified in Diamond Creek in a January 1989 sample at a maximum value of 33 µg/L. TCE values are historically higher during the winter months because of base flow contribution from the aquifer and less surface water runoff. TCE found in Diamond Creek may be associated with contamination from both Spill Site 7 and Plume A, a plume originating near the Weapons Storage Area. Evaluation of the impact of Plume A on Diamond Creek is beyond the scope of this document.

The sampling site due west of Spill Site 7 (D3) had a TCE value of 10.1 µg/L in November 2000. Plume A groundwater and Spill Site 7 are the most likely contributors of TCE to surface water at this location. The localized groundwater potentiometric map in the area of D3 suggests that groundwater from Spill Site 7 could be flowing west and into the stream. TCE was detected only once at the upstream sampling site D2 (upstream sampling location) in 1987 at a value of 3 µg/L. TCE was never detected in surface water at this site again, which suggests that the detection may have been an anomalous value. TCE and its associated breakdown products have not been detected in D2 sediment sampling events.

The breakdown products of TCE have also been detected in Diamond Creek. The highest historical value of *cis*-1,2-DCE was 8.8 µg/L at site D3.6 in August 1996. Levels in November 2000 were higher (9.4 µg/L). *trans*-1,2-DCE was detected only in historical surface water samples collected before 1990 and analyzed using Method 601. The *trans*-1,2-DCE values ranged from 1 to 8.8 µg/L. Vinyl chloride detections have not exceeded 2 µg/L in the historical or recent sampling data.

Aluminum, arsenic, cobalt, iron, and manganese are metals that exceed both the established background values for Diamond Creek sediment and residential RBCs. A majority of the exceedances was detected in the May 2000 SWRA sampling event. Manganese is the only

analyte in the historical data set that exceeds both the background value and the residential RBC. Values of aluminum, arsenic, cobalt, iron, and manganese in the 2000 sampling are approximately five times the historical values sampled in 1993 and 1994. Further historical upstream sampling locations (D1, D1-1, and D1-2) are elevated relative to the historical sediment sampling locations used for comparisons near Spill Site 7. The values seen in these historic sampling locations are comparable with the results of the May 2000 sampling event. In contrast, the May 2000 upstream sampling results for D1a were lower in value than the results for the sampling locations near Spill Site 7. This would suggest that the metal detections are naturally occurring and widespread. These metals do not show a trend in either upstream or downstream detections. The variation in metal detections could be attributed to the grain size (particularly clay content) of the sediment sample as well as the differing composition of sediment deposition along the streambed.

PCBs were detected in both surface water and sediment, but are not attributed to Spill Site 7. The only surface water detections are located at D4.6 and D4. Both dioxins and PCBs have been identified in surface water and sediment in upgradient samples as well as in surface water sediment samples across the base.

2.3.6 Fate and Transport

The fate and transport of soluble contaminants, such as TCE, in the subsurface can be broken into aqueous (e.g., dissolved) phase transport and NAPL transport. Aqueous-phase TCE is dissolved in water and would therefore migrate in the direction of groundwater flow. While this generally implies horizontal transport, if any vertical gradients are present, the TCE may migrate upward or downward in the aquifer along with the groundwater. No substantial vertical gradients have been identified near the grease trap at Spill Site 7. However, an upward vertical gradient has been defined near Diamond Creek. Based on this information, it would be expected that aqueous-phase TCE released from the grease trap would migrate directly downward through the vadose zone until it reached the water table. Migration would then be horizontal through the Spill Site 7 area toward Diamond Creek.

NAPLs such as TCE at concentrations greater than 1,100 milligrams per liter (mg/L) in water migrate through the aquifer primarily under the influence of gravity. Pure TCE has a density approximately 46 percent greater than that of water and is therefore referred to as a DNAPL. TCE released from the grease trap as a DNAPL would be expected to migrate downward through the vadose zone to the water table, then continue downward through the water column until it reached a hydraulic barrier to migration (i.e., aquitard). The DNAPL, if present in sufficient quantity, could pool on the aquitard in a localized low spot or migrate laterally, even upgradient, if the aquitard has an upgradient slope. Pooled TCE DNAPL, as well as that DNAPL present as a residual in the vadose and saturated zones, would act as a continuing source of groundwater contamination into the future.

The historical releases of TCE from the grease trap at Spill Site 7 were part of a process involving relatively steady water flows from floor drains and air conditioning units, with sporadic higher water flow events that may have caused a wash-out of the grease trap contents. Regardless of the specific occurrence that resulted in releases from the grease trap, the TCE was most likely accompanied by substantial quantities of water at all times. Because of this history, it is unlikely that there ever was a release of TCE DNAPL that would have resulted in downward migration of TCE through the water column. The more likely scenario is a release of aqueous-phase TCE along with a quantity of water.

Once a release from the grease trap occurred, migration of the TCE would have been controlled by surface and subsurface features of the site. The drainage ditch itself would have limited the overland flow to a distinct west-northwest direction during release events. In addition, the contaminants may have migrated westward along the ditch some distance before the surface soils allowed infiltration and downward migration to begin. This could have created the groundwater TCE distribution observed at Spill Site 7 (see Figure 2-12), where the groundwater is not significantly contaminated directly under or immediately near the grease trap, but becomes more contaminated at some distance westward from the source. This "delayed infiltration" model is supported by sampling data from SS7SG19, located approximately 75 to 100 feet west of the grease trap, where soil gas exhibited 26,000 ppbv TCE at a 10-foot depth, but only 560 ppbv TCE at 20 feet (see Figure 2-10).

An additional potential control on contaminant migration in the vadose zone is the presence of several caliche layers and soils with low permeability at the site (see Figures 2-4 and 2-5). These geologic features limit direct downward percolation of surface water to the groundwater system, and the field observations suggest that the caliche layers are slightly deeper to the west of the former grease trap, which could also explain the westward migration of contaminants before they reached the groundwater. This "geologic control" model is supported by the presence of low permeability caliche horizons with highly contaminated soils directly above them and minimal contamination below them. This relationship is apparent in the borehole log for SS7SB33, located just downstream of the grease trap, where the headspace reading is 231 ppm at 16 feet, just above a "No Recovery" zone signifying caliche. The headspace reading at 22 feet was 10.9 ppm.

In either of these conceptual models, alone or in concert, water is limited in its movement downward through the soil column, but it can move laterally either along the surface ditch or in a stair-step fashion from one caliche layer to the next until it reaches the groundwater system. Once the water moves through the soil column, and reaches the water table, contaminants would travel with the gradient of the groundwater. An additional factor that may have influenced migration in the vadose zone over the past 10 years is related to preferential flow of precipitation leaching through the soil column along the backfilled trenches from remedial actions during the 1992 Treatability Study.

Regardless of the combination of mechanisms acting on contaminant migration, the levels of TCE observed in the soil gas and downgradient groundwater suggest that a NAPL may be present as a residual in the soil matrix. Figure 2-13 depicts the occurrence of this residual NAPL, along with the vapor phase in soil gas, sorbed phase on soil particles, and dissolved phase in groundwater. This schematic suggests that the NAPL is not present in sufficient quantity to migrate as a fluid, but will continue to contribute to soil vapor and groundwater contamination into the future unless addressed. The residual NAPL is likely to be present in both the vadose and saturated zones, as depicted on the figure.

The presence of soil gas contaminants in distant areas north of the drainage ditch may be an artifact of volatilization from the contaminated groundwater. An example of this may be found at MW-151, where the groundwater TCE concentration was 13,170 ppb and the soil vapor concentration was 21,000 ppbv. Because there is no historical evidence of a TCE release near MW-151 and neither soil gas data nor groundwater data suggest continuity of contamination between the grease trap area and MW-151, it is most likely that the soil gas contamination is due to upward migration from the contaminated groundwater. MW-151 was constructed using 35 feet of screen and 42 feet of filter pack. It is reasonable to assume that the screen and filter pack are acting as a conduit for migration of VOCs released from the groundwater. This concept will be tested as part of the IRA, where additional soil gas samples will be collected prior to the remedial action to ensure that the soils near MW-151 do not represent a discrete source area.

2.4 RISK EVALUATION

A comprehensive BRA was performed for Spill Site 7 as part of the RI and is contained in the *Draft Final Zone D Source Areas RI Report* (USAF 2002a). The following summary is extracted from that document.

Human Health Risk Assessment

A baseline human health risk assessment was performed in accordance with the *Baseline Risk Assessment Scoping Document* (USAF 2001d) and the *Zone D Source Areas RI/FS Work Plan* (USAF 2001a) to determine whether contaminants in soils at the Spill Site 7 source area present unacceptable risks to human health. Analytical results from surface and surface/subsurface soil combined were used to identify chemicals of potential concern (COPCs) for evaluation in the risk assessment. There were no COPCs for surface soil. The only COPC for surface/subsurface soil combined was p-cymene, which has no toxicity values. Non-cancer hazards and cancer risks were therefore not quantified for any potential human receptors. p-Cymene was detected at a low frequency and at low concentrations that are not likely to have a significant adverse impact on the health of future construction workers, the only population potentially exposed to subsurface soils at this site.

Ecological Risk Assessment

An ecological risk assessment (ERA) was performed in accordance with the *Baseline Risk Assessment Scoping Document* (USAF 2001d) and the *Zone D Source Areas RI Work Plan* (USAF 2001a). One assessment end point was evaluated:

- Are local populations of plants, soil invertebrates, birds, and small mammals inhabiting the shortgrass prairie being maintained?

Terrestrial receptors used to represent birds and mammals are the western meadowlark, horned lark, and deer mouse. For the purpose of assessing risk, it was assumed that plants are exposed to surface (0 to 2 feet) and shallow subsurface (0 to 5 feet) soils and soil invertebrates, birds, and mammals are exposed to surface soil (0 to 2 feet).

Measured concentrations of chemicals in surface and shallow subsurface soil were compared to a series of screening thresholds to focus the ERA on those chemicals that may be site-related and may potentially pose an unacceptable risk. The ERA for surface and shallow subsurface soil in Spill Site 7 included comparison to background concentrations of inorganic chemicals, and comparison of both inorganic and organic chemical concentrations to conservative RBCs. Based on this screening, 11 inorganic constituents (antimony, barium, cadmium, chromium, copper, lead, mercury, selenium, thallium, vanadium, and zinc) and one organic constituent (Aroclor 1260) were retained as chemicals of potential ecological concern (COPECs) in surface and shallow subsurface soil.

Based on hazard quotients (HQs) calculated for receptors exposed to surface soil, antimony, barium, cadmium, copper, lead, mercury, selenium, thallium, vanadium, zinc, and Aroclor 1260 may present risks to small mammals in the Spill Site 7 source area.

Risks to avian receptors are all less than 10, which suggests low to moderate potential for adverse ecological effects.

Risks to soil fauna are somewhat elevated and may indicate the potential for low to moderate adverse ecological effect to these receptors.

Plants in the Spill Site 7 source area exposed to concentrations of chromium, copper, lead, selenium, and vanadium in surface and shallow subsurface soils may potentially experience adverse effects. The magnitude of these apparent risks to plants may be affected by the bioavailability of inorganic chemicals to plants. Metals need to come into contact with plant roots in order for uptake to occur, and metabolic activity of roots and the release of exudates affect the rate of solubilization and bioavailability of ions for plant absorption. Therefore, the apparent risks to plants may be overestimated. Because a toxicity reference value for terrestrial plants was not available for Aroclor 1260, an HQ could not be estimated for this chemical.

2.5 BASIS FOR REMOVAL ACTION

The BRA summarized above and detailed in the *Draft Final Source Areas RI Report* (USAF 2002a) indicates that no unacceptable risks exist for human health or ecological receptors due to exposures to soil contaminants at Spill Site 7. The groundwater contamination levels are sufficiently elevated above the MCLs to suggest that a risk would be posed by direct exposure to groundwater. It is likely that future and continuing contamination of the groundwater will occur in the source area and in downgradient locations due to leaching from contaminated soils. Furthermore, this groundwater contamination has the potential to impact the surface water in Diamond Creek and ultimately in Crow Creek, which was recently re-classified as a Class 2AB stream by WDEQ, thereby requiring a greater standard of protection.

Although there is no risk from direct exposure to site soils, the removal action is warranted based on potential impacts to the groundwater from contaminants in site soils. These impacts were estimated using SSLs, both published values and site-specific values for Spill Site 7. This procedure yields a list of the following contaminants: TCE, *cis*-1,2-DCE, and chromium. The removal action for Spill Site 7, which is detailed in the succeeding sections of the this report, is intended to address the soil medium and contaminants identified as providing a continuing source of groundwater contamination.

3.0 IDENTIFICATION OF REMOVAL ACTION GOALS AND OBJECTIVES

This section establishes the fundamental basis for selection of response actions to be implemented at Spill Site 7, including:

1. Any statutory limits applicable to implementation of the response action;
2. The overall scope, goals, and objectives of the response actions; and
3. The schedule for implementation of response activities.

3.1 STATUTORY LIMITS

The USAF is conducting the proposed CERCLA response action, therefore the EPA's statutory limits of a $2-million ceiling and 12-month duration for fund-financed removal actions do not apply. No other statutory issues present limits on this IRA.

3.2 GOALS AND OBJECTIVES

3.2.1 Goals and Objectives of the Removal Action

The goal of this removal action is to effectively address the vadose zone source area contamination in a manner that is protective of future groundwater, human health, and the environment and to comply with ARARs to the extent practicable. The contamination resulted from discharge through the grease trap to an open ditch flowing towards Diamond Creek. Known contaminants include TCE and its associated breakdown products, along with several metals that were identified in sludge and liquid waste in the grease trap at the time of removal.

The objectives of the removal actions considered in this EE/CA include:

- Reducing concentrations of TCE and associated daughter products in the unsaturated soil to below the calculated site-specific SSL, thereby eliminating this continuing source of groundwater contamination above MCLs; and
- Minimizing the potential for contaminated surface water runoff into Diamond Creek that may originate from areas of metals-contaminated surface soil.

Removal actions considered in this EE/CA will complement the PRB wall located downgradient of Spill Site 7. The wall is being used to treat chlorinated VOCs in the upper portions of the aquifer. By treating the source materials in the unsaturated soils, groundwater contamination is

reduced by reducing leaching of contaminants, resulting in less loading to the PRB wall and the potential for a longer operating life.

The first remedial action objective (RAO) for Spill Site 7 (reducing concentrations of TCE and associated daughter products in the unsaturated soil to below the calculated site specific SSL, thereby eliminating this continuing source of groundwater contamination above MCLs) will be evaluated against a narrative standard such that TCE contaminant concentrations in vadose zone soil shall be reduced to levels that do not cause or contribute to groundwater contamination in excess of the Federal Safe Drinking Water Act MCL for TCE of 5 µg/L. Table 3-1 presents the site-specific SSLs that will be used as the cleanup standards.

To evaluate compliance with this narrative vadose zone soil cleanup standard, soil remediation will be completed to the 10,000-ppbv soil gas line as defined on Figure 3-1. This treatment zone encompasses all soil samples that exceeded a site-specific SSL or RBC as well as the locations where elevated soil gas readings above 100,000 ppbv suggest the presence of a NAPL. The only exception is in the area of MW-151, where well completion data indicate that MW-151 has 35 feet of screen and a filter pack that extends to within 7 feet of the surface. This type of well completion may be acting as a conduit for contaminant migration into the vadose zone. The data suggest that the elevated soil gas readings are likely the result of groundwater off-gassing and do not reflect a source in the vadose zone. For this reason, the soils near MW-151 are not included in this interim action cost estimate. However, as a first step to the IRA, additional soil gas samples will be collected near MW-151 to verify that a VOC source is not present vadose zone.

If excavation is part of the preferred alternative, soil gas and/or field headspace analysis will be used once the excavation has reached the 10,000 ppbv boundary to guide the digging to follow preferential contaminant migration pathways. When this boundary is reached and field readings (PID/headspace) indicate that residual VOC levels are not elevated, bulk soil samples will be collected from the sidewalls to verify that the soils left in place are below the site-specific SSL criteria and therefore are protective of groundwater. The number and spacing of sidewall samples will be defined in the upcoming Spill Site 7 IRA Work Plan. If an in-situ method is the preferred alternative, bulk soil samples will be collected by drilling into the remedial zone and

sampled for VOCs once remediation is complete. This method will ensure that the low levels of residual VOCs left in the vadose zone are not sufficiently elevated to pose a threat to the underlying groundwater. Contaminants will still exist in the saturated soils, capillary fringe, and groundwater, however, this zone is not within the media of interest for the RAOs and will be addressed under the Zone D Groundwater RI/FS.

If soils are excavated, the excavated soils will be removed and either disposed off-site in a proper facility, disposed at the Waste Consolidation Area (WCA), or treated on-site. The excavation will be backfilled with clean soils either from an off-site source or from treated soils after on-site remediation has been completed and analytical results demonstrate that the soils meet applicable standards to allow placement back into the excavation.

The second RAO for Spill Site 7 (minimizing the potential for contaminated surface water runoff into Diamond Creek that may originate from areas of contaminated surface soils) will be evaluated against a narrative standard such that soils contaminated with metals above standards shall be reduced to levels that do not cause or contribute to contamination of Diamond Creek.

To evaluate compliance with this narrative, surface soils along the drainage ditch will be excavated and further characterized to ensure that no soils are present above the applicable TCLP standard. If the soils are found to be hazardous, based on the TCLP results, they will be disposed off-site in an approved facility.

All remedial alternatives evaluated in this EE/CA will contain provisions for protection of surface water and sediment in Diamond Creek during implementation. BMPs, such as run-on/runoff control plans, will be used to ensure that no contaminants from Spill Site 7 will impact the creek. Control of potential impacts from groundwater migration to surface water is beyond the scope of this EE/CA.

3.2.2 Interim Action Schedule

Work plan activities for this interim action are scheduled to begin in May 2003. The implementation of this first phase of the interim action is anticipated to be complete in 2003.

3.2.3 Compliance with ARARs and Other Criteria

Section 121(d)(2)(A) of CERCLA specifies that on-site removal actions be evaluated to determine whether they meet standards, requirements, criteria, or limitations under any Federal environmental law that is determined to be an ARAR. This provision also specifies that State ARARs must be met if they are more stringent than Federal requirements. Federal, State, local regulations, requirements, criteria, and limitations were evaluated to determine whether they are potentially applicable or relevant and appropriate to the screened alternatives in this EE/CA. Two factors must be considered for each removal action to determine whether it complies with ARARs: (1) the urgency of the situation, and (2) the scope of the remedial action. A regulation, standard, requirement, criterion, or limitation under Federal or State law may be either applicable or relevant and appropriate to a remedial action, including a removal action. Criteria, advisories, and guidelines that are not law may be used to provide guidance in the absence of ARARs or when ARARs are not sufficient to protect human health and the environment. These criteria, advisories, and guidelines are in the "to be considered" (TBC) category. It should be noted that no TBCs were identified for this removal action.

This EE/CA is being conducted for unsaturated soils at Spill Site 7. Saturated soils and direct groundwater restoration are not addressed within the scope of this action. However, this action will address potential unsaturated zone sources that are contributing VOC contamination to groundwater. Cleanup of saturated zone soils and groundwater has be addressed in the concurrent Zone D Groundwater RI, which is being conducted under a separate project. This removal action addresses a small area of metals contamination in shallow soil; however, inorganic impacts to groundwater at Spill Site 7 are minimal. Metals contamination in site soils is not a significant source of groundwater contamination.

3.2.3.1 Potential Applicable or Relevant and Appropriate Requirements

The following paragraphs briefly describe the potential Federal and State ARARs identified for the removal action at Spill Site 7. A full analysis of these ARARs in relation to the remedial alternatives is presented in Tables 4-2, 4-3, and 4-4.

3.2.3.1.1 Chemical-Specific ARARS

Potential chemical-specific Federal ARARs include the following:

- Federal Safe Drinking Water Act. Establishes drinking water standards to protect public health by limiting levels of contaminants.

Table 3-2 lists specific regulatory parts and sections of potential Federal and State chemical-specific ARARs.

3.2.3.1.2 Action-Specific ARARs

Potential action-specific Federal ARARs include the following:

- Clean Air Act (42 USC 7401-7642). Establishes air quality standards to protect public health and the environment. Includes National Emissions Standards for Hazardous Air Pollutants (40 CFR, Part 61, Subpart A) and National Primary and Secondary Ambient Air Quality Standards and Emissions.

- Clean Water Act (33 USC 1251-1376). Establishes requirements for permits to authorize the discharge of dredged or fill material into navigable waters of the United States, addresses wetlands (Section 404 permit), and identifies storm water management requirements under the National Pollutant Discharge Elimination System (NPDES).

- Resource Conservation and Recovery Act (RCRA) Land Disposal Restrictions (LDRs) (40 CFR 268.35). Hazardous waste that is placed in a land disposal unit must meet applicable LDR treatment standards contained in 40 CFR 268.41-268.43. For characteristic wastes, any remedial action or technique must reduce leachate concentrations to below TCLP criteria. Listed hazardous wastes usually require comparison to additional treatment standards (including Wyoming Hazardous Waste Rules and Regulations [WHWRR]) before being placed in a land disposal unit.

Potential action-specific State ARARs include the following:

- Wyoming Environmental Quality Act. In addition to listed actions in chemical-specific ARARs, the act also provides for the protection of the State's resources for beneficial use, in addition to the protection of public health.

- Wyoming Water Quality Rules and Regulations (WWQRR). Provides requirements for testing procedures, establishes human health values for surface water.

- Wyoming Air Quality Standards and Regulations. Identifies standards for air emissions from specific sources and types of contaminants.

- WHWRR. Identifies and lists hazardous waste and provides standards for hazardous waste generators, transporters, owners, and operators of hazardous waste treatment, storage, and disposal facilities.

The majority of the soils at Spill Site 7 would be characterized as non-hazardous waste. Any hazardous waste encountered during the removal action will be managed according to the WHWRR requirements. The application of these ARARs is analyzed in Tables 4-2, 4-3 and 4-4. Chlorinated contaminants in a few soil samples are elevated sufficiently such that the samples might be classified as hazardous waste based on TCLP analysis. Prior to implementation of the recommended alternative, soils will be analyzed for TCLP to determine whether contaminants are present above regulatory limits.

Table 3-3 lists specific regulatory parts and sections of potential Federal and State action-specific ARARs.

3.2.3.1.3 Location-Specific ARARs

The potential location-specific Federal ARARs may include some of the same Federal statutes listed as action-specific ARARs. In addition, the following ARARs are included:

- The Endangered Species Act of 1973 (16 USC 1531) (50 CFR Part 402) provides for consideration of the impacts on endangered and threatened species and their critical habitats during any remedial actions.

The principal potential location-specific State ARARs may include the following:

- WWQRR. Provides standards for protection of wetlands and provides classification categories for streams.

Table 3-4 lists these and other potential location-specific requirements of consideration at Spill Site 7.

BMPs will be implemented to minimize surface water runoff into Diamond Creek from the remedial areas. These BMPs consist primarily of run on/runoff controls, such as hay bales or silt fences. Excavation activities are not anticipated to affect the floodplain and/or wetlands areas associated with Diamond Creek due to the use of BMPs. Several groundwater monitoring wells

will be destroyed during excavation of contaminated soils. Prior to excavation, these wells will be abandoned according to well protection guidelines of the State of Wyoming.

4.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTIONS

This section identifies possible removal action alternatives, provides a preliminary screening, identifies evaluation criteria, and provides a detailed screening of the removal alternatives. Selection of the removal action is conducted in Section 5.0.

The removal action detailed in this section addresses an area at Spill Site 7 found to contain elevated levels of metals (e.g., chromium) and VOCs (e.g., TCE). The removal action focuses on an area containing elevated levels of these contaminants in unsaturated soils associated with the grease trap and drainage ditch. The proposed removal area was defined using the location of the drainage ditch and elevated soil gas readings. The removal area, shown on Figure 4-1, corresponds to an area of soil gas concentrations above 10,000 ppbv. This area encompasses all of the soil sampling locations where samples exceeded the SSLs or RBCs, as well as the locations where soil gas readings above 100,000 ppbv suggest that a NAPL may be present. Treatment of these soils would address soils with the possibility of contaminating groundwater and thereby meet the first RAO by reducing the contribution of contamination from the vadose zone soil to the groundwater.

The area of metals contamination is based on historical evidence of metal in the grease trap and from soil contamination, found along the drainage ditch from several soil samples as shown on Figure 2-11. Because of the presence of the drainage ditch, direct contribution of surface run-off to Diamond Creek could occur if no treatment was performed. By treating or removing the soil from an area approximately 120 feet long by 5 feet wide along the drainage ditch area to a depth of one foot, the second RAO will also be met, and potential impacts to Diamond Creek are eliminated. The concentrations of soil samples within these two zones were screened against TCLP criteria (40 CFR 261.24). As a guideline, if the bulk soil concentration is less than 20 times the TCLP value, the sample is not likely to exhibit the characteristic of toxicity as defined by RCRA. TCE in subsurface soil was the only contaminant that was present at levels greater than 20 times the TCLP criteria. These soils, if excavated, could be considered characteristic hazardous waste. This conclusion is based on an assessment of total contaminant concentrations relative to the TCLP criteria. Prior to determining the disposition of the surface soils, the soils collected from the ditch will be stockpiled in a lined containment area where two bulk soil

composite samples will be collected and analyzed for TCLP metals. If this testing finds the soils to be hazardous, they will be sent off-site to a permitted facility for hazardous waste treatment or disposal. If soils are not found to be hazardous, they can be returned to the excavation as backfill.

Temporary stockpiling of soils, as well as execution of any soil treatment, will occur within the Spill Site 7 contaminated area. The excavation, stockpiling, and treatment within this area will be managed to meet the substantive RCRA requirements for a corrective action management unit (CAMU), which governs LDRs. These requirements include engineering practices, such as the use of berms/liners and confirmation sampling after completion, which will be detailed in the upcoming Spill Site 7 IRA Work Plan.

During implementation of the selected removal action, an exclusion zone will be demarcated and one point of entry/egress from the site will be established. Decontamination facilities for personnel, vehicles, and equipment will be located at the entry/egress point. All personnel entering the Exclusion Zone must have adequate training according to Occupational Safety and Health Administration (OSHA) Regulations 29 CFR 1910.120, proper personal protective equipment (PPE) as determined by the site Health and Safety supervisor, and medical clearance to wear the proper PPE. All personnel on-site must sign in and out when arriving and departing the site and must undergo site-specific safety briefing before entry to the exclusion zone is permitted. Documentation will be kept at the field office, including training certifications and medical clearances for all site workers/visitors. All efforts will be made to eliminate any contamination migration during removal activities. Upon completion of the removal action, any long-term institutional and land-use controls will be instituted as specified in the forthcoming ROD for the site, which will be prepared subsequent to implementation of the IRA.

Conditions exist in the saturated soil and groundwater that could lead to recontamination of the vadose zone soils following implementation of this IRA. Therefore for each alternative, an additional year of soil vapor monitoring will be performed to ensure that rebound does not occur. If rebound does not occur, bulk soil samples will be collected at the end of one year and analyzed

for VOCs by an off-site laboratory to confirm completion of the IRA. If rebound does occur, additional action may be warranted.

4.1 IDENTIFICATION OF POSSIBLE REMOVAL ACTION ALTERNATIVES

The following section briefly describes response action categories being considered within this EE/CA.

No Action

In this alternative, the existing contaminated soil is left in its current condition.

Excavation and Disposal

This alternative includes stockpiling surface soils from the ditch, collecting two bulk soil samples to determine whether the soils are hazardous based on TCLP, excavation and removal of TCE-contaminated soil to the 10,000 ppbv soil gas boundary in the vadose zone, and disposal of the excavated soil in either the on-site WCA or an appropriate off-site landfill facility. Two waste streams will be generated: hazardous soil (off-site disposition only) and nonhazardous soil (on-site or off-site disposition).

In-situ Soil Vapor Extraction (SVE)

This alternative includes stockpiling surface soils from the ditch, collecting two bulk soil samples to determine whether the soils are hazardous based on TCLP, and implementation of in-situ SVE to remove contaminated soil gas, remediating the VOC-contaminated soil. SVE is considered by the EPA to be the "presumptive remedy" for VOC-contaminated soils (EPA 1993b, 1993c).

Excavation, Disposal, and Ex-situ SVE

This alternative includes stockpiling surface soils from the ditch, collecting two bulk soil samples to determine whether the soils are hazardous based on TCLP, removal of the VOC-contaminated soil and placement in an on-site ex-situ SVE facility. Excavated soils will be

stockpiled and treated within the defined CAMU. Soils that have been determined hazardous will be placed in an appropriate hazardous waste landfill.

4.2 INITIAL SCREENING OF POSSIBLE REMOVAL ACTIONS

The initial screening of response action categories for the EE/CA was conducted by evaluating general alternatives relative to specific criteria outlined in EPA guidance on removal actions and development of EE/CA documentation (EPA 1993a). These criteria include:

Implementability

- Technical viability and feasibility
- Availability of labor, material, and equipment resources
- Agency and community acceptance

Effectiveness

- Degree to which the response action mitigates risk to human health and the environment and achieves RAOs
- Short-term effectiveness
- Long-term reliability
- Compliance with ARARs

Cost

Relative capital and O&M costs among the various response options being considered. Costs are ranked as low, moderate, or high based on experience, independent estimates, and engineering judgment.

The results of the initial screening provide a basis for determining which of the possible response actions should be retained for further evaluation. The following subsections present the potential actions considered in each response action category and discuss the results of the initial screening with respect to Spill Site 7. Compliance with ARARs is addressed in Section 5.1.2.

4.2.1 No Action

This potential response action involves leaving contaminated soils in their current location and condition. No removal action or institutional controls will be implemented. Evaluation of the No Action response alternative is required by the NCP as a basis on which to compare active response alternatives.

Implementability

This response is readily implementable in that no direct actions are required. Nevertheless, the No Action alternative is unacceptable to pertinent regulatory agencies and local communities because it provides no protection for human health and the environment.

Effectiveness

This response option does not effectively protect human health and the environment because exposure pathways to the groundwater system for the contaminants of concern are not mitigated and RAOs are not met. Continued infiltration to groundwater, which discharges to the surface water system, will continue to occur. Impacts to groundwater may influence drinking water supplies, and surface water impacts may harm aquatic life if the No Action alternative is implemented.

Cost

No capital or O&M costs are incurred under this response option.

Response Option Summary

The No Action alternative is an undesirable response alternative based on its failure to adequately protect the environment. This option is therefore eliminated from further consideration for Spill Site 7.

4.2.2 Excavation and Disposal

Soil from the ditch will be stockpiled within the CAMU and sampled to determine whether surface soils are to be considered hazardous based on metals concentrations along the ditch. For the purposes of this EE/CA, it is assumed that an area 120 feet long by 5 feet wide will be excavated to a depth of 1 foot. This corresponds to approximately 23 bank cubic yards (BCY) (32 LCY) of soil. The soil will be stockpiled within a lined containment area and sampled. Two five-point composite samples will be analyzed for TCLP metals. If any metals exceed TCLP levels, the soils will be disposed in an appropriate off-site hazardous waste disposal or treatment facility. Those soils exhibiting concentrations below the screening criteria will be used as backfill material. Once metals-contaminated soil is removed and stockpiled, VOC remediation will commence. VOC remediation will be accomplished by excavating an area within the soil gas boundary of 10,000 ppbv (approximately 200 feet by 75 feet with a average depth of 15 feet). Within this 10,000-ppbv boundary lies an area of soil that: 1) may exceed the TCLP criteria for TCE, 2) exceeds site specific SSLs, and 3) has soil gas readings in excess of 100,000 ppbv, which may indicate the presence of NAPL in residual form. This area, with dimensions of 150 feet by 25 feet by 12 feet deep, contains soils that could potentially be characteristically hazardous. This option includes excavating approximately 1,200 BCY (2,400 LCY) of potentially hazardous material, hauling the hazardous soil to an approved off-site landfill, excavating the surrounding 6,300 BCY (9,200 LCY) of non-hazardous soil, hauling that material to the on-base WCA or an approved off-site non-hazardous landfill, and backfilling the entire excavation with an approved clean fill material from an off-site location. The two disposal options are screened in the same manner; the only differences are in final waste disposition and cost. The surface will be restored to match existing site conditions. Long-term monitoring is not required for this option, and no O&M costs would be associated with excavation and off-site disposal. Once the remedy is completed, long-term engineering and/or institutional controls will be implemented, as appropriate, to restrict access.

Implementability

This alternative is readily implementable at Spill Site 7. Numerous contractors, equipment vendors, and laboratories are available to perform the required work. In addition to the on-base

WCA, several CERCLA- and RCRA-approved solid and hazardous waste landfills have been identified that accept the anticipated wasted types and quantities. Based on previous activity at the other FEW landfill areas, regulatory and community acceptance of this response are assumed to be positive.

Effectiveness

Placement of the waste in a properly managed, constructed, and maintained landfill facility is effective in mitigating contaminant migration in the vadose zone. Excavation may present short-term impacts such as hazards associated with heavy equipment operations, excavation sidewall stability, fugitive dust emissions, vapor emission, and noise. Transportation of the contaminated materials presents similar hazards plus potential exposure to citizens along the transportation route and increased traffic density. These impacts will be controlled with engineering practices, administrative controls, PPE, and community-specific considerations related to the hauling route and work schedule.

Spill Site 7 geologic logs, soil boring, well installation activities, and soil gas sampling results, indicate that a headspace reading of 1,000 ppm will be effective as a field screening technique to allow removal of contaminants along preferential pathways. Once the field screening indicates that contamination with the potential to impact groundwater has been removed, bulk soil samples will be collected from the sidewalls to verify that the criteria of the first RAO have been met. Since the groundwater contains high levels of contamination, the floor of the excavation (top of the water table) will not be sampled. With the sampling and/or removal of metals in the surface soils from the ditch, the second RAO will also be met.

Cost

This alternative has moderate to high capital costs and no O&M costs. The higher capital cost is attributed to hauling distances and tipping fees at the commercial landfill facilities.

Response Option Summary

Excavation and off-site disposal is retained for further consideration as a primary IRA alternative for Spill Site 7.

4.2.3 In-Situ Soil Vapor Extraction

Soil from the ditch will be stockpiled and sampled to determine whether surface soils are to be considered hazardous based on metals contamination along the ditch. For the purposes of this EE/CA, it is assumed that an area 120 feet long by 5 feet wide will be excavated to a depth of 1 foot. This corresponds to approximately 23 BCY (32 LCY) of soil. The soil will be stockpiled within a lined containment area and sampled. Two samples will be analyzed for TCLP metals analysis. If any metals exceed TCLP levels, the soils will be disposed in an appropriate off-site hazardous waste disposal or treatment facility. Those soils exhibiting concentrations below the screening criteria will be used as backfill material. Once the metals-contaminated soil is stockpiled, VOC remediation will commence. VOCs in the subsurface will be remediated by in-situ SVE methods, which consist of mobilizing a treatment system to the site and constructing an extraction and collection system for contaminated soil vapors. The vapors would be extracted from the soil either by vertical or horizontal extraction wells. The extraction wells will then be routed to a blower to withdraw the contaminated vapors. Treatment of contaminant emissions is required. The system effluent will be treated with vapor-phase activated carbon. Once the remedy is completed, long-term engineering and/or institutional controls will be implemented, as appropriate, to restrict access.

Implementability

Treatment of the soil in-situ can be readily implemented at FEW based on accessibility to power sources, site access, and a wide variety of commercial remediation equipment vendors. Regulatory and community acceptance are assumed to be positive.

Effectiveness

SVE has proven to be an excellent treatment technology for VOCs in certain soil conditions and is considered by the EPA to be the presumptive remedy for VOC-contaminated soils (EPA 1993b, 1993c). Geological considerations such as the existence of low permeability lithologic sections and cemented caliche layers are likely to inhibit air flow and result in the formation of preferential pathways, thus reducing treatment effectiveness. Based on the uncertainty of the ability of SVE to effectively remediate less permeable contaminated zones, this alternative is rated as only moderately effective for this site.

Cost

Capital costs for in-situ treatment are relatively low compared to the other remedial options. O&M costs are relatively high because a remediation system will require periodic maintenance and performance monitoring.

Response Option Summary

In-situ SVE is retained for further consideration as a removal action for Spill Site 7.

4.2.4 Excavation and Ex-Situ Soil Vapor Extraction

Soil from the ditch will be stockpiled and sampled to determine whether surface soils are to be considered hazardous based on metals contamination along the ditch. For the purposes of this EE/CA, it is assumed that an area 120 feet long by 5 feet wide will be excavated to a depth of 1 foot. This corresponds to approximately 23 BCY (32 LCY) of soil. The soil will be stockpiled within a lined containment area and sampled. Two five-point composite samples will be analyzed for TCLP metals. If any metals exceed TCLP levels, the soils will be disposed in an appropriate off-site hazardous waste disposal or treatment facility. Those soils exhibiting concentrations below the screening criteria will be used as backfill material. Once metals-contaminated soil is removed and stockpiled, VOC remediation will commence. This alternative includes excavation of the approximately 11,600 LCY of VOC-contaminated soils based on the 10,000-ppbv soil gas contour, SVE treatment of soils within constructed above-ground treatment

cells, and backfill of the excavation with the treated material. Once the remedy is completed, long-term engineering and/or institutional controls will be implemented, as appropriate, to restrict access.

Implementability

The ex-situ treatment option can be readily implemented at FEW based on factors such as location, accessibility, electrical power, and equipment and material vendors. The large amount of space near Spill Site 7 makes ex-situ treatment fully implementable because the material will be handled and transported on-site within the CAMU. It is assumed that this alternative would be acceptable to the regulators and the community. This removal action is relatively straightforward and simple to demonstrate success.

Effectiveness

Ex-situ treatment is an effective remedial technology. The low-permeability contaminated soils and the confining caliche layers would not be a hindrance to the ex-situ technology as they are to the in-situ technology. Excavating the soil and placing the soil in the treatment units would effectively break apart cemented zones and ensure that large amounts of contaminated surface area are exposed to the SVE system, thereby enhancing SVE effectiveness. This will minimize the formation of preferential pathways that are often encountered during in-situ SVE operations.

Cost

Capital costs for excavation and ex-situ treatment are relatively high because temporary treatment facilities would need to be constructed, and the soil must be excavated and transported to the on-site treatment area. O&M costs would be incurred for a relatively short period to maintain operation of the system and to conduct performance monitoring. This remedial option would not require landfill tipping fees, off-site hauling, or importation of backfill material.

Response Option Summary

Excavation and ex-situ treatment of waste are considered practical for the Spill Site 7 site. This treatment response option is therefore retained for further consideration.

4.2.5 Retained Removal Options for Spill Site 7

The following three removal alternatives are retained for further consideration in the EE/CA with respect to the IRA at Spill Site 7:

- Alternative I – Excavation and Disposal of Metals-Contaminated Surface Soil and Excavation and Disposal of VOC-contaminated Unsaturated Soil.
- Alternative II – Excavation and Disposal of Metals-Contaminated Surface Soil and In-situ SVE of VOC-contaminated Unsaturated Soil.
- Alternative III – Excavation and Disposal of Metals-Contaminated Surface Soil and Excavation and Ex-situ SVE of VOC-contaminated Unsaturated Soil.

4.3 IDENTIFICATION OF SCREENING CRITERIA

Each response alternative identified in Section 4.2.5 will be evaluated independently based on guidance in the NCP (40 CFR Part 300) and EPA's *Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA* (EPA 1993a). Section 4.4 presents detailed descriptions and analyses of all identified response alternatives for Spill Site 7. Specific removal action details and costs have been determined for each alternative to assist in making appropriate engineering evaluations and cost analyses. A comparative analysis of the alternatives is presented in Section 5.

Like the initial screening effort, the response alternatives will be evaluated in Section 4.4 with respect to effectiveness, implementability, and cost. The following specific criteria will be considered:

Effectiveness

- Overall protection of human health and environment
- Compliance with ARARs

- Long-term effectiveness and permanence
- Reduction in toxicity, mobility and volume
- Short-term effectiveness (protection of community; protection of workers; immediate environmental impacts; and time until response objectives are achieved)

Implementability

- Technical feasibility
- Administrative feasibility
- Availability of services and materials
- Regulatory and community acceptance

Cost

- Capital cost
- Post-removal site control (PRSC) cost
- Total present worth cost

4.4 DETAILED SCREENING OF ALTERNATIVES – SPILL SITE 7

In Section 4.2, various response options were evaluated for general effectiveness, implementability, and cost. After this screening of alternatives, the response options retained for consideration were incorporated into complete removal action alternatives. The following three alternatives were developed for Spill Site 7:

- Alternative I – Surface Soil Excavation for Inorganics, Removal and Disposal of VOC-Contaminated Unsaturated Soil.
- Alternative II – Surface Soil Excavation for Inorganics, In-situ SVE of VOC-Contaminated Unsaturated Soil.
- Alternative III – Surface Soil Excavation for inorganics; Ex-situ SVE of VOC-Contaminated Unsaturated Soil.

The alternatives are summarized in Table 4-1.

4.4.1 Alternative I – Surface Soil Excavation and Disposal; Removal and Disposal of VOC-Contaminated Unsaturated Soils

Alternative I involves the complete removal of the approximate area within Spill Site 7 that exhibits soil gas readings above 10,000 ppbv. Prior to initiating the removal, surface soil located in the ditch will be stockpiled in a lined containment area and sampled for TCLP metals. This area is approximately 120 feet by 5 feet to a depth of 1 foot (32 LCY). Two five-point composite samples will be analyzed for TCLP metals. If any metals exceed TCLP criteria, the soil will be disposed in an appropriate off-site hazardous waste disposal or treatment facility. Those soils exhibiting concentrations below the screening criteria will be used as backfill material.

Upon completion of metals-contaminated soil excavation and stockpiling, the VOC-contaminated soil area will be addressed. This area is approximately 200 feet by 75 feet with an average depth of 15 feet (11,600 LCY). Contained within the excavation boundaries is a 150-foot by 25-foot area with a depth of 12 feet that contains potentially characteristic hazardous soils (2,400 LCY). The soils excavated from this area will be managed as characteristic hazardous waste for TCE. The area will be excavated with a hydraulic excavator, loaded into trucks, and hauled to an approved off-site hazardous waste disposal facility. Two non-hazardous disposal options will be considered for this alternative: disposal in the nearby WCA on the base or hauled to an off-site non-hazardous landfill facility. Figure 4-2 illustrates the proposed excavation areas. Once the excavation has extended to 10,000 ppbv soil gas boundary and field screening indicates that soils greater then 1,000 ppm have been removed, bulk soil samples will be collected from the sidewalls to verify that RAOs have been met.

Equipment will be mobilized to the site and an entry, exit, and loading area will be established within the CAMU. For evaluation purposes, it is assumed that material will be directly loaded into trucks during excavation; however, the depth and size of the excavation may prohibit such activities. If direct loading cannot be performed, the material will be staged within the CAMU. A wheel loader equipped with a 4-cubic-yard capacity bucket will be on-site to load trucks from stockpiles created by the excavator. Equipment will be decontaminated after handling the hazardous soils to prevent cross-contamination. For off-site disposal, the trucks will be tarped to

prevent soil and debris from contaminating the haul route, and a manifest (for hazardous material) or bill of lading (for nonhazardous material) will be given to the driver to track and provide a record of the quantity of excavated soil. Trucks hauling the hazardous material will be properly placarded and will follow all applicable Department of Transportation regulations regarding transportation of hazardous waste. A decontamination pad will be constructed at the truck exit to wash residual soil from dump truck tires to avoid contaminating nearby roadways. Decontamination water will be collected and used for dust control within contaminated areas (i.e., excavation pit, stockpiled soils awaiting treatment), or will be sampled and disposed of in an appropriate facility.

Backfilling with clean soils will commence prior to the completion of the excavation to limit the size of the open excavation. Because the floor of the excavation is known to contain contaminated soil, no confirmation samples are required of the floor. Sidewall samples will be collected to verify that soils left in place meet or exceed cleanup criteria. The backfill will be placed in lifts and will be compacted with a roller or vibratory compactor when the excavation depth is shallow enough to allow safe entry. The surface of the excavation will be restored to match existing site conditions and vegetation.

An additional year of soil vapor monitoring will be performed to ensure that rebound does not occur. If no rebound is exhibited, bulk soil samples from within the backfill will be collected at the end of one year and analyzed for VOCs by an off-site laboratory to confirm completion of the IRA. If rebound does occur, additional measures may be warranted.

Although the excavation will approach the depth of the water table, it is not anticipated that dewatering activities will be performed at the site. Pumps and holding tanks can be mobilized to the site if a large rain event occurs. Water not used for dust control would be disposed appropriately off-site.

The specific disposal facility will be determined prior to implementation. The non-hazardous material disposal facility will be either the on-base WCA or a permitted landfill able to accept the CERCLA waste. Placement, compaction, and capping will need to be performed if non-hazardous soil is hauled to the WCA. The facility chosen to accept the hazardous waste must be

permitted to accept characteristic hazardous wastes. Trucks will be weighed at the facility and manifest copies will be returned to the contractor (Earth Tech) and the generator (FEW). The backfill material will be certified to contain no hazardous constituents. Once the remedy is completed, long-term engineering and/or institutional controls will be implemented as appropriate to restrict access.

4.4.1.1 Effectiveness Evaluation

The removal of unsaturated contaminated material from the Spill Site 7 area will meet the RAOs by reducing current and future potential impacts to groundwater and surface water. During excavation, soils from the sidewalls of the excavation will be field-screened with a PID to determine the lateral extent of the excavation. A field screening level of 1,000 ppm will be used as a cutoff for removal of additional soil outside the 10,000-ppbv soil gas boundary. This field screening value is derived from a comparison of field PID readings from boring logs to analytical results and soil gas readings. The bottom of the excavation is within the capillary zone and will likely be contaminated. Confirmation samples from the sidewalls will be collected and analyzed to verify RAOs have been met.

4.4.1.1.1 Overall Protection of Human Health and Environment

This alternative will meet all of the RAOs listed in Section 3.2.1. Because the contaminated soil between the groundwater interface and the surface will be removed and replaced with clean fill material, the risk of leachate above the MCLs reaching the groundwater will be greatly reduced. The risk of surface water contamination will be eliminated by removal of contaminated surface soil. Since the contamination will be removed, potential risks of human and/or ecological receptors being exposed to contamination through direct contact with contaminated soil will also be reduced. Therefore, Alternative I provides protection of groundwater quality beneath the contaminated zone and provides protection to Diamond Creek's surface water quality at the outlet of the ditch.

4.4.1.1.2 Compliance with ARARs

Implementation of Alternative I is anticipated to meet ARARs specific to this alternative, including provisions of WDEQ waste regulations and applicable storm water regulations. An

analysis of the remedial alternatives' compliance with ARARs is provided in Tables 4-2, 4-3 and 4-4.

4.4.1.1.3 Long-term Effectiveness

Alternative I will achieve long-term effectiveness by removing unsaturated soil containing the highest contaminant levels. This potentially hazardous material is most likely to impact groundwater and surface water. Excavation and removal is the most common form of soil remediation, and placement in a landfill will isolate the contaminated media from any contact with potential receptors. No long-term adverse impacts are anticipated for this alternative.

4.4.1.1.4 Reduction of Toxicity, Mobility, and Volume

No reduction of contaminant toxicity or volume is anticipated as a result of waste excavation and subsequent disposal in a landfill facility because no treatment is being conducted. Placing the waste in a properly managed landfill unit will reduce the mobility of the contaminants.

4.4.1.1.5 Short-term Effectiveness

The short-term effectiveness of Alternative I is evaluated as follows:

Protection of the Community. Removal operations at Spill Site 7 will pose minimal risk to the public. Material handling activities will be conducted in areas where access is limited to trained workers, thereby minimizing exposure to occasional site visitors and recreational users.

Engineering controls and monitoring programs implemented during Alternative I construction and operation will ensure protection of workers and the local communities from potential short-term impacts. Fugitive dust emissions during removal activities and loading activities will be controlled following standard practices for dust suppression, such as the application of sprayed water or the use of tarps and plastic sheeting. Run-on and runoff will be managed using standard erosion control practices such as silt fencing or hay bales. These practices will control potential releases to Diamond Creek.

Protection of Workers. The excavation will require the use of heavy equipment. Workers implementing the removal action will have minimal contact with the contaminated materials.

Engineering controls, monitoring, and PPE will be used during the removal action to minimize potential worker exposure. The primary risks to workers are from fugitive dust, chemical vapors, and physical hazards associated with heavy equipment operation and excavation of hazardous materials. Dust suppression will be required to reduce inhalation exposures. It is not anticipated that any workers will enter the excavation, but if changing site conditions dictate the contrary, workers shall follow all excavation safety guidelines including benching, sloping, and shoring. These potential risks can be minimized by using OSHA-trained crews and appropriate controls that are standard at hazardous waste and construction sites. All workers shall have 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training and the 8-hour annual refresher courses as specified in 29 CFR 1910.120.

Short-term Environmental Impacts. The potential short-term environmental impacts are those commonly related to excavation. The impacts include fugitive dust emissions, chemical vapors, water run-on/runoff, and contaminant transport via personnel or vehicle. These potential impacts are readily controlled through dust suppression, engineered run-on/runoff controls, and decontamination facilities.

Time Until Response Objectives are Achieved. It is anticipated that mobilization, sampling, excavation, removal, transportation, backfill, site restoration, and demobilization will require approximately 8 to 10 weeks. The estimated volume of waste to be removed is 11,600 LCY, and the estimated time to excavate the total volume of contaminated soil is 4 weeks. Of that material, 2,400 LCY is assumed to be a characteristic hazardous waste and will be sent to a hazardous waste landfill. Backfilling and site restoration activities will coincide with removal activities.

4.4.1.2 Implementability

4.4.1.2.1 Technical Feasibility

Alternative I is considered technically feasible for Spill Site 7. The implementation of this alternative employs proven excavation equipment and techniques. The primary difficulties may be excavating material as it approaches the groundwater table. Conventional heavy equipment (e.g., a hydraulic excavator and front-end loader) will be able to operate at the site.

This alternative is easily adaptable to varying environmental conditions. Steps will be taken to continuously evaluate site conditions during excavation activities. Should unusual conditions arise, excavation activities will be suspended until the condition can be fully investigated. Run-on control berms and silt fencing will be constructed around the excavation area to direct and control rainwater during precipitation events. Adequate space exists on-site to create separate stockpiles within the CAMU should materials other than those characterized for disposal be encountered.

4.4.1.2.2 Administrative Feasibility

Although permits are not required for this removal action, all substantive requirements of applicable regulations will be followed. No structures will need to be erected for this work; therefore no building permits will be requested. No work is anticipated that will encroach on any surface water body. All material hauled to an off-site facility will be approved by the facility for disposal.

No easements or right-of-way acquisitions are required on USAF-owned and -controlled property; however, various utilities may run through the excavation area. If removal is required near the utilities, all utilities will be relocated or otherwise isolated and protected during removal and backfilling operations.

No adjacent or adjoining properties will be impacted by this alternative. Truck traffic from FEW to the landfill facility will occur during removal, but adjacent properties will not be impacted by this traffic. FEW's southern gate is adjacent to Interstate Highway 25, providing direct access to any anticipated local or regional landfills. There are no residences or businesses along the connecting route from FEW to the highway.

Once the remedy is completed, institutional controls will be implemented as appropriate to restrict access.

4.4.1.2.3 Availability of Services and Materials

The equipment necessary to complete this alternative is commonly available, heavy earth-moving equipment. All material required for backfilling and site restoration is readily available from numerous off-site vendors.

The off-site disposal facility may require additional waste characterization sampling other than surface soil sampling. Costs for completing these characterization samples are included in the cost estimate provided in Appendix C. TCLP and VOC testing is a standard requirement for most commercial disposal facilities, and related analytical services are available from a large number of commercial laboratories. In addition to the possibility of additional waste characterization sampling, confirmation sampling will be conducted upon completion of the excavation. No specialized testing services are required under this alternative.

4.4.1.2.4 State and Community Acceptance

State and community acceptance will be determined based on comments received during the public comment period. A 30-day public comment period will follow submittal of the Final EE/CA to the regulatory agencies. Both EPA Region VIII and WDEQ have been actively involved throughout the development of this EE/CA. A Responsiveness Summary will be prepared to address all significant public comments received and to discuss impacts of the EE/CA and proposed removal action for Spill Site 7.

4.4.1.3 Cost

This section presents the capital cost estimate, PRSC cost, and present worth cost estimate for Alternative I.

4.4.1.3.1 Capital Cost Estimate

- Mobilization/demobilization;
- Preparation of pre-construction and post-construction documents;
- Removal of surface soil in the drainage ditch area, approximately a 120-foot by 5-foot area to a depth of 1 foot;

- Transportation of the surface soil to a hazardous waste disposal facility;
- Temporary construction facilities, including haul roads;
- Excavating 2,400 LCY of hazardous VOC-contaminated material from 150-foot by 25-foot area to a depth of 12 feet and hauling to a hazardous waste disposal facility;
- Excavating 9,200 LCY of nonhazardous VOC-contaminated material from the surrounding area (resulting in a total excavation footprint of 200 feet by 75 feet to a depth of 15 feet) and hauling to the on-base WCA or a nonhazardous waste disposal facility;
- Material disposal in off-site facility or placement, compaction, and capping in the WCA;
- Backfilling, including placement and compaction, from off-site sources; and
- Site restoration.

The base capital cost for Alternative I is $1,095,261 for nonhazardous material disposal at the WCA, or $1,366,660 for nonhazardous material disposal at an off-site landfill. Contributing costs are summarized in Appendix C. This cost does not include USAF or regulatory agency administrative and oversight costs. The construction costs are summarized below.

4.4.1.3.2 Post-Removal Site Control Cost

The cost estimate for Alternative I assumes that no additional monitoring will be performed after the initial remedial action is completed; therefore there are no PRSC costs.

4.4.1.3.3 Total Present Worth Cost Estimate

Since no multi-year O&M costs are incurred as part of this alternative, the total present worth cost estimate is the same value as the capital costs. This cost is summarized below.

Remedial Option	Total Marked-Up Capital Costs	Operation and Maintenance	Total Remedial Option Cost
Excavation and off-site disposal – WCA disposal option	$1,095,261	NA	$1,095,261
Excavation and off-site disposal – Off-site facility disposal option	$1,366,660	NA	$1,366,660

A 5 percent annual interest rate is typically added to the remedial option costs; however, this project is anticipated to begin and mostly be completed in 2003. Therefore no discount rate was applied. Detailed cost estimation reports can be found in Appendix C.

4.4.2 Alternative II - Surface Soil Excavation with Stockpile; Removal and In-situ Soil Vapor Extraction of VOC-contaminated Material

Equipment will be mobilized to stockpile the metals-impacted surface soils from the ditch area, which is assumed to be 120 feet by 5 feet to a depth of 1 foot. The soil will be stockpiled in a lined containment area and sampled for TCLP metals. Two five-point composite samples will be analyzed for TCLP metals. If any metals exceed TCLP criteria, the soil will be disposed in an appropriate off-site hazardous waste disposal or treatment facility. Those soils exhibiting concentrations below the TCLP criteria will be used as backfill material. Once the metals-contaminated surface soil has been stockpiled, Alternative II will continue with the installation of an in-situ SVE system to remediate VOCs contained within the unsaturated soils. Under this option, contribution to groundwater contamination from the Spill Site 7 unsaturated soils will be mitigated. The details of the remediation technology are presented below.

This alternative involves installing either vertical SVE collection wells or horizontal SVE trenches, installing manifold piping connecting the wells, and installing a blower system with granular activated carbon (GAC) for contaminated vapor removal and treatment. During treatment, system performance will be monitored with vapor samples collected upstream and downstream of the GAC unit.

Prior to commencing site work, the determination must be made whether to utilize horizontal SVE trenches or vertical SVE wells. For the purposes of this EE/CA, it is assumed that approximately 18 vertical SVE wells will be installed using a hollow-stem auger (HSA) drill rig. The wells will be installed with screened intervals from the water table to approximately 10 feet bgs. Figure 4-3 shows the proposed system layout. Drill cuttings and excavation spoils will be sampled and managed according to characterization data.

Once the wells are installed, equipment will be mobilized to install the manifold piping. The piping will be installed a minimum of 3 feet bgs to protect it from weather and other surface

hazards. The piping will terminate at the location of the aboveground treatment facility. Flexible hoses will be used to attach the manifold to the blower system. The blower will remove air from the soil through the screened SVE collection wells. Vapor-phase GAC will be fitted to the blower effluent to remove contaminants from the emissions. Spent GAC will be disposed according to all applicable regulations.

Soil gas will be monitored during each phase of the in-situ remediation. Once soil gas levels fall below 42 ppbv and stabilize for a minimum of two weeks, the blowers can be shut down. An additional year of soil vapor monitoring will be required after system termination to ensure that no contaminant rebound occurs. Rebound will be checked through soil vapor collection using direct push techniques. If no rebound is exhibited, bulk soil samples will be collected at the end of one year and analyzed for VOCs by an off-site laboratory to confirm completion of the IRA. If rebound does occur, the system will be restarted. Once confirmation has been achieved, the wells will be abandoned and the site restored to its original condition. This alternative addresses the soils contributing to surface water runoff and soils leaching to the groundwater system; therefore the first and second RAOs will be met. Once the remedy is completed, long-term engineering and/or institutional controls will be implemented as appropriate to restrict access.

4.4.2.1 Effectiveness Evaluation

The removal of the contaminants from the unsaturated soil via surface soil removal and in-situ SVE meets the RAOs by reducing current and future impact to the groundwater and surface water. Both contaminated surface soil and soil vapor, the criterion by which the remediation area is delineated, will be removed and treated, minimizing the potential for contact by human and/or ecological receptors. It is anticipated that in-situ SVE may not be able to reach all impacted soils in a reasonable time frame because of heterogeneous soil conditions and cemented zones. Limited areas may contain soils above the site specific SSLs after remediation has been completed that may continue leaching to the groundwater table. This may necessitate a protracted treatment period.

4.4.2.1.1 Overall Protection of Human Health and the Environment

This alternative will meet the RAOs stated in Section 3.2.1. It is anticipated that surficial metals contamination and the volatile contamination within the highly contaminated zone will be removed, thereby minimizing the continued leachate infiltration to groundwater from unsaturated soils. Because the shallow soil will be remediated, the risk of human and/or ecological receptors being exposed to contamination through direct contact with the waste will be minimized.

4.4.2.1.2 Compliance with ARARs

Implementation of Alternative II is anticipated to meet ARARs specific to this alternative, including provisions of WDEQ waste and air quality regulations. An analysis of the remedial alternatives' compliance with ARARs is provided in Tables 4-2, 4-3 and 4-4.

4.4.2.1.3 Long-Term Effectiveness

Alternative II will achieve long-term effectiveness by removing elevated metals and volatile contamination from source areas within the Spill Site 7 remediation area. However, the effectiveness is questionable because the geology of the area to be remediated leads to concerns about projected system performance. While SVE is a proven and widely used remedial method, it has been shown to be less effective in low permeability material, which comprises the majority of the site. The possibility of contamination rebound exists with the in-situ SVE. The long-term effectiveness of Alternative II is questionable because of the geology at Spill Site 7. Other than the potential for rebound, no adverse long-term effects are anticipated.

4.4.2.1.4 Reduction of Toxicity, Mobility, and Volume

Surface soil removal and in-situ treatment will reduce the toxicity of the contaminated material by removing the surface soil and removing the volatile contaminants from the unsaturated soil. The volume of the contaminants will be reduced because recovered vapors will be collected in GAC canisters, which will hold a much higher volume of volatiles per unit volume than a comparable amount of native soil. This significant reduction in the toxicity and volume of contaminants is accomplished through treatment. The degree to which contaminant toxicity and volume is decreased depends on the effectiveness of the removal action. As stated in Section

4.4.2.1.3, the effectiveness of in-situ SVE at this location is in question, therefore toxicity and volume may not be completely reduced. The mobility of the contaminants will be decreased because the surface soil and carbon will be shipped to an approved disposal/recycling facility equipped with the means to prohibit contaminant migration. Regeneration of GAC may also result in the destruction of TCE.

4.4.2.1.5 Short-term Effectiveness

The short-term effectiveness of Alternative II is evaluated as follows:

Protection of the Community. Remedial operations at Spill Site 7 will pose minimal risk to the public. Remedial activities will be conducted in a remote area with limited access, thereby minimizing exposure risk to site workers and official site visitors.

Administrative and engineering controls, along with the O&M program, will ensure protection of workers and the local communities from potential short-term impacts. Fugitive dust control during system installation, equipment decontamination, and effluent vapor monitoring/treatment will be used during applicable remediation phases. Once the remedy is completed, institutional controls will be implemented as appropriate to restrict access.

Protection of Workers. Other than excavation equipment used to remove surface soils, the majority of the system installation will require use of a truck-mounted HSA drill rig. During drilling operations, all applicable safety precautions will be carried out to protect workers from potential drilling hazards. During system installation, some heavy equipment will be used. Engineering controls, monitoring, and PPE will be used during installation and O&M operations. Physical and chemical hazards during installation and operation are the primary hazards associated with this alternative. An advantage to in-situ remediation is that no excavation hazards exist and fugitive dust emissions are minimized. All site workers shall have 40-hour HAZWOPER training and 8-hour annual refresher courses as specified in 29 CFR 1910.120.

Short-term Environmental Impacts. Few short-term environmental impacts exist for Alternative II. Fugitive dust emissions could occur during surface soil removal, but dust suppression will be performed if the need arises. During system operation, breakthrough could

occur in the vapor collection system when the carbon is spent. The probability of such an occurrence is unlikely; weekly effluent monitoring will show slightly diminished removal efficiencies prior to breakthrough.

Time Until Response Objectives are Achieved. Surface soil stock piling and removal are anticipated to take three weeks, including laboratory turn-around time (TAT). System installation, including well drilling, installation, piping, trenching, and mechanical installations, is anticipated to take 6 weeks. The exact remedial duration of the in-situ SVE depends on numerous factors, including system efficiency, flow rates, and soil permeability. Based on preliminary assumptions and experience at similar sites, the SVE will be marginally effective; however, to allow for comparable costing, it is anticipated that response objectives will be met within approximately 3 years. An additional year of soil sampling and soil gas monitoring will be required prior to system demobilization to ensure that no contaminant rebound occurs. Thus, the total estimated remediation time for evaluation purposes is approximately 4 years.

4.4.2.2 Implementability

4.4.2.2.1 Technical Feasibility

No unusual procedures will be used in the implementation of Alternative II, and readily available material, labor, and equipment will be used to install the system. Wells, piping, and a blower/vapor collection system will be installed, requiring a minor engineering effort. The feasibility of removing contaminants from the low permeability and cemented soils may be an issue with this alternative.

4.4.2.2.2 Administrative Feasibility

Minor administrative issues could arise during transportation and disposal of the surface soil if the soil is characteristically hazardous. Although permits are not required for in-situ SVE operations, the substantive requirements of the applicable regulations will be followed. All operations will be conducted entirely on FEW. No structures requiring building permits will be constructed as part of this alternative. No work is anticipated that will encroach on a surface water body.

No easements or right-of-way acquisitions are required on USAF-owned and -controlled property. However, various utilities run through the site. If the system installation encroaches on utility placements, utilities will be relocated or otherwise isolated and protected during field operations. Alternative II will not impact adjacent or adjoining properties.

GAC will be utilized to treat the vapor stream effluent. Periodic monitoring will assess the GAC performance to ensure that no releases occur.

Since the soils will undergo treatment, no institutional controls or restrictions are anticipated. The soil must be adequately sampled to ensure that site-specific SSLs are met.

4.4.2.2.3 Availability of Services and Materials

The equipment necessary to complete this alternative is commonly available and includes truck-mounted drill rigs, excavation equipment, and industrial equipment such as blowers and piping.

Services required for system implementation include electrical tie-in, drilling, transportation, disposal, and mechanical work. All can be readily performed by a number of local subcontractors. Laboratory sample analysis is also anticipated for this alternative, and numerous laboratories perform the required analyses.

4.4.2.2.4 State and Community Acceptance

State and community acceptance will be determined based on comments received during the public comment period. A 30-day public comment period will follow submittal of the Final EE/CA to the regulatory agencies. Both EPA Region VIII and WDEQ have been actively involved throughout development of the EE/CA. A Responsiveness Summary will be prepared to address all significant public comments received and to discuss impacts of the EE/CA and the proposed removal action for Spill Site 7.

4.4.2.3 Cost

This section presents the capital cost estimate, O&M cost estimate, and present worth cost estimate for Alternative II.

4.4.2.3.1 Capital Cost Estimate

The capital cost estimate for Alternative II includes expenditures for:

- Mobilization/demobilization;
- Preparation of pre-construction and post-construction reports;
- Stockpiling and sampling of surface soils in the drainage ditch area for removal;
- Installation of SVE wells;
- Disposal of drill cuttings;
- Installation of piping for the system;
- Installation of the SVE system, including mechanical and electrical;
- System start-up costs; and
- System shutdown/site closure.

The base capital cost for Alternative II is $269,764

4.4.2.3.2 Operation and Maintenance

Alternative II will require substantial O&M during the life of the treatment system. The calculated O&M costs for the in-situ system are $216,197. Numerous assumptions are included in this estimate, such as:

- Three years of operation and one year of monitoring for rebound,
- Moderate maintenance level,
- Weekly monitoring including air analysis for VOCs, and
- Monthly visit by home office professional.

The costs for O&M under this estimate include sampling, labor, travel, electricity, and miscellaneous costs.

4.4.2.3.3 Total Present Worth Cost Estimate

The present worth calculation directly adds the estimated O&M cost to the capital cost estimate to obtain a total estimated project cost. Total present worth costs for this alternative are summarized below.

Remedial Option	Total Marked-Up Capital Costs	Operation and Maintenance	Total Remedial Option Cost
In-situ SVE	$269,764	$216,197	$485,961

By applying a 5 percent discount rate to the life of the project, the estimated cost projected back to today's values would be $468,451. Complete cost summaries for Alternative II can be found in Appendix D.

4.4.3 Alternative III – Surface Soil Excavation; Removal and Ex-situ Soil Vapor Extraction of VOC-contaminated Material

Alternative III includes excavation, stockpiling and sampling the soils in the top 12 inches of the ditch for TCLP metals, which consist of approximately 32 LCY of surface soil, and excavation of approximately 11,600 LCY of VOC-contaminated Spill Site 7 material, on-site staging, on-site treatment, and backfilling with the treated material. The site will then be restored to match the original conditions. The treatment of the waste will minimize future groundwater and surface water impacts. This option includes transportation of surface soil to an off-site facility based on the results of the sampling of the stockpiled surface soil.

A hydraulic excavator will be used to scrape the top 1 foot of soil from the surface soil area of contamination. The soil will be stockpiled within the CAMU and sampled. Two five-point composite samples will be analyzed for TCLP metals analysis. If any metals exceed the TCLP criteria, the soils will be disposed in an appropriate off-site hazardous waste disposal or treatment facility. Those soils exhibiting concentrations below the TCLP screening criteria will be used as backfill material. The disposal facility selection is contingent on the results of sampling.

During each phase of the excavation, sidewall samples will be collected to verify that soils left in place are below the site-specific SSLs for TCE and its daughter products. These samples will be collected after the 10,000-ppbv line has been reached and field screening indicates that the RAOs have been met.

Equipment will be mobilized to the site and an ex-situ SVE treatment area will be constructed within the CAMU. The treatment area is estimated to have a 4,000-cubic-yard capacity and will consist of earthen berms and a heavy plastic (60-mil) liner. A grid of slotted polyvinyl chloride (PVC) pipe will be installed atop the liner in lifts. Soil will be excavated and placed in windrows

on the treatment grid. The slotted pipe will be connected to a manifold that will be connected to a blower and an effluent vapor management system.

Treated soil must meet the soil gas criteria for TCE and the site-specific SSLs, which will be verified through bulk soil sampling. Soil vapors will be monitored to determine the progress of the remediation. Bulk soil samples will be collected after the soil gas criterion of 42 ppbv has been reached. Once this soil passes the bulk soil test, it can be used as backfill material. This cleanup level is protective of groundwater, which is a requirement of the first RAO. Figure 4-4 illustrates the conceptual ex-situ SVE system layout. By stockpiling the ditch soil, sampling and disposing of the soils in an appropriate manor, the second RAO will be meet.

Although the excavation will approach the depth of the water table, it is not anticipated that dewatering activities will be performed at the site. Pumps and holding tanks can be mobilized to the site if a large rain event occurs.

Following backfill, the site will be regraded and restored to match the original site conditions. Once the remedy is completed, long-term engineering and/or institutional controls will be implemented as appropriate to restrict access. Decontamination water will be collected and used for dust control within contaminated areas (i.e., excavation pit, stockpiled soils awaiting treatment) or will be sampled and disposed in an appropriate facility.

Once the excavation has been backfilled, a quarterly monitor program will begin to verify whether rebound has occurred. This will be accomplished via soil gas samples. If rebound has not occurred after one year, bulk soil samples will be collected from the backfill and analyzed by an approved lab. If rebound has occurred, additional steps will be required.

4.4.3.1 Effectiveness Evaluation

The removal and on-site treatment of unsaturated soils will meet RAOs by minimizing current and potential future impact on the surface water and groundwater. Ex-situ treatment also reduces potential for contact by humans by reducing potential impacts to indoor air quality.

4.4.3.1.1 Overall Protection of Human Health and Environment

This alternative will meet all of the RAOs listed in Section 3.2.1 because the soil will be removed and/or treated. The risk of the contaminated soil contributing to groundwater and surface water contamination and the potential risk for human and/or ecological receptors being exposed to contamination through direct waste contact will be minimized.

4.4.3.1.2 Compliance with ARARs

Implementation of Alternative III is anticipated to meet ARARs specific to this alternative, including provisions of WDEQ waste and air quality regulations. An analysis of the remedial alternatives' compliance with ARARs is provided in Tables 4-2, 4-3 and 4-4.

4.4.3.1.3 Long-term Effectiveness

Alternative III will achieve long-term effectiveness by disposing of metals-contaminated surface soil, removing and treating the contaminated unsaturated soil to a level that is protective of groundwater, and placing the treated material back into the excavation. Ex-situ methods enhance the effectiveness of SVE by permitting a larger contaminant surface area to be exposed to treatment. Future impacts to groundwater and surface water will be minimized. The potential for future direct contact with contaminated surface and subsurface soils will also be minimized.

4.4.3.1.4 Reduction of Toxicity, Mobility and Volume Through Treatment

The waste in the excavation area has been determined to contain approximately 2,400 LCY of potentially hazardous soil through previous characterization sampling, surrounded by 9,200 LCY of nonhazardous contaminated soil. Contaminant toxicity reduction is anticipated to occur during ex-situ treatment by removing contaminants from the excavated volume of soil. The volume of contamination is also expected to decrease by capturing VOC contaminants in GAC canisters. Regeneration of the GAC may result in destruction of TCE. Since the long-term effectiveness is comparably higher than in other alternatives, a larger amount of contaminant toxicity and volume reduction is expected for Alternative III. Surface soils, if hauled to an off-site facility, will undergo a reduction in contaminant mobility because the material will be disposed in a landfill with a properly constructed leachate management system.

4.4.3.1.5 Short-term Effectiveness

The short-term effectiveness of Alternative III is evaluated as follows:

Protection of the Community. Removal and treatment activities at Spill Site 7 will pose minimal risk to the public. Material handling activities will be conducted in remote areas where access is limited to trained workers, thereby minimizing exposure to occasional site visitors.

Engineering controls and monitoring programs implemented during Alternative III construction and operation will ensure protection of workers and the local communities from potential short-term impacts. Fugitive dust emissions will be controlled following standard dust suppression practices. Effluent vapor emissions will be monitored and controlled using GAC canisters. Once the remedy is completed, institutional controls will be implemented as appropriate to restrict access.

Protection of Workers. The majority of the soil excavation will require use of heavy equipment. Treatment system construction will require mechanical work, heavy equipment use, and hand tool use. Workers implementing the remedial action will have minimal contact with excavated materials. Engineering controls, monitoring, and PPE will be used during all phases to minimize potential worker exposure. The primary risks to workers are fugitive dust, chemical emissions, physical hazards associated with equipment and excavation, and noise levels. These potential risks can be minimized by using OSHA-trained crews and appropriate controls that are standard at hazardous waste and construction sites. Dust suppression activities will be performed to reduce potential inhalation exposures.

Short-term Environmental Impacts. The potential short-term environmental impacts are those resulting from fugitive dust emissions during excavation and backfilling, and chemical emissions during excavation and treatment. Surface water management is also a potential environmental impact. These impacts are considered relatively easy to control through dust suppression, vapor emission control, and engineered run-on/run-off controls.

Time Until Response Objectives are Achieved. Surface sampling and removal of soils with elevated metals are anticipated to take 3 weeks, including laboratory TAT. It is anticipated that

remediation system construction will take approximately 3 weeks to perform per treatment cell phase for an estimated three cell phases. The estimated time for the soil remediation is contingent on the treatment duration for the ex-situ treatment cell. The treatment duration can only be determined from actual site conditions. Assuming a 4,000-cubic-yard treatment area is constructed and the duration of treatment is 3 months, the soil remediation will take approximately 10 months to complete in phases. Backfilling the excavation, site restoration, and system demobilization will be completed in 1 month. Based on these preliminary assumptions, the work will be completed within 10 to 12 months. The treatment duration may be shortened or lengthened depending on observed system effectiveness. An additional year of soil vapor monitoring will be required after system termination to ensure that no contaminant rebound occurs. Rebound will be checked through soil vapor collection using direct-push techniques. If no rebound is exhibited, bulk soil samples will be collected at the end of one year and analyzed for VOCs by an off-site laboratory to confirm completion of the IRA. If rebound does occur, the system will be restarted.

4.4.3.2 Implementability

4.4.3.2.1 Technical Feasibility

Alternative III is considered technically feasible for Spill Site 7. The implementation of this alternative employs proven excavation and treatment equipment and techniques. A conventional excavator and front-end loader will be able to operate at the site.

This alternative is adaptable to varying environmental conditions. Steps will be taken to continuously evaluate the conditions during excavation activities. Should unusual conditions arise, excavation activities will be suspended until the condition can be fully investigated. The equipment proposed for excavation work is capable of breaking through the hard caliche layer present in the proposed excavation area with no modification. The breaking down of the cemented material and general loosening of the soil during excavation will allow for more effective vapor extraction. Run-on control berms will be constructed in appropriate locations to direct and control rainwater during precipitation events.

4.4.3.2.2 Administrative Feasibility

Although permits are not required for on-site removal at this site, the substantive requirements of applicable regulations will be followed. No transportation and/or disposal requirements will need to be met. No building permits will be required for the temporary treatment facilities to be constructed under this alternative.

No easements or right-of-way acquisitions are required on USAF-owned and -controlled property. However, various utilities run through the excavation area. If excavation is required near the utilities, all utilities will be relocated or otherwise isolated and protected during removal and backfilling operations.

Alternative III will not impact adjacent or adjoining properties since the ex-situ remediation of VOC-contaminated soils will remain on-site.

Since the soil will undergo treatment prior to backfilling, no institutional controls and restrictions are anticipated under this alternative. The soil must be adequately sampled to ensure that backfilled treated soil meets the site-specific SSLs.

4.4.3.2.3 Availability of Services and Materials

The equipment, services, and materials necessary to complete this alterative are all readily available. Equipment includes common, heavy earth-moving equipment, available from numerous local equipment rental suppliers. Services for this alternative include subcontracted electrical work, mechanical work, and laboratory services, all of which are readily available in the area. Materials, including blowers, piping, and plastic liner material, are readily available as well.

4.4.3.2.4 State and Community Acceptance

State and community acceptance will be determined based on comments received during the public comment period. A 30-day public comment period will follow submittal of the Final EE/CA to the regulatory agencies. Both EPA Region VIII and WDEQ have been actively involved throughout development of the EE/CA. A Responsiveness Summary will be prepared

to address all significant public comments received and to discuss impacts of the EE/CA and proposed removal action for Spill Site 7.

4.4.3.3 Cost

This section presents the capital cost estimate, O&M cost estimate, and present worth cost estimate for Alternative III.

4.4.3.3.1 Capital Cost Estimate

The capital cost estimate for Alternative III includes expenditures for:

- Mobilization/demobilization,
- Preparation of pre-construction and post-construction reports,
- Removal, stockpiling, and sampling of surface soil along the drainage ditch area,
- Construction of treatment area and staging area(s),
- Construction of treatment system,
- Soil removal and placement,
- Installation of drain piping in excavation bottom,
- Soil treatment,
- Sampling,
- Backfilling,
- Compaction, and
- Site restoration.

The base capital cost for Alternative III is $773,705.

4.4.3.3.2 Operation and Maintenance

Alternative III will require O&M throughout the treatment life. Numerous assumptions were made in the estimating process, including:

- Six months of operating duration,
- Moderate maintenance level,
- Weekly monitoring including air analysis for VOCs, and
- Monthly visit by home office professional.

The cost for O&M under this estimate is $138,247, which includes servicing the GAC units. Other tasks typically associated with O&M, such as charges for electricity, field technician hours, and sampling are included in the capital cost estimate. RACER cost estimating software

does not distinguish O&M separately for shorter duration treatment technologies such as ex-situ SVE.

4.4.3.3.3 Total Present Worth Cost Estimate

The present worth calculation directly adds the estimated O&M cost to the capital cost estimate to obtain a total estimated project cost. Total present worth costs for this alternative are summarized below.

Remedial Option	Total Marked-Up Capital Costs	Operation and Maintenance	Total Remedial Option Cost
Excavation and Ex-situ SVE	$773,705	$138,247	$906,249

Cost reports for Alternative III are included as Appendix E. A 5 percent discount factor is typically included in cost estimates; however, this project is anticipated to begin and be mostly completed in 2003. Therefore no discount rate was applied.

5.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section presents a comparative analysis of the removal action alternatives proposed for Spill Site 7. The analysis is an evaluation of the relative performance of each alternative compared to each of the evaluation criteria. The purpose of the comparative analysis is to identify the advantages and disadvantages of each alternative to provide the basis for selecting a recommended removal action in Section 6.

The comparative analysis uses the same NCP criteria discussed in the detailed analysis of alternatives in Section 4. These criteria are grouped into three categories as follows:

Effectiveness

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness

Implementability

- Technical feasibility
- Administrative feasibility
- Availability of services and materials
- Regulatory and community acceptance

Cost

- Capital cost
- Operation and maintenance
- Present worth cost

Table 5-1 summarizes the comparative analysis of removal actions.

5.1 EFFECTIVENESS

This section compares the effectiveness of each alternative against the five effectiveness criteria outlined above.

5.1.1 Overall Protection of Human Health and the Environment

All three alternatives meet this threshold criterion by providing adequate overall protection of human health and the environment. Site risks are eliminated, reduced, or controlled sufficiently through treatment, engineering, or institutional controls. No unacceptable short-term risks arise from implementation of any of the alternatives. All alternatives reduce the contribution to groundwater from contaminated saturated zone soils and reduce the potential for erosion and transport of surface soils to surface water bodies.

5.1.2 Compliance with ARARs

This is a threshold criterion, and all three alternatives will comply with ARARs in that the alternatives will reduce the potential for groundwater contamination through infiltration and for surface water contamination through runoff. The analysis of each alternative's compliance with potential ARARs is presented in Tables 4-2, 4-3, and 4-4.

5.1.3 Long-Term Effectiveness and Permanence

Alternative I will remove the contaminated unsaturated zone soil from the Spill Site 7 site. Removal of the unsaturated zone soil and backfilling with clean fill reduces the potential for future groundwater or surface water contamination. Alternative II may leave contaminants bound in the less permeable strata and will not completely remove contamination from the low-permeability clays or the caliche layers. SVE is largely ineffective in low-permeability soil horizons. Alternative III will effectively remove most contamination from the caliche layers and other low-permeability materials because the material will be brought above ground and broken up to increase surface area, thus increasing airflow and meeting the treatment objectives. Because a certified clean fill will be used as backfill in Alternative I, there is no possibility for low-level contamination to remain in the excavation area. In all alternatives, a dramatic rise in the groundwater table or migration of contaminated soil vapors could re-introduce contamination to the vadose zone.

Alternative I ranks highest in long-term effectiveness, followed closely by Alternative III. Alternative II is the least effective.

5.1.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

Alternative I would reduce neither the toxicity nor the volume of the unsaturated zone contamination. The contaminant mobility would be reduced with placement of the material in a properly constructed and managed landfill. Alternative II would reduce the toxicity of the contamination by removing volatile contamination from the soil. The volume of contamination would also be reduced by adsorbing the volatile contamination to the GAC. Contaminant mobility would be reduced by placing spent carbon in a landfill or regenerating the carbon for re-use. Regeneration of GAC may result in the destruction of TCE. Alternative III would reduce the toxicity of the contamination by removing the volatile contamination from the soil. Contaminant volume in unsaturated soils would decrease by adsorbing the volatile contamination to the GAC. Contaminant mobility would be reduced by placing spent carbon in a landfill or regenerating it, which may also result in destruction of TCE. Alternative III would reduce the toxicity and volume to a larger degree than Alternative II because it is believed to be the most effective of the treatment options. Alternative III ranks the highest because the treatment is most effective, followed by Alternative I, and finally Alternative II, because the effectiveness is assumed to be low.

5.1.5 Short-Term Effectiveness

Alternatives I and III would present slight increases in risk to the environment associated with potential fugitive dust emissions and contaminated soil erosion and transport as well as hazards associated with surface water infiltration during large precipitation events. These risks can easily be managed with standard engineering controls. Alternative II would present slight increases in risk to the environment associated with vapor emissions from the remediation system effluent. Proper monitoring and maintenance easily prevents such an occurrence. Alternative III also will minimally increase risk during implementation. Fugitive dust, excavation hazards, and vapor emissions are all possible with Alternative III as well, but easily managed with engineering controls. Alternative I ranks highest (most effective) in short-term effectiveness because of the relatively short project duration, followed by Alternative III. Alternative II is the least effective because it has the longest implementation period.

5.2 IMPLEMENTABILITY

This section compares the implementability of each alternative against the four implementability criteria outlined in Section 5.0.

5.2.1 Technical Feasibility

All three alternatives are technically feasible because they use proven techniques and standard equipment and materials. No unusual conditions or practices will be encountered during the implementation of any of the alternatives.

5.2.2 Administrative Feasibility

Alternatives I, II, and III all have minimal administrative issues. Alternative II is the most feasible in that only the soils contaminated with metals would be removed from the area along with drilling waste. Alternatives I, II, and III may have administrative issues related to confirmation sampling and long-term monitoring to track rebound and off-gassing from the groundwater. Alternative I has administrative feasibility issues associated with trucks traveling on and off the base due to heightened security measures. The alternatives ranked from most feasible to least feasible are Alternative II, Alternative III, and Alternative I.

5.2.3 Availability of Services and Materials

All services and materials required for implementation of all four alternatives are readily available within 100 miles of the site. Alternatives I and III will require more heavy equipment use than Alternative II because of the in-situ nature of Alternative II. However, the relatively small size of the project will have no impact on local labor or equipment availability.

5.2.4 State and Community Acceptance

State and community acceptance for the three alternatives is unknown, but is assumed to be equivalent for all three alternatives. A 30-day public comment period will follow submittal of the Final EE/CA to the regulatory agencies. Evaluation of State and community acceptance will be completed after receipt of comments on the EE/CA. Both EPA and WDEQ have been actively involved with the USAF throughout development of the EE/CA.

5.3 COST

Alternative II has the lowest cost by a large margin. Uncertainties associated with implementing Alternative II could cause O&M costs to be significantly higher. Alternative III involves significantly less cost than the off-site disposal option of Alternative I, and similar cost to the WCA disposition option. Both Alternatives I and III show a high degree of success in remedial actions for soils with low permeability.

5.4 CONCLUSIONS

Alternative II, involving in-situ SVE, is the least desirable alternative because of the potential effectiveness limitations associated with implementing the technology in low-permeability soils and caliche layers. It is believed that Alternative II will be less protective of human health and the environment than the other two alternatives because residual contamination will be left in place as opposed to being excavated with the soil. Alternative I, involving excavation and disposal of the entire area including untreated hazardous material to a depth of 15 feet, is also less desirable because of the high capital cost of the alternative and more significant challenges involved with hauling a large volume of VOC-contaminated material off-site. In addition, the toxicity and volume of contaminants are not reduced by Alternative I. Alternative III is recommended as the removal action for Spill Site 7.

6.0 RECOMMENDED REMOVAL ACTION ALTERNATIVE

Alternatives I, II, and III have been analyzed against the NCP criteria listed in Section 4.0 and have been compared against one another in Section 5.0. Based on the comparison in Section 5.0, it is recommended that Alternative III (i.e., surface soil removal and disposal, excavation of subsurface soils, ex-situ SVE, on-site backfilling with treated material) be selected for the remedial action proposed at Spill Site 7. The primary difference between the three alternatives evaluated for this site under this EE/CA is effectiveness.

Implementability

Each alternative has administrative challenges associated with confirmation sampling to verify that the treated soils are sufficiently clean to use as backfill. Alternative I has an additional challenge of transporting waste off-site.

Effectiveness

Alternatives I and III are the most effective because the contaminated soil is completely removed. In the case of Alternative I, the soil is removed from the site. In the case of Alternative III, the soil is excavated, thereby exposing the low-permeability soils and increasing SVE effectiveness.

- Long-term effectiveness and permanence — Excavation and removal is the most effective because it will completely remove the low-permeability caliche layers, which are believed to contain high contaminant levels and are not amenable to in-situ SVE. Excavation and ex-situ treatment is the next most effective. Future groundwater contamination may occur from material remaining on-site from Alternative II due to its lower effectiveness.

- Reduction of mobility — Alternative I reduces the contaminant mobility by placing the material in an approved landfill facility. It does not reduce the toxicity or volume of contamination. Alternative III reduces toxicity and volume by concentrating contaminants in a small volume of GAC. Regeneration of GAC may result in destruction of the TCE.

Cost

Alternative III is the lower cost alternative of the two most effective alternatives (I and III).

- Capital Cost — Alternative I has significantly higher capital cost because of the expense of off-site hazardous waste disposal.

- O&M Cost — No O&M cost is associated with Alternative I, but relatively small O&M cost is associated with Alternative III.

Because of its high effectiveness and relatively low cost when compared to Alternative I, Alternative III is selected as the removal action for Spill Site 7.

6.1 SCOPE OF SELECTED REMOVAL ACTION

Implementation of the removal action will include the following field activities:

- Mobilization,
- Site preparation,
- Excavation of metals-contaminated surface soils and sampling of stockpiled soils,
- Excavation of VOC-contaminated subsurface soil,
- Treatment of VOC-contaminated material with ex-situ SVE,
- Collection of confirmation samples,
- Quarterly monitoring for rebound,
- Backfilling the excavation with treated material,
- Site restoration including removal of the treatment system, and
- Equipment decontamination and demobilization.

These activities are described below.

Mobilization

All necessary personnel, equipment, and materials will be mobilized to the site. Nearby temporary storage and office facilities will be established. Equipment decontamination and material staging areas will be delineated. Administrative issues will be resolved prior to completion of mobilization.

Site Preparation

Vegetative material will be removed from the site. Decontamination facilities, the SVE system, and material storage facilities will be constructed. Engineering controls, including dust suppression equipment and run-on/runoff control and berms, will be constructed. Any temporary haul roads required will be constructed as well.

Excavation of Metals-contaminated Surface Soil and Sampling of Stockpiled Soils

The top 12 inches of soil from the sidewalls and floor of the ditch will be scraped and stockpiled in a containment area. Two five-point bulk soil composite samples will be collected and analyzed for TCLP metals. The samples will be sent to an approved laboratory facility with an accelerated TAT to facilitate disposal if warranted. If the soil fails TCLP criteria, the soil will be hauled to an off-site facility approved to accept hazardous material. If the soil passes the TCLP criteria, the material will be staged and will be used as backfill.

Excavation of VOC-contaminated Subsurface Soil

The VOC-contaminated material, consisting of an estimated 11,600 LCY of material in the area exhibiting the highest soil gas readings (10,000 ppbv soil gas boundary), will be excavated and staged on-site within the footprint of the CAMU. Excavations beyond the soil gas boundary limits in the sidewalls will be delineated in the field using headspace readings from a PID. This will provide a mechanism for field decisions to chase or follow preferential contaminant pathways not detected in the RI surface investigations.

A review of the geologic logs from Spill Site 7 soil boring and well installation activities and of the soil gas sampling results indicates that a field headspace reading of 1,000 ppm will be effective to delineate the most-contaminated area. All locations with soil gas readings above 10,000 ppbv were accompanied by field headspace readings above 1,000 ppm. Therefore soils exhibiting greater than 1,000 ppm total VOCs in temperature-stabilized headspace samples will be excavated for treatment. This excavation criterion will be re-evaluated during the excavation activities to ensure that it is appropriate. Any changes in the criteria will be presented to the regulatory agencies for approval prior to implementation. The excavated soil will be spread in windrows in constructed ex-situ SVE treatment cells. Air monitoring will be conducted during all excavation activities.

Treatment of VOC-contaminated Material with Ex-situ SVE

Soils to be treated by ex-situ SVE will be placed in a containment area that is constructed of berms covered with an impermeable layer with a manifold of slotted PVC pipe placed between

the lifts of soil. The windrows will be covered to minimize migration of soil from erosion and direct contact, but the covers will allow for air movement from the exterior to the PVC manifold. Blowers connected to the manifold will draw air through the soil, removing volatile contaminants. The system effluent will be captured in GAC canisters that will remove volatiles from the air stream. Effluent soil gas entering the GAC canisters will be monitored to determine the progress of the remediation. A target of 42 ppbv has been set to determine when soils have reached a level that would be protective of groundwater.

Henry's law can be used to define the equilibrium concentration of water with respect to vapor in accordance with the equation below (ASTM 1995):

$$C_{v,\,eq} = H\, C_{w,eq}$$

where

$C_{v,\,eq}$ = equilibrium vapor concentration, ppb-vapor
$C_{w,eq}$ = equilibrium dissolved concentration, ppb-water
H = Henry's Law Constant, (ppb-vapor)/(ppb-water)

From the literature, H = 0.422 for TCE (EPA 1996). Note that units on $C_{v,\,eq}$ and $C_{w,eq}$ must be consistent to avoid conversion factors and that the Henry's Law constant is functionally unitless.

The *Soil Screening Guidance, User's Guide* (EPA 1996) recommends a default DAF of 20, which is the dilution that can be attributed to a leachate that is protective of groundwater. Using this relationship and the MCL of 5 ppb for TCE in drinking water yields:

Acceptable leachate concentration = MCL x DAF = 5 ppb x 20 = 100 ppb

Setting the acceptable leachate concentration equal to $C_{w,eq}$ and using the H described above yields:

$$C_{v,\,eq} = 0.422*100 \text{ ppb} = 42 \text{ ppb-vapor}$$

Therefore, based on this evaluation, the contaminated vadose zone soils will have a treatment end point of 42 µg/L in vapor. Once this end point is reached, bulk soil samples will be collected

and analyzed to verify that VOC levels in the soils have met the first RAO and to verify that the soils can be returned to the excavation are protective of human health, the environment and groundwater. This process will be repeated until all of the soil in the area of interest has been addressed.

Collection of Confirmation Samples

In addition to the above soil samples, sidewall samples will be collected to verify that soil left in place will be protective to the environment and groundwater systems. This will be completed after field screening techniques indicated that the excavation goals have been met.

Once the remediation has been completed and the soil has been returned to the excavation, confirmation samples will also be collected under the stockpile and treatment areas. These samples will be analyzed for VOCs by an approved laboratory.

An additional year of soil vapor monitoring will be required after system termination to ensure that contaminant rebound has not occurred. Rebound will be checked through soil vapor collection using direct-push techniques. If no rebound is exhibited, bulk soil samples will be collected at the end of one year and analyzed for VOCs by an off-site laboratory to confirm completion of the IRA. If rebound does occur, the system will be re-started.

Backfilling the Excavation with Treated Material

Following completion of the confirmation sampling of the treatment cell soils verifying that soils are at or below the site-specific SSLs, the excavation will be backfilled with treated material. The material will be placed in 1-foot compacted lifts to ground surface.

Site Restoration, Including Removal of the Treatment System

All haul roads will be removed from the site. The earthen berms for the SVE system and the staging area will be removed. Piping and associated treatment system materials will be disposed according to all applicable regulations. Vegetative cover will be placed to match existing site conditions.

Equipment Decontamination and Demobilization

Decontamination water will be collected and used for dust control within contaminated areas (i.e., excavation pit, stockpiled soils awaiting treatment) or will be sampled and disposed in an appropriate facility. Equipment used on-site will be decontaminated prior to demobilization. All spent GAC canisters, decontamination water, PPE, and any generated investigation-derived waste will be disposed according to all applicable regulations. The decontamination pad and any temporary facilities will be removed, and the site restored to match pre-implementation conditions.

7.0 PILOT STUDY – REDUCTIVE DECHLORINATION IN THE UPPERMOST SATURATED ZONE

A pilot study is being proposed to minimize recontamination of treated soils from gases originating from the groundwater and/or from direct contact from the fluctuating groundwater water table. This pilot study will take advantage of the open hole during excavation to place slotted PVC piping and gravel pack below the remediated soils and use this piping to inject treatment material, such as Hydrogen Release Compound® (HRC®).

Once sufficient material is excavated, slotted Schedule 80 PVC drain pipe and a 1-foot gravel pack will be placed in the bottom of the excavation. After implementing the removal action and backfilling the excavation, the piping will be used to introduce a hydrogen donor such as HRC or sodium lactate to the capillary fringe to facilitate reductive dechlorination in the saturated soils and associated groundwater. This in-situ application will be conducted to minimize the potential for recontamination of the treated soil through groundwater fluctuations and vapor migration. Approximately 10 rows of the slotted drain pipe will be placed in the excavation. Both ends of the slotted pipe will be fitted with elbows, and a vertical section of Schedule 80 pipe will be installed to approximately 2 feet above grade. Once the sections of piping are installed, a 1-foot gravel pack will be placed over the piping to facilitate the dispersion of the hydrogen donor to protect the PVC during backfill operations and to act as a vapor collection medium.

Injection of HRC® is a demonstrated technology for reducing TCE in saturated soil and groundwater. It is effective at reducing the levels of sorbed and dissolved phase TCE and may be effective on small amounts of residual NAPL as well. Bench-scale testing using sodium lactate has demonstrated that this may be a low-cost alternative to HRC®. For planning purposes, HRC® will be presented as the selected injection medium. However, based on further bench testing and cost evaluation, FEW may request that sodium lactate be employed instead of HRC®.

Approximately 2,300 pounds of HRC® will be mixed into a liquid solution and pumped into the drainpipe network. This will address contamination at the top of the saturated soil. Following the HRC® injection, the pipe network will be flushed with a surge of clean water in two separate

events to force some mixing of the HRC® with the material in the upper saturated zone. Nearby wells will be monitored for a 9-month period to assess the need for a re-application of HRC®. It is anticipated that a reduction in TCE levels in the groundwater will be apparent within the first 6 months of the monitoring period.

The substantive requirements of the WDEQ's underground injection control program will be met during the injection of the HRC®. Because this is not a recurrent injection, it is considered a pilot-scale project with minimal regulatory requirements.

Appendix F contains separate costing for the HRC® application.

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TABLES

TABLE 2-1
U.S. FISH & WILDLIFE SERVICE DESIGNATED ENDANGERED OR THREATENED SPECIES INHABITING SOUTHEASTERN WYOMING
SPILL SITE 7 - F.E. WARREN AFB

Common Name	Scientific Name	Family	Group	Historic Range	Designation	Designated Since
Bald eagle	*Haliaeetus leucocephalus*	Accipitridae	Birds	North America south to northern Mexico	Threatened	07/12/1995
American peregrine falcon	*Falco peregrinus anatum*	Falconidae	Birds	Nests from central Alaska across north-central Canada to central Mexico, winters to South America	Delisted Taxon, Recovered, Being Monitored First Five Years	08/25/1999
Whooping crane	*Grus americana*	Gruidae	Birds	Canada, U.S.A. (Rocky Mountains east to Carolinas), Mexico	Endangered	03/11/1967
Black-footed ferret	*Mustela nigripes*	Mustelidae	Mammals	Western U.S.A., western Canada	Endangered	03/11/1967
Toad, Wyoming	*Bufo hemiophrys baxteri*	Bufonidae	Amphibians	U.S.A. (WY)	Endangered	01/17/1984
Mouse, Preble's meadow jumping	*Zapus hudsonius preblei*	Zapodidae	Mammals	U.S.A. (CO, WY)	Threatened	05/13/1998
Greenback cutthroat trout	*Oncorhynchus clarki stomias*	Salmonidae	Fishes	U.S.A. (CO, WY)	Threatened	04/18/1978
Butterfly plant, Colorado	*Gaura neomexicana coloradensis*	Onagraceae	Flowering Plants	U.S.A. (CO, NE, WY)	Threatened	10/18/2000

TABLE 2-2
DETECTIONS OF ORGANIC COMPOUNDS IN SOIL GAS
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (ppbv)	RL (ppbv)
SS7SG01A 4/2/2001	10	TO14	cis-1,2-Dichloroethylene	11,000	120
	10	TO14	trans-1,2-Dichloroethene	280	120
	10	TO14	Trichloroethylene (TCE)	89,000	120
SS7SG01B 4/2/2001	16	TO14	cis-1,2-Dichloroethylene	570	14
	16	TO14	m,p-Xylene (Sum Of Isomers)	36	14
	16	TO14	o-Xylene (1,2-Dimethylbenzene)	16	14
	16	TO14	Toluene	58	14
	16	TO14	Trichloroethylene (TCE)	9,800	14
SS7SG01C 4/10/2001	21	TO14	cis-1,2-Dichloroethylene	150	5
	21	TO14	Toluene	6.2	5
	21	TO14	Trichloroethylene (TCE)	1,100	5
SS7SG02A 4/2/2001	10	TO14	cis-1,2-Dichloroethylene	1,800	56
	10	TO14	Toluene	64	56
	10	TO14	Trichloroethylene (TCE)	40,000	56
SS7SG02B 4/2/2001	17	TO14	cis-1,2-Dichloroethylene	1,000	20
	17	TO14	Toluene	34	20
	17	TO14	Trichloroethylene (TCE)	14,000	20
SS7SG03A 4/2/200	10	TO14	cis-1,2-Dichloroethylene	160	6.6
	10	TO14	Ethylbenzene	6.9	6.6
	10	TO14	m,p-Xylene (Sum Of Isomers)	20	6.6
	10	TO14	o-Xylene (1,2-Dimethylbenzene)	8.5	6.6
	10	TO14	Toluene	30	6.6
	10	TO14	Trichloroethylene (TCE)	4,700	6.6
SS7SG03B 4/2/2001	20	TO14	cis-1,2-Dichloroethylene	130	7.2
	20	TO14	m,p-Xylene (Sum Of Isomers)	12	7.2
	20	TO14	Toluene	16	7.2
	20	TO14	Trichloroethylene (TCE)	5,400	7.2
SS7SG04A 4/2/2001	10	TO14	m,p-Xylene (Sum Of Isomers)	8.1	5
	10	TO14	Toluene	12	5
	10	TO14	Trichloroethylene (TCE)	210	5
SS7SG05A 4/3/2001	8	TO14	cis-1,2-Dichloroethylene	1,200	12
	8	TO14	m,p-Xylene (Sum Of Isomers)	15	12
	8	TO14	Toluene	13	12
	8	TO14	Trichloroethylene (TCE)	9,000	12
SS7SG05A (FD) 4/3/2001	8	TO14	cis-1,2-Dichloroethylene	1,100	12
	8	TO14	Toluene	14	12
	8	TO14	Trichloroethylene (TCE)	8,400	12
SS7SG05B 4/3/2001	13.5	TO14	cis-1,2-Dichloroethylene	34	5
	13.5	TO14	m,p-Xylene (Sum Of Isomers)	9.2	5
	13.5	TO14	Methylene Chloride	6.3	5
	13.5	TO14	Toluene	14	5
	13.5	TO14	Trichloroethylene (TCE)	440	5
SS7SG07A 4/3/2001	10	TO14	cis-1,2-Dichloroethylene	27,000	170
	10	TO14	trans-1,2-Dichloroethene	350	170
	10	TO14	Trichloroethylene (TCE)	120,000	170

TABLE 2-2
DETECTIONS OF ORGANIC COMPOUNDS IN SOIL GAS
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (ppbv)	RL (ppbv)
SS7SG07B 4/3/2001	20	TO14	cis-1,2-Dichloroethylene	5,900	910
	20	TO14	Trichloroethylene (TCE)	650,000	910
SS7SG08A 4/3/2001	10	TO14	cis-1,2-Dichloroethylene	39	8.4
	10	TO14	m,p-Xylene (Sum Of Isomers)	22	8.4
	10	TO14	Toluene	32	8.4
	10	TO14	Trichloroethylene (TCE)	5,500	8.4
SS7SG08B 4/3/2001	16	TO14	cis-1,2-Dichloroethylene	35	10
	16	TO14	m,p-Xylene (Sum Of Isomers)	20	10
	16	TO14	Toluene	28	10
	16	TO14	Trichloroethylene (TCE)	6,900	10
SS7SG09A 4/3/2001	10	TO14	cis-1,2-Dichloroethylene	2,000	50
	10	TO14	Trichloroethylene (TCE)	34,000	50
SS7SG09B 4/3/2001	19	TO14	Benzene	5.2	5
	19	TO14	cis-1,2-Dichloroethylene	51	5
	19	TO14	m,p-Xylene (Sum Of Isomers)	11	5
	19	TO14	Toluene	16	5
	19	TO14	Trichloroethylene (TCE)	2,100	5
SS7SG10A 4/3/2001	10	TO14	cis-1,2-Dichloroethylene	20	5
	10	TO14	Ethylbenzene	9.8	5
	10	TO14	m,p-Xylene (Sum Of Isomers)	36	5
	10	TO14	o-Xylene (1,2-Dimethylbenzene)	13	5
	10	TO14	Toluene	54	5
	10	TO14	Trichloroethylene (TCE)	2,200	5
SS7SG10B 4/3/2001	19	TO14	Benzene	8	5
	19	TO14	cis-1,2-Dichloroethylene	8.2	5
	19	TO14	m,p-Xylene (Sum Of Isomers)	11	5
	19	TO14	Toluene	23	5
	19	TO14	Trichloroethylene (TCE)	470	5
SS7SG11A 4/3/2001	10	TO14	m,p-Xylene (Sum Of Isomers)	10	5
	10	TO14	Toluene	15	5
	10	TO14	Trichloroethylene (TCE)	230	5
SS7SG11B 4/3/2001	18	TO14	m,p-Xylene (Sum Of Isomers)	7.4	5
	18	TO14	Toluene	9.9	5
	18	TO14	Trichloroethylene (TCE)	130	5
SS7SG12A 4/3/2001	10	TO14	m,p-Xylene (Sum Of Isomers)	8.2	5
	10	TO14	Toluene	14	5
	10	TO14	Trichloroethylene (TCE)	170	5
SS7SG12B 4/3/2001	18	TO14	m,p-Xylene (Sum Of Isomers)	5.9	5
	18	TO14	Toluene	11	5
	18	TO14	Trichloroethylene (TCE)	100	5
SS7SG13A 4/3/2001	10	TO14	m,p-Xylene (Sum Of Isomers)	9	5
	10	TO14	Toluene	14	5
	10	TO14	Trichloroethylene (TCE)	66	5
SS7SG13B (FD) 4/3/2001	19.5	TO14	m,p-Xylene (Sum Of Isomers)	10	5

TABLE 2-2
DETECTIONS OF ORGANIC COMPOUNDS IN SOIL GAS
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (ppbv)	RL (ppbv)
SS7SG13B (FD) 4/3/2001 (cont.)	19.5	TO14	Toluene	16	5
	19.5	TO14	Trichloroethylene (TCE)	53	5
SS7SG14A 4/4/2001	10	TO14	m,p-Xylene (Sum Of Isomers)	5.6	5
	10	TO14	Toluene	10	5
	10	TO14	Trichloroethylene (TCE)	22	5
SS7SG15A 4/4/2001	10	TO14	cis-1,2-Dichloroethylene	12,000	25
	10	TO14	trans-1,2-Dichloroethene	580	25
	10	TO14	Trichloroethylene (TCE)	17,000	25
SS7SG15B 4/4/2001	19.5	TO14	cis-1,2-Dichloroethylene	120	5
	19.5	TO14	m,p-Xylene (Sum Of Isomers)	5.7	5
	19.5	TO14	Toluene	10	5
	19.5	TO14	trans-1,2-Dichloroethene	5.2	5
	19.5	TO14	Trichloroethylene (TCE)	630	5
SS7SG15B (FD) 4/4/2001	19.5	TO14	cis-1,2-Dichloroethylene	190	5
	19.5	TO14	m,p-Xylene (Sum Of Isomers)	6.8	5
	19.5	TO14	Toluene	10	5
	19.5	TO14	trans-1,2-Dichloroethene	6.4	5
	19.5	TO14	Trichloroethylene (TCE)	1,100	5
SS7SG16A 4/4/2001	10	TO14	cis-1,2-Dichloroethylene	270	5
	10	TO14	m,p-Xylene (Sum Of Isomers)	5.9	5
	10	TO14	Toluene	9.3	5
	10	TO14	trans-1,2-Dichloroethene	8	5
	10	TO14	Trichloroethylene (TCE)	1,000	5
SS7SG16B 4/4/2001	16	TO14	cis-1,2-Dichloroethylene	210,000	3,600
	16	TO14	trans-1,2-Dichloroethene	5,200	3,600
	16	TO14	Trichloroethylene (TCE)	2,700,000	3,600
SS7SG16B (FD) 4/4/2001	16	TO14	cis-1,2-Dichloroethylene	220,000	4,200
	16	TO14	trans-1,2-Dichloroethene	5,200	4,200
	16	TO14	Trichloroethylene (TCE)	3,000,000	4,200
SS7SG17A 4/4/2001	12	TO14	cis-1,2-Dichloroethylene	700	33
	12	TO14	Trichloroethylene (TCE)	21,000	33
SS7SG17B 4/4/2001	22	TO14	cis-1,2-Dichloroethylene	540	25
	22	TO14	Trichloroethylene (TCE)	18,000	25
SS7SG18A 4/16/2001	10	TO14	cis-1,2-Dichloroethylene	31,000	2,000
	10	TO14	Trichloroethylene (TCE)	1,700,000	2,000
SS7SG18B 4/16/2001	15	TO14	cis-1,2-Dichloroethylene	51,000	4,000
	15	TO14	Trichloroethylene (TCE)	2,600,000	4,000
SS7SG19A 4/16/2001	10	TO14	cis-1,2-Dichloroethylene	17,000	36
	10	TO14	trans-1,2-Dichloroethene	730	36
	10	TO14	Trichloroethylene (TCE)	28,000	36
SS7SG19A (FD) 4/16/2001	10	TO14	cis-1,2-Dichloroethylene	16,000	36
	10	TO14	trans-1,2-Dichloroethene	720	36
	10	TO14	Trichloroethylene (TCE)	26,000	36

TABLE 2-2
DETECTIONS OF ORGANIC COMPOUNDS IN SOIL GAS
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (ppbv)	RL (ppbv)
SS7SG19B 4/16/2001	20	TO14	cis-1,2-Dichloroethylene	56	5
	20	TO14	m,p-Xylene (Sum Of Isomers)	11	5
	20	TO14	o-Xylene (1,2-Dimethylbenzene)	5	5
	20	TO14	Toluene	16	5
	20	TO14	Trichloroethylene (TCE)	560	5
SS7SG20A 4/16/2001	10	TO14	Benzene	14	5
	10	TO14	Ethylbenzene	6	5
	10	TO14	m,p-Xylene (Sum Of Isomers)	15	5
	10	TO14	o-Xylene (1,2-Dimethylbenzene)	7.3	5
	10	TO14	Toluene	21	5
	10	TO14	Trichloroethylene (TCE)	10	5
SS7SG20B 4/16/2001	16	TO14	m,p-Xylene (Sum Of Isomers)	6.1	5
	16	TO14	Toluene	8.8	5
	16	TO14	Trichloroethylene (TCE)	290	5
SS7SG25A 5/21/2001	9.5 - 10	TO14	Methylene Chloride	6.3	5
	9.5 - 10	TO14	Tetrachloroethylene(Pce)	5.6	5
	9.5 - 10	TO14	Toluene	12	5
	9.5 - 10	TO14	Trichloroethylene (TCE)	360	5
SS7SG25B 5/21/2001	17.5 - 18	TO14	Trichloroethylene (TCE)	32	5
SS7SG26B 5/21/2001	18.5 - 19	TO14	Toluene	5.3	5
	18.5 - 19	TO14	Trichloroethylene (TCE)	22	5
SS7SG27A 5/21/2001	9.5 - 10	TO14	Trichloroethylene (TCE)	390	5
SS7SG27B 5/21/2001	17.5 - 18	TO14	cis-1,2-Dichloroethylene	18	5
	17.5 - 18	TO14	Methylene Chloride	48	5
	17.5 - 18	TO14	Tetrachloroethylene(Pce)	14	5
	17.5 - 18	TO14	Toluene	23	5
	17.5 - 18	TO14	Trichloroethylene (TCE)	170	5
SS7SG28A 5/21/2001	14.5 - 15	TO14	m,p-Xylene (Sum Of Isomers)	10	5
	14.5 - 15	TO14	Toluene	70	5
	14.5 - 15	TO14	Trichloroethylene (TCE)	16	5
SS7SG28B 5/21/2001	17.5 - 18	TO14	Methylene Chloride	17	5
	17.5 - 18	TO14	Toluene	34	5
	17.5 - 18	TO14	Trichloroethylene (TCE)	35	5
SS7SG41A 4/3/2001	10	TO14	cis-1,2-Dichloroethylene	15	5
	10	TO14	m,p-Xylene (Sum Of Isomers)	9.4	5
	10	TO14	Toluene	14	5
	10	TO14	Trichloroethylene (TCE)	110	5

TABLE 2-2
DETECTIONS OF ORGANIC COMPOUNDS IN SOIL GAS
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (ppbv)	RL (ppbv)
SS7SG41B 4/3/2001	18	TO14	cis-1,2-Dichloroethylene	91.0	5
	18	TO14	m,p-Xylene (Sum Of Isomers)	9.8	5
	18	TO14	Methylene Chloride	5.4	5
	18	TO14	Toluene	14	5
	18	TO14	Trichloroethylene (TCE)	2,300	5

Notes:

ppbv = parts per billion of volume

RL = reporting limit

FD = field duplicate

Values shown represent screening level data and have not been validated.

TABLE 2-3
DETECTIONS OF INORGANIC COMPOUNDS IN SURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SS01	0-2	SW6010	Aluminum	7,550			24	78,000	8,370	--	--
5/16/2001	0-2	SW6010	Antimony	0.59	J	F	1.1	31	0.47	13	--
	0-2	SW6010	**Arsenic**	**2.1**			1.1	0.43	1.7	0.026	100
	0-2	SW6010	Barium	62			0.54	5,500	121	2,100	2,000
	0-2	SW6010	Beryllium	0.44			0.027	160	0.79	1,200	--
	0-2	SW6010	Calcium	3,400			11	--	13,000	--	--
	0-2	SW6010	Chromium, Total	9.5			0.27	230	8.1	42	100
	0-2	SW6010	Cobalt	2.9			0.27	1,600	4.2	--	--
	0-2	SW6010	Copper	5.2			1.1	3,100	6.4	11,000	--
	0-2	SW6010	Iron	7,530			3.2	47,000	8,640	--	--
	0-2	SW6010	Lead	4.4			1.1	--	9	--	100
	0-2	SW6010	Magnesium	2,500			27	--	2,690	--	--
	0-2	SW6010	Manganese	95			0.54	1,600	255	950	--
	0-2	SW6010	Nickel	5.0			2.2	1,600	4.9	--	--
	0-2	SW6010	Potassium	1,600			54	--	2,500	--	--
	0-2	SW6010	Selenium	2.2			1.1	390	0.25	19	20
	0-2	SW6010	Sodium	72.2			11	--	357	--	--
	0-2	SW6010	Vanadium	18			0.54	550	18.1	5,100	--
	0-2	SW6010	Zinc	18			1.1	23,000	32	14,000	--
SS7SS02	0-1	SW6010	Aluminum	22,100			24	78,000	8,370	--	--
6/20/2001	0-1	SW6020	**Arsenic**	**2.81**			0.56	0.43	1.7	0.026	100
	0-1	SW6010	Barium	410			0.56	5,500	121	2,100	2,000
	0-1	SW6010	Beryllium	1.0			0.028	160	0.79	1,200	--
	0-1	SW6010	Cadmium	6.88			0.11	39	1	27	20
	0-1	SW6010	Calcium	42,000			11	--	13,000	--	--
	0-1	SW6010	**Chromium, Total**	**49**			0.28	230	8.1	42	100
	0-1	SW6010	Cobalt	4.3			0.28	1,600	4.2	--	--
	0-1	SW6010	Copper	480			1.1	3,100	6.4	11,000	--
	0-1	SW6010	Iron	16,200			3.3	47,000	8,640	--	--
	0-1	SW6020	Lead	168			5.6	--	9	--	100
	0-1	SW6010	Magnesium	7,100			28	--	2,690	--	--
	0-1	SW6010	Manganese	230			0.56	1,600	255	950	--
	0-1	SW6010	Molybdenum	0.72	J	F	2.2	390	2	--	--
	0-1	SW6010	Nickel	12			2.2	1,600	4.9	--	--
	0-1	SW6010	Potassium	4,200			56	--	2,500	--	--

TABLE 2-3
DETECTIONS OF INORGANIC COMPOUNDS IN SURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SS02	0-1	SW6020	Selenium	0.321			0.22	390	0.25	19	20
6/20/2001	0-1	SW6010	Silver	0.20	J	F	0.56	390	1.5	31	100
(cont.)	0-1	SW6010	Sodium	71.9			11	--	357	--	--
	0-1	SW6020	Thallium	0.202			0.11	5.5	0.25	3.6	--
	0-1	SW6010	Vanadium	29			0.56	550	18.1	5,100	--
	0-1	SW6010	Zinc	600			1.1	23,000	32	14,000	--
SS7SS06	0-1	SW6010	Aluminum	17,900			26	78,000	8,370	--	--
6/14/2001	0-1	SW6020	Arsenic	1.35			0.58	0.43	1.7	0.026	100
	0-1	SW6010	Barium	130			0.58	5,500	121	2,100	200
	0-1	SW6010	Beryllium	0.82			0.029	160	0.79	1,200	--
	0-1	SW6010	Calcium	7,200			12	--	13,000	--	--
	0-1	SW6010	Chromium, Total	12			0.29	230	8.1	42	100
	0-1	SW6010	Cobalt	5.5			0.29	1,600	4.2	--	--
	0-1	SW6010	Copper	7.1			1.2	3,100	6.4	11,000	--
	0-1	SW6010	Iron	13,600			3.5	47,000	8,640	--	--
	0-1	SW6020	Lead	6.73			0.58	--	9	--	100
	0-1	SW6010	Magnesium	4,200			29	--	2,690	--	--
	0-1	SW6010	Manganese	210			0.58	1,600	255	950	--
	0-1	SW6010	Nickel	7.3			2.3	1,600	4.9	--	--
	0-1	SW6010	Potassium	2,900			58	--	2,500	--	--
	0-1	SW6020	Selenium	0.263			0.23	390	0.25	19	20
	0-1	SW6010	Sodium	47.9			12	--	357	--	--
	0-1	SW6020	Thallium	0.166			0.12	5.5	0.25	3.6	--
	0-1	SW6010	Vanadium	23			0.58	550	18.1	5,100	--
	0-1	SW6010	Zinc	38			1.2	23,000	32	14,000	--
SS7SS16	0-2	SW6010	Aluminum	13,100			25	78,000	8,370	--	--
4/5/2001	0-2	SW6020	**Arsenic**	**2.08**			0.57	0.43	1.7	0.026	100
	0-2	SW6010	Barium	140	J	M	0.57	5,500	121	2,100	2,000
	0-2	SW6010	Beryllium	0.56			0.029	160	0.79	1,200	--
	0-2	SW6010	Cadmium	0.0441	J	F	0.11	39	1	27	20
	0-2	SW6010	Calcium	24,000			11	--	13,000	--	--
	0-2	SW6010	Chromium, Total	8.5			0.29	230	8.1	42	100
	0-2	SW6010	Cobalt	4.0			0.29	1,600	4.2	--	--
	0-2	SW6010	Copper	6.3			1.1	3,100	6.4	11,000	--
	0-2	SW6010	Iron	9,490			3.4	47,000	8,640	--	--

TABLE 2-3
DETECTIONS OF INORGANIC COMPOUNDS IN SURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SS16	0-2	SW6020	Lead	5.75	J	M	0.57	--	9	--	100
4/5/2001	0-2	SW6010	Magnesium	4,100			29	--	2,690	--	--
(cont.)	0-2	SW6010	Manganese	180			0.57	1,600	255	950	--
	0-2	SW6010	Nickel	5.5			2.3	1,600	4.9	--	--
	0-2	SW6010	Potassium	2,700			57	--	2,500	--	--
	0-2	SW6020	Selenium	0.334			0.23	390	0.25	19	20
	0-2	SW6010	Sodium	53.6			11	--	357	--	--
	0-2	SW6020	Thallium	0.151			0.11	5.5	0.25	3.6	--
	0-2	SW6010	Vanadium	21			0.57	550	18.1	5,100	--
	0-2	SW6010	Zinc	28			1.1	23,000	32	14,000	--
SS7SS18	0-2	SW6010	Aluminum	6,610			23	78,000	8,370	--	--
4/16/2001	0-2	SW6020	Antimony	0.184	J	F	0.21	31	0.47	13	--
	0-2	SW6020	Arsenic	0.539			0.53	0.43	1.7	0.026	100
	0-2	SW6010	Barium	68			0.53	5,500	121	2,100	2,000
	0-2	SW6010	Beryllium	0.42			0.027	160	0.79	1,200	--
	0-2	SW6010	Calcium	2,100			11	--	13,000	--	--
	0-2	SW6010	Chromium, Total	10			0.27	230	8.1	42	100
	0-2	SW6010	Cobalt	2.5			0.27	1,600	4.2	--	--
	0-2	SW6010	Copper	4.4			1.1	3,100	6.4	11,000	--
	0-2	SW6010	Iron	8,090			3.2	47,000	8,640	--	--
	0-2	SW6020	Lead	2.05			0.53	--	9	--	100
	0-2	SW6010	Magnesium	2,300			27	--	2,690	--	--
	0-2	SW6010	Manganese	68			0.53	1,600	255	950	--
	0-2	SW6010	Nickel	4.5			2.1	1,600	4.9	--	--
	0-2	SW6010	Potassium	1,600			53	--	2,500	--	--
	0-2	SW6020	Selenium	0.195	J	F	0.21	390	0.25	19	20
	0-2	SW6010	Sodium	40.5			11	--	357	--	--
	0-2	SW6010	Vanadium	19			0.53	550	18.1	5,100	--
	0-2	SW6010	Zinc	16			1.1	23,000	32	14,000	--
SS7SS26	0-1	SW6010	Aluminum	12,500			24	78,000	8,370	--	--
6/14/2001	0-1	SW6020	**Arsenic**	**2.30**			0.55	0.43	1.7	0.026	100
	0-1	SW6010	Barium	110			0.55	5,500	121	2,100	2,000
	0-1	SW6010	Beryllium	0.63			0.027	160	0.79	1,200	--
	0-1	SW6010	Cadmium	0.311			0.11	39	1	27	20
	0-1	SW6010	Calcium	22,000			11	--	13,000	--	--

TABLE 2-3
DETECTIONS OF INORGANIC COMPOUNDS IN SURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SS26	0-1	SW6010	Chromium, Total	9.8			0.27	230	8.1	42	100
6/14/2001	0-1	SW6010	Cobalt	3.9			0.27	1,600	4.2	--	--
(cont.)	0-1	SW6010	Copper	14			1.1	3,100	6.4	11,000	--
	0-1	SW6010	Iron	10,400			3.3	47,000	8,640	--	--
	0-1	SW6020	Lead	56.2			0.55	--	9	--	100
	0-1	SW6010	Magnesium	3,900			27	--	2,690	--	--
	0-1	SW6010	Manganese	210			0.55	1,600	255	950	--
	0-1	SW6010	Nickel	6.8			2.2	1,600	4.9	--	--
	0-1	SW6010	Potassium	2,500			55	--	2,500	--	--
	0-1	SW6020	Selenium	0.233			0.22	390	0.25	19	20
	0-1	SW6010	Sodium	65.8			11	--	357	--	--
	0-1	SW6020	Thallium	0.129			0.11	5.5	0.25	3.6	--
	0-1	SW6010	Vanadium	23			0.55	550	18.1	5,100	--
	0-1	SW6010	Zinc	82			1.1	23,000	32	14,000	--
SS7SS33	0-1	SW6010	Aluminum	15,500			23	78,000	8,370	--	--
6/15/2001	0-1	SW6020	Arsenic	1.43			0.53	0.43	1.7	0.026	100
	0-1	SW6010	Barium	149			0.53	5,500	121	2,100	2,000
	0-1	SW6010	Beryllium	0.712			0.027	160	0.79	1,200	--
	0-1	SW6010	Cadmium	0.149			0.11	39	1	27	20
	0-1	SW6010	Calcium	11,200			11	--	13,000	--	--
	0-1	SW6010	Chromium, Total	12.7			0.27	230	8.1	42	100
	0-1	SW6010	Cobalt	4.38			0.27	1,600	4.2	--	--
	0-1	SW6010	Copper	9.10			1.1	3,100	6.4	11,000	--
	0-1	SW6010	Iron	11,900			3.2	47,000	8,640	--	--
	0-1	SW6020	Lead	14.0			0.53	--	9	--	100
	0-1	SW6010	Magnesium	4,030			27	--	2,690	--	--
	0-1	SW6010	Manganese	223			0.53	1,600	255	950	--
	0-1	SW6010	Nickel	6.56			2.1	1,600	4.9	--	--
	0-1	SW6010	Potassium	3,070			53	--	2,500	--	--
	0-1	SW6020	Selenium	0.309			0.21	390	0.25	19	20
	0-1	SW6010	Sodium	51.3			11	--	357	--	--
	0-1	SW6020	Thallium	0.132			0.11	5.5	0.25	3.6	--
	0-1	SW6010	Vanadium	24.1			0.53	550	18.1	5,100	--
	0-1	SW6010	Zinc	44.5			1.1	23,000	32	14,000	--

TABLE 2-3
DETECTIONS OF INORGANIC COMPOUNDS IN SURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SS34	0-1	SW6010	Aluminum	18,000			24	78,000	8,370	--	--
6/15/2001	0-1	SW6020	**Arsenic**	**1.80**			0.55	0.43	1.7	0.026	100
	0-1	SW6010	Barium	140			0.55	5,500	121	2,100	2,000
	0-1	SW6010	Beryllium	0.82			0.027	160	0.79	1,200	--
	0-1	SW6010	Cadmium	0.0433	J	F	0.11	39	1	27	20
	0-1	SW6010	Calcium	5,200			11	--	13,000	--	--
	0-1	SW6010	Chromium, Total	12			0.27	230	8.1	42	100
	0-1	SW6010	Cobalt	5.3			0.27	1,600	4.2	--	--
	0-1	SW6010	Copper	8.3			1.1	3,100	6.4	11,000	--
	0-1	SW6010	Iron	13,200			3.3	47,000	8,640	--	--
	0-1	SW6020	Lead	6.73			0.55	--	9	--	100
	0-1	SW6010	Magnesium	4,600			27	--	2,690	--	--
	0-1	SW6010	Manganese	250			0.55	1,600	255	950	--
	0-1	SW6010	Nickel	7.0			2.2	1,600	4.9	--	--
	0-1	SW6010	Potassium	3,400			55	--	2,500	--	--
	0-1	SW6020	Selenium	0.129	J	F	0.22	390	0.25	19	20
	0-1	SW6010	Sodium	56.2			11	--	357	--	--
	0-1	SW6020	Thallium	0.122			0.11	5.5	0.25	3.6	--
	0-1	SW6010	Vanadium	25			0.55	550	18.1	5,100	--
	0-1	SW6010	Zinc	39			1.1	23,000	32	14,000	--
SS7SS35	0-1	SW6010	Aluminum	19,600			24	78,000	8,370	--	--
6/20/2001	0-1	SW6020	**Arsenic**	**2.42**			0.54	0.43	1.7	0.026	100
	0-1	SW6010	Barium	150			0.54	5,500	121	2,100	2,000
	0-1	SW6010	Beryllium	0.80			0.027	160	0.79	1,200	--
	0-1	SW6010	Cadmium	0.0379	J	F	0.11	39	1	27	20
	0-1	SW6010	Calcium	35,000			11	--	13,000	--	--
	0-1	SW6010	Chromium, Total	12			0.27	230	8.1	42	100
	0-1	SW6010	Cobalt	4.8			0.27	1,600	4.2	--	--
	0-1	SW6010	Copper	9.2			1.1	3,100	6.4	11,000	--
	0-1	SW6010	Iron	13,300			3.3	47,000	8,640	--	--
	0-1	SW6020	Lead	14.9			0.54	--	9	--	100
	0-1	SW6010	Magnesium	6,700			27	--	2,690	--	--
	0-1	SW6010	Manganese	220			0.54	1,600	255	950	--
	0-1	SW6010	Nickel	7.7			2.2	1,600	4.9	--	--
	0-1	SW6010	Potassium	3,700			54	--	2,500	--	--

TABLE 2-3
DETECTIONS OF INORGANIC COMPOUNDS IN SURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SS35	0-1	SW6020	Selenium	0.258			0.22	390	0.25	19	20
6/20/2001	0-1	SW6010	Silver	0.31	J	F	0.54	390	1.5	31	100
(cont.)	0-1	SW6010	Sodium	74.8			11	--	357	--	--
	0-1	SW6020	Thallium	0.100	J	F	0.11	5.5	0.25	3.6	--
	0-1	SW6010	Vanadium	31			0.54	550	18.1	5,100	--
	0-1	SW6010	Zinc	39			1.1	23,000	32	14,000	--
SS7SS36	0-1	SW6010	Aluminum	17,100			24	78,000	8,370	--	--
6/20/2001	0-1	SW6020	**Arsenic**	**1.75**			0.54	0.43	1.7	0.026	100
	0-1	SW6010	Barium	140			0.54	5,500	121	2,100	2,000
	0-1	SW6010	Beryllium	0.73			0.027	160	0.79	1,200	--
	0-1	SW6010	Calcium	7,800			11	--	13,000	--	--
	0-1	SW6010	Chromium, Total	13			0.27	230	8.1	42	100
	0-1	SW6010	Cobalt	4.8			0.27	1,600	4.2	--	--
	0-1	SW6010	Copper	7.0			1.1	3,100	6.4	11,000	--
	0-1	SW6010	Iron	13,100			3.2	47,000	8,640	--	--
	0-1	SW6020	Lead	7.14			0.54	--	9	--	100
	0-1	SW6010	Magnesium	4,300			27	--	2,690	--	--
	0-1	SW6010	Manganese	210			0.54	1,600	255	950	--
	0-1	SW6010	Nickel	6.8			2.2	1,600	4.9	--	--
	0-1	SW6010	Potassium	3,200			54	--	2,500	--	--
	0-1	SW6020	Selenium	0.278			0.22	390	0.25	19	20
	0-1	SW6010	Sodium	48.7			11	--	357	--	--
	0-1	SW6020	Thallium	0.130			0.11	5.5	0.25	3.6	--
	0-1	SW6010	Vanadium	28			0.54	550	18.1	5,100	--
	0-1	SW6010	Zinc	38			1.1	23,000	32	14,000	--
SS7SS39	0-1	SW6010	Aluminum	15,900			24	78,000	8,370	--	--
6/21/2001	0-1	SW6020	Arsenic	1.67			0.54	0.43	1.7	0.026	100
	0-1	SW6010	Barium	130			0.54	5,500	121	2,100	2,000
	0-1	SW6010	Beryllium	0.77			0.027	160	0.79	1,200	--
	0-1	SW6010	Calcium	16,000			11	--	13,000	--	--
	0-1	SW6010	Chromium, Total	10			0.27	230	8.1	42	100
	0-1	SW6010	Cobalt	4.7			0.27	1,600	4.2	--	--
	0-1	SW6010	Copper	8.9			1.1	3,100	6.4	11,000	--
	0-1	SW6010	Iron	11,400			3.3	47,000	8,640	--	--
	0-1	SW6020	Lead	10.9			0.54	--	9	--	100

TABLE 2-3
DETECTIONS OF INORGANIC COMPOUNDS IN SURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SS39 6/21/2001 (cont.)	0-1	SW6010	Magnesium	5,100			27	--	2,690	--	--
	0-1	SW6010	Manganese	220			0.54	1,600	255	950	--
	0-1	SW6010	Nickel	7.1			2.2	1,600	4.9	--	--
	0-1	SW6010	Potassium	3,200			54	--	2,500	--	--
	0-1	SW6020	Selenium	0.345			0.22	390	0.25	19	20
	0-1	SW6010	Sodium	50.5			11	--	357	--	--
	0-1	SW6020	Thallium	0.133			0.11	5.5	0.25	3.6	--
	0-1	SW6010	Vanadium	23			0.54	550	18.1	5,100	--
	0-1	SW6010	Zinc	40			1.1	23,000	32	14,000	--

Notes:

mg/kg = milligrams per kilogram

QAPP = Quality Assurance Project Plan

RL = Reporting Limit

RBC = EPA Region III risk-based concentration values for residential soils.

TCLP = Toxicity Characteristic Leaching Procedure

X 20* = Values posted are 20 times the regulatory TCLP standard for comparison to metal concentrations in bulk soil

Background = Background values based on the "Geochemical Background Concentrations of Selected Constituents in Soil, Shallow Groundwater, Surface Water, and Sediment, Operable Unit 2, F.E. Warren Air Force Base" (Revised Draft, September 1999).

SSL = Soil Screening Level at a Dilution Attenuation Factor of 20.

J = The analyte was positively identified, but the quantitation is an estimation.

F = The analyte was positively identified, but the associated numerical value is below the RL.

M = A matrix effect was present.

-- = No published standard.

Bold indicates exceedance of RBC and background value or SSL and background value.

TABLE 2-4
DETECTIONS OF ORGANIC COMPOUNDS IN SURFACE AND SUBSURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SS02 6/20/2001	0 - 1	SW8270C	2,4-Dimethylphenol	0.741			0.33	1,600	6.7	
SS7SS26 6/14/2001	0 - 1	SW8082	PCB-1260 (Arochlor 1260)	0.0322	J	F	0.77	0.32	--	--
SS7SS35 6/20/2001	0 - 1	SW8081A	Heptachlor	0.00054	J	F	0.0018	0.14	0.84	0.16
SS7SS39 6/20/2001	0 - 1	SW8270C	Acenaphthene	0.119	J	F	0.76	4,700	100	--
	0 - 1	SW8270C	Di-N-Butyl Phthalate	0.0948	J	F	0.76	7,800	5,000	--
	0 - 1	SW8270C	Di-N-Octylphthalate	0.126	J	F	0.76	1,600	2,400,000	--
SS7SB01A 5/16/2001	16 - 17	SW8260B	1,2,4-Trimethylbenzene	0.000987	J	M	0.0092	100,000	--	--
	16 - 17	SW8260B	1,3,5-Trimethylbenzene (Mesitylene)	0.00341	J	M	0.0039	100,000	--	--
	16 - 17	SW8260B	**Cis-1,2-Dichloroethylene**	**0.544**	J	J	0.0079	20,000	0.35	--
	16 - 17	SW8260B	N-Butylbenzene	0.00263	J	M	0.0066	82,000	--	--
	16 - 17	SW8260B	Naphthalene	0.00111	J	M	0.0026	4,100	0.15	--
	16 - 17	SW8260B	O-Xylene (1,2-Dimethylbenzene)	0.000987	J	F	0.0066	4,100,000	230	--
	16 - 17	SW8260B	Sec-Butylbenzene	0.00213	J	M	0.0092	82,000	--	--
	16 - 17	SW8260B	Toluene	0.00366	J	F	0.0066	410,000	8.8	--
	16 - 17	SW8260B	**Trichloroethylene (TCE)**	**4.81**	J	J	0.013	520	0.015	10
SS7SB01B 5/16/2001	20 - 22	SW8260B	Cis-1,2-Dichloroethylene	0.00161	J	F	0.0078	20,000	0.35	--
	20 - 22	SW8260B	Toluene	0.00294	J	F	0.0065	410,000	8.8	--
	20 - 22	SW8260B	Trichloroethylene (TCE)	0.00539	J	F	0.013	520	0.015	10
SS7SB02A 6/20/2001	7 - 8	SW8260B	**1,1,2-Trichloroethane**	**0.00196**	J	F	0.0071	100	0.00078	--
	7 - 8	SW8260B	1,2,4-Trimethylbenzene	0.0455			0.01	100,000	--	--
	7 - 8	SW8260B	1,3,5-Trimethylbenzene (Mesitylene)	0.00403	J	F	0.0043	100,000	--	--
	7 - 8	SW8260B	Cis-1,2-Dichloroethylene	0.0438			0.0086	20,000	0.35	--
	7 - 8	SW8260B	Ethylbenzene	0.00241	J	F	0.0043	200,000	15	--
	7 - 8	SW8260B	Isopropylbenzene (Cumene)	0.00157	J	F	0.011	200,000	64	--
	7 - 8	SW8260B	M-Xylene (1,3-Dimethylbenzene)	0.0046	J	F	0.0071	4,100,000	250	--
	7 - 8	SW8260B	N-Butylbenzene	0.00823			0.0071	82,000	--	--
	7 - 8	SW8260B	N-Propylbenzene	0.00486			0.0029	82,000	28	--
	7 - 8	SW8260B	Naphthalene	0.00619			0.0029	41,000	0.15	--

TABLE 2-4
DETECTIONS OF ORGANIC COMPOUNDS IN SURFACE AND SUBSURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7B02A 6/20/2001 (cont.)	7 - 8	SW8260B	O-Xylene (1,2-Dimethylbenzene)	0.00534	J	F	0.0071	4,100,000	230	--
	7 - 8	SW8260B	P-Cymene (P-Isopropyltoluene)	0.00273	J	F	0.0086	--	--	--
	7 - 8	SW8260B	Sec-Butylbenzene	0.00494	J	F	0.01	82,000	--	--
	7 - 8	SW8260B	Tetrachloroethylene (PCE)	0.0022	J	F	0.01	110	0.0480	14
	7 - 8	SW8260B	Toluene	0.00307	J	F	0.0071	410,000	8.8	--
	7 - 8	SW8260B	**Trichloroethylene (TCE)**	**0.846**	J	F	1.4	520	0.015	10
SS7SB02B 6/20/2001	5 - 7	SW8260B	Cis-1,2-Dichloroethylene	0.336	M	F	0.82	20,000	0.35	--
	5 - 7	SW8260B	**Trichloroethylene (TCE)**	**40.4**			14	520	0.015	10
SS7SB02C 6/20/2001	15.5 - 16.5	SW8260B	Cis-1,2-Dichloroethylene	0.00326	J	F	0.0075	20,000	0.35	--
	15.5 - 16.5	SW8260B	**Trichloroethylene (TCE)**	**0.0762**			0.013	520	0.015	10
SS7SB06A 6/14/2001	4 - 5	SW8260B	Toluene	0.000546	J	F	0.0052	410,000	8.8	--
SS7SB06B 6/14/2001	14 - 16	SW8260B	Toluene	0.00868			0.0062	410,000	8.8	--
	14 - 16	SW8260B	Trichloroethylene (TCE)	0.000975	J	F	0.012	520	0.015	10
SS7SB06C 6/14/2001	24 - 26	SW8260B	Cis-1,2-Dichloroethylene	0.0115			0.0083	20,000	0.35	--
	24 - 26	SW8260B	Toluene	0.0106			0.0069	410,000	8.8	--
	24 - 26	SW8260B	**Trichloroethylene (TCE)**	**0.107**			0.014	520	0.015	10
SS7SB16A 4/5/2001	8 - 9	SW8260B	Cis-1,2-Dichloroethylene	0.0854			0.0085	20,000	0.35	--
	8 - 9	SW8260B	Methylene Chloride	0.00199	J	F	0.0028	760	0.019	--
	8 - 9	SW8260B	**Trichloroethylene (TCE)**	**0.26**			0.014	520	0.015	10
SS7SB16B 4/5/2001	17 - 18	SW8260B	Trichloroethylene (TCE)	0.00329	J	F	0.013	520	0.015	10
SS7SB16C 4/5/2001	14 - 15	SW8260B	**1,1,2-Trichloroethane**	**0.00433**	J	F	0.0071	100	0.00078	--
	14 - 15	SW8260B	**Chloroform**	**0.00133**	J	F	0.0029	940	0.00089	120
	14 - 15	SW8260B	Cis-1,2-Dichloroethylene	0.268			0.0086	20,000	0.35	--
	14 - 15	SW8260B	Methylene Chloride	0.00769			0.0029	760	0.019	--
	14 - 15	SW8260B	O-Xylene (1,2-Dimethylbenzene)	0.000814	J	F	0.0071	4,100,000	230	--
	14 - 15	SW8260B	Toluene	0.000757	J	F	0.0071	410,000	8.8	--
	14 - 15	SW8260B	**Trichloroethylene (TCE)**	**1.96**			1.4	520	0.015	10
SS7SB17B 4/4/2001	20 - 21.5	SW8260B	Cis-1,2-Dichloroethylene	0.00165	J	F	0.0083	20,000	0.35	--
	20 - 21.5	SW8260B	**Trichloroethylene (TCE)**	**0.0319**			0.014	520	0.015	10

TABLE 2-4
DETECTIONS OF ORGANIC COMPOUNDS IN SURFACE AND SUBSURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SB18A 4/16/2001	14 - 16	SW8260B	1,1,2-Trichloroethane	0.000639	J	F	0.006	100	0.00078	--
	14 - 16	SW8260B	Cis-1,2-Dichloroethylene	0.127			0.0072	20,000	0.35	--
	14 - 16	SW8260B	Tetrachloroethylene (PCE)	0.000904	J	F	0.0084	110	0.0480	14
	14 - 16	SW8260B	**Trichloroethylene (TCE)**	**3.47**			1.2	520	0.015	10
SS7SB18B 4/16/2001	19 - 21	SW8260B	Cis-1,2-Dichloroethylene	0.00184	J	F	0.008	20,000	0.35	--
	19 - 21	SW8270C	Diethyl Phthalate	0.109	J	F	0.93	1,600,000	450	--
SS7SB18B 4/16/2001	19 - 21	SW8260B	Naphthalene	0.00088	J	F	0.0027	41,000	0.15	--
	19 - 21	SW8260B	**Trichloroethylene (TCE)**	**0.142**			0.013	520	0.015	10
SS7SB18C 4/16/2001	23 - 24	SW8260B	Cis-1,2-Dichloroethylene	0.0205			0.0083	20,000	0.35	--
	23 - 24	SW8260B	**Trichloroethylene (TCE)**	**1.77**			1.4	520	0.015	10
SS7SB26A 6/14/2001	4 - 6	SW8260B	Toluene	0.00741			0.006	410,000	8.8	--
SS7SB26B 6/14/2001	15 - 17	SW8260B	*Toluene*	*0.0041*	J	F	0.006	410,000	8.8	--
	15 - 17	SW8260B	Toluene	0.0236			0.006	410,000	8.8	--
SS7SB26C 6/14/2001	21 - 23	SW8260B	Benzene	0.00136	J	F	0.0025	100	0.0018	10
	21 - 23	SW8260B	Toluene	0.0379			0.0063	410,000	8.8	--
	21 - 23	SW8260B	Trichloroethylene (TCE)	0.0138			0.013	520	0.015	10
SS7SB33A 6/15/2001	6 - 7	SW8260B	Toluene	0.0167			0.0058	410,000	8.8	--
	6 - 7	SW8260B	Trichloroethylene (TCE)	0.00728	J	F	0.012	520	0.015	10
SS7SB33B 6/15/2001	15.5 - 16	SW8260B	Cis-1,2-Dichloroethylene	0.0125			0.0073	20,000	0.35	--
	15.5 - 16	SW8260B	Toluene	0.021			0.0061	410,000	8.8	--
	15.5 - 16	SW8260B	Trichloroethylene (TCE)	0.00561	J	F	0.012	520	0.015	10
SS7SB34B 6/15/2001	17 - 18	SW8260B	**1,1,2-Trichloroethane**	**0.00095**	J	F	0.0063	100	0.00078	--
	17 - 18	SW8260B	Cis-1,2-Dichloroethylene	0.00814			0.0075	20,000	0.35	--
	17 - 18	SW8260B	Toluene	0.00108	J	F	0.0063	410,000	8.8	--
	17 - 18	SW8260B	**Trichloroethylene (TCE)**	**0.0395**			0.013	520	0.015	10
SS7SB35B 6/20/2001	21 - 22	SW8260B	Toluene	0.00688			0.006	410,000	8.8	--
SS7SB36A 6/20/2001	6 - 8	SW8260B	Toluene	0.0137	M	M	0.0059	410,000	8.8	--

TABLE 2-4
DETECTIONS OF ORGANIC COMPOUNDS IN SURFACE AND SUBSURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SB36B 6/20/2001	10 - 11	SW8260B	1,2,4-Trimethylbenzene	0.0393		M	0.0097	100,000	--	--
	10 - 11	SW8260B	Cis-1,2-Dichloroethylene	0.0139			0.0083	20,000	0.35	--
	10 - 11	SW8260B	Ethylbenzene	0.00075	J	M	0.0042	200,000	15	--
	10 - 11	SW8260B	Isopropylbenzene (Cumene)	0.00147	J	M	0.011	200,000	64	--
	10 - 11	SW8260B	N-Butylbenzene	0.00703		M	0.0069	82,000	--	--
	10 - 11	SW8260B	N-Propylbenzene	0.00365		M	0.0028	82,000	28	--
SS7SB36B 6/20/2001 (cont.)	10 - 11	SW8260B	Naphthalene	0.000986	J	M	0.0028	4,100	0.15	--
	10 - 11	SW8260B	O-Xylene (1,2-Dimethylbenzene)	0.00393	J	M	0.0069	4,100,000	230	--
	10 - 11	SW8260B	P-Cymene (P-Isopropyltoluene)	0.00508	J	M	0.0083	--	--	--
SS7SB36B 6/20/2001	10 - 11	SW8260B	Sec-Butylbenzene	0.00429	J	M	0.0097	82,000	--	--
	10 - 11	SW8260B	Toluene	0.0249		M	0.0069	410,000	8.8	--
	10 - 11	SW8260B	Trichloroethylene (TCE)	0.0139	J	M	0.014	520	0.015	10
SS7SB36C 6/20/2001	18.5 - 19.5	SW8260B	Toluene	0.00316	J	F	0.0061	410,000	8.8	--
	18.5 - 19.5	SW8260B	**Trichloroethylene (TCE)**	**0.0213**			0.012	520	0.015	10
SS7SB38A 6/21/2001	6 - 8	SW8260B	Toluene	0.00216	J	F	0.0068	410,000	8.8	--
	6 - 8	SW8260B	Trichloroethylene (TCE)	0.00101	J	F	0.014	520	0.015	10
SS7SB39B 6/21/2001	14 - 15	SW8260B	Cis-1,2-Dichloroethylene	0.000867	J	F	0.008	20,000	0.35	--
	14 - 15	SW8260B	Trichloroethylene (TCE)	0.00221	J	F	0.013	520	0.015	10
SS7SB39C 6/21/2001	16 - 17	SW8260B	Cis-1,2-Dichloroethylene	0.000691	J	F	0.0074	20,000	0.35	--
	16 - 17	SW8260B	Trichloroethylene (TCE)	0.00142	J	F	0.012	520	0.015	10

Notes:
mg/kg = milligrams per kilogram
QAPP = Quality Assurance Project Plan
RL = Reporting Limit
RBC = EPA Region III risk-based concentration values for industrial soils (October 2001).
SSL = Soil Screening Level at a Dilution Attenuation Factor of 20.
TCLP = Toxicity Characteristic Leaching Procedure
X 20* = Values posted are 20 times the regulatory TCLP standard for comparison to organic concentrations in bulk soil.
Field duplicate (denoted by italics).
J = The analyte was positively identified, the quantitation is an estimation.
M = A matrix effect was present.
F = The analyte was positively identified, but the associated numerical value is below the RL.
-- = No published standard.
Bold indicates exceedance of an RBC and/or SSL.
Residential RBC values are used for comparison with samples SS7SS02, SS7SS26, SS7SS35 and SS7SS39.
Both surface and subsurface soils are presented on this table.

TABLE 2-5
DETECTIONS OF INORGANIC COMPOUNDS IN SUBSURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SB01A 5/16/2001	16-17	SW6010	Aluminum	28,900			29	2,000,000	8,450	--	--
	16-17	SW6010	Antimony	2.2	J	M	1.3	820	0.5	13	--
	16-17	SW6010	**Arsenic**	**8.0**			1.3	3.8	2.7	0.026	100
	16-17	SW6010	Barium	120			0.66	140,000	104	2,100	2,000
	16-17	SW6010	Beryllium	1.4			0.033	4,100	1.1	1,200	--
	16-17	SW6010	Calcium	11,000			13	--	54,200	--	--
	16-17	SW6010	Chromium, Total	15			0.33	6,100	9.1	42	100
	16-17	SW6010	Cobalt	9.6	J	M	0.33	41,000	4.8	--	--
	16-17	SW6010	Copper	13			1.3	82,000	4.1	11,000	--
	16-17	SW6010	Iron	18,400			3.9	1,200,000	8,340	--	--
	16-17	SW6010	Lead	8.4			1.3	--	6.7	--	100
	16-17	SW6010	Magnesium	11,000			33	--	4,540	--	--
	16-17	SW6010	Manganese	370			0.66	41,000	254	950	--
	16-17	SW6010	Nickel	12			2.6	41,000	5.9	--	--
	16-17	SW6010	Potassium	5,700			66	--	2,680	--	--
	16-17	SW6010	Selenium	7.5			1.3	10,000	0.25	19	20
	16-17	SW6010	Sodium	153			13	--	386	--	--
	16-17	SW6010	Thallium	0.76	J	F	2.6	140	0.25	3.6	--
	16-17	SW6010	Vanadium	47			0.66	14,000	25.2	5,100	--
	16-17	SW6010	Zinc	52			1.3	610,000	20.9	14,000	--
SS7SB01B 5/16/2001	20-22	SW6010	Aluminum	41,700			29	2,000,000	8,450	--	--
	20-22	SW6010	Antimony	3.5			1.3	820	0.5	13	--
	20-22	SW6010	**Arsenic**	**11**			1.3	3.8	2.7	0.026	100
	20-22	SW6010	Barium	120			0.67	140,000	104	2,100	2,000
	20-22	SW6010	Beryllium	2.0			0.033	4,100	1.1	1,200	--
	20-22	SW6010	Calcium	9,500			13	--	54,200	--	--
	20-22	SW6010	Chromium, Total	23			0.33	6,100	9.1	42	100
	20-22	SW6010	Cobalt	9.8			0.33	41,000	4.8	--	--
	20-22	SW6010	Copper	22			1.3	82,000	4.1	11,000	--
	20-22	SW6010	Iron	25,200			4	1,200,000	8,340	--	--
	20-22	SW6010	Lead	7.3			1.3	--	6.7	--	100
	20-22	SW6010	Magnesium	15,000			33	--	4,540	--	--
	20-22	SW6010	Manganese	300			0.67	41,000	254	950	--

TABLE 2-5
DETECTIONS OF INORGANIC COMPOUNDS IN SUBSURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SB01B	20-22	SW6010	Nickel	18			2.7	41,000	5.9	--	--
5/16/2001	20-22	SW6010	Potassium	8,800			67	--	2,680	--	--
(cont.)	20-22	SW6010	Selenium	9.9			1.3	10,000	0.25	19	20
	20-22	SW6010	Sodium	197			13	--	386	--	--
	20-22	SW6010	Thallium	0.91	J	F	2.7	140	0.25	3.6	--
	20-22	SW6010	Vanadium	63			0.67	14,000	25.2	5,100	--
	20-22	SW6010	Zinc	82			1.3	610,000	20.9	14,000	--
SS7SB02A	7-8	SW6010	Aluminum	41,400			31	2,000,000	8,450	--	--
6/20/2001	7-8	SW6020	**Arsenic**	**6.17**			0.71	3.8	2.7	0.026	100
	7-8	SW6010	Barium	150			0.71	140,000	104	2,100	2,000
	7-8	SW6010	Beryllium	2.0			0.036	4,100	1.1	1,200	--
	7-8	SW6010	Calcium	46,000			14	--	54,200	--	--
	7-8	SW6010	Chromium, Total	23			0.36	6,100	9.1	42	100
	7-8	SW6010	Cobalt	10			0.36	41,000	4.8	--	--
	7-8	SW6010	Copper	23			1.4	82,000	4.1	11,000	--
	7-8	SW6010	Iron	26,300			4.3	1,200,000	8,340	--	--
	7-8	SW6020	Lead	23.0			0.71	--	6.7	--	100
	7-8	SW6010	Magnesium	15,000			36	--	4,540	--	--
	7-8	SW6010	Manganese	410			0.71	41,000	254	950	--
	7-8	SW6010	Nickel	18			2.9	41,000	5.9	--	--
	7-8	SW6010	Potassium	9,500			71	--	2,680	--	--
	7-8	SW6020	Selenium	0.503			0.29	10,000	0.25	19	20
	7-8	SW6010	Silver	0.32	J	F	0.71	10,000	1.5	31	100
	7-8	SW6010	Sodium	214			14	--	386	--	--
	7-8	SW6020	Thallium	0.329			0.14	140	0.25	3.6	--
	7-8	SW6010	Vanadium	56			0.71	14,000	25.2	5,100	--
	7-8	SW6010	Zinc	83			1.4	610,000	20.9	14,000	--
SS7SB02B	5-7	SW6010	Aluminum	23,000			30	2,000,000	8,450	--	--
6/20/2001	5-7	SW6020	**Arsenic**	**3.45**			0.68	3.8	2.7	0.026	100
	5-7	SW6010	Barium	230			0.68	140,000	104	2,100	2,000
	5-7	SW6010	Beryllium	0.96			0.034	4,100	1.1	1,200	--
	5-7	SW6010	Cadmium	0.168			0.14	1,000	1	27	20
	5-7	SW6010	Calcium	130,000			1400	--	54,200	--	--

TABLE 2-5
DETECTIONS OF INORGANIC COMPOUNDS IN SUBSURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SB02B 6/20/2001 (cont.)	5-7	SW6010	Chromium, Total	16			0.34	6,100	9.1	42	100
	5-7	SW6010	Cobalt	6.6			0.34	41,000	4.8	--	--
	5-7	SW6010	Copper	11			1.4	82,000	4.1	11,000	--
	5-7	SW6010	Iron	14,500			4.1	1,200,000	8,340	--	--
	5-7	SW6020	Lead	11.3			0.68	--	6.7	--	100
	5-7	SW6010	Magnesium	9,600			34	--	4,540	--	--
	5-7	SW6010	Manganese	320			0.68	41,000	254	950	--
	5-7	SW6010	Nickel	12			2.7	41,000	5.9	--	--
	5-7	SW6010	Potassium	4,800			68	--	2,680	--	--
	5-7	SW6020	Selenium	0.389			0.27	10,000	0.25	19	20
	5-7	SW6010	Silver	0.29	J	F	0.68	10,000	1.5	31	100
	5-7	SW6010	Sodium	87.0			14	--	386	--	--
	5-7	SW6020	Thallium	0.305			0.14	140	0.25	3.6	--
	5-7	SW6010	Vanadium	31			0.68	14,000	25.2	5,100	--
	5-7	SW6010	Zinc	45			1.4	610,000	20.9	14,000	--
SS7SB02C 6/20/2001	15.5-16.5	SW6010	Aluminum	20,900			28	2,000,000	8,450	--	--
	15.5-16.5	SW6020	Arsenic	2.10			0.63	3.8	2.7	0.026	100
	15.5-16.5	SW6010	Barium	91			0.63	140,000	104	2,100	2,000
	15.5-16.5	SW6010	Beryllium	1.0			0.031	4,100	1.1	1,200	--
	15.5-16.5	SW6010	Calcium	6,700			13	--	54,200	--	--
	15.5-16.5	SW6010	Chromium, Total	16			0.31	6,100	9.1	42	100
	15.5-16.5	SW6010	Cobalt	7.2			0.31	41,000	4.8	--	--
	15.5-16.5	SW6010	Copper	9.7			1.3	82,000	4.1	11,000	--
	15.5-16.5	SW6010	Iron	18,300			19	1,200,000	8,340	--	--
	15.5-16.5	SW6020	Lead	4.46			0.63	--	6.7	--	100
	15.5-16.5	SW6010	Magnesium	8,700			31	--	4,540	--	--
	15.5-16.5	SW6010	Manganese	250			0.63	41,000	254	950	--
	15.5-16.5	SW6010	Nickel	12			2.5	41,000	5.9	--	--
	15.5-16.5	SW6010	Potassium	4,200			63	--	2,680	--	--
	15.5-16.5	SW6010	Sodium	121			13	--	386	--	--
	15.5-16.5	SW6020	Thallium	0.233			0.13	140	0.25	3.6	--
	15.5-16.5	SW6010	Vanadium	32			0.63	14,000	25.2	5,100	--
	15.5-16.5	SW6010	Zinc	45			1.3	610,000	20.9	14,000	--

TABLE 2-5
DETECTIONS OF INORGANIC COMPOUNDS IN SUBSURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SB06A 6/20/2001	4-5	SW6010	Aluminum	2,580			23	2,000,000	8,450	--	--
	4-5	SW6020	Arsenic	0.712			0.52	3.8	2.7	0.026	100
	4-5	SW6010	Barium	180			0.52	140,000	104	2,100	2,000
	4-5	SW6010	Beryllium	0.17			0.026	4,100	1.1	1,200	--
	4-5	SW6010	Calcium	24,000			10	--	54,200	--	--
	4-5	SW6010	Chromium, Total	2.6			0.26	6,100	9.1	42	100
	4-5	SW6010	Cobalt	1.5			0.26	41,000	4.8	--	--
	4-5	SW6010	Copper	1.8			1	82,000	4.1	11,000	--
	4-5	SW6010	Iron	3,190			3.1	1,200,000	8,340	--	--
	4-5	SW6020	Lead	1.95			0.52	--	6.7	--	100
	4-5	SW6010	Magnesium	1,100			26	--	4,540	--	--
	4-5	SW6010	Manganese	48			0.52	41,000	254	950	--
	4-5	SW6010	Nickel	1.6	J	F	2.1	41,000	5.9	--	--
	4-5	SW6010	Potassium	510			52	--	2,680	--	--
	4-5	SW6010	Sodium	39.3			10	--	386	--	--
	4-5	SW6010	Vanadium	7.4			0.52	14,000	25.2	5,100	--
	4-5	SW6010	Zinc	6.9			1	610,000	20.9	14,000	--
SS7SB06B 6/14/2001	14-16	SW6010	Aluminum	17,400		M	27	2,000,000	8,450	--	--
	14-16	SW6020	Arsenic	2.12	J	M	0.62	3.8	2.7	0.026	100
	14-16	SW6010	Barium	84.1			0.62	140,000	104	2,100	2,000
	14-16	SW6010	Beryllium	0.743			0.031	4,100	1.1	1,200	--
	14-16	SW6010	Calcium	7,420			12	--	54,200	--	--
	14-16	SW6010	Chromium, Total	12.7			0.31	6,100	9.1	42	100
	14-16	SW6010	Cobalt	7.33			0.31	41,000	4.8	--	--
	14-16	SW6010	Copper	7.47			1.2	82,000	4.1	11,000	--
	14-16	SW6010	Iron	14,400		M	3.7	1,200,000	8,340	--	--
	14-16	SW6020	Lead	5.26	J	M	0.62	--	6.7	--	100
	14-16	SW6010	Magnesium	7,250			31	--	4,540	--	--
	14-16	SW6010	Manganese	272			0.62	41,000	254	950	--
	14-16	SW6010	Nickel	9.94			2.5	41,000	5.9	--	--
	14-16	SW6010	Potassium	3,250			62	--	2,680	--	--
	14-16	SW6010	Sodium	76.8			12	--	386	--	--

TABLE 2-5
DETECTIONS OF INORGANIC COMPOUNDS IN SUBSURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SB06B	14-16	SW6020	Thallium	0.119	J	F	0.12	140	0.25	3.6	--
6/14/2001	14-16	SW6010	Vanadium	33.2			0.62	14,000	25.2	5,100	--
(cont.)	14-16	SW6010	Zinc	34.1			1.2	610,000	20.9	14,000	--
SS7SB06C	24-26	SW6010	Aluminum	40,700			31	2,000,000	8,450	--	--
6/14/2001	24-26	SW6020	**Arsenic**	**7.60**			0.69	3.8	2.7	0.026	100
	24-26	SW6010	Barium	150			0.69	140,000	104	2,100	2,000
	24-26	SW6010	Beryllium	1.9			0.035	4,100	1.1	1,200	--
	24-26	SW6010	Calcium	19,000			14	--	54,200	--	--
	24-26	SW6010	Chromium, Total	25			1.7	6,100	9.1	42	100
	24-26	SW6010	Cobalt	10			0.35	41,000	4.8	--	--
	24-26	SW6010	Copper	21			1.4	82,000	4.1	11,000	--
	24-26	SW6010	Iron	30,800			21	1,200,000	8,340	--	--
	24-26	SW6020	Lead	13.3			0.69	--	6.7	--	100
	24-26	SW6010	Magnesium	15,000			35	--	4,540	--	--
	24-26	SW6010	Manganese	290			0.69	41,000	254	950	--
	24-26	SW6010	Nickel	18			2.8	41,000	5.9	--	--
	24-26	SW6010	Potassium	8,700			69	--	2,680	--	--
	24-26	SW6020	Selenium	0.450			0.28	10,000	0.25	19	20
	24-26	SW6010	Sodium	178			14	--	386	--	--
	24-26	SW6020	Thallium	0.319			0.14	140	0.25	3.6	--
	24-26	SW6010	Vanadium	55			0.69	14,000	25.2	5,100	--
	24-26	SW6010	Zinc	91			1.4	610,000	20.9	14,000	--
SS7SB16A	8-9	SW6010	Aluminum	45,800			30	2,000,000	8,450	--	--
4/5/2001	8-9	SW6020	**Arsenic**	**7.01**			0.68	3.8	2.7	0.026	100
	8-9	SW6010	Barium	200			0.68	140,000	104	2,100	2,000
	8-9	SW6010	Beryllium	2.0			0.034	4,100	1.1	1,200	--
	8-9	SW6010	Calcium	30,000			14	--	54,200	--	--
	8-9	SW6010	Chromium, Total	25			0.34	6,100	9.1	42	100
	8-9	SW6010	Cobalt	11			0.34	41,000	4.8	--	--
	8-9	SW6010	Copper	26			1.4	82,000	4.1	11,000	--
	8-9	SW6010	Iron	25,800			4.1	1,200,000	8,340	--	--
	8-9	SW6020	Lead	16.1			0.68	--	6.7	--	100
	8-9	SW6010	Magnesium	16,000			34	--	4,540	--	--

TABLE 2-5
DETECTIONS OF INORGANIC COMPOUNDS IN SUBSURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SB16A 4/5/2001 (cont.)	8-9	SW6010	Manganese	420			0.68	41,000	254	950	--
	8-9	SW6010	Nickel	19			2.7	41,000	5.9	--	--
	8-9	SW6010	Potassium	9,900			68	--	2,680	--	--
	8-9	SW6020	Selenium	0.559			0.27	10,000	0.25	19	20
	8-9	SW6010	Sodium	205			14	--	386	--	--
	8-9	SW6020	Thallium	0.509			0.14	140	0.25	3.6	--
	8-9	SW6010	Vanadium	65			0.68	14,000	25.2	5,100	--
	8-9	SW6010	Zinc	86			1.4	610,000	20.9	14,000	--
SS7SB16B 4/5/2001	17-18	SW6020	**Arsenic**	**4.64**			0.63	3.8	2.7	0.026	100
	17-18	SW6010	Barium	97			0.63	140,000	104	2,100	2,000
	17-18	SW6010	Beryllium	1.3			0.031	4,100	1.1	1,200	--
	17-18	SW6010	Calcium	7,900			13	--	54,200	--	--
	17-18	SW6010	Chromium, Total	14			0.31	6,100	9.1	42	100
	17-18	SW6010	Cobalt	8.2			0.31	41,000	4.8	--	--
	17-18	SW6010	Copper	14			1.3	82,000	4.1	11,000	--
	17-18	SW6010	Iron	18,500			19	1,200,000	8,340	--	--
	17-18	SW6020	Lead	9.30			0.63	--	6.7	--	100
	17-18	SW6010	Magnesium	11,000			31	--	4,540	--	--
	17-18	SW6010	Manganese	360			3.1	41,000	254	950	--
	17-18	SW6010	Nickel	11			2.5	41,000	5.9	--	--
	17-18	SW6010	Potassium	5,300			63	--	2,680	--	--
	17-18	SW6020	Selenium	0.380			0.25	10,000	0.25	19	20
	17-18	SW6010	Sodium	151			13	--	386	--	--
	17-18	SW6020	Thallium	0.219			0.13	140	0.25	3.6	--
	17-18	SW6010	Vanadium	43			0.63	14,000	25.2	5,100	--
	17-18	SW6010	Zinc	48			1.3	610,000	20.9	14,000	--
SS7SB16C 4/5/2001	14-15	SW6010	Aluminum	38,800			32	2,000,000	8,450	--	--
	14-15	SW6020	**Arsenic**	**6.75**			3.7	3.8	2.7	0.026	100
	14-15	SW6010	Barium	140			0.74	140,000	104	2,100	2,000
	14-15	SW6010	Beryllium	1.5			0.037	4,100	1.1	1,200	--
	14-15	SW6010	Calcium	8,700			15	--	54,200	--	--
	14-15	SW6010	Chromium, Total	22			0.37	6,100	9.1	42	100
	14-15	SW6010	Cobalt	11			0.37	41,000	4.8	--	--

TABLE 2-5
DETECTIONS OF INORGANIC COMPOUNDS IN SUBSURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SB16C 4/5/2001 (cont.)	14-15	SW6010	Copper	19			1.5	82,000	4.1	11,000	--
	14-15	SW6010	Iron	22,600			4.4	1,200,000	8,340	--	--
	14-15	SW6020	Lead	22.4			0.74	--	6.7	--	100
	14-15	SW6010	Magnesium	14,000			37	--	4,540	--	--
	14-15	SW6010	Manganese	360			0.74	41,000	254	950	--
	14-15	SW6010	Nickel	17			2.9	41,000	5.9	--	--
	14-15	SW6010	Potassium	7,400			74	--	2,680	--	--
	14-15	SW6020	Selenium	0.291			0.29	10,000	0.25	19	20
	14-15	SW6010	Sodium	190			15	--	386	--	--
	14-15	SW6020	Thallium	0.657			0.15	140	0.25	3.6	--
	14-15	SW6010	Vanadium	55			0.74	14,000	25.2	5,100	--
	14-15	SW6010	Zinc	70			1.5	610,000	20.9	14,000	--
SS7SB17A 4/5/2001	8-10	SW6010	Aluminum	39,700			28	2,000,000	8,450	--	--
	8-10	SW6020	**Arsenic**	**4.75**			1.3	3.8	2.7	0.026	100
	8-10	SW6010	Barium	180	J	M	0.63	140,000	104	2,100	2,000
	8-10	SW6010	Beryllium	1.9	J	M	0.032	4,100	1.1	1,200	--
	8-10	SW6010	Calcium	39,000			13	--	54,200	--	--
	8-10	SW6010	Chromium, Total	24			0.32	6,100	9.1	42	100
	8-10	SW6010	Cobalt	10	J	M	0.32	41,000	4.8	--	--
	8-10	SW6010	Copper	21	J	M	1.3	82,000	4.1	11,000	--
	8-10	SW6010	Iron	23,000			3.8	1,200,000	8,340	--	--
	8-10	SW6020	Lead	8.58		M	1.3	--	6.7	--	100
	8-10	SW6010	Magnesium	14,000			32	--	4,540	--	--
	8-10	SW6010	Manganese	380			0.63	41,000	254	950	--
	8-10	SW6010	Nickel	16	J	M	2.5	41,000	5.9	--	--
	8-10	SW6010	Potassium	8,500	J	M	63	--	2,680	--	--
	8-10	SW6010	Sodium	214			13	--	386	--	--
	8-10	SW6020	Thallium	0.377			0.25	140	0.25	3.6	--
	8-10	SW6010	Vanadium	59	J	M	0.63	14,000	25.2	5,100	--
	8-10	SW6010	Zinc	72	J	M	1.3	610,000	20.9	14,000	--

TABLE 2-5
DETECTIONS OF INORGANIC COMPOUNDS IN SUBSURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SB17B 4/5/2001	20-21.5	SW6010	Aluminum	52,700			31	2,000,000	8,450	--	--
	20-21.5	SW6020	**Arsenic**	**8.23**			1.4	3.8	2.7	0.026	100
	20-21.5	SW6010	Barium	130			0.71	140,000	104	2,100	2,000
	20-21.5	SW6010	Beryllium	2.2			0.036	4,100	1.1	1,200	--
	20-21.5	SW6010	Calcium	10,000			14	--	54,200	--	--
	20-21.5	SW6010	Chromium, Total	28			0.36	6,100	9.1	42	100
	20-21.5	SW6010	Cobalt	7.6			0.36	41,000	4.8	--	--
	20-21.5	SW6010	Copper	24			1.4	82,000	4.1	11,000	--
	20-21.5	SW6010	Iron	29,700			4.3	1,200,000	8,340	--	--
	20-21.5	SW6020	Lead	13.0			1.4	--	6.7	--	100
	20-21.5	SW6010	Magnesium	18,000			36	--	4,540	--	--
	20-21.5	SW6010	Manganese	220			0.71	41,000	254	950	--
	20-21.5	SW6010	Nickel	20			2.9	41,000	5.9	--	--
	20-21.5	SW6010	Potassium	12,000			71	--	2,680	--	--
	20-21.5	SW6010	Sodium	221			14	--	386	--	--
	20-21.5	SW6020	Thallium	0.429			0.29	140	0.25	3.6	--
	20-21.5	SW6010	Vanadium	73			0.71	14,000	25.2	5,100	--
	20-21.5	SW6010	Zinc	100			1.4	610,000	20.9	14,000	--
SS7SB18A 4/16/2001	14-16	SW6010	Aluminum	16,400			27	2,000,000	8,450	--	--
	14-16	SW6020	Arsenic	2.12			0.6	3.8	2.7	0.026	100
	14-16	SW6010	Barium	200			0.6	140,000	104	2,100	2,000
	14-16	SW6010	Beryllium	0.72			0.03	4,100	1.1	1,200	--
	14-16	SW6010	Calcium	34,000			12	--	54,200	--	--
	14-16	SW6010	Chromium, Total	12			0.3	6,100	9.1	42	100
	14-16	SW6010	Cobalt	4.1			0.3	41,000	4.8	--	--
	14-16	SW6010	Copper	8.8			1.2	82,000	4.1	11,000	--
	14-16	SW6010	Iron	11,600			0.36	1,200,00	8,340	--	--
	14-16	SW6020	Lead	6.46			0.6	--	6.7	--	100
	14-16	SW6010	Magnesium	5,900			30	--	4,540	--	--
	14-16	SW6010	Nickel	7.6			2.4	41,000	5.9	--	--
	14-16	SW6010	Potassium	3,500			60	--	2,680	--	--
	14-16	SW6020	Selenium	0.237	J	F	0.24	10,000	0.25	19	20
	14-16	SW6010	Sodium	69.5			12	--	386	--	--

TABLE 2-5
DETECTIONS OF INORGANIC COMPOUNDS IN SUBSURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SB18A	14-16	SW6020	Thallium	0.142			0.12	140	0.25	3.6	--
4/16/2001	14-16	SW6010	Vanadium	28			0.6	14,000	25.2	5,100	--
(cont.)	14-16	SW6010	Zinc	35			1.2	610,000	20.9	14,000	--
SS7SB18B	19-21	SW6010	Aluminum	26,700			29	2,000,000	8,450	--	--
4/16/2001	19-21	SW6020	**Arsenic**	**3.80**			0.67	3.8	2.7	0.026	100
	19-21	SW6010	Barium	99			0.67	140,000	104	2,100	2,000
	19-21	SW6010	Beryllium	1.2			0.033	4,100	1.1	1,200	--
	19-21	SW6010	Calcium	19,000			13	--	54,200	--	--
	19-21	SW6010	Chromium, Total	16			0.33	6,100	9.1	42	100
	19-21	SW6010	Cobalt	5.5			0.33	41,000	4.8	--	--
	19-21	SW6010	Copper	13			1.3	82,000	4.1	11,000	--
	19-21	SW6010	Iron	16,300			4	1,200,000	8,340	--	--
	19-21	SW6020	Lead	7.77			0.67	--	6.7	--	100
	19-21	SW6010	Magnesium	9,700			33	--	4,540	--	--
	19-21	SW6010	Manganese	180			0.67	41,000	254	950	--
	19-21	SW6010	Nickel	11			2.7	41,000	5.9	--	--
	19-21	SW6010	Potassium	5,200			67	--	2,680	--	--
	19-21	SW6020	Selenium	0.319			0.27	10,000	0.25	19	20
	19-21	SW6010	Sodium	147			13	--	386	--	--
	19-21	SW6020	Thallium	0.169			0.13	140	0.25	3.6	--
	19-21	SW6010	Vanadium	38			0.67	14,000	25.2	5,100	--
	19-21	SW6010	Zinc	49			1.3	610,000	20.9	14,000	--
SS7SB18C	23-24	SW6010	Aluminum	31,300			31	2,000,000	8,450	--	--
4/16/2001	23-24	SW6020	Arsenic	3.44			0.69	3.8	2.7	0.026	100
	23-24	SW6010	Barium	130			0.69	140,000	104	2,100	2,000
	23-24	SW6010	Beryllium	1.5			0.035	4,100	1.1	1,200	--
	23-24	SW6010	Calcium	18,000			14	--	54,200	--	--
	23-24	SW6010	Chromium, Total	19			0.35	6,100	9.1	42	100
	23-24	SW6010	Cobalt	11			0.35	41,000	4.8	--	--
	23-24	SW6010	Copper	17			1.4	82,000	4.1	11,000	--
	23-24	SW6010	Iron	19,600			4.2	1,200,000	8,340	--	--
	23-24	SW6020	Lead	8.31			0.69	--	6.7	--	100
	23-24	SW6010	Magnesium	11,000			35	--	4,540	--	--

TABLE 2-5
DETECTIONS OF INORGANIC COMPOUNDS IN SUBSURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SB18C 4/16/2001 (cont.)	23-24	SW6010	Manganese	370			0.69	41,000	254	950	--
	23-24	SW6010	Nickel	14			2.8	41,000	5.9	--	--
	23-24	SW6010	Potassium	6,400			69	--	2,680	--	--
	23-24	SW6020	Selenium	0.301			0.28	10,000	0.25	19	20
	23-24	SW6010	Sodium	182			14	--	386	--	--
	23-24	SW6020	Thallium	0.130	J	F	0.14	140	0.25	3.6	--
	23-24	SW6010	Vanadium	50			0.69	14,000	25.2	5,100	--
	23-24	SW6010	Zinc	62			1.4	610,000	20.9	14,000	--
SS7SB26A 6/14/2001	4-6	SW6010	Aluminum	18,100			27	2,000,000	8,450	--	--
	4-6	SW6020	Arsenic	2.46			0.6	3.8	2.7	0.026	100
	4-6	SW6010	Barium	130			0.6	140,000	104	2,100	2,000
	4-6	SW6010	Beryllium	0.78			0.03	4,100	1.1	1,200	--
	4-6	SW6010	Cadmium	0.102	J	F	0.12	1,000	1	27	20
	4-6	SW6010	Calcium	74,000			1,200	--	54,200	--	--
	4-6	SW6010	Chromium, Total	13			0.3	6,100	9.1	42	100
	4-6	SW6010	Cobalt	6.5			0.3	41,000	4.8	--	--
	4-6	SW6010	Copper	7.3			1.2	82,000	4.1	11,000	--
	4-6	SW6010	Iron	13,900			0.36	1,200,000	8,340	--	--
	4-6	SW6020	Lead	6.49			0.6	--	6.7	--	100
	4-6	SW6010	Magnesium	7,000			30	--	4,540	--	--
	4-6	SW6010	Manganese	340			0.6	41,000	254	950	--
	4-6	SW6010	Nickel	8.7			2.4	41,000	5.9	--	--
	4-6	SW6010	Potassium	3,000			60	--	2,680	--	--
	4-6	SW6010	Sodium	79.2			12	--	386	--	--
	4-6	SW6020	Thallium	0.164			0.12	140	0.25	3.6	--
	4-6	SW6010	Vanadium	33			0.6	14,000	25.2	5,100	--
	4-6	SW6010	Zinc	32			1.2	610,000	20.9	14,000	--
SS7SB26B 6/14/2001	15-17	SW6010	Aluminum	25,400			27	2,000,000	8,450	--	--
	15-17	SW6020	Arsenic	2.89			0.6	3.8	2.7	0.026	100
	15-17	SW6010	Barium	88			0.6	140,000	104	2,100	2,000
	15-17	SW6010	Beryllium	1.1			0.03	4,100	1.1	1,200	--
	15-17	SW6010	Calcium	29,000	J	J	12	--	54,200	--	--
	15-17	SW6010	Chromium, Total	16			0.3	6,100	9.1	42	100

TABLE 2-5
DETECTIONS OF INORGANIC COMPOUNDS IN SUBSURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SB26B 6/14/2001 (cont.)	15-17	SW6010	Cobalt	7.0	J	J	0.3	41,000	4.8	--	--
	15-17	SW6010	Copper	11			1.2	82,000	4.1	11,000	--
	15-17	SW6010	Iron	17,700			0.36	1,200,000	8,340	--	--
	15-17	SW6020	Lead	7.72	J	J	0.6	--	6.7	--	100
	15-17	SW6010	Magnesium	9,800			30	--	4,540	--	--
	15-17	SW6010	Manganese	250	J	J	0.6	41,000	254	950	--
	15-17	SW6010	Nickel	12			2.4	41,000	5.9	--	--
	15-17	SW6010	Potassium	4,500			60	--	2,680	--	--
	15-17	SW6020	Selenium	0.178	J	F	0.24	10,000	0.25	19	20
	15-17	SW6010	Sodium	125			12	--	386	--	--
	15-17	SW6020	Thallium	0.208	J	J	0.12	140	0.25	3.6	--
	15-17	SW6010	Vanadium	38			0.6	14,000	25.2	5,100	--
	15-17	SW6010	Zinc	48			1.2	610,000	20.9	14,000	--
SS7SB26B (FD) 6/14/2001	15-17	SW6010	Aluminum	25,500			26	2,000,000	8,450	--	--
	15-17	SW6020	Arsenic	2.43			0.6	3.8	2.7	0.026	100
	15-17	SW6010	Barium	100			0.6	140,000	104	2,100	2,000
	15-17	SW6010	Beryllium	1.1			0.03	4,100	1.1	1,200	--
	15-17	SW6010	Calcium	48,000			12	--	54,200	--	--
	15-17	SW6010	Chromium, Total	15			0.3	6,100	9.1	42	100
	15-17	SW6010	Cobalt	8.6			0.3	41,000	4.8	--	--
	15-17	SW6010	Copper	11			1.2	82,000	4.1	11,000	--
	15-17	SW6010	Iron	17,500			0.36	1,200,000	8,340	--	--
	15-17	SW6020	Lead	5.49			0.6	--	6.7	--	100
	15-17	SW6010	Magnesium	9,800			30	--	4,540	--	--
	15-17	SW6010	Manganese	330			0.6	41,000	254	950	--
	15-17	SW6010	Nickel	12			2.4	41,000	5.9	--	--
	15-17	SW6010	Potassium	4,800			60	--	2,680	--	--
	15-17	SW6010	Sodium	131			12	--	386	--	--
	15-17	SW6020	Thallium	0.152			0.12	140	0.25	3.6	--
	15-17	SW6010	Vanadium	39			0.6	14,000	25.2	5,100	--
	15-17	SW6010	Zinc	49			1.2	610,000	20.9	14,000	--

TABLE 2-5
DETECTIONS OF INORGANIC COMPOUNDS IN SUBSURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SB26C 6/14/2001	21-23	SW6010	Aluminum	27,400			28	2,000,000	8,450	--	--
	21-23	SW6020	**Arsenic**	**4.79**			0.63	3.8	2.7	0.026	100
	21-23	SW6010	Barium	110			0.63	140,000	104	2,100	2,000
	21-23	SW6010	Beryllium	1.2			0.031	4,100	1.1	1,200	--
	21-23	SW6010	Calcium	7,300			13	--	54,200	--	--
	21-23	SW6010	Chromium, Total	12			0.31	6,100	9.1	42	100
	21-23	SW6010	Cobalt	7.9			0.31	41,000	4.8	--	--
	21-23	SW6010	Copper	12			1.3	82,000	4.1	11,000	--
	21-23	SW6010	Iron	16,100			3.8	1,200,000	8,340	--	--
	21-23	SW6020	Lead	8.86			0.63	--	6.7	--	100
	21-23	SW6010	Magnesium	11,000			31	--	4,540	--	--
	21-23	SW6010	Manganese	290			0.63	41,000	254	950	--
	21-23	SW6010	Nickel	12			2.5	41,000	5.9	--	--
	21-23	SW6010	Potassium	4,400			63	--	2,680	--	--
	21-23	SW6010	Sodium	114			13	--	386	--	--
	21-23	SW6020	Thallium	0.211			0.13	140	0.25	3.6	--
	21-23	SW6010	Vanadium	35			0.63	14,000	25.2	5,100	--
	21-23	SW6010	Zinc	51			1.3	610,000	20.9	14,000	--
SS7SB33A 6/15/2001	6-7	SW6010	Aluminum	19,900			26	2,000,000	8,450	--	--
	6-7	SW6020	Arsenic	2.12			0.58	3.8	2.7	0.026	100
	6-7	SW6010	Barium	100			0.58	140,000	104	2,100	2,000
	6-7	SW6010	Beryllium	0.92			0.029	4,100	1.1	1,200	--
	6-7	SW6010	Calcium	39,000			12	--	54,200	--	--
	6-7	SW6010	Chromium, Total	12			0.29	6,100	9.1	42	100
	6-7	SW6010	Cobalt	6.3			0.29	41,000	4.8	--	--
	6-7	SW6010	Copper	8.3			1.2	82,000	4.1	11,000	--
	6-7	SW6010	Iron	13,800			3.5	1,200,000	8,340	--	--
	6-7	SW6020	Lead	5.81			0.58	--	6.7	--	100
	6-7	SW6010	Magnesium	7,700			29	--	4,540	--	--
	6-7	SW6010	Manganese	280			0.58	41,000	254	950	--
	6-7	SW6010	Nickel	9.8			2.3	41,000	5.9	--	--
	6-7	SW6010	Potassium	3,300			58	--	2,680	--	--
	6-7	SW6010	Sodium	57.9			12	--	386	--	--

TABLE 2-5
DETECTIONS OF INORGANIC COMPOUNDS IN SUBSURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SB33A	6-7	SW6020	Thallium	0.173			0.12	140	0.25	3.6	--
6/15/2001	6-7	SW6010	Vanadium	30			0.58	14,000	25.2	5,100	--
(cont.)	6-7	SW6010	Zinc	34			1.2	610,000	20.9	14,000	--
SS7SB33B	15.5-16	SW6010	Aluminum	21,500			27	2,000,000	8,450	--	--
6/15/2001	15.5-16	SW6020	Arsenic	3.34			0.61	3.8	2.7	0.026	100
	15.5-16	SW6010	Barium	93			0.61	140,000	104	2,100	2,000
	15.5-16	SW6010	Beryllium	0.940			0.03	4,100	1.1	1,200	--
	15.5-16	SW6010	Calcium	27,000			12	--	54,200	--	--
	15.5-16	SW6010	Chromium, Total	16.3			0.3	6,100	9.1	42	100
	15.5-16	SW6010	Cobalt	7.93			0.3	41,000	4.8	--	--
	15.5-16	SW6010	Copper	11			1.2	82,000	4.1	11,000	--
	15.5-16	SW6010	Iron	18,400			18	1,200,000	8,340	--	--
	15.5-16	SW6020	Lead	6.61			0.61	--	6.7	--	100
	15.5-16	SW6010	Magnesium	8,500			30	--	4,540	--	--
	15.5-16	SW6010	Manganese	290			3	41,000	254	950	--
	15.5-16	SW6010	Nickel	11			2.4	41,000	5.9	--	--
	15.5-16	SW6010	Potassium	4,300			61	--	2,680	--	--
	15.5-16	SW6010	Sodium	100			12	--	386	--	--
	15.5-16	SW6020	Thallium	0.179			0.12	140	0.25	3.6	--
	15.5-16	SW6010	Vanadium	37			0.61	14,000	25.2	5,100	--
	15.5-16	SW6010	Zinc	44			1.2	61,000	20.9	14,000	--
SS7SB33C	22-23	SW6010	Aluminum	27,000			27	2,000,000	8,450	--	--
6/15/2001	22-23	SW6020	Arsenic	3.35			0.61	3.8	2.7	0.026	100
	22-23	SW6010	Barium	120			0.61	140,000	104	2,100	2,000
	22-23	SW6010	Beryllium	1.1			0.03	4,100	1.1	1,200	--
	22-23	SW6010	Calcium	8,600			12	--	54,200	--	--
	22-23	SW6010	Chromium, Total	12			0.3	6,100	9.1	42	100
	22-23	SW6010	Cobalt	6.4			0.3	41,000	4.8	--	--
	22-23	SW6010	Copper	11			1.2	82,000	4.1	11,000	--
	22-23	SW6010	Iron	15,400			3.7	1,200,000	8,340	--	--
	22-23	SW6020	Lead	7.62			0.61	--	6.7	--	100
	22-23	SW6010	Magnesium	11,000			30	--	4,540	--	--
	22-23	SW6010	Manganese	260			0.61	41,000	254	950	--

TABLE 2-5
DETECTIONS OF INORGANIC COMPOUNDS IN SUBSURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SB33C 6/15/2001 (cont.)	22-23	SW6010	Nickel	12			2.4	41,000	5.9	--	--
	22-23	SW6010	Potassium	4,200			61	--	2,680	--	--
	22-23	SW6010	Sodium	135			12	--	386	--	--
	22-23	SW6020	Thallium	0.160			0.12	140	0.25	3.6	--
	22-23	SW6010	Vanadium	33			0.61	14,000	25.2	5,100	--
	22-23	SW6010	Zinc	49			1.2	610,000	20.9	14,000	--
SS7SB34A 6/15/2001	5-6	SW6010	Aluminum	4,120			22	2,000,000	8,450	--	--
	5-6	SW6020	Arsenic	0.788			0.51	3.8	2.7	0.026	100
	5-6	SW6010	Barium	110			0.51	140,000	104	2,100	2,000
	5-6	SW6010	Beryllium	0.25			0.025	4,100	1.1	1,200	--
	5-6	SW6010	Calcium	20,000			10	--	54,200	--	--
	5-6	SW6010	Chromium, Total	5.6			0.25	6,100	9.1	42	100
	5-6	SW6010	Cobalt	1.3			0.25	41,000	4.8	--	--
	5-6	SW6010	Copper	2.8			1	82,000	4.1	11,000	--
	5-6	SW6010	Iron	4,380			3	1,200,000	8,340	--	--
	5-6	SW6020	Lead	1.90			0.51	--	6.7	--	100
	5-6	SW6010	Magnesium	1,700			25	--	4,540	--	--
	5-6	SW6010	Manganese	61			0.51	41,000	254	950	--
	5-6	SW6010	Molybdenum	0.61	J	F	2	10,000	2	--	--
	5-6	SW6010	Nickel	2.2			2	41,000	5.9	--	--
	5-6	SW6010	Potassium	820			51	--	2,680	--	--
	5-6	SW6010	Sodium	80.7			10	--	386	--	--
	5-6	SW6010	Vanadium	11			0.51	14,000	25.2	5,100	--
	5-6	SW6010	Zinc	9.3			1	610,000	20.9	14,000	--
SS7SB34B 6/15/2001	17-18	SW6010	Aluminum	21,400			28	2,000,000	8,450	--	--
	17-18	SW6020	Arsenic	2.56			0.63	3.8	2.7	0.026	100
	17-18	SW6010	Barium	65			0.63	140,000	104	2,100	2,000
	17-18	SW6010	Beryllium	0.94			0.031	4,100	1.1	1,200	--
	17-18	SW6010	Calcium	6,300			13	--	54,200	--	--
	17-18	SW6010	Chromium, Total	14			0.31	6,100	9.1	42	100
	17-18	SW6010	Cobalt	7.1			0.31	41,000	4.8	--	--
	17-18	SW6010	Copper	7.5			1.3	82,000	4.1	11,000	--
	17-18	SW6010	Iron	17,400			3.8	1,200,000	8,340	--	--

TABLE 2-5
DETECTIONS OF INORGANIC COMPOUNDS IN SUBSURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SB34B 6/15/2001 (cont.)	17-18	SW6020	Lead	4.95			0.63	--	6.7	--	100
	17-18	SW6010	Magnesium	8,200			31	--	4,540	--	--
	17-18	SW6010	Manganese	250			0.63	41,000	254	950	--
	17-18	SW6010	Nickel	9.8			2.5	41,000	5.9	--	--
	17-18	SW6010	Potassium	3,300			63	--	2,680	--	--
	17-18	SW6010	Sodium	98.8			13	--	386	--	--
	17-18	SW6020	Thallium	0.141			0.13	140	0.25	3.6	--
	17-18	SW6010	Vanadium	40			0.63	14,000	25.2	5,100	--
	17-18	SW6010	Zinc	38			1.3	610,000	20.9	14,000	--
SS7SB34C 6/15/2001	24-25	SW6010	Aluminum	29,300			27	2,000,000	8,450	--	--
	24-25	SW6020	Arsenic	0.369			0.62	3.8	2.7	0.026	100
	24-25	SW6010	Barium	100			0.62	140,000	104	2,100	2,000
	24-25	SW6010	Beryllium	1.3			0.031	4,100	1.1	1,200	--
	24-25	SW6010	Calcium	7,400			12	--	54,200	--	--
	24-25	SW6010	Chromium, Total	14			0.31	6,100	9.1	42	100
	24-25	SW6010	Cobalt	8.6			0.31	41,000	4.8	--	--
	24-25	SW6010	Copper	15			1.2	82,000	4.1	11,000	--
	24-25	SW6010	Iron	18,400			3.7	1,200,000	8,340	--	--
	24-25	SW6020	Lead	7.58			0.62	--	6.7	--	100
	24-25	SW6010	Magnesium	11,000			31	--	4,540	--	--
	24-25	SW6010	Manganese	280			0.62	41,000	254	950	--
	24-25	SW6010	Nickel	12			2.5	41,000	5.9	--	--
	24-25	SW6010	Potassium	5,300			62	--	2,680	--	--
	24-25	SW6010	Sodium	137			12	--	386	--	--
	24-25	SW6020	Thallium	0.108	J	F	0.12	140	0.25	3.6	--
	24-25	SW6010	Vanadium	40			0.62	14,000	25.2	5,100	--
	24-25	SW6010	Zinc	57			1.2	610,000	20.9	14,000	--
SS7SB35A 6/20/2001	6-8	SW6010	Aluminum	14,400			22	2,000,000	8,450	--	--
	6-8	SW6020	Arsenic	2.05			0.51	3.8	2.7	0.026	100
	6-8	SW6010	Barium	93			0.51	140,000	104	2,100	2,000
	6-8	SW6010	Beryllium	0.55			0.026	4,100	1.1	1,200	--
	6-8	SW6010	Cadmium	0.0647	J	F	0.1	1,000	1	27	20
	6-8	SW6010	Calcium	62,000			1,000	--	54,200	--	--

TABLE 2-5
DETECTIONS OF INORGANIC COMPOUNDS IN SUBSURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SB35A 6/20/2001 (cont.)	6-8	SW6010	Chromium, Total	7.4			0.26	6,100	9.1	42	100
	6-8	SW6010	Cobalt	0.36			0.26	41,000	4.8	--	--
	6-8	SW6010	Copper	6.4			1	82,000	4.1	11,000	--
	6-8	SW6010	Iron	8,450			3.1	1,200,000	8,340	--	--
	6-8	SW6020	Lead	5.21			0.51	--	6.7	--	100
	6-8	SW6010	Magnesium	5,300			26	--	4,540	--	--
	6-8	SW6010	Manganese	250			0.51	41,000	254	950	--
	6-8	SW6010	Nickel	5.8			2	41,000	5.9	--	--
	6-8	SW6010	Potassium	2,500			51	--	2,680	--	--
	6-8	SW6020	Selenium	0.260			0.2	10,000	0.25	19	20
	6-8	SW6010	Sodium	67.0			10	--	386	--	--
	6-8	SW6020	Thallium	0.0943	J	F	0.1	140	0.25	3.6	--
	6-8	SW6010	Vanadium	21			0.51	14,000	25.2	5,100	--
	6-8	SW6010	Zinc	25			1	610,000	20.9	14,000	--
SS7SB35B 6/20/2001	21-22	SW6010	Aluminum	31,700			26	2,000,000	8,450	--	--
	21-22	SW6020	**Arsenic**	**4.02**			0.6	3.8	2.7	0.026	100
	21-22	SW6010	Barium	110			0.6	140,000	104	2,100	2,000
	21-22	SW6010	Beryllium	1.5			0.03	4,100	1.1	1,200	--
	21-22	SW6010	Calcium	7,300			12	--	54,200	--	--
	21-22	SW6010	Chromium, Total	16			0.3	6,100	9.1	42	100
	21-22	SW6010	Cobalt	7.0			0.3	41,000	4.8	--	--
	21-22	SW6010	Copper	15			1.2	82,000	4.1	11,000	--
	21-22	SW6010	Iron	20,800			0.36	1,200,000	8,340	--	--
	21-22	SW6020	Lead	9.60			0.6	--	6.7	--	100
	21-22	SW6010	Magnesium	11,000			30	--	4,540	--	--
	21-22	SW6010	Manganese	230			0.6	41,000	254	950	--
	21-22	SW6010	Nickel	13			2.4	41,000	5.9	--	--
	21-22	SW6010	Potassium	6,300			60	--	2,680	--	--
	21-22	SW6020	Selenium	0.162	J	F	0.24	10,000	0.25	19	20
	21-22	SW6010	Sodium	151			12	--	386	--	--
	21-22	SW6020	Thallium	0.19			0.12	140	0.25	3.6	--
	21-22	SW6010	Vanadium	46			0.6	14,000	25.2	5,100	--
	21-22	SW6010	Zinc	65			1.2	610,000	20.9	14,000	--

TABLE 2-5
DETECTIONS OF INORGANIC COMPOUNDS IN SUBSURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SB35C 6/20/2001	27-29	SW6010	Aluminum	18,800			26	2,000,000	8,450	--	--
	27-29	SW6020	Arsenic	1.13			0.6	3.8	2.7	0.026	100
	27-29	SW6010	Barium	57			0.6	140,000	104	2,100	2,000
	27-29	SW6010	Beryllium	0.75			0.03	4,100	1.1	1,200	--
	27-29	SW6010	Calcium	12,000			12	--	54,200	--	--
	27-29	SW6010	Chromium, Total	7.6			0.3	6,10	9.1	42	100
	27-29	SW6010	Cobalt	5.0			0.3	41,000	4.8	--	--
	27-29	SW6010	Copper	10			1.2	82,000	4.1	11,000	--
	27-29	SW6010	Iron	11,300			0.36	1,200,000	8,340	--	--
	27-29	SW6020	Lead	3.30			0.6	--	6.7	--	100
	27-29	SW6010	Magnesium	7,000			30	--	4,540	--	--
	27-29	SW6010	Manganese	220			0.6	41,000	254	950	--
	27-29	SW6010	Nickel	6.3			2.4	41,000	5.9	--	--
	27-29	SW6010	Potassium	2,300			60	--	2,680	--	--
	27-29	SW6010	Sodium	72.6			12	--	386	--	--
	27-29	SW6010	Vanadium	31			0.6	14,000	25.2	5,100	--
	27-29	SW6010	Zinc	31			1.2	610,000	20.9	14,000	--
SS7SB36A 6/20/2001	6-8	SW6010	Aluminum	19,200			26	2,000,000	8,450	--	--
	6-8	SW6020	Arsenic	2.52			0.59	3.8	2.7	0.026	100
	6-8	SW6010	Barium	89	J	M	0.59	140,000	104	2,100	2,000
	6-8	SW6010	Beryllium	0.83			0.029	4,100	1.1	1,200	--
	6-8	SW6010	Cadmium	0.124			0.12	1,000	1	27	20
	6-8	SW6010	Calcium	120,000			59	--	54,200	--	--
	6-8	SW6010	Chromium, Total	17			0.29	6,100	9.1	42	100
	6-8	SW6010	Cobalt	5.7			0.29	41,000	4.8	--	--
	6-8	SW6010	Copper	7.9			1.2	82,000	4.1	11,000	--
	6-8	SW6010	Iron	14,500			18	1,200,000	8,340	--	--
	6-8	SW6020	Lead	6.56			0.59	--	6.7	--	100
	6-8	SW6010	Magnesium	7,300			29	--	4,540	--	--
	6-8	SW6010	Manganese	390			0.59	41,000	254	950	--
	6-8	SW6010	Nickel	8.7			2.4	41,000	5.9	--	--
	6-8	SW6010	Potassium	3,400			59	--	2,680	--	--
	6-8	SW6010	Silver	0.21	J	F	0.59	10,000	1.5	31	100

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DETECTIONS OF INORGANIC COMPOUNDS IN SUBSURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SB36A	6-8	SW6010	Sodium	76.4			12	--	386	--	--
6/20/2001	6-8	SW6020	Thallium	0.180			0.12	140	0.25	3.6	--
(cont.)	6-8	SW6010	Vanadium	32			0.59	14,000	25.2	5,100	--
	6-8	SW6010	Zinc	36			1.2	610,000	20.9	14,000	--
SS7SB36B	10-11	SW6010	Aluminum	47,900			31	2,000,000	8,450	--	--
6/20/2001	10-11	SW6020	**Arsenic**	**4.56**			0.69	3.8	2.7	0.026	100
	10-11	SW6010	Barium	170			0.69	140,000	104	2,100	2,000
	10-11	SW6010	Beryllium	2.0			0.035	4,100	1.1	1,200	--
	10-11	SW6010	Calcium	21,000			14	--	54,200	--	--
	10-11	SW6010	Chromium, Total	33			0.35	6,100	9.1	42	100
	10-11	SW6010	Cobalt	18			0.35	41,000	4.8	--	--
	10-11	SW6010	Copper	25			1.4	82,000	4.1	11,000	--
	10-11	SW6010	Iron	29,300			4.2	1,200,000	8,340	--	--
	10-11	SW6020	Lead	17.2			0.69	--	6.7	--	100
	10-11	SW6010	Magnesium	16,000			35	--	4,540	--	--
	10-11	SW6010	Manganese	340			0.69	41,000	254	950	--
	10-11	SW6010	Nickel	22			2.8	41,000	5.9	--	--
	10-11	SW6010	Potassium	10,000			69	--	2,680	--	--
	10-11	SW6020	Selenium	0.285			0.28	10,000	0.25	19	20
	10-11	SW6010	Sodium	265			14	--	386	--	--
	10-11	SW6020	Thallium	0.304			0.14	140	0.25	3.6	--
	10-11	SW6010	Vanadium	63			0.69	14,000	25.2	5,100	--
	10-11	SW6010	Zinc	94			1.4	610,000	20.9	14,000	--
SS7SB36C	18.5-19.5	SW6010	Aluminum	24,400			27	2,000,000	8,450	--	--
6/20/2001	18.5-19.5	SW6020	**Arsenic**	**4.17**			0.61	3.8	2.7	0.026	100
	18.5-19.5	SW6010	Barium	100			0.61	140,000	104	2,100	2,000
	18.5-19.5	SW6010	Beryllium	0.94			0.03	4,100	1.1	1,200	--
	18.5-19.5	SW6010	Cadmium	0.251			0.12	1,000	1	27	20
	18.5-19.5	SW6010	Calcium	140,000			1,200	--	54,200	--	--
	18.5-19.5	SW6010	Chromium, Total	16			0.3	6,100	9.1	42	100
	18.5-19.5	SW6010	Cobalt	7.0			0.3	41,000	4.8	--	--
	18.5-19.5	SW6010	Copper	12			1.2	82,000	4.1	11,000	--
	18.5-19.5	SW6010	Iron	14,800			3.7	1,200,000	8,340	--	--

TABLE 2-5
DETECTIONS OF INORGANIC COMPOUNDS IN SUBSURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SB36C 6/20/2001 (cont.)	18.5-19.5	SW6020	Lead	8.50			0.61	--	6.7	--	100
	18.5-19.5	SW6010	Magnesium	8,600			30	--	4,540	--	--
	18.5-19.5	SW6010	Manganese	340			0.61	41,000	254	950	--
	18.5-19.5	SW6010	Nickel	9.1			2.4	41,000	5.9	--	--
	18.5-19.5	SW6010	Potassium	4,500			61	--	2,680	--	--
	18.5-19.5	SW6020	Selenium	0.251			0.24	10,000	0.25	19	20
	18.5-19.5	SW6010	Sodium	127			12	--	386	--	--
	18.5-19.5	SW6020	Thallium	0.157			0.12	140	0.25	3.6	--
	18.5-19.5	SW6010	Vanadium	36			0.61	14,000	25.2	5,100	--
	18.5-19.5	SW6010	Zinc	44			1.2	610,000	20.9	14,000	--
SS7SB39A 6/21/2001	6-8	SW6010	Aluminum	19,100			28	2,000,000	8,450	--	--
	6-8	SW6020	Arsenic	2.62			0.64	3.8	2.7	0.026	100
	6-8	SW6010	Barium	100			0.64	140,000	104	2,100	2,000
	6-8	SW6010	Beryllium	1.1			0.032	4,100	1.1	1,200	--
	6-8	SW6010	Calcium	20,000	J	M	13	--	54,200	--	--
	6-8	SW6010	Chromium, Total	12			0.32	6,100	9.1	42	100
	6-8	SW6010	Cobalt	6.1			0.32	41,000	4.8	--	--
	6-8	SW6010	Copper	8.2			1.3	82,000	4.1	11,000	--
	6-8	SW6010	Iron	13,700			3.8	1,200,000	8,340	--	--
	6-8	SW6020	Lead	8.37			0.64	--	6.7	--	100
	6-8	SW6010	Magnesium	7,900			32	--	4,540	--	--
	6-8	SW6010	Manganese	220			0.64	41,000	254	950	--
	6-8	SW6010	Nickel	9.7			2.6	41,000	5.9	--	--
	6-8	SW6010	Potassium	3,700	J	M	64	--	2,680	--	--
	6-8	SW6020	Selenium	0.350			0.26	10,000	0.25	19	20
	6-8	SW6010	Sodium	57.6			13	--	386	--	--
	6-8	SW6020	Thallium	0.250			0.13	140,	0.25	3.6	--
	6-8	SW6010	Vanadium	28			0.64	14,000	25.2	5,100	--
	6-8	SW6010	Zinc	36			1.3	610,000	20.9	14,000	--
SS7SB39B 6/21/2001	14-15	SW6010	Aluminum	37,100			29	2,000,000	8,450	--	--
	14-15	SW6020	Arsenic	3.76			0.67	3.8	2.7	0.026	100
	14-15	SW6010	Barium	140			0.67	140,000	104	2,100	2,000
	14-15	SW6010	Beryllium	1.8			0.033	4,100	1.1	1,200	--

TABLE 2-5
DETECTIONS OF INORGANIC COMPOUNDS IN SUBSURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)
SS7SB39B 6/21/2001 (cont.)	14-15	SW6010	Calcium	39,000			13	--	54,200	--	--
	14-15	SW6010	Chromium, Total	25			0.33	6,100	9.1	42	100
	14-15	SW6010	Cobalt	7.4			0.33	41,000	4.8	--	--
	14-15	SW6010	Copper	19			1.3	82,000	4.1	11,000	--
	14-15	SW6010	Iron	24,000			4	1,200,000	8,340	--	--
	14-15	SW6020	Lead	8.44			0.67	--	6.7	--	100
	14-15	SW6010	Magnesium	13,000			33	--	4,540	--	--
	14-15	SW6010	Manganese	220			0.67	41,000	254	950	--
	14-15	SW6010	Nickel	16			2.7	41,000	5.9	--	--
	14-15	SW6010	Potassium	8,500			67	--	2,680	--	--
	14-15	SW6020	Selenium	0.427			0.27	10,000	0.25	19	20
	14-15	SW6010	Sodium	185			13	--	386	--	--
	14-15	SW6020	Thallium	0.308			0.13	140,	0.25	3.6	--
	14-15	SW6010	Vanadium	48			0.67	14,000	25.2	5,100	--
	14-15	SW6010	Zinc	76			1.3	610,000	20.9	14,000	--
SS7SB39C 6/21/2001	16-17	SW6010	Aluminum	10,900			27	2,000,000	8,450	--	--
	16-17	SW6020	Arsenic	2.07			0.62	3.8	2.7	0.026	100
	16-17	SW6010	Barium	48			0.62	140,000	104	2,100	2,000
	16-17	SW6010	Beryllium	0.49			0.031	4,100	1.1	1,200	--
	16-17	SW6010	Calcium	4,500			12	--	54,200	--	--
	16-17	SW6010	Chromium, Total	9.0			0.31	6,100	9.1	42	100
	16-17	SW6010	Cobalt	5.6			0.31	41,000	4.8	--	--
	16-17	SW6010	Copper	4.9			1.2	82,000	4.1	11,000	--
	16-17	SW6010	Iron	11,600			3.7	1,200,000	8,340	--	--
	16-17	SW6020	Lead	4.90			0.62	--	6.7	--	100
	16-17	SW6010	Magnesium	4,500			31	--	4,540	--	--
	16-17	SW6010	Manganese	210			0.62	41,000	254	950	--
	16-17	SW6010	Nickel	6.4			2.5	41,000	5.9	--	--
	16-17	SW6010	Potassium	2,000			62	--	2,680	--	--
	16-17	SW6020	Selenium	0.154	J	F	0.25	10,000	0.25	19	10
	16-17	SW6010	Sodium	65.3			12	--	386	--	--
	16-17	SW6020	Thallium	0.151			0.12	140	0.25	3.6	--
	16-17	SW6010	Vanadium	27			0.62	14,000	25.2	5,100	--
	16-17	SW6010	Zinc	23			1.2	610,000	20.9	14,000	--

TABLE 2-5
DETECTIONS OF INORGANIC COMPOUNDS IN SUBSURFACE SOIL
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Sample Interval (feet)	Analytical Method Code	Analyte	Result (mg/kg)	Lab Flag	QAPP Flag	RL (mg/kg)	RBC (mg/kg)	Background (mg/kg)	SSL (mg/kg)	TCLP X 20* (mg/kg)

Notes:

mg/kg = milligrams per kilogram

QAPP = Quality Assurance Project Plan

RL = Reporting Limit

RBC = EPA Region III risk-based concentration values for industrial soils.

TCLP = Toxicity Characteristic Leaching Procedure

X 20* = Values posted are 20 times the regulatory TCLP standard for comparison to metal concentrations in bulk soil

Background = Background values based on the "Geochemical Background Concentrations of Selected Constituents in Soil, Shallow Groundwater, Surface Water, and Sediment, Operable Unit 2, F.E. Warren Air Force Base" (Revised Draft, September 1999).

SSL = Soil Screening Level at a Dilution Attenuation Factor of 20.

J = The analyte was positively identified, but the quantitation is an estimation.

F = The analyte was positively identified but the associated numerical value is below the RL.

M = A matrix effect was present.

-- = No published standard.

Bold indicates exceedance of RBC and background value or SSL and background value.

TABLE 2-6
DETECTIONS OF ORGANIC COMPOUNDS IN GROUNDWATER
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Analytical Method Code	Analyte	Result (µg/L)	Lab Flag	QAPP Flag	RL (µg/L)	RBC (µg/L)	Primary MCL (µg/L)
MW-027 3/14/2001	SW8260B	1,1-Dichloroethane	0.38		F	0.4	800	--
	SW8260B	1,1-Dichloroethene	1.99			1.2	0.044	7
	SW8260B	Chloroform	12.03		B	0.3	0.15	80*
	SW8260B	Cis-1,2-Dichloroethylene	33.38			9.6	61	70
	SW8260B	Trans-1,2-Dichloroethene	0.44		F	0.6	120	100
	SW8260B	**Trichloroethylene (TCE)**	**103.4**			8	1.6	5
MW-027 7/12/2001	SW8260B	1,1-Dichloroethane	0.29	J	F	0.5	800	--
	SW8260B	1,1-Dichloroethene	1.2			1.2	0.044	7
	SW8260B	Cis-1,2-Dichloroethylene	37		M	1.2	61	70
	SW8260B	**Trichloroethylene (TCE)**	**110**		B	1	1.6	5
MW-069 3/19/2001	SW8260B	1,1,2-Trichloroethane	0.89		F	1	0.19	5
	SW8260B	1,1-Dichloroethane	0.24		F	0.4	800	--
	SW8260B	1,1-Dichloroethene	0.44		F	1.2	0.044	7
	SW8260B	Carbon Tetrachloride	0.2		F	2.1	0.16	5
	SW8260B	Chloroform	1.19		B	0.3	0.15	80*
	SW8260B	Cis-1,2-Dichloroethylene	53.7			12	61	70
	SW8260B	Trans-1,2-Dichloroethene	1.47			0.6	120	100
	SW8260B	**Trichloroethylene (TCE)**	**1,812**			100	1.6	5
MW-1013 3/22/2001	SW8260B	Acetone	1,393			400	610	--
	SW8260B	Bromomethane	0.34		F	1.1	8.5	--
	SW8260B	Cis-1,2-Dichloroethylene	13.34			1.2	61	70
	SW8260B	Methylene Chloride	0.2		F	0.3	4.1	--
	SW8260B	**Trichloroethylene (TCE)**	**57.5**			40	1.6	5
	SW8260B	Vinyl Chloride	0.27		F	1.1	0.015	2
MW-1013 9/21/2001	SW8260B	Acetone	2,649			1000	610	--
	SW8260B	Acetone	2,012			10	610	--
	SW8260B	Chloroform	0.08		F	0.3	0.15	80*
	SW8260B	Cis-1,2-Dichloroethylene	0.85		F	1.2	61	70
	SW8260B	Trichloroethylene (TCE)	3.97			1	1.6	5
MW-1014 10/5/2001	SW8260B	Acetone	22.5			10	610	--
	SW8260B	Benzene	0.17		F	0.4	0.32	5
	SW8260B	Cis-1,2-Dichloroethylene	0.17		F	1.2	61	70

TABLE 2-6
DETECTIONS OF ORGANIC COMPOUNDS IN GROUNDWATER
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Analytical Method Code	Analyte	Result (µg/L)	Lab Flag	QAPP Flag	RL (µg/L)	RBC (µg/L)	Primary MCL (µg/L)
MW-1014 10/5/2001 (cont.)	SW8260B	Methylene Chloride	0.08		F	0.3	4.1	--
	SW8260B	Toluene	0.16		F	1.1	750	1000
	SW8260B	Trichloroethylene (TCE)	2.08			1	1.6	5
MW-1014 3/23/2001	SW8260B	Acetone	33			10	610	--
	SW8260B	Bromomethane	0.22		F	1.1	8.5	--
	SW8260B	Chloroform	0.75		b	0.3	0.15	80*
	SW8260B	Cis-1,2-Dichloroethylene	1.32			1.2	61	70
	SW8260B	**Trichloroethylene (TCE)**	**24.88**			2	1.6	5
MW-149 7/11/2001	SW8260B	1,1-Dichloroethane	0.33	J	F	0.5	800	--
	SW8260B	1,1-Dichloroethene	1.4			1.2	0.044	7
	SW8260B	1,2,3-Trichlorobenzene	0.16	J	F	1	0	--
	SW8260B	Cis-1,2-Dichloroethylene	24			1.2	61	70
	SW8260B	**Trichloroethylene (TCE)**	**66**		B	1	1.6	5
MW-150 7/11/2001	SW8260B	Cis-1,2-Dichloroethylene	5.6			1.2	61	70
	SW8260B	**Trichloroethylene (TCE)**	**47**		B	1	1.6	5
MW-151 3/14/2001	SW8260B	**1,1,2-Trichloroethane**	**5.46**			1	0.19	5
	SW8260B	1,1-Dichloroethane	0.85			0.4	800	--
	SW8260B	1,1-Dichloroethene	1.95			1.2	0.044	7
	SW8260B	1,2-Dichloroethane	0.25		F	0.6	0.12	5
	SW8260B	1,2-Dichloropropane	0.3		F	0.4	0.16	5
	SW8260B	Benzene	0.08		F	0.4	0.32	5
	SW8260B	Carbon Tetrachloride	0.84		F	2.1	0.16	5
	SW8260B	Chloroform	6.61		B	0.3	0.15	80*
	SW8260B	**Cis-1,2-Dichloroethylene**	**282**			120	61	70
	SW8260B	Tetrachloroethylene (PCE)	0.47		F	1.4	1.1	5
	SW8260B	Toluene	0.11		F	1.1	750	1000
	SW8260B	Trans-1,2-Dichloroethene	9.69			0.6	120	100
	SW8260B	**Trichloroethylene (TCE)**	**13,170**			1000	1.6	5
MW-172A 3/9/2001	SW8260B	Bromomethane	0.14		F	1.1	8.5	--
	SW8260B	*Methylene Chloride*	*0.12*		F	0.3	4.1	--
	SW8260B	*Trichloroethylene (TCE)*	*0.16*		F	1	1.6	5

TABLE 2-6
DETECTIONS OF ORGANIC COMPOUNDS IN GROUNDWATER
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Analytical Method Code	Analyte	Result (µg/L)	Lab Flag	QAPP Flag	RL (µg/L)	RBC (µg/L)	Primary MCL (µg/L)
MW-172B 2/26/2001	SW8260B	Acetone	1.4		F	10	610	--
	SW8260B	Chloroform	0.25		F	0.3	0.15	80*
	SW8260B	Methylene Chloride	0.15		F	0.3	4.1	--
	SW8260B	Toluene	0.25		F	1.1	750	1000
	SW8260B	Trichloroethylene (TCE)	0.73		F	1	1.6	5
MW-172C 2/26/2001	SW8260B	Bromodichloromethane	0.27		F	0.8	0.17	--
	SW8260B	Carbon Tetrachloride	0.21		F	2.1	0.16	5
	SW8260B	Chloroform	2.01		B	0.3	0.15	80*
	SW8260B	Cis-1,2-Dichloroethylene	0.51		F	1.2	61	70
	SW8260B	Methylene Chloride	0.14		F	0.3	4.1	--
	SW8260B	**Trichloroethylene (TCE)**	**8.3**			1	1.6	5
MW-173 3/7/2001	SW8260B	Trichloroethylene (TCE)	0.21		F	1	1.6	5
MW-174A 3/14/2001	SW8260B	Trichloroethylene (TCE)	0.12		F	1	1.6	5
MW-174B 3/14/2001	SW8260B	Trichloroethylene (TCE)	0.53		F	1	1.6	5
MW-174C 3/14/2001	SW8260B	1,1,2-Trichloroethane	0.24		F	1	0.19	5
	SW8260B	Chloroform	0.48		B	0.3	0.15	80*
	SW8260B	Cis-1,2-Dichloroethylene	22.51			4.8	61	70
	SW8260B	Trans-1,2-Dichloroethene	0.65			0.6	120	100
	SW8260B	**Trichloroethylene (TCE)**	**470.9**			40	1.6	5
MW-182 4/6/2001	SW8260B	1,1,2-Trichloroethane	0.31	J	F	1	0.19	5
	SW8260B	*1,1,2-Trichloroethane*	*0.3*	J	F	1	0.19	5
	SW8260B	1,1-Dichloroethene	1.36			1.2	0.044	7
	SW8260B	*1,1-Dichloroethene*	*1.37*			1.2	0.044	7
	SW8260B	Chloroform	3.17			0.5	0.15	80*
	SW8260B	*Chloroform*	*3.22*			0.5	0.15	80*
	SW8260B	Cis-1,2-Dichloroethylene	64.7			1.2	61	70
	SW8260B	*Cis-1,2-Dichloroethylene*	*62.8*			1.2	61	70

TABLE 2-6
DETECTIONS OF ORGANIC COMPOUNDS IN GROUNDWATER
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Analytical Method Code	Analyte	Result (µg/L)	Lab Flag	QAPP Flag	RL (µg/L)	RBC (µg/L)	Primary MCL (µg/L)
MW-182 4/6/2001 (cont.)	SW8260B	Trans-1,2-Dichloroethene	0.94			0.6	120	100
	SW8260B	*Trans-1,2-Dichloroethene*	*0.84*			0.6	120	100
	SW8260B	***Trichloroethylene (TCE)***	***888***			10	1.6	5
	SW8260B	***Trichloroethylene (TCE)***	***892***			10	1.6	5
MW-183 4/6/2001	SW8260B	1,1,2-Trichloroethane	0.63	J	F	1	0.19	5
	SW8260B	1,1-Dichloroethene	2.07			1.2	0.044	7
	SW8260B	Chloroform	1.97			0.5	0.15	80*
	SW8260B	Cis-1,2-Dichloroethylene	41.2			1.2	61	70
	SW8260B	**Trichloroethylene (TCE)**	**559**			10	1.6	5
MW-184 7/12/2001	SW8260B	1,1-Dichloroethene	0.69	J	F	1.2	0.044	7
	SW8260B	Cis-1,2-Dichloroethylene	2.9			1.2	61	70
	SW8260B	**Trichloroethylene (TCE)**	**170**		B	1	1.6	5
MW-189 3/6/2001	SW8260B	1,1,1-Trichloroethane	0.59		F	0.8	3,200	200
	SW8260B	1,1,2-Trichloroethane	0.12		F	1	0.19	5
	SW8260B	1,1-Dichloroethene	1.21			1.2	0.044	7
	SW8260B	Bromodichloromethane	0.71		F	0.8	0.17	--
	SW8260B	Carbon Tetrachloride	0.34		F	2.1	0.16	5
	SW8260B	Chloroform	10.53		B	0.3	0.15	80*
	SW8260B	Cis-1,2-Dichloroethylene	4.32			1.2	61	70
	SW8260B	Tetrachloroethylene (PCE)	0.11		F	1.4	1.1	5
	SW8260B	Trans-1,2-Dichloroethene	0.16		F	0.6	120	100
	SW8260B	**Trichloroethylene (TCE)**	**82**		M	10	1.6	5
	SW8260B	Trichlorofluoromethane	0.08		F	0.8	1,300	--
MW-190 7/12/2001	SW8260B	1,1,2-Trichloroethane	2.7			1	0.19	5
	SW8260B	1,1-Dichloroethene	0.58	J	F	1.2	0.044	7
	SW8260B	**Cis-1,2-Dichloroethylene**	**180**			60	61	70
	SW8260B	Tetrachloroethylene (PCE)	0.29	J	F	1.4	1.1	5
	SW8260B	Trans-1,2-Dichloroethene	1.4			0.6	120	100
	SW8260B	**Trichloroethylene (TCE)**	**4,400**		B	50	1.6	5
MW-312 3/7/2001	SW8260B	1,1,1-Trichloroethane	0.33		F	0.8	3,200	200
	SW8260B	1,1-Dichloroethene	0.66		F	1.2	0.044	7
	SW8260B	Chloroform	0.32		B	0.3	0.15	80*

TABLE 2-6
DETECTIONS OF ORGANIC COMPOUNDS IN GROUNDWATER
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Analytical Method Code	Analyte	Result (µg/L)	Lab Flag	QAPP Flag	RL (µg/L)	RBC (µg/L)	Primary MCL (µg/L)
MW-312 3/7/2001 (cont.)	SW8260B	Cis-1,2-Dichloroethylene	0.39		F	1.2	61	70
	SW8260B	Methylene Chloride	0.16		F	0.3	4.1	--
	SW8260B	**Trichloroethylene (TCE)**	**64.94**			4	1.6	5
MW-312D 3/7/2001	SW8260B	Methylene Chloride	0.17		F	0.3	4.1	--
MW-312M1 3/7/2001	SW8260B	1,1,1-Trichloroethane	0.82			0.8	3,200	200
	SW8260B	1,1-Dichloroethene	2.12			1.2	0.044	7
	SW8260B	Chloroform	0.33		B	0.3	0.15	80*
	SW8260B	Cis-1,2-Dichloroethylene	0.18		F	1.2	61	70
	SW8260B	**Trichloroethylene (TCE)**	**39.11**			4	1.6	5
MW-321M1 3/7/2001	SW8260B	Methylene Chloride	0.12		F	0.3	4.1	--
MW-700 3/19/2001	SW8260B	Cis-1,2-Dichloroethylene	0.36		F	1.2	61	70
	SW8260B	Trichloroethylene (TCE)	4.26			1	1.6	5
MW-701 3/16/2001	SW8260B	Cis-1,2-Dichloroethylene	0.13		F	1.2	61	70
	SW8260B	**Trichloroethylene (TCE)**	**7.1**			1	1.6	5
MW-702 3/15/2001	SW8260B	1,1,2-Trichloroethane	1.49			1	0.19	5
	SW8260B	1,1-Dichloroethane	1.35			0.4	800	--
	SW8260B	1,1-Dichloroethene	2.04			1.2	0.044	7
	SW8260B	1,2-Dichloroethane	0.23		F	0.6	0.12	5
	SW8260B	Benzene	0.18		F	0.4	0.32	5
	SW8260B	Bromodichloromethane	0.29		F	0.8	0.17	--
	SW8260B	Carbon Tetrachloride	0.73		F	2.1	0.16	5
	SW8260B	Chloroform	4.24		B	0.3	0.15	80*
	SW8260B	**Cis-1,2-Dichloroethylene**	**167.7**			24	61	70
	SW8260B	Tetrachloroethylene (PCE)	0.14		F	1.4	1.1	5
	SW8260B	Trans-1,2-Dichloroethene	6.86			0.6	120	100
	SW8260B	**Trichloroethylene (TCE)**	**2,848**			200	1.6	5
MW-703 3/15/2001	SW8260B	1,1-Dichloroethene	0.2		F	1.2	0.044	7
	SW8260B	Cis-1,2-Dichloroethylene	0.3		F	1.2	61	70
	SW8260B	**Trichloroethylene (TCE)**	**24.77**			2	1.6	5

TABLE 2-6
DETECTIONS OF ORGANIC COMPOUNDS IN GROUNDWATER
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Analytical Method Code	Analyte	Result (µg/L)	Lab Flag	QAPP Flag	RL (µg/L)	RBC (µg/L)	Primary MCL (µg/L)
MW-707 3/15/2001	SW8260B	Cis-1,2-Dichloroethylene	0.35		F	1.2	61	70
	SW8260B	**Trichloroethylene (TCE)**	**37.73**			4	1.6	5
SS7MW06 7/12/2001	SW8260B	1,1,2-Trichloroethane	1.5			1	0.19	5
	SW8260B	1,1-Dichloroethane	0.41	J	F	0.5	800	--
	SW8260B	1,1-Dichloroethene	1	J	F	1.2	0.044	7
	SW8260B	**Cis-1,2-Dichloroethylene**	**190**			1.2	61	70
	SW8015	Ethane	0.89		S	0.5	--	--
	SW8015	Ethene	0.62		S	0.5	--	--
	SW8015	Methane	0.73		S	0.5	--	--
	SW9060	Total Organic Carbon	3.2	S	S	1	--	--
	SW8260B	Trans-1,2-Dichloroethene	1.8			0.6	120	100
	SW8260B	**Trichloroethylene (TCE)**	**2,600**		B	100	1.6	5
SS7MW35 7/12/2001	SW8260B	*1,1,2-Trichloroethane*	*0.26*	J	F	1	0.19	5
	SW8260B	1,1,2-Trichloroethane	0.27	J	F	1	0.19	5
	SW8260B	*1,1-Dichloroethene*	*0.93*	J	F	1.2	0.044	7
	SW8260B	1,1-Dichloroethene	0.99	J	F	1.2	0.044	7
	SW8260B	Chloroform	19			0.5	0.15	80*
	SW8260B	***Cis-1,2-Dichloroethylene***	***73***			1.2	61	70
	SW8260B	**Cis-1,2-Dichloroethylene**	**75**			1.2	61	70
	SW8270C	*Di-N-Octylphthalate*	*47.5*			10	730	--
	SW8260B	Trans-1,2-Dichloroethene	0.5	J	F	0.6	120	100
	SW8260B	*Trans-1,2-Dichloroethene*	*0.52*	J	F	0.6	120	100
	SW8260B	***Trichloroethylene (TCE)***	***460***		B	10	1.6	5
	SW8260B	**Trichloroethylene (TCE)**	**470**			10	1.6	5
SS7TW10 6/21/2001	SW8260B	1,1,2-Trichloroethane	4.65			1	0.19	5
	SW8260B	1,1-Dichloroethene	1.73			1.2	0.044	7
	SW8260B	1,2-Dichloroethane	0.56	J	F	0.7	0.12	5
	SW8260B	Chloroform	8.85	M	M	0.5	0.15	80*
	SW8260B	**Cis-1,2-Dichloroethylene**	**279**			60	61	70
	SW8260B	Tetrachloroethylene (PCE)	0.33	J	F	1.4	1.1	5
	SW8260B	Trans-1,2-Dichloroethene	2.19			0.6	120	100
	SW8260B	**Trichloroethylene (TCE)**	**5,300**	M		50	1.6	5

TABLE 2-6
DETECTIONS OF ORGANIC COMPOUNDS IN GROUNDWATER
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Analytical Method Code	Analyte	Result (µg/L)	Lab Flag	QAPP Flag	RL (µg/L)	RBC (µg/L)	Primary MCL (µg/L)
SS7TW13 6/21/2001	SW8260B	*1,1,2-Trichloroethane*	*0.26*	J	F	1	0.19	5
	SW8260B	1,1,2-Trichloroethane	0.4	J	F	1	0.19	5
	SW8260B	*1,1-Dichloroethene*	*0.81*	J	F	1.2	0.044	7
	SW8260B	1,1-Dichloroethene	0.76	J	F	1.2	0.044	7
	SW8260B	Carbon Tetrachloride	0.27	J	F	2.1	0.16	5
	SW8260B	*Carbon Tetrachloride*	*0.28*	J	F	2.1	0.16	5
	SW8260B	Chloroform	1.71			0.5	0.15	80*
	SW8260B	*Chloroform*	*1.72*			0.5	0.15	80*
	SW8260B	Cis-1,2-Dichloroethylene	24.8			1.2	61	70
	SW8260B	*Cis-1,2-Dichloroethylene*	*21*			1.2	61	70
	SW8260B	*Trans-1,2-Dichloroethene*	*0.28*	J	F	0.6	120	100
	SW8260B	Trans-1,2-Dichloroethene	0.29	J	F	0.6	120	100
	SW8260B	***Trichloroethylene (TCE)***	***486***			10	1.6	5
	SW8260B	**Trichloroethylene (TCE)**	**526**			10	1.6	5
SS7TW16 4/5/2001	SW8260B	1,1-Dichloroethene	3.04			1.2	0.044	7
	SW8260B	1,2-Dichloroethane	0.28	J	F	0.7	0.12	5
	SW8260B	Chloroform	6.48			0.5	0.15	80*
	SW8260B	Cis-1,2-Dichloroethylene	44.3			1.2	61	70
	SW8260B	**Trichloroethylene (TCE)**	**242**			10	1.6	5
SS7TW26 6/22/2001	SW8260B	1,1,2-Trichloroethane	0.29	J	F	1	0.19	5
	SW8260B	1,1-Dichloroethene	0.54	J	F	1.2	0.044	7
	SW8260B	Chloroform	1.81			0.5	0.15	80*
	SW8260B	Cis-1,2-Dichloroethylene	4.09			1.2	61	70
	SW8260B	**Trichloroethylene (TCE)**	**104**			1	1.6	5
SS7TW29 6/21/2001	SW8260B	1,1,2-Trichloroethane	1.22			1	0.19	5
	SW8260B	Chloroform	10.8			0.5	0.15	80*
	SW8260B	**Cis-1,2-Dichloroethylene**	**286**			60	61	70
	SW8260B	Trans-1,2-Dichloroethene	1.9			0.6	120	100
	SW8260B	**Trichloroethylene (TCE)**	**1,830**			50	1.6	5
SS7TW30 6/14/2001	SW8260B	1,1,2-Trichloroethane	3.03			1	0.19	5
	SW8260B	1,1-Dichloroethene	0.57	J	F	1.2	0.044	7
	SW8260B	Benzene	0.25	J	F	0.5	0.32	5

TABLE 2-6
DETECTIONS OF ORGANIC COMPOUNDS IN GROUNDWATER
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Analytical Method Code	Analyte	Result (µg/L)	Lab Flag	QAPP Flag	RL (µg/L)	RBC (µg/L)	Primary MCL (µg/L)
SS7TW30	SW8260B	Chloroform	8.3			0.5	0.15	80*
6/14/2001	SW8260B	**Cis-1,2-Dichloroethylene**	**412**			60	61	70
(cont.)	SW8260B	Ethylbenzene	0.33	J	F	1	1,300	700
	SW8260B	M-Xylene (1,3-Dimethylbenzene)	1.36			1	12,000	--
	SW8260B	O-Xylene (1,2-Dimethylbenzene)	0.81	J	F	1.1	12,000	--
	SW8260B	Trans-1,2-Dichloroethene	2.86			0.6	120	100
	SW8260B	**Trichloroethylene (TCE)**	**3,520**			50	1.6	5
SS7TW31	SW8260B	1,1,2-Trichloroethane	2.24			1	0.19	5
6/21/2001	SW8260B	1,1-Dichloroethene	0.51	J	F	1.2	0.044	7
	SW8260B	Benzene	0.48	J	F	0.5	0.32	5
	SW8260B	Chloroform	2.22			0.5	0.15	80*
	SW8260B	Cis-1,2-Dichloroethylene	52.8			1.2	61	70
	SW8260B	Ethylbenzene	2.08			1	1,300	700
	SW8260B	M-Xylene (1,3-Dimethylbenzene)	8.35			1	12,000	--
	SW8260B	O-Xylene (1,2-Dimethylbenzene)	4.22			1.1	12,000	--
	SW8260B	Trans-1,2-Dichloroethene	0.34	J	F	0.6	120	100
	SW8260B	**Trichloroethylene (TCE)**	**1,360**			10	1.6	5
SS7TW32	SW8260B	1,1,2-Trichloroethane	0.61	J	F	1	0.19	5
6/14/2001	SW8260B	Chloroform	11.9			0.5	0.15	80*
	SW8260B	**Cis-1,2-Dichloroethylene**	**147**			1.2	61	70
	SW8260B	Trans-1,2-Dichloroethene	1.03			0.6	120	100
	SW8260B	**Trichloroethylene (TCE)**	**932**			10	1.6	5
SS7TW37	SW8260B	**1,1,2-Trichloroethane**	**5.72**			1	0.19	5
6/21/2001	SW8260B	1,1-Dichloroethene	1.16	J	F	1.2	0.044	7
	SW8260B	1,2-Dichloroethane	0.54	J	F	0.7	0.12	5
	SW8260B	Chloroform	9.41			0.5	0.15	80*
	SW8260B	**Cis-1,2-Dichloroethylene**	**499**			60	61	70
	SW8260B	Trans-1,2-Dichloroethene	6.24			0.6	120	100
	SW8260B	**Trichloroethylene (TCE)**	**4,040**			50	1.6	5
SS7TW38	SW8260B	1,1,2-Trichloroethane	2.07			1	0.19	5
6/21/2001	SW8260B	1,1-Dichloroethene	0.55	J	F	1.2	0.044	7
	SW8260B	Chloroform	12.9			0.5	0.15	80*

TABLE 2-6
DETECTIONS OF ORGANIC COMPOUNDS IN GROUNDWATER
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Analytical Method Code	Analyte	Result (µg/L)	Lab Flag	QAPP Flag	RL (µg/L)	RBC (µg/L)	Primary MCL (µg/L)
SS7TW38 6/21/2001 (cont.)	SW8260B	**Cis-1,2-Dichloroethylene**	**199**			1.2	61	70
	SW8260B	Trans-1,2-Dichloroethene	1.47			0.6	120	100
	SW8260B	**Trichloroethylene (TCE)**	**1,740**			50	1.6	5

Notes:

µg/L = micrograms per liter

QAPP = Quality Assurance Project Plan

RL = Reporting Limit

Field duplicate indicated by italics

RBC = EPA Region III risk-based concentration values for tap water (10/01/01 version).

MCL = Maximum Contaminant Level

Primary MCLs = U.S. EPA, Office of Water, Current Drinking Water Standards, National Primary Drinking Water Regulations.

J = The analyte was positively identified, the quantitation is an estimation.

F = The analyte was positively identified, but the associated numerical value is below the RL.

B = The analyte was found in an associated blank, as well as in the sample.

M = A matrix effect was present

Bold indicates an exceedance of both RBC and MCL values.

-- = No published standard.

* Primary MCL for Total Trihalomethanes

Field duplicate (denoted by italics)

TABLE 2-7
DETECTIONS OF INORGANIC COMPOUNDS IN GROUNDWATER
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Analytical Method Code	Analyte	Result (µg/l)	Lab Flag	QAPP Flag	RL (µg/l)	Background (µg/l)	RBC (µg/l)	Primary MCL (µg/l)	Secondary MCL (µg/l)
MW-027	SW6010	Arsenic	1.85			1	3	0.045	50	--
7/12/2001	SW6010	Barium	188			5	170	2,600	2,000	--
	SW6010	Beryllium	0.04	J	F	3	1	73	4	--
	SW6010	**Calcium**	**130,000**		B	200	98,700	--	--	--
	SW6010	Iron	51			40	430	22,000	--	--
	SW6010	**Magnesium**	**17,600**			100	17,100	--	--	--
	SW6010	Potassium	3,490			500	4,100	--	--	--
	SW6010	Selenium	1.5			1	4	180	50	--
	SW6010	Silicon	12,000			2,000	--	--	--	--
	SW6010	Silver	1.1	J	F	4	15	180	--	100
	SW6010	**Sodium**	**22,000**			500	18,800	--	--	--
	SW6010	Thallium	0.318			0.2	1	2.6	2	--
	SW6010	Vanadium	5.17	J	F	10	9	260	--	--
MW-149	SW6010	Aluminum	2,100			100	500	37,000	--	50
7/11/2001	SW6010	Arsenic	2.41			1	3	0.045	50	--
	SW6010	Barium	216			5	170	2,600	2,000	--
	SW6010	Beryllium	0.15	J	F	3	1	73	4	--
	SW6010	**Calcium**	**120,000**		B	200	98,700	--	--	--
	SW6010	Chromium	7.82			5	5	110	100	--
	SW6010	Cobalt	0.72	J	F	6	20	730	--	--
	SW6010	Copper	20			5	15	1,500	1,300	1,000
	SW6010	Iron	1,400			40	430	22,000	--	--
	SW6010	Lead	1.28			1	5	--	15	--
	SW6010	Magnesium	16,100			100	17,100	--	--	--
	SW6010	Manganese	32			3	29	730	--	--
	SW6010	Molybdenum	3.04	J	F	15	20	180	--	--
	SW6010	Nickel	4.44	J	F	10	20	730	--	--
	SW6010	Potassium	3,980			500	4,100	--	--	--
	SW6010	Selenium	2.41			1	4	180	50	--
	SW6010	Silicon	17,000			5,000	--	--	--	--
	SW6010	Silver	1.1	J	F	4	15	180	--	100
	SW6010	**Sodium**	**20,000**			500	18,800	--	--	--

TABLE 2-7
DETECTIONS OF INORGANIC COMPOUNDS IN GROUNDWATER
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Analytical Method Code	Analyte	Result (µg/l)	Lab Flag	QAPP Flag	RL (µg/l)	Background (µg/l)	RBC (µg/l)	Primary MCL (µg/l)	Secondary MCL (µg/l)
MW-149	SW6010	Thallium	0.13	J	F	0.2	1	2.6	2	--
7/11/2001	SW6010	Vanadium	8.41	J	F	10	9	260	--	--
(cont.)	SW6010	Zinc	41.7			20	23	11,000	--	5,000
MW-150	SW6010	Arsenic	2.28			1	3	0.045	50	--
7/11/2001	SW6010	Barium	185			5	170	2,600	2,000	--
	SW6010	Beryllium	0.06	J	F	3	1	73	4	--
	SW6010	Calcium	97,000		B	200	98,700	--	--	--
	SW6010	Iron	81			40	430	22,000	--	--
	SW6010	Magnesium	138			100	17,100	--	--	--
	SW6010	Molybdenum	2.09	J	F	15	20	180	--	--
	SW6010	Potassium	321			500	4,100	--	--	--
	SW6010	Selenium	3.06			1	4	180	50	--
	SW6010	Silicon	12,000			2,000	--	--	--	--
	SW6010	Silver	0.85	J	F	4	15	180	--	100
	SW6020	Sodium	17,000			500	18,800	--	--	--
	SW6020	Vanadium	5.73	J	F	10	9	260	--	--
MW-184	SW6010	Aluminum	240			100	500	37,000	--	50
7/12/2001	SW6010	Arsenic	2.09			1	3	0.045	50	--
	SW6010	Barium	113			5	170	2,600	2,000	--
	SW6010	Beryllium	0.07	J	F	3	1	73	4	--
	SW6010	Calcium	49,000		B	200	98,700	--	--	--
	SW6010	Chromium	0.97	J	F	5	5	110	100	--
	SW6010	Iron	190			40	430	22,000	--	--
	SW6010	Magnesium	6,840			100	17,100	--	--	--
	SW6010	Manganese	4.23			3	29	730	--	--
	SW6010	Potassium	2,410			500	4,100	--	--	--
	SW6010	Selenium	1.73			1	4	180	50	--
	SW6010	Silicon	11,000			2,000	--	--	--	--
	SW6010	Silver	0.5	J	F	4	15	180	--	100
	SW6020	Sodium	8,600			500	18,800	--	--	--
	SW6020	Vanadium	5.94	J	F	10	9	260	--	--

TABLE 2-7
DETECTIONS OF INORGANIC COMPOUNDS IN GROUNDWATER
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Analytical Method Code	Analyte	Result (µg/l)	Lab Flag	QAPP Flag	RL (µg/l)	Background (µg/l)	RBC (µg/l)	Primary MCL (µg/l)	Secondary MCL (µg/l)
MW-189	SW6010	Aluminum	141		F	200	500	37,000	--	50
3/6/2001	SW6010	Arsenic	2.6		F	5	3	0.045	50	--
	SW6010	Barium	180			5	170	2,600	2,000	--
	SW6010	**Calcium**	**119,000**			1,100	98,700	--	--	--
	SW6010	Iron	128		F	200	430	22,000	--	--
	SW6010	**Magnesium**	**18,400**			100	17,100	--	--	--
	SW6010	Manganese	2.3		F	3	29	730	--	--
	SW6010	Nickel	6		F	20	20	730	--	--
	SW6010	Potassium	3,510			2,500	4,100	--	--	--
	SW6010	**Sodium**	**20,800**			1,000	18,800	--	--	--
	SW7060	Vanadium	5.5		F	10	9	260	--	--
MW-190	SW6010	Aluminum	2,800			100	500	37,000	--	50
7/12/2001	SW6010	Antimony	0.635	J	F	1	3	15	6	--
	SW6010	Arsenic	2.38			1	3	0.045	50	--
	SW6010	Barium	180			5	170	2,600	2,000	--
	SW6010	Beryllium	0.19	J	F	3	1	73	4	--
	SW6010	Calcium	76,000		B	200	98,700	--	--	--
	SW6010	Chromium	3.55	J	F	5	5	110	100	--
	SW6010	Cobalt	1.09	J	F	6	20	730	--	--
	SW6010	Copper	2	J	F	5	15	1,500	1,300	1,000
	SW6010	Iron	1,500			40	430	22,000	--	--
	SW6010	Lead	2.48			1	5	--	15	--
	SW6010	Magnesium	10,500			100	17,100	--	--	--
	SW6010	Manganese	93.5			3	29	730	--	--
	SW6010	Nickel	4.47	J	F	10	20	730	--	--
	SW6010	Potassium	3,330			500	4,100	--	--	--
	SW6010	Selenium	4.14			1	4	180	50	--
	SW6020	Silicon	18,000			500	--	--	--	--
	SW6020	Silver	0.84	J	F	4	15	180	--	100
	SW6020	Sodium	10,000			500	18,800	--	--	--
	SW6020	Vanadium	8.4	J	F	10	9	260	--	--

TABLE 2-7
DETECTIONS OF INORGANIC COMPOUNDS IN GROUNDWATER
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Analytical Method Code	Analyte	Result (µg/l)	Lab Flag	QAPP Flag	RL (µg/l)	Background (µg/l)	RBC (µg/l)	Primary MCL (µg/l)	Secondary MCL (µg/l)
MW-06	SW6010	Aluminum	500			100	500	37,000	--	50
7/12/2001	SW6010	Arsenic	2.02			1	3	0.045	50	--
	SW6010	Barium	150			5	170	2,600	2,000	--
	SW6010	Beryllium	0.1	J	F	3	1	73	4	--
	SW6010	**Calcium**	**100,000**		B	200	98,700	--	--	--
	SW6010	Chromium	13.5			5	5	110	100	--
	SW6010	Copper	2.4	J	F	5	15	1,500	1,300	1,000
	SW6010	Iron	420			40	430	22,000	--	--
	SW6010	Lead	0.619	J	F	1	5	--	15	--
	SW6010	Magnesium	12,600			100	17,100	--	--	--
	SW6010	Manganese	27.5			3	29	730	--	--
	SW6010	Molybdenum	3.4	J	F	15	20	180	--	--
	SW6010	Nickel	5.32	J	F	10	20	730	--	--
	SW6010	Potassium	3,470			500	4,100	--	--	--
	SW6010	Selenium	2.92			1	4	180	50	--
	SW6010	Silicon	13,000			500	--	--	--	--
	SW6010	Silver	0.89	J	F	4	15	180	--	100
	SW6020	Sodium	17,000			500	18,800	--	--	--
	SW6020	Vanadium	5.35	J	F	10	9	260	--	--
	SW6020	Zinc	22.5			20	23	11,000	--	5,000
MW-35	SW6010	Aluminum	410	J	J	100	500	37,000	--	50
7/12/2001	SW6010	Arsenic	2.26			1	3	0.045	50	--
	SW6010	Barium	106			5	170	2,600	2,000	--
	SW6010	Beryllium	0.06	J	F	3	1	73	4	--
	SW6010	Calcium	86,000		B	200	98,700	--	--	--
	SW6010	Chromium	5.47			5	5	110	100	--
	SW6010	Copper	1.1	J	F	5	15	1,500	1,300	1,000
	SW6010	Iron	300	J	J	40	430	22,000	--	--
	SW6010	Magnesium	12,100			100	17,100	--	--	--
	SW6010	Manganese	7.25	J	J	3	29	730	--	--
	SW6010	Potassium	302			500	4,100	--	--	--
	SW6010	Selenium	2.59	J	J	1	4	180	50	--
	SW6010	Silicon	11,000			5,000	--	--	--	--

TABLE 2-7
DETECTIONS OF INORGANIC COMPOUNDS IN GROUNDWATER
SPILL SITE 7 - F.E. WARREN AFB

Sample ID and Date	Analytical Method Code	Analyte	Result (µg/l)	Lab Flag	QAPP Flag	RL (µg/l)	Background (µg/l)	RBC (µg/l)	Primary MCL (µg/l)	Secondary MCL (µg/l)
MW-35 7/12/2001 (cont.)	SW6010	Silver	0.72	J	F	4	15	180	--	100
	SW6010	**Sodium**	**19,000**			500	18,800	--	--	--
	SW6020	Vanadium	6.16	J	F	10	9	260	--	--
	SW6020	Zinc	34.2			20	23	11,000	--	5,000
MW-35 (FD) 7/12/2001	SW6010	Aluminum	260			100	500	37,000	--	50
	SW6010	Arsenic	2.3			1	3	0.045	50	--
	SW6010	Barium	104			5	170	2,300	2,000	--
	SW6010	Beryllium	0.04	J	F	3	1	73	4	--
	SW6010	Calcium	8,500		B	200	98,700	--	--	--
	SW6010	Chromium	5.69			5	5	110	100	--
	SW6010	Copper	1			5	15	1,500	1,300	1,000
	SW6010	Iron	220			40	430	22,000	--	--
	SW6010	Magnesium	11,900			100	17,100	--	--	--
	SW6010	Manganese	5.6			3	29	730	--	--
	SW6010	Potassium	2,970			500	4,100	--	--	--
	SW6010	Selenium	3.1			1	4	180	50	--
	SW6010	Silicon	11,000			5,000	--	--	--	--
	SW6010	Silver	0.74	J	F	4	15	180	--	100
	SW6010	**Sodium**	**19,000**			500	18,800	--	--	--
	SW6020	Thallium	0.201			2	1	2.6	2	--
	SW6020	Vanadium	5.81	J	F	10	9	260	--	--
	SW6020	Zinc	30.8			20	23	11,000	--	5,000

Notes:
µg/L = micrograms per liter
QAPP = Quality Assurance Project Plan
RL = Reporting Limit
FD = field duplicate
Background = Background values based on the "Geochemical Background Concentrations of Selected Constituents in Soil, Shallow Groundwater, Surface Water, and Sediment, Operable Unit 2,
RBC = EPA Region III risk-based concentration values for tap water.
MCL = Maximum Contaminant Level
Primary MCLs = U.S. EPA, Office of Water, Current Drinking Water Standards, National Primary Drinking Water Regulations.
Secondary MCLs = U.S. EPA, Office of Water, Current Drinking Water Standards, National Secondary Drinking Water Regulations.
J = The analyte was positively identified, the quantitation is an estimation.
F = The analyte was positively identified, but the associated numerical value is below the RL.
B = The analyte was found in an associated blank, as well as in the sample.
Bold indicates an exceedance of a Background and RBC or MCL value.
-- = No published standard.

TABLE 2-8
SUMMARY OF GROUNDWATER DATA
SPILL SITE 7 - F.E.WARREN AFB

Constituent	Analytical Method	Number of Samples	Detection Frequency	Number of Detections	RL Range	MDL Range	Test Value Range	Mean	Units	Standard Deviation	Coefficient Of Variation	Count of Primary MCL Exceedances	Count of Secondary MCL Exceedances	WDEQ	WDEQ Units	Number of WDEQ Exceedances
Groundwater Inorganics																
BROMIDE	SW9056	1	1.00E+00	1	5.00E-01 - 5.00E-01	1.00E-01 - 1.00E-01	3.67E+02 - 3.67E+02	3.67E+02	ug/l						ug/l	
FLUORIDE	SW9056	1	1.00E+00	1	1.00E+00 - 1.00E+00	1.00E-01 - 1.00E-01	6.53E+02 - 6.53E+02	6.53E+02	ug/l			0	0	1400	ug/l	0
NITROGEN, NITRATE (AS N)	SW9056	1	1.00E+00	1	1.00E+01 - 1.00E+01	6.70E-01 - 6.70E-01	9.10E+03 - 9.10E+03	9.10E+03	ug/l			0			ug/l	
Groundwater Metals																
ALUMINUM	SW6010	8	7.50E-01	6	1.00E-01 - 2.00E-01	1.50E-02 - 4.90E-02	5.00E+01 - 2.80E+03	7.86E+02	ug/l	1.06E+03	1.34E+00		8	100	ug/l	6
ANTIMONY	SW6020	7	1.43E-01	1	1.00E-03 - 1.00E-03	4.00E-04 - 5.00E-04	5.00E-01 - 6.35E-01	5.19E-01	ug/l	5.10E-02	9.83E-02	0			ug/l	
ARSENIC	SW6020	7	1.00E+00	7	1.00E-03 - 5.00E-03	3.00E-04 - 7.00E-04	1.85E+00 - 2.41E+00	2.19E+00	ug/l	2.08E-01	9.49E-02	0		50	ug/l	0
ARSENIC	SW7060	1	1.00E+00	1	1.00E-03 - 5.00E-03	3.00E-04 - 7.00E-04	2.60E+00 - 2.60E+00	2.60E+00	ug/l			0		50	ug/l	0
BERYLLIUM	SW6010	8	8.75E-01	7	3.00E-03 - 5.00E-03	1.00E-04 - 1.00E-03	4.00E-02 - 2.50E+00	3.96E-01	ug/l	8.52E-01	2.15E+00	0		11	ug/l	0
CALCIUM	SW6010	8	1.00E+00	8	2.00E-01 - 1.10E+00	2.00E-02 - 3.10E-02	4.90E+04 - 1.30E+05	9.71E+04	ug/l	2.67E+04	2.75E-01				ug/l	
CHROMIUM, TOTAL	SW6010	8	6.25E-01	5	5.00E-03 - 1.00E-02	7.00E-04 - 1.10E-03	9.70E-01 - 1.35E+01	5.19E+00	ug/l	3.99E+00	7.68E-01	0		50	ug/l	0
COBALT	SW6010	8	2.50E-01	2	6.00E-03 - 6.00E-03	5.00E-04 - 2.46E-03	7.20E-01 - 3.00E+00	2.48E+00	ug/l	9.75E-01	3.94E-01			50	ug/l	0
COPPER	SW6010	8	5.00E-01	4	5.00E-03 - 1.00E-02	1.00E-03 - 1.20E-03	1.00E+00 - 2.00E+01	4.74E+00	ug/l	6.27E+00	1.32E+00	0	0	10	ug/l	1
IRON	SW6010	8	1.00E+00	8	4.00E-02 - 2.00E-01	4.00E-03 - 4.60E-03	5.10E+01 - 1.50E+03	4.99E+02	ug/l	5.98E+02	1.20E+00		3	300	ug/l	3
LEAD	SW6020	7	4.29E-01	3	1.00E-03 - 5.00E-03	3.00E-04 - 5.00E-04	5.00E-01 - 2.48E+00	9.11E-01	ug/l	7.48E-01	8.21E-01	0		4	ug/l	0
LEAD	SW7421	1	1.00E+00	1	1.00E-03 - 5.00E-03	3.00E-04 - 5.00E-04	6.00E-01 - 6.00E-01	6.00E-01	ug/l			0		4	ug/l	0
MANGANESE	SW6010	8	7.50E-01	6	3.00E-03 - 3.00E-03	2.00E-04 - 2.00E-03	1.50E+00 - 9.35E+01	2.12E+01	ug/l	3.16E+01	1.49E+00		1	50	ug/l	1
MOLYBDENUM	SW6010	8	3.75E-01	3	1.50E-02 - 1.50E-02	1.10E-03 - 4.10E-03	2.09E+00 - 7.50E+00	5.75E+00	ug/l	2.44E+00	4.24E-01				ug/l	
NICKEL	SW6010	8	5.00E-01	4	1.00E-02 - 2.00E-02	3.60E-03 - 6.00E-03	4.44E+00 - 6.00E+00	5.03E+00	ug/l	4.91E-01	9.77E-02			50	ug/l	0
SELENIUM	SW7740	1	1.00E+00	1	1.00E-03 - 5.00E-03	2.00E-04 - 7.00E-04	3.50E+00 - 3.50E+00	3.50E+00	ug/l			0		10	ug/l	0
SELENIUM	SW6020	7	1.00E+00	7	1.00E-03 - 5.00E-03	2.00E-04 - 7.00E-04	1.50E+00 - 4.14E+00	2.69E+00	ug/l	9.02E-01	3.35E-01	0		10	ug/l	0
SILVER	SW6010	8	8.75E-01	7	4.00E-03 - 1.00E-02	5.00E-04 - 2.50E-03	5.00E-01 - 5.00E+00	1.38E+00	ug/l	1.48E+00	1.07E+00		0	0.1	ug/l	8
THALLIUM	SW6020	7	4.29E-01	3	2.00E-04 - 2.00E-04	1.00E-04 - 1.00E-04	1.00E-01 - 3.18E-01	1.50E-01	ug/l	8.29E-02	5.53E-01	0			ug/l	
VANADIUM	SW6010	8	1.00E+00	8	1.00E-02 - 1.00E-02	1.40E-03 - 3.60E-03	5.17E+00 - 8.41E+00	6.33E+00	ug/l	1.32E+00	2.08E-01			100	ug/l	0
ZINC	SW6010	8	3.75E-01	3	1.00E-02 - 2.00E-02	1.80E-03 - 3.20E-03	5.00E+00 - 4.17E+01	1.79E+01	ug/l	1.35E+01	7.51E-01		0	50	ug/l	0
Groundwater Miscellaneous																
TOTAL DISSOLVED SOLIDS (RESIDUE, FILTERABLE)	E160.1	1	1.00E+00	1	-	-	4.60E+05 - 4.60E+05	4.60E+05	ug/l				0	500000	ug/l	0
Groundwater Organics																
1,1,1-TRICHLOROETHANE	SW8260	44	6.98E-02	3	8.00E-01 - 8.00E+01	8.00E-02 - 8.00E+00	3.30E-01 - 8.20E-01	4.13E-01	UG/L	7.08E-02	1.72E-01	0			UG/L	
1,1,2-TRICHLOROETHANE	SW8260	44	4.32E-01	19	1.00E+00 - 1.00E+02	1.00E-01 - 1.04E+01	1.20E-01 - 5.72E+00	1.05E+00	UG/L	1.32E+00	1.26E+00	2			UG/L	
1,1-DICHLOROETHANE	SW8260	32	2.19E-01	7	4.00E-01 - 4.00E+01	1.20E-01 - 1.26E+01	2.00E-01 - 1.35E+00	2.83E-01	UG/L	2.30E-01	8.13E-01				UG/L	
1,1-DICHLOROETHENE	SW8260	44	5.35E-01	23	1.20E+00 - 1.20E+02	7.00E-02 - 7.40E+00	2.00E-01 - 3.04E+00	9.29E-01	UG/L	6.10E-01	6.57E-01	0			UG/L	
1,2,3-TRICHLOROBENZENE	SW8260	32	3.13E-02	1	3.00E-01 - 3.00E+01	1.00E-01 - 1.15E+01	1.50E-01 - 5.00E-01	2.16E-01	UG/L	1.39E-01	6.42E-01				UG/L	

TABLE 2-8
SUMMARY OF GROUNDWATER DATA
SPILL SITE 7 - F.E.WARREN AFB

Constituent	Analytical Method	Number of Samples	Detection Frequency	Number of Detections	RL Range	MDL Range	Test Value Range	Mean	Units	Standard Deviation	Coefficient Of Variation	Count of Primary MCL Exceedances	Count of Secondary MCL Exceedances	WDEQ	WDEQ Units	Number of WDEQ Exceedances
Groundwater Organics																
1,2-DICHLOROETHANE	SW8260	44	1.14E-01	5	6.00E-01 - 6.00E+01	9.00E-02 - 8.60E+00	2.30E-01 - 5.60E-01	3.26E-01	UG/L	5.76E-02	1.76E-01	0			UG/L	
1,2-DICHLOROPROPANE	SW8260	32	3.13E-02	1	4.00E-01 - 4.00E+01	7.00E-02 - 7.30E+00	2.00E-01 - 3.00E-01	2.14E-01	UG/L	2.61E-02	1.22E-01	0			UG/L	
ACETONE	SW8260	25	2.00E-01	5	1.00E+01 - 4.00E+02	6.00E-01 - 5.59E+01	1.40E+00 - 2.65E+03	1.68E+02	UG/L	5.86E+02	3.49E+00				UG/L	
BENZENE	SW8260	44	1.14E-01	5	4.00E-01 - 4.00E+01	8.00E-02 - 7.60E+00	8.00E-02 - 4.80E-01	2.23E-01	UG/L	5.19E-02	2.33E-01	0			UG/L	
BROMODICHLOROMETHANE	SW8260	32	9.38E-02	3	8.00E-01 - 8.00E+01	8.00E-02 - 8.40E+00	2.70E-01 - 7.10E-01	4.24E-01	UG/L	7.55E-02	1.78E-01				UG/L	
BROMOMETHANE	SW8260	32	9.38E-02	3	1.10E+00 - 1.10E+02	7.00E-02 - 1.00E+01	1.40E-01 - 5.50E-01	5.20E-01	UG/L	9.72E-02	1.87E-01				UG/L	
CARBON TETRACHLORIDE	SW8260	44	1.36E-01	6	2.10E+00 - 2.10E+02	8.00E-02 - 8.00E+00	2.00E-01 - 1.05E+00	9.66E-01	UG/L	2.34E-01	2.43E-01	0			UG/L	
CHLOROFORM	SW8260	44	5.45E-01	24	3.00E-01 - 3.00E+01	7.00E-02 - 6.90E+00	8.00E-02 - 1.29E+01	2.78E+00	UG/L	4.07E+00	1.47E+00				UG/L	
cis-1,2-DICHLOROETHYLENE	SW8260	44	8.18E-01	36	1.20E+00 - 9.60E+00	9.00E-02 - 2.10E+00	1.30E-01 - 4.99E+02	7.17E+01	UG/L	1.19E+02	1.67E+00	11			UG/L	
DIBROMOCHLOROMETHANE	SW8260	32	0.00E+00	0	5.00E-01 - 5.00E+01	7.00E-02 - 8.20E+00	2.50E-01 - 3.00E-01	2.61E-01	UG/L	2.10E-02	8.05E-02				UG/L	
ETHANE	SW8015	1	1.00E+00	1	5.00E-01 - 5.00E-01	2.20E-01 - 2.20E-01	8.90E-01 - 8.90E-01	8.90E-01	UG/L						UG/L	
ETHENE	SW8015	1	1.00E+00	1	5.00E-01 - 5.00E-01	2.30E-01 - 2.30E-01	6.20E-01 - 6.20E-01	6.20E-01	UG/L						UG/L	
ETHYLBENZENE	SW8260	44	4.55E-02	2	6.00E-01 - 6.00E+01	8.00E-02 - 8.00E+00	3.00E-01 - 2.08E+00	4.18E-01	UG/L	2.74E-01	6.55E-01	0			UG/L	
METHANE	SW8015	1	1.00E+00	1	5.00E-01 - 5.00E-01	4.30E-01 - 4.30E-01	7.30E-01 - 7.30E-01	7.30E-01	UG/L						UG/L	
METHYLENE CHLORIDE	SW8260	44	1.82E-01	8	3.00E-01 - 3.00E+01	6.00E-02 - 1.10E+01	8.00E-02 - 1.00E+00	5.16E-01	UG/L	4.27E-01	8.29E-01				UG/L	
O-XYLENE (1,2-DIMETHYLBENZENE)	SW8260	44	4.55E-02	2	1.10E+00 - 1.10E+02	1.00E-01 - 1.07E+01	5.50E-01 - 4.22E+00	6.39E-01	UG/L	5.54E-01	8.66E-01				UG/L	
TETRACHLOROETHYLENE(PCE)	SW8260	44	1.14E-01	5	1.40E+00 - 1.40E+02	9.00E-02 - 9.20E+00	1.10E-01 - 7.00E-01	6.51E-01	UG/L	1.46E-01	2.24E-01	0			UG/L	
TOLUENE	SW8260	44	6.82E-02	3	1.10E+00 - 1.10E+02	1.00E-01 - 1.02E+01	1.10E-01 - 5.50E-01	5.24E-01	UG/L	9.73E-02	1.85E-01	0			UG/L	
TOTAL ORGANIC CARBON	SW9060	1	1.00E+00	1	1.00E+00 - 1.00E+00	5.00E-01 - 5.00E-01	3.20E+03 - 3.20E+03	3.20E+03	ug/l						ug/l	
trans-1,2-DICHLOROETHENE	SW8260	44	4.09E-01	18	6.00E-01 - 6.00E+01	9.00E-02 - 8.70E+00	1.60E-01 - 9.69E+00	1.09E+00	UG/L	1.92E+00	1.77E+00	0			UG/L	
TRICHLOROETHYLENE (TCE)	SW8260	44	9.32E-01	41	1.00E+00 - 8.00E+00	9.00E-02 - 9.42E+01	1.20E-01 - 1.32E+04	1.08E+03	UG/L	2.30E+03	2.12E+00	33			UG/L	
TRICHLOROFLUOROMETHANE	SW8260	32	3.13E-02	1	8.00E-01 - 8.00E+01	6.00E-02 - 6.40E+00	8.00E-02 - 5.00E-01	4.12E-01	UG/L	7.36E-02	1.79E-01				UG/L	
VINYL CHLORIDE	SW8260	44	2.27E-02	1	1.10E+00 - 1.10E+02	9.00E-02 - 9.30E+00	2.70E-01 - 5.50E-01	5.44E-01	UG/L	4.22E-02	7.76E-02	0			UG/L	

Notes
RL = Reporting Limit
MDL = Method Detection L
Test Value = Detected value or 1/2 Reporting Limit
UG/L = micrograms per liter
MCL = Maximum Contaminant Level, United States Environmental Protection Agency Primary and Secondary Drinking Water Standards, September 2001.
WDEQ = Wyoming Department of Environmental Quality, Quality Standards for Wyoming, Chapter 8, most conservative value chosen between domestic, agriculture, livestock, and fish/aquatic life, March 1993.

TABLE 2-9
SUMMARY OF SOIL DATA
SPILL SITE 7 - F.E.WARREN AFB

Constituent	Analytical Method	Number of Samples	Detection Frequency	Number of Detections	RL Range	MDL Range	Test Value Range	Mean	Units	Standard Deviation	Coefficient Of Variation	RBC	RBC (Non-Carcinogens)	Number of RBC Exceedances
Subsurface Soil Metals														
ALUMINUM	SW6010	45	9.78E-01	44	2.20E+01 - 3.20E+01	3.20E+00 - 4.60E+00	1.40E+01 - 5.27E+04	2.34E+04	MG/KG	1.23E+04	5.25E-01	2.0E+06 N	2.00E+05	0
ANTIMONY	SW6020	42	2.38E-02	1	2.00E-01 - 5.70E-01	1.00E-01 - 2.90E-01	1.00E-01 - 2.85E-01	1.30E-01	MG/KG	3.51E-02	2.70E-01	8.2E+02 N	8.20E+01	0
ANTIMONY	SW6010	3	1.00E+00	3	2.00E-01 - 5.70E-01	1.00E-01 - 2.90E-01	5.90E-01 - 3.50E+00	2.10E+00	MG/KG	1.46E+00	6.95E-01	8.2E+02 N	8.20E+01	0
ARSENIC	SW6020	42	1.00E+00	42	5.10E-01 - 3.70E+00	1.10E-01 - 7.40E-01	5.39E-01 - 8.23E+00	3.19E+00	MG/KG	1.85E+00	5.80E-01	3.8E+00 C	3.80E+00	11
BARIUM	SW6010	45	1.00E+00	45	5.10E-01 - 7.40E-01	1.40E-02 - 2.10E-02	4.80E+01 - 4.10E+02	1.28E+02	MG/KG	5.80E+01	4.53E-01	1.4E+05 N	1.40E+04	0
BERYLLIUM	SW6010	45	1.00E+00	45	2.50E-02 - 3.70E-02	8.10E-03 - 1.20E-02	1.70E-01 - 2.20E+00	1.08E+00	MG/KG	5.20E-01	4.81E-01	4.1E+03 N	4.10E+02	0
CADMIUM	SW6010	45	2.44E-01	11	1.00E-01 - 6.90E-01	3.20E-02 - 2.20E-01	3.79E-02 - 6.88E+00	2.42E-01	MG/KG	1.01E+00	4.19E+00		0.00E+00	0
CALCIUM	SW6010	45	1.00E+00	45	1.00E+01 - 1.40E+03	2.90E+00 - 3.90E+02	2.10E+03 - 1.40E+05	2.76E+04	MG/KG	3.19E+04	1.16E+00		0.00E+00	0
COBALT	SW6010	45	1.00E+00	45	2.50E-01 - 3.70E-01	4.30E-02 - 6.30E-02	1.30E+00 - 1.80E+01	6.75E+00	MG/KG	3.02E+00	4.48E-01	4.1E+04 N	4.10E+03	0
COPPER	SW6010	45	1.00E+00	45	1.00E+00 - 1.50E+00	1.50E-01 - 2.10E-01	1.80E+00 - 4.80E+02	2.23E+01	MG/KG	7.00E+01	3.13E+00	8.2E+04 N	8.20E+03	0
IRON	SW6010	45	1.00E+00	45	3.00E+00 - 2.10E+01	1.10E+00 - 7.80E+00	3.19E+03 - 3.08E+04	1.62E+04	MG/KG	6.41E+03	3.95E-01	1.2E+06 N	1.20E+05	0
LEAD	SW6020	42	1.00E+00	42	5.10E-01 - 5.60E+00	2.50E-01 - 2.80E+00	1.90E+00 - 1.68E+02	1.36E+01	MG/KG	2.59E+01	1.90E+00		0.00E+00	0
MANGANESE	SW6010	45	9.78E-01	44	5.10E-01 - 3.10E+00	7.10E-03 - 4.40E-02	3.00E-01 - 4.20E+02	2.53E+02	MG/KG	9.55E+01	3.78E-01	4.1E+04 N	4.10E+03	0
MERCURY	SW7471	45	1.11E-01	5	1.00E-01 - 1.50E-01	1.80E-02 - 2.60E-02	1.97E-02 - 5.89E-01	7.38E-02	MG/KG	8.25E-02	1.12E+00		0.00E+00	0
MOLYBDENUM	SW6010	45	8.89E-02	4	2.00E+00 - 2.90E+00	1.20E-01 - 1.80E-01	6.10E-01 - 1.45E+00	1.21E+00	MG/KG	1.66E-01	1.38E-01	1.0E+04 N	1.00E+03	0
NICKEL	SW6010	45	1.00E+00	45	2.00E+00 - 2.90E+00	1.10E-01 - 1.50E-01	1.60E+00 - 2.20E+01	1.07E+01	MG/KG	4.77E+00	4.47E-01	4.1E+04 N	4.10E+03	0
POTASSIUM	SW6010	45	1.00E+00	45	5.10E+01 - 7.40E+01	6.00E+00 - 8.70E+00	5.10E+02 - 1.20E+04	4.72E+03	MG/KG	2.67E+03	5.66E-01		0.00E+00	0
SELENIUM	SW6020	42	6.43E-01	27	2.00E-01 - 5.70E-01	1.00E-01 - 2.90E-01	1.00E-01 - 5.59E-01	2.44E-01	MG/KG	1.19E-01	4.86E-01	1.0E+04 N	1.00E+03	0
SILVER	SW6010	45	1.11E-01	5	5.10E-01 - 1.40E+00	1.00E-01 - 2.90E-01	2.00E-01 - 7.00E-01	3.15E-01	MG/KG	8.12E-02	2.58E-01	1.0E+04 N	1.00E+03	0
THALLIUM	SW6020	42	9.05E-01	38	1.00E-01 - 2.90E-01	5.10E-02 - 1.40E-01	5.00E-02 - 6.57E-01	2.00E-01	MG/KG	1.24E-01	6.19E-01	1.4E+02 N	1.40E+01	0
THALLIUM	SW6010	3	6.67E-01	2	1.00E-01 - 2.90E-01	5.10E-02 - 1.40E-01	7.60E-01 - 1.10E+00	9.23E-01	MG/KG	1.70E-01	1.85E-01	1.4E+02 N	1.40E+01	0
VANADIUM	SW6010	45	1.00E+00	45	5.10E-01 - 7.40E-01	2.30E-01 - 3.40E-01	7.40E+00 - 7.30E+01	3.62E+01	MG/KG	1.49E+01	4.11E-01	1.4E+04 N	1.40E+03	0
ZINC	SW6010	45	1.00E+00	45	1.00E+00 - 1.50E+00	4.70E-01 - 6.80E-01	6.90E+00 - 6.00E+02	6.08E+01	MG/KG	8.53E+01	1.40E+00	6.1E+05 N	6.10E+04	0
Subsurface Soil Organics														
1,1,2-TRICHLOROETHANE	SW8260	35	1.14E-01	4	5.10E-03 - 6.80E-01	5.00E-04 - 6.80E-02	6.39E-04 - 3.40E-01	1.26E-02	MG/KG	5.70E-02	4.51E+00	1.0E+02 C	1.00E+02	0
1,2,3-TRICHLOROBENZENE	SW8260	35	2.86E-02	1	2.00E-03 - 2.70E-01	5.00E-04 - 6.80E-02	7.84E-04 - 1.35E-01	5.07E-03	MG/KG	2.26E-02	4.46E+00		0.00E+00	0
1,2,4-TRIMETHYLBENZENE	SW8260	35	8.57E-02	3	7.10E-03 - 9.60E-01	5.00E-04 - 6.80E-02	9.87E-04 - 4.80E-01	2.00E-02	MG/KG	8.05E-02	4.02E+00	1.0E+05 N	1.00E+04	0
1,3,5-TRIMETHYLBENZENE (MESITYLENE)	SW8260	35	5.71E-02	2	3.00E-03 - 4.10E-01	5.00E-04 - 6.80E-02	1.50E-03 - 2.05E-01	7.79E-03	MG/KG	3.43E-02	4.40E+00		0.00E+00	0
ACENAPHTHENE	SW8270	36	2.78E-02	1	7.10E-01 - 7.70E+00	4.50E-02 - 9.10E-01	1.19E-01 - 3.85E+00	5.21E-01	MG/KG	5.75E-01	1.10E+00	1.2E+05 N	1.20E+04	0
BENZENE	SW8260	35	2.86E-02	1	2.00E-03 - 2.70E-01	5.00E-04 - 6.80E-02	1.00E-03 - 1.35E-01	5.09E-03	MG/KG	2.26E-02	4.44E+00	1.0E+02 C	1.00E+02	0
CHLOROFORM	SW8260	35	2.86E-02	1	2.00E-03 - 2.70E-01	5.00E-04 - 6.80E-02	1.00E-03 - 1.35E-01	5.08E-03	MG/KG	2.26E-02	4.45E+00	9.4E+02 C	9.40E+02	0
cis-1,2-DICHLOROETHYLENE	SW8260	35	4.86E-01	17	6.10E-03 - 8.20E-01	5.00E-04 - 6.80E-02	6.91E-04 - 5.44E-01	4.42E-02	MG/KG	1.14E-01	2.57E+00	2.0E+04 N	2.00E+03	0
DI-n-BUTYL PHTHALATE	SW8270	45	2.22E-02	1	7.10E-01 - 7.70E+00	3.30E-02 - 9.10E-01	9.48E-02 - 3.85E+00	4.97E-01	MG/KG	5.15E-01	1.04E+00	2.0E+05 N	2.00E+04	0
DI-n-OCTYLPHTHALATE	SW8270	41	2.44E-02	1	7.10E-01 - 7.70E+00	3.30E-02 - 9.10E-01	1.26E-01 - 3.85E+00	5.06E-01	MG/KG	5.39E-01	1.07E+00	4.1E+04 N	4.10E+03	0
DIETHYL PHTHALATE	SW8270	44	2.27E-02	1	7.10E-01 - 7.70E+00	5.20E-02 - 9.10E-01	1.09E-01 - 3.85E+00	4.98E-01	MG/KG	5.21E-01	1.05E+00	1.6E+06 N	1.60E+05	0

TABLE 2-9
SUMMARY OF SOIL DATA
SPILL SITE 7 - F.E.WARREN AFB

Constituent	Analytical Method	Number of Samples	Detection Frequency	Number of Detections	RL Range	MDL Range	Test Value Range	Mean	Units	Standard Deviation	Coefficient Of Variation	RBC	RBC (Non-Carcinogens)	Number of RBC Exceedances
Subsurface Soil Organics														
ETHYLBENZENE	SW8260	35	5.71E-02	2	3.00E-03 - 4.10E-01	5.00E-04 - 6.80E-02	7.50E-04 - 2.05E-01	7.67E-03	MG/KG	3.43E-02	4.48E+00	2.0E+05 N	2.00E+04	0
HEPTACHLOR	SW8081	45	2.22E-02	1	1.70E-03 - 3.80E-02	4.00E-04 - 8.90E-03	5.40E-04 - 1.90E-02	1.43E-03	MG/KG	2.68E-03	1.88E+00	1.3E+00 C	1.30E+00	0
ISOPROPYLBENZENE (CUMENE)	SW8260	35	5.71E-02	2	8.10E-03 - 1.10E+00	5.00E-04 - 6.80E-02	1.47E-03 - 5.50E-01	2.04E-02	MG/KG	9.22E-02	4.52E+00	2.0E+05 N	2.00E+04	0
M-XYLENE (1,3-DIMETHYLBENZENE)	SW8260	35	2.86E-02	1	5.10E-03 - 6.80E-01	5.00E-04 - 6.80E-02	2.55E-03 - 3.40E-01	1.28E-02	MG/KG	5.69E-02	4.45E+00	4.1E+06 N	4.10E+05	0
METHYLENE CHLORIDE	SW8260	35	5.71E-02	2	2.00E-03 - 2.70E-01	1.00E-03 - 1.40E-01	1.00E-03 - 1.35E-01	5.28E-03	MG/KG	2.26E-02	4.28E+00	7.6E+02 C	7.60E+02	0
n-BUTYLBENZENE	SW8260	35	8.57E-02	3	5.10E-03 - 6.80E-01	5.00E-04 - 6.80E-02	2.55E-03 - 3.40E-01	1.30E-02	MG/KG	5.69E-02	4.38E+00	8.2E+04 N	8.20E+03	0
n-PROPYLBENZENE	SW8260	35	5.71E-02	2	2.00E-03 - 2.70E-01	5.00E-04 - 6.80E-02	1.00E-03 - 1.35E-01	5.25E-03	MG/KG	2.26E-02	4.31E+00	8.2E+04 N	8.20E+03	0
NAPHTHALENE	SW8260	35	1.14E-01	4	2.00E-03 - 2.70E-01	5.00E-04 - 6.80E-02	8.80E-04 - 1.35E-01	5.21E-03	MG/KG	2.26E-02	4.34E+00	4.1E+04 N	4.10E+03	0
O-XYLENE (1,2-DIMETHYLBENZENE)	SW8260	35	1.14E-01	4	5.10E-03 - 6.80E-01	5.00E-04 - 6.80E-02	8.14E-04 - 3.40E-01	1.27E-02	MG/KG	5.70E-02	4.49E+00		0.00E+00	0
P-CYMENE (p-ISOPROPYLTOLUENE)	SW8260	35	5.71E-02	2	6.10E-03 - 8.20E-01	5.00E-04 - 6.80E-02	2.73E-03 - 4.10E-01	1.54E-02	MG/KG	6.87E-02	4.47E+00		0.00E+00	0
PCB-1260 (AROCHLOR 1260)	SW8082	39	2.56E-02	1	7.10E-01 - 1.00E+00	8.30E-03 - 1.20E-02	3.22E-02 - 5.00E-01	4.24E-01	MG/KG	7.59E-02	1.79E-01		0.00E+00	0
SEC-BUTYLBENZENE	SW8260	35	8.57E-02	3	7.10E-03 - 9.60E-01	5.00E-04 - 6.80E-02	2.13E-03 - 4.80E-01	1.79E-02	MG/KG	8.04E-02	4.49E+00	8.2E+04 N	8.20E+03	0
TETRACHLOROETHYLENE(PCE)	SW8260	35	5.71E-02	2	7.10E-03 - 9.60E-01	5.00E-04 - 6.80E-02	9.04E-04 - 4.80E-01	1.78E-02	MG/KG	8.04E-02	4.51E+00	1.1E+02 C	1.10E+02	0
TOLUENE	SW8260	35	5.14E-01	18	5.10E-03 - 6.80E-01	5.00E-04 - 6.80E-02	5.46E-04 - 3.40E-01	1.65E-02	MG/KG	5.69E-02	3.44E+00	4.1E+05 N	4.10E+04	0
TRICHLOROETHYLENE (TCE)	SW8260	35	6.57E-01	23	1.00E-02 - 1.40E+01	5.00E-04 - 6.80E-01	9.75E-04 - 4.04E+01	1.54E+00	MG/KG	6.84E+00	4.43E+00	5.2E+02 C	5.20E+02	0
Surface Soil Metals														
ANTIMONY	SW6010	1	1.00E+00	1	2.10E-01 - 2.30E-01	1.10E-01 - 1.20E-01	5.90E-01 - 5.90E-01	5.90E-01	MG/KG			3.1E+01 N	3.10E+00	0
ANTIMONY	SW6020	10	1.00E-01	1	2.10E-01 - 2.30E-01	1.10E-01 - 1.20E-01	1.05E-01 - 1.84E-01	1.18E-01	MG/KG	2.34E-02	1.98E-01	3.1E+01 N	3.10E+00	0
BARIUM	SW6010	11	1.00E+00	11	5.30E-01 - 5.80E-01	1.50E-02 - 1.60E-02	6.20E+01 - 4.10E+02	1.48E+02	MG/KG	9.20E+01	6.22E-01	5.5E+03 N	5.50E+02	0
CADMIUM	SW6010	11	5.45E-01	6	1.10E-01 - 2.30E-01	3.40E-02 - 7.40E-02	3.79E-02 - 6.88E+00	7.09E-01	MG/KG	2.05E+00	2.89E+00		0.00E+00	0
LEAD	SW6020	10	1.00E+00	10	5.30E-01 - 5.60E+00	2.70E-01 - 2.80E+00	2.05E+00 - 1.68E+02	2.92E+01	MG/KG	5.12E+01	1.75E+00		0.00E+00	0
MERCURY	SW7471	11	2.73E-01	3	1.10E-01 - 1.20E-01	1.90E-02 - 2.10E-02	1.97E-02 - 2.10E-01	6.33E-02	MG/KG	5.07E-02	8.01E-01		0.00E+00	0
MOLYBDENUM	SW6010	11	9.09E-02	1	2.10E+00 - 2.30E+00	1.30E-01 - 1.40E-01	7.20E-01 - 1.15E+00	1.07E+00	MG/KG	1.19E-01	1.12E-01	3.9E+02 N	3.90E+01	0
SELENIUM	SW6020	10	1.00E+00	10	2.10E-01 - 2.30E-01	1.10E-01 - 1.20E-01	1.29E-01 - 3.45E-01	2.66E-01	MG/KG	6.74E-02	2.53E-01	3.9E+02 N	3.90E+01	0
SILVER	SW6010	11	1.82E-01	2	5.30E-01 - 1.20E+00	1.10E-01 - 2.40E-01	2.00E-01 - 6.00E-01	2.99E-01	MG/KG	1.03E-01	3.46E-01	3.9E+02 N	3.90E+01	0
THALLIUM	SW6020	10	9.00E-01	9	1.10E-01 - 1.20E-01	5.30E-02 - 5.80E-02	5.50E-02 - 2.02E-01	1.32E-01	MG/KG	3.87E-02	2.93E-01	5.5E+00 N	5.50E-01	0
Surface Soil Organics														
ACENAPHTHENE	SW8270	8	1.25E-01	1	7.40E-01 - 7.70E+00	4.50E-02 - 9.10E-01	1.19E-01 - 3.85E+00	7.86E-01	MG/KG	1.24E+00	1.58E+00	4.7E+03 N	4.70E+02	0
DI-n-BUTYL PHTHALATE	SW8270	11	9.09E-02	1	7.40E-01 - 7.70E+00	3.30E-02 - 9.10E-01	9.48E-02 - 3.85E+00	6.72E-01	MG/KG	1.06E+00	1.57E+00	7.8E+03 N	7.80E+02	0
DI-n-OCTYLPHTHALATE	SW8270	10	1.00E-01	1	7.40E-01 - 7.70E+00	3.30E-02 - 9.10E-01	1.26E-01 - 3.85E+00	7.06E-01	MG/KG	1.11E+00	1.57E+00	1.6E+03 N	1.60E+02	0
HEPTACHLOR	SW8081	11	9.09E-02	1	1.80E-03 - 3.80E-02	4.00E-04 - 8.90E-03	5.40E-04 - 1.90E-02	2.54E-03	MG/KG	5.46E-03	2.15E+00	1.4E-01 C	1.40E-01	0
PCB-1260 (AROCHLOR 1260)	SW8082	5	2.00E-01	1	7.40E-01 - 8.00E-01	8.80E-03 - 9.50E-03	3.22E-02 - 4.00E-01	3.11E-01	MG/KG	1.57E-01	5.03E-01		0.00E+00	0

TABLE 2-9
SUMMARY OF SOIL DATA
SPILL SITE 7 - F.E.WARREN AFB

Constituent	Analytical Method	Number of Samples	Detection Frequency	Number of Detections	RL Range	MDL Range	Test Value Range	Mean	Units	Standard Deviation	Coefficient Of Variation	RBC	RBC (Non-Carcinogens)	Number of RBC Exceedances

Notes

RL = Reporting Limit

MDL = Method Detection Limit

Test Value = Detected value or 1/2 Reporting Limit

RBC = Risk Based Concentration from EPA 9/25/01, Residential RBC used for Surface Soil Comparison Industrial RBC used for Subsurface Soil Comparison

TABLE 3-1
ORGANIC AND INORGANIC CLEANUP STANDARDS
SPILL SITE 7 - F.E. WARREN AFB

Analyte	Cleanup Standard (mg/kg)
TCE	0.0407
cis-1,2-DCE	0.3687
Chloroform	0.4800
1,1,2-Trichloroethane	0.0269
Arsenic	5
Barium	100
Cadmium	1
Chromium	5
Lead	5
Mercury	0.2
Selenium	1
Silver	5

Notes:

TCE = Trichloroethylene

DCE = Dichloroethylene

mg/kg = milligrams per kilogram

Standards for organic analytes are based on Site-Specific SSL values

Standards for inorganic analytes are based on Toxicity Characteristic Leachate Procedure values

TABLE 3-2
POTENTIAL CHEMICAL-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SPILL SITE 7 - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citations	Description	Applicable/ Relevant and Appropriate [1]	Comments
Federal				
Federal Safe Drinking Water Act MCL	42 USC Section 300	Establishes drinking water standards to protect public health by limiting levels of contaminants	No/No	Only applicable or relevant and appropriate in the event of an unanticipated discharge to Diamond Creek. Used to calculate soil gas screening criteria for the protection of groundwater. MCL for TCE is equal to 5 µg/L and calculated with Henry's law constant and a dilution attenuation factor to equal a soil gas criteria of 42 ppbv.
State of Wyoming				
Wyoming Air Quality Standards and Regulations	Chapter 2, Sections 1-10	Establishes ambient air standards.	Yes/--	Applicable and relevant and appropriate since remedial actions may result in emission discharges to atmosphere.

Notes:

1) An ARAR cannot be both "applicable" and "relevant and appropriate" (either "Yes/–" or "No/Yes"). If an ARAR is determined to be "applicable" the determination of "relevant and appropriate" is not needed (i.e. "Yes/–") since the "applicable" determination already makes that requirement of an environmental law an ARAR.

ARAR = applicable or relevant and appropriate requirements
MCL = Maximum Contaminant Level
NA = not applicable
ppbv = parts per billion volume
TLE = trichloroethene
ug/L = micrograms per liter
USC = United States Code

TABLE 3-3
POTENTIAL ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SPILL SITE 7 - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citations	Description	Applicable/ Relevant and Appropriate [1]	Comments
Federal				
Clean Water Act	33 USC Section 1251–1376	Establishes requirements for regulating discharge of pollutants in waters.	--	Substantive requirements apply.
NPDES Storm Water Regulations	40 CFR Part 122	Establishes requirements for discharge of storm water	Yes/--	Storm water may occur from the site, making substantive requirements applicable.
Clean Air Act	42 USC 7401–7642	Establishes air quality standards to protect public health and the environment	--	Substantive requirements apply.
National Primary and Secondary Ambient Air Quality Standards and Emissions	40 CFR, Part 50	Establishes standards for carbon monoxide, nitrogen oxide, ozone, sulfur dioxide, particulate matter, and lead	Yes/--	Emissions from excavation and remedial discharges of dust and gasses will be subject to national ambient air quality standards unless state standards are more stringent.
Resource Conservation and Recovery Act	40 CFR, Part 264, Subpart S	Provides rules and regulations for corrective action management units, temporary units, and staging piles	Yes/--	Chapter 10 of the Wyoming Hazardous Waste Rules and Regulations has primacy; but has not adopted all the amendments.
State of Wyoming				
Wyoming Environmental Quality Act	Article 2, W.S. 35-11-201	Addresses discharge or emission of air contaminants	Yes/--	Compliance with state air quality numeric and other substantive requirements identified as ARARs satisfies all requirements of this provision.
	Article 3, W.S. 35-11-301 to 35-11-311	Prohibits certain acts without a permit	Yes/--	Compliance with state water quality substantive requirements (permits are not required) identified as ARARs satisfies all requirements of this provision.
	Article 5, W.S. 35-11-516, 519	Provides requirements for hazardous waste generators, transporters, and corrective action	Yes/--	If hazardous waste is generated during excavation, this chapter would apply. It is applicable as necessary to implement other substantive requirements.

TABLE 3-3
POTENTIAL ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SPILL SITE 7 - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citations	Description	Applicable/ Relevant and Appropriate [1]	Comments
Wyoming Water Quality Rules and Regulations	Chapter I, Section 18	Establishes human health values for surface waters	Yes/--	Applies in relation to excavation activities to minimize surface water runoff into Diamond Creek.
	Chapter III, Sections 4, 5, 7, 8	Provides requirements for construction, installation, or modification of facilities capable of causing or contributing to pollution	Yes/--	Substantive provisions apply, but no permits are required.
	Chapter XI, Part G	Standards for the Design and Construction and for the Abandonment of Monitoring Wells	Yes/--	Applies to excavation activities where well abandonment is required.
Wyoming Air Quality Standards and Regulations	Chapter 2, Sections 1-10	Establishes ambient air standards.	Yes/--	Applicable to the emissions from excavation and off gasses of contaminated soils.
	Chapter 2, Section 11	Provides ambient air standards for odors	Yes/--	Applicable to the emissions from excavation activities and off gasses of contaminated soils.
	Chapter 3, Sections 1,2,6	Provides requirements for emission control of fugitive dust and volatile organic compounds	Yes/--	Applicable to the emissions from excavation activities and off gasses of contaminated soils.
	Chapter 5, Sections 1 and 3	National Emission Standards	Yes/--	Applicable to the emissions from remediation options.
	Chapter 6, Section 2	Provides requirements for permit requirements for construction, modification, and operations	Yes/--	Although permits are not required, substantive requirements of BACT apply.
Wyoming Hazardous Waste Rules and Regulations	Chapter 1	Provides overview and Definitions	Yes/--	Applicable as necessary to implement other substantive requirements.

TABLE 3-3
POTENTIAL ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SPILL SITE 7 - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citations	Description	Applicable/ Relevant and Appropriate	Comments
Wyoming Hazardous Waste Rules and Regulations (cont.)	Chapter 2 (*49 CFR 171-179*)	Identifies and lists hazardous waste	Yes/--	Provisions are applicable in identifying listed or characteristic hazardous waste subject to other substantive requirements.
	Chapter 8 (*40 CFR 264, Subparts A-DD*)	Sets standards for generators of hazardous waste	Yes/--	The generation of hazardous wastes are anticipated in the remediation process and these standards will apply.
	Chapter 9 *(49 CFR 171-179)*	Sets standards for transporters of hazardous waste	Yes/--	The generation of hazardous wastes are anticipated in the remediation process and these standards will apply..
	Chapter 10 *(40 CFR 264, Subparts A-DD)*	Sets standards for owners and operators of hazardous waste treatment, storage, and disposal facilities	Yes/--	If hazardous waste is generated during excavation, this chapter would apply if the hazardous waste is treated on site, except when treated in a container, or if hazardous waste is stored for longer than 90 days (although that length of storage is not anticipated).
	Chapter 11, Sections 4(g), 5, 6, 9(b) and (e), 10, 11 (except (h)(iii) and (k), 24, 31 *(40 CFR 265, Subparts A-DD)*	Sets interim status standards for owners and operators of hazardous waste treatment, storage, and disposal facilities.	Yes/--	The generation of hazardous wastes are anticipated in the remediation process and these standards will apply.
	Chapter 13 *(40CFR 268, Subparts A-E)*	Addresses land disposal restrictions.	Yes/--	The generation of hazardous wastes are anticipated in the remediation process and these restrictions will apply. Compliance with LDR requirements will be met through the implementing the CAMU (*see RCRA Part 264 Subpart S above*)

Notes:

1) An ARAR cannot be both "applicable" and "relevant and appropriate" (either "Yes/--" or "No/Yes"). If an ARAR is determined to be "applicable" the determination of "relevant and appropriate" is not needed (i.e. "Yes/--") since the "applicable" determination already makes that requirement of an environmental law an ARAR.

ARAR = Applicable or Relevant and Appropriate Requirement
BACT = Best available control technology
CFR = Code of Federal Regulations
DOT = Department of Transportation
EPA = United States Environmental Protection Agency
NPDES = National Pollutant Discharge Elimination System
USAF = United States Air Force
USC = United States Code
WDEQ = Wyoming Department of Environmental Quality
W. S. = Wyoming Statute

TABLE 3-4
POTENTIAL LOCATION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SPILL SITE 7 - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate [1]	Comments
Federal				
Clean Water Act	40 CFR, Part 230 33 CFR, Parts 320-330	Prohibits the discharge of dredged or fill material into wetlands without a permit	Yes/--	Mitigation plans should be developed as necessary to avoid discharging any material into wetlands.
Endangered Species Act	16 USC Section 1531; 50 CFR Parts 17 and 402	Requires that federal activities not jeopardize the continued existence of any threatened or endangered species.	Yes/--	Mitigation plans should be developed as necessary to avoid damaging the sensitive habitat.
State of Wyoming				
Wyoming Water Quality Rules and Regulations	Chapter 1, Appendix A	Provides classifications for surface waters	Yes/--	The alternatives acknowledge the classification of Diamond Creek, Crow Creek and the unnamed tributary as Class 3B, Class 2AB, and Class 3B, respectfully.
	Chapter 1, Section 12	Addresses protection of wetlands	Yes/--	An authorized wetlands mitigation process includes any process under Section 404 of the Clean Water Act or under U.S. Army Corps of Engineers Wetlands regulations. If unexpected conditions cause the disturbance of the wetlands associated with Diamond Creek, these requirements would be applicable.

Notes:

1) An ARAR cannot be both "applicable" and "relevant and appropriate" (either "Yes/–" or "No/Yes"). If an ARAR is determined to be "applicable" the determination of "relevant and appropriate" is not needed (i.e. "Yes/--") since the "applicable" determination already makes that requirement of an environmental law an ARAR.

CFR = Code of Federal Regulations
USC = United States Code

TABLE 4-1
SUMMARY OF SPILL SITE 7 ALTERNATIVES
F.E. WARREN AIR FORCE BASE

	Alternative	I. Excavation and Disposal	II. Excavation and Disposal, In-situ Soil Vapor Extraction	III. Excavation and Disposal, Excavation and Ex-situ SVE
	Description	Metals-contaminated surface soil and VOC-contaminated unsaturated soil will be excavated and hauled to an off-site disposal facility.	Metals-contaminated surface soils will be excavated and disposed off-site. A SVE system will be installed to remove VOCs from the unsaturated soil.	Metals-contaminated surface soils will be excavated and disposed off-site. Unsaturated soil will be excavated and treated on-site via SVE. The treated material will then be used as backfill material.
Effectiveness	**Overall Protection of Human Health and the Environment**	Soil removal eliminates unsaturated soil contamination at the site. Disposal of material in a secure landfill ensures no subsequent exposure to contaminants.	Surface soil removal eliminates potential impacts to the surface water or direct human contact. SVE minimizes volatile contamination at the site without hazards associated with excavation.	Surface soil removal eliminates potential impacts to the surface water or direct human contact. Excavation and on-site treatment reduces volatile contamination at the site. Saturated soil treatment reduces potential impacts to groundwater.
	Compliance with ARARs	Will comply with ARARs.	Will comply with ARARs.	Will comply with ARARs.
	Long-term Effectiveness and Permanence	Potential contribution to groundwater contamination reduced by physically removing unsaturated zone contamination and reducing saturated zone contamination. This alternative is permanent since the contaminated material is removed from the site.	Removal of surface soils is a permanent solution. Contaminant contribution to groundwater is reduced by treating the contaminated material in-situ. A percentage of contaminant may be left bound in tight soils.	Risk is reduced by removing the contaminated material and treating the material ex-situ. Contaminant removal is permanent.
	Reduction in Toxicity, Mobility, and Volume	Contaminant mobility is reduced by placing contaminated soil in a secure landfill facility.	Volume and toxicity are reduced by treating the contaminated soil in-situ. Mobility is reduced by placing spent GAC in a secure landfill facility or regenerating it. Regeneration of GAC may result in TCE destruction.	Volume and toxicity are reduced by treating the contaminated soil ex-situ. Mobility is reduced by placing spent GAC in a secure landfill facility. Regeneration of GAC may result in TCE destruction.
	Short-term Effectiveness	During implementation, may increase risk to community, and environment by transporting hazardous materials; risk to workers may minimally increase from fugitive dust emissions.	During implementation, risk will not significantly increase to community, environment, or workers.	During implementation of alternative, risk to community, environment, and workers may minimally increase from fugitive dust and vapor emissions.
Implementability	**Technical Feasibility**	Technically feasible because alternative uses proven excavation and treatment techniques, materials, and equipment.	Technically feasible because alternative uses proven excavation techniques, materials, and equipment.	Technically feasible because alternative uses proven excavation techniques, materials, and equipment.
	Administrative Feasibility	Administratively feasible. Must comply with regulations associated with off-site disposal of hazardous and CERCLA material, as well as UIC program issues.	Administratively feasible. Must comply with air emission statutes (if applicable).	Administratively feasible. Must comply with air emission statutes (if applicable), regulations regarding backfilling with treated soils, and UIC program requirements.
	Availability of Services and Materials	Material and equipment are readily located in the area. Size of project will not affect availability of equipment or labor force.	Material and equipment are readily located in the area. Size of project will not affect availability of equipment or labor force.	Material and equipment are readily located in the area. Size of project will not affect availability of equipment or labor force.
	State and Community Acceptance	Unknown. Will be evaluated following 30-day public comment period.	Unknown. Will be evaluated following 30-day public comment period.	Unknown. Will be evaluated following 30-day public comment period.
Cost	**Capital Cost**	WCA Facility: $1,095,261 Off-site Landfill: $1,366,660	$269,764	$773,705

TABLE 4-1
SUMMARY OF SPILL SITE 7 ALTERNATIVES
F.E. WARREN AIR FORCE BASE

	Alternative	I. Excavation and Disposal	II. Excavation and Disposal, In-situ Soil Vapor Extraction	III. Excavation and Disposal, Excavation and Ex-situ SVE
	O & M Cost	WCA Facility: $0 Off-site Landfill: $0	$216,197	$138,247
	Total Cost	WCA Facility: $1,095,261 Off-site Landfill: $1,366,660	$485,961	$911,952

Notes:
All remedial alternatives include removal of contaminated surface material.
Details can be found in Appendices C through E.

ARAR Applicable or Relevant and Appropriate Standards, Limitations, Criteria, and Requirements
CERCLA Comprehensive Environmental
GAC granular activate carbon
HRC Hydrogen Release Compound
SVE soil vapor extraction
TCE trichloroethene
UIC underground injection control
VOC volatile organic compounds
WCA waste consolidation area

TABLE 4-2
ANALYSIS OF COMPLIANCE WITH POTENTIAL CHEMICAL-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SPILL SITE 7 - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate [1]	Comments
Federal				
Federal Safe Drinking Water Act MCL	42 USC Section 300	Establishes drinking water standards to protect public health by limiting levels of contaminants.	Alternative 1 – No/No Alternative 2 – No/No Alternative 3 – No/No	MCLs are not applicable or relevant and appropriate to the scopes of these actions since water is not being treated for restoration or for public supply. MCLs are used to calculate soil gas screening criteria for the protection of groundwater. MCL for TCE is equal to 5 ug/L and calculated with Henry's law constant and a dilution attenuation factor to equal a soil gas criterion. Although not anticipated, water generated from any dewatering activities will be analyzed and treated or disposed of in compliance with the Federal Safe Drinking Water Act.
State of Wyoming				
Wyoming Air Quality Standards and Regulations	Chapter 2, Sections 1-10	Establishes ambient air standards.	Alternative 1 – **Yes**/No Alternative 2 – **Yes**/No Alternative 3 – **Yes**/No	Applicable or relevant and appropriate since remedial actions, especially excavation activities, may result in emission discharges to atmosphere. Emissions from these remedial actions will not exceed the ambient standards listed in Table 4-2, Wyoming Air Quality Standards and Regulations, Chapter 2 Sections 1-10.

Notes:

1) An ARAR cannot be both "applicable" and "relevant and appropriate" (either "Yes/–" or "No/Yes"). If an ARAR is determined to be "applicable" the determination of "relevant and appropriate" is not needed (i.e. "Yes/–") since the "applicable" determination already makes that requirement of an environmental law an ARAR.

ARAR = applicable or relevant and appropriate requirements
MCL = Maximum Contaminant Level
NA = not applicable
TCE = trichloroethene
ug/L = micrograms per liter
USC = United States Code

TABLE 4-3
ANALYSIS OF COMPLIANCE WITH POTENTIAL ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SPILL SITE 7, F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate [1]	Comments
Federal				
Clean Water Act	33 USC Section 1251–1376			
NPDES Storm Water Regulations	40 CFR, Part 122	Establishes requirements for discharge of storm water	Alternative 1 – No/No Alternative 2 – No/No Alternative 3 – No/No	NPDES Storm Water regulations are not applicable, relevant or appropriate to the scopes of these alternatives, except with the occurrence of an unanticipated discharge of materials to Diamond Creek. Due to Section 121(e) of CERCLA, which states that no federal, state or local permits are required for on-site Superfund response actions, no NPDES permits are required, but substantive requirements apply. No discharge to surface waters is planned in these alternatives. Best management practices will be implemented to minimize surface water runoff into Diamond Creek from the remedial areas. BMPs include run-on/run-off controls such as silt fencing and hay bales.
Clean Air Act	42 USC 7401–7642			
National Primary and Secondary Ambient Air Quality Standards and Emissions	40 CFR, Part 50	Emissions from excavation and remedial discharges of dust and gasses will be subject to national ambient air quality standards unless state standards are more stringent.	Alternative 1 – **Yes**/No Alternative 2 – **Yes**/No Alternative 3 – **Yes**/No.	CAA is applicable or relevant and appropriate to all three remedial alternatives since air emissions are anticipated. Best management practices will be implemented to minimize fugitive dust emissions to comply with the Clean Air Act. BMPs include tarping/covering of soils piles, wetting of soils, and off gas treatment.

TABLE 4-3
ANALYSIS OF COMPLIANCE WITH POTENTIAL ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SPILL SITE 7, F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate [1]	Comments
Resource Conservation and Recovery Act *(Chapter 10 of the WHWRR has primacy, but has not adopted all the amendments)*	40 CFR, Part 264, Subpart S	Provides rules and regulations for corrective action management units (CAMUs), temporary units, and staging piles.	Alternative 1 – No/No Alternative 2 – No/No Alternative 3 – **Yes**/--	**Alternatives 1 & 2** –*See Comments below for Chapter 10 of WHWRR.* **Alternative 3** – *See Comments below for Chapter 10 of WHWRR.* Under the Amendments to Corrective Action Management Unit Rule (67 FR 2962, January 22, 2002) the CAMU would be classified as a storage and/or treatment only CAMU. This designation means as long as the CAMU does not exceed the staging pile time limit (2 ½ years), the CAMU is subject to only the performance and design criteria, operating, and closure standards for staging piles found in 40 CFR 264.554(d)(1)(i)-(ii), 40 CFR 264.554(d)(2) and 40 CFR 264.554(e), (f), (j), and (k).BMPs such as berms, tarps, liners, and run-on/run-off controls will be used to ensure compliance with the staging piles regulations. Storage and/or treatment only CAMUs are not subject to the CAMU designation criteria (40 CFR 264.552(c) and the CAMU design treatment, ground-water monitoring and corrective action, and closure requirements at 40 CFR 264.522(e)(3) through (6) (67 FR 2996, January 22, 2002). However, to ensure protection of human health and the environment, BMPs including use of a liner beneath the soil, tarps and berms, run on/run off controls, bulk soil sampling after closure and removal of liner will be implemented. Long-term groundwater and surface water sampling will also be conducted as part of a concurrent remedial program. Additionally, to be protective of human health and the environment this alternative will achieve clean up levels that are in compliance with the Minimum National Treatment Standards [40 CFR 264(e)(4)(iv)]. The cleanup goal for TCE (0.04 mg/kg), based from a site specific calculated SSL, will met the 90% Capped by 10XUTS standard.

TABLE 4-3
ANALYSIS OF COMPLIANCE WITH POTENTIAL ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SPILL SITE 7, F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate [1]	Comments
State of Wyoming				
Wyoming Environmental Quality Act	Article 2, W.S. 35-11-201	Prohibits discharges or emissions of any air contaminant in any form so as to cause pollution, which violates rules, regulations and standards adopted by the Air Quality Council.	Alternative 1 – **Yes**/-- Alternative 2 – **Yes**/-- Alternative 3 – **Yes**/--	Compliance with state numeric and other substantive air quality requirements identified as ARARs satisfies all requirements of this provision.
	Article 3, W.S. 35-11-301 to 35-11-311	Prohibits certain acts without a permit	Alternative 1 – No/No Alternative 2 – No/No Alternative 3 – No/No	Not applicable or relevant and appropriate, due to Section 121(e) of CERCLA, which states that no federal, state or local permits are required for on-site Superfund response actions. Substantive provisions apply, but no permits are required. None of the remedial alternatives will involve the usage of onsite oil field waste disposal facilities, commercial waste treatment, storage, disposal facilities, or involve the drainage of manmade wetlands, wetland losses or wetland mitigation.
	Article 5, W.S. 35-11-516, 519	Provides requirements for hazardous waste generators, transporters, and corrective action	Alternative 1 – **Yes**/-- Alternative 2 – **Yes**/-- Alternative 3 – **Yes**/--	Article 5 of the WEQA is applicable or relevant and appropriate to all three alternatives since the generation of hazardous waste is anticipated. During the transportation of hazardous waste off-site, appropriate record keeping will occur. A manifest (for hazardous material) or bill of lading (for nonhazardous material) will be given to the transporter, appropriate container labeling and DOT approved vehicle placards will be used. Personnel will have necessary OSHA training described under 29 CFR 1910.120, have proper Personal Protective Equipment (PPE) available, and have medical clearance to wear proper PPE. None of the alternatives will utilize an onsite hazardous waste management facility, thus corrective action requirements are not applicable.

TABLE 4-3
ANALYSIS OF COMPLIANCE WITH POTENTIAL ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SPILL SITE 7, F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate [1]	Comments
Wyoming Water Quality Rules and Regulations	Chapter I, Section 18	Establishes human health values for surface waters	Alternative 1 – No/No Alternative 2 – No/No Alternative 3 – No/No	Not applicable, relevant or appropriate to the scopes of these alternatives, except with the occurrence of an unanticipated discharge of materials to Diamond Creek. Best management practices such as run-on/run-off controls (silt fences, hay bales) will be implemented to minimize surface water runoff into Diamond Creek from the remedial areas. Excavation activities are not anticipated to affect the floodplain and/or wetlands areas associated with Diamond Creek.
	Chapter III, Sections 4, 5, 7, 8	Provides requirements for construction, installation, or modification of facilities capable of causing or contributing to pollution	Alternative 1 – No/No Alternative 2 – No/No Alternative 3 – No/No	Not applicable or relevant and appropriate, due to Section 121(e) of CERCLA, which states that no federal, state or local permits are required for on-site Superfund response actions. No actions resulting from the implementation of these alternatives will require a permit to Construct, Modify Public Water Supplies, Wastewater Facilities, and other Facilities Capable of Causing or Contributing to Pollution.
	Chapter XI, Part G	Standards for the Design and Construction and for the Abandonment of Monitor Wells	Alternative 1 – **Yes**/-- Alternative 2 – No/No Alternative 3 – **Yes**/--	**Alternative 2** – Not applicable or relevant and appropriate since no groundwater monitoring wells will be abandoned as a result of the implementation of this alternative. **Alternative 1 & 3** – Applicable or relevant and appropriate since the abandonment of groundwater monitoring wells will be required. Groundwater monitoring wells will be modified if possible. If modification is not possible, these wells will be abandoned according to well protection guidelines of the State of Wyoming.

TABLE 4-3
ANALYSIS OF COMPLIANCE WITH POTENTIAL ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SPILL SITE 7, F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate [1]	Comments
Wyoming Air Quality Standards and Regulations	Chapter 2, Sections 1-10	Establishes ambient air standards.	Alternative 1 – **Yes**/-- Alternative 2 – **Yes**/-- Alternative 3 – **Yes**/--	Applicable or relevant and appropriate since remedial actions, especially excavation activities, may result in emission discharges to atmosphere. Emissions from these remedial actions will not exceed the following ambient standards: **PM_{10} particulate matter:** 50 µg/m^3 – annual arithmetic mean 150 µg/m^3 – 24-hour average concentration with not more than one expected exceedance per year. **$PM_{2.5}$ particulate matter:** 15 µg/m^3 – annual arithmetic mean 65 µg/m^3 – 98th percentile 24-hour average concentration **Nitrogen Oxides:** 100 µg/m^3 (0.05 ppm) – annual arithmetic mean **Sulfur Oxides:** 60 µg/m^3 (0.02 ppm) – annual arithmetic mean 260 µg/m^3 (0.10 ppm) – maximum 24-hour concentration not to be exceeded more than once per year 1,300 µg/m^3 (0.50 ppm) – maximum 3-hour concentration not to be exceeded more than once per year **Carbon Monoxide:** 10 mg/m^3 (9 ppm) – maximum 8-hr concentration not to be exceeded more than once per year 40 mg/m^3 (35 ppm) – maximum 1-hour concentration not to be exceeded more than once per year **Ozone:** 0.08 ppm – daily maximum average 235 µg/m^3 (0.12 ppm) – maximum hourly average **Hydrogen Sulfide:** 70 µg/m^3 – ½ hour average not to be exceeded more than 2 times a year 40 µg/m^3 – ½ hour average not to be exceeded more than 2 times in any 5 consecutive days **Suspended Sulfates:** 0.25 mg SO_3/ 100cm^3 per day – maximum annual average 0.50 mg SO_3/ 100cm^3 per day – maximum 30 day value **Fluorides:** 3.0 µg/m^3 – maximum concentration per 12-hour average 1.8 µg/m^3 – maximum concentration per 24-hour average 0.5 µg/m^3 – maximum concentration per 7-day average 0.4 µg/m^3 – maximum concentration per 30-day average **Lead:** 1.5 µg/m^3 – maximum arithmetic mean averaged over a calendar quarter BMPs, such as tarping/covering of soil piles and wetting of soils, will be implemented in the remedial area to limit the emission of fugitive dust.

TABLE 4-3
ANALYSIS OF COMPLIANCE WITH POTENTIAL ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SPILL SITE 7, F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate [1]	Comments
Wyoming Air Quality Standards and Regulations (continued)	Chapter 2, Section 11	Provides ambient air standards for odors	Alternative 1 – No/No Alternative 2 – No/No Alternative 3 – No/No	Not applicable or relevant and appropriate since no actions as the result of the implementation of these alternatives are expected to cause odor emission defined in Chapter 2, Section 11(b)(i,ii). In the event that an odor emission occurs, the location of the remedial action within FEW would allow the odor emission to be sufficiently diluted and dispersed with odor-free air and be undetectable at the property line by a scentometer using methodologies described in Section 11(a)(i).
	Chapter 3, Section 1,2,6	Provides general emission standards and requirements for emission control for fugitive dust and volatile organic compounds (VOCs)	Alternative 1 – **Yes**/-- Alternative 2 – **Yes**/-- Alternative 3 – **Yes**/--	Applicable or relevant and appropriate since remedial actions have the potential for causing of the emission of fugitive dust and VOCs. <u>Fugitive Dust:</u> **Alternatives 1, 2, & 3** – BMPs, such as tarping and watering, will be used in the remedial area to limit the emission of fugitive dust during excavation. For off-site disposal, the trucks will be tarped to prevent fugitive dust emission. <u>VOCs:</u> **Alternatives 1**– Field monitoring will be performed to ensure air quality is maintained with respect to TCE. A Best Available Control Technology will be implemented if necessary, although it is not expected. **Alterative 2 & 3** – Field monitoring will be performed to ensure air quality is maintained with respect to TCE. As per Section 6(b), a Best Available Control Technology (BACT), vapor-phase GAC, will be fitted to the blower effluent to remove contaminants from the emissions and effluent will be sampled to determine if the effluent stream contains unacceptable levels of contaminants. Chapter 3 does not provide numerical emission standards for non-flare VOC emissions.

TABLE 4-3
ANALYSIS OF COMPLIANCE WITH POTENTIAL ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SPILL SITE 7, F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate [1]	Comments
Wyoming Air Quality Standards and Regulations (continued)	Chapter 5, Section 1 and 3	National Emission Standards	Alternative 1 – No/-- Alternative 2 – **Yes**/-- Alternative 3 – **Yes**/--	**Alternative 1** – Not applicable or relevant and appropriate, since no activities occurring during the implementation of this alternative will utilize a stationary source that emits or has the potential to emit hazardous air pollutants listed in Chapter 5, Section 3(d)(ii)(A)(I). **Alternative 2 & 3** - Applicable or relevant and appropriate since these alternatives utilize a stationary source that emits or has the potential to emit hazardous air pollutants, TCE, listed in Chapter 5, Section 3(d)(ii)(A)(I). Substantive provisions apply, but no permits or administrative provisions are required due to Section 121(e) of CERCLA. The SVE system will operate in a manner constant with good air pollution control practices for minimizing emissions to least to the levels required by all applicable standards. The blower effluent will be treated with GAC to remove contaminants from the emissions and effluent will be sampled to determine if the effluent stream contains unacceptable levels of contaminants.
	Chapter 6, Section 2	Provides requirements for permits for construction, modification, and operations	Alternative 1 – **Yes**/-- Alternative 2 – **Yes**/-- Alternative 3 – **Yes**/--	Substantive provisions are applicable or relevant and appropriate. However, due to Section 121(e) of CERCLA, which states that no federal, state or local permits are required for on-site Superfund response actions, permits are not required. **Alternative 1** – Field monitoring will be performed to ensure air quality is maintained with respect to TCE. A Best Available Control Technology will be implemented if necessary, although it is highly improbable. **Alterative 2 & 3** – Field monitoring will be performed to ensure air quality is maintained with respect to TCE. The SVE blower effluent will be treated with a BACT, vapor-phase GAC, will be fitted to the blower effluent to remove contaminants from the emissions and effluent will be sampled to determine if the effluent stream contains unacceptable levels of contaminants.

TABLE 4-3
ANALYSIS OF COMPLIANCE WITH POTENTIAL ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SPILL SITE 7, F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate [1]	Comments
Wyoming Hazardous Waste Rules and Regulations *(The WEQA gives authorization to the WHWRR to adopt RCRA regulations at a State level and has primacy over RCRA regulations)*	Chapter 1	Provides overview and Definitions	Alternative 1 – **Yes**/-- Alternative 2 – **Yes**/-- Alternative 3 – **Yes**/--	WHWRR is applicable or relevant and appropriate due to the anticipated generation of hazardous waste for all three alternatives. Excavated soil that is characterized as hazardous will be managed as a hazardous waste. If dewatering is preformed, the collected water will be analyzed and treated as a hazardous waste as necessary. **Alternative 2** – Water used to decontaminate the augers will be collected, characterized, and managed as a hazardous waste as necessary. **Alterative 2 & 3** – Spent GAC will be also managed as a hazardous waste.
	Chapter 2 *(40 CFR 261, Subpart A-D)*	Identifies and lists hazardous waste	Alternative 1 – **Yes**/-- Alternative 2 – **Yes**/-- Alternative 3 – **Yes**/--	WHWRR is applicable or relevant and appropriate due to the anticipated generation of hazardous waste for all three alternatives. The implementation of these alternatives will abide by the requirements of Chapter 2 of the WHWRR. Generation of hazardous waste is anticipated for all of these remedial actions. Excavated metal contaminated soil will be characterized using TCLP metals analysis. TCE-contaminated excavated soil will be analyzed for TCLP and if the soil exceeds the maximum concentration for TCE (0.5 mg/L) it will be managed and treated as hazardous waste.

TABLE 4-3
ANALYSIS OF COMPLIANCE WITH POTENTIAL ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SPILL SITE 7, F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate [1]	Comments
Wyoming Hazardous Waste Rules and Regulations (continued)	Chapter 8 *(40 CFR 262, Subpart A-H)*	Sets standards for generators of hazardous waste	Alternative 1 – **Yes**/-- Alternative 2 – **Yes**/-- Alternative 3 – **Yes**/--	WHWRR is applicable or relevant and appropriate due to the anticipated generation of hazardous waste for all three alternatives. Excavated metal contaminated soil will be characterized using TCLP metals. Decontamination water will be collected and may be used for dust control within the area of gross contamination. **Alternative 1** – The TCE-contaminated excavated soil will be analyzed for TCLP and if the soil exceeds the maximum concentration for TCE (0.5 mg/L) it will be managed and treated as hazardous waste. Hazardous waste will accumulation will be kept within the given 90 days accumulation time. **Alternative 2** – The drill cuttings generated from the SVE well installation will be characterized, consolidated into bulk containers, and hauled off to a properly permitted disposal facility.
	Chapter 9 *(49 CFR 171 – 179)*	Sets standards for transporters of hazardous waste	Alternative 1 – **Yes**/-- Alternative 2 – **Yes**/-- Alternative 3 – **Yes**/--	WHWRR is applicable or relevant and appropriate due to the anticipated generation of hazardous waste for all three alternatives. For off-site disposal, the trucks will be tarped to prevent soil and debris from contaminating the haul route, and a manifest (for hazardous material) or bill of lading (for nonhazardous material) will be given to the transporter to track and provide a record of the quantity of excavated soil. Trucks hauling the hazardous material will be properly placarded and will follow all applicable Department of Transportation (DOT) regulations (49 CFR 171-179) regarding transportation of hazardous waste. A decontamination pad will be constructed at the truck exit to remove residual soil from dump truck tires to avoid contaminating nearby roadways.

TABLE 4-3
ANALYSIS OF COMPLIANCE WITH POTENTIAL ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SPILL SITE 7, F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate [1]	Comments
Wyoming Hazardous Waste Rules and Regulations (continued)	Chapter 10 *(40 CFR 264, Subparts A-DD)*	Sets standards for owners and operators of hazardous waste treatment, storage, and disposal facilities	Alternative 1 – No/No. Alternative 2 – No/No. Alternative 3 – **Yes**/--.	**Alternatives 1 & 2** - Not applicable or relevant and appropriate. Implementation of these alternatives does not involve the use of an onsite hazardous waste, treatment, storage, and disposal (TSD) facility. **Alternative 3** – Applicable or relevant and appropriate since the ex-situ SVE treatment of excavated soils will be managed as a Corrective Action Management Unit (CAMU) as defined in Chapter 10, Section 18(a) [40 CFR 264.552(a)]. *(See Comments for RCRA, Part 264, Subpart S above)*
	Chapter 11, Sections 4(g), 5, 6, 9(b) and (e), 10, 11 (except (h)(iii) and (k), 24, 31 *(40 CFR 265, Subparts A-DD)*	Sets interim status standards for owners and operators of hazardous waste treatment, storage, and disposal facilities.	Alternative 1 – No/No. Alternative 2 – No/No. Alternative 3 – No/No.	**Alternatives 1 & 2** - Not applicable or relevant and appropriate. Implementation of these alternatives does not involve the use of an onsite hazardous waste, treatment, storage, and disposal (TSD) facility. **Alternative 3** – Not applicable or relevant and appropriate since the ex-situ SVE treatment of excavated soils does not met the qualifications of Interim Status as defined in Section 2(a).
	Chapter 13 *(40 CFR 268, Subparts A-E)*	Addresses land disposal restrictions.	Alternative 1 – No/No. Alternative 2 – No/No. Alternative 3 – **Yes**/--.	**Alternatives 1 & 2** - Not applicable or relevant and appropriate. Implementation of these alternatives does not involve the use of an onsite hazardous waste, treatment, storage, and disposal (TSD) facility. **Alternative 3** – Applicable or relevant and appropriate since the ex-situ SVE treatment of excavated soils will be managed as a Corrective Action Management Unit (CAMU) as defined in Chapter 10, Section 18(a) [40 CFR 264.552(a)]. The act of "placement" will occur within the CAMU as the contaminated soils are transferred to ex-situ SVE treatment cell. Onsite treatment of soil will meet substantive requirements of the LDRs, including use of a liner beneath the soil and bulk soil sampling after the completion and removal of the liner. *(See Comments for RCRA, Part 264, Subpart S above)*

TABLE 4-3
ANALYSIS OF COMPLIANCE WITH POTENTIAL ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SPILL SITE 7, F.E. WARREN AFB

Notes:

1) An ARAR cannot be both "applicable" and "relevant and appropriate" (either "Yes/--" or "No/Yes"). If an ARAR is determined to be "applicable" the determination of "relevant and appropriate" is not needed (i.e. "Yes/--") since the "applicable" determination already makes that requirement of an environmental law an ARAR.

ARAR = Applicable or Relevant and Appropriate Requirement
BACT = Best Available Control Technology
BMP = Best Management Practice
CAMU = Corrective Action Management Unit
CFR = Code of Federal Regulations
DOT = Department of Transportation
EPA = United States Environmental Protection Agency
GAC = Granular Activated Carbon
LDR = Land Disposal Restriction
NPDES = National Pollutant Discharge Elimination System
SVE = Soil Vapor Extraction
TCLP = Toxicity Characteristic Leaching Procedure
TSD = Treatment, Storage, Disposal
USAF = United States Air Force
USC = United States Code
WEQA = Wyoming Environmental Quality Act
WDEQ = Wyoming Department of Environmental Quality
WHWRR = Wyoming Hazardous Waste Regulations and Rules
W. S. = Wyoming Statute

TABLE 4-4
ANALYSIS OF COMPLIANCE WITH POTENTIAL LOCATION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SPILL SITE 7, F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate [1]	Comments
Federal				
Clean Water Act Prohibits the discharge of dredged or fill material into wetlands without a permit.	40 CFR, Part 230 33 CFR 320-330	Substantive requirements apply to actions involving disturbance of wetlands.	Alternative 1 – No/No Alternative 2 – No/No Alternative 3 – No/No	The CWA is not applicable or relevant and appropriate since none of alternatives will disturb designated wetlands or discharge into surface waters. CWA would only be applicable in the event of an unanticipated discharge of materials to Diamond Creek. However, due to close proximity to Diamond Creek, BMPs will be implemented to prevent surface impacts to Diamond Creek and Crow Creek. BMPs include run-on/run-off controls such as silt fencing and hay bales.
Endangered Species Act Requires that federal activities not jeopardize the continued existence of any threatened or endangered species.	16 USC Section 1531; 50 CFR, Parts 17 and 402	Mitigation plans should be developed as necessary to avoid damaging critical habitat.	Alternative 1 – No/No Alternative 2 – No/No Alternative 3 – No/No	The Endangered Species Act is not applicable or relevant and appropriate since none of alternatives will disturb areas that provide a critical habitat for designated endangered species. The Endangered Species Act would only be applicable in the event of an unanticipated discharge of materials to a sensitive habitat. However, due to the close proximity to Diamond Creek, which is a potential critical habitat for endangered species, BMPs will be implemented to prevent surface impacts to Diamond Creek and Crow Creek. BMPs include run-on/run-off controls such as silt fencing and hay bales.

TABLE 4-4
ANALYSIS OF COMPLIANCE WITH POTENTIAL LOCATION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SPILL SITE 7, F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate [1]	Comments
State of Wyoming				
Wyoming Water Quality Rules and Regulations Provides classifications for surface waters	Chapter 1, Appendix A	Provides descriptions of stream classifications for Diamond Creek, Crow Creek and the unnamed tributary.	Alternative 1 – No/No Alternative 2 – No/No Alternative 3 – No/No	Chapter 1 of the WWQRR is not applicable or relevant and appropriate since none of alternatives will discharge into surface waters. Chapter 1would only be applicable in the event of an unanticipated discharge of materials to Diamond Creek. However, due to close proximity to Diamond Creek, BMPs will be implemented to prevent surface impacts to Diamond Creek and Crow Creek. BMPs include run-on/run-off controls such as silt fencing and hay bales. The alternatives acknowledge the classification of Diamond Creek, Crow Creek and the unnamed tributary as Class 3B, Class 2AB, and Class 3B, respectfully.
	Chapter 1, Section 12	Addresses protection of wetlands	Alternative 1 – No/No Alternative 2 – No/No Alternative 3 – No/No	Chapter 1 of the WWQRR is not applicable or relevant and appropriate since none of alternatives will disturb designated wetlands. Chapter 1 would only be applicable in the event of an unanticipated discharge of materials to Diamond Creek. However, due to close proximity to Diamond Creek, BMPs will be implemented to prevent surface impacts to Diamond Creek and Crow Creek. BMPs include run-on/run-off controls such as silt fencing and hay bales.

Notes:

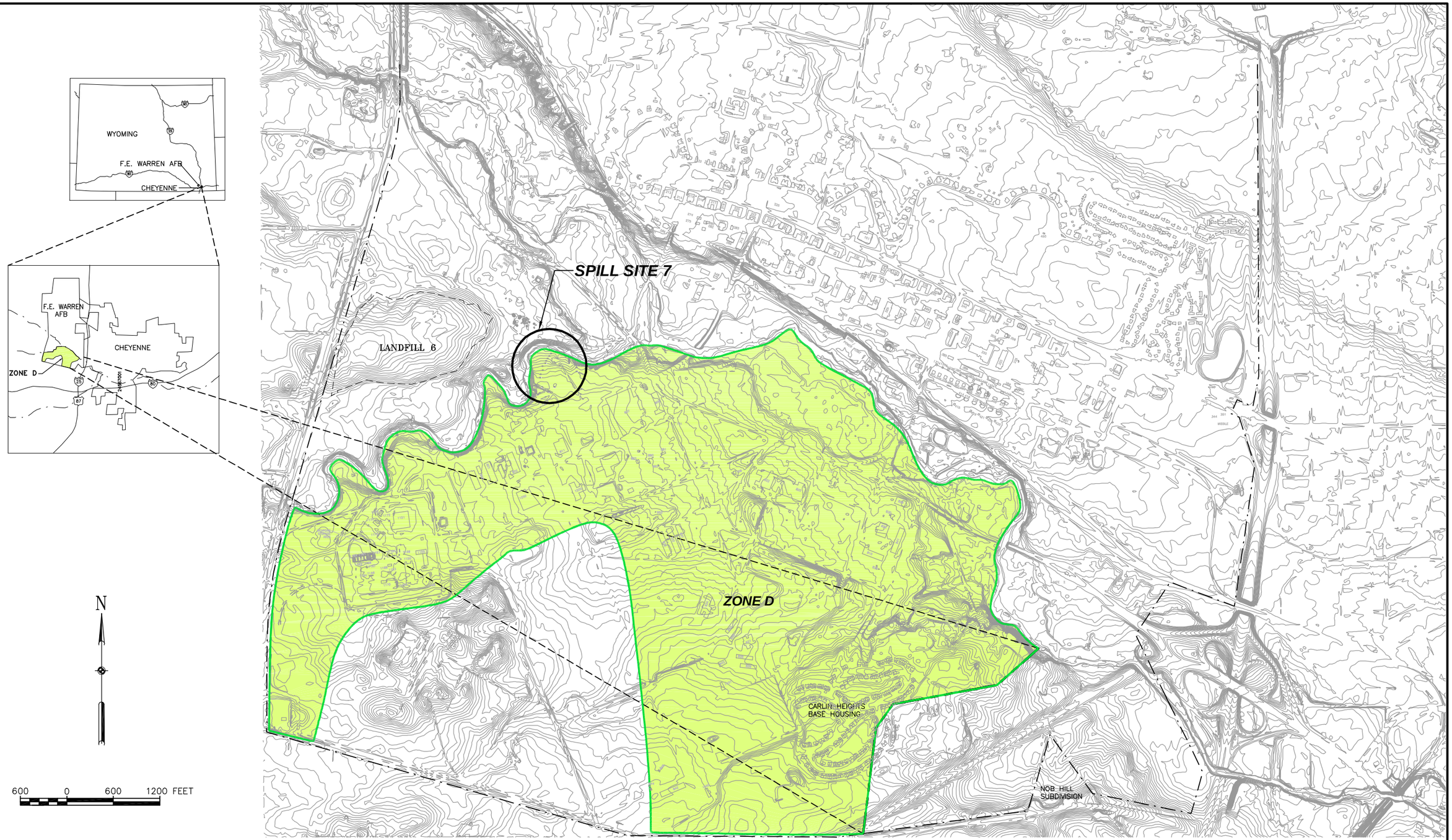
1) An ARAR cannot be both "applicable" and "relevant and appropriate" (either "Yes/--" or "No/Yes"). If an ARAR is determined to be "applicable" the determination of "relevant and appropriate" is not needed (i.e. "Yes/--") since the "applicable" determination already makes that requirement of an environmental law an ARAR.

BMP = Best Management Practice
CFR = Code of Federal Regulations
USC = United States Code
WWQRR = Wyoming Water Quality Rules and Regulations

TABLE 5-1
SPILL SITE 7 COMPARATIVE ANALYSIS
SPILL SITE 7 – F.E. WARREN AFB

Criterion	Surpasses the Criterion and/or Clearly the Best Alternative	Clearly Meets Criterion and/or Very Effective Alternative(s)	Minimally Meets Criterion and/or Moderately Effective Alternative(s)	Does Not Meet Criterion and/or Clearly the Least Effective Alternative(s)
Overall Protection of Human Health and Environment		Alternatives I, II and III		
Compliance with ARARs		Alternatives I, II and III		
Long-term Effectiveness and Permanence	Alternative I	Alternatives III		Alternative II
Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative III	Alternative I	Alternative II	
Short-term Effectiveness	Alternative III	Alternative I	Alternative II	
Technical Feasibility		Alternatives I, II and III		
Administrative Feasibility		Alternatives II, and III	Alternative I	
Availability of Services and Materials		Alternatives I, II and III		
State and Community Acceptance		Alternatives I, II and III		
Capital cost	Alternative II	Alternative III		Alternative I
Operation and Maintenance	Alternative I	Alternative III		Alternative II
Present Worth Cost	Alternative II	Alternative III		Alternative I

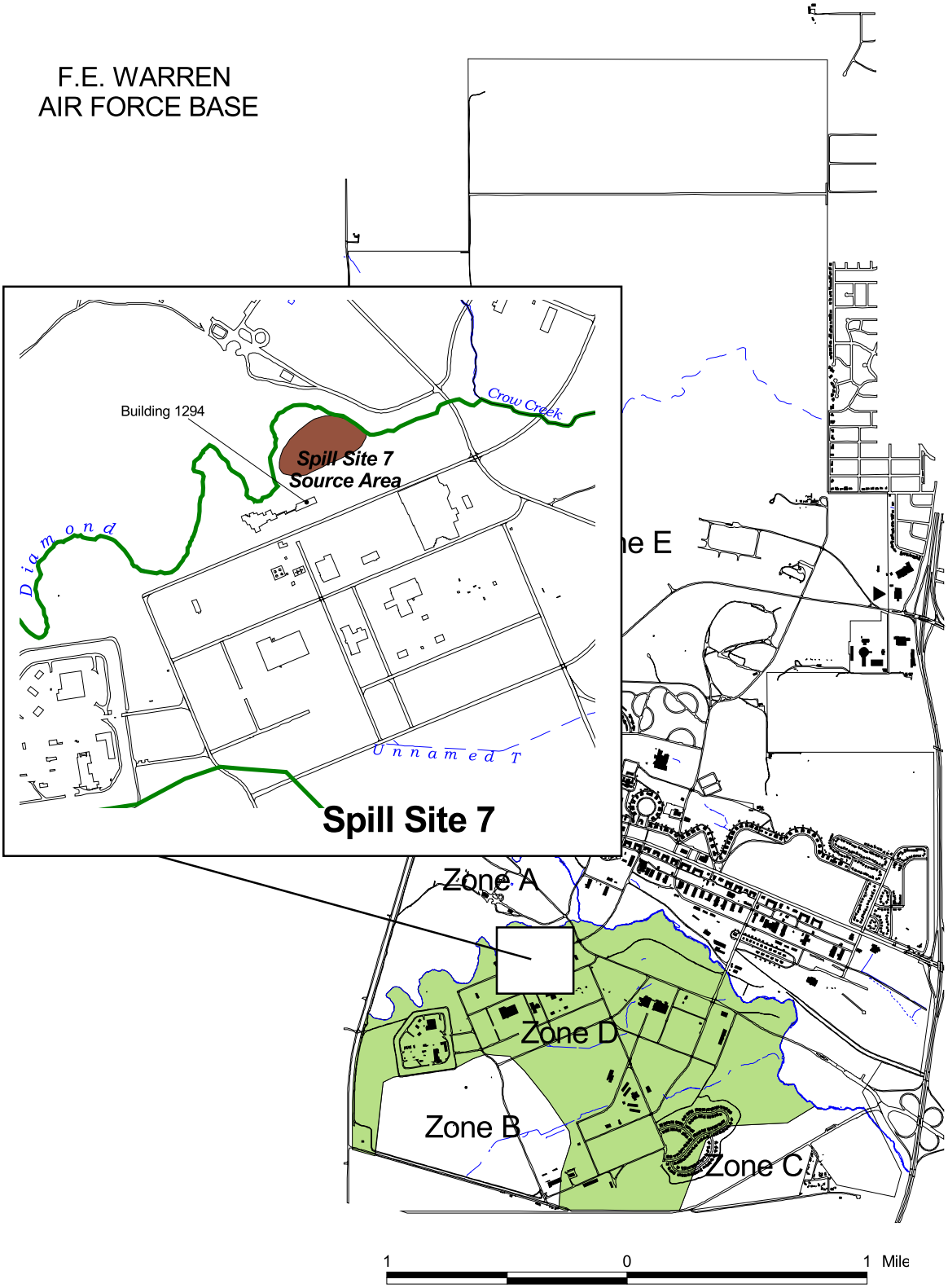
FIGURES

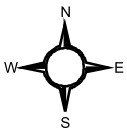


M:\GIS\FEW\PROJECT\EE_CA\SITE1.DWG EMH

EARTH TECH

FIGURE 2–1
SPILL SITE 7
SITE LOCATION MAP
SPILL SITE 7 EE/CA
F.E. WARREN AIR FORCE BASE, CHEYENNE, WYOMING



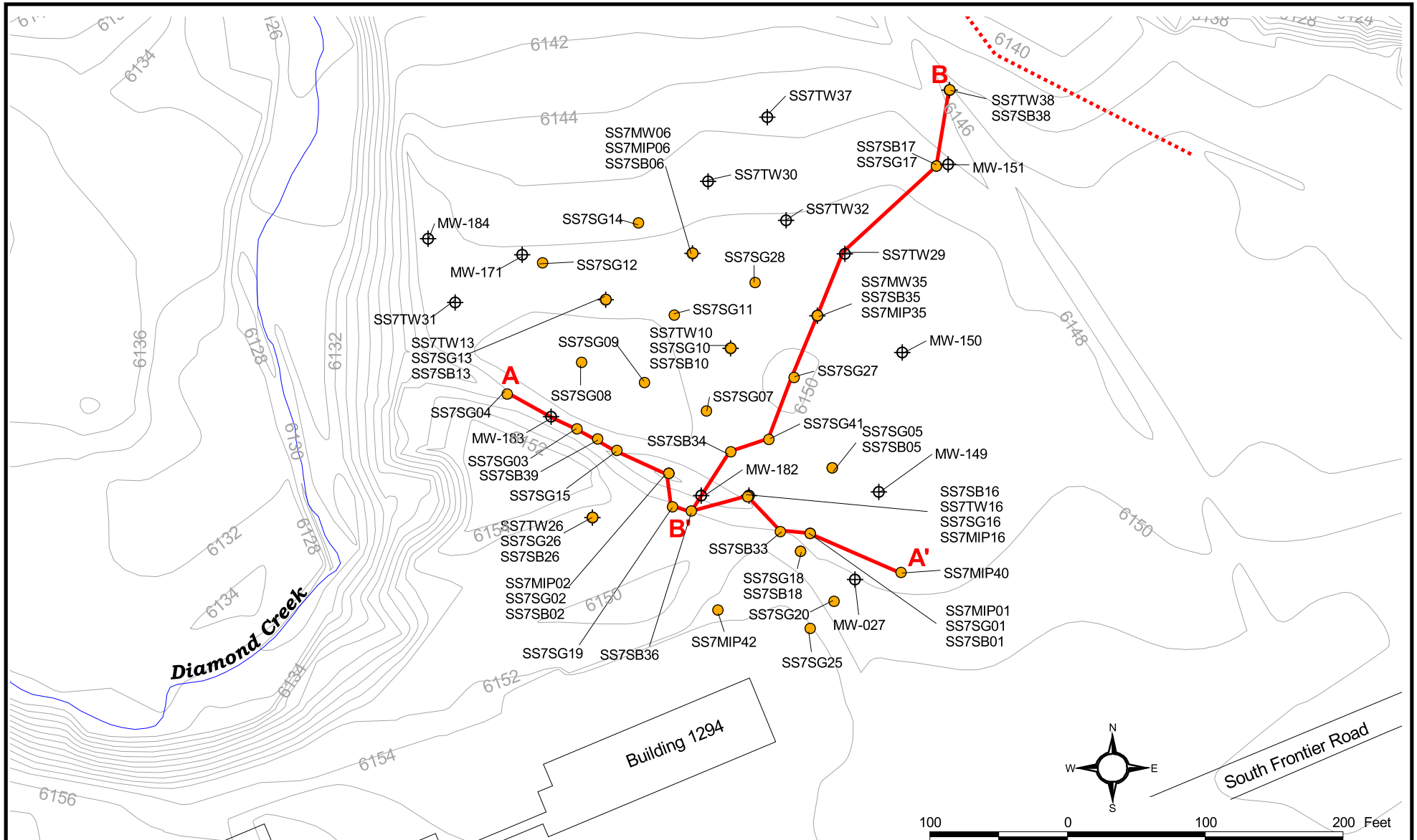


EARTH TECH

FIGURE 2-2

SPILL SITE 7
LOCATION MAP

SPILL SITE 7 EE/CA
F.E. WARREN AIR FORCE BASE, CHEYENNE, WYOMING



Legend

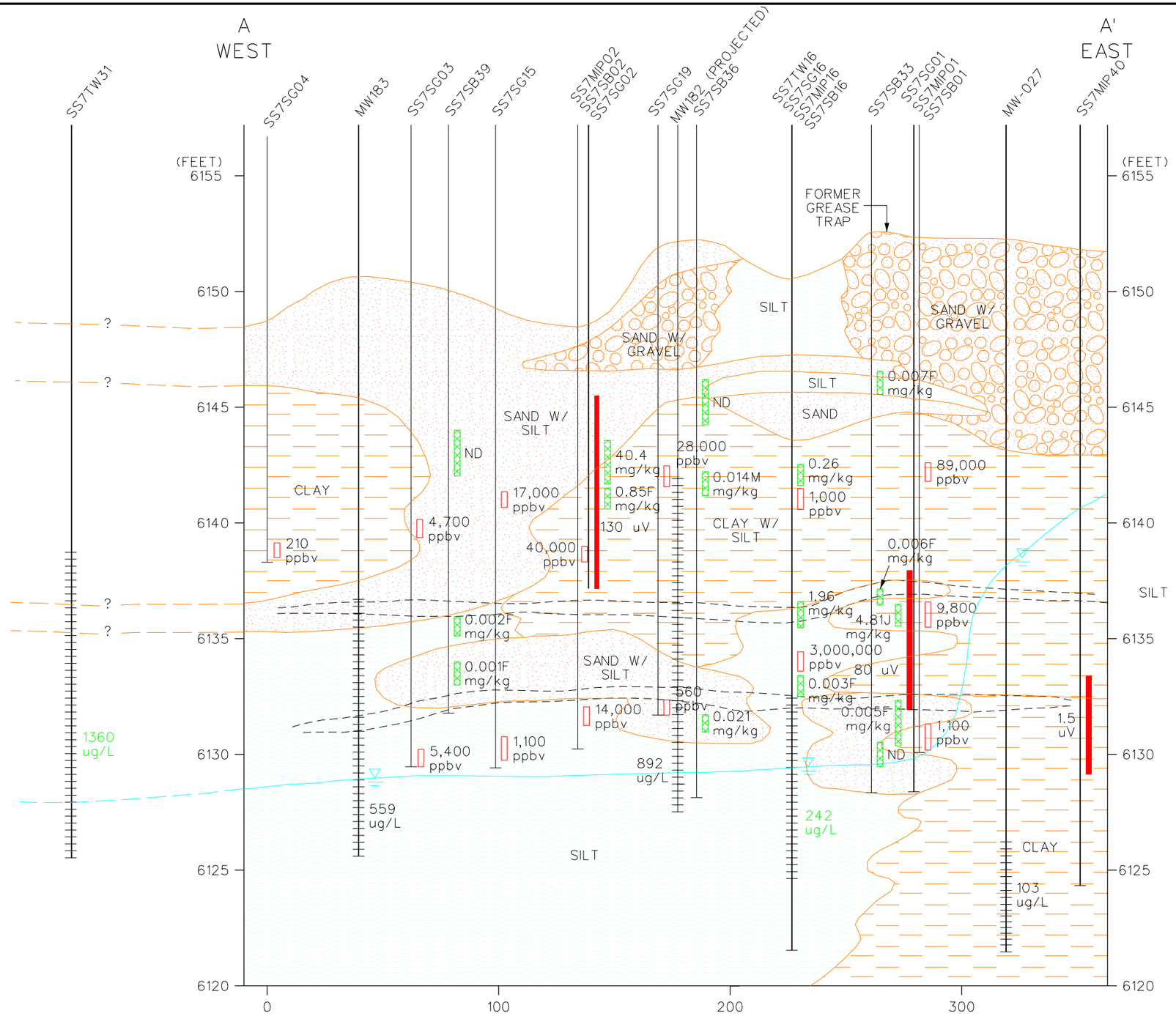
- Cross-Section Transects
- Monitoring Well
- Borehole/MIP/Soil Gas
- Topographic Contour (2 foot interval)
- PRB Wall

EARTH TECH

FIGURE 2-3
SPILL SITE 7
SAMPLE LOCATIONS AND CROSS-SECTION TRANSECTS

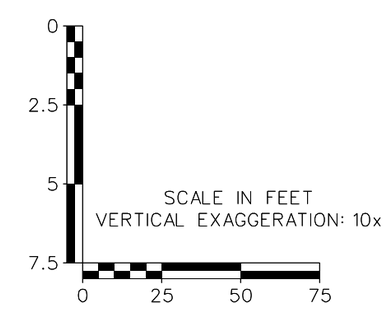
SPILL SITE 7 EE/CA
F.E. WARREN AIR FORCE BASE, CHEYENNE, WYOMING

m/gis/few/project/ee-ca/plumes_soil_1101.apr



LEGEND

- MIP RESPONSE LOCATION + MAXIMUM VALUE IN 10^5 uV
- SOIL GAS SAMPLE LOCATION + TCE VALUE IN ppbv
- BULKSOIL SAMPLE LOCATION + TCE VALUE IN mg/kg
- ND NON DETECT
- WATER TABLE ELEVATION, JULY 2001
- CEMENTED LAYER
- SHALLOW WATER TABLE
- MW183 BOREHOLE ID
- WELL SCREEN INTERVAL TCE VALUE IN ug/L (TW DATA IN GREEN)
- ASPHALT
- ORGANIC
- GRAVEL
- SAND W/ GRAVEL
- SAND
- SAND W/ SILT
- SAND W/ CLAY
- SILT W/ SAND
- SILT
- SILT W/ CLAY
- CLAY W/ SAND
- CLAY W/ SILT
- CLAY



LITHOLOGIC INFORMATION WAS NOT AVAILABLE FOR LOCATIONS SS7TW31, SS7SG03, SS7SG04, SS7SG15, SS7SG19, OR SS7MIP40. THESE LOCATIONS ARE INCLUDED TO ILLUSTRATE THE SPATIAL DISTRIBUTION OF ANALYTICAL RESULTS AND MIP MEASUREMENTS.

THE RELATIVE THICKNESS AND DISTRIBUTION OF SOME SURFACE AND NEAR-SURFACE SOILS SUGGEST THAT THEY ARE NON-NATIVE FILL MATERIALS OR SITE MATERIALS THAT HAVE BEEN REDISTRIBUTED DURING SITE ACTIVITES.

F THE ANALYTE WAS POSITIVELY IDENTIFIED BUT THE ASSOCIATED NUMERICAL VALUE IS BELOW THE RL.

M A MATRIX EFFECT WAS PRESENT.

J THE ANALYTE WAS POSITIVELY IDENTIFIED, BUT THE QUANTITATION IS AN ESTIMATION.

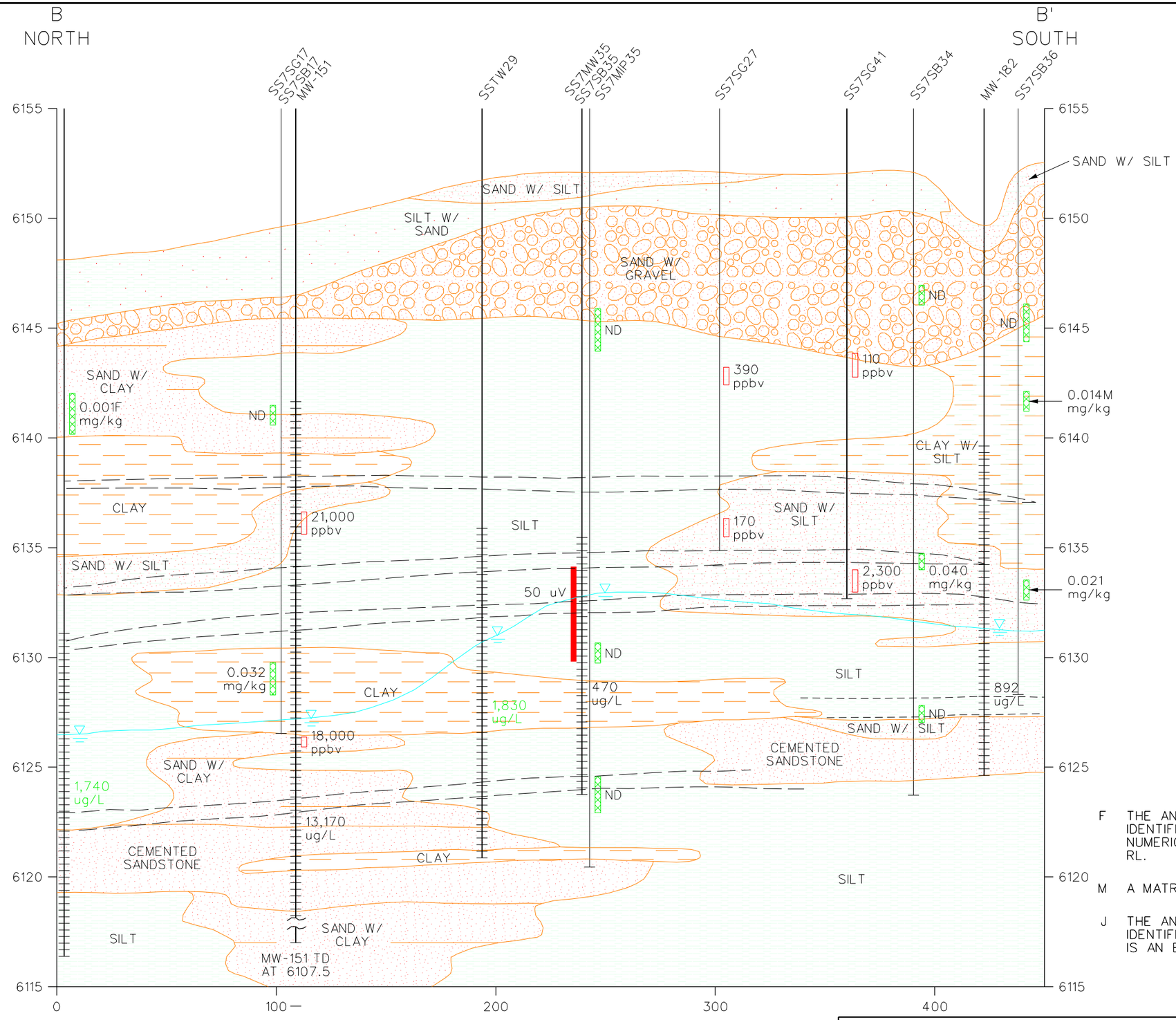
E A R T H T E C H

FIGURE 2-4
SPILL SITE 7
CROSS SECTION A-A'

SPILL SITE 7 EE/CA
F.E. WARREN AIR FORCE BASE, CHEYENNE WYOMING

DATE: 02/26/02

CAD FILE: M:\GIS\FEW\PROJECT\EE_CA\PLUME_SS7_XA.DGN



LEGEND

- MIP RESPONSE LOCATION + MAXIMUM VALUE IN 10^5 uV
- SOIL GAS SAMPLE LOCATION + TCE VALUE IN ppbv
- BULKSOIL SAMPLE LOCATION + TCE VALUE IN mg/kg
- ND NON DETECT
- WATER TABLE ELEVATION, JULY 2001
- CEMENTED LAYER
- SHALLOW WATER TABLE
- MW183 BOREHOLE ID
- WELL SCREEN INTERVAL TCE VALUE IN ug/L (TW DATA IN GREEN)
- ASPHALT
- ORGANIC
- GRAVEL
- SAND W/ GRAVEL
- SAND
- SAND W/ SILT
- SAND W/ CLAY
- SILT W/ SAND
- SILT
- SILT W/ CLAY
- CLAY W/ SAND
- CLAY W/ SILT
- CLAY

F THE ANALYTE WAS POSITIVELY IDENTIFIED BUT THE ASSOCIATED NUMERICAL VALUE IS BELOW THE RL.

M A MATRIX EFFECT WAS PRESENT.

J THE ANALYTE WAS POSITIVELY IDENTIFIED, BUT THE QUANTITATION IS AN ESTIMATION.

0 2.5 5 7.5

0 25 50 75

SCALE IN FEET
VERTICAL EXAGGERATION: 10x

NOTES:

LITHOLOGIC INFORMATION WAS NOT AVAILABLE FOR LOCATIONS SS7TW29, SS7SG27, OR SS7SG41 THESE LOCATIONS ARE INCLUDED TO ILLUSTRATE THE SPATIAL DISTRIBUTION OF ANALYTICAL RESULTS AND MIP MEASUREMENTS.

THE RELATIVE THICKNESS AND DISTRIBUTION OF SOME SURFACE AND NEAR-SURFACE SOILS SUGGESTS THAT THEY ARE NON-NATIVE FILL MATERIALS OR SITE MATERIALS THAT HAVE BEEN REDISTRIBUTED DURING SITE ACTIVITES.

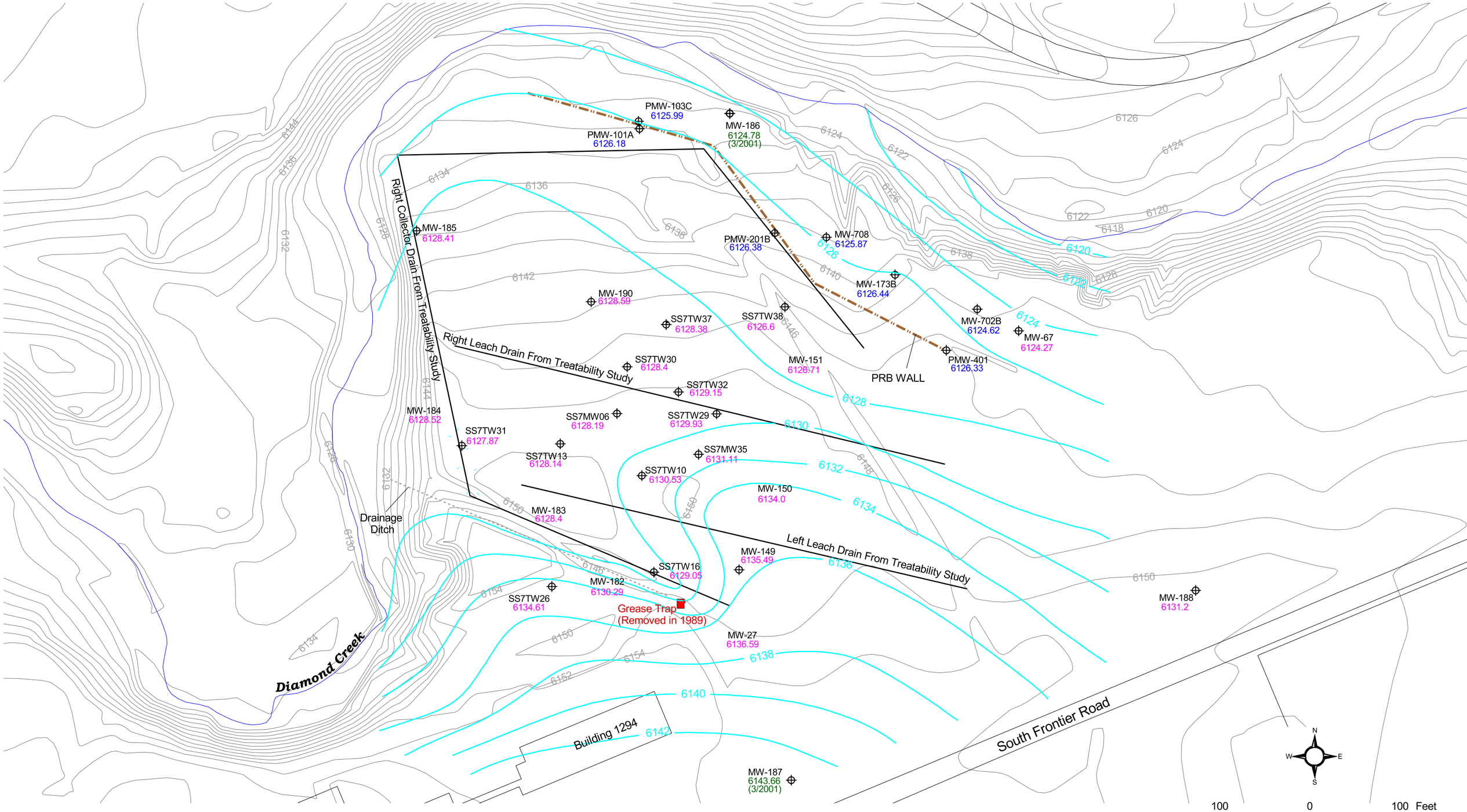
E A R T H T E C H

FIGURE 2-5
SPILL SITE 7
CROSS SECTION B-B'

SPILL SITE 7 EE/CA
F.E. WARREN AIR FORCE BASE, CHEYENNE WYOMING

DATE: 05/15/02

CAD FILE: M:\GIS\FEW\PROJECT\EE_CA\PLUME_SS7_XB.DGN



Legend

- Drain from Treatability Study
- Monitoring Well
- Topographic Contours (2 foot interval)
- 6142 Groundwater elevation

6124.62 November 12, 2001 Water levels
6128.4 November 21, 2001 Water levels
6143.66 March 2001 Water levels (included as reference only)

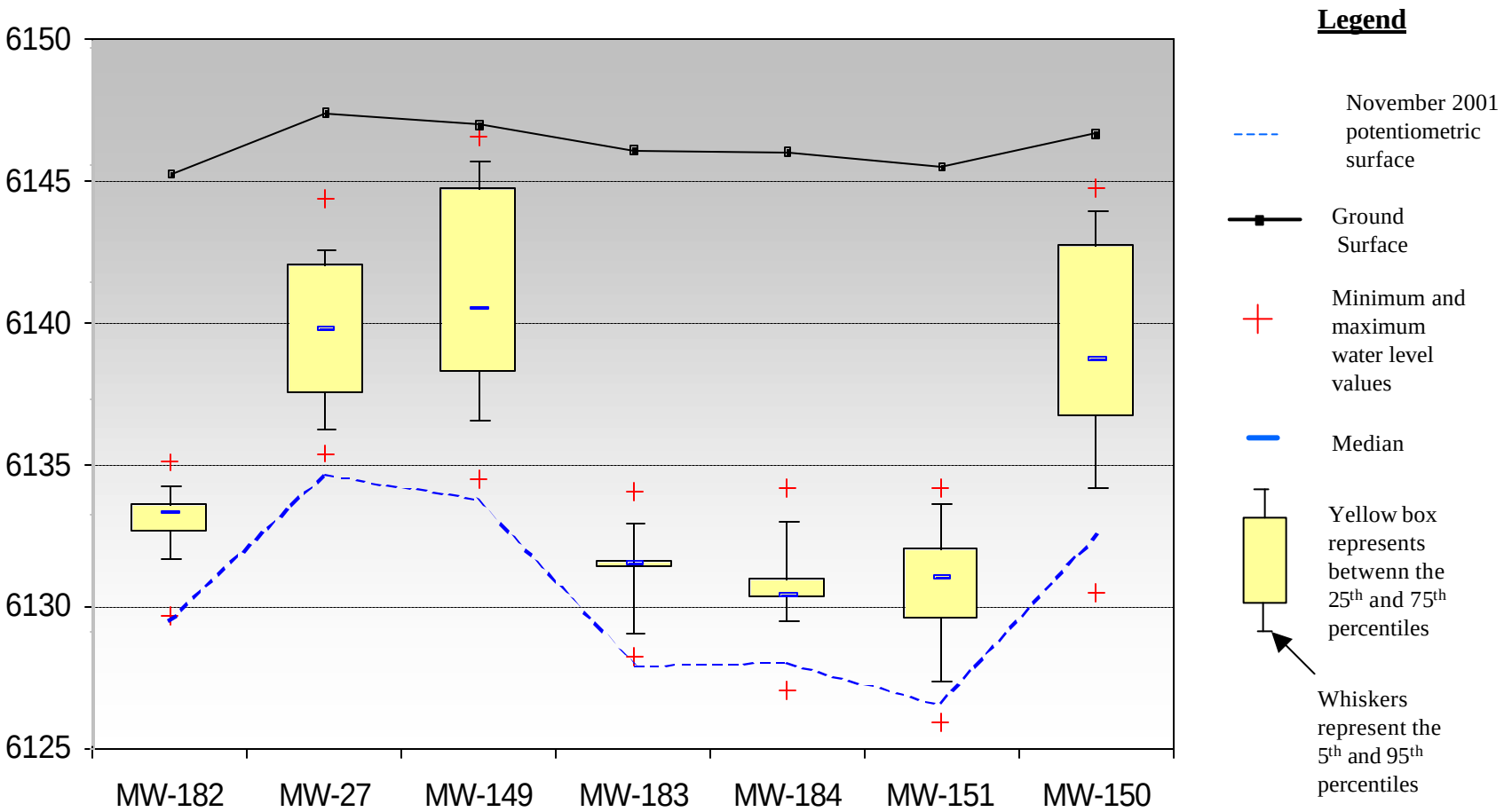
m/gis/few/project/eeca/plumes_soil_1101d.apr Layout Gwelev

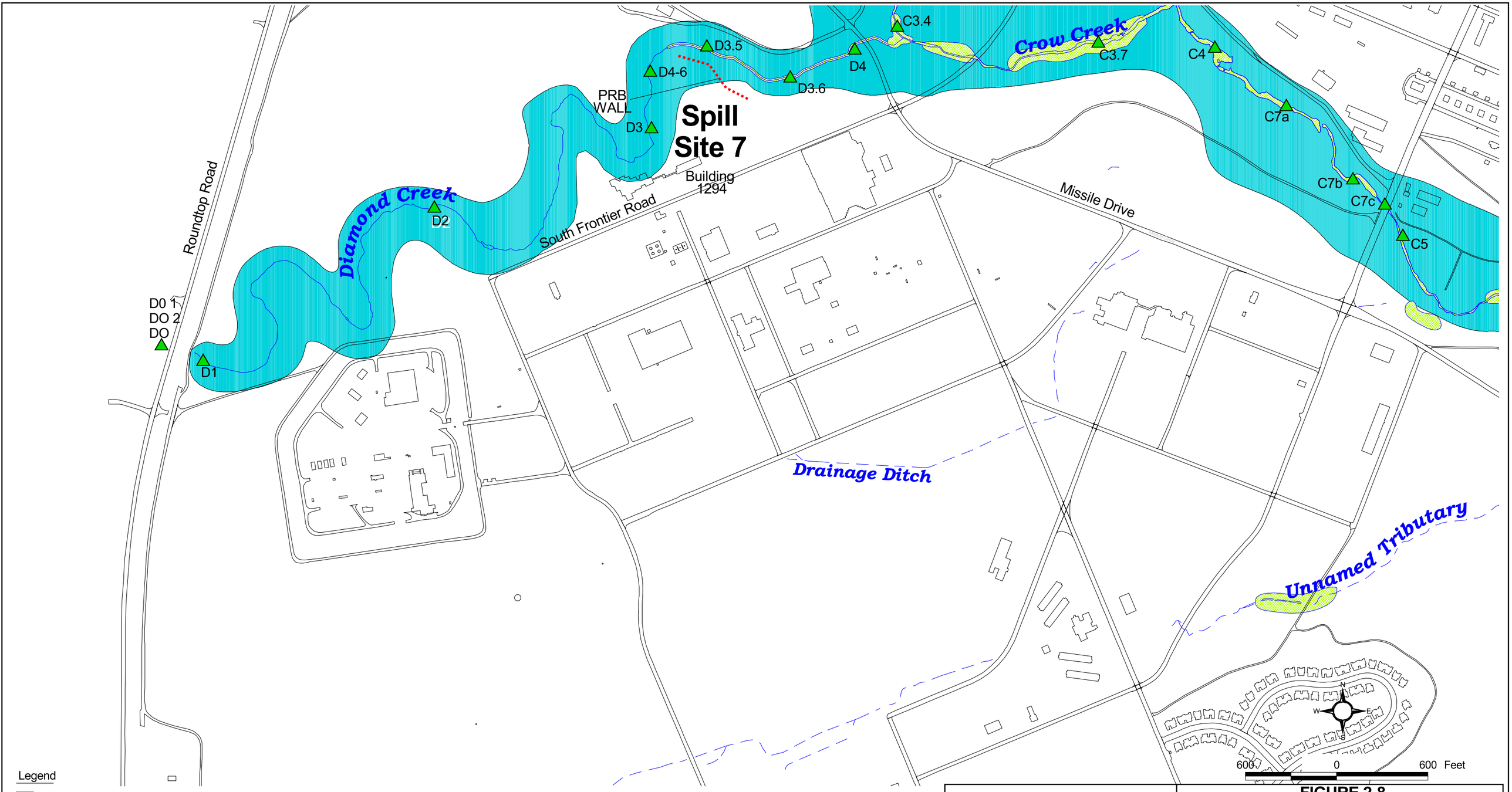
EARTH TECH

FIGURE 2-6
SPILL SITE 7
GROUNDWATER ELEVATION MAP
NOVEMBER 2001

SPILL SITE 7 EE/CA
F.E. WARREN AIR FORCE BASE, CHEYENNE, WYOMING

FIGURE 2-7
HISTORIC WATER LEVELS AT SPILL SITE 7
SPILL SITE 7 – F.E. WARREN AFB





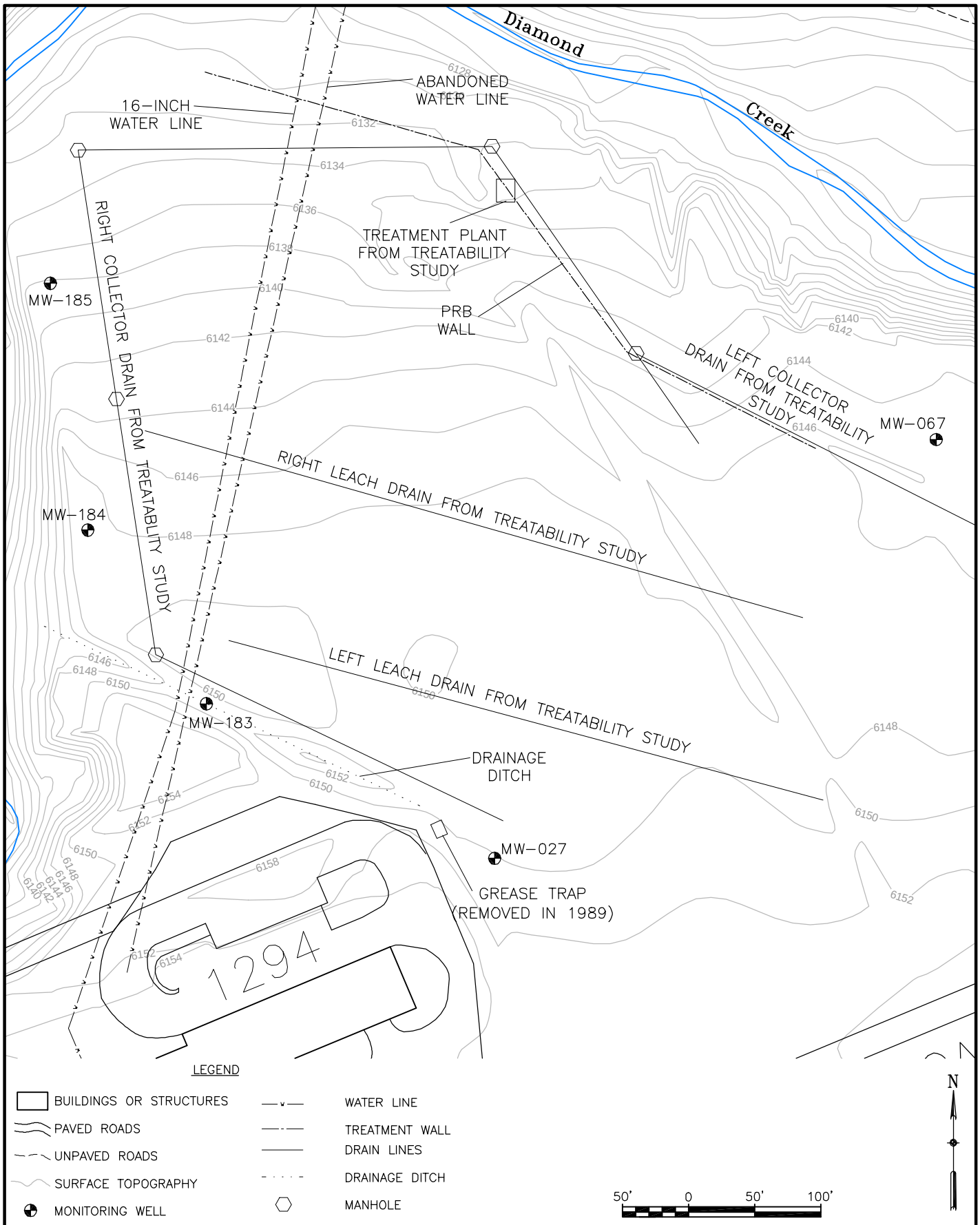
Legend

- 100 yr Flood Plain (Boundaries approximate)
- Wetland Boundaries
- Surface water/sediment sampling location
- PRB Wall

m/gis/few/project/ee_ca/plumes_soil_1101e.apr Layout Fig2_11

EARTH TECH

FIGURE 2-8
SPILL SITE 7
SURFACE WATER RISK ASSESSMENT
SAMPLE LOCATION
MAP
SPILL SITE 7 EE/CA
F.E. WARREN AIR FORCE BASE, CHEYENNE, WYOMING



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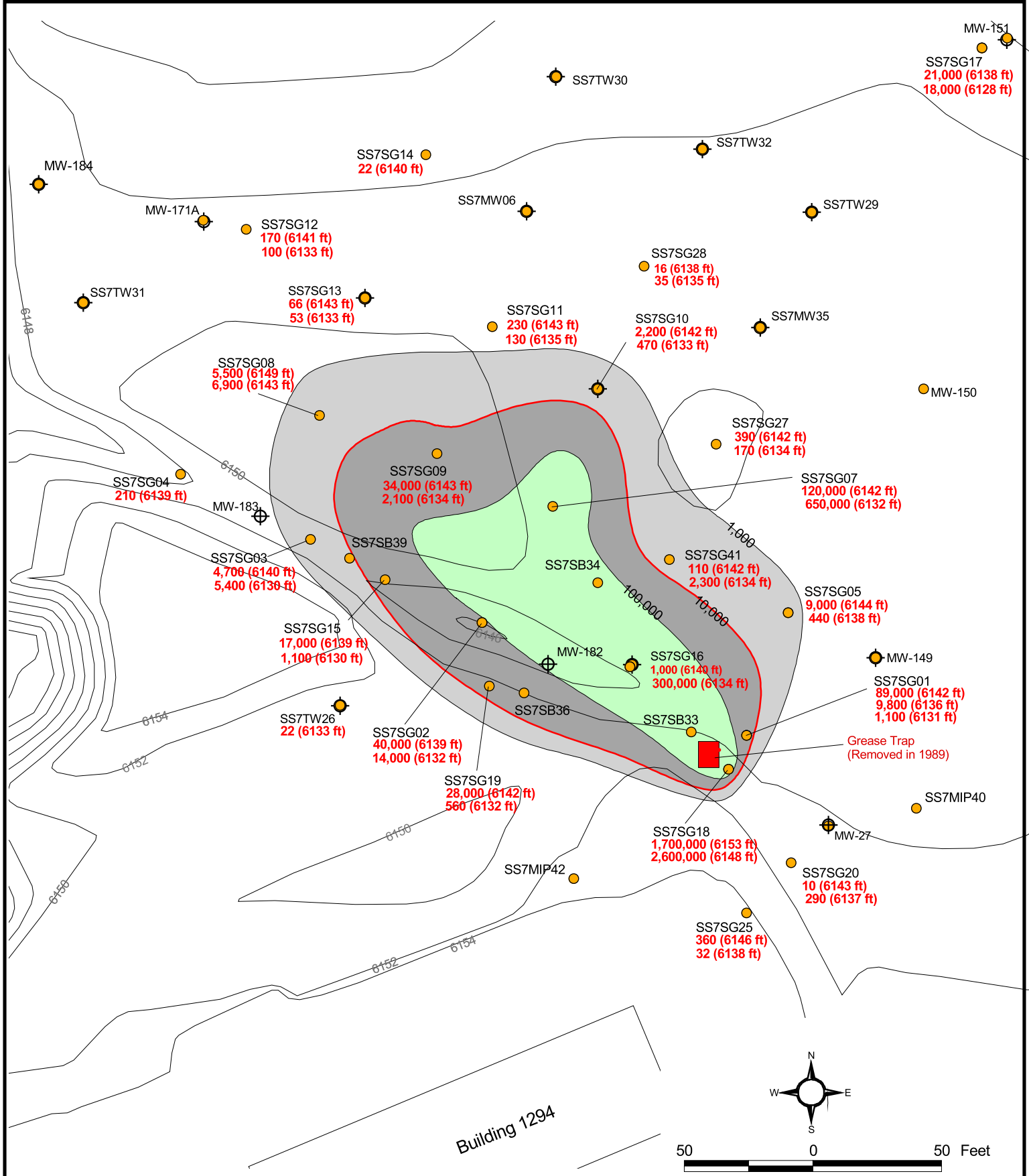
E A R T H T E C H

FIGURE 2-9
SPILL SITE 7
PREVIOUS REMEDIAL ACTION LOCATIONS

SPILL SITE 7 EE/CA

F.E. WARREN AIR FORCE BASE, CHEYENNE, WYOMING



Legend

10,000 TCE Plume
ppbv ftmsl
120,000 (6142 ft)

Monitoring Well

Borehole/MIP/Soil Gas

Topographic Contours
(2 foot interval)

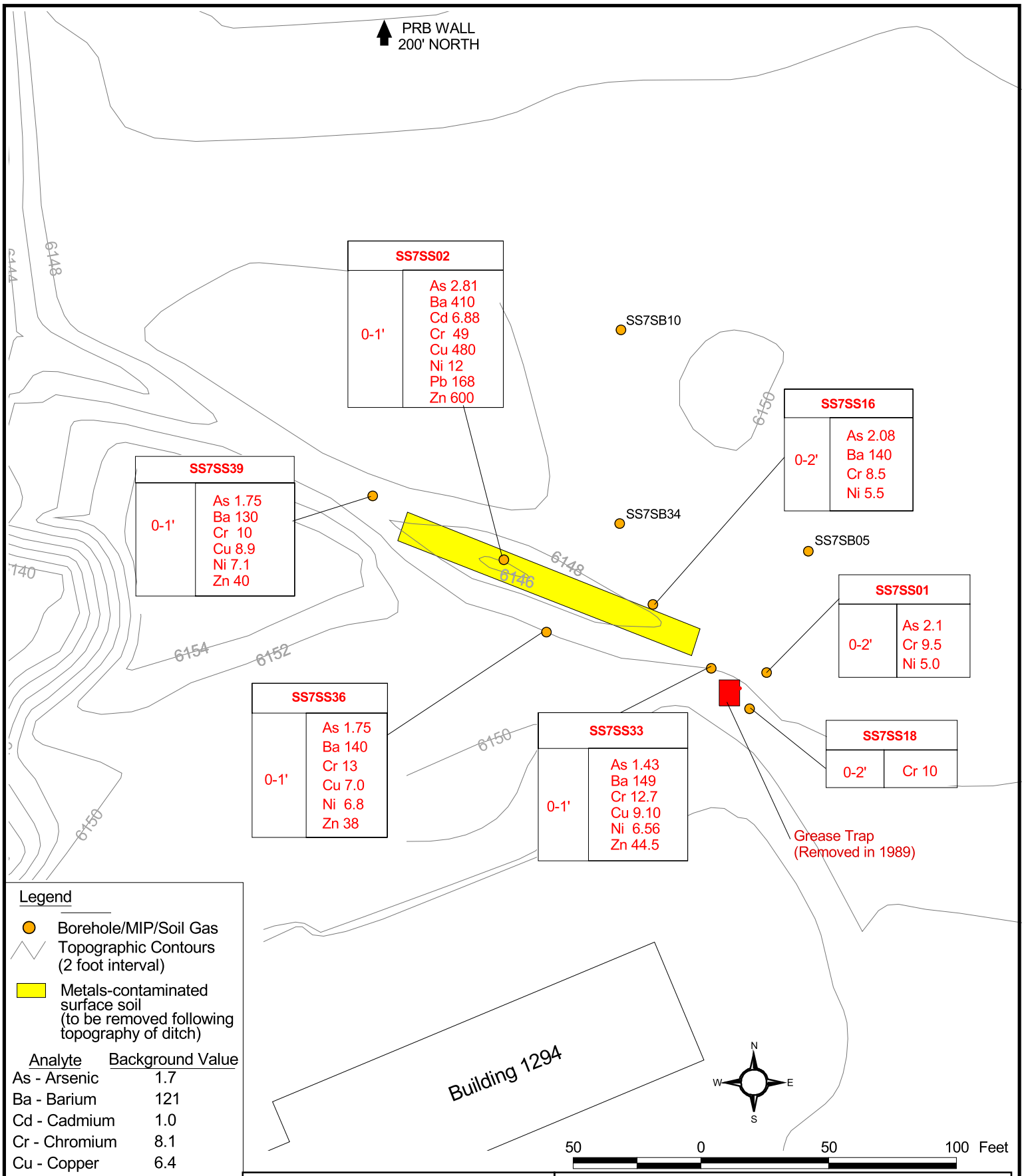
Note: Soil remediation boundary TCE detections posted in parts per billion volume (ppbv).
Sample depths range from 6135 to 6143 feet above msl.

EARTH TECH

FIGURE 2-10
SPILL SITE 7
MAXIMUM TCE DETECTIONS IN SOIL GAS

SPILL SITE 7 EE/CA
F.E. WARREN AIR FORCE BASE, CHEYENNE, WYOMING

m/gis/few/project/spillsite_7_figs.apr
Layout Figure_4 8/21/02



Legend

- Borehole/MIP/Soil Gas
- Topographic Contours (2 foot interval)
- Metals-contaminated surface soil (to be removed following topography of ditch)

Analyte	Background Value
As - Arsenic	1.7
Ba - Barium	121
Cd - Cadmium	1.0
Cr - Chromium	8.1
Cu - Copper	6.4
Ni - Nickel	4.9
Pb - Lead	9.0
Zn - Zinc	32

Note:
All results posted in mg/kg.
All results posted exceed background concentration.

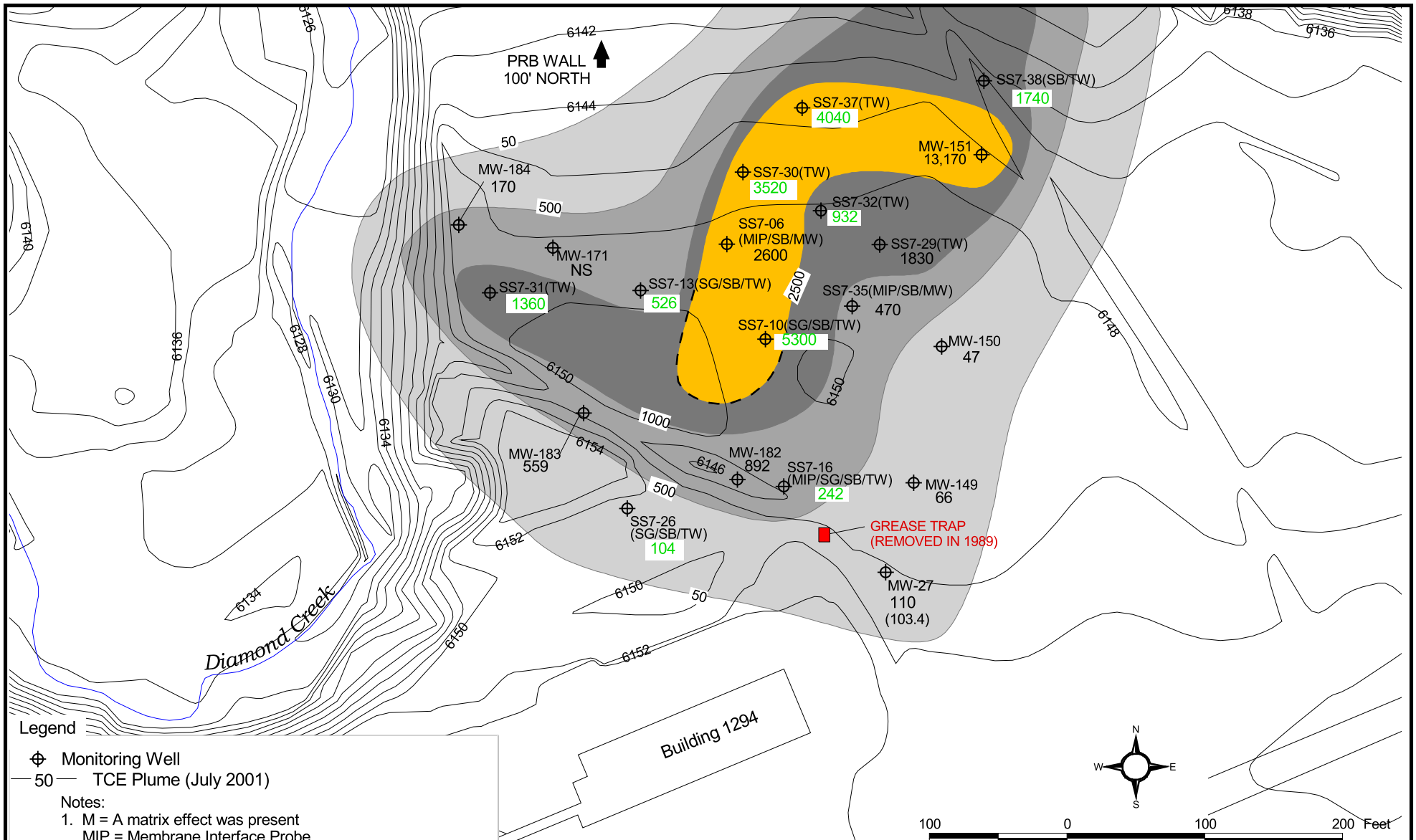
EARTH TECH

FIGURE 2-11

METALS CONCENTRATIONS IN SOIL ALONG THE DRAINAGE DITCH

SPILL SITE 7 EE/CA
F.E. WARREN AIR FORCE BASE, CHEYENNE, WYOMING

m/gis/few/project/ee_ca/metals.apr
Layout metals2 10/23/02



Legend

Monitoring Well

50 TCE Plume (July 2001)

Notes:

1. M = A matrix effect was present
   MIP = Membrane Interface Probe
   MW = Monitoring Well
   SB = Soil Boring
   SG = Soil Gas
   TCE = Trichloroethene
   TW = Temporary Well
   NS = No Samples
2. TCE detections reported in micrograms per liter (ug/L).
3. Temporary well data are shaded in green and denote screening level data only.

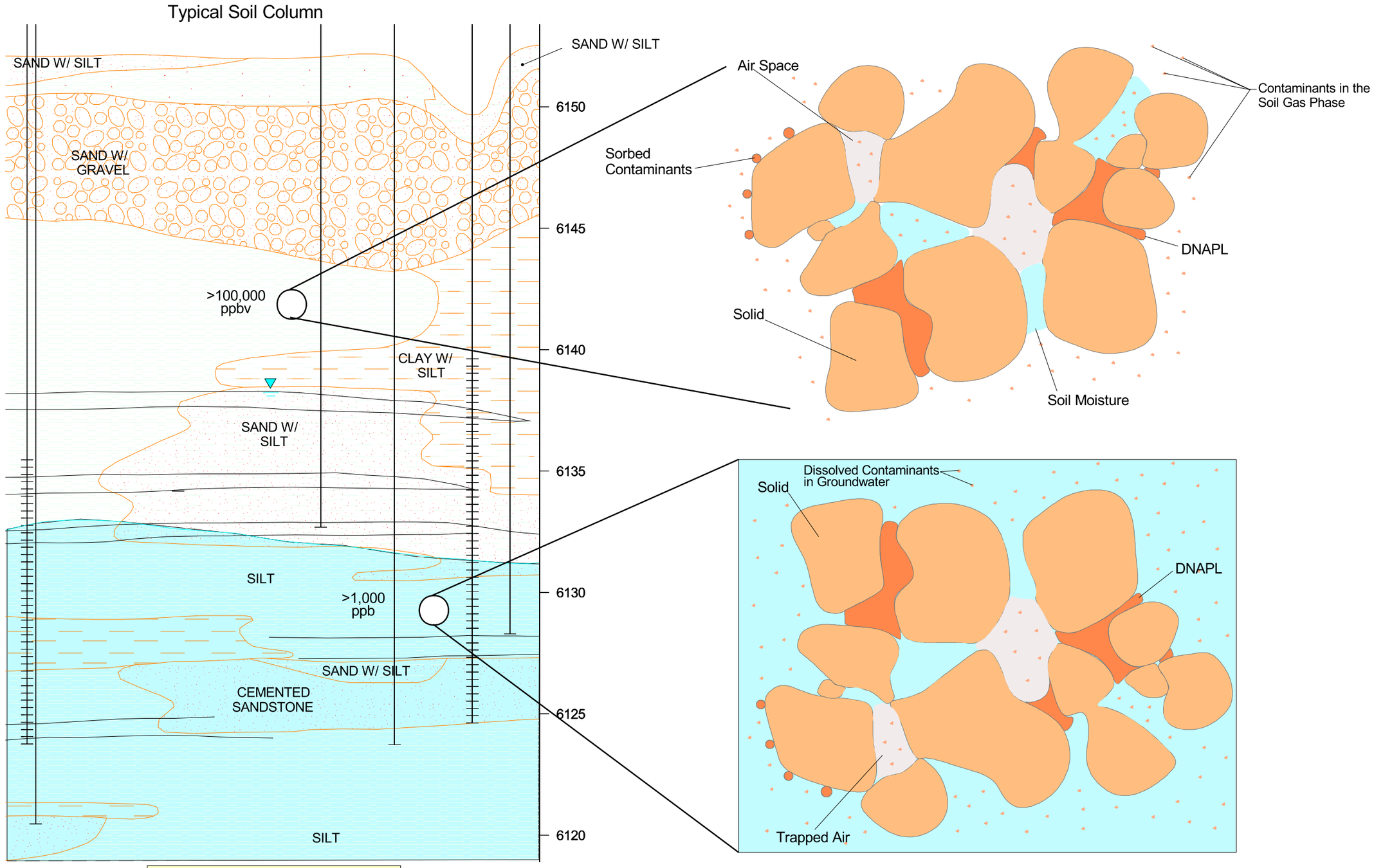
EARTH TECH

FIGURE 2-12

SPILL SITE 7
TCE DETECTIONS IN GROUNDWATER

SPILL SITE 7 EE/CA
F.E. WARREN AIR FORCE BASE, CHEYENNE, WYOMING

m/gis/few/project/EECA/plumes_gw1.apr/spill site 7 tce detections



Expanded View of Residual NAPL Trapped in Pores Between Soil Particles

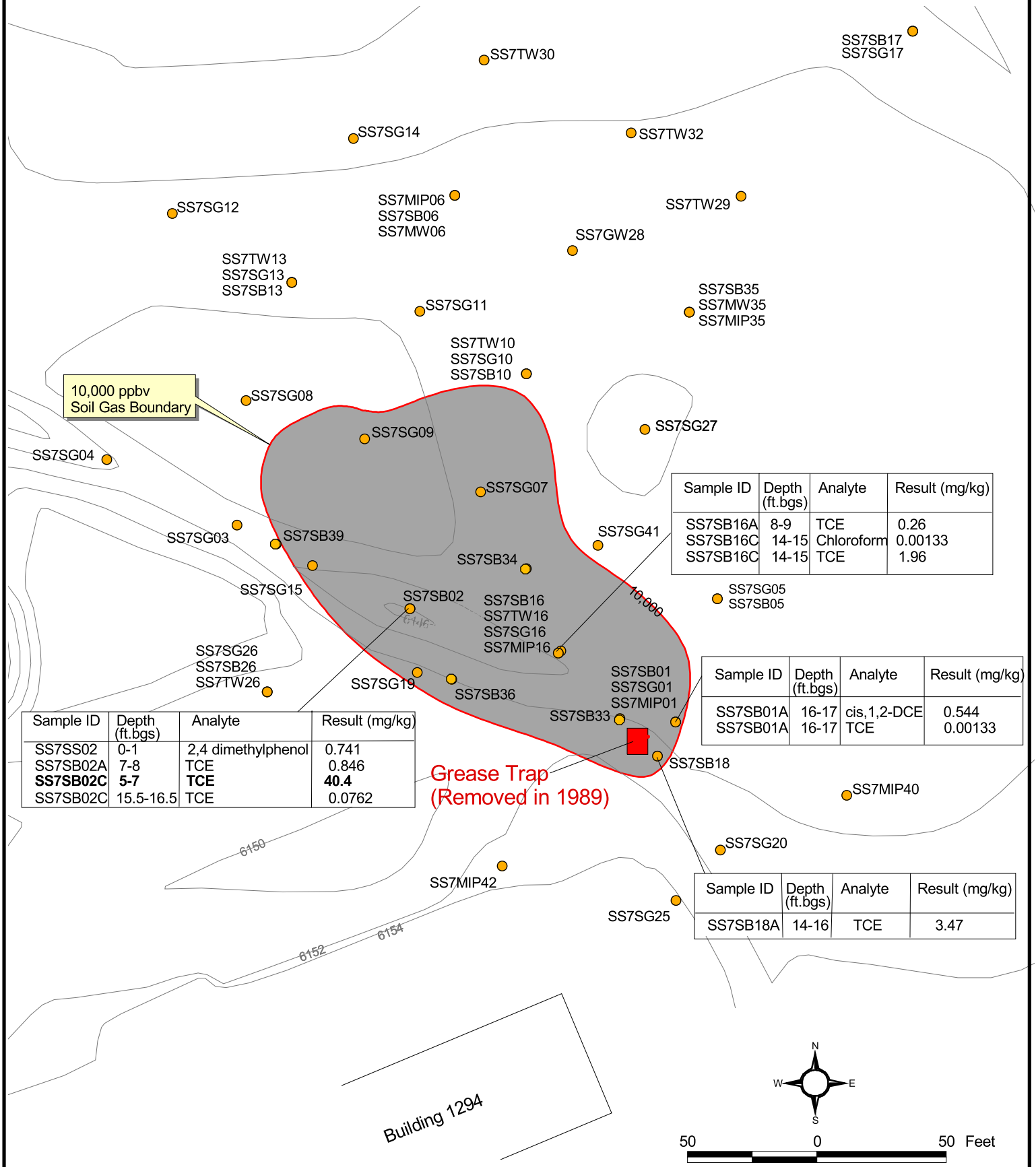
EARTH TECH

FIGURE 2-13

RESIDUAL NAPL REPRESENTATION

SPILL SITE 7 EE/CA
F.E. WARREN AIR FORCE BASE, CHEYENNE, WYOMING

m/gis/few/project/eeca/dnapl_plus layout dnapl_plus 5/20/02



Sample ID	Depth (ft.bgs)	Analyte	Result (mg/kg)
SS7SB16A	8-9	TCE	0.26
SS7SB16C	14-15	Chloroform	0.00133
SS7SB16C	14-15	TCE	1.96

Sample ID	Depth (ft.bgs)	Analyte	Result (mg/kg)
SS7SB01A	16-17	cis,1,2-DCE	0.544
SS7SB01A	16-17	TCE	0.00133

Sample ID	Depth (ft.bgs)	Analyte	Result (mg/kg)
SS7SS02	0-1	2,4 dimethylphenol	0.741
SS7SB02A	7-8	TCE	0.846
SS7SB02C	**5-7**	**TCE**	**40.4**
SS7SB02C	15.5-16.5	TCE	0.0762

Sample ID	Depth (ft.bgs)	Analyte	Result (mg/kg)
SS7SB18A	14-16	TCE	3.47

Notes: All detections posted exceed the site-specific SSL; SS7B02B is shown in bold because it exceeds the site-specific SSL and the TCLP value.

Legend

-10,000— TCE Plume ppbv

Borehole/MIP/Soil Gas

Topographic Contours (2 foot interval)

TCE Trichloroethylene

DCE Dichloroethylene

EARTH TECH

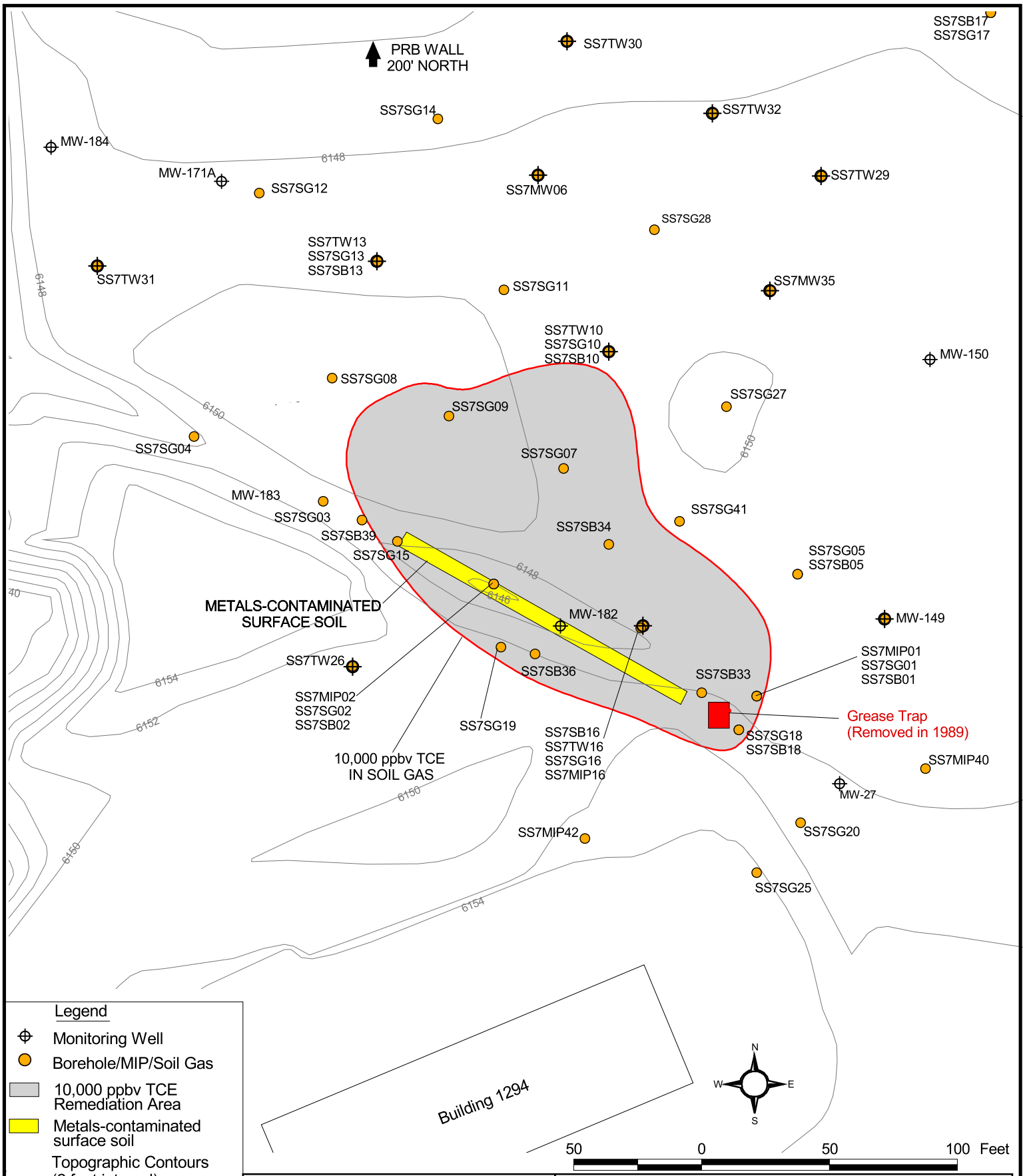
FIGURE 3-1

SPILL SITE 7 ORGANIC EXCEEDANCE LOCATIONS

SPILL SITE 7 EE/CA

F.E. WARREN AIR FORCE BASE, CHEYENNE, WYOMING

m/gis/few/project/spillsite_7_figs.apr
Layout Soilboring 8/12/02



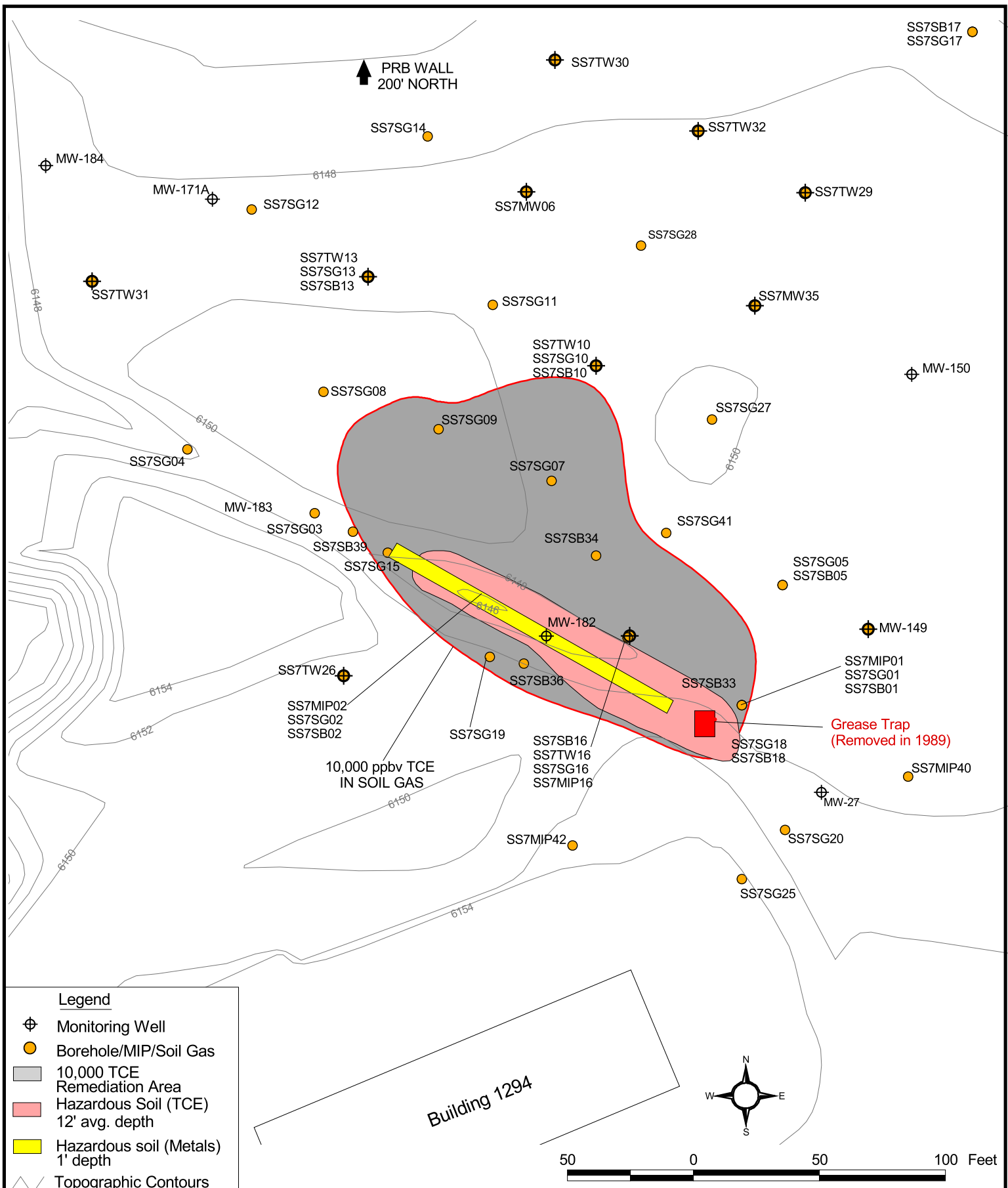
EARTH TECH

FIGURE 4-1

SPILL SITE 7
SOIL REMEDIATION AREA

SPILL SITE 7 EE/CA
F.E. WARREN AIR FORCE BASE, CHEYENNE, WYOMING

m/gis/few/project/ee_ca/spillsite_7_figs.apr Layout fig4-1 soil rem 2/5/02



Note:
Soil remediation boundary derived from 10,000 ppbv soil gas readings in deep soils. Metals contaminated soil derived from surface soil sampling.

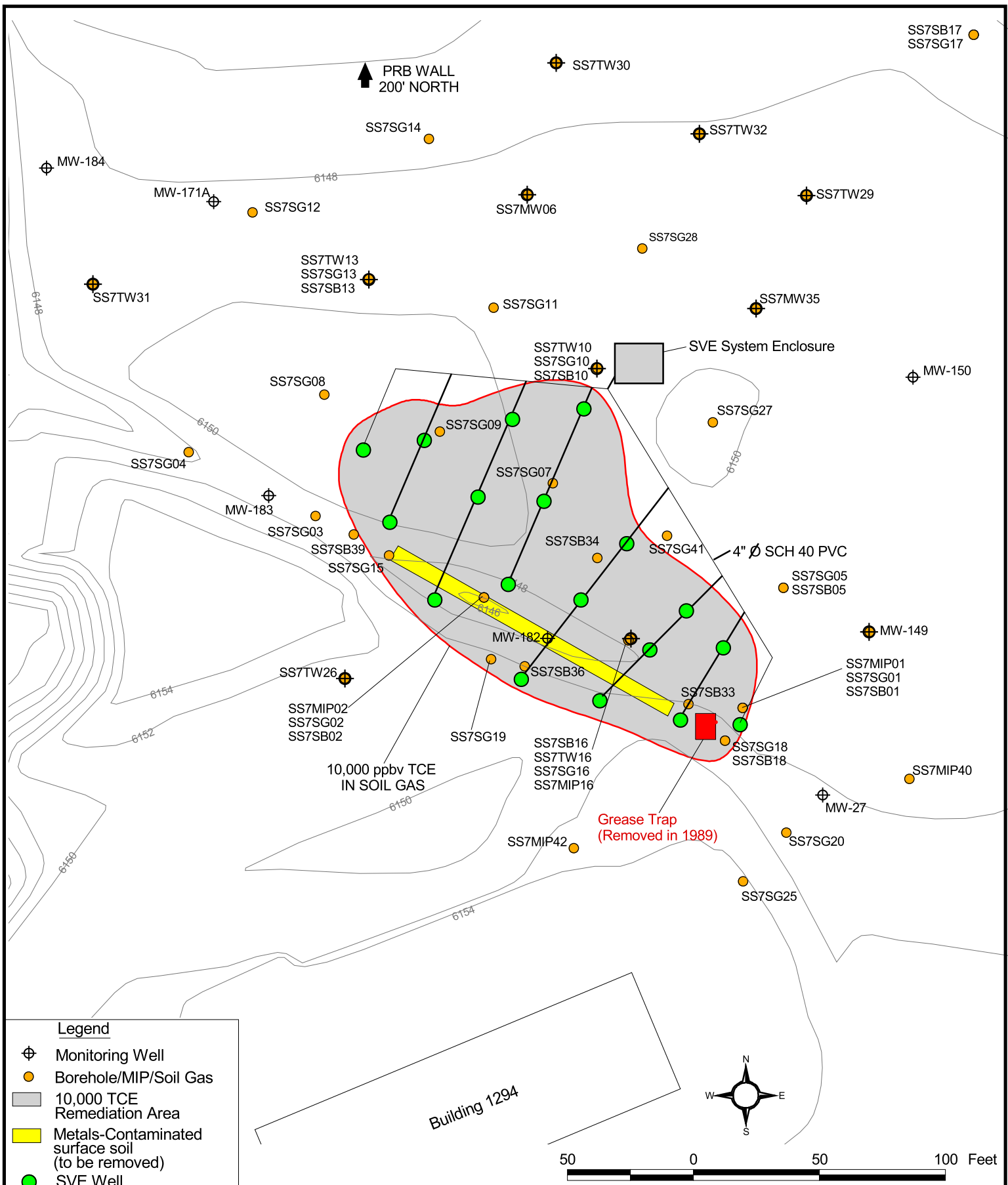
EARTH TECH

FIGURE 4-2

SPILL SITE 7
ALTERNATIVE I
SOIL EXCAVATION AREA

SPILL SITE 7 EE/CA
F.E. WARREN AIR FORCE BASE, CHEYENNE, WYOMING

m/gis/few/project/ee_ca/spillsite_7_figs.apr Layout fig4-2 excav area 2/5/02



Note:
Soil remediation boundary derived from 10,000 ppbv soil gas readings in deep soils. Remediation elements not to scale, actual design may very.

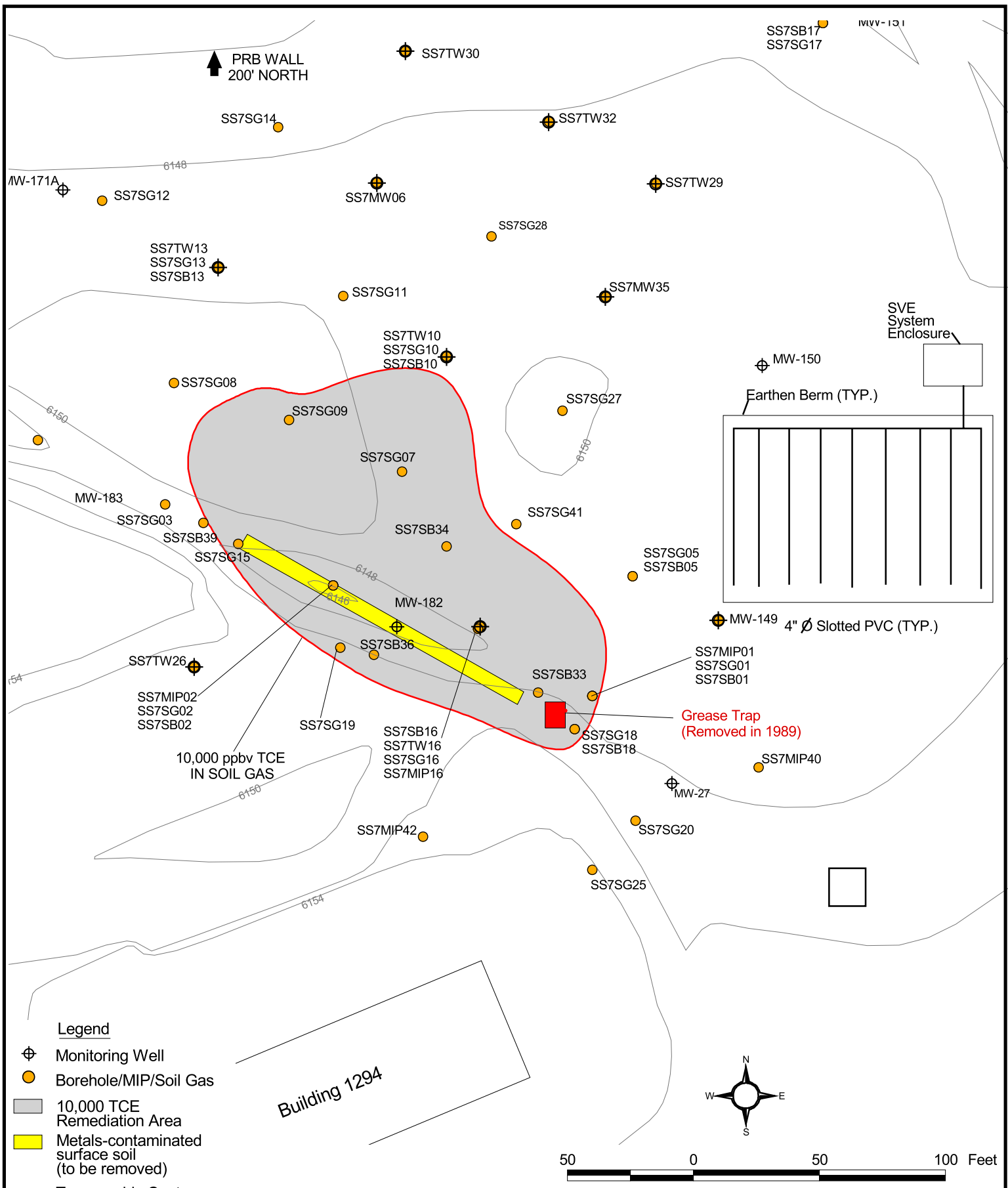
E A R T H T E C H

FIGURE 4-3

SPILL SITE 7
ALTERNATIVE II
CONCEPTUAL SVE SYSTEM LAYOUT

SPILL SITE 7 EE/CA
F.E. WARREN AIR FORCE BASE, CHEYENNE, WYOMING

m/gis/few/project/ee_ca/spillsite_7_figs.apr Layout fig4-3 consep sve 2/5/02



Note:
Soil remediation boundary derived from 10,000 ppbv soil gas readings in deep soils. Remediation elements not to scale. Actual design may vary.

EARTH TECH

FIGURE 4-4
SPILL SITE 7
ALTERNATIVE III
CONCEPTUAL EX-SITU SVE SYSTEM LAYOUT

SPILL SITE 7 EE/CA
F.E. WARREN AIR FORCE BASE, CHEYENNE, WYOMING

m/gis/few/project/ee_ca/spillsite_7_figs.apr Layout fig4-4 ex-situ 2/5/02

APPENDIX A

GROUNDWATER ELEVATIONS

TABLE A-1
HISTORIC WATER LEVELS
SPILL SITE 7 EE/CA - F.E. WARREN AFB

Monitoring Well	Sampling Date	Static Water Level (feet)	Total Well Depth (feet)	Mesuring Point Elevation (feet)	Mean Sea Level Water Level (feet)
MW-027	04/22/86	13.44	31	6153.40	6139.96
MW-027	06/26/86	12.76	31	6153.40	6140.64
MW-027	08/12/86	9.8	31	6153.40	6143.60
MW-027	10/08/86	9.05	31	6153.40	6144.35
MW-027	03/23/87	12.04	31	6153.40	6141.36
MW-027	06/12/87	10	31	6153.40	6143.40
MW-027	04/05/88	14.32	31	6153.40	6139.08
MW-027	09/27/88	13.47	31	6153.40	6139.93
MW-027	10/11/88	13.22	31	6153.40	6140.18
MW-027	01/05/89	14.33	31	6153.40	6139.07
MW-027	04/20/89	14.33	31	6153.40	6139.07
MW-027	07/11/89	13.84	31	6153.40	6139.56
MW-027	10/22/91	12.56	31	6153.40	6140.84
MW-027	09/29/92	16.84	31	6153.40	6136.56
MW-027	10/04/94	16.19	31	6153.40	6137.21
MW-027	04/13/95	17.83	31	6153.40	6135.57
MW-027	04/20/95	17.3	31	6153.40	6136.10
MW-027	04/21/95	17.19	31	6153.40	6136.21
MW-027	04/24/95	17.4	31	6153.40	6136.00
MW-027	04/25/95	17.45	31	6153.40	6135.95
MW-027	04/26/95	17.33	31	6153.40	6136.07
MW-027	04/27/95	16.99	31	6153.40	6136.41
MW-027	04/28/95	16.34	31	6153.40	6137.06
MW-027	05/01/95	16.27	31	6153.40	6137.13
MW-027	05/02/95	16.24	31	6153.40	6137.16
MW-027	05/03/95	16.12	31	6153.40	6137.28
MW-027	05/04/95	16.08	31	6153.40	6137.32
MW-027	05/05/95	15.89	31	6153.40	6137.51
MW-027	05/08/95	15.85	31	6153.40	6137.55
MW-027	05/09/95	15.75	31	6153.40	6137.65
MW-027	05/10/95	15.55	31	6153.40	6137.85
MW-027	05/11/95	15.4	31	6153.40	6138.00
MW-027	05/12/95	15.33	31	6153.40	6138.07
MW-027	05/15/95	15.59	31	6153.40	6137.81
MW-027	05/16/95	15.66	31	6153.40	6137.74
MW-027	05/17/95	15.69	31	6153.40	6137.71
MW-027	05/18/95	15.5	31	6153.40	6137.90
MW-027	05/19/95	15.4	31	6153.40	6138.00
MW-027	05/22/95	15.29	31	6153.40	6138.11
MW-027	05/23/95	15.19	31	6153.40	6138.21
MW-027	05/24/95	14.91	31	6153.40	6138.49
MW-027	05/25/95	14.67	31	6153.40	6138.73
MW-027	05/26/95	14.46	31	6153.40	6138.94
MW-027	05/31/95	14.26	31	6153.40	6139.14
MW-027	06/02/95	13.94	31	6153.40	6139.46
MW-027	06/05/95	13.75	31	6153.40	6139.65
MW-027	06/07/95	13.35	31	6153.40	6140.05

TABLE A-1
HISTORIC WATER LEVELS
SPILL SITE 7 EE/CA - F.E. WARREN AFB

Monitoring Well	Sampling Date	Static Water Level (feet)	Total Well Depth (feet)	Mesuring Point Elevation (feet)	Mean Sea Level Water Level (feet)
MW-027	06/09/95	12.34	31	6153.40	6141.06
MW-027	06/12/95	13.01	31	6153.40	6140.39
MW-027	06/14/95	11.42	31	6153.40	6141.98
MW-027	06/16/95	11.19	31	6153.40	6142.21
MW-027	06/19/95	10.94	31	6153.40	6142.46
MW-027	06/21/95	11.05	31	6153.40	6142.35
MW-027	06/23/95	11.03	31	6153.40	6142.37
MW-027	06/26/95	11.02	31	6153.40	6142.38
MW-027	06/28/95	11.12	31	6153.40	6142.28
MW-027	06/30/95	11.05	31	6153.40	6142.35
MW-027	07/03/95	10.68	31	6153.40	6142.72
MW-027	07/05/95	10.71	31	6153.40	6142.69
MW-027	07/07/95	10.88	31	6153.40	6142.52
MW-027	07/10/95	11.37	31	6153.40	6142.03
MW-027	07/12/95	11.65	31	6153.40	6141.75
MW-027	07/14/95	11.81	31	6153.40	6141.59
MW-027	07/17/95	12.06	31	6153.40	6141.34
MW-027	07/19/95	11.5	31	6153.40	6141.90
MW-027	07/21/95	11.06	31	6153.40	6142.34
MW-027	07/24/95	11.17	31	6153.40	6142.23
MW-027	07/26/95	10.94	31	6153.40	6142.46
MW-027	07/28/95	11.39	31	6153.40	6142.01
MW-027	07/31/95	11.92	31	6153.40	6141.48
MW-027	08/02/95	11.7	31	6153.40	6141.70
MW-027	08/04/95	11.7	31	6153.40	6141.70
MW-027	08/07/95	11.7	31	6153.40	6141.70
MW-027	08/09/95	11.58	31	6153.40	6141.82
MW-027	08/11/95	11.24	31	6153.40	6142.16
MW-027	08/14/95	10.93	31	6153.40	6142.47
MW-027	08/16/95	10.85	31	6153.40	6142.55
MW-027	08/18/95	11.22	31	6153.40	6142.18
MW-027	08/21/95	10.89	31	6153.40	6142.51
MW-027	08/23/95	11.14	31	6153.40	6142.26
MW-027	08/25/95	10.81	31	6153.40	6142.59
MW-027	08/28/95	11.21	31	6153.40	6142.19
MW-027	08/30/95	10.95	31	6153.40	6142.45
MW-027	09/01/95	10.83	31	6153.40	6142.57
MW-027	09/05/95	11.46	31	6153.40	6141.94
MW-027	09/06/95	11.58	31	6153.40	6141.82
MW-027	09/08/95	11.35	31	6153.40	6142.05
MW-027	09/11/95	11	31	6153.40	6142.40
MW-027	09/13/95	11.19	31	6153.40	6142.21
MW-027	09/15/95	10.95	31	6153.40	6142.45
MW-027	09/18/95	11.11	31	6153.40	6142.29
MW-027	09/20/95	11.03	31	6153.40	6142.37
MW-027	09/22/95	10.48	31	6153.40	6142.92
MW-027	09/25/95	10.92	31	6153.40	6142.48

TABLE A-1
HISTORIC WATER LEVELS
SPILL SITE 7 EE/CA - F.E. WARREN AFB

Monitoring Well	Sampling Date	Static Water Level (feet)	Total Well Depth (feet)	Mesuring Point Elevation (feet)	Mean Sea Level Water Level (feet)
MW-027	09/27/95	11.11	31	6153.40	6142.29
MW-027	09/29/95	11.07	31	6153.40	6142.33
MW-027	10/02/95	11.67	31	6153.40	6141.73
MW-027	10/04/95	11.6	31	6153.40	6141.80
MW-027	10/06/95	11.63	31	6153.40	6141.77
MW-027	10/11/95	11.94	31	6153.40	6141.46
MW-027	10/13/95	11.92	31	6153.40	6141.48
MW-027	10/16/95	11.82	31	6153.40	6141.58
MW-027	10/18/95	11.82	31	6153.40	6141.58
MW-027	10/20/95	11.88	31	6153.40	6141.52
MW-027	10/23/95	11.49	31	6153.40	6141.91
MW-027	10/25/95	11.63	31	6153.40	6141.77
MW-027	10/27/95	12.22	31	6153.40	6141.18
MW-027	10/30/95	12.75	31	6153.40	6140.65
MW-027	11/01/95	13.18	31	6153.40	6140.22
MW-027	11/03/95	13.53	31	6153.40	6139.87
MW-027	11/06/95	13.93	31	6153.40	6139.47
MW-027	11/08/95	14.22	31	6153.40	6139.18
MW-027	11/13/95	14.77	31	6153.40	6138.63
MW-027	11/20/95	15.34	31	6153.40	6138.06
MW-027	11/22/95	15.42	31	6153.40	6137.98
MW-027	11/27/95	15.68	31	6153.40	6137.72
MW-027	11/29/95	15.77	31	6153.40	6137.63
MW-027	12/01/95	15.82	31	6153.40	6137.58
MW-027	12/04/95	15.9	31	6153.40	6137.50
MW-027	12/06/95	16.01	31	6153.40	6137.39
MW-027	12/08/95	16.07	31	6153.40	6137.33
MW-027	12/11/95	16.13	31	6153.40	6137.27
MW-027	12/13/95	16.19	31	6153.40	6137.21
MW-027	01/10/96	16.36	31	6153.40	6137.04
MW-027	01/12/96	16.68	31	6153.40	6136.72
MW-027	01/16/96	16.74	31	6153.40	6136.66
MW-027	01/19/96	16.76	31	6153.40	6136.64
MW-027	01/23/96	16.84	31	6153.40	6136.56
MW-027	01/26/96	16.89	31	6153.40	6136.51
MW-027	01/30/96	16.93	31	6153.40	6136.47
MW-027	02/02/96	16.97	31	6153.40	6136.43
MW-027	02/05/96	16.99	31	6153.40	6136.41
MW-027	02/09/96	16.99	31	6153.40	6136.41
MW-027	02/13/96	16.84	31	6153.40	6136.56
MW-027	02/16/96	16.08	31	6153.40	6137.32
MW-027	02/23/96	14.09	31	6153.40	6139.31
MW-027	03/01/96	13.85	31	6153.40	6139.55
MW-027	03/08/96	14.35	31	6153.40	6139.05
MW-027	03/15/96	15.1	31	6153.40	6138.30
MW-027	03/22/96	15.39	31	6153.40	6138.01
MW-027	03/29/96	16.05	31	6153.40	6137.35

TABLE A-1
HISTORIC WATER LEVELS
SPILL SITE 7 EE/CA - F.E. WARREN AFB

Monitoring Well	Sampling Date	Static Water Level (feet)	Total Well Depth (feet)	Mesuring Point Elevation (feet)	Mean Sea Level Water Level (feet)
MW-027	06/22/98	16.46	31	6153.40	6136.94
MW-027	03/27/01	17.94	31	6153.40	6135.46
MW-027	07/18/01	14.98	31	6153.40	6138.42
MW-027	10/10/01	16.14	31	6153.40	6137.26
MW-027	11/21/01	16.81	31	6153.40	6136.59
MW-149	10/15/92	19.29	32	6154.36	6135.07
MW-149	10/04/94	16.46	32	6154.36	6137.90
MW-149	11/09/94	16.25	32	6154.36	6138.11
MW-149	11/10/94	15.8	32	6154.36	6138.56
MW-149	11/18/94	16.46	32	6154.36	6137.90
MW-149	11/25/94	16.74	32	6154.36	6137.62
MW-149	12/02/94	16.92	32	6154.36	6137.44
MW-149	01/03/95	17.5	32	6154.36	6136.86
MW-149	02/03/95	17.69	32	6154.36	6136.67
MW-149	04/03/95	17.83	32	6154.36	6136.53
MW-149	04/13/95	17.93	32	6154.36	6136.43
MW-149	04/20/95	16.96	32	6154.36	6137.40
MW-149	04/21/95	16.96	32	6154.36	6137.40
MW-149	04/24/95	17.25	32	6154.36	6137.11
MW-149	04/25/95	17.34	32	6154.36	6137.02
MW-149	04/26/95	17.07	32	6154.36	6137.29
MW-149	04/27/95	16.45	32	6154.36	6137.91
MW-149	04/28/95	15.35	32	6154.36	6139.01
MW-149	05/01/95	15.65	32	6154.36	6138.71
MW-149	05/02/95	15.62	32	6154.36	6138.74
MW-149	05/03/95	15.44	32	6154.36	6138.92
MW-149	05/04/95	15.43	32	6154.36	6138.93
MW-149	05/05/95	15.15	32	6154.36	6139.21
MW-149	05/08/95	15.14	32	6154.36	6139.22
MW-149	05/09/95	15.26	32	6154.36	6139.10
MW-149	05/10/95	14.98	32	6154.36	6139.38
MW-149	05/11/95	14.83	32	6154.36	6139.53
MW-149	05/12/95	14.8	32	6154.36	6139.56
MW-149	05/15/95	15.36	32	6154.36	6139.00
MW-149	05/16/95	15.48	32	6154.36	6138.88
MW-149	05/17/95	15.61	32	6154.36	6138.75
MW-149	05/18/95	15.46	32	6154.36	6138.90
MW-149	05/19/95	15.36	32	6154.36	6139.00
MW-149	05/22/95	15.33	32	6154.36	6139.03
MW-149	05/23/95	15.26	32	6154.36	6139.10
MW-149	05/24/95	14.83	32	6154.36	6139.53
MW-149	05/25/95	14.4	32	6154.36	6139.96
MW-149	05/26/95	14.19	32	6154.36	6140.17
MW-149	05/31/95	14	32	6154.36	6140.36
MW-149	06/02/95	13.56	32	6154.36	6140.80
MW-149	06/05/95	13.5	32	6154.36	6140.86
MW-149	06/07/95	12.82	32	6154.36	6141.54

TABLE A-1
HISTORIC WATER LEVELS
SPILL SITE 7 EE/CA - F.E. WARREN AFB

Monitoring Well	Sampling Date	Static Water Level (feet)	Total Well Depth (feet)	Mesuring Point Elevation (feet)	Mean Sea Level Water Level (feet)
MW-149	06/09/95	11.51	32	6154.36	6142.85
MW-149	06/12/95	11.49	32	6154.36	6142.87
MW-149	06/14/95	10.28	32	6154.36	6144.08
MW-149	06/16/95	9.6	32	6154.36	6144.76
MW-149	06/19/95	9.5	32	6154.36	6144.86
MW-149	06/21/95	9.29	32	6154.36	6145.07
MW-149	06/23/95	9.18	32	6154.36	6145.18
MW-149	06/26/95	9.13	32	6154.36	6145.23
MW-149	06/28/95	9.32	32	6154.36	6145.04
MW-149	06/30/95	9.17	32	6154.36	6145.19
MW-149	07/03/95	8.68	32	6154.36	6145.68
MW-149	07/05/95	8.75	32	6154.36	6145.61
MW-149	07/07/95	9.03	32	6154.36	6145.33
MW-149	07/10/95	10.01	32	6154.36	6144.35
MW-149	07/12/95	10.75	32	6154.36	6143.61
MW-149	07/14/95	10.95	32	6154.36	6143.41
MW-149	07/17/95	11.36	32	6154.36	6143.00
MW-149	07/19/95	9.7	32	6154.36	6144.66
MW-149	07/21/95	9.01	32	6154.36	6145.35
MW-149	07/24/95	9.21	32	6154.36	6145.15
MW-149	07/26/95	8.85	32	6154.36	6145.51
MW-149	07/28/95	9.63	32	6154.36	6144.73
MW-149	07/31/95	11.02	32	6154.36	6143.34
MW-149	08/02/95	10.46	32	6154.36	6143.90
MW-149	08/04/95	10.14	32	6154.36	6144.22
MW-149	08/07/95	10.47	32	6154.36	6143.89
MW-149	08/09/95	10.85	32	6154.36	6143.51
MW-149	08/11/95	9.2	32	6154.36	6145.16
MW-149	08/14/95	8.73	32	6154.36	6145.63
MW-149	08/16/95	8.66	32	6154.36	6145.70
MW-149	08/18/95	9.38	32	6154.36	6144.98
MW-149	08/21/95	8.67	32	6154.36	6145.69
MW-149	08/23/95	9.25	32	6154.36	6145.11
MW-149	08/25/95	8.63	32	6154.36	6145.73
MW-149	08/28/95	9.41	32	6154.36	6144.95
MW-149	08/30/95	8.77	32	6154.36	6145.59
MW-149	09/01/95	8.68	32	6154.36	6145.68
MW-149	09/05/95	10.07	32	6154.36	6144.29
MW-149	09/06/95	10.42	32	6154.36	6143.94
MW-149	09/08/95	9.53	32	6154.36	6144.83
MW-149	09/11/95	8.86	32	6154.36	6145.50
MW-149	09/13/95	9.19	32	6154.36	6145.17
MW-149	09/15/95	8.69	32	6154.36	6145.67
MW-149	09/18/95	8.93	32	6154.36	6145.43
MW-149	09/20/95	8.72	32	6154.36	6145.64
MW-149	09/22/95	7.82	32	6154.36	6146.54
MW-149	09/25/95	8.68	32	6154.36	6145.68

TABLE A-1
HISTORIC WATER LEVELS
SPILL SITE 7 EE/CA - F.E. WARREN AFB

Monitoring Well	Sampling Date	Static Water Level (feet)	Total Well Depth (feet)	Mesuring Point Elevation (feet)	Mean Sea Level Water Level (feet)
MW-149	09/27/95	9.01	32	6154.36	6145.35
MW-149	09/29/95	8.93	32	6154.36	6145.43
MW-149	10/02/95	10.23	32	6154.36	6144.13
MW-149	10/04/95	9.75	32	6154.36	6144.61
MW-149	10/06/95	9.74	32	6154.36	6144.62
MW-149	10/11/95	10.5	32	6154.36	6143.86
MW-149	10/13/95	10.3	32	6154.36	6144.06
MW-149	10/16/95	10.06	32	6154.36	6144.30
MW-149	10/18/95	10	32	6154.36	6144.36
MW-149	10/20/95	10.07	32	6154.36	6144.29
MW-149	10/23/95	9.01	32	6154.36	6145.35
MW-149	10/25/95	9.47	32	6154.36	6144.89
MW-149	10/27/95	10.73	32	6154.36	6143.63
MW-149	10/30/95	11.83	32	6154.36	6142.53
MW-149	11/01/95	12.41	32	6154.36	6141.95
MW-149	11/03/95	12.92	32	6154.36	6141.44
MW-149	11/06/95	13.5	32	6154.36	6140.86
MW-149	11/08/95	13.89	32	6154.36	6140.47
MW-149	11/13/95	14.67	32	6154.36	6139.69
MW-149	11/20/95	15.36	32	6154.36	6139.00
MW-149	11/22/95	15.47	32	6154.36	6138.89
MW-149	11/27/95	15.77	32	6154.36	6138.59
MW-149	11/29/95	15.86	32	6154.36	6138.50
MW-149	12/01/95	15.96	32	6154.36	6138.40
MW-149	12/04/95	16.05	32	6154.36	6138.31
MW-149	12/06/95	16.13	32	6154.36	6138.23
MW-149	12/08/95	16.21	32	6154.36	6138.15
MW-149	12/11/95	16.26	32	6154.36	6138.10
MW-149	12/13/95	16.31	32	6154.36	6138.05
MW-149	01/10/96	16.79	32	6154.36	6137.57
MW-149	01/12/96	16.69	32	6154.36	6137.67
MW-149	01/16/96	16.77	32	6154.36	6137.59
MW-149	01/19/96	16.82	32	6154.36	6137.54
MW-149	01/23/96	16.88	32	6154.36	6137.48
MW-149	01/26/96	16.92	32	6154.36	6137.44
MW-149	01/30/96	16.96	32	6154.36	6137.40
MW-149	02/02/96	16.99	32	6154.36	6137.37
MW-149	02/05/96	17.02	32	6154.36	6137.34
MW-149	02/09/96	17.03	32	6154.36	6137.33
MW-149	02/13/96	16.99	32	6154.36	6137.37
MW-149	02/16/96	15.62	32	6154.36	6138.74
MW-149	02/23/96	12.55	32	6154.36	6141.81
MW-149	03/01/96	12.36	32	6154.36	6142.00
MW-149	03/08/96	13.14	32	6154.36	6141.22
MW-149	03/15/96	14.26	32	6154.36	6140.10
MW-149	03/22/96	14.63	32	6154.36	6139.73
MW-149	03/29/96	15.74	32	6154.36	6138.62

TABLE A-1
HISTORIC WATER LEVELS
SPILL SITE 7 EE/CA - F.E. WARREN AFB

Monitoring Well	Sampling Date	Static Water Level (feet)	Total Well Depth (feet)	Mesuring Point Elevation (feet)	Mean Sea Level Water Level (feet)
MW-149	06/22/98	18.95	32	6154.36	6135.41
MW-149	03/27/01	19.86	32	6154.36	6134.50
MW-149	07/18/01	16.98	32	6154.36	6137.38
MW-149	10/10/01	18.28	32	6154.36	6136.08
MW-149	11/21/01	18.87	32	6154.36	6135.49
MW-150	10/15/92	21.11	32	6154.56	6133.45
MW-150	10/04/94	18.02	32	6154.56	6136.54
MW-150	11/09/94	17.94	32	6154.56	6136.62
MW-150	11/10/94	17.5	32	6154.56	6137.06
MW-150	11/18/94	18.03	32	6154.56	6136.53
MW-150	11/25/94	18.28	32	6154.56	6136.28
MW-150	12/02/94	18.44	32	6154.56	6136.12
MW-150	01/03/95	18.97	32	6154.56	6135.59
MW-150	02/03/95	19.15	32	6154.56	6135.41
MW-150	04/03/95	19.29	32	6154.56	6135.27
MW-150	04/13/95	19.28	32	6154.56	6135.28
MW-150	04/20/95	18.54	32	6154.56	6136.02
MW-150	04/21/95	18.46	32	6154.56	6136.10
MW-150	04/21/95	23.81	32	6154.56	6130.75
MW-150	04/24/95	18.7	32	6154.56	6135.86
MW-150	04/24/95	24	32	6154.56	6130.56
MW-150	04/25/95	18.78	32	6154.56	6135.78
MW-150	04/25/95	24.02	32	6154.56	6130.54
MW-150	04/26/95	18.62	32	6154.56	6135.94
MW-150	04/27/95	18.18	32	6154.56	6136.38
MW-150	04/28/95	17.27	32	6154.56	6137.29
MW-150	05/01/95	17.27	32	6154.56	6137.29
MW-150	05/02/95	17.26	32	6154.56	6137.30
MW-150	05/03/95	17.11	32	6154.56	6137.45
MW-150	05/04/95	17.07	32	6154.56	6137.49
MW-150	05/05/95	16.84	32	6154.56	6137.72
MW-150	05/08/95	16.84	32	6154.56	6137.72
MW-150	05/09/95	16.88	32	6154.56	6137.68
MW-150	05/10/95	16.7	32	6154.56	6137.86
MW-150	05/11/95	16.49	32	6154.56	6138.07
MW-150	05/12/95	16.47	32	6154.56	6138.09
MW-150	05/15/95	16.97	32	6154.56	6137.59
MW-150	05/16/95	17.1	32	6154.56	6137.46
MW-150	05/17/95	17.21	32	6154.56	6137.35
MW-150	05/18/95	17.1	32	6154.56	6137.46
MW-150	05/19/95	17.01	32	6154.56	6137.55
MW-150	05/22/95	16.89	32	6154.56	6137.67
MW-150	05/23/95	16.88	32	6154.56	6137.68
MW-150	05/24/95	16.45	32	6154.56	6138.11
MW-150	05/25/95	16.1	32	6154.56	6138.46
MW-150	05/26/95	15.87	32	6154.56	6138.69
MW-150	05/31/95	15.69	32	6154.56	6138.87

TABLE A-1
HISTORIC WATER LEVELS
SPILL SITE 7 EE/CA - F.E. WARREN AFB

Monitoring Well	Sampling Date	Static Water Level (feet)	Total Well Depth (feet)	Mesuring Point Elevation (feet)	Mean Sea Level Water Level (feet)
MW-150	06/02/95	15.28	32	6154.56	6139.28
MW-150	06/05/95	15.23	32	6154.56	6139.33
MW-150	06/07/95	14.57	32	6154.56	6139.99
MW-150	06/09/95	13.31	32	6154.56	6141.25
MW-150	06/12/95	13.21	32	6154.56	6141.35
MW-150	06/14/95	12.09	32	6154.56	6142.47
MW-150	06/16/95	11.66	32	6154.56	6142.90
MW-150	06/19/95	11.37	32	6154.56	6143.19
MW-150	06/21/95	11.6	32	6154.56	6142.96
MW-150	06/23/95	11.54	32	6154.56	6143.02
MW-150	06/26/95	11.49	32	6154.56	6143.07
MW-150	06/28/95	11.69	32	6154.56	6142.87
MW-150	06/30/95	11.48	32	6154.56	6143.08
MW-150	07/03/95	10.88	32	6154.56	6143.68
MW-150	07/05/95	10.97	32	6154.56	6143.59
MW-150	07/07/95	10.75	32	6154.56	6143.81
MW-150	07/10/95	12.14	32	6154.56	6142.42
MW-150	07/12/95	12.61	32	6154.56	6141.95
MW-150	07/14/95	12.74	32	6154.56	6141.82
MW-150	07/14/95	13.16	32	6154.56	6141.40
MW-150	07/19/95	11.72	32	6154.56	6142.84
MW-150	07/21/95	11.11	32	6154.56	6143.45
MW-150	07/24/95	11.61	32	6154.56	6142.95
MW-150	07/26/95	10.8	32	6154.56	6143.76
MW-150	07/28/95	11.97	32	6154.56	6142.59
MW-150	07/31/95	12.86	32	6154.56	6141.70
MW-150	08/02/95	12.22	32	6154.56	6142.34
MW-150	08/04/95	12	32	6154.56	6142.56
MW-150	08/07/95	12.44	32	6154.56	6142.12
MW-150	08/09/95	11.64	32	6154.56	6142.92
MW-150	08/11/95	11.23	32	6154.56	6143.33
MW-150	08/14/95	10.75	32	6154.56	6143.81
MW-150	08/16/95	10.55	32	6154.56	6144.01
MW-150	08/18/95	11.26	32	6154.56	6143.30
MW-150	08/21/95	10.53	32	6154.56	6144.03
MW-150	08/23/95	11.28	32	6154.56	6143.28
MW-150	08/25/95	10.64	32	6154.56	6143.92
MW-150	08/28/95	11.88	32	6154.56	6142.68
MW-150	08/30/95	10.65	32	6154.56	6143.91
MW-150	09/01/95	10.6	32	6154.56	6143.96
MW-150	09/05/95	12.18	32	6154.56	6142.38
MW-150	09/06/95	12.38	32	6154.56	6142.18
MW-150	09/08/95	11.18	32	6154.56	6143.38
MW-150	09/11/95	10.77	32	6154.56	6143.79
MW-150	09/13/95	11.33	32	6154.56	6143.23
MW-150	09/15/95	10.63	32	6154.56	6143.93
MW-150	09/18/95	11.13	32	6154.56	6143.43

TABLE A-1
HISTORIC WATER LEVELS
SPILL SITE 7 EE/CA - F.E. WARREN AFB

Monitoring Well	Sampling Date	Static Water Level (feet)	Total Well Depth (feet)	Mesuring Point Elevation (feet)	Mean Sea Level Water Level (feet)
MW-150	09/20/95	10.65	32	6154.56	6143.91
MW-150	09/22/95	9.78	32	6154.56	6144.78
MW-150	09/25/95	10.66	32	6154.56	6143.90
MW-150	09/27/95	10.97	32	6154.56	6143.59
MW-150	09/29/95	10.84	32	6154.56	6143.72
MW-150	10/02/95	12.3	32	6154.56	6142.26
MW-150	10/04/95	11.82	32	6154.56	6142.74
MW-150	10/06/95	11.75	32	6154.56	6142.81
MW-150	10/11/95	12.28	32	6154.56	6142.28
MW-150	10/13/95	12.1	32	6154.56	6142.46
MW-150	10/16/95	11.94	32	6154.56	6142.62
MW-150	10/18/95	11.91	32	6154.56	6142.65
MW-150	10/20/95	11.96	32	6154.56	6142.60
MW-150	10/23/95	10.97	32	6154.56	6143.59
MW-150	10/25/95	11.63	32	6154.56	6142.93
MW-150	10/27/95	12.68	32	6154.56	6141.88
MW-150	10/30/95	13.5	32	6154.56	6141.06
MW-150	11/01/95	14.05	32	6154.56	6140.51
MW-150	11/03/95	14.53	32	6154.56	6140.03
MW-150	11/06/95	15.1	32	6154.56	6139.46
MW-150	11/08/95	15.56	32	6154.56	6139.00
MW-150	11/13/95	16.33	32	6154.56	6138.23
MW-150	11/20/95	17.01	32	6154.56	6137.55
MW-150	11/22/95	17.11	32	6154.56	6137.45
MW-150	11/27/95	17.4	32	6154.56	6137.16
MW-150	11/29/95	17.5	32	6154.56	6137.06
MW-150	12/01/95	17.58	32	6154.56	6136.98
MW-150	12/04/95	17.67	32	6154.56	6136.89
MW-150	12/06/95	17.76	32	6154.56	6136.80
MW-150	12/08/95	17.83	32	6154.56	6136.73
MW-150	12/11/95	17.88	32	6154.56	6136.68
MW-150	12/13/95	17.94	32	6154.56	6136.62
MW-150	01/10/96	18.36	32	6154.56	6136.20
MW-150	01/12/96	18.28	32	6154.56	6136.28
MW-150	01/16/96	18.35	32	6154.56	6136.21
MW-150	01/19/96	18.39	32	6154.56	6136.17
MW-150	01/23/96	18.44	32	6154.56	6136.12
MW-150	01/26/96	18.47	32	6154.56	6136.09
MW-150	01/30/96	18.51	32	6154.56	6136.05
MW-150	02/02/96	18.54	32	6154.56	6136.02
MW-150	02/05/96	18.57	32	6154.56	6135.99
MW-150	02/09/96	18.63	32	6154.56	6135.93
MW-150	02/13/96	18.56	32	6154.56	6136.00
MW-150	02/16/96	17.33	32	6154.56	6137.23
MW-150	02/23/96	13.99	32	6154.56	6140.57
MW-150	03/01/96	13.95	32	6154.56	6140.61
MW-150	03/08/96	14.77	32	6154.56	6139.79

TABLE A-1
HISTORIC WATER LEVELS
SPILL SITE 7 EE/CA - F.E. WARREN AFB

Monitoring Well	Sampling Date	Static Water Level (feet)	Total Well Depth (feet)	Mesuring Point Elevation (feet)	Mean Sea Level Water Level (feet)
MW-150	03/15/96	15.86	32	6154.56	6138.70
MW-150	03/22/96	16.31	32	6154.56	6138.25
MW-150	03/29/96	17.31	32	6154.56	6137.25
MW-150	06/22/98	20.4	32	6154.56	6134.16
MW-150	06/25/98	20.37	32	6154.56	6134.19
MW-150	03/27/01	21.5	32	6154.56	6133.06
MW-150	07/18/01	18.96	32	6154.56	6135.60
MW-150	10/10/01	20.08	32	6154.56	6134.48
MW-150	11/21/01	20.56	32	6154.56	6134.00
MW-151	10/15/92	26.77	42	6152.81	6126.04
MW-151	10/04/94	23.56	42	6152.81	6129.25
MW-151	11/09/94	23.63	42	6152.81	6129.18
MW-151	11/10/94	23.21	42	6152.81	6129.60
MW-151	11/18/94	23.62	42	6152.81	6129.19
MW-151	11/25/94	23.73	42	6152.81	6129.08
MW-151	12/02/94	23.8	42	6152.81	6129.01
MW-151	01/03/95	24.1	42	6152.81	6128.71
MW-151	02/03/95	24.1	42	6152.81	6128.71
MW-151	04/03/95	24.22	42	6152.81	6128.59
MW-151	04/13/95	24.19	42	6152.81	6128.62
MW-151	04/20/95	23.77	42	6152.81	6129.04
MW-151	04/26/95	23.86	42	6152.81	6128.95
MW-151	04/27/95	23.54	42	6152.81	6129.27
MW-151	04/28/95	23.14	42	6152.81	6129.67
MW-151	05/01/95	23.62	42	6152.81	6129.19
MW-151	05/02/95	23.52	42	6152.81	6129.29
MW-151	05/03/95	23.21	42	6152.81	6129.60
MW-151	05/04/95	23.06	42	6152.81	6129.75
MW-151	05/05/95	22.8	42	6152.81	6130.01
MW-151	05/08/95	22.74	42	6152.81	6130.07
MW-151	05/09/95	22.4	42	6152.81	6130.41
MW-151	05/10/95	22.09	42	6152.81	6130.72
MW-151	05/11/95	21.98	42	6152.81	6130.83
MW-151	05/12/95	21.99	42	6152.81	6130.82
MW-151	05/15/95	22.35	42	6152.81	6130.46
MW-151	05/16/95	22.4	42	6152.81	6130.41
MW-151	05/17/95	22.3	42	6152.81	6130.51
MW-151	05/18/95	21.88	42	6152.81	6130.93
MW-151	05/19/95	21.65	42	6152.81	6131.16
MW-151	05/22/95	21.32	42	6152.81	6131.49
MW-151	05/23/95	21.35	42	6152.81	6131.46
MW-151	05/24/95	21.18	42	6152.81	6131.63
MW-151	05/25/95	21.03	42	6152.81	6131.78
MW-151	05/26/95	20.96	42	6152.81	6131.85
MW-151	05/31/95	20.94	42	6152.81	6131.87
MW-151	06/02/95	20.71	42	6152.81	6132.10
MW-151	06/05/95	20.6	42	6152.81	6132.21

TABLE A-1
HISTORIC WATER LEVELS
SPILL SITE 7 EE/CA - F.E. WARREN AFB

Monitoring Well	Sampling Date	Static Water Level (feet)	Total Well Depth (feet)	Mesuring Point Elevation (feet)	Mean Sea Level Water Level (feet)
MW-151	06/07/95	20.23	42	6152.81	6132.58
MW-151	06/09/95	19.27	42	6152.81	6133.54
MW-151	06/12/95	19.4	42	6152.81	6133.41
MW-151	06/14/95	18.83	42	6152.81	6133.98
MW-151	06/16/95	18.91	42	6152.81	6133.90
MW-151	06/19/95	18.9	42	6152.81	6133.91
MW-151	06/21/95	19.27	42	6152.81	6133.54
MW-151	06/23/95	19.34	42	6152.81	6133.47
MW-151	06/26/95	19.35	42	6152.81	6133.46
MW-151	06/28/95	19.52	42	6152.81	6133.29
MW-151	06/30/95	19.2	42	6152.81	6133.61
MW-151	07/03/95	18.67	42	6152.81	6134.14
MW-151	07/05/95	18.96	42	6152.81	6133.85
MW-151	07/07/95	19.08	42	6152.81	6133.73
MW-151	07/10/95	20.64	42	6152.81	6132.17
MW-151	07/12/95	21.1	42	6152.81	6131.71
MW-151	07/14/95	21.14	42	6152.81	6131.67
MW-151	07/17/95	21.5	42	6152.81	6131.31
MW-151	07/19/95	20.94	42	6152.81	6131.87
MW-151	07/21/95	20.82	42	6152.81	6131.99
MW-151	07/24/95	21.06	42	6152.81	6131.75
MW-151	07/26/95	20.58	42	6152.81	6132.23
MW-151	07/28/95	21.2	42	6152.81	6131.61
MW-151	07/31/95	21.72	42	6152.81	6131.09
MW-151	08/02/95	21.31	42	6152.81	6131.50
MW-151	08/04/95	21.22	42	6152.81	6131.59
MW-151	08/07/95	21.58	42	6152.81	6131.23
MW-151	08/09/95	20.9	42	6152.81	6131.91
MW-151	08/11/95	20.83	42	6152.81	6131.98
MW-151	08/14/95	20.66	42	6152.81	6132.15
MW-151	08/16/95	20.45	42	6152.81	6132.36
MW-151	08/18/95	20.55	42	6152.81	6132.26
MW-151	08/21/95	20.34	42	6152.81	6132.47
MW-151	08/23/95	20.54	42	6152.81	6132.27
MW-151	08/25/95	20.36	42	6152.81	6132.45
MW-151	08/28/95	21.2	42	6152.81	6131.61
MW-151	08/30/95	20.73	42	6152.81	6132.08
MW-151	09/01/95	20.53	42	6152.81	6132.28
MW-151	09/05/95	21.27	42	6152.81	6131.54
MW-151	09/06/95	21.38	42	6152.81	6131.43
MW-151	09/08/95	20.6	42	6152.81	6132.21
MW-151	09/11/95	20.56	42	6152.81	6132.25
MW-151	09/13/95	20.83	42	6152.81	6131.98
MW-151	09/15/95	20.56	42	6152.81	6132.25
MW-151	09/18/95	20.77	42	6152.81	6132.04
MW-151	09/20/95	20.53	42	6152.81	6132.28
MW-151	09/22/95	20.3	42	6152.81	6132.51

TABLE A-1
HISTORIC WATER LEVELS
SPILL SITE 7 EE/CA - F.E. WARREN AFB

Monitoring Well	Sampling Date	Static Water Level (feet)	Total Well Depth (feet)	Mesuring Point Elevation (feet)	Mean Sea Level Water Level (feet)
MW-151	09/25/95	20.48	42	6152.81	6132.33
MW-151	09/27/95	20.43	42	6152.81	6132.38
MW-151	09/29/95	20.35	42	6152.81	6132.46
MW-151	10/02/95	21.3	42	6152.81	6131.51
MW-151	10/04/95	20.98	42	6152.81	6131.83
MW-151	10/06/95	20.94	42	6152.81	6131.87
MW-151	10/11/95	21.16	42	6152.81	6131.65
MW-151	10/13/95	21.12	42	6152.81	6131.69
MW-151	10/16/95	21.05	42	6152.81	6131.76
MW-151	10/18/95	21.09	42	6152.81	6131.72
MW-151	10/20/95	21.15	42	6152.81	6131.66
MW-151	10/23/95	20.87	42	6152.81	6131.94
MW-151	10/25/95	21.12	42	6152.81	6131.69
MW-151	10/27/95	21.77	42	6152.81	6131.04
MW-151	10/30/95	21.94	42	6152.81	6130.87
MW-151	11/01/95	22.05	42	6152.81	6130.76
MW-151	11/03/95	22.17	42	6152.81	6130.64
MW-151	11/06/95	22.29	42	6152.81	6130.52
MW-151	11/08/95	22.43	42	6152.81	6130.38
MW-151	11/13/95	22.65	42	6152.81	6130.16
MW-151	11/20/95	22.9	42	6152.81	6129.91
MW-151	11/22/95	22.92	42	6152.81	6129.89
MW-151	11/27/95	23.05	42	6152.81	6129.76
MW-151	11/29/95	23.08	42	6152.81	6129.73
MW-151	12/01/95	23.12	42	6152.81	6129.69
MW-151	12/04/95	23.16	42	6152.81	6129.65
MW-151	12/06/95	23.21	42	6152.81	6129.60
MW-151	12/08/95	23.25	42	6152.81	6129.56
MW-151	12/11/95	23.24	42	6152.81	6129.57
MW-151	12/13/95	23.29	42	6152.81	6129.52
MW-151	01/10/96	23.44	42	6152.81	6129.37
MW-151	01/12/96	23.42	42	6152.81	6129.39
MW-151	01/16/96	23.45	42	6152.81	6129.36
MW-151	01/19/96	23.51	42	6152.81	6129.30
MW-151	01/23/96	23.53	42	6152.81	6129.28
MW-151	01/26/96	23.53	42	6152.81	6129.28
MW-151	01/30/96	23.56	42	6152.81	6129.25
MW-151	02/02/96	23.56	42	6152.81	6129.25
MW-151	02/05/96	23.56	42	6152.81	6129.25
MW-151	02/09/96	23.51	42	6152.81	6129.30
MW-151	02/13/96	23.58	42	6152.81	6129.23
MW-151	02/16/96	23.38	42	6152.81	6129.43
MW-151	02/23/96	22.59	42	6152.81	6130.22
MW-151	03/01/96	22.47	42	6152.81	6130.34
MW-151	03/08/96	22.69	42	6152.81	6130.12
MW-151	03/15/96	22.86	42	6152.81	6129.95
MW-151	03/22/96	22.95	42	6152.81	6129.86

TABLE A-1
HISTORIC WATER LEVELS
SPILL SITE 7 EE/CA - F.E. WARREN AFB

Monitoring Well	Sampling Date	Static Water Level (feet)	Total Well Depth (feet)	Mesuring Point Elevation (feet)	Mean Sea Level Water Level (feet)
MW-151	03/29/96	23.13	42	6152.81	6129.68
MW-151	06/22/98	26.22	42	6152.81	6126.59
MW-151	06/24/98	26.21	42	6152.81	6126.60
MW-151	03/27/01	26.88	42	6152.81	6125.93
MW-151	07/18/01	25.38	42	6152.81	6127.43
MW-151	10/10/01	25.74	42	6152.81	6127.07
MW-151	11/21/01	26.1	42	6152.81	6126.71
MW-182	10/23/92	22.64	25	6152.34	6129.70
MW-182	10/04/94	19.41	25	6152.34	6132.93
MW-182	04/13/95	20.29	25	6152.34	6132.05
MW-182	04/20/95	20.21	25	6152.34	6132.13
MW-182	04/21/95	20.15	25	6152.34	6132.19
MW-182	04/24/95	20.18	25	6152.34	6132.16
MW-182	04/25/95	20.19	25	6152.34	6132.15
MW-182	04/26/95	20.17	25	6152.34	6132.17
MW-182	04/27/95	20.15	25	6152.34	6132.19
MW-182	04/28/95	20.42	25	6152.34	6131.92
MW-182	05/01/95	19.98	25	6152.34	6132.36
MW-182	05/02/95	20.01	25	6152.34	6132.33
MW-182	05/03/95	19.94	25	6152.34	6132.40
MW-182	05/04/95	19.91	25	6152.34	6132.43
MW-182	05/05/95	19.87	25	6152.34	6132.47
MW-182	05/08/95	19.7	25	6152.34	6132.64
MW-182	05/09/95	19.65	25	6152.34	6132.69
MW-182	05/10/95	19.58	25	6152.34	6132.76
MW-182	05/11/95	19.54	25	6152.34	6132.80
MW-182	05/12/95	19.54	25	6152.34	6132.80
MW-182	05/15/95	19.53	25	6152.34	6132.81
MW-182	05/16/95	19.54	25	6152.34	6132.80
MW-182	05/17/95	19.33	25	6152.34	6133.01
MW-182	05/18/95	19.07	25	6152.34	6133.27
MW-182	05/19/95	19.09	25	6152.34	6133.25
MW-182	05/22/95	18.12	25	6152.34	6134.22
MW-182	05/23/95	19.08	25	6152.34	6133.26
MW-182	05/24/95	19.05	25	6152.34	6133.29
MW-182	05/25/95	19.03	25	6152.34	6133.31
MW-182	05/26/95	19.09	25	6152.34	6133.25
MW-182	05/31/95	18.97	25	6152.34	6133.37
MW-182	06/02/95	18.91	25	6152.34	6133.43
MW-182	06/05/95	18.65	25	6152.34	6133.69
MW-182	06/07/95	18.73	25	6152.34	6133.61
MW-182	06/09/95	17.46	25	6152.34	6134.88
MW-182	06/12/95	17.28	25	6152.34	6135.06
MW-182	06/14/95	17.7	25	6152.34	6134.64
MW-182	06/21/95	18.07	25	6152.34	6134.27
MW-182	06/23/95	18.21	25	6152.34	6134.13
MW-182	06/26/95	18.29	25	6152.34	6134.05

TABLE A-1
HISTORIC WATER LEVELS
SPILL SITE 7 EE/CA - F.E. WARREN AFB

Monitoring Well	Sampling Date	Static Water Level (feet)	Total Well Depth (feet)	Mesuring Point Elevation (feet)	Mean Sea Level Water Level (feet)
MW-182	06/28/95	18.28	25	6152.34	6134.06
MW-182	06/30/95	18.24	25	6152.34	6134.10
MW-182	07/03/95	17.51	25	6152.34	6134.83
MW-182	07/05/95	17.77	25	6152.34	6134.57
MW-182	07/07/95	18.27	25	6152.34	6134.07
MW-182	07/10/95	18.55	25	6152.34	6133.79
MW-182	07/12/95	18.63	25	6152.34	6133.71
MW-182	07/14/95	18.66	25	6152.34	6133.68
MW-182	07/17/95	18.71	25	6152.34	6133.63
MW-182	07/19/95	18.65	25	6152.34	6133.69
MW-182	07/21/95	18.6	25	6152.34	6133.74
MW-182	07/24/95	18.64	25	6152.34	6133.70
MW-182	07/26/95	18.6	25	6152.34	6133.74
MW-182	07/28/95	18.68	25	6152.34	6133.66
MW-182	07/31/95	18.76	25	6152.34	6133.58
MW-182	08/02/95	18.72	25	6152.34	6133.62
MW-182	08/04/95	18.71	25	6152.34	6133.63
MW-182	08/07/95	18.73	25	6152.34	6133.61
MW-182	08/09/95	18.73	25	6152.34	6133.61
MW-182	08/11/95	18.68	25	6152.34	6133.66
MW-182	08/14/95	18.6	25	6152.34	6133.74
MW-182	08/16/95	18.59	25	6152.34	6133.75
MW-182	08/18/95	18.64	25	6152.34	6133.70
MW-182	08/21/95	18.6	25	6152.34	6133.74
MW-182	08/23/95	18.63	25	6152.34	6133.71
MW-182	08/25/95	18.59	25	6152.34	6133.75
MW-182	08/28/95	18.65	25	6152.34	6133.69
MW-182	08/30/95	18.68	25	6152.34	6133.66
MW-182	09/01/95	18.63	25	6152.34	6133.71
MW-182	09/05/95	18.68	25	6152.34	6133.66
MW-182	09/06/95	18.7	25	6152.34	6133.64
MW-182	09/08/95	18.66	25	6152.34	6133.68
MW-182	09/11/95	18.61	25	6152.34	6133.73
MW-182	09/13/95	18.64	25	6152.34	6133.70
MW-182	09/15/95	18.63	25	6152.34	6133.71
MW-182	09/18/95	18.67	25	6152.34	6133.67
MW-182	09/20/95	18.63	25	6152.34	6133.71
MW-182	09/22/95	18.52	25	6152.34	6133.82
MW-182	09/25/95	18.6	25	6152.34	6133.74
MW-182	09/27/95	18.62	25	6152.34	6133.72
MW-182	09/29/95	18.63	25	6152.34	6133.71
MW-182	10/02/95	18.74	25	6152.34	6133.60
MW-182	10/04/95	18.75	25	6152.34	6133.59
MW-182	10/06/95	18.75	25	6152.34	6133.59
MW-182	10/11/95	18.8	25	6152.34	6133.54
MW-182	10/13/95	18.81	25	6152.34	6133.53
MW-182	10/16/95	18.82	25	6152.34	6133.52

TABLE A-1
HISTORIC WATER LEVELS
SPILL SITE 7 EE/CA - F.E. WARREN AFB

Monitoring Well	Sampling Date	Static Water Level (feet)	Total Well Depth (feet)	Mesuring Point Elevation (feet)	Mean Sea Level Water Level (feet)
MW-182	10/18/95	18.81	25	6152.34	6133.53
MW-182	10/20/95	18.83	25	6152.34	6133.51
MW-182	10/23/95	18.79	25	6152.34	6133.55
MW-182	10/25/95	18.79	25	6152.34	6133.55
MW-182	10/27/95	18.89	25	6152.34	6133.45
MW-182	10/30/95	18.99	25	6152.34	6133.35
MW-182	11/01/95	19.09	25	6152.34	6133.25
MW-182	11/03/95	19.15	25	6152.34	6133.19
MW-182	11/06/95	19.24	25	6152.34	6133.10
MW-182	11/08/95	19.31	25	6152.34	6133.03
MW-182	11/13/95	19.59	25	6152.34	6132.75
MW-182	11/20/95	19.59	25	6152.34	6132.75
MW-182	11/22/95	19.54	25	6152.34	6132.80
MW-182	11/27/95	19.6	25	6152.34	6132.74
MW-182	11/29/95	19.62	25	6152.34	6132.72
MW-182	12/01/95	19.63	25	6152.34	6132.71
MW-182	12/04/95	19.64	25	6152.34	6132.70
MW-182	12/06/95	19.68	25	6152.34	6132.66
MW-182	12/08/95	19.7	25	6152.34	6132.64
MW-182	12/11/95	19.67	25	6152.34	6132.67
MW-182	12/13/95	19.72	25	6152.34	6132.62
MW-182	01/10/96	19.91	25	6152.34	6132.43
MW-182	01/12/96	19.88	25	6152.34	6132.46
MW-182	01/16/96	19.89	25	6152.34	6132.45
MW-182	01/19/96	19.91	25	6152.34	6132.43
MW-182	01/23/96	19.92	25	6152.34	6132.42
MW-182	01/26/96	19.95	25	6152.34	6132.39
MW-182	01/30/96	19.97	25	6152.34	6132.37
MW-182	02/02/96	19.98	25	6152.34	6132.36
MW-182	02/05/96	19.98	25	6152.34	6132.36
MW-182	02/09/96	20	25	6152.34	6132.34
MW-182	02/13/96	19.9	25	6152.34	6132.44
MW-182	02/16/96	19.83	25	6152.34	6132.51
MW-182	02/23/96	19.52	25	6152.34	6132.82
MW-182	03/01/96	19.44	25	6152.34	6132.90
MW-182	03/08/96	19.54	25	6152.34	6132.80
MW-182	03/15/96	19.67	25	6152.34	6132.67
MW-182	03/22/96	19.71	25	6152.34	6132.63
MW-182	03/29/96	19.8	25	6152.34	6132.54
MW-182	06/22/98	22.4	25	6152.34	6129.94
MW-182	03/27/01	22.32	25	6152.34	6130.02
MW-182	07/18/01	20.94	25	6152.34	6131.40
MW-182	10/10/01	21.74	25	6152.34	6130.60
MW-182	11/21/01	22.07	25	6152.34	6130.27
MW-183	10/23/92	24.49	25	6153.51	6129.02
MW-183	10/04/94	21.72	25	6153.51	6131.79
MW-183	04/13/95	22.35	25	6153.51	6131.16

TABLE A-1
HISTORIC WATER LEVELS
SPILL SITE 7 EE/CA - F.E. WARREN AFB

Monitoring Well	Sampling Date	Static Water Level (feet)	Total Well Depth (feet)	Mesuring Point Elevation (feet)	Mean Sea Level Water Level (feet)
MW-183	04/20/95	22.31	25	6153.51	6131.20
MW-183	04/21/95	22.27	25	6153.51	6131.24
MW-183	04/24/95	22.29	25	6153.51	6131.22
MW-183	04/25/95	22.29	25	6153.51	6131.22
MW-183	04/26/95	22.29	25	6153.51	6131.22
MW-183	04/27/95	22.27	25	6153.51	6131.24
MW-183	04/28/95	22.25	25	6153.51	6131.26
MW-183	05/01/95	22.23	25	6153.51	6131.28
MW-183	05/02/95	22.22	25	6153.51	6131.29
MW-183	05/03/95	22.22	25	6153.51	6131.29
MW-183	05/04/95	22.19	25	6153.51	6131.32
MW-183	05/05/95	22.2	25	6153.51	6131.31
MW-183	05/08/95	22.11	25	6153.51	6131.40
MW-183	05/09/95	22.09	25	6153.51	6131.42
MW-183	05/10/95	22.03	25	6153.51	6131.48
MW-183	05/11/95	22.03	25	6153.51	6131.48
MW-183	05/12/95	22.02	25	6153.51	6131.49
MW-183	05/15/95	21.98	25	6153.51	6131.53
MW-183	05/16/95	21.98	25	6153.51	6131.53
MW-183	05/17/95	21.92	25	6153.51	6131.59
MW-183	05/18/95	21.5	25	6153.51	6132.01
MW-183	05/19/95	21.39	25	6153.51	6132.12
MW-183	05/22/95	21.27	25	6153.51	6132.24
MW-183	05/24/95	21.46	25	6153.51	6132.05
MW-183	05/25/95	21.58	25	6153.51	6131.93
MW-183	05/26/95	21.63	25	6153.51	6131.88
MW-183	05/31/95	21.46	25	6153.51	6132.05
MW-183	06/02/95	21.4	25	6153.51	6132.11
MW-183	06/05/95	20.95	25	6153.51	6132.56
MW-183	06/07/95	21.16	25	6153.51	6132.35
MW-183	06/09/95	19.6	25	6153.51	6133.91
MW-183	06/12/95	19.41	25	6153.51	6134.10
MW-183	06/14/95	20.03	25	6153.51	6133.48
MW-183	06/16/95	20.39	25	6153.51	6133.12
MW-183	06/19/95	20.73	25	6153.51	6132.78
MW-183	06/21/95	20.69	25	6153.51	6132.82
MW-183	06/23/95	20.86	25	6153.51	6132.65
MW-183	06/26/95	20.95	25	6153.51	6132.56
MW-183	06/28/95	20.93	25	6153.51	6132.58
MW-183	06/30/95	20.89	25	6153.51	6132.62
MW-183	07/03/95	19.89	25	6153.51	6133.62
MW-183	07/05/95	20.18	25	6153.51	6133.33
MW-183	07/07/95	21.64	25	6153.51	6131.87
MW-183	07/10/95	21.82	25	6153.51	6131.69
MW-183	07/12/95	21.86	25	6153.51	6131.65
MW-183	07/14/95	21.87	25	6153.51	6131.64
MW-183	07/17/95	21.87	25	6153.51	6131.64

TABLE A-1
HISTORIC WATER LEVELS
SPILL SITE 7 EE/CA - F.E. WARREN AFB

Monitoring Well	Sampling Date	Static Water Level (feet)	Total Well Depth (feet)	Mesuring Point Elevation (feet)	Mean Sea Level Water Level (feet)
MW-183	07/19/95	21.87	25	6153.51	6131.64
MW-183	07/21/95	21.86	25	6153.51	6131.65
MW-183	07/24/95	21.87	25	6153.51	6131.64
MW-183	07/26/95	21.86	25	6153.51	6131.65
MW-183	07/28/95	21.85	25	6153.51	6131.66
MW-183	07/31/95	21.9	25	6153.51	6131.61
MW-183	08/02/95	21.89	25	6153.51	6131.62
MW-183	08/04/95	21.89	25	6153.51	6131.62
MW-183	08/07/95	21.89	25	6153.51	6131.62
MW-183	08/09/95	21.88	25	6153.51	6131.63
MW-183	08/11/95	21.88	25	6153.51	6131.63
MW-183	08/14/95	21.85	25	6153.51	6131.66
MW-183	08/16/95	21.86	25	6153.51	6131.65
MW-183	08/18/95	21.88	25	6153.51	6131.63
MW-183	08/21/95	21.86	25	6153.51	6131.65
MW-183	08/23/95	21.86	25	6153.51	6131.65
MW-183	08/25/95	21.85	25	6153.51	6131.66
MW-183	08/28/95	21.87	25	6153.51	6131.64
MW-183	08/30/95	21.87	25	6153.51	6131.64
MW-183	09/01/95	21.87	25	6153.51	6131.64
MW-183	09/05/95	21.85	25	6153.51	6131.66
MW-183	09/06/95	21.87	25	6153.51	6131.64
MW-183	09/08/95	21.86	25	6153.51	6131.65
MW-183	09/11/95	21.85	25	6153.51	6131.66
MW-183	09/13/95	21.85	25	6153.51	6131.66
MW-183	09/15/95	21.86	25	6153.51	6131.65
MW-183	09/18/95	21.86	25	6153.51	6131.65
MW-183	09/20/95	21.85	25	6153.51	6131.66
MW-183	09/22/95	21.81	25	6153.51	6131.70
MW-183	09/25/95	21.84	25	6153.51	6131.67
MW-183	09/27/95	21.84	25	6153.51	6131.67
MW-183	09/29/95	21.85	25	6153.51	6131.66
MW-183	10/02/95	21.88	25	6153.51	6131.63
MW-183	10/04/95	21.88	25	6153.51	6131.63
MW-183	10/06/95	21.9	25	6153.51	6131.61
MW-183	10/11/95	21.88	25	6153.51	6131.63
MW-183	10/13/95	21.9	25	6153.51	6131.61
MW-183	10/16/95	21.89	25	6153.51	6131.62
MW-183	10/18/95	21.9	25	6153.51	6131.61
MW-183	10/20/95	21.9	25	6153.51	6131.61
MW-183	10/23/95	21.9	25	6153.51	6131.61
MW-183	10/25/95	21.9	25	6153.51	6131.61
MW-183	10/27/95	21.93	25	6153.51	6131.58
MW-183	10/30/95	21.96	25	6153.51	6131.55
MW-183	11/01/95	21.99	25	6153.51	6131.52
MW-183	11/03/95	22	25	6153.51	6131.51
MW-183	11/06/95	22.03	25	6153.51	6131.48

TABLE A-1
HISTORIC WATER LEVELS
SPILL SITE 7 EE/CA - F.E. WARREN AFB

Monitoring Well	Sampling Date	Static Water Level (feet)	Total Well Depth (feet)	Mesuring Point Elevation (feet)	Mean Sea Level Water Level (feet)
MW-183	11/08/95	22.06	25	6153.51	6131.45
MW-183	11/13/95	22.11	25	6153.51	6131.40
MW-183	11/20/95	22.13	25	6153.51	6131.38
MW-183	11/22/95	22.13	25	6153.51	6131.38
MW-183	11/27/95	22.16	25	6153.51	6131.35
MW-183	11/29/95	22.16	25	6153.51	6131.35
MW-183	12/01/95	22.16	25	6153.51	6131.35
MW-183	12/04/95	22.17	25	6153.51	6131.34
MW-183	12/06/95	22.18	25	6153.51	6131.33
MW-183	12/08/95	22.2	25	6153.51	6131.31
MW-183	12/11/95	22.18	25	6153.51	6131.33
MW-183	12/13/95	22.21	25	6153.51	6131.30
MW-183	01/10/96	22.3	25	6153.51	6131.21
MW-183	01/12/96	22.27	25	6153.51	6131.24
MW-183	01/16/96	22.27	25	6153.51	6131.24
MW-183	01/19/96	22.28	25	6153.51	6131.23
MW-183	01/23/96	22.27	25	6153.51	6131.24
MW-183	01/26/96	22.29	25	6153.51	6131.22
MW-183	01/30/96	22.3	25	6153.51	6131.21
MW-183	02/02/96	22.3	25	6153.51	6131.21
MW-183	02/05/96	22.3	25	6153.51	6131.21
MW-183	02/09/96	22.28	25	6153.51	6131.23
MW-183	02/13/96	22.27	25	6153.51	6131.24
MW-183	02/16/96	22.24	25	6153.51	6131.27
MW-183	02/23/96	22.12	25	6153.51	6131.39
MW-183	03/01/96	22.09	25	6153.51	6131.42
MW-183	03/08/96	22.14	25	6153.51	6131.37
MW-183	03/15/96	22.2	25	6153.51	6131.31
MW-183	03/22/96	22.22	25	6153.51	6131.29
MW-183	03/29/96	22.23	25	6153.51	6131.28
MW-183	06/22/98	25.05	25	6153.51	6128.46
MW-183	06/26/98	24.61	25	6153.51	6128.90
MW-183	03/27/01	25.26	25	6153.51	6128.25
MW-183	07/18/01	24.49	25	6153.51	6129.02
MW-183	10/10/01	24.93	25	6153.51	6128.58
MW-183	11/21/01	25.11	25	6153.51	6128.40
MW-184	10/23/92	24.67	37	6153.33	6128.66
MW-184	10/04/94	22.42	37	6153.33	6130.91
MW-184	11/09/94	22.62	37	6153.33	6130.71
MW-184	11/10/94	22.72	37	6153.33	6130.61
MW-184	11/18/94	22.55	37	6153.33	6130.78
MW-184	12/02/94	22.53	37	6153.33	6130.80
MW-184	01/03/95	22.82	37	6153.33	6130.51
MW-184	02/03/95	22.78	37	6153.33	6130.55
MW-184	04/03/95	23.04	37	6153.33	6130.29
MW-184	04/13/95	23.07	37	6153.33	6130.26
MW-184	04/20/95	23.24	37	6153.33	6130.09

TABLE A-1
HISTORIC WATER LEVELS
SPILL SITE 7 EE/CA - F.E. WARREN AFB

Monitoring Well	Sampling Date	Static Water Level (feet)	Total Well Depth (feet)	Mesuring Point Elevation (feet)	Mean Sea Level Water Level (feet)
MW-184	04/21/95	23.19	37	6153.33	6130.14
MW-184	04/24/95	23	37	6153.33	6130.33
MW-184	04/25/95	22.98	37	6153.33	6130.35
MW-184	04/26/95	23.1	37	6153.33	6130.23
MW-184	04/27/95	23.24	37	6153.33	6130.09
MW-184	04/28/95	23.25	37	6153.33	6130.08
MW-184	05/01/95	23.03	37	6153.33	6130.30
MW-184	05/02/95	22.98	37	6153.33	6130.35
MW-184	05/03/95	22.55	37	6153.33	6130.78
MW-184	05/04/95	22.82	37	6153.33	6130.51
MW-184	05/05/95	22.87	37	6153.33	6130.46
MW-184	05/08/95	22.36	37	6153.33	6130.97
MW-184	05/09/95	22.26	37	6153.33	6131.07
MW-184	05/10/95	22.2	37	6153.33	6131.13
MW-184	05/11/95	22.24	37	6153.33	6131.09
MW-184	05/12/95	22.2	37	6153.33	6131.13
MW-184	05/15/95	21.87	37	6153.33	6131.46
MW-184	05/16/95	21.85	37	6153.33	6131.48
MW-184	05/17/95	21.66	37	6153.33	6131.67
MW-184	05/18/95	21.1	37	6153.33	6132.23
MW-184	05/19/95	20.96	37	6153.33	6132.37
MW-184	05/22/95	20.92	37	6153.33	6132.41
MW-184	05/23/95	20.96	37	6153.33	6132.37
MW-184	05/24/95	21.03	37	6153.33	6132.30
MW-184	05/25/95	21.12	37	6153.33	6132.21
MW-184	05/26/95	21.21	37	6153.33	6132.12
MW-184	05/31/95	20.94	37	6153.33	6132.39
MW-184	06/02/95	20.95	37	6153.33	6132.38
MW-184	06/05/95	20.57	37	6153.33	6132.76
MW-184	06/07/95	20.71	37	6153.33	6132.62
MW-184	06/09/95	19.57	37	6153.33	6133.76
MW-184	06/12/95	19.13	37	6153.33	6134.20
MW-184	06/14/95	19.82	37	6153.33	6133.51
MW-184	06/16/95	20.06	37	6153.33	6133.27
MW-184	06/19/95	20.35	37	6153.33	6132.98
MW-184	06/21/95	20.34	37	6153.33	6132.99
MW-184	06/23/95	20.45	37	6153.33	6132.88
MW-184	06/26/95	20.54	37	6153.33	6132.79
MW-184	06/28/95	20.52	37	6153.33	6132.81
MW-184	06/30/95	20.47	37	6153.33	6132.86
MW-184	07/03/95	19.77	37	6153.33	6133.56
MW-184	07/05/95	19.96	37	6153.33	6133.37
MW-184	07/07/95	20.26	37	6153.33	6133.07
MW-184	07/10/95	21.7	37	6153.33	6131.63
MW-184	07/12/95	21.81	37	6153.33	6131.52
MW-184	07/14/95	22.03	37	6153.33	6131.30
MW-184	07/17/95	22.09	37	6153.33	6131.24

TABLE A-1
HISTORIC WATER LEVELS
SPILL SITE 7 EE/CA - F.E. WARREN AFB

Monitoring Well	Sampling Date	Static Water Level (feet)	Total Well Depth (feet)	Mesuring Point Elevation (feet)	Mean Sea Level Water Level (feet)
MW-184	07/19/95	22.8	37	6153.33	6130.53
MW-184	07/21/95	22.85	37	6153.33	6130.48
MW-184	07/24/95	22.69	37	6153.33	6130.64
MW-184	07/26/95	22.93	37	6153.33	6130.40
MW-184	07/28/95	22.44	37	6153.33	6130.89
MW-184	07/31/95	22.33	37	6153.33	6131.00
MW-184	08/02/95	22.89	37	6153.33	6130.44
MW-184	08/04/95	22.98	37	6153.33	6130.35
MW-184	08/07/95	22.83	37	6153.33	6130.50
MW-184	08/09/95	23.01	37	6153.33	6130.32
MW-184	08/11/95	23.03	37	6153.33	6130.30
MW-184	08/14/95	23.04	37	6153.33	6130.29
MW-184	08/16/95	23.04	37	6153.33	6130.29
MW-184	08/18/95	22.93	37	6153.33	6130.40
MW-184	08/21/95	23.07	37	6153.33	6130.26
MW-184	08/23/95	22.93	37	6153.33	6130.40
MW-184	08/25/95	23.05	37	6153.33	6130.28
MW-184	08/28/95	22.72	37	6153.33	6130.61
MW-184	08/30/95	23.09	37	6153.33	6130.24
MW-184	09/01/95	23.13	37	6153.33	6130.20
MW-184	09/05/95	23.13	37	6153.33	6130.20
MW-184	09/06/95	22.65	37	6153.33	6130.68
MW-184	09/08/95	23.02	37	6153.33	6130.31
MW-184	09/11/95	22.98	37	6153.33	6130.35
MW-184	09/13/95	22.88	37	6153.33	6130.45
MW-184	09/15/95	23.03	37	6153.33	6130.30
MW-184	09/18/95	23	37	6153.33	6130.33
MW-184	09/20/95	22.95	37	6153.33	6130.38
MW-184	09/22/95	22.98	37	6153.33	6130.35
MW-184	09/25/95	22.89	37	6153.33	6130.44
MW-184	09/27/95	22.7	37	6153.33	6130.63
MW-184	09/29/95	22.74	37	6153.33	6130.59
MW-184	10/02/95	22.4	37	6153.33	6130.93
MW-184	10/04/95	22.66	37	6153.33	6130.67
MW-184	10/06/95	22.74	37	6153.33	6130.59
MW-184	10/11/95	22.68	37	6153.33	6130.65
MW-184	10/13/95	22.84	37	6153.33	6130.49
MW-184	10/16/95	22.91	37	6153.33	6130.42
MW-184	10/18/95	22.92	37	6153.33	6130.41
MW-184	10/20/95	22.96	37	6153.33	6130.37
MW-184	10/23/95	23.03	37	6153.33	6130.30
MW-184	10/25/95	22.9	37	6153.33	6130.43
MW-184	10/27/95	22.59	37	6153.33	6130.74
MW-184	10/30/95	22.49	37	6153.33	6130.84
MW-184	11/01/95	22.49	37	6153.33	6130.84
MW-184	11/03/95	22.55	37	6153.33	6130.78
MW-184	11/06/95	22.6	37	6153.33	6130.73

TABLE A-1
HISTORIC WATER LEVELS
SPILL SITE 7 EE/CA - F.E. WARREN AFB

Monitoring Well	Sampling Date	Static Water Level (feet)	Total Well Depth (feet)	Mesuring Point Elevation (feet)	Mean Sea Level Water Level (feet)
MW-184	11/08/95	22.65	37	6153.33	6130.68
MW-184	11/13/95	22.78	37	6153.33	6130.55
MW-184	11/20/95	22.9	37	6153.33	6130.43
MW-184	11/22/95	22.91	37	6153.33	6130.42
MW-184	11/27/95	22.98	37	6153.33	6130.35
MW-184	11/29/95	23	37	6153.33	6130.33
MW-184	12/01/95	23	37	6153.33	6130.33
MW-184	12/04/95	23.01	37	6153.33	6130.32
MW-184	12/06/95	23.04	37	6153.33	6130.29
MW-184	12/08/95	23.07	37	6153.33	6130.26
MW-184	12/11/95	23.01	37	6153.33	6130.32
MW-184	12/13/95	23.06	37	6153.33	6130.27
MW-184	01/10/96	23.01	37	6153.33	6130.32
MW-184	01/12/96	23.02	37	6153.33	6130.31
MW-184	01/16/96	23.03	37	6153.33	6130.30
MW-184	01/19/96	23.07	37	6153.33	6130.26
MW-184	01/23/96	23.02	37	6153.33	6130.31
MW-184	01/26/96	22.96	37	6153.33	6130.37
MW-184	01/30/96	22.94	37	6153.33	6130.39
MW-184	02/02/96	22.91	37	6153.33	6130.42
MW-184	02/05/96	22.93	37	6153.33	6130.40
MW-184	02/09/96	22.88	37	6153.33	6130.45
MW-184	02/13/96	22.93	37	6153.33	6130.40
MW-184	02/16/96	23.15	37	6153.33	6130.18
MW-184	02/23/96	23.15	37	6153.33	6130.18
MW-184	03/01/96	23.1	37	6153.33	6130.23
MW-184	03/08/96	23.07	37	6153.33	6130.26
MW-184	03/15/96	22.93	37	6153.33	6130.40
MW-184	03/22/96	23.16	37	6153.33	6130.17
MW-184	03/29/96	22.9	37	6153.33	6130.43
MW-184	06/22/98	26.15	37	6153.33	6127.18
MW-184	06/25/98	26.2	37	6153.33	6127.13
MW-184	03/27/01	25.06	37	6153.33	6128.27
MW-184	07/18/01	23.97	37	6153.33	6129.36
MW-184	10/10/01	24.55	37	6153.33	6128.78
MW-184	11/21/01	24.81	37	6153.33	6128.52

APPENDIX B

SITE-SPECIFIC SSL CALCULATIONS

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LIST OF ACRONYMS AND ABBREVIATIONS

C_s	sorbed concentration
C_w	target soil leachate (or water concentration)
DAF	dilution attenuation factor
EE/CA	Engineering Estimate/Cost Analysis
EPA	U.S. Environmental Protection Agency
f_{oc}	fraction organic carbon
g/cc	grams per cubic centimeter
K	hydraulic conductivity
K_d	soil-water partition coefficient
K_{oc}	soil organic carbon-water partition coefficient
L/kg	liters per kilogram
m/m	meters per meter
m/yr	meters per year
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
RBC	risk-based concentration
SSL	soil screening level
TCE	trichloroethene

1.0 QUANTITATIVE EVALUATION OF CONTAMINANT ATTENUATION

U.S. Environmental Protection Agency (EPA) Soil Screening Levels (SSLs) were developed to estimate the pathway of migration to groundwater. SSLs are risk-based concentrations (RBCs) derived from equations combining exposure information assumptions with EPA toxicity data (EPA 1996b). To calculate SSLs for the migration-to-groundwater pathway, a target soil leachate concentration (C_w) is first obtained by multiplying the acceptable groundwater concentration for a constituent by a dilution attenuation factor (DAF) to account for the reduction in concentration due to dilution in the aquifer. The EPA guidance defines two exposure pathways for subsurface soils: inhalation of volatiles, and ingestion of groundwater contaminated by the migration of contaminants through soil to an underlying potable aquifer (1996). This section addresses the contamination of groundwater through the migration of contaminants in the unsaturated subsurface soil.

For this evaluation, soil concentrations were first screened against the Region III SSLs (EPA 2001a). Concentrations exceeding these initial screening levels were compared to SSLs calculated using site-specific data. For the Region III SSLs, the target soil leachate concentration was simply the Region III tap water RBC multiplied by a DAF equal to 20. Because of the conservative nature of the Region III SSLs, they are used as a screening tool to eliminate constituents as a contaminant source migrating to groundwater at F.E. Warren Air Force Base. These screening SSLs are conservative because of the underlying assumptions regarding 1) the absence of attenuation (other than partitioning due to the presence of organic matter), and 2) the placement of the well adjacent to the source. Also, the use of the soil/water equation to calculate SSLs assumes an infinite source of constituents extending to the top of the aquifer.

Site-specific SSLs have been developed for Spill Site 7 (Tables B1-1 through B1-2). The DAF and SSL values were recalculated to evaluate the unsaturated soils and the potential risk of leachate reaching and contaminating the groundwater. In the site-specific SSLs, the target soil leachate concentration calculation, the EPA Current Drinking Water Standards Maximum Contaminant Levels (MCLs) were multiplied by the DAF (EPA 2001b).

The SSL partitioning equation for migration of constituents to groundwater is:

$$SSL = C_w \times \left[K_d + \left(\frac{\theta_w + \theta_a H'}{\rho_b} \right) \right]$$

where:

SSL = migration-to-groundwater soil screening level (milligram per kilogram [mg/kg])

C_w = target soil leachate concentration (milligram per liter [mg/L]) [MCL or tap water RBC if the MCL does not exist for the contaminant] multiplied by the DAF

K_d = soil-water partition coefficient (liter per kilogram [L/kg])

θ_w = water-filled soil porosity (default = 0.3 L_{water}/L_{soil})

θ_a = air-filled soil porosity (calculated from porosity = 0.095 L_{air}/L_{soil})

ρ_b = bulk soil density (1.33 grams per cubic centimeter [g/cc])

H′ = dimensionless Henry's Law Constant (unitless; chemical specific)

where:

$$\theta_a = n - \theta_w$$

n = porosity

and

$$n = 1 - \frac{\rho_b}{\rho_s}$$

where:

ρ_s = particle density (value for clay soils = 2.2 g/cc) (Tindall and Kunkell 1999)

The default values used for water-filled porosity are taken from the EPA's *Soil Screening Guidance: User's Guide* (1996). Air-filled soil porosity is calculated by porosity minus the default value for water-filled soil porosity (θ_w = 0.3) presented in the EPA *User's Guide* (1996). Porosity is determined from the ratio of bulk soil density and the particle density of clay soils. Bulk soil density was obtained from native soil samples taken during the Zone C Landfill 3

Remedial Investigation (United States Air Force 2000). The samples were taken from approximately 30 feet below ground surface and represent native conditions. This value (ρ_b = 1.33 g/cc) is lower than the default presented in the EPA guidance (ρ_b = 1.5 g/cc); the value is consequently closer to a soil density for clay.

1.1 DILUTION FACTOR MODEL

As contaminants migrate through the soil and groundwater, the concentration is reduced by attenuation and dilution. The reduction in groundwater concentration is attributed to dilution by the aquifer. This reduction in concentration can be expressed by a DAF, which is defined as the ratio of soil leachate concentration to the receptor point concentration. The lowest DAF is 1, where there is no dilution or attenuation of a contaminant. The higher the DAF, the greater the degree of dilution and attenuation of the constituent from the leachate to the receptor. Higher DAF values represent a large reduction in the contaminant concentration. A default DAF of 20 is suggested by the EPA (1996) to represent contaminated soils up to 0.5 acre in size. The DAF equation considers infiltration rate (or recharge), hydraulic conductivity, source length, and mixing zone depth. These are calculated using site-specific data values from each particular source area.

The DAF equation is:

$$DAF = 1 + \frac{Kid}{IL}$$

where:

K = hydraulic conductivity (meters per year [m/yr])

i = hydraulic gradient (meter per meter [m/m])

D = mixing zone depth (assumed to be 5 meters)

I = infiltration rate (0.034 m/yr)

L = source length parallel to flow (assumed to be 27 meters for Spill Site 7)

The mixing zone depth is approximately 15 feet below the water table interface. The larger the mixing zone depth, the larger the calculated DAF and SSL. The source length parallel to flow for Spill Site 7 is assumed to be 90 feet. The source length defined for Spill Site 7 defines a size less than half an acre, which is the assumption in the EPA *User's Guide* (1996). Inferences about the size of the source area were assumed using the groundwater isocontours for trichloroethene (TCE) initially. The source area was refined using the soil gas results at depth. The larger the source length parallel to flow, the smaller the calculated DAF and SSL.

1.2 SENSITIVITY DISCUSSION

The infiltration rate and the soil-water partition coefficient (K_d) value are highly sensitive variables in the SSL calculations. The effect of changes in the infiltration rate on the SSL equation is linear; if the infiltration rate is doubled, twice as much water reaches the water table. Conversely, if the infiltration rate is reduced, the travel time through the unsaturated zone is slower and the attenuation processes have more time to operate. The Oil Inspection Section of the Colorado Department of Labor and Employment suggests using 10 percent of the average annual precipitation as the infiltration rate (1999). The average annual precipitation at the Cheyenne Municipal Airport was 13.29 inches from 1951 through 1980. Therefore the infiltration would be 1.33 inches per year. This is a conservative number because of the high evaporation rate and the semi-arid climate in Wyoming. The infiltration rate was assumed to be the same for the entire base. K_d values are a direct relationship of the soil organic carbon-water partition coefficient (K_{oc}) and the fraction of organic carbon (f_{oc}). The K_{oc} values used are from the EPA *User's Guide* (1996, Table C-1) because it contains a relatively complete list of contaminants. K_d values for inorganic compounds are listed in Table C-4 (EPA, 1996a) with an average pH equal to 8 for the soils at FEW (Environmental Restoration Management Sampling Program, 2001). . When K_{oc} or K_d values were not listed in the the EPA User's Guide, values were obtained from the Risk Assessment Information System website (Risk Assessment Information System 2002).

The MCL or tap water RBC value as well as the hydraulic conductivity (K) value chosen for each plume also affect the SSL calculation. In the case of manganese, the MCL and RBC are

fairly close. The K values were chosen from slug test data that match the intervals where the groundwater contamination is highest.

Only unsaturated soil results for Spill Site 7 were considered for the SSL screen. The unsaturated zone thickness varies between plumes. Water table elevations across the base have been known to fluctuate by approximately 4 feet in the last 10 years

.

2.0 QUANTITATIVE EVALUATION OF SATURATED SOIL SORPTION

The K_d method relates the concentration of a constituent in groundwater to the concentration of the same constituent in soil (EPA, 1996a). The method assumes that the constituent concentration in soil is due solely to the contact of the soil with contaminated water. Therefore the soil concentration depends on the adsorption of the constituent from the water. The relation is:

$$C_s = K_d C_w$$

where:

C_s = sorbed concentration (mg/kg)

K_d = soil-water partition coefficient (L/kg)

C_w = groundwater concentration (mg/L)

The K_d relation assumes that the sorbed soil concentration (C_s) and water concentration (C_w) are from samples in direct contact (EPA 1996a, equation 11). For this reason, only saturated soils are evaluated. If a given soil result is greater than 10 times the predicted C_s value, the soil concentration is considered a possible source. Conversely, if the soil result is less than 10 times the predicted C_s, the soil concentration is considered insignificant in relation to groundwater.

Both inorganic and organic analytes were evaluated using this method. To demonstrate the sensitivity of the K_d method in relation to inorganic analytes; the background inorganic subsurface soil values were compared with the background inorganic groundwater values. Aluminum, arsenic, barium, chromium, iron, magnesium, manganese, and selenium background values all were large enough to be considered "sources" for the equivalent background groundwater value. Considering the outcome, less emphasis was placed on the inorganic detections in relation to the K_d method as an evaluation of a potential source. Furthermore, after evaluating several of the patterns of these inorganic constituents, it was concluded that inorganic detections are related to naturally occurring processes in soils rather than contamination. Organic constituents with relation to the K_d method are only considered in the EE/CA.

In general, Spill Site 7 exhibits behavior indicating that soils are not contributing to groundwater (Table B2-1). Spill Site 7 exhibits groundwater contamination that has remained steady over a significant amount of time, indicating a source is present in the soils, but none was encountered during this investigation. A localized amount of TCE in saturated soils can have a lasting impact on the groundwater.

3.0 BIODEGRADATION IN GROUNDWATER

An evaluation of the reductive dechlorination screening protocol was performed for one well in each source area. The proportion of cis-1,2-dichloroethene to TCE in soils suggested that biodegradation was occurring. The environmental chemistry and the oxidation-reduction potential of a site play an important role in determining whether reductive dechlorination will occur. BIOCHLOR (EPA 2000) is used to model the degradation of chlorinated solvents. The natural attenuation screening protocol assigns a score to an area depending on the geochemical factor. Reductive dechlorination was evaluated in the source areas in the well that had the highest contamination. Table B3-1 shows the results for Spill Site 7.

The screening indicated that Spill Site 7 has limited evidence for anaerobic biodegradation of chlorinated organics (score between 5 and 10). Since this evaluation was only implemented for one well in each source area, it represents an oversimplified view of the groundwater in the source areas. A more thorough view of biodegradation in groundwater is warranted for the source area. This exercise was implemented to evaluate the potential for groundwater and soil interaction.

4.0 REFERENCES

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TABLE B1-1
SUMMARY OF SPILL SITE 7 RECALCULATED SSLs IN UNSATURATED SOILS
SPILL SITE 7 - F.E. WARREN AFB

	H'	K_d (L/kg)	US EPA Region III SSL: DAF = 1	US EPA Region III SSL: DAF = 20	Recalc[1] DAF	SSL[1] (mg/kg)	Surface Soil Background UCL Values (mg/kg)	Surface Soil Background Range (mg/kg)	Subsurface Soil Background UCL Value (mg/kg)	Subsurface Soil Background Range (mg/kg)	RBC - Industrial (mg/kg)	Range of Values Detected in Unsaturated Soils (mg/kg)
*TCE	0.422	0.166	0.00077	0.015	19.30	0.040686894	--	--	--	--	520	0.00097 - 40.4
*c-DCE	0.167	0.0355	0.017	0.35		0.368742066	--	--	--	--	20000	0.00086 - 0.554
Chloroform	0.15	0.0398	0.000045	0.00089		0.4876	--	--	--	--	940	0.00133
1,1,2-Trichloroethane	0.0374	0.0501	0.000039	0.00078		0.027	--	--	--	--	100	0.000633 - 0.00433
Arsenic		31	0.0013	0.026		30.127	1.7	0.93 - 3.2	2.7	0.38 - 7.2	3.8	0.539 - 7.01
*Chromium		14	2.1	42		27.450	8.1	2.4 - 12.17	9.1	1.0 - 14.5	6100	5.6 - 49

[1] bulk soil density = 1.33 g/cc and the source area is defined as 90' long by 30' aquifer thickness and a mixing zone depth of 15'.

ND = not detected

Calculation assumes:
1) a K value of 221 m/yr which is the average K of 8 wells (MW-069, MW-150, MW-151, MW-171B, MW-190, MW-703, MW-703A, and MW-703B) at 22 to 57 feet bgs at approximately 25 feet bgs.
2) a f_{oc} (fraction organic carbon) value of 0.1%, half the reporting limit of TOC (total organic carbon) analysis.
3) an infiltration rate of 0.034 m/yr, which is 10% of the average annual precipitation rate.
4) a water-filled porosity of 0.3 and an air-filled porosity of 0.095.

U.S EPA maximum contaminant level for primary and secondary drinking water regulations (2001b) are used for TCE, cis-DCE, total trihalomethanes (chloroform), 1,1,2-TCA, arsenic, and total chromium.

Unsaturated soils exist to approximately 16 feet below ground surface.

*Still exceeds the recalculated SSLs.

Notes:
mg/kg = milligrams per kilogram
H' = Henry's Law coefficient (unitless)
Kd = soil water partition coefficient
L/kg = liters per kilogram
DAF = dilution attenuation factor
SSL = soil screening level
Background values equal to the 95% upper confidence limit established for FEW (USAF 1999b)
Industrial soil RBC (EPA 2001a).
m/yr = meters per year
K = hydraulic conductivity
-- = no published value
g/cc = grams per cubic centimeter
TCE = trichloroethene
DCE = dichloroethene
TCA = trichloroethane

TABLE B1-2
ANALYTE-SPECIFIC SSL CALCULATION FOR SPILL SITE 7
SPILL SITE 7 - F.E. WARREN AFB

SS7 - average K of 8 wells at 22 to 57 feet bgs.

Dilution Attenuation Factor:

DAF (unitless) = 1 + Kid/IL

SSL:

SSL (mg/kg) = (C_w/1000 * DAF) * [K_d + ((q_w + q_a * H')/P_b)]

Input Parameter	Units	TCE	cis-1,2-DCE	Chloroform	1,1,2-TCA	Arsenic	Total Chromium
SSL ----->		**0.0407**	**0.3687**	**0.4876**	**0.0269**	**30.1269**	**27.4501**
DAF ----->		**19.3**	**19.3**	**19.3**	**19.3**	**19.3**	**19.3**
K_{oc} (organic carbon partition coefficient)	L/kg	166	35.5	39.8	50.1		
f_{oc} (organic carbon fraction)	mg/mg	0.001	0.001	0.002	0.001	0.001	0.001
K_d (soil-water part. coefficient = K_{oc} * f_{oc})	L/kg	0.166	0.0355	0.0796	0.0501	31	14
q_w (water-filled porosity)	L water/L soil	0.3	0.3	0.3	0.3	0.3	0.3
q_a (air-filled porosity)	L air/L soil	0.095	0.095	0.095	0.095	0.095	0.095
H' (Henry's Law Constant)	---	0.422	0.167	0.15	0.0374		
P_b (soil bulk density)	kg/L	1.33	1.33	1.33	1.33	1.33	1.33
K (hydraulic Conductivity)	m/yr	221	221	221	221	221	221
i (hydraulic gradient)	m/m	0.0152	0.0152	0.0152	0.0152	0.0152	0.0152
I (infiltration rate)	m/yr	0.034	0.034	0.034	0.034	0.034	0.034
L (source length parallel to flow)	m	27	27	27	27	27	27
d_a (aquifer thickness)	m	10	10	10	10	10	10
d (mixing zone depth)	m	5	5	5	5	5	5
C_W (MCL)	µg/L	5	70	80	5	50	100

Notes:

MCL = maximum contaminant level, Current Drinking Water Standards (EPA 2001b).

L = liter

kg = kilogram

mg = milligram

yr = year

m = meter

µg = microgram

TCE = trichloroethene

DCE = dichloroethene

TCA = trichloroethane

TABLE B2-1
K_d Method
SPILL SITE 7 - F.E. WARREN AFB

Sample Location	Soil Sample Beginning Depth (feet)	Soil Sample Ending Depth (feet)	Concentration in Soil (mg/kg)	Maximum Concentration in Groundwater[a] (µg/L)	f_{oc} (mg/mg)	K_{oc} (L/kg)	K_d (L/kg)	MCL (µg/L)	Predicted Soil Concentration[b] (µg/kg)	Predicted Soil Concentration[b] (mg/kg)	Measured Soil Concentration> Predicted[c]	Measured Soil Concentration> MCL value	Measured Soil Concentration> 10 Times Predicted[c]	Measured Soil Concentration> 10 Times MCL value
Organic Analytes:														
TCE														
SS7MW35				540	0.001	166	0.166	5	89.64	0.08964				
MW-190				4400	0.001	166	0.166	5	730.4	0.7304				
MW-151				13170	0.001	166	0.166	5	2186.22	2.18622				
MCL concentration				5	0.001	166	0.166	5	0.83	0.00083				
SS7SB02C	15.5	16.5	0.0762								No	Yes	No	Yes
SS7SB06C	24	26	0.107								No	Yes	No	Yes
SS7SB16B	17	18	0.00329								No	Yes	No	No
SS7SB17B	20	21.5	0.0319								No	Yes	No	Yes
SS7SB18B	19	21	0.142								No	Yes	No	Yes
SS7SB18C	23	24	1.77								Yes	Yes	No	Yes
SS7SB26C	21	23	0.0138								No	Yes	No	Yes
SS7SB33B	15.5	16	0.00561								No	Yes	No	No
SS7SB34B	17	18	0.0395								No	Yes	No	Yes
SS7SB36C	18.5	19.5	0.0213								No	Yes	No	Yes
SS7SB39C	16	17	0.00142								No	Yes	No	No
***cis*-1,2-DCE**														
MW-182				64	0.001	35.5	0.0355	70	2.272	0.002272				
SS7MW06				190	0.001	35.5	0.0355	70	6.745	0.006745				
MW-151				282	0.001	35.5	0.0355	70	10.011	0.010011				
MCL concentration				70	0.001	35.5	0.0355	70	2.485	0.002485				
SS7SB01A	16	17	0.544								Yes	Yes	Yes	Yes
SS7SB01B	20	22	0.00161								No	No	No	No
SS7SB02C	15.5	16.5	0.00326								No	Yes	No	No
SS7SB06C	24	26	0.0115								Yes	Yes	No	No
SS7SB17B	20	21.5	0.00165								No	No	No	No
SS7SB18B	19	21	0.00184								No	No	No	No
SS7SB18C	23	24	0.0205								Yes	Yes	No	No
SS7SB33B	15.5	16	0.0125								Yes	Yes	No	No
SS7SB34B	17	18	0.00814								Yes	Yes	No	No
SS7SB39C	16	17	0.000691								No	No	No	No
1,1,2-Trichloroethane														
MW-151				5.46	0.001	50.1	0.0501	5	0.273546	0.000273546				
SS7MW06				1.5	0.001	50.1	0.0501	5	0.07515	0.00007515				
MCL concentration				5	0.001	50.1	0.0501	5	0.2505	0.0002505				
SS7SB34B	17	18	0.00095								Yes	Yes	No	No

Notes:

a. Maximum measured groundwater concentration for site.

b. Based on: $C_s = K_d C_w$ (EPA 1996, equation 11)

where:

C_s = sorbed concentration, mg/kg

K_d = soil/water partition coefficient

C_w = groundwater concentration, mg/L

K_{oc} = organic carbon partition coefficient

f_{oc} = fraction of organic carbon in soil based on one-half detection limit for TOC.

kg = kilogram

L = liter

mg = milligram

µg = microgram

c. If the measured concentration is greater than predicted, a source may be indicated. Comparison to 10 times the predicted value provides greater confidence that there may be a soil source.

MCL = maximum contaminant level (EPA, 2001)

Compared soil samples to the representative number in the outlined box.

TABLE B3-1

SPILL SITE 7 - F.E. WARREN AIR FORCE BASE

Natural Attenuation Screening Protocol	Interpretation	Score
The following is taken from the USEPA protocol (USEPA, 1998). The results of this scoring process have no regulatory significance.	Inadequate evidence for anaerobic biodegradation* of chlorinated organic	0 to 5
	Limited evidence for anaerobic biodegradation* of chlorinated organics	6 to 14
	Adequate evidence for anaerobic biodegradation* of chlorinated organics	15 to 20
	Strong evidence for anaerobic biodegradation* of chlorinated organics	>20
	* reductive dechlorination	

Score: 8

Scroll to End of Tab

Analysis	Concentration in Most Contam. Zone	Interpretation	Yes	No	Points Awarded
Oxygen*	<0.5 mg/L	Tolerated, suppresses the reductive pathway at higher concentrations	◆	●	0
	>5mg/L	Not tolerated; however, VC may be oxidized aerobically	●	◆	-3
Nitrate*	<1 mg/L	At higher concentrations may compete with reductive pathway	◆	●	0
Iron II*	>1 mg/L	Reductive pathway possible; VC may be oxidized under Fe(III)-reducing conditions	◆	●	0
Sulfate*	<20 mg/L	At higher concentrations may compete with reductive pathway	◆	●	0
Sulfide*	>1 mg/L	Reductive pathway possible	◆	●	0
Methane*	<0.5 mg/L	VC oxidizes	◆	●	0
	>0.5 mg/L	Ultimate reductive daughter product, VC Accumulates	●	◆	3
Oxidation Reduction Potential* (ORP)	<50 millivolts (mV)	Reductive pathway possible	◆	●	0
	<-100mV	Reductive pathway likely	◆	●	0
pH*	5 < pH < 9	Optimal range for reductive pathway	●	◆	0
	5 > pH >9	Outside optimal range for reductive pathway	◆	●	0
TOC	>20 mg/L	Carbon and energy source; drives dechlorination; can be natural or anthropogenic	◆	●	0
Temperature*	>20°C	At T >20°C biochemical process is accelerated	◆	●	0
Carbon Dioxide	>2x background	Ultimate oxidative daughter product	●	◆	1
Alkalinity	>2x background	Results from interaction of carbon dioxide with aquifer minerals	◆	●	0
Chloride*	>2x background	Daughter product of organic chlorine	◆	●	0
Hydrogen	>1 nM	Reductive pathway possible, VC may accumulate	◆	◆	0
	<1 nM	VC oxidized	◆	◆	0
Volatile Fatty Acid	>0.1 mg/L	Intermediates resulting from biodegradation of aromatic compounds; carbon and energy source	◆	◆	0
BTEX*	>0.1 mg/L	Carbon and energy source; drives dechlorination	◆	●	0
PCE*		Material released	◆	●	0
TCE*		Material released	●	◆	0
		Daughter product of PCE [a/]	◆	●	0
DCE*		Material released	◆	●	0
		Daughter product of TCE. If cis is greater than 80% of total DCE it is likely a daughter product of TCE[a/]; 1,1-DCE can be a chem. reaction product of TCA	●	◆	2
VC*		Material released	◆	●	0
		Daughter product of DCE[a/]	◆	●	0
1,1,1-Trichloroethane*		Material released	◆	●	0
DCA		Daughter product of TCA under reducing conditions	◆	●	0
Carbon Tetrachloride		Material released	◆	●	0
Chloroethane*		Daughter product of DCA or VC under reducing conditions	◆	●	0
Ethene/Ethane	>0.01 mg/L	Daughter product of VC/ethene	●	◆	2
	>0.1 mg/L	Daughter product of VC/ethene	●	◆	3
Chloroform		Material released	◆	●	0
		Daughter product of Carbon Tetrachloride	◆	●	0
Dichloromethane		Material released	◆	●	0
		Daughter product of Chloroform	◆	●	0

* required analysis.

a/ Points awarded only if it can be shown that the compound is a daughter product (i.e., not a constituent of the source NAPL).

SCORE

Reset

End of Form

APPENDIX C

COST ESTIMATE ALTERNATIVE I

Phase Technology Cost Detail Report
(without Markups)

Folder: FE Warren

Installation

Name: Spill Site 7 EE/CA (Final)
ID: Spill Site 7 EE/CA (Final)
Location: FE WARREN AFB (CHEYENNE), WYOMING
Modifiers:

Material	1.0619	(Modified)
Labor	0.8413	(Modified)
Equipment	0.9676	(Modified)

Category: None
Report Option: Calendar Year
Description: Final EE/CA for interim action at Spill Site 7, F.E. Warren AFB, Cheyenne, Wyoming.

Project

Name: RA1A - Excavation and Removal LF
ID: RA1A - Excavation and Removal LF
Type: None
Description: Excavation and removal of the Spill Site 7 vadose zone soils.

Phase

Name: RA - Excavation and Removal LF
Type: Remedial Action
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate
Approach: Ex Situ
Media/Waste Type: Soil
Secondary Media/Waste Type: N/A
Contaminant: Volatile Organic Compounds (VOCs)
Secondary Contaminant: Metals
Markup Template: System Defaults

Cost Database Date: 2002
Cost Type: User-Defined
Print Date: 9/17/2002 2:02:05 PM

Phase Technology Cost Detail Report
(without Markups)

Start Date: 8/1/2002 **O&M Markup Template:** N/A

Description: Excavation and removal of material to off-site landfill.

Phase Technology Cost Detail Report
(without Markups)

Technology: Excavation

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
17030276	1 CY, Crawler-mounted, Hydraulic Excavator	22.22	CY	0.00	1.43	2.13	$79.17	☐
17030415	Backfill with Excavated Material	34.76	CY	0.32	2.27	0.76	$116.36	☐
17030418	Delivered & Dumped, Backfill with Stone	11.11	BCY	24.79	0.51	0.74	$289.28	☐
33020401	Disposable Materials per Sample	2.00	EA	8.15	0.00	0.00	$16.29	☐
33021102	Soil Moisture Content ASTM D2216	2.00	EA	23.89	0.00	0.00	$47.79	☐
33021709	TAL Metals (EPA 6010/7000s), Soil Analysis	2.00	EA	324.75	0.00	0.00	$649.50	☐
33170803	Decontaminate Heavy Equipment	1.00	EA	0.00	260.12	0.00	$260.12	☐
				Total Element Cost			**$1,458.50**	
				Total Technology Cost			**$1,458.50**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Off-site Transportation and Waste Disposal

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33190102	Bulk Solid Hazardous Waste Loading Into Truck	2,432.00	CY	0.00	0.61	1.30	$4,632.23	☐
33190205	Transport Bulk Solid Hazardous Waste, Maximum 20 CY (per Mile)	17,080.00	MI	1.61	0.00	0.00	$27,568.83	☐
33190311	Truck Washout/Decontamination	122.00	EA	159.29	0.00	0.00	$19,432.77	☐
33197264	Landfill Hazardous Solid Bulk Waste by CY	2,432.00	CY	100.00	0.00	0.00	$243,200.00	☑
				Total Element Cost			**$294,833.83**	
				Total Technology Cost			**$294,833.83**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Decontamination Facilities

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33170818	1,800 PSI Pressure Washer Rental	1.00	MO	1,115.00	0.00	0.00	$1,115.00	☐
33170823	Operation of Pressure Washer, Including Water, Soap, Electricity, Labor	30.00	HR	6.64	30.59	0.00	$1,116.71	☐
				Total Element Cost			**$2,231.71**	
				Total Technology Cost			**$2,231.71**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Professional Labor Management

Element: Professional Labor Percentage

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33220138	Project Management Labor Cost	1.00	LS	0.00	18,407.83	0.00	$18,407.83	☑
33220139	Planning Documents Labor Cost	1.00	LS	0.00	18,407.83	0.00	$18,407.83	☑
33220140	Construction Oversight Labor Cost	1.00	LS	0.00	20,248.61	0.00	$20,248.61	☑
33220141	Reporting Labor Cost	1.00	LS	0.00	2,577.10	0.00	$2,577.10	☑
33220142	As-Built Drawings Labor Cost	1.00	LS	0.00	2,577.10	0.00	$2,577.10	☑
33220143	Public Notice Labor Cost	1.00	LS	0.00	552.23	0.00	$552.23	☑
33220144	Site Closure Activities Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
33220145	Permitting Labor Cost	1.00	LS	0.00	36,815.65	0.00	$36,815.65	☑
33220146	Responsible Party Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
33220147	Reimbursement Claims Preparation Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
33220148	Other Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
				Total Element Cost			**$99,586.34**	
				Total Technology Cost			**$99,586.34**	

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 9/17/2002 2:02:05 PM

Phase Technology Cost Detail Report
(without Markups)

Technology: Excavation

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
17030278	3 CY, Crawler-mounted, Hydraulic Excavator	10,625.00	CY	0.00	0.78	1.17	$20,701.75	☐
17030418	Delivered & Dumped, Backfill with Stone	447.22	BCY	24.79	0.51	0.74	$11,644.62	☐
17030423	Unclassified Fill, 6" Lifts, Off-Site, Includes Delivery, Spreading, and Compaction	13,291.25	CY	5.74	0.95	1.96	$114,985.26	☐
33020401	Disposable Materials per Sample	100.00	EA	8.15	0.00	0.00	$814.55	☐
33021720	Volatile Organic Analysis (SW 5035/SW 8260B), Soil Analysis	100.00	EA	205.54	0.00	0.00	$20,553.51	☐
33080584	Plastic Laminate Waste Pile Cover	99,046.40	SF	0.12	0.02	0.00	$13,252.41	☐
33170803	Decontaminate Heavy Equipment	1.00	EA	0.00	260.12	0.00	$260.12	☐
				Total Element Cost			**$182,212.23**	
				Total Technology Cost			**$182,212.23**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Load and Haul

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
17020401	Dump Charges	9,200.00	CY	10.00	0.00	0.00	$92,000.00	☑
17030224	966, 4.0 CY, Wheel Loader	47.00	HR	0.00	25.07	58.64	$3,934.24	☐
17030288	26 CY, Semi Dump	1,215.00	HR	0.00	21.03	59.86	$98,279.77	☐
				Total Element Cost			**$194,214.01**	
				Total Technology Cost			**$194,214.01**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Special Well Drilling & Installation

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010101	Mobilize/DeMobilize Drilling Rig & Crew	1.00	LS	0.00	657.45	1,928.39	$2,585.83	☐
33020401	Disposable Materials per Sample	10.00	EA	8.15	0.00	0.00	$81.46	☐
33020601	Drilling 2.5" Diameter Soil Borings, No Sampling	75.00	LF	7.77	3.23	5.15	$1,210.59	☐
33021720	Volatile Organic Analysis (SW 5035/SW 8260B), Soil Analysis	10.00	EA	205.54	0.00	0.00	$2,055.35	☐
33170808	Decontaminate Rig, Augers, Screen (Rental Equipment)	2.00	DAY	110.54	0.00	0.00	$221.09	☐
33231172	Split Spoon Sample, 2" x 24", During Drilling	15.00	EA	41.02	0.00	0.00	$615.24	☐
33231178	Move Rig/Equipment Around Site	4.00	EA	55.94	94.51	277.21	$1,710.62	☐
33231182	Furnish 55 Gallon Drum for Drill Cuttings & Development Water	1.00	EA	76.99	0.00	0.00	$76.99	☐
				Total Element Cost			**$8,557.17**	
				Total Technology Cost			**$8,557.17**	

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 9/17/2002 2:02:05 PM

Phase Technology Cost Detail Report
(without Markups)

Technology: Groundwater Monitoring Well

Element: Aquifer 1

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33020303	Organic Vapor Analyzer Rental, per Day	4.00	DAY	114.91	0.00	0.00	$459.65	☐
33020307	Soil Gas Investigation & Analysis	8.00	DAY	103.40	0.00	0.00	$827.22	☐
33020308	Soil Gas Probes	10.00	EA	2,557.10	0.00	0.00	$25,570.98	☐
33021720	Volatile Organic Analysis (SW 5035/SW 8260B), Soil Analysis	20.00	EA	205.54	0.00	0.00	$4,110.70	☐
33021834	Volatile Organic Compounds (TO-14)	40.00	DAY	109.42	0.00	0.00	$4,376.80	☐
33170808	Decontaminate Rig, Augers, Screen (Rental Equipment)	4.00	DAY	110.54	0.00	0.00	$442.18	☐
33220112	Field Technician	64.00	HR	0.00	15.81	0.00	$1,011.86	☐
33230101	2" PVC, Schedule 40, Well Casing	150.00	LF	1.13	2.19	6.43	$1,462.40	☐
33230201	2" PVC, Schedule 40, Well Screen	100.00	LF	2.61	2.83	8.29	$1,372.73	☐
33230301	2" PVC, Well Plug	10.00	EA	5.49	3.29	9.64	$184.24	☐
33231101	Hollow Stem Auger, 8" Dia Borehole, Depth <= 100 ft	260.00	LF	0.00	6.01	17.63	$6,145.49	☐
33231173	Split Spoon Sampling	60.00	LF	0.00	9.39	27.55	$2,216.43	☐
33231182	Furnish 55 Gallon Drum for Drill Cuttings & Development Water	14.00	EA	76.99	0.00	0.00	$1,077.83	☐

Phase Technology Cost Detail Report
(without Markups)

Element: Aquifer 1

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33231401	2" Screen, Filter Pack	120.00	LF	2.93	1.86	5.46	$1,231.00	☐
33231811	2" Well, Portland Cement Grout	120.00	LF	1.09	0.00	0.00	$131.02	☐
33232101	2" Well, Bentonite Seal	10.00	EA	8.71	7.40	21.69	$378.04	☐
				Total Element Cost			**$50,998.55**	

Element: General Aquifers

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010101	Mobilize/DeMobilize Drilling Rig & Crew	1.00	LS	0.00	657.45	1,928.39	$2,585.83	☐
33231504	Surface Pad, Concrete, 2' x 2' x 4"	10.00	EA	38.18	68.31	4.32	$1,108.06	☐
33232301	5' Guard Posts, Cast Iron, Concrete Fill	40.00	EA	24.27	29.30	0.05	$2,144.67	☐
				Total Element Cost			**$5,838.56**	
				Total Technology Cost			**$56,837.11**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Monitoring (12 - months only)

Element: Surface Soil

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33020603	Surface Soil Sampling Equipment	1.00	EA	395.03	0.00	0.00	$395.03	☐
33021102	Soil Moisture Content ASTM D2216	3.00	EA	23.89	0.00	0.00	$71.68	☐
33021709	TAL Metals (EPA 6010/7000s), Soil Analysis	3.00	EA	324.75	0.00	0.00	$974.25	☐
				Total Element Cost			**$1,440.95**	

Element: Soil Gas

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33020306	Monitoring Gas Vents	40.00	EA	0.00	8.72	0.00	$348.83	☐
33021837	Army Suites - Air - 3 Suites	44.00	EA	896.60	0.00	0.00	$39,450.61	☐
				Total Element Cost			**$39,799.44**	

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010104	Car or Van Mileage Charge	200.00	MI	0.36	0.00	0.00	$71.74	☐

Phase Technology Cost Detail Report
(without Markups)

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33220102	Project Manager	4.00	HR	0.00	39.36	0.00	$157.43	☐
33220105	Project Engineer	30.00	HR	0.00	29.14	0.00	$874.13	☐
33220108	Project Scientist	193.00	HR	0.00	23.69	0.00	$4,572.13	☐
33220109	Staff Scientist	80.00	HR	0.00	22.61	0.00	$1,809.00	☐
33220112	Field Technician	50.00	HR	0.00	15.81	0.00	$790.52	☐
33220114	Word Processing/Clerical	36.00	HR	0.00	13.10	0.00	$471.66	☐
33220115	Draftsman/CADD	32.00	HR	0.00	20.30	0.00	$649.73	☐
				Total Element Cost			**$9,396.34**	
				Total Technology Cost			**$50,636.73**	

Phase Technology Cost Detail Report
(without Markups)

Technology: SITE RESTORATION

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
18050301	Topsoil, 6" Lifts, Off-Site	278.00	CY	19.45	3.83	3.08	$7,326.97	☐
18050402	Seeding, Vegetative Cover	0.80	ACRE	3,572.78	64.32	51.49	$2,950.88	☐
				Total Element Cost			**$10,277.85**	
				Total Technology Cost			**$10,277.85**	
				Total Phase Cost			**$900,845.48**	

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 9/17/2002 2:02:05 PM

Phase Technology Cost Detail Report
(without Markups)

Folder: FE Warren

Installation

Name: Spill Site 7 EE/CA (Final)
ID: Spill Site 7 EE/CA (Final)
Location: FE WARREN AFB (CHEYENNE), WYOMING
Modifiers:

Material	1.0619	(Modified)
Labor	0.8413	(Modified)
Equipment	0.9676	(Modified)

Category: None
Report Option: Calendar Year
Description: Final EE/CA for interim action at Spill Site 7, F.E. Warren AFB, Cheyenne, Wyoming.

Project

Name: RA1B - Excavation and Removal WCA
ID: RA1B - Excavation and Removal WCA
Type: None
Description: Excavation and removal of vadose zone soils and disposal in the on-site waste consolidation area (WCA).

Phase

Name: RA - Excavation and Removal WCA
Type: Remedial Action
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate
Media/Waste Type: Soil
Secondary Media/Waste Type: N/A
Contaminant: Volatile Organic Compounds (VOCs)
Secondary Contaminant: Metals

Phase Technology Cost Detail Report
(without Markups)

Approach: Ex Situ
Start Date: 8/1/2002
Description: Excavation and removal of material to on-site WCA.

Markup Template: System Defaults
O&M Markup Template: N/A

Phase Technology Cost Detail Report
(without Markups)

Technology: Excavation

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
17030276	1 CY, Crawler-mounted, Hydraulic Excavator	22.22	CY	0.00	1.43	2.13	$79.17	☐
17030415	Backfill with Excavated Material	34.76	CY	0.32	2.27	0.76	$116.36	☐
17030418	Delivered & Dumped, Backfill with Stone	11.11	BCY	24.79	0.51	0.74	$289.28	☐
33020401	Disposable Materials per Sample	2.00	EA	8.15	0.00	0.00	$16.29	☐
33021102	Soil Moisture Content ASTM D2216	2.00	EA	23.89	0.00	0.00	$47.79	☐
33021709	TAL Metals (EPA 6010/7000s), Soil Analysis	2.00	EA	324.75	0.00	0.00	$649.50	☐
33170803	Decontaminate Heavy Equipment	1.00	EA	0.00	260.12	0.00	$260.12	☐
				Total Element Cost			**$1,458.50**	
				Total Technology Cost			**$1,458.50**	

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 9/17/2002 2:02:50 PM

Phase Technology Cost Detail Report
(without Markups)

Technology: Off-site Transportation and Waste Disposal

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33190102	Bulk Solid Hazardous Waste Loading Into Truck	2,432.00	CY	0.00	0.61	1.30	$4,632.23	☐
33190205	Transport Bulk Solid Hazardous Waste, Maximum 20 CY (per Mile)	17,080.00	MI	1.61	0.00	0.00	$27,568.83	☐
33190311	Truck Washout/Decontamination	122.00	EA	159.29	0.00	0.00	$19,432.77	☐
33197264	Landfill Hazardous Solid Bulk Waste by CY	2,432.00	CY	100.00	0.00	0.00	$243,200.00	☑
				Total Element Cost			**$294,833.83**	
				Total Technology Cost			**$294,833.83**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Decontamination Facilities

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33170818	1,800 PSI Pressure Washer Rental	1.00	MO	1,115.00	0.00	0.00	$1,115.00	☐
33170823	Operation of Pressure Washer, Including Water, Soap, Electricity, Labor	30.00	HR	6.64	30.59	0.00	$1,116.71	☐
				Total Element Cost			**$2,231.71**	
				Total Technology Cost			**$2,231.71**	

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 9/17/2002 2:02:50 PM

Phase Technology Cost Detail Report
(without Markups)

Technology: Professional Labor Management

Element: Professional Labor Percentage

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33220138	Project Management Labor Cost	1.00	LS	0.00	15,736.11	0.00	$15,736.11	☑
33220139	Planning Documents Labor Cost	1.00	LS	0.00	15,736.11	0.00	$15,736.11	☑
33220140	Construction Oversight Labor Cost	1.00	LS	0.00	17,309.72	0.00	$17,309.72	☑
33220141	Reporting Labor Cost	1.00	LS	0.00	2,203.06	0.00	$2,203.06	☑
33220142	As-Built Drawings Labor Cost	1.00	LS	0.00	2,203.06	0.00	$2,203.06	☑
33220143	Public Notice Labor Cost	1.00	LS	0.00	472.08	0.00	$472.08	☑
33220144	Site Closure Activities Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
33220145	Permitting Labor Cost	1.00	LS	0.00	31,472.23	0.00	$31,472.23	☑
33220146	Responsible Party Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
33220147	Reimbursement Claims Preparation Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
33220148	Other Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
				Total Element Cost			**$85,132.38**	
				Total Technology Cost			**$85,132.38**	

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 9/17/2002 2:02:50 PM

Phase Technology Cost Detail Report
(without Markups)

Technology: Excavation

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
17030278	3 CY, Crawler-mounted, Hydraulic Excavator	10,625.00	CY	0.00	0.78	1.17	$20,701.75	☐
17030418	Delivered & Dumped, Backfill with Stone	447.22	BCY	24.79	0.51	0.74	$11,644.62	☐
17030423	Unclassified Fill, 6" Lifts, Off-Site, Includes Delivery, Spreading, and Compaction	13,291.25	CY	5.74	0.95	1.96	$114,985.26	☐
33020401	Disposable Materials per Sample	100.00	EA	8.15	0.00	0.00	$814.55	☐
33021720	Volatile Organic Analysis (SW 5035/SW 8260B), Soil Analysis	100.00	EA	205.54	0.00	0.00	$20,553.51	☐
33080584	Plastic Laminate Waste Pile Cover	99,046.40	SF	0.12	0.02	0.00	$13,252.41	☐
33170803	Decontaminate Heavy Equipment	1.00	EA	0.00	260.12	0.00	$260.12	☐
				Total Element Cost			**$182,212.23**	
				Total Technology Cost			**$182,212.23**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Load and Haul

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
17030224	966, 4.0 CY, Wheel Loader	55.00	HR	0.00	25.07	58.64	$4,603.90	☐
17030288	26 CY, Semi Dump	220.00	HR	0.00	21.03	59.86	$17,795.51	☐
				Total Element Cost			**$22,399.42**	
				Total Technology Cost			**$22,399.42**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Special Well Drilling & Installation

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010101	Mobilize/DeMobilize Drilling Rig & Crew	1.00	LS	0.00	657.45	1,928.39	$2,585.83	☐
33020401	Disposable Materials per Sample	10.00	EA	8.15	0.00	0.00	$81.46	☐
33020601	Drilling 2.5" Diameter Soil Borings, No Sampling	75.00	LF	7.77	3.23	5.15	$1,210.59	☐
33021720	Volatile Organic Analysis (SW 5035/SW 8260B), Soil Analysis	10.00	EA	205.54	0.00	0.00	$2,055.35	☐
33170808	Decontaminate Rig, Augers, Screen (Rental Equipment)	2.00	DAY	110.54	0.00	0.00	$221.09	☐
33231172	Split Spoon Sample, 2" x 24", During Drilling	15.00	EA	41.02	0.00	0.00	$615.24	☐
33231178	Move Rig/Equipment Around Site	4.00	EA	55.94	94.51	277.21	$1,710.62	☐
33231182	Furnish 55 Gallon Drum for Drill Cuttings & Development Water	1.00	EA	76.99	0.00	0.00	$76.99	☐
				Total Element Cost			**$8,557.17**	
				Total Technology Cost			**$8,557.17**	

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 9/17/2002 2:02:50 PM

Phase Technology Cost Detail Report
(without Markups)

Technology: Groundwater Monitoring Well

Element: Aquifer 1

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33020303	Organic Vapor Analyzer Rental, per Day	4.00	DAY	114.91	0.00	0.00	$459.65	☐
33020307	Soil Gas Investigation & Analysis	8.00	DAY	103.40	0.00	0.00	$827.22	☐
33020308	Soil Gas Probes	10.00	EA	2,557.10	0.00	0.00	$25,570.98	☐
33021720	Volatile Organic Analysis (SW 5035/SW 8260B), Soil Analysis	20.00	EA	205.54	0.00	0.00	$4,110.70	☐
33021834	Volatile Organic Compounds (TO-14)	40.00	DAY	109.42	0.00	0.00	$4,376.80	☐
33170808	Decontaminate Rig, Augers, Screen (Rental Equipment)	4.00	DAY	110.54	0.00	0.00	$442.18	☐
33220112	Field Technician	64.00	HR	0.00	15.81	0.00	$1,011.86	☐
33230101	2" PVC, Schedule 40, Well Casing	150.00	LF	1.13	2.19	6.43	$1,462.40	☐
33230201	2" PVC, Schedule 40, Well Screen	100.00	LF	2.61	2.83	8.29	$1,372.73	☐
33230301	2" PVC, Well Plug	10.00	EA	5.49	3.29	9.64	$184.24	☐
33231101	Hollow Stem Auger, 8" Dia Borehole, Depth <= 100 ft	260.00	LF	0.00	6.01	17.63	$6,145.49	☐
33231173	Split Spoon Sampling	60.00	LF	0.00	9.39	27.55	$2,216.43	☐
33231182	Furnish 55 Gallon Drum for Drill Cuttings & Development Water	14.00	EA	76.99	0.00	0.00	$1,077.83	☐

Phase Technology Cost Detail Report
(without Markups)

Element: Aquifer 1

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33231401	2" Screen, Filter Pack	120.00	LF	2.93	1.86	5.46	$1,231.00	☐
33231811	2" Well, Portland Cement Grout	120.00	LF	1.09	0.00	0.00	$131.02	☐
33232101	2" Well, Bentonite Seal	10.00	EA	8.71	7.40	21.69	$378.04	☐
				Total Element Cost			**$50,998.55**	

Element: General Aquifers

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010101	Mobilize/DeMobilize Drilling Rig & Crew	1.00	LS	0.00	657.45	1,928.39	$2,585.83	☐
33231504	Surface Pad, Concrete, 2' x 2' x 4"	10.00	EA	38.18	68.31	4.32	$1,108.06	☐
33232301	5' Guard Posts, Cast Iron, Concrete Fill	40.00	EA	24.27	29.30	0.05	$2,144.67	☐
				Total Element Cost			**$5,838.56**	
				Total Technology Cost			**$56,837.11**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Monitoring (12 - months only)

Element: Surface Soil

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33020603	Surface Soil Sampling Equipment	1.00	EA	395.03	0.00	0.00	$395.03	☐
33021102	Soil Moisture Content ASTM D2216	3.00	EA	23.89	0.00	0.00	$71.68	☐
33021709	TAL Metals (EPA 6010/7000s), Soil Analysis	3.00	EA	324.75	0.00	0.00	$974.25	☐
				Total Element Cost			**$1,440.95**	

Element: Soil Gas

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33020306	Monitoring Gas Vents	40.00	EA	0.00	8.72	0.00	$348.83	☐
33021837	Army Suites - Air - 3 Suites	44.00	EA	896.60	0.00	0.00	$39,450.61	☐
				Total Element Cost			**$39,799.44**	

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010104	Car or Van Mileage Charge	200.00	MI	0.36	0.00	0.00	$71.74	☐

Phase Technology Cost Detail Report
(without Markups)

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33220102	Project Manager	4.00	HR	0.00	39.36	0.00	$157.43	☐
33220105	Project Engineer	30.00	HR	0.00	29.14	0.00	$874.13	☐
33220108	Project Scientist	193.00	HR	0.00	23.69	0.00	$4,572.13	☐
33220109	Staff Scientist	80.00	HR	0.00	22.61	0.00	$1,809.00	☐
33220112	Field Technician	50.00	HR	0.00	15.81	0.00	$790.52	☐
33220114	Word Processing/Clerical	36.00	HR	0.00	13.10	0.00	$471.66	☐
33220115	Draftsman/CADD	32.00	HR	0.00	20.30	0.00	$649.73	☐
				Total Element Cost			**$9,396.34**	
				Total Technology Cost			**$50,636.73**	

Phase Technology Cost Detail Report
(without Markups)

Technology: SITE RESTORATION

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
18050301	Topsoil, 6" Lifts, Off-Site	278.00	CY	19.45	3.83	3.08	$7,326.97	☐
18050402	Seeding, Vegetative Cover	0.80	ACRE	3,572.78	64.32	51.49	$2,950.88	☐
				Total Element Cost			**$10,277.85**	
				Total Technology Cost			**$10,277.85**	
				Total Phase Cost			**$714,576.93**	

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 9/17/2002 2:02:50 PM

Project Cost Over Time Report (with Markups)

Folder: FE Warren
Installation Name: Spill Site 7 EE/CA (Final)
Installation ID: Spill Site 7 EE/CA (Final)
Project Name: RA1A - Excavation and Removal LF
Site Type: None
Project ID: RA1A - Excavation and Removal LF

Location: FE WARREN AFB (CHEYENNE), WYC

Initial Phase Start Date: 8/1/2002

Phase	Phase Name	Calendar Year 1 2002	Calendar Year 2 2003	Row Total
Remedial Action	RA - Excavation and Removal LF (Capital)	$1,321,445	$47,476	$1,368,921
Sub-Total		$1,321,445	$47,476	$1,368,921
Discount Factor		1	1.05	
Total		$1,321,445	$45,215	$1,366,660

Cost Database Date: 2002
Cost Type: User-Defined
Date: 9/17/2002
Time: 1:58 PM

Project Cost Over Time Report (with Markups)

)MING

Phase	Phase Name
Remedial Action	RA - Excavation and Removal LF (Capital)
Sub-Total	
Discount Factor (5%)	
NPV	

Cost Database Date: 2002
Cost Type: User-Defined
Date: 9/17/2002
Time: 1:58 PM

Project Cost Over Time Report (with Markups)

Folder: FE Warren
Installation Name: Spill Site 7 EE/CA (Final)
Installation ID: Spill Site 7 EE/CA (Final)
Project Name: RA1B - Excavation and Removal WCA
Site Type: None
Project ID: RA1B - Excavation and Removal WCA

Location: FE WARREN AFB (CHEYENNE), WYC

Initial Phase Start Date: 8/1/2002

Phase	Phase Name	Calendar Year 1 2002	Calendar Year 2 2003	Row Total
Remedial Action	RA - Excavation and Removal WCA (Capital)	$1,050,046	$47,476	$1,097,522
Sub-Total		$1,050,046	$47,476	$1,097,522
Discount Factor		1	1.05	
Total		$1,050,046	$45,215	$1,095,261

Cost Database Date: 2002
Cost Type: User-Defined
Date: 9/17/2002
Time: 1:59 PM

Project Cost Over Time Report (with Markups)

)MING

Phase	Phase Name
Remedial Action	RA - Excavation and Removal WCA (Capital)
Sub-Total	
Discount Factor (5%)	
NPV	

Cost Database Date: 2002
Cost Type: User-Defined
Date: 9/17/2002
Time: 1:59 PM

APPENDIX D

COST ESTIMATE ALTERNATIVE II

Phase Technology Cost Detail Report
(without Markups)

Folder: FE Warren

Installation

Name: Spill Site 7 EE/CA (Final)
ID: Spill Site 7 EE/CA (Final)
Location: FE WARREN AFB (CHEYENNE), WYOMING
Modifiers:

Material	1.0619	(Modified)
Labor	0.8413	(Modified)
Equipment	0.9676	(Modified)

Category: None
Report Option: Calendar Year
Description: Final EE/CA for interim action at Spill Site 7, F.E. Warren AFB, Cheyenne, Wyoming.

Project

Name: RA2 - In Situ SVE
ID: RA2 - In Situ SVE
Type: None
Description: Installation of wells and an in-situ SVE system to remove VOCs from the vadose zone soils.

Phase

Name: RA - In-situ SVE
Type: Remedial Action
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate
Media/Waste Type: Soil
Secondary Media/Waste Type: N/A
Contaminant: Volatile Organic Compounds (VOCs)
Secondary Contaminant: Metals

Phase Technology Cost Detail Report
(without Markups)

Approach: In Situ
Start Date: 8/1/2002
Description: Installation of an in-situ soil vapor extraction system.

Markup Template: System Defaults
O&M Markup Template: System Defaults

Phase Technology Cost Detail Report
(without Markups)

Technology: Soil Vapor Extraction

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010101	Mobilize/DeMobilize Drilling Rig & Crew	1.00	LS	0.00	657.45	1,928.39	$2,585.83	☐
33020303	Organic Vapor Analyzer Rental, per Day	8.00	DAY	114.91	0.00	0.00	$919.30	☐
33132305	5 HP, 230V, 280 SCFM, Vapor Recovery System	1.00	EA	6,875.80	337.14	0.00	$7,212.94	☐
33132343	Knockout Drum	1.00	EA	76.99	0.00	0.00	$76.99	☐
33132377	Equipment Enclosure, 8' x 15', Portable Building/Shed; lined, insulated, skid mounted, w/exhaust fan	1.00	EA	2,492.49	0.00	0.00	$2,492.49	☐
33170808	Decontaminate Rig, Augers, Screen (Rental Equipment)	8.00	DAY	110.54	0.00	0.00	$884.35	☐
33220112	Field Technician	128.00	HR	0.00	15.81	0.00	$2,023.72	☐
33230102	4" PVC, Schedule 40, Well Casing	400.00	LF	2.65	3.29	9.64	$6,232.52	☐
33230202	4" PVC, Schedule 40, Well Screen	200.00	LF	5.94	4.40	12.92	$4,653.92	☐
33230302	4" PVC, Well Plug	40.00	EA	23.02	4.82	14.14	$1,679.44	☐
33231103	Hollow Stem Auger, 11" Dia Borehole, Depth <= 100 ft	640.00	LF	0.00	9.39	27.54	$23,636.48	☐

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 9/17/2002 2:03:18 PM

Phase Technology Cost Detail Report
(without Markups)

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33231182	Furnish 55 Gallon Drum for Drill Cuttings & Development Water	40.00	EA	76.99	0.00	0.00	$3,079.51	☐
33231402	4" Screen, Filter Pack	280.00	LF	5.17	3.29	9.64	$5,068.78	☐
33231812	4" Well, Portland Cement Grout	280.00	LF	1.64	0.00	0.00	$458.56	☐
33232102	4" Well, Bentonite Seal	40.00	EA	21.79	18.49	54.25	$3,781.05	☐
33260428	2" PVC, Schedule 80, Connection Piping	660.00	LF	0.84	2.41	0.00	$2,141.11	☐
33260460	4" PVC, Schedule 80, Manifold Piping	440.00	LF	2.50	5.19	0.00	$3,381.49	☐
33270124	2" PVC, Schedule 80, Tee	40.00	EA	12.00	0.00	0.00	$480.02	☐
33270134	2" PVC, Schedule 80, 90 Degree, Elbow	40.00	EA	3.26	0.00	0.00	$130.54	☐
33270136	4" PVC, Schedule, 90 Degree, Elbow	40.00	EA	13.49	0.00	0.00	$539.63	☐
33270167	4" x 2" Reducer, PVC Schedule 80	40.00	EA	35.16	0.00	0.00	$1,406.53	☐
33270440	2" PVC, Sch 80, Ball Valve	40.00	EA	83.90	0.00	0.00	$3,355.92	☐
33310209	Pressure Gauge	40.00	EA	66.22	35.20	0.00	$4,057.09	☐
				Total Element Cost			**$80,278.22**	
				Total Technology Cost			**$80,278.22**	

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 9/17/2002 2:03:18 PM

Phase Technology Cost Detail Report
(without Markups)

Technology: Carbon Adsorption (Gas)

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
18020322	8" Structural Slab on Grade	25.00	SF	3.86	2.32	0.34	$163.05	☐
33021501	Saturation Indicator	1.00	EA	47.79	0.00	0.00	$47.79	☐
33021506	Monitoring Port with Gas Monitor	2.00	EA	1.07	12.11	0.00	$26.36	☐
33131907	250 CFM, 400 Lb Fill, Closed Upflow, 11.3" Pressure Drop	2.00	EA	1,380.47	257.73	0.00	$3,276.39	☐
33310209	Pressure Gauge	2.00	EA	66.22	35.20	0.00	$202.85	☐
				Total Element Cost			**$3,716.44**	
				Total Technology Cost			**$3,716.44**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Decontamination Facilities

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33170818	1,800 PSI Pressure Washer Rental	1.00	MO	1,115.00	0.00	0.00	$1,115.00	☐
33170823	Operation of Pressure Washer, Including Water, Soap, Electricity, Labor	20.00	HR	6.64	30.59	0.00	$744.48	☐
				Total Element Cost			**$1,859.47**	
				Total Technology Cost			**$1,859.47**	

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 9/17/2002 2:03:18 PM

Phase Technology Cost Detail Report
(without Markups)

Technology: Overhead Electrical Distribution

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
20020302	4/0 ACSR Conductor	1,590.00	LF	0.42	0.52	0.06	$1,601.61	☐
20020310	1/C #2 Aluminum, Bare, Wire	665.00	LF	0.16	0.36	0.04	$376.72	☐
20020404	45' Class 3 Treated Power Pole	3.00	EA	346.31	234.78	43.68	$1,874.34	☐
20020420	Straight-line Structure, 5 KV Pole Top	1.00	EA	108.46	189.93	35.34	$333.73	☐
20020430	Terminal Structure, 5 KV Pole Top	2.00	EA	1,225.80	720.71	134.10	$4,161.22	☐
20020514	5 KV, 500 MCM, Shielded Cable, Copper	135.00	LF	5.83	1.63	0.30	$1,047.52	☐
20020550	5 KV, 3/0 to 500 MCM Conductor, Terminations & Splicing	6.00	EA	280.73	251.34	0.00	$3,192.42	☐
20039902	4" Rigid Steel Conduit	45.00	LF	9.38	5.79	0.00	$682.30	☐
				Total Element Cost			**$13,269.86**	
				Total Technology Cost			**$13,269.86**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Residual Waste Management

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33190103	Load Drums on Disposal Vehicle	40.00	EA	0.00	1.54	1.45	$119.86	☐
33190204	Transport 55 Gallon Drums of Hazardous Waste, Max 80 drums (per Mile)	50.00	MI	1.68	0.00	0.00	$83.89	☐
33190317	Waste Stream Evaluation Fee, Not Including 50% Rebate on 1st Shipment	1.00	EA	461.93	0.00	0.00	$461.93	☐
33197205	Landfill Nonhazardous Solid Waste, 55 Gallon Drum	40.00	EA	13.50	0.00	0.00	$540.00	☑
				Total Element Cost			**$1,205.67**	
				Total Technology Cost			**$1,205.67**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Professional Labor Management

Element: Professional Labor Percentage

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33220138	Project Management Labor Cost	1.00	LS	0.00	3,762.36	0.00	$3,762.36	☑
33220139	Planning Documents Labor Cost	1.00	LS	0.00	3,511.54	0.00	$3,511.54	☑
33220140	Construction Oversight Labor Cost	1.00	LS	0.00	3,009.89	0.00	$3,009.89	☑
33220141	Reporting Labor Cost	1.00	LS	0.00	501.65	0.00	$501.65	☑
33220142	As-Built Drawings Labor Cost	1.00	LS	0.00	501.65	0.00	$501.65	☑
33220143	Public Notice Labor Cost	1.00	LS	0.00	150.49	0.00	$150.49	☑
33220144	Site Closure Activities Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
33220145	Permitting Labor Cost	1.00	LS	0.00	5,016.48	0.00	$5,016.48	☑
33220146	Responsible Party Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
33220147	Reimbursement Claims Preparation Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
33220148	Other Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
				Total Element Cost			**$16,454.06**	
				Total Technology Cost			**$16,454.06**	

Cost Database Date: 2002

Cost Type: User-Defined

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Phase Technology Cost Detail Report
(without Markups)

Technology: Excavation

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
17030276	1 CY, Crawler-mounted, Hydraulic Excavator	22.22	CY	0.00	1.43	2.13	$79.17	☐
17030418	Delivered & Dumped, Backfill with Stone	11.11	BCY	24.79	0.51	0.74	$289.28	☐
17030423	Unclassified Fill, 6" Lifts, Off-Site, Includes Delivery, Spreading, and Compaction	37.78	CY	5.74	0.95	1.96	$326.84	☐
33020401	Disposable Materials per Sample	2.00	EA	8.15	0.00	0.00	$16.29	☐
33021102	Soil Moisture Content ASTM D2216	2.00	EA	23.89	0.00	0.00	$47.79	☐
33021709	TAL Metals (EPA 6010/7000s), Soil Analysis	2.00	EA	324.75	0.00	0.00	$649.50	☐
33080584	Plastic Laminate Waste Pile Cover	281.52	SF	0.12	0.02	0.00	$37.67	☐
33170803	Decontaminate Heavy Equipment	1.00	EA	0.00	260.12	0.00	$260.12	☐
				Total Element Cost			**$1,706.66**	
				Total Technology Cost			**$1,706.66**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Off-site Transportation and Waste Disposal

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33190102	Bulk Solid Hazardous Waste Loading Into Truck	32.00	CY	0.00	0.61	1.30	$60.95	☐
33190205	Transport Bulk Solid Hazardous Waste, Maximum 20 CY (per Mile)	280.00	MI	1.61	0.00	0.00	$451.95	☐
33190311	Truck Washout/Decontamination	2.00	EA	159.29	0.00	0.00	$318.57	☐
33197264	Landfill Hazardous Solid Bulk Waste by CY	32.00	CY	100.00	0.00	0.00	$3,200.00	☑
				Total Element Cost			**$4,031.47**	
				Total Technology Cost			**$4,031.47**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Operations and Maintenance (12 - months only)

Element: Miscellaneous

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	16.00	DAY	85.00	0.00	0.00	$1,360.00	☑
33010205	Mobilize Crew, 50 Miles, per Person	8.00	EA	71.47	0.00	0.00	$571.76	☐
33010423	Disposable Gloves (Latex)	106.00	PAIR	0.22	0.00	0.00	$23.08	☐
33010425	Disposable Coveralls (Tyvek)	106.00	EA	4.55	0.00	0.00	$482.50	☐
33190340	Non Haz Drummed Site Waste - Load, Transp, & Landfill Disp (55-Gal Drums)	3.00	EA	209.23	0.00	0.00	$627.68	☐
33199921	DOT Steel Drum, 55 Gallon	3.00	EA	76.99	0.00	0.00	$230.96	☐
33220106	Staff Engineer	16.00	HR	0.00	23.22	0.00	$371.48	☐
33220112	Field Technician	16.00	HR	0.00	15.81	0.00	$252.96	☐
33240104	Startup Costs	1.00	LS	1,347.46	1,347.46	673.73	$3,368.66	☑
99020110	Annual Maintenance Materials and Labor	1.00	LS	335.98	335.98	167.99	$839.95	☑
				Total Element Cost			**$8,129.04**	

Phase Technology Cost Detail Report
(without Markups)

Element: Soil Vapor Extraction

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33021803	Tentative ID Compunds, GC/MS, Air (30/5041/8260B - TO-14), Air Analysis	48.00	EA	146.54	0.00	0.00	$7,034.03	☐
33220106	Staff Engineer	45.00	HR	0.00	23.22	0.00	$1,044.80	☐
33220112	Field Technician	223.00	HR	0.00	15.81	0.00	$3,525.70	☐
33420101	Electrical Charge	105,120.00	KWH	0.07	0.00	0.00	$7,064.06	☐
				Total Element Cost			**$18,668.59**	

Element: Carbon Adsorption (Gas)

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33021803	Tentative ID Compunds, GC/MS, Air (30/5041/8260B - TO-14), Air Analysis	12.00	EA	146.54	0.00	0.00	$1,758.51	☐
33132070	Coal Based, 4MM Pellet, For Solvent Recovery < 2000 Lb Disposable	6,801.00	LB	1.95	0.00	0.00	$13,286.43	☐
33132074	Remove and Dispose of Spent Carbon from Offgas Treatment	6,801.00	LB	0.29	0.00	0.00	$1,953.25	☐
33220106	Staff Engineer	26.00	HR	0.00	23.22	0.00	$603.66	☐
33220112	Field Technician	130.00	HR	0.00	15.81	0.00	$2,055.34	☐

Phase Technology Cost Detail Report
(without Markups)

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33420101	Electrical Charge	10,512.00	KWH	0.07	0.00	0.00	$706.41	☐

Total Element Cost	**$20,363.60**
Total Technology Cost	**$47,161.22**
Runtime Percent Cost Adjustment	**97%**
O & M Total Cost	**$45,746.38**

Phase Technology Cost Detail Report
(without Markups)

Technology: Special Well Drilling & Installation

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010101	Mobilize/DeMobilize Drilling Rig & Crew	1.00	LS	0.00	657.45	1,928.39	$2,585.83	☐
33020401	Disposable Materials per Sample	10.00	EA	8.15	0.00	0.00	$81.46	☐
33020601	Drilling 2.5" Diameter Soil Borings, No Sampling	75.00	LF	7.77	3.23	5.15	$1,210.59	☐
33021720	Volatile Organic Analysis (SW 5035/SW 8260B), Soil Analysis	10.00	EA	205.54	0.00	0.00	$2,055.35	☐
33170808	Decontaminate Rig, Augers, Screen (Rental Equipment)	2.00	DAY	110.54	0.00	0.00	$221.09	☐
33231172	Split Spoon Sample, 2" x 24", During Drilling	15.00	EA	41.02	0.00	0.00	$615.24	☐
33231178	Move Rig/Equipment Around Site	4.00	EA	55.94	94.51	277.21	$1,710.62	☐
33231182	Furnish 55 Gallon Drum for Drill Cuttings & Development Water	1.00	EA	76.99	0.00	0.00	$76.99	☐

Total Element Cost	**$8,557.17**
Total Technology Cost	**$8,557.17**

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 9/17/2002 2:03:18 PM

Phase Technology Cost Detail Report
(without Markups)

Technology: Monitoring (12 - months only)

Element: Surface Soil

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33020603	Surface Soil Sampling Equipment	1.00	EA	395.03	0.00	0.00	$395.03	☐
33021102	Soil Moisture Content ASTM D2216	3.00	EA	23.89	0.00	0.00	$71.68	☐
33021709	TAL Metals (EPA 6010/7000s), Soil Analysis	3.00	EA	324.75	0.00	0.00	$974.25	☐
				Total Element Cost			**$1,440.95**	

Element: Soil Gas

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33020306	Monitoring Gas Vents	40.00	EA	0.00	8.72	0.00	$348.83	☐
33021803	Tentative ID Compunds, GC/MS, Air (30/5041/8260B - TO-14), Air Analysis	44.00	EA	146.54	0.00	0.00	$6,447.86	☐
				Total Element Cost			**$6,796.69**	

Phase Technology Cost Detail Report
(without Markups)

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010104	Car or Van Mileage Charge	620.00	MI	0.36	0.00	0.00	$222.39	☐
33010202	Per Diem (per person)	4.00	DAY	85.00	0.00	0.00	$340.00	☑
33220102	Project Manager	4.00	HR	0.00	39.36	0.00	$157.43	☐
33220105	Project Engineer	30.00	HR	0.00	29.14	0.00	$874.13	☐
33220108	Project Scientist	252.00	HR	0.00	23.69	0.00	$5,969.83	☐
33220109	Staff Scientist	80.00	HR	0.00	22.61	0.00	$1,809.00	☐
33220112	Field Technician	56.00	HR	0.00	15.81	0.00	$885.38	☐
33220114	Word Processing/Clerical	36.00	HR	0.00	13.10	0.00	$471.66	☐
33220115	Draftsman/CADD	32.00	HR	0.00	20.30	0.00	$649.73	☐
				Total Element Cost			**$11,379.55**	
				Total Technology Cost			**$19,617.19**	

Phase Technology Cost Detail Report
(without Markups)

Technology: SITE RESTORATION

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
18050301	Topsoil, 6" Lifts, Off-Site	278.00	CY	19.45	3.83	3.08	$7,326.97	☐
18050402	Seeding, Vegetative Cover	0.80	ACRE	3,572.78	64.32	51.49	$2,950.88	☐
				Total Element Cost			**$10,277.85**	
				Total Technology Cost			**$10,277.85**	
				Total Phase Cost			**$206,720.44**	

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 9/17/2002 2:03:18 PM

Project Cost Over Time Report (with Markups)

Folder: FE Warren
Installation Name: Spill Site 7 EE/CA (Final)
Installation ID: Spill Site 7 EE/CA (Final)
Project Name: RA2 - In Situ SVE
Site Type: None
Project ID: RA2 - In Situ SVE

Location: FE WARREN AFB (CHEYENNE), WYOMING

Initial Phase Start Date: 8/1/2002

Phase	Phase Name	Calendar Year 1 2002	Calendar Year 2 2003	Calendar Year 3 2004	Calendar Year 4 2005
Remedial Action	RA - In-situ SVE (Capital)	$244,029	$25,735		
Remedial Action	RA - In-situ SVE (O&M)	$28,381	$70,380	$70,788	$46,648
Sub-Total		$272,410	$96,115	$70,788	$46,648
Discount Factor		1	1.05	1.1025	1.157625
Total		$272,410	$91,538	$64,207	$40,296

Cost Database Date: 2002
Cost Type: User-Defined
Date: 9/17/2002
Time: 2:00 PM

Project Cost Over Time Report (with Markups)

Row Total	Phase	Phase Name
$269,764	Remedial Action	RA - In-situ SVE (Capital)
$216,197	Remedial Action	RA - In-situ SVE (O&M)
$485,961	**Sub-Total**	
	Discount Factor (5%)	
$468,451	**NPV**	

Cost Database Date: 2002
Cost Type: User-Defined
Date: 9/17/2002
Time: 2:00 PM

APPENDIX E

COST ESTIMATE ALTERNATIVE III

Phase Technology Cost Detail Report
(without Markups)

Folder: FE Warren

Installation

Name: Spill Site 7 EE/CA (Final)
ID: Spill Site 7 EE/CA (Final)
Location: FE WARREN AFB (CHEYENNE), WYOMING
Modifiers:

Material	1.0619	(Modified)
Labor	0.8413	(Modified)
Equipment	0.9676	(Modified)

Category: None
Report Option: Calendar Year
Description: Final EE/CA for interim action at Spill Site 7, F.E. Warren AFB, Cheyenne, Wyoming.

Project

Name: RA3 - Ex situ SVE
ID: RA3 - Ex situ SVE
Type: None
Description: Excavation and ex-situ SVE of the vadose zone soils.

Phase

Name: RA - Ex-situ SVE
Type: Remedial Action
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate
Approach: Ex Situ
Media/Waste Type: Soil
Secondary Media/Waste Type: N/A
Contaminant: Volatile Organic Compounds (VOCs)
Secondary Contaminant: Metals
Markup Template: System Defaults

Cost Database Date: 2002
Cost Type: User-Defined
Print Date: 9/17/2002 2:03:47 PM

Phase Technology Cost Detail Report
(without Markups)

Start Date: 8/1/2002 **O&M Markup Template:** System Defaults

Description: Excavation and ex-situ soil vapor extraction of the vadose zone soils.

Phase Technology Cost Detail Report
(without Markups)

Technology: Excavation

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
17030278	3 CY, Crawler-mounted, Hydraulic Excavator	8,333.33	CY	0.00	0.78	1.17	$16,236.66	☐
17030415	Backfill with Excavated Material	9,592.53	CY	0.32	2.27	0.76	$32,110.04	☐
17030418	Delivered & Dumped, Backfill with Stone	277.78	BCY	24.79	0.51	0.74	$7,232.78	☐
33020401	Disposable Materials per Sample	100.00	EA	8.15	0.00	0.00	$814.55	☐
33021720	Volatile Organic Analysis (SW 5035/SW 8260B), Soil Analysis	100.00	EA	205.54	0.00	0.00	$20,553.51	☐
33170803	Decontaminate Heavy Equipment	1.00	EA	0.00	260.12	0.00	$260.12	☐
				Total Element Cost			**$77,207.66**	
				Total Technology Cost			**$77,207.66**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Ex Situ Vapor Extraction

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
17030217	953, 2.0 CY, Track Loader	212.00	HR	0.00	30.57	60.28	$19,261.39	☐
17030419	Crushed Stone, 1/2" to 3/4"	413.17	CY	19.16	2.67	0.80	$9,349.38	☐
17030420	Backfill Trench, Borrow Material, Delivered & Dumped Only	113.89	CY	5.42	1.05	1.68	$927.41	☐
17039903	Hand Place Small Earth Fill Berm	113.89	CY	0.00	48.94	0.00	$5,573.66	☐
19020601	12" x 12" Underground French Drain	624.00	LF	2.12	0.87	0.26	$2,024.57	☐
19040621	550 Gallon Horizontal Plastic Sump with 4" NPT Connection	1.00	EA	1,427.98	194.51	0.00	$1,622.49	☐
33021506	Monitoring Port with Gas Monitor	15.00	EA	1.07	12.11	0.00	$197.67	☐
33080503	Polymeric Liner Anchor Trench, 3' x 1.5'	656.00	LF	0.05	0.49	0.17	$464.45	☐
33080563	40 Mil Polymeric Liner, PVC	26,536.00	SF	0.33	0.84	0.17	$35,356.57	☐
33080590	Waste Pile Cover, 135 Lb Tear, 2 - 2.5 Year Life	3,033.67	SY	1.62	0.18	0.00	$5,460.61	☐
33132337	30 HP, 580 SCFM Vapor Extraction Blower, Monthly Rental	36.00	MO	2,256.54	0.00	0.00	$81,235.35	☐
33132343	Knockout Drum	4.00	EA	76.99	0.00	0.00	$307.95	☐
33132348	Install/Assemble Rental Vacuum Extraction Blower	4.00	EA	0.00	337.14	0.00	$1,348.54	☐

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 9/17/2002 2:03:47 PM

Phase Technology Cost Detail Report
(without Markups)

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33220112	Field Technician	279.00	HR	0.00	15.81	0.00	$4,411.07	☐
33260445	4" PVC, Schedule 40, Manifold Piping	355.41	LF	1.86	5.19	0.00	$2,505.43	☐
33260802	4" Slotted PVC Pipe	1,500.00	LF	5.31	1.92	0.00	$10,844.85	☐
33270106	4" PVC, Schedule 40, Tee	17.00	EA	14.84	0.00	0.00	$252.20	☐
33270116	4" PVC, Schedule 40, 90 Degree, Elbow	6.00	EA	10.00	0.00	0.00	$59.98	☐
33270404	4" Iron Body Check Valve	15.00	EA	235.88	71.75	0.00	$4,614.50	☐
33290412	15 GPM Submersible Sump Pump	1.00	EA	801.59	62.16	0.00	$863.74	☐
33310209	Pressure Gauge	15.00	EA	66.22	35.20	0.00	$1,521.41	☐
33420101	Electrical Charge	699,463.00	KWH	0.07	0.00	0.00	$47,003.91	☐
				Total Element Cost			**$235,207.12**	
				Total Technology Cost			**$235,207.12**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Carbon Adsorption (Gas)

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
18020322	8" Structural Slab on Grade	85.00	SF	3.86	2.32	0.34	$554.37	☐
33021501	Saturation Indicator	2.00	EA	47.79	0.00	0.00	$95.57	☐
33021506	Monitoring Port with Gas Monitor	2.00	EA	1.07	12.11	0.00	$26.36	☐
33131914	1,500 CFM, 5,700 Lb Fill, Closed Upflow, 11.5" Pressure Drop	2.00	EA	15,291.36	1,107.73	182.71	$33,163.60	☐
33310209	Pressure Gauge	2.00	EA	66.22	35.20	0.00	$202.85	☐
				Total Element Cost			**$34,042.75**	
				Total Technology Cost			**$34,042.75**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Decontamination Facilities

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33170818	1,800 PSI Pressure Washer Rental	1.00	MO	1,115.00	0.00	0.00	$1,115.00	☐
33170823	Operation of Pressure Washer, Including Water, Soap, Electricity, Labor	40.00	HR	6.64	30.59	0.00	$1,488.95	☐
				Total Element Cost			**$2,603.95**	
				Total Technology Cost			**$2,603.95**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Residual Waste Management

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33190103	Load Drums on Disposal Vehicle	8.00	EA	0.00	1.54	1.45	$23.97	☐
33190204	Transport 55 Gallon Drums of Hazardous Waste, Max 80 drums (per Mile)	50.00	MI	1.68	0.00	0.00	$83.89	☐
33190317	Waste Stream Evaluation Fee, Not Including 50% Rebate on 1st Shipment	1.00	EA	461.93	0.00	0.00	$461.93	☐
33197205	Landfill Nonhazardous Solid Waste, 55 Gallon Drum	8.00	EA	13.50	0.00	0.00	$108.00	☑
				Total Element Cost			**$677.79**	
				Total Technology Cost			**$677.79**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Professional Labor Management

Element: Professional Labor Percentage

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33220138	Project Management Labor Cost	1.00	LS	0.00	15,030.39	0.00	$15,030.39	☑
33220139	Planning Documents Labor Cost	1.00	LS	0.00	14,028.37	0.00	$14,028.37	☑
33220140	Construction Oversight Labor Cost	1.00	LS	0.00	12,024.32	0.00	$12,024.32	☑
33220141	Reporting Labor Cost	1.00	LS	0.00	2,004.05	0.00	$2,004.05	☑
33220142	As-Built Drawings Labor Cost	1.00	LS	0.00	2,004.05	0.00	$2,004.05	☑
33220143	Public Notice Labor Cost	1.00	LS	0.00	601.22	0.00	$601.22	☑
33220144	Site Closure Activities Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
33220145	Permitting Labor Cost	1.00	LS	0.00	20,040.53	0.00	$20,040.53	☑
33220146	Responsible Party Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
33220147	Reimbursement Claims Preparation Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
33220148	Other Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
				Total Element Cost			**$65,732.93**	
				Total Technology Cost			**$65,732.93**	

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 9/17/2002 2:03:47 PM

Phase Technology Cost Detail Report
(without Markups)

Technology: Excavation

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
17030276	1 CY, Crawler-mounted, Hydraulic Excavator	22.22	CY	0.00	1.43	2.13	$79.17	☐
17030418	Delivered & Dumped, Backfill with Stone	11.11	BCY	24.79	0.51	0.74	$289.28	☐
17030423	Unclassified Fill, 6" Lifts, Off-Site, Includes Delivery, Spreading, and Compaction	37.78	CY	5.74	0.95	1.96	$326.84	☐
33020401	Disposable Materials per Sample	2.00	EA	8.15	0.00	0.00	$16.29	☐
33021102	Soil Moisture Content ASTM D2216	2.00	EA	23.89	0.00	0.00	$47.79	☐
33021709	TAL Metals (EPA 6010/7000s), Soil Analysis	2.00	EA	324.75	0.00	0.00	$649.50	☐
33080584	Plastic Laminate Waste Pile Cover	281.52	SF	0.12	0.02	0.00	$37.67	☐
33170803	Decontaminate Heavy Equipment	1.00	EA	0.00	260.12	0.00	$260.12	☐
				Total Element Cost			**$1,706.66**	
				Total Technology Cost			**$1,706.66**	

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 9/17/2002 2:03:47 PM

Phase Technology Cost Detail Report
(without Markups)

Technology: Off-site Transportation and Waste Disposal

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33190102	Bulk Solid Hazardous Waste Loading Into Truck	32.00	CY	0.00	0.61	1.30	$60.95	☐
33190205	Transport Bulk Solid Hazardous Waste, Maximum 20 CY (per Mile)	280.00	MI	1.61	0.00	0.00	$451.95	☐
33190311	Truck Washout/Decontamination	2.00	EA	159.29	0.00	0.00	$318.57	☐
33197264	Landfill Hazardous Solid Bulk Waste by CY	32.00	CY	100.00	0.00	0.00	$3,200.00	☑
				Total Element Cost			**$4,031.47**	
				Total Technology Cost			**$4,031.47**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Operations and Maintenance (12 - months only)

Element: Miscellaneous

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	40.00	DAY	85.00	0.00	0.00	$3,400.00	☑
33010205	Mobilize Crew, 50 Miles, per Person	16.00	EA	71.47	0.00	0.00	$1,143.52	☐
33010206	Mobilize Crew, Local, per Person	4.00	EA	23.82	0.00	0.00	$95.29	☐
33010423	Disposable Gloves (Latex)	81.00	PAIR	0.22	0.00	0.00	$17.63	☐
33010425	Disposable Coveralls (Tyvek)	81.00	EA	4.55	0.00	0.00	$368.70	☐
33190340	Non Haz Drummed Site Waste - Load, Transp, & Landfill Disp (55-Gal Drums)	3.00	EA	209.23	0.00	0.00	$627.68	☐
33199921	DOT Steel Drum, 55 Gallon	3.00	EA	76.99	0.00	0.00	$230.96	☐
33220106	Staff Engineer	16.00	HR	0.00	23.22	0.00	$371.48	☐
33220112	Field Technician	64.00	HR	0.00	15.81	0.00	$1,011.86	☐
33240104	Startup Costs	1.00	LS	2,857.27	2,857.27	1,428.64	$7,143.18	☑
99020110	Annual Maintenance Materials and Labor	1.00	LS	136.17	136.17	68.09	$340.43	☑
				Total Element Cost			**$14,750.75**	

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 9/17/2002 2:03:47 PM

Phase Technology Cost Detail Report
(without Markups)

Element: Carbon Adsorption (Gas)

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33021803	Tentative ID Compunds, GC/MS, Air (30/5041/8260B - TO-14), Air Analysis	26.00	EA	146.54	0.00	0.00	$3,810.10	☐
33131942	Coal-based, 4 mm Pellet, for Solvent Recovery 2,000 - 10,000 Lb	42,501.00	LB	1.05	0.00	0.00	$44,681.30	☐
33132065	Removal, Transport, Regeneration of Spent Carbon, < 2K lb	42,501.00	LB	0.63	0.00	0.00	$26,856.38	☐
33220106	Staff Engineer	54.00	HR	0.00	23.22	0.00	$1,253.76	☐
33220112	Field Technician	268.00	HR	0.00	15.81	0.00	$4,237.16	☐
33420101	Electrical Charge	65,700.00	KWH	0.07	0.00	0.00	$4,415.04	☐

Total Element Cost	**$85,253.74**
Total Technology Cost	**$100,004.49**
Runtime Percent Cost Adjustment	**97%**
O & M Total Cost	**$97,004.36**

Phase Technology Cost Detail Report
(without Markups)

Technology: Special Well Drilling & Installation

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010101	Mobilize/DeMobilize Drilling Rig & Crew	1.00	LS	0.00	657.45	1,928.39	$2,585.83	☐
33170808	Decontaminate Rig, Augers, Screen (Rental Equipment)	2.00	DAY	110.54	0.00	0.00	$221.09	☐
33230102	4" PVC, Schedule 40, Well Casing	37.50	LF	2.65	3.29	9.64	$584.30	☐
33230202	4" PVC, Schedule 40, Well Screen	50.00	LF	5.94	4.40	12.92	$1,163.48	☐
33230302	4" PVC, Well Plug	5.00	EA	23.02	4.82	14.14	$209.93	☐
33231178	Move Rig/Equipment Around Site	4.00	EA	55.94	94.51	277.21	$1,710.62	☐
33231182	Furnish 55 Gallon Drum for Drill Cuttings & Development Water	8.00	EA	76.99	0.00	0.00	$615.90	☐
33231402	4" Screen, Filter Pack	65.00	LF	5.17	3.29	9.64	$1,176.68	☐
33231812	4" Well, Portland Cement Grout	5.00	LF	1.64	0.00	0.00	$8.19	☐
33232102	4" Well, Bentonite Seal	5.00	EA	21.79	18.49	54.25	$472.63	☐
				Total Element Cost			**$8,748.65**	
				Total Technology Cost			**$8,748.65**	

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 9/17/2002 2:03:47 PM

Phase Technology Cost Detail Report
(without Markups)

Technology: SITE RESTORATION

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
18050301	Topsoil, 6" Lifts, Off-Site	278.00	CY	19.45	3.83	3.08	$7,326.97	☐
18050402	Seeding, Vegetative Cover	0.80	ACRE	3,572.78	64.32	51.49	$2,950.88	☐
				Total Element Cost			**$10,277.85**	
				Total Technology Cost			**$10,277.85**	

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 9/17/2002 2:03:47 PM

Phase Technology Cost Detail Report
(without Markups)

Technology: Monitoring (12 - months only)

Element: Subsurface Soil

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33020606	Power Auger Rental	5.00	DAY	18.99	0.00	0.00	$94.93	☐
33021720	Volatile Organic Analysis (SW 5035/SW 8260B), Soil Analysis	22.00	EA	205.54	0.00	0.00	$4,521.77	☐
				Total Element Cost			**$4,616.71**	

Element: Soil Gas

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33020306	Monitoring Gas Vents	40.00	EA	0.00	8.72	0.00	$348.83	☐
33021803	Tentative ID Compunds, GC/MS, Air (30/5041/8260B - TO-14), Air Analysis	44.00	EA	146.54	0.00	0.00	$6,447.86	☐
				Total Element Cost			**$6,796.69**	

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010104	Car or Van Mileage Charge	740.00	MI	0.36	0.00	0.00	$265.44	☐

Phase Technology Cost Detail Report
(without Markups)

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	12.00	DAY	85.00	0.00	0.00	$1,020.00	☑
33220102	Project Manager	4.00	HR	0.00	39.36	0.00	$157.43	☐
33220105	Project Engineer	30.00	HR	0.00	29.14	0.00	$874.13	☐
33220108	Project Scientist	337.00	HR	0.00	23.69	0.00	$7,983.46	☐
33220109	Staff Scientist	80.00	HR	0.00	22.61	0.00	$1,809.00	☐
33220112	Field Technician	129.00	HR	0.00	15.81	0.00	$2,039.53	☐
33220114	Word Processing/Clerical	45.00	HR	0.00	13.10	0.00	$589.58	☐
33220115	Draftsman/CADD	41.00	HR	0.00	20.30	0.00	$832.47	☐

Total Element Cost	**$15,571.03**
Total Technology Cost	**$26,984.43**
Total Phase Cost	**$564,225.62**

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 9/17/2002 2:03:47 PM

Project Cost Over Time Report (with Markups)

Folder: FE Warren
Installation Name: Spill Site 7 EE/CA (Final)
Installation ID: Spill Site 7 EE/CA (Final)
Project Name: RA3 - Ex situ SVE
Site Type: None
Project ID: RA3 - Ex situ SVE

Location: FE WARREN AFB (CHEYENNE), WYOMING

Initial Phase Start Date: 8/1/2002

Phase	Phase Name	Calendar Year 1 2002	Calendar Year 2 2003	Row Total	Phase
Remedial Action	RA - Ex-situ SVE (Capital)	$739,139	$34,566	$773,705	Remedial Action
Remedial Action	RA - Ex-situ SVE (O&M)	$53,048	$85,199	$138,247	Remedial Action
Sub-Total		$792,187	$119,765	$911,952	**Sub-Total**
Discount Factor		1	1.05		**Discount Factor (5%**
Total		$792,187	$114,062	$906,249	**Total**

Cost Database Date: 2002
Cost Type: User-Defined
Date: 9/17/2002
Time: 2:00 PM

Project Cost Over Time Report (with Markups)

Phase Name

RA - Ex-situ SVE (Capital)
RA - Ex-situ SVE (O&M)

%)

Cost Database Date: 2002
Cost Type: User-Defined
Date: 9/17/2002
Time: 2:00 PM

APPENDIX F

COST ESTIMATE PILOT TEST

Phase Technology Cost Detail Report
(without Markups)

Folder: FE Warren

Installation

Name: Spill Site 7 EE/CA (Final)
ID: Spill Site 7 EE/CA (Final)
Location: FE WARREN AFB (CHEYENNE), WYOMING
Modifiers:

Material	1.0619	(Modified)
Labor	0.8413	(Modified)
Equipment	0.9676	(Modified)

Category: None
Report Option: Calendar Year
Description: Final EE/CA for interim action at Spill Site 7, F.E. Warren AFB, Cheyenne, Wyoming.

Project

Name: Pilot Test - HRC Application
ID: Pilot Test - HRC Application
Type: None
Description: Installation of drain piping in the base of the excavation (RA1 and RA3 only), and application of HRC to the capillary fringe.

Phase

Name: Pilot Test - HRC application
Type: Remedial Action
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate
Media/Waste Type: Groundwater
Secondary Media/Waste Type: Soil
Contaminant: Volatile Organic Compounds (VOCs)
Secondary Contaminant: None

Cost Database Date: 2002
Cost Type: User-Defined
Print Date: 9/17/2002 2:04:15 PM

Phase Technology Cost Detail Report
(without Markups)

Approach: In Situ
Start Date: 8/1/2002
Description: HRC will be applied to a network of pipes installed in the excavation in Alternatives 1 and 3.

Markup Template: System Defaults
O&M Markup Template: N/A

Phase Technology Cost Detail Report
(without Markups)

Technology: Monitoring (12 - months only)

Element: Groundwater

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33020401	Disposable Materials per Sample	55.00	EA	8.15	0.00	0.00	$448.00	☐
33020402	Decontamination Materials per Sample	55.00	EA	7.33	0.00	0.00	$402.99	☐
33021509	Water Quality Parameter Testing Device	2.00	WK	232.56	0.00	0.00	$465.11	☐
33022131	Purgeable Halocarbons (SW 5030B/SW 8021B Halocarbons), Water Analysis	55.00	EA	136.40	0.00	0.00	$7,502.24	☐
33022132	Purgeable Aromatics (SW 5030B/SW 8021B Aromatics), Water Analysis	55.00	EA	108.38	0.00	0.00	$5,960.73	☐
33231186	Well Development Equipment Rental (weekly)	2.00	WK	232.56	0.00	0.00	$465.11	☐
33232407	Disposable Bailer, Polyethylene, 1.5" Outside Diameter x 36"	50.00	EA	9.50	0.00	0.00	$475.20	☐
				Total Element Cost			**$15,719.38**	

Phase Technology Cost Detail Report
(without Markups)

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010104	Car or Van Mileage Charge	1,050.00	MI	0.36	0.00	0.00	$376.64	☐
33010202	Per Diem (per person)	20.00	DAY	85.00	0.00	0.00	$1,700.00	☑
33220102	Project Manager	4.00	HR	0.00	39.36	0.00	$157.43	☐
33220105	Project Engineer	30.00	HR	0.00	29.14	0.00	$874.13	☐
33220108	Project Scientist	288.00	HR	0.00	23.69	0.00	$6,822.66	☐
33220109	Staff Scientist	80.00	HR	0.00	22.61	0.00	$1,809.00	☐
33220112	Field Technician	188.00	HR	0.00	15.81	0.00	$2,972.34	☐
33220114	Word Processing/Clerical	40.00	HR	0.00	13.10	0.00	$524.07	☐
33220115	Draftsman/CADD	36.00	HR	0.00	20.30	0.00	$730.95	☐
				Total Element Cost			**$15,967.21**	
				Total Technology Cost			**$31,686.59**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Soil Flushing

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
17030257	Cat 215, 1.0 CY, Soil, Shallow, Trenching	4.91	CY	0.00	0.45	0.67	$5.47	☐
18020322	8" Structural Slab on Grade	25.00	SF	3.86	2.32	0.34	$163.05	☐
33270116	4" PVC, Schedule 40, 90 Degree, Elbow	5.00	EA	10.00	0.00	0.00	$49.99	☐
33270404	4" Iron Body Check Valve	3.00	EA	235.88	71.75	0.00	$922.90	☐
33290110	15 HP, 300 GPM, Centrifugal Pump	1.00	EA	2,936.61	524.35	0.00	$3,460.96	☐
33420101	Electrical Charge	136,117.00	KWH	0.07	0.00	0.00	$9,160.67	☐
				Total Element Cost			**$13,763.04**	
				Total Technology Cost			**$13,763.04**	

Phase Technology Cost Detail Report
(without Markups)

Technology: HRC INJECTION

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
17030430	Gravel, 6" Lifts	300.00	CY	6.14	2.67	1.80	$3,181.77	☐
19020125	4" PVC Pipe Sanitary	200.00	LF	1.10	3.42	1.62	$1,229.52	☐
33020401	Disposable Materials per Sample	12.00	EA	8.15	0.00	0.00	$97.75	☐
33220102	Project Manager	4.00	HR	0.00	39.36	0.00	$157.43	☐
33220106	Staff Engineer	8.00	HR	0.00	23.22	0.00	$185.74	☐
33220110	QA/QC Officer	16.00	HR	0.00	51.50	0.00	$824.06	☐
33220112	Field Technician	16.00	HR	0.00	15.81	0.00	$252.96	☐
33220119	Health and Safety Officer	16.00	HR	0.00	20.67	0.00	$330.72	☐
33230212	4" PVC, Schedule 80, Well Screen	500.00	LF	6.26	3.29	9.64	$9,592.55	☐
33230302	4" PVC, Well Plug	10.00	EA	23.02	4.82	14.14	$419.86	☐
33232301	5' Guard Posts, Cast Iron, Concrete Fill	10.00	EA	24.27	29.30	0.05	$536.17	☐
33270126	4" PVC, Schedule 80, Tee	10.00	EA	18.89	0.00	0.00	$188.92	☐
33270136	4" PVC, Schedule, 90 Degree, Elbow	10.00	EA	13.49	0.00	0.00	$134.91	☐
33270441	4" PVC, Sch 80, Ball Valve	10.00	EA	266.62	0.00	0.00	$2,666.21	☐

Phase Technology Cost Detail Report
(without Markups)

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33320107	7.5 GPH, 860 PSI, 260 Gallon Chemical Feed System with Polyethylene Tank with Steel Overpack	1.00	EA	2,336.18	751.01	0.00	$3,087.19	☐
33430301	Bulk ORC Powder, less than 2500 lbs	2,267.00	LB	7.57	0.00	0.00	$17,160.28	☑
99010601	General-purpose Laborer	1.00	MWK	0.00	962.37	0.00	$962.37	☐
				Total Element Cost			**$41,008.40**	
				Total Technology Cost			**$41,008.40**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Groundwater Monitoring Well

Element: Aquifer 1

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33020303	Organic Vapor Analyzer Rental, per Day	4.00	DAY	114.91	0.00	0.00	$459.65	☐
33021781	Army Suites - Soil/Sediment - 3 Suites	10.00	EA	1,035.28	0.00	0.00	$10,352.78	☐
33170808	Decontaminate Rig, Augers, Screen (Rental Equipment)	4.00	DAY	110.54	0.00	0.00	$442.18	☐
33220112	Field Technician	64.00	HR	0.00	15.81	0.00	$1,011.86	☐
33230101	2" PVC, Schedule 40, Well Casing	200.00	LF	1.13	2.19	6.43	$1,949.86	☐
33230201	2" PVC, Schedule 40, Well Screen	100.00	LF	2.61	2.83	8.29	$1,372.73	☐
33230301	2" PVC, Well Plug	10.00	EA	5.49	3.29	9.64	$184.24	☐
33231101	Hollow Stem Auger, 8" Dia Borehole, Depth <= 100 ft	310.00	LF	0.00	6.01	17.63	$7,327.32	☐
33231173	Split Spoon Sampling	70.00	LF	0.00	9.39	27.55	$2,585.84	☐
33231182	Furnish 55 Gallon Drum for Drill Cuttings & Development Water	16.00	EA	76.99	0.00	0.00	$1,231.80	☐
33231401	2" Screen, Filter Pack	120.00	LF	2.93	1.86	5.46	$1,231.00	☐
33231811	2" Well, Portland Cement Grout	170.00	LF	1.09	0.00	0.00	$185.61	☐
33232101	2" Well, Bentonite Seal	10.00	EA	8.71	7.40	21.69	$378.04	☐
				Total Element Cost			**$28,712.89**	

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 9/17/2002 2:04:15 PM

Phase Technology Cost Detail Report
(without Markups)

Element: General Aquifers

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010101	Mobilize/DeMobilize Drilling Rig & Crew	1.00	LS	0.00	657.45	1,928.39	$2,585.83	☐
33231504	Surface Pad, Concrete, 2' x 2' x 4"	10.00	EA	38.18	68.31	4.32	$1,108.06	☐
33232301	5' Guard Posts, Cast Iron, Concrete Fill	40.00	EA	24.27	29.30	0.05	$2,144.67	☐

Total Element Cost	**$5,838.56**
Total Technology Cost	**$34,551.45**
Total Phase Cost	**$121,009.48**

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 9/17/2002 2:04:15 PM

Project Cost Over Time Report (with Markups)

Folder: FE Warren
Installation Name: Spill Site 7 EE/CA (Final)
Installation ID: Spill Site 7 EE/CA (Final)
Project Name: Pilot Test - HRC Application
Site Type: None
Project ID: Pilot Test - HRC Application

Location: FE WARREN AFB (CHEYENNE), WYC

Initial Phase Start Date: 8/1/2002

Phase	Phase Name	Calendar Year 1 2002	Calendar Year 2 2003	Row Total
Remedial Action	Pilot Test - HRC application (Capital)	$163,444	$26,952	$190,396
Sub-Total		$163,444	$26,952	$190,396
Discount Factor		1	1.05	
Total		$163,444	$25,669	$189,113

Cost Database Date: 2002
Cost Type: User-Defined
Date: 9/17/2002
Time: 2:01 PM

Project Cost Over Time Report (with Markups)

)MING

Phase	Phase Name
Remedial Action	Pilot Test - HRC application (Capital)
Sub-Total	
Discount Factor (5%)	
NPV	

Cost Database Date: 2002
Cost Type: User-Defined
Date: 9/17/2002
Time: 2:01 PM

APPENDIX G

RESPONSE TO WDEQ AND EPA COMMENTS

RESPONSES TO WDEQ COMMENTS ON DRAFT ENGINEERING EVALUATION/COST ANALYSIS SPILL SITE 7 - OPERABLE UNIT 2 F. E. WARREN AIR FORCE BASE CHEYENNE, WYOMING FEBRUARY 2002

1. Comment: Page 2-2, Geology, last line discusses the upper 130 feet of the Ogallala Formation, and the complete thickness of the Brule Formation. Suggest adding the complete thickness, or range in thickness, of the Ogallala across FEW for consistency.

Response: The text has been revised as follows:

> The geology at FEW consists primarily of Quaternary terrace deposits that generally do not exceed 25 feet in thickness. These unconsolidated deposits, which are thickest along the streams, consist mainly of clay, silt, sand with some gravel, cobbles and boulders. The Quaternary deposits are hydraulically connected with the underlying Tertiary Ogallala Formation. The Ogallala Formation consists of a heterogeneous mixture of clay, silt, sand and gravel, which is up to 300 feet thick in this part of Wyoming. Some layers are well cemented whereas others tend to be friable and unconsolidated. In general, the upper 130 feet of the Ogallala Formation consist of silty clay with slightly consolidated sand and gravel layers interbedded with clay and silt. Sandstone and conglomerate beds also are present. The Ogallala Formation dips to the northeast at about 52 feet per mile and has an approximate strike of northwest. The Quaternary deposits and the Ogallala Formation form the High Plains aquifer at FEW.

2. Comment: Table 3-3, page 1 of 1, comments column, third block from top, appears to contain a typo. Suggest replacing "be" with "been."

Response: The typographical error has been corrected as suggested.

3. Comment: Pages 6-3 and 6-4, Subsection, Treatment of VOC-Contaminated Material with SVE, states that after sampling indicates successful soil treatment to below hazardous waste criteria that the soil will be combined with non-hazardous material. Subsection, Backfilling the Excavation, states that the excavation will be backfilled with treated material. What concentration of TCE will be allowed in material to be backfilled?

Response: The treatment goal for the ex-situ SVE system is a narrative standard of 42 ppbv, which meets the first RAO of reducing concentrations of TCE and associated daughter products in unsaturated soil that act as a continuing source of contamination to the groundwater. The

narrative standard is presented in Section 3.2.1 of the Draft Final EE/CA. For exact wording of the changed text see the EPA General Comment #5.

4. Comment: Page 6-4, the subsection Backfilling the Excavation with Clean Fill from an Off-site Source contains only discussion of backfilling with treated material rather than clean fill from off-site. Please clarify.

Response: The subsection has been renamed to Backfilling the Excavation with Treated Material. The correct subsection title will be included in the Draft Final EE/CA and the content will reflect the clarification that the excavation will be backfilled with treated soil.

End of WDEQ comments and responses.

RESPONSES TO EPA COMMENTS ON DRAFT ENGINEERING EVALUATION/COST ANALYSIS SPILL SITE 7 - OPERABLE UNIT 2 F. E. WARREN AIR FORCE BASE CHEYENNE, WYOMING FEBRUARY 2002

General Comments

1. Comment: The Draft Engineering Evaluation/Cost Analysis (EE/CA) presents a summary of the nature and extent of contamination and the evaluation of removal action alternatives for Spill Site 7 in Operable Unit (OU) 2 at the F.E. Warren Air Force Base (FEW) in Wyoming. However, no summary is provided to document that the site meets the National Contingency Plan (NCP) criteria for initiating a removal action. Although this documentation must be included within an Action Memorandum, the documentation should be summarized in the EE/CA. In this case, the most appropriate criterion of the NCP, appears to be 40 CFR Sec. 300.415 (b)(2)(iv) for "high levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface, that may migrate."

Response: The following paragraph has been added to Section 1.0 following the 3rd paragraph:

> The authority for this response action stems from the NCP as codified in 40 CFR 300.415(b)(1), under which a determination has been made that there is a threat to public health or welfare or the environment posed by the contamination present at Spill Site 7. This determination of whether an IRA is needed was based on factors set out in 300.415(b)(2), specifically, (iv) High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface, that may migrate. In the case of Spill Site 7, the contaminants are present throughout the soil column and have the potential to migrate into the groundwater continuously into the future.

2A. Comment: The document suggests that soil contamination is acting as a continuing source of contamination to ground water downgradient from the area of soil contamination and Section 2.3 discusses contamination migrating laterally from the source area in step-wise fashion due to the presence of caliche layers. However, a clearly explained site model is not provided, and the information presented in the EE/CA is insufficient to support the lateral migration aspect of the conceptual site model. The document should include a stand-alone section on the conceptual site model and should include information that supports that site model.

Response: Section 2.3 has been modified with the addition of Section 2.3.6 Fate and Transport, which serves as the conceptual site model. (To avoid confusion, the phrase "conceptual model" is reserved for the portion of the baseline risk assessment that defines the contaminated media, the factors of exposure, and the potential receptors.)

The following text has been added to clarify the contaminant release, the migration pathways, and the occurrence of contaminants in soil, soil gas, and groundwater in the source area:

> In summary, the contamination at Spill Site 7 is dominated by TCE and its daughter products, which are present in the shallow and deep soil gas, in saturated and unsaturated soils, and in the groundwater. The historical releases of TCE from the grease trap were part of a process involving relatively steady water flows from floor drains and air conditioning units with sporadic higher water flow events that may have cause a wash-out of the grease trap contents. Regardless of the specific occurrence that resulted in releases from the grease trap, the TCE was most likely accompanied by substantial quantities of water at all times. Because of this history, it is unlikely that there ever was a release of pure TCE product that would have resulted in downward migration of TCE NAPL. The more likely scenario is a release of dissolved phase TCE along with a quantity of water, resulting in accumulation of TCE in the saturated and unsaturated soil, as well as the groundwater.
>
> The migration of the TCE, once the release from the grease tap occurred, would have been dictated by surface and subsurface features of the site. The drainage ditch itself would have limited the overland flow to a distinct west-northwest direction during release events. In addition, the contaminants may have migrated westward along the ditch some distance before the surface soils allowed infiltration and downward migration to begin. This could have created the groundwater TCE distribution observed at Spill Site 7 (see Figure 2-12), where the groundwater is not significantly contaminated directly under, or immediately nearby, the grease trap, but becomes more contaminated at some distance westward from the source. This "delayed infiltration" model is supported by sampling data from SS7SG19, located 75-100 feet west of the grease trap, where soil gas exhibited 26,000 ppbv TCE at 10 feet depth, but only 560 ppbv TCE at 20 feet (see Figures 2-9 and 2-10).
>
> An additional potential control on contaminant migration in the vadose zone is the presence of several caliche layers and soils with low permeability at the site (see Figures 2-4 and 2-5). These geologic features limit direct downward percolation of surface water to the groundwater system, and the field observations suggest that the caliche layers are slightly deeper to the west from the former grease trap, which could also explain the westward migration of contaminants before they reached the groundwater. This "geologic control" model is supported by the presence of low permeability caliche horizons with highly contaminated soils directly above them and minimal contamination below them. This relationship is apparent in the borehole log for SS7SB33, located just downstream of the grease trap, where the headspace reading is 231 ppm at 16 feet, just above a "No Recovery" zone signifying caliche. The headspace reading at 22 feet was 10.9 ppm.
>
> With either of these concepts, alone or in concert, water is limited in its movement downward through the soil column, but it can move laterally either along the surface

ditch or in a stair-step fashion from one caliche layer to the next until it reaches the groundwater system. Once it reaches the water table, contaminants would travel with the gradient of the groundwater. An additional factor that may have influenced migration in the vadose zone over the past 10 years is related to preferential flow of precipitation leaching through the soil column along the backfilled trenches from remedial actions during the 1992 Treatability Study.

The presence of soil gas contaminants just above the water table in distant areas north of the drainage ditch may be an artifact of volatilization from the contaminated groundwater.

Regardless of the combination of mechanisms acting on contaminant migration, the levels of TCE observed in the soil gas and downgradient groundwater suggest that a NAPL may be present as a residual in the soil matrix. Figure 2-13 depicts the occurrence of this residual NAPL, along with the vapor phase in soil gas, sorbed phase on soil particles, and dissolved phase in groundwater. This schematic suggests that the NAPL is not present in sufficient quantity to migrate as a fluid, but will continue to contribute to soil vapor and groundwater contamination into the future unless addressed. The residual NAPL appears to be present in both the vadose and saturated zones, as depicted in the figure.

2B. Comment: In addition, Discuss the relationship between ground-water contamination and vapor-phase contamination at downgradient areas. For example, the soil gas reading at location SS7SG17 was 21,000 parts per billion by volume (ppbv) (see Figures 2-3 and 2-4) and the concentration of trichloroethylene (TCE) in ground water at nearby well MW151 was 13,170 micrograms per liter (ug/l) (Figure 2-12). The presence of downgradient vapor phase concentrations should be discussed as part of the conceptual site model, including how that contamination may or may not relate to ground-water contamination.

Response: A discussion of the relationship between soil gas and groundwater contamination is included in the newly created Section 2.3.6, which is presented in the Response to Comment #2A above.

3A. Comment: The document discusses risk posed by the contaminated soil. However, the risks posed by the site, the identification of contaminants of concern (COCs), and the contaminant concentrations on which the risk comparisons are based are not clearly defined. Section 2.3.3.1 discusses soil screening levels (SSLs), including site-specific SSLs, and Section 2.4 discusses site risks, but it is unclear whether risk-based concentrations (RBCs), SSLs, or site-specific SSLs are the final risk comparison criteria. Furthermore, it is unclear whether the COCs derived from the RBC evaluation are the same ones derived from the SSL evaluation. The EE/CA should clearly identify the risks posed by the site, including the exposure pathways, the final list of COCs, the basis for selection of the COCs, and the concentrations of COCs that pose a risk.

Response: The RBC values are presented in Sections 2.3.2 and 2.3.4 as screening criteria to assess whether site soils may pose a risk under standard exposure conditions. The baseline risk assessment (BRA) for Spill Site 7 had not been completed at the time of production of the EE/CA. Now that the BRA has been completed and reviewed, the results from the BRA for Spill Site 7 will be presented in the Spill Site 7 EE/CA. To address the risk issues, Section 2.4 will be replaced in its entirety with the following:

2.4 RISK EVALUATION

A comprehensive baseline risk assessment (BRA) was performed for Spill Site 7 as part of the Remedial Investigation and is contained in the Zone D Source Areas Draft RI Report submitted for review in February 2002 (USAF 2002). The following summary is extracted from that document:

Human Health Risk Assessment

A baseline HHRA was performed in accordance with the *Baseline Risk Assessment Scoping Document* (USAF 2001f) and the *Zone D RI Work Plan* (USAF 2001a) to determine if contaminants in soils at the Spill Site 7 source area present unacceptable risks to human health. Analytical results from surface and surface/subsurface soil combined were used to identify COPCs for evaluation in the risk assessment. There were no COPCs for surface soil. The only COPC for surface/subsurface soil combined was p-cymene, which has no toxicity values. Noncancer hazards and cancer risks were therefore not quantified for any potential human receptors. p-Cymene was detected at a low frequency and at low concentrations that are not likely to have a significant adverse impact on the health of future construction workers potentially exposed to subsurface soils at this site.

Ecological Risk Assessment

An ERA was performed in accordance with the *Baseline Risk Assessment Scoping Document* (USAF 2001f) and the *Zone D Source Areas RI Work Plan* (USAF 2001a). One assessment end point was evaluated:

- Are local populations of plants, soil invertebrates, birds, and small mammals inhabiting the short grass prairie being maintained?

Terrestrial receptors used to represent birds and mammals are the western meadowlark, horned lark, and deer mouse. For the purpose of assessing risk, it was assumed that plants are exposed to surface (0 to 2 feet) and shallow subsurface (0 to 5 feet) soils; soil invertebrates, birds, and mammals are exposed to surface soil (0 to 2 feet).

Measured concentrations of chemicals in surface and shallow subsurface soil were compared to a series of screening thresholds to focus the ERA on those chemicals

that may be site-related and may potentially pose an unacceptable risk. The ERA for surface and shallow subsurface soil in Spill Site 7 included comparison to background concentrations of inorganic chemicals, and comparison of both inorganic and organic chemical concentrations to conservative RBCs. Based on this screening, 11 inorganic constituents (antimony, barium, cadmium, chromium, copper, lead, mercury, selenium, thallium, vanadium, and zinc) and one organic constituent (Aroclor 1260) were retained as COPECs in surface and shallow subsurface soil.

Based on HQs calculated for receptors exposed to surface soil, antimony, barium, cadmium, copper, lead, mercury, selenium, thallium, vanadium, zinc, and Aroclor 1260 may present risks to small mammals in the Spill Site 7 source area.

Risks to avian receptors are all less than 10, which suggests low to moderate potential for adverse ecological effects.

Risks to soil fauna are somewhat elevated and may indicate the potential for low to moderate adverse ecological effect to these receptors.

Plants in the Spill Site 7 source area exposed to concentrations of chromium, copper, lead, selenium, and vanadium in surface and shallow subsurface soils may potentially experience adverse effects. The magnitude of these apparent risks to plants may be affected by the bioavailability of inorganic chemicals to plants. Metals need to come into contact with plant roots in order for uptake to occur, and metabolic activity of roots and the release of exudates affect the rate of solubilization and bioavailability of ions for plant absorption. Therefore, the apparent risks to plants may be overestimated. Because a TRV for terrestrial plants was not available for Aroclor 1260, an HQ could not be estimated for this chemical.

3B. Comment: EPA notes the risk assessment for the draft Zone D source area remedial investigation (RI) report also assesses Spill Site 7, in this case more formally. In this case, no potential contaminants of concern were identified for quantitative risk assessment (although p-cymene was retained for qualitative evaluation) for surface or subsurface soils. The draft RI does identify a strong potential for further contamination of ground water. Using this information indicates removal action objectives should be keyed more towards contaminant fate and transport.

Response: Removal action objectives have been revised to focus more appropriately on the protection of groundwater rather than on any discussion of site risks, which are minimal. See Response to Comment #5 for revisions to the RAO text.

4A. Comment: The document presents soil contaminant information in tables according to depth and in figures (Figures 2-9 and 2-10) as “shallow” and “deep”, which are defined

according to elevations. However, ground surface and mean elevations for each borehole or well location are not provided, so it is not possible to correlate the information on the figures to the information in the tables. A table should be provided, or the existing contaminant-related tables revised, to show ground surface elevations and sample elevations for all water and soil borehole locations.

Response: Ground surface elevations were not provided for each borehole for readability of the figures. Table 2.2b has been added to provide ground surface elevations for all soil gas points.

4B. Comment: It also appears that the "shallow" and "deep" elevation definitions indicated in Figures 2-9 and 2-10 are arbitrary and result in areas of contamination that are excluded from the contaminant isopleths. For example, Table 2-2 indicates that total soil gas readings in excess of 10,000 ppbv were measured at a depth of 8 feet below ground surface (bgs) at location SS7SG05, but the soil gas reading of 440 ppbv measured at a depth of 13.5 feet bgs, is shown for the shallow soil gas detections in Figure 2-9. In addition, Table 2-2 indicates that soil gas readings of 28,000 ppbv were measured at location SS7SG19A, but these readings are not shown on either Figure 2-9 or Figure 2-10.

The basis for the classification of "shallow" and "deep" should be reconsidered, and if retained, should be revised to a less arbitrary classification in which data is not excluded from consideration. The classification should include an explanation of why a "shallow" and "deep" division in the soil contaminant data is necessary, why the "shallow" and "deep" division is important to an understanding of the site characteristics, and how this division relates to the removal action. Figures 2-9 and 2-10 should be revised accordingly.

Response: The classification of shallow vs. deep was based on the executed sampling strategy, which was detailed in the approved Work Plan. This strategy called for collection of soil gas samples at approximately 5 feet deep and directly above the water table. The actual shallow samples were collected between 4 and 12 feet depth and the deep samples varied from 14 to 26 feet deep. The variability in depths was a result of physical limitations imposed by the caliche layers. The depth of the shallow and deep soil gas samples were adjusted to compensate for the surface topography. Elevations of sample depths were subtracted from the surface elevations and a midpoint was chosen to display soil gas concentration in the upper and lower unsaturated zones. It was necessary to adjust elevations to mean sea level to correlate to geology and water tables and was useful in identifying potential contaminant infiltration locations versus locations where contaminated soil gas may be derived from migrating groundwater contamination. Although a full 3-dimensionsional analysis and portrayal of the data would be preferable, the distribution and numbers of samples do not lend themselves to that level of evaluation. Therefore the "shallow" and "deep" assessment and presentation will be retained. It should be noted that in locations where a sample was not located within a horizon (Shallow or Deep), "NS" was added to the figure to indicate "not sampled." In areas where two or more samples were collected within a horizon, the higher of the two points was plotted. Section 2.3.1 was revised to clarify the depths used as follows:

The shallow and deep soil gas results are posted in Figure 2-9 and Figure 2-10. These two figures show concentrations of TCE at approximately 4-12 feet deep and just above the water table (14 to 26 feet bgs). These two sample depths were defined in the approved Work Plan to allow evaluation of potential shallow contaminant infiltration zones as well as to define the vapor distribution at greater depths just above the water table, which may be related to volatilization of groundwater contamination. As seen in Figure 2-9, a proportion of the contaminants appear to have migrated westward from the grease trap in the shallow vadose zone before reaching the groundwater. Figure 2-10 exhibits a broader soil gas plume in the soils just above the water table, which suggests that the contaminants have started to migrate to the north, more consistent with the local groundwater flow direction.

5. Comment: The basis for the removal area boundary is not well defined. The document indicates that vapor-phase contaminant concentrations (soil gas readings) were used to determine the boundary of the removal area. The concerns with the current basis of the removal area boundary include:

- establishing a link between soil gas readings and contaminant concentrations in soil and risk,
- why the criteria of "deep" and a soil gas reading of 10,000 ppbv were selected for setting the boundary,
- areas exist outside of the proposed removal area in both the vertical and lateral directions which meet the criteria of "deep" and contain soil gas readings greater than 10,000 ppbv,
- explaining the exclusion of areas in which the soil gas readings did not meet the criteria of "deep," such as location SS7SG05A at which soil gas readings summed to more than 10,000 ppbv at a depth of 8 feet, and
- explaining the exclusion of areas in which the soil gas readings did not meet the criteria of 10,000 ppbv, but still contained elevated soil gas readings.

The boundaries of the removal area should be based on concentrations of COCs in soil which exceed the removal action objective (criteria based risk and/or potential to contaminate ground water). Any areas at which the COCs exceed the criteria, but are not included within the removal area, must be fully explained.

Response: The cleanup criteria should not be tied to bulk soil sampling because this has proven to be an unreliable indicator of vadose zone contamination at FEW and other U.S. Air Force IRP sites. The RAO is tied to potential contribution to groundwater: this can be from soil vapors or contaminants sorbed to the soil; however, soil vapor is a more reliable indicator of vadose zone contamination levels than bulk soil because it is less sensitive to geological heterogeneity. This approach has been used successfully at Air Force Plant (AFP) 44 in Tucson, Arizona, where bulk soil samples so seldom identify VOC contamination they are generally not collected at the site. At one AFP 44 IRP site

> where bulk soil sampling during the RI indicated minimal VOC contamination, a large-scale SVE system extracted over 75,000 pounds of VOCs to achieve closure. Bulk soil sampling suffers from a small sample area when a split-spoon sampler brings up a 2-inch-diameter sample, it may not reflect what is found 1 foot away in potentially different geologic conditions. Soil gas samples, like groundwater samples, are representative of a broader area because the media sampled reflect equilibrium conditions within the radius of sampling influence (ROI) of the well or probe. This sampling ROI is often many feet in soil gas sampling.

At FEW, the interim removal action (IRA) is intended to reduce VOC levels in the most contaminated portion of the site to levels that will not contribute to future groundwater contamination. In executing this IRA, the narrative standard presented above as well as additional language relating soil gas levels to potential groundwater levels will be added to the end of Section 3.2.1 as follows:

> The first RAO for Spill Site 7 (reduce potential for groundwater contamination) will be evaluated against a narrative standard such that TCE contaminant concentration in vadose zone soil shall be reduced to levels that do not cause or contribute to groundwater contamination in excess of the Federal Safe Drinking Water Act MCL for TCE of 5 µg/L.
>
> To evaluate compliance with this narrative vadose zone soil cleanup standard, the potential contribution of TCE from the soil to the groundwater will be evaluated using soil vapor sample results rather than bulk soil sampling. This will be done to avoid under representing contaminated zones in the heterogeneous soil matrix that may be missed with discrete soil sampling, but are typically reflected in a soil gas sample due to its greater sampling area.
>
> Henry's law can be used to define the equilibrium concentration of water with respect to vapor in accordance with the equation below:
>
> $C_{v,\,eq} = H\, C_{w,eq}$ (ASTM 1995)
>
> where:
>
> $C_{v,\,eq}$ = equilibrium vapor concentration, ppb - vapor
> $C_{w,eq}$ = equilibrium dissolved concentration, ppb - water
> H = Henry's Law constant, (ppb - vapor)/(ppb - water)
>
> From the literature, H = 0.422 for TCE (EPA 1996). Note that units on $C_{v,\,eq}$ and $C_{w,eq}$ must be consistent to avoid using conversion factors and that the Henry's Law constant is functionally unitless.

The *EPA Soil Screening Guidance User's Guide* (EPA 1996b) recommends a default DAF of 20, which is the dilution that can be attributed to a leachate that is protective of groundwater. Using this relationship and the MCL of 5 µg/L for TCE in drinking water yields:

Acceptable leachate concentration = MCL X DAF = 5 ppb x 20 = 100 ppb.

Setting the acceptable leachate concentration equal to $C_{w,eq}$ and using H described above yields:

$C_{v,\ eq}$ = 0.422* 100 ppb = 42 ppb – vapor

Therefore, based on this evaluation, the contaminated vadose zone soils will have a treatment end point of 42 ppb in vapor. Once this end point is reached, the soils will be returned to the excavation.

Compliance with the first RAO for saturated zone soils will not be evaluated using bulk soil analytical data due to the inherent heterogeneity of site soils and demonstrated lack of representativeness of those samples at Spill Site 7. Because the goal is to reduce the contaminants in the soil such that they are protective of groundwater, the evaluation criteria for success in the saturated zone soil cleanup will be a reduction in groundwater contamination levels over time. Furthermore, because the PRB wall is located downgradient from a portion of the source area, the objective will not be to eliminate groundwater contamination emanating from the source area, but will be to substantially reduce the levels and allow the PRB wall to clean up the remaining dissolved phase contamination in the groundwater. Additional groundwater monitoring wells may be installed in specific locations downgradient of the source area and baseline data will be collected prior to any remedial action to allow assessment of the effectiveness of any source reduction activities in the saturated soils.

6. Comment: Discuss the potential integration of this removal action with future anticipated remedial actions that might result from the remedial investigation (RI)/feasibility study (FS). Discussion should be provided with regard to how the proposed removal action would complement, or be integrated with, future remedial actions. This needs to be addressed in the identification and screening of alternatives, and the reader briefly reminded in Sec. 6 because consistency with final remedies may also have a bearing on the preferred alternative.

Response: The RI related to Spill Site 7 has been completed at the draft level and has reached the conclusion that further remedial action at Spill Site 7 is required to address the source material in the saturated soils. The scope of the recommended removal action described in the Draft EE/CA has been enhanced to address the saturated soil source area. The implementation of the proposed IRA will also be integrated with the existing PRB wall located immediately north of the Spill Site 7 source area. The addition of saturated soil treatment, results in many changes to the document, which are too numerous to document here. Changes related to the integration

with the PRB wall are also numerous, but the last part of the Response to Comment # 5 somewhat addresses this issue.

7. Comment: A partial site history is included in Sec. 2.2.1 (page 2-6) and other site history is discussed in Sec. 2.3 (page 2-12), but these discussions are incomplete with large time gaps in the history. Provide a more comprehensive discussion on site history, including building and land use.

Response: The following sentence has been added to Section 2.2.1 at the end of the second paragraph:

> No additional information is available concerning the historical usage of the grease traps or activities at Spill Site 7.

8. Comment: Provide Tables 2-8 and 2-9 which were not included with the document.

Response: These inadvertently omitted tables contain summary information derived from tables that were presented in the Draft document. They will both be included in the Draft Final EE/CA.

9. Comment: Confirmation sampling is needed in excavated areas to verify removal action objectives have been met. This will need to be added to cost estimates. If soil gas readings are retained as the basis for determining the removal action boundary, a link between soil gas readings and concentrations of COCs in soil should be firmly established. Soil gas cannot be effectively used for confirmation sampling while the excavation is open.

Response: Confirmation samples were included in the cost estimates, but were inadvertently omitted from the text. The link between soil gas readings and groundwater concentrations has been added to the document, as described in the response to General Comment #5 above. Confirmation sampling occurs in several forms during this IRA. First, samples will be collected prior to any action to verify the location of metals-contaminated soils and define the area for removal of those soils. Following excavation of the metals contaminated soils, confirmation samples will be collected from that excavated area to confirm that the appropriate amount of soils have been removed. Samples will also be collected from the stockpiled soils to determine the appropriate disposal option. Second, soil samples from the side-walls of the excavation will be screened with field headspace readings using a photoionization detector to verify that the gross contamination is removed for treatment. Third, clean up confirmation sampling would be performed on excavated and treated soils to verify that the treated soil can be put back in the excavation with minimal risk of further contaminating groundwater. Since the excavation is not intended to progress into the unsaturated zone, there is no need for confirmation sampling at the bottom of the excavation. Contamination will still be present in the saturated soil and groundwater. Language supporting this strategy has been added to Section 6.1 as follows:

Delineation of Metals in Surface Soil

Twelve surface soil samples will be collected from the drainage ditch area, six samples at a depth of 0-1 foot and six at a depth of 3-4 feet, prior to the initiation of excavation activities. The samples will be sent to an approved laboratory facility with an accelerated turnaround time for metals analysis by EPA Method 6010 and TCLP analysis for metals to facilitate disposal, if warranted.

Excavation of Surface Soil Material

Based on surface soil inorganic results, material along the drainage ditch encompassing an area estimated to be 120 feet by 5 feet will be removed to a depth of approximately 1 foot. The soil will be loaded into trucks and hauled off-site to an approved landfill facility. The facility selection is dependent on the results of the proposed sampling activities. Ten soil samples will be collected following the excavation to confirm that the removal of elevated metals-contaminated soils is complete.

Excavation of VOC-contaminated Subsurface Material

The VOC-contaminated material, consisting of an estimated 10,500 LCY of material in the area exhibiting the highest soil gas readings, will be excavated and staged on-site, within the footprint of the AOC. Excavation limits in the sidewalls will be defined in the field using headspace readings from a PID. A review of the geologic logs from Spill Site 7 soil boring and well installation activities, as well as review of the soil gas sampling results, indicates that a field headspace reading of 1,000 ppm will be effective at delineating the most contaminated area. All locations with soil gas readings above 10,000 ppbv, were accompanied by field headspace readings above 1,000 ppm. Therefore, soils exhibiting greater than 1,000 ppm total VOCs in temperature-stabilized headspace samples will be excavated for treatment. This excavation criterion will be reevaluated during the excavation activities to ensure that it is appropriate. Any changes in the criterion will be presented to the regulatory agencies for approval prior to usage. The excavated soil material will be spread in windrows in constructed ex-situ SVE treatment cells. Air monitoring will be conducted during all excavation activities.

Treatment of VOC-contaminated Material with SVE

The VOC-contaminated soil will be spread in windrows in the treatment area, which will consist of bermed sidewalls and a manifold of slotted PVC pipe on which the hazardous soil will be placed. Blowers connected to the manifold draw air through the soil, removing volatile contaminants. The system effluent will be captured in GAC canisters that remove volatiles from the air stream. After sampling indicates successful soil treatment to below the narrative standard

defined in Section 3.2.1, the soil will be returned to the excavation. This process will be repeated until all of the soil in the area of interest has been addressed.

Site Restoration, Including Removal of the Treatment System

All haul roads will be removed from the site. Earthen berms for the SVE system and the staging area will be removed. Piping and associated treatment system materials will be disposed according to all applicable regulations. Vegetative cover will be placed to match existing site conditions.

Demobilization and Equipment Decontamination

Equipment used on-site will be decontaminated prior to demobilization. All spent GAC canisters, decontamination water, personal protective equipment, and any generated investigation-derived waste will be disposed according to all applicable regulations. The decontamination pad will be removed, any temporary facilities will be removed, and the site restored to match pre-implementation conditions.

10. Comment: In the cost estimates in Sec. 4, identify the discount (interest) rate by which the total present worth costs are estimated. The project managers have agreed to 5% as a default value.

Response: The RACER version used for the cost estimating was updated with 2002 costs as defaults. Since this project is 2002 project, no escalation was applied.

Specific Comments

11. Comment: Sec. 1.0, Page 1-1, 2nd paragraph. Define what is meant by "source area" so that the scope and intent of the removal is briefly described. The original "source" for contaminants was the oil-water separator (OWS) which overflowed. Remaining contaminants transported through soil media can also be treated as a source.

Response: The source area, as defined in the RI, has been added to the 2nd paragraph of Section 1.0 as follows:

The EE/CA addresses the vadose and saturated zone source areas within Spill Site 7. The following criteria were established to determine if a source is present in unsaturated or saturated soils and whether removal action is necessary to reduce risk to human or ecological receptors or to be protective of groundwater or surface water at the site:

1. Direct field observations: Are odors, staining, or elevated headspace readings present?

2. Human or ecological risk: Does contamination of any medium present a risk to human ecological receptors?

3. Exceedance of MCLs in groundwater: Do contaminant concentrations in groundwater exceed MCLs?

4. Potential leaching of unsaturated soils: Do contamination levels in bulk soil exceed calculated site-specific soil screening levels?

5. Potential leaching of saturated soils: Do contamination levels in bulk soil exist at levels where the resultant soil leachate would raise groundwater concentrations above MCLs?

6. Elevated soil gas readings: Do soil gas readings exist at levels indicative of residual free-phase contamination in vadose zone soils (Cohen and Mercer 1993)?

7. Historical groundwater contamination: Do historical groundwater concentrations in the source investigation area increase or stay the same over long periods of time?

Based on these criteria, unsaturated and saturated soils at Spill Site 7 are source areas for future and continuing groundwater contamination.

12. Comment: Sec. 2.1.1, Surrounding Land Use, Sec 2.1.6, Sensitive Ecosystems. These descriptions are suitable at the base-wide scale. However, for most of these topics the specifics pertinent to Spill Site 7 still need to be added. In particular, proximity to the removal area such [that] the reader can ascertain the likelihood of affects by the action on the ecosystem and/or whether actions will need measures to prevent effects. Because of past interim actions on the site, this should already be known by Air Force experience and can thus be addressed in this EE/CA.

Response: Because of the distance between the source area and the sensitive habitats and wetlands areas, it is unlikely that any of the proposed activities will have an impact. Every effort will be made to control fugitive dust emissions, vapor releases, and sediment runoff to ensure that the local area is not impacted during the field activities. The following text was added to the end of Section 2.1.1.

> Land use at Spill Site 7 itself is open field. There are no regular activities at the source area or the proposed treatment area beyond quarterly environmental sampling.

And, the following text was added to the end of Section 2.1.6:

> None of the sensitive ecosystems described above are located within the footprint of the Spill Site 7 source area or treatment location. However, the presence of these sensitive areas in the vicinity of Diamond Creek makes them important to the selection and execution of the potential removal alternatives for Spill Site 7.

13A. Comment: Sec. 2.1.4, Page 2-3. Although Figure 2-6 presents ground-water levels, and a range of values for depth-to-ground water is discussed, a table showing the depth-to-ground water for individual wells is needed. A table showing the historical and current depth-to-ground water for individual wells is relevant to any response action which may key to the water table, which fluctuates.

Response: The preferred remedial action is not contingent on the depth of groundwater. Rather, the excavation will be implemented to the water table, regardless of the depth at the time of the action. Following this excavation, piping will be installed to facilitate injection of treatment materials. Regardless of water table fluctuations, this piping network will be equally effective. Detailed water level data for Spill Site 7 are presented in the Zone D Groundwater RI by another contractor.

13B Comment: Ground-water elevations presented in Figure 2-6 are from measurements collected during the weeks of November 12 and 21, 2001. Ground-water elevation figures are typically based on measurements that are collected on the same day (or within a few days if there are a large number of wells). Explain whether water level data collected over a two-week time period may have affected the ground-water elevations presented in Figure 2-6 (i.e., are any changes expected to be significant).

Response: Sampling occurred over a two-week period. Since there are multiple contractors on-site, an attempt was made to coordinate some of the fieldwork within similar time periods. Water levels obtained from wells near the PRB wall were from the long-term monitoring program, while the second data set, collected in and around the source area, was collected as part of the source areas RI to provide a wider range of coverage for Spill Site 7. Duplication of field efforts was not warranted due to base flow conditions during winter months and no precipitation events during the 2-week period. Text was inserted in Section 2.1.4 as follows:

> Site-wide water levels were collected the weeks of November 12 and 21, 2001. Although water levels are typically collected over a shorter period of time, these readings were obtained as part of two separate projects by two contractors. No rain events occurred during the two week period, so these data are deemed usable.

13C Comment: The discussion refers to contours presenting a "V" pattern pointing to the southeast centered on the collection drain from a previous study. The proximity of the "V" to the drainage ditch associated with the original oil-water separator may indicate a facilitated ground water transport pathway. The highest levels of contamination detected are also in this vicinity, with concentration zones elongated somewhat along this trend. This fate and transport mechanism belongs in the site conceptual model.

Response: The potential fate and transport mechanism described above has been added to the discussion in Section 2.3.1 as described in the response to General Comment #4.

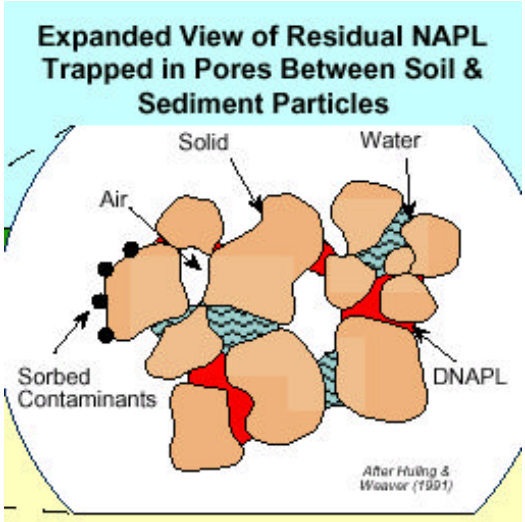
14. Comment: Sec. 2.2.1, Page 2-6. Even though a grease trap (oil-water separator) and drainage ditch associated with the building drain system was apparently in use from 1960 to 1988, and is the suspected original source of contamination, the trap and drainage ditch are only discussed for the time periods of 1960 to 1966 and 1987 to 1988. Any available additional history should be provided for the grease trap and drainage ditch at the site, and the entire discussion should be within the context of site history.

Response: The following sentence has been added to Section 2.2.1 at the end of the second paragraph:

> No additional information is available concerning the historical usage of the grease traps or activities at Spill Site 7.

15A. Comment: Sec. 2.3, Analytical Data/Extent of Contamination. Because of the low solubility of TCE and the relatively high concentrations found in ground water, there is a potential for the development of a dense, non-aqueous phase liquid (DNAPL) moving through the subsurface in addition to the water phase. Describe the potential for this to occur, and the transport of the organic phase. In this case, it would travel similarly to water under gravity above the water table. Beneath the water table, it would continue to travel downward (or "stair step" downward) until it reaches a permeability barrier such as a clay zone) while small amounts dissolve [into] the ground water plume.

Response: The contaminant levels in the groundwater suggest that a residual NAPL phase may be present as "ganglia" trapped within the soil structure. This residual NAPL is a continuing source for groundwater contamination and is being addressed in this EE/CA through treatment of the saturated zone source area, which is where it resides. There is no evidence in the groundwater or soil data to suggest that a "pool" of DNAPL is present at Spill Site 7. The following figure more appropriately represents the conceptual occurrence of the TCE as sorbed phase and residual NAPL. A similar figure has been added to the document as Figure 2-13 and the concept is described in detail in newly created Section 2.3.6, Fate and Transport. Response to Comment # 2A presents the added text.



15B. Comment: Clarify if there are any field observations which are consistent with the "stair-step" model of transport. For example, were cores taken at intervals intersecting the caliche surfaces and/or clay surfaces? Was residual staining, free liquid, or such observed?

Response: The main observation that requires lateral migration before infiltration to the water table is the fact that the groundwater contaminant plume is not centered on the grease trap, but begins more than 200 feet to the west, which is not in the general, preferred groundwater flow direction. From this point, it begins to migrate northward along with the general groundwater flow direction. This observation requires a mechanism to transport the contaminant discharges from the grease trap westward, then allow downward migration to the water table with no further westward migration along the surface. The stair-step model is supported by the presence of low permeability caliche horizons with highly contaminated soils directly above them and minimal contamination below them. This is present in the borehole log for SS7SB33, located just downstream of the grease trap, where the headspace reading is 231 ppm at 16 feet, just above a "No Recovery" zone signifying caliche. The headspace reading at 22 feet was 10.9 ppm. A delayed infiltration model, where contaminants migrate along the ditch while slowly infiltrating the soil is supported by other sampling locations. The soil gas readings in SS7SG19, also due west of the grease trap, exhibit as much as 28,000 ppbv TCE at 10 feet depth, then a maximum of 560 ppbv TCE at 20 feet. These two locations are between the grease trap and the core of the elevated TCE plume in groundwater, and both point to a lateral migration before infiltration, regardless of what the exact mechanism is. A second model for downward migration is that the contaminants migrated along impermeable layers and were intercepted by preferential pathways created by excavating, then filling the remediation system trenches that are located near the former grease trap. Language has been inserted into Section 2.3 elaborating on these concepts.

16A. Comment: Sec. 2.3.2, Subsurface Soil Samples, Page 2-12. The base wide background report numbers are mean values. Determining whether a metal is elevated above background should involve comparing background means (i.e., the 95% upper confidence level of the mean) to means from the site (the 95% UCLM). Low numbers of site samples may not allow such a

comparison. In this case, identify the range of background occurrences and the standard deviation of the mean. Compare this to the range of site sample values. If the metal occurs in normal or log-normal distribution in background, EPA and WDEQ have accepted the mean plus two standard deviations as an upper tolerance level to identify whether site samples are elevated above background. Only metals potentially elevated should be considered to contribute to excess risk (and thus the comparison to RBCs or SSLs).

Response: This statistical evaluation involving 95 UCL values for site data and background, and evaluation of normality, was performed as part of the Plume Heads RI report. The reader is referred to Section 9.4.1.3 in the Source Areas RI for a robust statistical evaluation and the "Summary Statistics Tables for Compounds Detected."

16B. Comments: Paragraph two provides values for residential RBCs. However, some values correspond to SSLs rather than residential RBCs according to the Environmental Protection Agency (EPA) Region 3 RBC table (EPA 2001). Some values for RBC appear to be reported too low (exponents on the table were apparently not correctly carried through).

Response: The SSL values for chromium III and chromium VI were inadvertently referred to as RBC values. This error will be corrected and the text has been revised as follows:

> Total chromium was evaluated against the residential RBC and SSL for the hexavalent chromium ion (chromium VI), which has the most conservative RBC and SSL values of the chromium ions. The residential RBC for chromium III is 1.2E+05 mg/kg as compared to 2.3E+02 mg/kg for chromium VI (EPA 2001a). The SSL for chromium III is 2.0E+09 mg/kg as compared to 42 mg/kg for chromium VI (EPA 2001a). Typically, chromium III is six times more prevalent than chromium VI. Eleven surface soil samples have values for total chromium that exceeded the SSL values. Site personnel indicate sodium chromate may have been used at Building 1294/4000. Disassociation of sodium chromate may produce chromium VI.

The values for non-carcinogenic compounds have been adjusted downward in the RBC tables by a factor of 1/10, as indicated on Page 3 of the memo to RBC Table Users from Jennifer Hubbard, Toxicologist, Region III Superfund Technical Support Section dated September 25, 2001.

17. Comment: Sec. 2.3.3.1, Soil Screening Levels, Page 2-14. Demonstrate how the dilution attenuation factor (DAF) value of 24 was developed and provide the site-specific SSLs which result. Identify the equation(s), assumptions, and input values used to derive the DAF value. Provide the resultant site-specific SSLs for all of the analytes that exceeded the general EPA Region III SSL criteria and any site-specific SSLs.

Response: The text has been modified to clarify the derivation of the site-specific DAF and SSL values. The original DAF value of 24 represents preliminary work and has since been

recalculated (now equal to 19.3) to account for a more representative hydraulic gradient. The text for Sec. 2.3.3.1 now reads:

> SSLs are used to aid in the determination of the likelihood of a contaminant migrating through the soil profile into the groundwater. EPA Region III publishes SSLs for unsaturated soils in relation to dilution attenuation factors (DAFs) of 1 and 20 and the tap water RBC (EPA 2002). This section briefly summarizes the site-specific SSLs , which are detailed in the *Draft Zone D Source Areas RI Report* (USAF 2002). For this evaluation, soil concentrations were first screened against the Region III SSLs with a DAF equal to 20 (EPA 2002). Only unsaturated zone soil results for Spill Site 7 were considered for the SSL screen.
>
> The exceedances of the general EPA Region III SSL criteria (where DAF equals 20) are:
>
> - TCE
> - cis-1,2-DCE
> - chloroform
> - 1,1,2-TCA
> - 2,4-dimethylphenol
> - arsenic
> - barium
> - cadmium
> - chromium
> - manganese
> - selenium
> - thallium
>
> Concentrations exceeding these initial screening levels were compared to SSLs calculated using site-specific data. The site-specific SSL and DAF equations, assumptions, and input values are found in the *Draft Zone D Source Areas RI Report*.
>
> The exceedances of the site-specific SSLs (where DAF is equal to 19.3) are shown in the following table with the Region III SSL values and site-specific SSL values:

Analyte	Region III SSL value (mg/kg)	Site-specific SSL value (mg/kg)
TCE	0.00026	0.0407
cis-1-2-DCE	0.035	0.3687
Chloroform	0.00091	0.0008
2,4-dimethylphenol	0.67	0.612
Manganese	95	62.931

The SSL partitioning equation for migration of constituents to groundwater is derived from equation 10 of the EPA's *Soil Screening Guidance: User's Guide* (EPA 1996b). The DAF equation is equation 11 in the EPA's *Soil Screening Guidance: User's Guide* (EPA 1996b). The *Draft Zone D Source Areas RI Report* lists all of the values and equations used for Spill Site 7 (USAF 2002).

TCE, cis-1,2-DCE, 2,4-dimethylphenol, and chloroform exceedances were noted in the area of the ditch and historic grease trap. Manganese exceeded the SSL in the majority of the unsaturated samples but is attributed to naturally occurring processes.

18. Comment: Secs. 2.3.2 through 2.3.3.1. A table summarizing the soil COCs along with their respective levels for risk (residential and industrial) and SSLs would be appropriate. This helps define removal action objectives and may identify where removal objectives may need to change to meet potential remedial action objectives. If a risk or SSL is very low it may be below the ability to accurately measure (i.e., the reporting limit for any acceptable method is above the criteria), it would also be useful to identify because this may become the measure for a removal action objective by default.

Response: A more thorough summary of the risks at Spill Site 7 has been added to Section 2.4. This summary presents the COPCs and the results of the baseline risk assessment, which was not completed at the time the Draft EE/CA was submitted.

19A. Comment: Sec. 2.3.4, Ground Water Samples, Pages 2-14 and 2-15. This discussion indicates the ground-water contamination is centered around well SS7TW10. However, this Section does not mention that the highest concentration of TCE in ground water occurs at MW-151, nor does it provide an explanation (i.e., within the context of fate and transport) of this detected concentration.

Response: The scope of the Zone D Sources RI/FS and associated Spill Site 7 EE/CA was limited by agreement among the RPMs to define continuing sources to groundwater contamination. A thorough assessment of the groundwater dissolved phase plume is being conducted under another project. The results of that project will be factored into the interim removal action planning phase, as well as the Proposed Plan and ROD for the permanent remedy

for Spill Site 7. Notes were added throughout the document, clarifying that the groundwater evaluation is peripheral to this EE/CA.

19B. Comments: The last sentence of this section states, "It appears the TCE plume has moved north and west away from the grease trap." Ground-water movement as the reason for the presence of ground-water contamination downgradient from the grease trap appears to be contradictory to a site model in which downgradient ground-water contamination is the result of step-wise lateral migration from soil contamination. Discussion of ground-water movement and the TCE plume should be consistent with a conceptual site model supported by the site's data.

Response: See the responses to general comment 2A.

20A. Comment: Sec. 2.3.5, Surface Water and Sediment, Pages 2-15 through 2-17. Tabulate the data being discussed. Chemical concentrations should compare surface water and sediment data results with RBCs and, in the case of surface water, the values for a Class 2AB stream. This helps define removal action objectives and may identify where removal objectives may need to change to meet potential remedial action objectives.

Response: The scope of this EE/CA is limited to a detailed evaluation of the source materials. The data and evaluation requested are fully contained in the *Draft Final Surface Water Risk Assessment*, issued by the USAF in January of 2002.

20B. Comment: The last paragraph on page 2-16 concludes elevated values of metals detected in sediment are naturally occurring and widespread. This conclusion is partially based on the presence of elevated metal concentrations in upgradient sediment samples. However, the last paragraph also mentions that polychlorinated biphenyls (PCBs) and dioxins have been identified in surface water and sediment in upgradient samples. Standing alone, this statement suggests contamination from upgradient sources. Briefly discuss other contamination sources and their impact on Diamond Creek. Also, specifically identify whether VOCs were detected in sediment samples, particularly if the VOCs are attributable to Spill Site 7.

Response: The scope of this EE/CA is limited to a detailed evaluation of the source materials. The data and evaluation requested are fully contained in the *Draft Final Surface Water Risk Assessment*, issued by the USAF in January of 2002.

21. Comment: Sec. 2.4, Risk Evaluation, Page 2-17. 3rd sentence: describes a statistical analysis and references Figures 2-8 and 2-9. However, no information is provided regarding the type of statistical analysis or the assumptions made in the analysis. Provide this.

4th sentence: This indicates that the values determined from the statistical analysis were compared to Wyoming Department of Environmental Quality (WDEQ) standards and RBCs to determine constituents that may pose a risk to human health or the environment. Although the analytical results of the soil and ground-water samples are compared to RBCs in Tables 2-3

through 2-7, the comparison of the statistical results to the RBCs is not provided. WDEQ standards do not appear to have been compared.

Barium, lead, cadmium, and chromium are identified as metals that exceed the RBCs. However, in Sec. 4.0, only lead, cadmium, and chromium are mentioned as having elevated levels within the removal action area. Explain the absence of barium.

Response: A more thorough summary of the risks at Spill Site 7 has been added to Section 2.4. This type of statistical evaluation was performed as part of the Plume Heads RI report. The reader is referred to Section 9.4.1.3 of the Source Areas RI for a robust statistical evaluation of the site data as compared to the background data set.

22. Comment: Sec. 3.2.1, Goals and Objectives of the Removal Action, Pages 3-1 and 3-2. Explicitly identify the COCs as suggested by the EE/CA guidance (EPA 1993) and identify the clean-up levels to be achieved by the removal action. Defining the COCs and the clean-up levels help describe how a removal action objective (RAO) is achieved.

Response: See the response to General Comment #5.

23A. Comment: Sec. 3.2.3, Page 3-3, "Compliance with ARARs and ..." For a removal action, such as evaluated in this EE/CA, ARARs within the scope of the action must be met to the extent practicable. For remedial actions, ARARs must be met or a waiver justified under the criteria in the NCP. For this reason, discussion is needed which clearly states the following: Ground water restoration is not being addressed within the scope of this action. However, this action will address potential sources for contributing contamination to ground water. Contamination in ground water will be addressed in the overall RI/FS for ground water plumes in Zone D (OU2). ARARs which pertain to ground water restoration will be addressed as part of the overall remedial investigation/feasibility study.

Response: The 2nd full paragraph in Section 3.2.3 has been revised as follows:

> This EE/CA is being conducted for saturated and unsaturated soils in the Spill Site 7 source area. Direct groundwater restoration is not addressed within the scope of this action. However, this action will address potential sources that are contributing VOC contamination to groundwater. Groundwater cleanup will be addressed in the concurrent Zone D Groundwater RI, which is being conducted under a separate project. This removal action addresses a small area of metals contamination in shallow soil; however, because inorganic impacts to groundwater at Spill Site 7 are minimal, metals contamination in site soils is not a significant source of groundwater contamination.

23B. Comment: 3rd sentence: "remedial" should be removal.

Response: The text has been revised as suggested.

23C. Comment: The second paragraph indicates that the removal action is not intended to address metals contamination. This contradicts Sec. 3.2.1 in which metals are included as "known contaminants" and Sec. 4.0 in which a surface soil area with elevated metals is identified as an area to be addressed with the removal action. Reconcile for consistency.

Response: The text has been revised as suggested. See the response above.

24A. Comment: Secs. 3.2.3.1.1, 3.2.3.1.2, and 3.2.3.1.3 ARARs. As a preliminary identifier of ARARs, these discussions should mainly be a listing of key ARARs at this point, with the actual analysis within the context of the Detailed Screening of alternatives. The alternatives haven't been described yet. Much of the discussion beyond the listing needs to be addressed in Sec. 4.

Response: The text has been changed to add more detail regarding ARARs in Section 4 under Detailed Screening of Alternatives. Section 4.4.1.1.2 has been changed to read:

> Implementation of Alternative I is anticipated to meet ARARs specific to this alternative, including provisions of WDEQ waste regulations and applicable storm water regulations. A complete evaluation of the ARARs is provided in Section 3.2.3.
>
> Excavated material will be managed in accordance with applicable ARARs. Excavated wastes will be properly characterized, manifested, and transported under RCRA and state regulations. Any waste found to be contaminated above the WHWRR regulatory limits will be managed separately in accordance with the WHWRR requirements. Prior to shipment off site, the excavated material will be covered with a high density polyethylene (HDPE) liner during precipitation to comply with WWQRR. Wastes will be hauled only to properly licensed disposal facilities approved to accept CERCLA wastes.
>
> Decontamination water will be applied to excavated and stockpiled soils in the AOC to minimize fugitive dust emissions to comply with the Clean Air Act requirement as specified in Section 4.4.1.1.5. Field monitoring will be performed to ensure air quality is maintained with respect to TCE.
>
> Although not anticipated, water generated from any dewatering efforts will be analyzed and treated or disposed of appropriately in compliance with WHWRR.
>
> Engineering controls and PPE will be used to comply with OSHA requirements as stated in Section 4.4.1.1.5. A Health and Safety Plan will be followed during the implementation of this alternative.
>
> As indicated in the baseline risk assessment in the *Draft Zone D Source Areas RI Report*, the area does not provide a habitat for any endangered or threatened species.

Diamond Creek will be protected from surface water run-off during excavation by using engineering controls to comply with the Wyoming Environmental Quality Act as stated in Section 4.4.1.1.5.

Section 4.4.2.1.2 has been changed to read:

Implementation of Alternative II is anticipated to meet ARARs specific to this alternative, including provisions of WDEQ waste and air quality regulations. A complete evaluation of the ARARs is provided in Section 3.2.3.

Minimal residual waste will be generated by this alternative. Approximately 32 LCY of surface soil will be generated during metals-contaminated soil removal. Drill cuttings from the SVE well installation will be managed according to all applicable regulations. The cuttings will be characterized, consolidated into bulk containers, and hauled to an off-site disposal facility. Water used to decontaminate the augers will also be collected and managed to applicable regulations. GAC vessels used to treat the effluent stream that exhibit breakthrough will either be replaced through a vendor or a subcontractor will replace the carbon within the vessels to comply with the Clean Air Act. No other waste streams are anticipated to be generated at this time.

Any waste found to be contaminated above the WHWRR regulatory limits will be managed separately in accordance with WHWRR requirements. Waste will be analyzed for TCLP to determine whether or not it is hazardous. The waste will be shipped accordingly to an appropriate disposal facility. Any waste found to be three times the background values for metals will be disposed off-site. Prior to shipment, the excavated material will be covered with a HDPE liner during precipitation to comply with WWQRR.

Decontamination water will be applied to excavated and stockpiled soils in the AOC to minimize fugitive dust emissions to comply with the Clean Air Act requirement as specified in Section 4.4.1.1.5. Field monitoring will be performed to ensure air quality is maintained with respect to TCE.

Although not required, water generated from any dewatering efforts will be analyzed and treated or disposed of appropriately in compliance with WHWRR.

Engineering controls and PPE will be used to comply with OSHA requirements as stated in Section 4.4.2.1.5. A Health and Safety Plan will be followed during the implementation of this alternative.

As indicated in the baseline risk assessment in the *Draft Zone D Source Areas RI Report*, the area does not provide a habitat for any endangered or threatened species.

Diamond Creek will be protected from surface water run-off during excavation using engineering controls to comply with the Wyoming Environmental Quality Act as stated in Section 4.4.2.1.5.

Section 4.4.3.1.2 has been changed to read:

Implementation of Alternative III is anticipated to meet ARARs specific to this alternative, including provisions of WDEQ waste and air quality regulations. A complete evaluation of the ARARs is provided in Section 3.2.3.

Excavated material will be managed in accordance with the required ARARs. The treated material will be properly analyzed prior to backfill to ensure that only clean material is placed in the excavation. All stockpiled soils will be located in the AOC. Treatment system effluent will be sampled and all applicable notifications/permits will be completed. GAC vessels used to treat the effluent stream that exhibit breakthrough will either be replaced through a vendor or a subcontractor will replace the carbon within the vessels to comply with the Clean Air Act.

Any waste found to be contaminated above the WHWRR regulatory limits will be managed separately in accordance with WHWRR requirements. Waste will be analyzed for TCLP to determine whether or not it is hazardous. The waste will be shipped accordingly to an appropriate disposal facility or backfilled if it is determined to be non-hazardous. Any waste found to be three times the background values for metals will be disposed off-site. Prior to shipment, the excavated material will be covered with a HDPE liner during precipitation to comply with WWQRR.

Decontamination water will be applied to excavated and stockpiled soils in the AOC to minimize fugitive dust emissions to comply with the Clean Air Act requirement as specified in Section 4.4.1.1.5. Field monitoring will be performed to ensure air quality is maintained with respect to TCE.

Although not required, water generated from any dewatering efforts will be analyzed and treated or disposed of appropriately in compliance with WHWRR.

Engineering controls and PPE will be used to comply with OSHA requirements as stated in Section 4.4.3.1.5. A Health and Safety Plan will be followed during the implementation of this alternative.

As indicated in the baseline risk assessment in the *Draft Zone D Source Areas RI Report*, the area does not provide a habitat for any endangered or threatened species.

> Diamond Creek will be protected from surface water run-off during excavation using engineering controls to comply with the Wyoming Environmental Quality Act as stated in Section 4.4.3.1.5.

24B. Comments: OSHA and DOT requirements for off-site transport of hazardous materials are not potential ARARs. They are simply requirements to hazardous waste operations and transport.

Response: OSHA and DOT requirements have been deleted from the text and tables.

25A. Comment: Sec. 4.0, Identification and Analysis of Removal Actions, Page 4-1. This discussion also needs to address consistency with potential final remedies. Briefly address engineering and institutional controls which will be used during the duration of the removal. Identify that most long-term institutional and land-use controls will be addressed in the Record of Decision for the final remedy for Spill Site 7.

Response: The following language has been added to Section 4.0, following the 2nd paragraph:

> During implementation of the selected removal action, an Exclusion Zone will be demarcated and one point of entry/egress from the site will be established. Decontamination facilities for personnel, vehicles, and equipment will be located at the entry/egress point. All personnel entering the Exclusion Zone must have adequate training according to 29 CFR 1910.120, proper PPE as determined by the site Health and Safety supervisor, and medical clearance to wear the proper PPE. All personnel on-site must sign in and out when arriving and departing the site and must undergo site-specific safety briefing before entry to the Exclusion Zone is permitted. Documentation will be kept at the Field Office, including training certifications and medical clearances for all site workers/visitors. All efforts will be made to eliminate any contaminant migration during removal activities. Upon completion of the removal action, any long-term institutional and land-use controls will be instituted as specified in the forthcoming Record of Decision for the site, which will be prepared subsequent to implementation of the interim removal action.

25B. Comment: Paragraph 2. This paragraph identifies the area of contamination on which the removal action alternative evaluation is based. However, the use of soil gas readings (and the level of 10,000 ppbv) as the basis for the TCE-related removal action is not adequately linked to either the risk evaluation or to the RAOs. In addition, the removal area is not well defined. Specific items required to adequately evaluate the removal area include:

a. identification of the lateral and vertical extent in which the volatile organic COCs exceed the risk-determined and RAO-specified contaminant levels (this area should be supported by figures with analytical results), and

b. identification of the horizontal and vertical extent in which the metal COCs exceed the risk-determined and RAO-specified contaminant levels (this area should be supported by figures with analytical results).

Response: The use of the 10,000 ppbv soil gas reading as a basis for the removal action is being used in lieu of any soil-based RAO or risk-based level due to the fact minimal bulk soil contamination was noted. The elevated soil gas readings indicate contamination at levels high enough to justify removal. The second paragraph has been modified to read:

> The removal action detailed in this section addresses an area at Spill Site 7 found to contain elevated levels of metals, specifically lead, chromium, and cadmium, and VOCs, specifically TCE. The removal action focuses on an area containing elevated concentrations in surface soil, bulk soil, and soil gas samples, as well as the past existence of a grease trap. The proposed removal area was defined using the location of the drainage ditch and elevated soil gas readings. The removal area, shown in Figure 4-1, corresponds to an area of shallow and deep soil gas concentrations above 10,000 ppbv. It has been determined that vadose zone soils within the 10,000 ppbv soil gas concentration zone have the potential to contribute to groundwater contamination, and removal of those soils would meet the first RAO by reducing the contribution of vadose zone soil to groundwater contamination. Within the removal area, there are two zones of elevated soil contamination: one, a surface soil area with elevated metals, and the other, a subsurface soil area with elevated TCE concentrations. The area of metals contamination is based on historical evidence of metal contamination in the grease trap and on soil contamination found along the drainage ditch as shown in Figure 2-11. That, combined with the physical feature of a drainage ditch, which could directly contribute surface run-off to Diamond Creek, is why the second RAO will be met by removing the 120-foot-long by 5-foot-wide drainage ditch area to a depth of one foot. The concentrations of these two zones were screened against TCLP criteria (40 CFR 261.24). As a guideline, if the bulk soil criteria is less than 20 times the TCLP value, the sample is not likely to exhibit the characteristic of toxicity as defined by RCRA. TCE, total chromium and lead were the only contaminants that were greater than 20 times the TCLP concentration. The material, if excavated, may be considered characteristic hazardous waste. This conclusion is based on an assessment of total contaminant concentrations relative to the TCLP criteria. Prior to shipment off-site, additional TCLP sampling will be conducted to refine the removal area and determine how excavation spoils will be managed.

26. Comment: Sec. 4.1, Page 4-2. The "Excavation and Off-site Disposal" is not described consistently through the detailed analysis. As described here, the reader will assume only an off-site landfill facility for the wastes. The description in Sec. 4.2.2 includes use of the WCA. The WCA is an on-site facility. It may be simpler to treat this as excavation and disposal alternative with the on- and off-site disposal options described. By similar reasoning, "Excavation and Ex-

situ Soil Vapor Extraction" should be more to the effect of "Excavation, Treatment, and Disposal." Disposal options could include the same excavation, WCA, or off-site facility. Identify which was used for cost estimation. SVE would be a presumptive technology for the treatment of VOCs in soils; identify it as such in the document.

Response: The subsection title "Excavation and Off-site Disposal" has been changed to read "Excavation and Disposal." The change has been made throughout the document. That paragraph has been changed to read:

> This alternative includes additional surface soil sampling to further dramatize the extent of metals contamination, removal, and off-site disposal of metals-contaminated soil in the drainage ditch area, and excavation and removal of TCE-contaminated soil in the vadose zone with disposal of the excavated soil in either the on-site Waste Consolidation Area (WCA) or an appropriate off-site landfill facility. Two waste streams will be generated: hazardous soil (off-site disposition only) and non-hazardous soil (on-site or off-site disposition). An additional element of this alternative is the installation of a piping network, an initial injection of a reductive dechlorination enhancing substrate, such as HRC, and a monitoring period of 9 months from the injection date. This aspect of the remedial action alternative is designed to reduce the saturated zone contaminant levels. The excavation will be backfilled with clean fill material after the piping system is installed.

The subsection "Excavation and Ex-situ Soil Vapor Extraction" was similarly changed as follows:

> *Excavation, Disposal and Ex-situ Soil Vapor Extraction*
>
> This alternative includes additional surface soil sampling to further characterize the extent of metals contamination, removal and off-site disposal of metals-contaminated soil in the drainage ditch area, and removal of the VOC-contaminated soil and placement in an on-site ex situ SVE facility. An additional element of this alternative is the installation of a piping network, an initial injection of a reductive dechlorination enhancing substrate, such as HRC, and a monitoring period of 9 months from the injection date. This aspect of the remedial action alternative is designed to reduce the saturated zone contaminant levels. Treated soils will be returned to the excavation.

27. Comment: Sec. 4.2.1, No Action. Identify this alternative is required by the NCP to serve as a baseline for comparison. Describe what potential changes/damages to overall human health and the environment will continue to exist or may occur in the future if no action is taken. Acceptance by regulators and the community are not criteria appropriate to establishing a baseline. Since no access restrictions are proposed as part of any of the alternatives, the significance of the second sentence is unclear. Clarify or correct.

Response: Section 4.2.1 was changed to read:

> This potential response action involves leaving contaminated soils in their current location and condition. No removal action or institutional controls will be implemented. Evaluation of the No Action response alternative is required by the NCP as a basis on which to compare active response alternatives.

The subsection "Effectiveness" was changed to read:

> This response option does not effectively protect human health and the environment because exposure pathways to the groundwater system for the contaminants of concern are not mitigated and RAOs are not met. Continued infiltration to groundwater which discharges to the surface water system will continue to occur. Impacts to groundwater may influence drinking water supplies, and surface water impacts may harm aquatic life if the No Action alternative is implemented.

28. Comment: Sec. 4.2.2, Page 4-4, Sec. 4.2.3, Page 4-5, and Sec. 4.4.1, Page 4-10. Identify which metals, and what concentrations, will be used to determine the extent of contamination. Address the waste disposal options for hazardous waste and non-hazardous wastes separately. This intermixes the options to the point where a reader may assume hazardous wastes could go into the WCA.

Response: The 2nd paragraph of Section 4.0 describes the specific metals of concern to be lead, chromium, and cadmium, though other metals with elevated concentrations will be evaluated appropriately. The volume of soil along the drainage ditch will be excavated, stockpiled within the AOC and sampled. Total metals analysis and TCLP analysis will be run on the samples. If TCLP analysis suggests that the soils are non-hazardous, the total analysis will be used to determine if metals concentrations are three times the background limits. If soils exceed the three times background criteria, they will be hauled off-site or to the WCA for disposal depending on concentrations. If soils fail the TCLP testing they will be hauled off-site and disposed as a hazardous waste. If the soils exhibit concentrations less than three times background, they will be treated for VOCs and used as backfill material along with the treated unsaturated soils.This edit has been made in the first paragraph of Sections 4.2.2, 4.2.3, and 4.2.4.

29. Comment: Sec. 4.2.4, Implementability, last sentence (Page 4-7). The phrase "although administrative issues could arise" indicates potential administrative implementability issues are anticipated. If so, this is the place to address them.

Response: The subsection "Implementability" has been changed to read:

> The ex-situ treatment option can be readily implemented at FEW based on factors such as location, accessibility, electrical power, and equipment and material vendors. The large amount of space near Spill Site 7 makes ex-situ treatment fully implementable since the material will be handled and transported on-site. It

> is assumed that this alternative will be acceptable to the regulators and community, although administrative issues such as treatment goals, air emissions, and backfill standards could arise. Strict criteria will be developed and approved prior to implementation of the removal action.

30A. Comment: Sec. 4.4.1, Alternative I. 1st paragraph, 2nd sentence. "IRA" should be "removal."

Response: The change has been made in the text.

30B. Comment: 3rd paragraph: If the depth and size of excavation prohibits direct loading, will a staging area be needed? If so, how will the staging area be sited and constructed? This will need to comply with RCRA LDRs, meaning some form of liner if the waste pile is outside the area of contamination. Will decontamination water be collected and consolidated for disposal?

Response: The 3rd paragraph has been changed to read:

> Equipment will be mobilized to the site and an entry, exit, and loading area will be established within the AOC. For evaluation purposes, it is assumed that material will be directly loaded into trucks during excavation; however, the depth and size of the excavation may prohibit such activities. If direct loading cannot be performed, the material will be staged within the area of contamination. A wheel loader equipped with a 4-cubic-yard capacity bucket will be on-site to load trucks from stockpiles created by the excavator. Equipment will be decontaminated after handling the hazardous soils to prevent cross-contamination. For off-site disposal, the trucks will be tarped to prevent soil and debris from contaminating the haul route, and a manifest (for hazardous material) or bill of lading (for non-hazardous material) will be given to the driver to track and provide a record of the quantity of excavated soil. Trucks hauling hazardous materials will be properly placarded and will follow all applicable DOT regulations regarding transportation of hazardous waste. A decontamination pad will be constructed at the truck exit to wash residual soil from dump truck tires to avoid contaminating nearby roadways. Decontamination water will be collected and used for dust control within the area of contamination.

30C. Comment: 4th paragraph: Will backfill actually have to be brought in from off-site, or is there a suitable borrow area on base (a determination of which goes directly to the feasibility/implementability of alternatives)? Limiting the size of the excavation is good practice; backfilling prior to confirmation sampling results is not.

Response: For the analysis of Alternative I, it is assumed that fill material will be transported from an off-site source. However, if a suitable on-base borrow area is identified prior to implementation, it will be addressed in the IRA Work Plan. Off-site backfill will not significantly affect the feasibility or implementability of the alternatives; however, the

implementation cost will be reduced if an on-site borrow source exists.

The text in the 4th paragraph has been changed to read:

> Once sufficient material is excavated, slotted Schedule 80 PVC drain pipe will be placed in the bottom of the excavation. The bottom of the excavation will be in contact with the capillary fringe. After implementing the removal action and backfilling the excavation, the piping will be used to introduce a hydrogen donor such as Hydrogen Release Compound® (HRC®) to the capillary fringe to facilitate reductive dechlorination in the saturated soils and associated groundwater. This HRC application will be conducted to minimize the potential for recontamination of the treated soil through groundwater fluctuations and vapor migration as well as to reduce the saturated soil contribution to groundwater contamination. Approximately 10 rows of the slotted drain pipe will be placed in the excavation, with one end of the slotted pipe fitted with an elbow and a vertical section of Schedule 80 pipe placed to approximately 2 feet above grade. Once the sections of piping are installed, backfill material will be imported from an off-site location. The backfilling will commence prior to excavation completion to limit the size of the open excavation. Because the floor of the excavation is known to contain contaminated soil, no confirmation samples are required. The backfill will be placed in lifts and will be compacted with a roller or vibratory compactor when the excavation depth is shallow enough to allow safe entry. The surface of the excavation will be restored to match existing site conditions.

30D. Comment: 5th paragraph: "Trash pumps" should just be "pumps." Will excavation be timed to coincide with lower seasonal water levels or is de-watering expected to allow excavation to a certain elevation?

Response: The word "trash" has been deleted from the text. Dewatering equipment will be available at the site, but will only be used if large precipitation events hinder site activities. The contaminated soil continues below the water table. This IRA is not intended to excavate the total depth of contaminated soil, rather vadose zone soils will be excavated, saturated zone soils will be partially treated in place by the HRC application. The paragraph has been revised to read:

> Although the excavation will approach the depth of the water table, it is not anticipated that dewatering activities will be performed at the site. Pumps and holding tanks can be mobilized to the site if a large rain event occurs. Any water generated from this would be disposed appropriately off-site.

31. Comment: Sec. 4.4.1.1, Page 4-11, Effectiveness Evaluation, Paragraph 1. Determination of the cleanup levels is part of the EE/CA and cannot be an "after the fact" determination.

Response: The text in Section 4.4.1.1 has been changed to read:

> The removal of contaminated unsaturated material from the Spill Site 7 area and the reduction in contribution to groundwater contamination from saturated soils meet the RAOs by reducing current and future potential impacts to groundwater and surface water. Soil will be treated until a soil gas level of 42 ppbv is achieved in the excavated soils, as defined in Section 3.2.1. During excavation, soils from the sidewalls of the excavation will be screened with a PID to determine the lateral extent of the excavation. A field screening level of 1,000 ppm will be used as a cut off for removal of additional soil. This value is derived from review of boring logs and ensures the removal of soils that would yield a value of greater than 10,000 ppbv in soil gas. The bottom of the excavation is within the capillary zone and will likely be contaminated, so no confirmation samples will be collected from the excavation floor. Pipe placement and HRC application will address the contamination in the capillary fringe and the upper portions of the saturated zone and help to reduce future impacts on the groundwater.

32. Comment: Sec. 4.4.1.1.2, Compliance with ARARs. This entire discussion can be summarized in the statement "this alternative will meet ARARs." This approach is entirely insufficient where enough of the alternative is developed such that the various actions and requirements can now be related (analyzed). Given this relationship, the ARARs can now be analyzed such that detailed discussion can *describe how* the alternative will meet ARARs.

For example, there are a number of potential actions described, but none of the necessary information or determinations needed. A staging area will need some form of liner to comply with the land disposal restrictions (LDRs) unless it is within the area of contamination (AOC). The ex-situ treatment unit (or emissions treatment) does not require a permit, but the substantive requirements need to be identified along with a description of how these requirements will be met. Because portions of the soils may be hazardous waste, how will the placement of the soils back in the excavation not constitute placement of a hazardous waste? Will meeting the removal action objectives demonstrate the waste is no longer hazardous (or no longer has to be managed as hazardous waste).

Response: All staging areas used for handling of excavated soils will be constructed within the AOC. Section 4.4.1.1.2 addresses Alternative 1, Excavation and Disposal, therefore no mention of treatment unit requirements or placement of treated soil needs to be made because Alternative 1 does not involve either aspect. However, Section 4.4.3.1.2, Compliance with ARARs for Alternative 3, has been changed to read:

> Implementation of Alternative I is anticipated to meet ARARs specific to this alternative, including provisions of WDEQ waste regulations and applicable storm water regulations. A complete evaluation of ARARs is provided in Section 3.2.3.
>
> Excavated material will be managed in accordance with applicable ARARs. The treated material will be analyzed to meet the clean up standard defined in Section 3.2.1 to ensure that only clean material is placed in the excavation. All stockpiled soils will be located

> within the AOC at Spill Site 7. Treatment system effluent will be sampled and all applicable notifications and permit requirements will be met. GAC vessels used to treat the effluent stream that exhibit breakthrough will either be replaced through a vendor or a subcontractor will replace the carbon within the vessels to comply with the clean air act.
>
> Any waste found to be contaminated above the WHWRR regulatory limits will be managed separately in accordance with the WHWRR requirements. Waste will be analyzed for TCLP to determine whether or not it is hazardous. The waste will be shipped accordingly to an appropriate disposal facility or backfilled if determined to be non-hazardous. Any waste found to be three times the background values for metals will be disposed of off-site. Prior to shipment, the excavated material will be covered with a HDPE liner during precipitation to comply with WWQRR.

When RAOs are met for the excavated and treated soil, the material may not be considered hazardous due to significant reductions in toxicity. The Baseline Risk Assessment in the Draft RI determined that the site soils at Spill Site 7 do not pose a risk to human health or the environment prior to the removal action. Once this treated soil meets the RAO treatment goals, as defined in Section 3.2.1, it will no longer have the potential to cause or contribute to groundwater contamination in excess of the MCL. At this point, the material can be re-placed in the excavation.

33. Comment: Sec. 4.4.1.1.4, Page 4-13, and Sec. 4.4.2.1.4, Page 4-21, Reduction of Toxicity, Mobility, and Volume (TMV). The full criterion is reduction of toxicity, mobility, and volume *through treatment at the site.* In Alternative I, there is no treatment at the site; volume and mobility are nonetheless reduced. Treatment is part of Alternatives II and III, which will directly reduce toxicity, mobility, and volume. Discuss the degrees of reduction of TMV, the degree to which treatment will be irreversible, the type and quantity of residuals that will remain after treatment, and whether the alternative will satisfy the preference for treatment (EPA, 1993). Very little of this is addressed.

Response: The text in Section 4.4.1.1.4 has been changed to read:

> No reduction of contaminant toxicity or volume is anticipated as a result of waste excavation and subsequent disposal in a landfill facility because no treatment is being conducted. The mobility of the contaminants will be reduced by placing the waste in a properly managed landfill unit. The volume and toxicity of saturated soil contaminants will be reduced by reductive dechlorination.

The text in Section 4.4.2.1.4 has been changed to read:

> Surface soil removal and in-situ treatment will reduce the toxicity of the contaminated material by removing surface soil and removing volatile contaminants from the unsaturated soil, resulting in less contamination in a similar soil volume. The volume of the contaminants will also be reduced since

> recovered vapors will be collected in GAC canisters, which will hold a much higher amount of volatiles per unit volume than a comparable amount of native soil. This significant reduction in toxicity and volume of contaminants is accomplished through treatment. The degree to which contaminant toxicity and volume is decreased depends on the effectiveness of the removal action. As mentioned in Section 4.4.2.1.3, the effectiveness of in-situ SVE at this location is in question, so toxicity and volume may not be reduced sufficiently. The mobility of the contaminants will be decreased because the surface soil and carbon will be shipped to an approved disposal/recycling facility equipped with means to prohibit contaminant migration. Regeneration of GAC may also result in the destruction of TCE.

A similar change has been made to Section 4.4.3.1.4, Reduction of Toxicity, Mobility, and Volume for Alternative 3.

34. Comment: Sec. 4.4.2.1.5, Short-term Effectiveness, Page 4-22, Paragraph 2. This paragraph discusses the time until RAOs are achieved and indicates that the response objectives will be met in approximately three years. This time period appears to be inconsistent with the discussion in Sec. 4.4.2.1.3, which states that the long-term effectiveness of in-situ soil vapor extraction (SVE) is questionable in low permeability material. Reconcile the apparent discrepancy.

Response: The three-year cleanup period is an estimate assuming that the technology is effective. The estimate is used to determine operation and maintenance costs. The technology has questionable effectiveness in low-permeability soils and the actual project duration could be considerably longer. The text was changed as follows:

> **Time Until Response Objectives are Achieved.** Surface soil sampling and removal are anticipated to take 3 weeks, including laboratory turn-around time (TAT). System installation including well drilling, installation, piping, trenching, and mechanical installations are anticipated to take 6 weeks. The exact remedial duration of the in situ SVE depends on numerous factors including run time, system efficiency, flow rates, and soil permeability. Based on preliminary assumptions and experience at similar sites, the SVE will be only marginally effective; however, to allow for comparable costing, it is assumed that response objectives will be met within approximately 3 years. An additional year of monitoring will be required after system demobilization to ensure that no contaminant rebound occurs. Thus, the total estimated remediation time for evaluation purposes is approximately 4 years.

35. Comment: Sec. 4.4.2.2.2, Administrative Feasibility, 1st full paragraph of Page 4-23. These easement/encroachment issues also need to be addressed for the other alternatives.

Response: Similar language has been added to the discussion of Administrative Feasibility for the other alternatives.

36. Comment: Sec. 4.4.3, Alternative III, Pages 4-25 through 4-32. The discussion indicates that the treatment of low permeability soils will be enhanced with ex-situ SVE because the surface area exposed to air flow will be increased. Other enhancements would be useful to consider. Mixing of the soils and/or mixing a bulking agent into the low-permeability soils prior to placement in the treatment cells should be considered in the evaluation and cost estimate as appropriate.

The first paragraph on page 4-26 indicates that the treated soil must meet the SSL criteria for TCE of 0.015 milligrams per kilogram (mg/kg) to be used as backfill. However, the extent of excavation is based on a soil gas reading of 10,000 ppbv. The use of two different criteria, one for excavation and one for treatment, is inconsistent and should be resolved.

In addition, Figures 2-4 and 2-5 suggest that a large quantity of soil will meet this SSL criteria even before treatment. Is a staging of soils planned or needed to sort soils requirement treatment and for those which do not. Clarify how areas of soil in the treatment cell that do not meet the standard will be identified. (No discussion is provided regarding the sampling of the soil in the ex-situ cells prior to or after treatment, tracking (or mapping) of "known" contaminated soil in the treatment cells.) Because of the concern with placement of contaminated soils back into the excavation and the presence of a large quantity of uncontaminated soil at the start of treatment, this aspect of the alternative needs to be developed, evaluated, and considered in the cost estimate.

Response: When the soil is excavated and treated, it will undergo a natural volume expansion due to the creation of air voids. It is estimated that soils (caliche and other blocky soils) will be broken into small (6 inch or less) pieces. Because of this natural expansion from soils being broken apart, a swell factor of approximately 30 percent has been applied. Adding a bulking agent would cause this swell factor to increase. Unless the bulking agent is able to penetrate the 6-inch particles, it would not provide any additional benefit.

A narrative standard for unsaturated zone cleanup goals has been developed and is presented in Section 3.2.1 and presented in the response to General Comment #5. This standard cites a soil gas value of 42 ppbv as the maximum allowable soil gas concentration at which the corresponding soil does not impact groundwater above MCLs. The strategy results in treatment of soils to be cleaner than the surrounding soils that were not excavated. The soils outside the excavation are not deemed to be significant sources of contamination to groundwater, which is contaminated well in excess of the MCLs at Spill Site 7. If VOCs are released to the groundwater from the residual in the unexcavated soils, the impacted groundwater will be intercepted by the downgradient PRB wall. A similar approach is presented in Section 3.2.1 for saturated soils, as discussed in response to General Comment #5.

37. Comment: Sec. 4.4.3.1.3, Long-term Effectiveness (Alternative III), last sentence. This states post-remedial soil sampling will be used to verify this potential (the potential to verify if elevated soil vapors can re-enter the remediated area). No such statement appears for the other alternatives, which can be treated consistently for this concern. Because the underlying ground

water is contaminated with high concentrations of VOCs, it is almost a given vapors will re-enter the soil matrix. Where this becomes important is if this is to the degree vapors can bind to soil in excess of the projected remedial goals and thus re-establishing the risks.

Response: Section 4.4.3.1.3 has been changed to read:

> Alternative III will achieve long-term effectiveness by disposing of metals-contaminated surface soil, removing and treating contaminated unsaturated zone soils, treating the saturated soils to a level that is protective of groundwater, and placing the treated material into the excavation. Ex-situ methods enhance the effectiveness of SVE by permitting a larger contaminant surface area to be exposed to treatment. Future impacts to groundwater and surface water will be minimized. The potential for future direct contact with contaminated surface and subsurface soils will also be minimized. The installation of piping and subsequent HRC application will eliminate the possibility of contaminated groundwater or vapors re-entering the treated vadose zone and reduce the contribution of contamination in the saturated soils to groundwater contamination.

38. Comment: Sec. 4.4.3.3.2, Implementability, Page 4-31. The operation and maintenance (O&M) costs for Alternative III (ex-situ SVE) are stated as $19,277 for one year of operation. However, the O&M costs for Alternative II (in-situ SVE) presented in Sec. 4.4.2.3.2 (page 4-24) were indicated to be $185,613 for three years of operation (or $61,871 per year). The annualized O&M costs appear to differ by a significant amount without described significant differences in operation. The basis of the costs should be consistent for both alternatives or explained further.

Response: The actual operation time of the ex-situ SVE system is estimated to be six months. The RACER program does not include a separate O&M line item because this technology is implemented over a short duration. The O&M costs that are included in the separate line item only include the granular activated carbon (GAC) units. The remaining tasks typically considered elements of O&M, such as electric charges, field technician hours, air sampling, etc., are included as capital costs. The following note has been added to Section 4.4.3.3.2 to clarify this discrepancy:

> The cost for O&M under this estimate is $20,372 and includes servicing the granular activated carbon (GAC) units. Other tasks typically associated with O&M, such as electric charge, field technician hours, and sampling are included in the capital cost estimate. RACER cost estimating software does not distinguish O&M separately for shorter duration treatment technologies such as ex-situ SVE.

39. Comment: Sec. 5.1.3, Long-term Effectiveness and Permanence, Page 5-2. For all of the alternatives, contamination will remain below the base of excavation and beyond the boundary of the removal area. In addition, Plume A enters into Spill Site 7 from upgradient. This remaining contamination (and any effects on the action) should be identified within the discussion of long-term effectiveness.

Response: The text in Section 5.1.3 has been changed to read:

> Alternative I will remove all of the contaminated unsaturated zone soil from the Spill Site 7 site. In addition, installation of a piping network at the base of the excavation and injection of HRC will facilitate reductive dechlorination in the saturated zone soils. Removal of the unsaturated zone soil and backfilling with clean fill, and treatment of the saturated soils minimizes the potential for future groundwater or surface water contamination. Alternative II may leave contaminants bound in the less permeable strata and will not completely remove contamination from the low-permeability clays or the caliche layers. SVE is largely ineffective in low-permeability soil horizons. In addition, Alternative II does not address saturated zone contamination. Alternative III will effectively remove most contamination from the caliche layers and other low-permeability materials since the material will be handled above ground, exposing more surface area to treatment than is possible with an in-situ approach. In addition, installation of a piping network at the base of the excavation and injection of HRC will facilitate reductive dechlorination in the saturated zone soils. Because a certified clean fill will be used as backfill in Alternative I, there exists no possibility for low-level contamination to remain in the excavation area. In all alternatives, a dramatic rise in the groundwater table or migration of contaminated soil vapors could re-introduce contamination to the vadose zone. This possibility is reduced by HRC injection at the top of the water table.
>
> It should be noted that although this removal action is intended to target only the source area, contamination will remain in place below and beyond the proposed treatment area. The presence of contaminated groundwater below the treatment area could potentially hinder removal actions as well and will reduce saturated zone soil contamination. The additional activities of placing a network of drain pipe and injecting treatment agents at the base of the excavation, located at the capillary fringe, as presented in Sections 4.4.1 and 4.4.3, will help to prevent any re-contamination of the removal area from vapors or groundwater fluctuation, and will reduce saturated zone soil contamination. Since Alternatives I and III involve complete excavation down to the capillary fringe, those alternatives make installing the pipe network very effective, whereas Alternative II would involve costly directional boring and installation and, therefore, this enhancement was omitted from Alternative II.
>
> Alternative I ranks highest in long-term effectiveness, followed by Alternative III, and finally, Alternative II is the least effective.

40. Comment: Sec. 5.4, Conclusions, Page 5-5. The purpose of this section is to summarize the tradeoffs among the alternatives, such that the relative advantages and disadvantages are clear to the reader (i.e., a narrative summary of Table 5-1). Clarify where the alternatives rank similarly and under which criteria there are noteworthy differences.

No alternative should be "eliminated" except on the basis of failing to meet threshold criteria (protectiveness, compliance with ARARs). This Sec. presents the conclusions of the EE/CA and states, "Alternative I . . . is eliminated from consideration as a removal action because of . . . and administrative challenges involved with hauling material off-site." The same administrative challenges apply to Alternatives II and III because of disposal of metal-contaminated soil off-site, but no mention is made of these administrative challenges. Even though Alternative I includes a larger volume of material for off-site disposal because it includes VOC-contaminated soil, the impact of administrative issues should be applied consistently to all of the alternatives and this Sec. should be revised accordingly.

Response: The fact that the same administrative issues exist for all alternatives involving off-site disposal of metals-contaminated material is presented in Section 5.2.2. Section 5.4 has been changed to read:

> Alternative II, involving in-situ SVE, is a less desirable alternative because of the potential effectiveness limitations associated with implementing the technology in low permeability soils and caliche layers. It is believed that Alternative II will be less protective of human health and the environment than the other two alternatives because residual contamination will be left in place as opposed to excavating the soil. Alternative I, involving excavation and disposal of the entire area, including untreated hazardous material, to a depth of 15 feet, is also a less desirable alternative because of the high capital cost of the alternative and more significant administrative challenges involved with hauling a large volume of VOC-contaminated material off-site. In addition, the toxicity and volume of contaminants are not reduced by Alternative I. Despite some administrative challenges associated with using treated material as backfill, Alternative III is recommended as the removal action for Spill Site 7.

41A. Comment: Sec. 6.0, Recommended Removal Action Alternative. 2nd paragraph, Implementability. Identify the administrative challenges.

Response: The administrative challenges anticipated for implementation of Alternative III are backfilling with treated material effluent air emissions and injection of HRC. Therefore the 2nd paragraph, Implementability, has been changed to read:

> All of the alternatives have administrative challenges, but Alternative III has fewer and more easily addressed issues. Alternative III has administrative challenges associated with gaining approval to backfill the excavation with treated material and to emit system effluent air. Alternative III also has potential issues with injection of HRC, but the site UCC program permits this type of remedial injection.

41B. Comment: 3rd paragraph, Effectiveness, Reduction of Mobility. Don't all of the alternatives reduce mobility? If so, explain why Alternative I does more or better.

Response: The reduction of mobility for Alternative I is mentioned because it reduces neither toxicity or volume of contaminants. The text in the 3rd paragraph has been changed to read:

> Reduction of mobility – Alternative I reduces the contaminant mobility by placing the material in an approved landfill facility. It does not reduce the toxicity or volume of contamination. Alternative III reduces toxicity and volume by concentrating contaminants in a small volume of GAC. Regeneration of GAC may result in destruction of TCE. Alternatives I and III reduce toxicity and volume of saturated zone contaminants by reductive dechlorination with HRC.

41C. Comment: Most of what is in Section 6.1 actually belongs in the initial description of Alternative III. Similar items need to be included for Alternatives I and II.

Response: It is felt that to eliminate redundancy, the initial descriptions of the three removal alternatives provide a sufficient level of detail. Alternative III should be the only alternative that receives a detailed breakdown of project scope in Section 6.1 since it is the "Recommended Removal Action Alternative."

42. Comment: Sec. 6.0, Page 6-4, 1st paragraph. The subtitle needs revision. The alternative calls for backfill from treated soils, not backfill from an off-site source.

Response: The subtitle has been changed to read "Backfilling the Excavation with Treated Material."

Tables

43. Comment: Table 2.3, 2.4, and 2.5. These tables provide the concentrations of compounds in soil and compares them to RBCs. The notes to the tables indicate that the RBCs are the EPA Region III RBCs for industrial soils. However, the notes do not explain that the non-carcinogenic values on the table are 0.1 times the EPA Region III RBCs to account for possible additive effects. Further explanation of the non-carcinogenic RBCs and should be provided in the notes to the tables. Metals are presumably screened against residential RBCs so these should also be shown.

Response: The notes to Tables 2-3 and 2-4 indicate that the RBCs are the EPA Region III RBCs for industrial soils. Table 2-3 contains both subsurface and surface sample results. The notes to Table 2-3 have been clarified to indicate that the RBC values are industrial RBC values, with the exception that the RBC values for samples SS7SS02 and SS7SS39 are residential RBC values because these are surface soils. Further explanation in the notes of all three tables has been included to clarify the reduction in the non-carcinogenic values by 1/10 to account for possible additive effects. The notes to Table 2-5 indicate that the RBCs are the EPA Region III RBCs for

residential soils. Metals in surface samples were screened against residential RBCs and are presented in Table 2-5.

44A. Comment: Tables 3.1 and 3.2. Table 3.1 identifies the chemical-specific ARARs and Table 3.2 identifies the action-specific ARARs. However, many of the ARARs shown in Table 3.1 as chemical-specific requirements are action-specific requirements. The RI/FS guidance (EPA 1988) states that the chemical-specific requirements are those that may define acceptable exposure levels, and therefore may be used in establishing preliminary remediation goals. The guidance also indicates in Appendix E that discharge standards relating to remedial actions are action-specific ARARs. Tables 3.1 and 3.2 should be revised to be consistent with the guidance on ARARs.

Response: Tables 3-1 and 3-2 have been revised. Note that Section 3.2.3.1.1 (Chemical-Specific ARARs) and Section 3.2.3.1.2 (Action-Specific ARARs) have been modified to summarize the information stated in Table 3-1 and Table 3-2, respectively. All of the ARARs were moved from Table 3-1 to Table 3-2 because they are related to excavation activities. The Safe Drinking Water Act has been added to Table 3-1.

44B. Comment: Table 3-[3], Page 3-8, "Dredge and Fill". Reconcile: This refers to an ARAR applicable to wetlands, but no site description or setting information is given pertaining to wetlands which may be affected.

Response: Because the AOC is not within a wetland and the activities are not anticipated to be conducted in any wetlands, this ARAR was removed from the table.

45. Comment: Table 3-2, Page 3-10. For Chapter I, Sec. 28, identify what kind of requirements pertain to undesirable aquatic life (i.e., does it prohibit the introduction of undesirable aquatic life?). For Chapter IV, various Sections, clarify if these requirements are to report and/or address releases, so that the reader can understand the conditions of applicability.

Response: Table 3-2 has been revised. The reference to Chapter I, Section 28 has been removed. Chapter IV of the Wyoming Water Quality Rules and Regulations will not apply to any remediation alternatives since no water will be discharged or released to Diamond Creek. Chapter IV will not be included as an ARAR.

46. Comment: Table 4-1. This table presents a summary of the evaluation criteria for the three alternatives. The table shows that only Alternative I includes disposal of contaminated soil. However, the text suggests that all three alternatives include disposal of metal-contaminated soil. The table should be revised to include an explanatory note that disposal of metal-contaminated soil is common to all three alternatives. A note to the table should also be added to indicate whether the capital cost of each alternative includes the cost for disposal of metal-contaminated soil. As appropriate, comments made on the text of the document should also be considered as a basis for revision of the table.

Response: Table 4-1 has been modified to reflect the above comments. The table has also been updated to reflect responses to other comments.

Figures

47. Comment: Figures, General Comment: Where possible (considering scale and how "busy" the diagram would be), illustrate the location of the permeable reactive barrier wall, known utilities, sensitive species habitat, and the 100-year flood plain.

Response: The PRB wall has been added to Figures 2-6 and 2-7. The direction and distance to the PRB wall has been added to Figures 2-3, 2-9, 2-10, 2-11, 2-12, 4-1, 4-2, 4-3, and 4-4. The known utilities at Spill Site 7, which are not extensive, cannot be added without making the figures too cluttered. The sensitive species habitat and 100-year floodplain are now shown in Figure 2-7.

48A. Comment: Figures 2-4 and 2-5. Include a note which explains the qualifications associated with the analytical data, such as M, F, or J.

Response: A note explaining the lab QAPP qualifiers has been added to the figures.

48B. Comment: Project the approximate location of the grease trap and the approximate invert of the drain adjacent to the A-A' cross-Sec. line.

Response: The grease trap has been projected onto the A-A' cross-section, Figure 2-4. The exact location and depth of the French drain/interceptor system piping are not known. No as-built drawings of the system are available. In addition, the French drain system was intended to be installed well below the water table, and these cross-sections do not project information very far below the water table, so the location of the French drains may not apply.

49. Comment: Figure 2-6. This figure presents the ground-water elevations measured in November 2001. Provide the date(s) on which measurements were collected for individual wells.

Response: A note has been added to the figure giving the measurement dates for the wells on the figure.

50. Comment: Figure 4-1. This figure presents the proposed soil remediation area. However, it is unclear how the boundary of the soil remediation area corresponds to contaminant concentrations because contaminant concentrations are not plotted on the figure. The contaminant concentrations on which the soil remediation boundary is based should be plotted on the figure.

Response: This figure has been updated. The excavation is based in Figures 2-9 and 2-10, which depict the soil gas concentrations at the source area. The concentrations at the excavation boundary have been added to Figure 4-1.

Appendices

51. Comment: Appendix A. This appendix presents the costs for surface soil removal and in-situ soil vapor extraction. The O & M costs shown on the Phase Cost Detail Report (with Markups) do not correspond to the O & M costs shown on the Phase Technology Cost Detail report (without Markups). Reconcile the apparent inconsistency.

Response: The inconsistency has been reconciled.

References

ASTM 1995. *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites.* ASTM Standard 1739-95. Equation from Table X3.1, page 215.

EPA 1996a. *Soil Screening Guidance: Technical Background Document*. EPA/540/R95/128. Office of Solid Waste and Emergency Response, Washington, DC. from Table 36, page 136.

EPA 1996b. *Soil Screening Guidance: Users Guide.* EPA/540/R95/128. Office of Solid Waste and Emergency Response, Washington, DC. From page 30, discussion of "Dilution Factor Model."

DRAFT

RESPONSE TO EPA AND WDEQ COMMENTS ON

DRAFT FINAL ENGINEERING EVALUATION/COST ANALYSIS
SPILL SITE 7 - OPERABLE UNIT 2
F. E. WARREN AIR FORCE BASE, WYOMING
AUGUST 2002

General Response: Several administrative structure changes occurred between the Draft EE/CA and the Final EE/CA, shortly after this Draft Final EE/CA document was submitted to EPA. The Final EE/CA acknowledges these changes by addressing only the unsaturated soils, dealing with the treatment area as a CAMU, rather than an AOC, and specifically defining remediation boundaries and goals. Below are written responses to EPA's Response Evaluations, clarifying or expanding text from early versions of the EE/CA. All of WDEQs comments are addressed within the EPA's comments.

EPA's review of the draft-final document is in the form of a response evaluation. The original comment is repeated, followed by an evaluation of the Response to Comment (RTC). Only comments for which EPA believes more is needed to address the issue(s) are repeated. The remainder are satisfactorily addressed.

The original comments were structured as General Comments and Specific Comments. General Comments pertain to the document as a whole or summarize issues within the specific comments. Specific Comments are keyed to concerns in the document by Section (Sec.), page, paragraph, figure, table, sentence, or other identifier as indicated.

General Comments

EPA Comment 5. The basis for the removal area boundary is not well defined. The document indicates that vapor-phase contaminant concentrations (soil gas readings) were used to determine the boundary of the removal area. The concerns with the current basis of the removal area boundary include:

- establishing a link between soil gas readings and contaminant concentrations in soil and risk,
- why the criteria of "deep" and a soil gas reading of 10,000 ppbv were selected for setting the boundary,
- areas exist outside of the proposed removal area in both the vertical and lateral directions which meet the criteria of "deep" and contain soil gas readings greater than 10,000 ppbv,

- explaining the exclusion of areas in which the soil gas readings did not meet the criteria of "deep", such as location SS7SG05A at which soil gas readings summed to more than 10,000 ppbv at a depth of 8 feet, and

- explaining the exclusion of areas in which the soil gas readings did not meet the criteria of 10,000 ppbv, but still contained elevated soil gas readings.

The boundaries of the removal area should be based on concentrations of COCs in soil which exceed the removal action objective (criteria based risk and/or potential to contaminate ground water). Any areas at which the COCs exceed the criteria, but are not included within the removal area, must be fully explained.

Response Evaluation: The RTC indicates EPA was taken somewhat out of context.

EPA's concern as expressed in this comment was more to the effect of the defined RAOs being difficult to relate to the proposed boundary of excavation (although the concerns about sampling methods and verification also exist). In the draft document, there was a perceived disjuncture in the scope of activity, narrative of the RAOs, and the means of measuring those goals, regardless of the means of measurement. This may be due to phrasing or an actual difference in meaning. Rephrasing to the more generalized goal in this draft final version (reduce potential to contribute to ground water) unfortunately has not addressed this. This results in a potential subsequent disjuncture in this document's ability to address issues of consistency with the final remedy. The current phrasing is relatively broad. Any degree of contamination removed can reduce the potential for further cross-media contamination. The question then is whether the amount removed makes a difference.

The first was in establishing a link between the soil gas measurements and other levels which are typically associated with RAOs. For soils, few ARARs exist, so cleanup levels are typically based on some form of exposure risk or potential to further contaminate ground water. They can also be based on other criteria, such as volumes in which high concentrations exist, but these are generally still defined by some form of criteria. For example, the 10,000 ppbv soil gas appears to relate to the volume in which residual DNAPL may exist. This is an acceptable criteria, provided it is presented so the scope of the action is defined and the potential scope of what remains is identified. What is the degree of uncertainty in this? Is there a potential for missing residual DNAPL at this soil gas level, or is there a margin for error factored in?

Presuming the intent is to focus on residual DNAPL, then adjacent volumes with relatively high concentrations of adsorbed VOCs would be expected to remain. These concentrations may present a risk or potential to further contaminate ground water, which would remain to be addressed in the feasibility study (FS) for the final remedy. The proposed sampling is unlikely to definitively identify what degree of problem may remain. High vapor concentrations would mainly be an indication more work is needed without necessarily clarifying whether this is for residual DNAPL or adsorbed contaminants.

The link or relationship to other measurements by which risk or other RAOs are defined does not have to be directly correlative. Does the 10,000 ppbv-defined volume encompass all of the bulk soil measurements by which a risk or potential to further contaminate ground water is measured? Although qualitative, this at least provides the reader with a means of identifying some of what the intended scope should accomplish.

Many of the other bulletins went towards refinement of the volume to be excavated and are partly addressed. The reader may question why this particular volume with soil gas greater than 10,000 ppbv needs to be addressed as opposed to other volumes with similarly high readings. There are high readings outside the contiguously marked area. Could residual DNAPL be left in these areas after the removal? If so, why not address those within the context of the removal?

Response: The remedial action objectives (RAOs) are based on reducing the level of the COCs in the unsaturated soils to a level below the site-specific SSL or below TCLP for each contaminant. RAOs are not based on either human or ecological risk because the baseline risk assessment indicates that no unacceptable risk exists. Remediation is based solely on protection of groundwater by minimizing the potential for vadose zone soils to leach to the groundwater. Table 3-1 has been added to Section 3.2 to specifically present the numerical remediation goals.

Analyte	Cleanup Standard (mg/kg)
TCE	0.0407
cis-1,2-DCE	0.3687
Chloroform	0.4800
1,1,2-Trichloroethane	0.0269
Arsenic	5
Barium	100
Cadmium	1
Chromium	5
Lead	5
Mercury	0.2
Selenium	1
Silver	5

Notes:

TCE = trichloroethylene

DCE = dichloroethylene

mg/kg = milligrams per kilogram

Standards for organic analytes are based on site-specific SSL values.

Standards for inorganic analytes are based on toxicity characteristic leachate procedure values.

In addition, the following text replaces the last several paragraphs of Section 3.2:

> *"To evaluate compliance with this narrative vadose zone soil cleanup standard, soil remediation will be completed to the 10,000-ppbv soil gas line as defined on Figure 3-1. This treatment zone encompasses all soil samples that exceeded a site-specific SSL or RBC as well as the locations where elevated soil gas readings above 100,000 ppbv suggest the presence of a NAPL. The only exception is in the area of MW-151, where well completion data indicate that MW-151 has 35 feet of screen and a filter pack that extends to within 7 feet of the surface. This type of well completion may be acting as a conduit for contaminant migration into the vadose zone. The data suggest that the elevated soil gas readings are likely the result of groundwater off-gassing and do not reflect a source in the vadose zone. For this reason, the soils near MW151 are not included in this interim action cost estimate. However, as a first step to the IRA, additional soil gas samples will be collected near MW-151 to verify that a VOC source is not present vadose zone.*
>
> *"If excavation is part of the preferred alternative, soil gas and/or field headspace analysis will be used once the excavation has reached the 10,000 ppbv boundary to guide the digging to follow preferential contaminant migration pathways. When this boundary is reached and field readings (PID/headspace) indicate that residual VOC levels are not elevated, bulk soil samples will be collected from the sidewalls to verify that the soils left in place are below the site-specific SSL criteria and therefore are protective of groundwater. The number and spacing of sidewall samples will be defined in the upcoming Spill Site 7 IRA Work Plan. If an in-situ method is the preferred alternative, bulk soil samples will be collected by drilling into the remedial zone and sampled for VOCs once remediation is complete. This method will ensure that the low levels of residual VOCs left in the vadose zone are not sufficiently elevated to pose a threat to the underlying groundwater. Contaminants will still exist in the saturated soils, capillary fringe, and groundwater, however, this zone is not within the media of interest for the RAOs and will be addressed under the Zone D Groundwater RI/FS.*
>
> *"If soils are excavated, the excavated soils will be removed and either disposed off-site in a proper facility, disposed at the Waste Consolidation Area (WCA), or treated on-site. The excavation will be backfilled with clean soils either from an off-site source or from*

treated soils after on-site remediation has been completed and analytical results demonstrate that the soils meet applicable standards to allow placement back into the excavation.

"The second RAO for Spill Site 7 (minimizing the potential for contaminated surface water runoff into Diamond Creek that may originate from areas of contaminated surface soils) will be evaluated against a narrative standard such that soils contaminated with metals above standards shall be reduced to levels that do not cause or contribute to contamination of Diamond Creek.

"To evaluate compliance with this narrative, surface soils along the drainage ditch will be excavated and further characterized to ensure that no soils are present above the applicable TCLP standard. If the soils are found to be hazardous, based on the TCLP results, they will be disposed off-site in an approved facility.

"All remedial alternatives evaluated in this EE/CA will contain provisions for protection of surface water and sediment in Diamond Creek during implementation. BMPs, such as run-on/runoff control plans, will be used to ensure that no contaminants from Spill Site 7 will impact the creek. Control of potential impacts from groundwater migration to surface water is beyond the scope of this EE/CA."

Response Evaluation: What is the value in even defining shallow and deep for the purpose of this removal? Shallow and deep definitions in the work plan were for the convenience of planning the work; if they have little or no relevance to how this action is defined, why are the distinctions being used? Does 11,000 ppbv mean something different at 10 feet depth rather than 5 feet depth?

Response: For the purpose of this EE/CA, the soil gas maps have been redrawn to show the maximum level of contamination for a given location. Earlier maps were used to aid in determining the pathway of VOCs into the groundwater. Figure 2-10 shows the maximum concentrations for TCE and defines the 10,000-ppbv boundary.

Response Evaluation: The soil gas criterion appears to be limited to TCE. TCE is not the sole VOC present. TCE and it's degradation products are potential COCs. Will addressing TCE also address the DCE isomers and vinyl chloride? Other VOCs are also present in ground water, which exceed MCLs. Are these not also from the same source? Will addressing the soil volume based on TCE in soil gas address these? If not, will this also be something the FS for the final remedy will need to address?

Response: TCE is the primary contaminant present. Other degradation products are present in the vadose soils at lower levels. The proposed alternatives will effectively treat all of the volatile contaminants that are acting as a source to the groundwater. With the implementation of this EE/CA, the soils in the unsaturated zone will not need to be addressed by additional remediation under the FS process.

Response Evaluation: The RTC confuses and/or intermixes the removal action objective with treatment system objectives. The removal action objective is to remove the volume of soil, which accomplishes a defined goal. The treatment system objectives define when the treated material may be returned to the excavation. Returning the treated soils to the excavation is a decision based on criteria different from how far laterally to excavate. Bulk soil samples are needed. The Data Quality Objectives (DQOs) differ as well as potential defense-ability, the time frame is less critical, and there is ready access to the media. The partitioning calculation, however, may provide a better indicator for when this sampling is warranted.

Response: Bulk samples for VOCs will be collected for verification of sidewalls. The field screening techniques, boundaries for excavation and remediation levels have been separated and addressed under appropriate sections for clarity. The RAOs have been restated to say:

"The objectives of the removal actions considered in this EE/CA include:

- *Reducing concentrations of TCE and associated daughter products in the unsaturated soil to below the calculated site-specific SSL, thereby eliminating this continuing source of groundwater contamination above MCLs; and*

- *Minimizing the potential for contaminated surface water runoff into Diamond Creek that may originate from areas of metals-contaminated surface soil."*

Response Evaluation: EPA is unclear on the rationale behind the statement "soil vapor is a more reliable indicator of vadose zone contamination levels than bulk soil because it is less sensitive to geological heterogeneity." Both are vulnerable to geological heterogeneity and the geological materials at FE Warren demonstrate a high degree of vertical and lateral heterogeneity. In fact, except in higher concentration areas such as SS7, soil gas has been relatively unreliable for identifying potential plumes and sources.

Response: The statement has been rephrased. The purpose of the statement was only to indicate that soil gas could represent a larger fraction of the sampling area than a discrete bulk soil sample, which may miss a zone of higher concentration near the sample location.

Response Evaluation: Regarding AFP 44: A sampling method and decision-making criteria may or may not have relevance to what is proposed here, but it is not possible to tell from the provided information. Elaborate on similarities and differences between AFP 44 and SS7. There may be situational differences which also factor into the feasibility of sampling type and amount. Relative comparisons would include the media, depths, contaminants, details of the sampling method (and how this met Data Quality Objectives), whether a certain percentage were analyzed in the laboratory, form of contaminant (i.e., free-phase, residual, adsorbed), and whether there were significant waste disposal issues. Regardless of the situation at AFP44, the proposed excavation at SS7 does allow for access to samples. EPA acknowledges the limitations of bulk soil sampling as described. Vapor samples also have limitations. Drawing air from distances of feet away can also result in dilution and potentially a premature end to excavation.

> **Response:** Although the sites do have many similarities, the reference has been removed.

EPA Comment 6. Discuss the potential integration of this removal action with future anticipated remedial actions that might result from the remedial investigation (RI)/feasibility study (FS). Discussion should be provided with regard to how the proposed removal action would complement, or be integrated with, future remedial actions. This needs to be addressed in the identification and screening of alternatives, and the reader briefly reminded in Sec. 6 because consistency with final remedies may also have a bearing on the preferred alternative.

Response Evaluation: The administrative structure changed shortly after this document was submitted and EPA acknowledges the response was written to address the previous structure. The vadose zone and saturated zones will be addressed separately, and by different contractors.

There are, however, some remaining issues reconsidering the focus is the vadose zone and the delivery piping system is a treatability study for the saturated zone. Vadose zone soils not addressed by the removal action objectives which ultimately guide this removal will still need to be addressed in the context of the final remedy. The feasibility study (FS) for the final remedy will need to analyze possible alternatives. In order to know what the removal action has achieved, it is important to be able to identify what remains laterally. The no further action alternative, which would rely on prior actions such as the PRB is just one of the alternatives. Just because the PRB is there does not necessarily mean the best alternative is no further action (which is at times discussed in project manager's meetings, but this is not a decision until the site has been through RI/FS). The FS will need a starting point, which depends on the goals ultimately achieved by this removal. It may be the presumption that residual DNAPL has been removed (and adsorbed contaminants remain). It may also be some or all vadose zone contaminants of concern (or which may contribute to ground water) have been removed, which defines a volume of soils to address or establishes no alternative is necessary to develop. This is why a level or degree of removal is important to identify, even if it is more qualitative (such as removal of residual DNAPL). EPA would be unable to accept a presumption in the FS which is not supported by results of the removal which are not verifiable or documentable.

Response: By treating all soils within the 10,000-ppbv soil gas boundary and soils outside that boundary based on field screening, soils with possible DNAPL along with all other soils in the vadose zone exceeding site-specific SSLs will be treated to a level that is protective of human health, ecological receptors, and the groundwater. Sidewall samples will be collected for bulk soil analysis to verify that this level of remediation is completed. The delivery pipe system has been removed from the alternatives discussions. A reductive dechlorination pilot test will be completed to study the effects of a hydrogen donor-type product such as HRC. This pilot test will also minimize potential recontamination of treated or backfilled soils from off-gassing of VOCs in the groundwater due to groundwater table fluctuations. With completion of this EE/CA, the soils in the unsaturated zone for Spill Site 7 will not need to be addressed in the Source Area FS. See Response to Comment 5 for text changes related to these issues.

Response Evaluation: This is also part of why EPA described a need for confirmation samples. EPA agrees locations from the base of the excavation, provided the base is to the water table (a clear capillary fringe), may not be relevant to documenting removal goals because the media in question (vadose soils) no longer exists through this area. This presumes excavation at low water table. EPA is considering whether basal samples would be useful in the treatability study or relevant with water level fluctuations. Sidewall locations are a different situation. High concentrations may indicate some additional residual remains, or lower concentrations would indicate adsorbed contaminants remain. Very low concentrations or non-detects may indicate a need to no longer address the soils (although the scope of the removal is not intended to be this extensive).

Response: Sidewall bulk soil samples (or borehole samples in Alternative II) will be collected to verify that contaminated soils elevated above the site-specific SSLs have been removed or treated. Soils above the site-specific SSLs may cause an increase in groundwater contamination above the MCLs through leaching. Soils with levels below the site-specific SSLs may be left on-site and still be protective of groundwater, human health and the environment. Elevated soil concentrations may still exist in the saturated soils and will be addressed in the Groundwater FS. Soils in the capillary fringe should be considered saturated and addressed in the Groundwater FS. See Response to Comment 5 for text changes related to these issues.

EPA Comment 9. Confirmation sampling is needed in excavated areas to verify removal action objectives have been met. This will need to be added to cost estimates. If soil gas readings are retained as the basis for determining the removal action boundary, a link between soil gas readings and concentrations of COCs in soil should be firmly established. Soil gas cannot be effectively used for confirmation sampling while the excavation is open.

Response Evaluation: See the Response Evaluations for Comments 5 and 6. EPA believes confirmation samples which define concentrations laterally, if not vertically, are necessary to establish what needs to be addressed in the FS for the final remedy.

Response: See responses to Comments 5 and 6.

EPA Comment 12. Sec. 2.1.1, Surrounding Land Use, Sec 2.1.6, Sensitive Ecosystems. These descriptions are suitable at the base-wide scale. However, for most of these topics the specifics pertinent to Spill Site 7 still need to be added. In particular, proximity to the removal area such the reader can ascertain the likelihood of affects by the action on the ecosystem and/or whether actions will need measures to prevent effects. Because of past interim actions on the site, this should already be known by Air Force experience and can thus be addressed in this EE/CA.

Response Evaluation: The discussion for sensitive ecosystems is lacking. It merely states none of these are within the footprint of the source area. This is misleading because sensitive ecosystems are adjacent to the area, described generally as "in and around Diamond Creek". The response to comments indicates little concern because of the distances, but these are not described. Specifically describe those ecosystems adjacent to the area, with relevant geographic data (is it 10 feet or 1000 feet away? Is the surface drainage (topography) towards or away from sensitive areas?

Response*:* Because the distance is 200 feet or more between the source area and the sensitive habitats and wetlands areas, it is unlikely that any of the proposed activities will have an impact. The remediation area, including the excavation, staging, and treatment facility, is located on a terrace or bench approximately 20 vertical feet above the stream channel and sensitive ecosystems, as shown on Figure 4-1. Engineering controls will be used to reduce fugitive dust emissions, vapor releases, and surface water runoff to ensure that the local area is not impacted during the field activities. These best management practices will be detailed in the work plan for this interim action. The following text has been added to the end of Section 2.1.1.

> *"Land use at Spill Site 7 itself is open field. There are no regular activities at the source area or proposed treatment area beyond quarterly environmental sampling."*

The following text has been added to the following Sections:

Section 2.1.5

> *"In the area of interest at Spill Site 7, during large precipitation events, the surface water flow may occur as sheet flow across the area, which slopes towards Diamond Creek, and as channelized flow in the man-made drainage ditch along the southern portion of the area, which was used by the historic grease trap."*

Section 2.1.6

> *"None of the sensitive ecosystems described above are located within the footprint of the Spill Site 7 source area or treatment zone. Wetlands in Diamond Creek are located approximately 250 feet north-northwest of the planned action. However, their presence or potential presence in and around Diamond Creek makes them of importance to the selection of potential removal alternatives for Spill Site 7 unsaturated soils. Best management practices (BMPs), such as hay bales, berms and silt fences, will be utilized during any removal actions to restrict storm water from flowing into and/or runoff from leaving the site and flowing into areas of sensitive habitat or Diamond Creek."*

EPA Comment 13. Sec. 2.1.4, Page 2-3. Although Figure 2-6 presents ground-water levels, and a range of values for depth-to-ground water is discussed, a table showing the depth-to-ground water for individual wells is needed. A table showing the historical and current depth-to-ground water for individual wells is relevant to any response action which may key to the water table, which fluctuates.

The discussion refers to contours presenting a "V" pattern pointing to the southeast centered on the collection drain from a previous study. The proximity of the "V" to the drainage ditch associated with the original oil-water separator may indicate a facilitated ground water transport pathway. The highest levels of contamination detected are also in this vicinity, with concentration zones elongated somewhat along this trend. This fate and transport mechanism belongs in the site conceptual model.

Response Evaluation: The RTC states the preferred alternative is not contingent on the depth of the ground water because implementation depth is to the water table regardless of the depth at the time of the excavation. The presumption in this is that there may be no way to optimize the alternative by timing excavation to the seasonally lowest water levels. The data should be added with an evaluation of the feasibility of taking advantage of the levels and, if not feasible, at least supports an assessment of how sensitive aspects of the alternative are to the levels. Moreover, if the optimal time is not feasible, the information is still useful. If the excavation is completed during higher water levels, then a volume of unexcavated soil would recur once water levels drop again. This may need to be recognized in the context of the FS for the final remedy.

> **Response:** An analysis of the groundwater table has been added. (See attached box and whisker plots) Figure 2-7. The groundwater table at Spill Site 7 has fluctuated 8 to 10 feet over historical records. Fall and winter exhibit the lowest levels. Timing for the IRA appears to coincide with this low water table time-period. The preferred remedial action is not contingent on the depth of the groundwater. Rather, the excavation will be implemented to the water table, regardless of the depth at the time of the action. Since COCs are present in the groundwater above the MCLs, once the water table returns to

previous levels, it is likely that the soil will be re-contaminated through adsorption back onto the soil. The proposed pilot study will address this effect. By using the proposed subsurface network of piping, these soils can be treated whether they are above or below the water table. Delaying remedial actions to wait for low water table conditions would only delay the overall remediation. The piping network can also act as a vent to collect groundwater off-gas when the groundwater table falls below the elevation of the piping. Minor edits throughout the document state that the excavation will be conducted to the top of the water table. The following text has been modified in section 2.1.4.

> *"Groundwater was encountered between 9 and 26 feet bgs. Figure 2-6 shows the November 2001 water elevations and groundwater contours reflecting these measurements. On a base-wide scale, groundwater flow is to the northeast, somewhat parallel to Diamond Creek and towards Crow Creek. However, at Spill Site 7 the groundwater flow is split, with the majority of groundwater flowing to the north while portions flow to the west. This flow pattern results in flow towards Diamond Creek. The contour lines show a distinct "V" pattern pointing to the southeast, which is centered on the collection drain from a previous treatability study. This drain was installed to a depth of 6 feet below the base of Diamond Creek, which puts it well below the local water table. The flow pattern near this drain indicates it may be acting as a preferential flow path for the shallow groundwater, increasing flow to Diamond Creek. This preferential flow path may have an impact on saturated zone and groundwater remedial actions, which are being addressed by another contractor. Historical groundwater levels at Spill Site 7 were found to fluctuate over 10 feet throughout the historical record as shown on Figure 2-7. This groundwater data can be found in Appendix A. Seasonal lows occur through the fall to early spring, depending on snow melt and rain fall recharge."*

Response Evaluation: The RTC indicates the discussion of the "V" pattern was added to Section 2.3.1, which describes Soil Gas and Membrane Interface Probe Survey. There is no relevant discussion in this section. Nor is EPA clear how this relates to General Comment 4, where the topic is defining shallow and deep zones. EPA acknowledges this is a saturated zone phenomenon. However, it will affect flow in the uppermost saturated zone. Depending on location and layout of the piping for delivering material to the saturated zone for the proposed treatability study, this influence may affect where the delivered materials flow.

Response: The V pattern was added to section 2.1.4 "Hydrogeology." The pilot test distribution of treatment materials will likely follow this flow path.

EPA Comment 15. Sec. 2.3, Analytical Data/Extent of Contamination. Because of the low solubility of TCE and the relatively high concentrations found in ground water, there is a potential for the development of a dense, non-aqueous phase liquid (DNAPL) moving through the subsurface in addition to the water phase. Describe the potential for this to occur, and the transport of the organic phase. In this case, it would travel similarly to water under gravity above the water table. Beneath the water table, it would continue to travel downward (or "stair step" downward) until it reaches a permeability barrier such as a clay zone) while small amounts dissolve to for the ground water plume.

Clarify if there are any field observations which are consistent with the "stair-step" model of transport. For example, were cores taken at intervals intersecting the caliche surfaces and/or clay surfaces? Was residual staining, free liquid, or such observed?

Response Evaluation: The EPA comment was intended to have the general process described for the general audience (which best fits in the new discussion of Fate and Transport). This would include addressing the potential for DNAPL beneath the water table even though the scope of the action is primarily the vadose zone.

Most of the observations regarding the "stair step" transport in the RTC are within Section 2.3 as identified. Combining these observations to support the transport process have not been put together in the document as coherently as is the RTC. Recommend a discussion similar to that in the RTC be placed in Fate and Transport.

Response: The following text has been added to the beginning of Section 2.3.6:

> *"The fate and transport of soluble contaminants, such as TCE, in the subsurface can be broken into aqueous (e.g., dissolved) phase transport and NAPL transport. Aqueous-phase TCE is dissolved in water and would therefore migrate in the direction of groundwater flow. While this generally implies horizontal transport, if any vertical gradients are present, the TCE may migrate upward or downward in the aquifer along with the groundwater. No substantial vertical gradients have been identified near the grease trap at Spill Site 7. However, an upward vertical gradient has been defined near Diamond Creek. Based on this information, it would be expected that aqueous-phase TCE released from the grease trap would migrate directly downward through the vadose zone until it reached the water table. Migration would then be horizontal through the Spill Site 7 area toward Diamond Creek.*

"NAPLs such as TCE at concentrations greater than 1,100 milligrams per liter (mg/L) in water migrate through the aquifer primarily under the influence of gravity. Pure TCE has a density approximately 46 percent greater than that of water and is therefore referred to as a DNAPL. TCE released from the grease trap as a DNAPL would be expected to migrate downward through the vadose zone to the water table, then continue downward through the water column until it reached a hydraulic barrier to migration (i.e., aquitard). The DNAPL, if present in sufficient quantity, could pool on the aquitard in a localized low spot or migrate laterally, even upgradient, if the aquitard has an upgradient slope. Pooled TCE DNAPL, as well as that DNAPL present as a residual in the vadose and saturated zones, would act as a continuing source of groundwater contamination into the future.

"The historical releases of TCE from the grease trap at Spill Site 7 were part of a process involving relatively steady water flows from floor drains and air conditioning units, with sporadic higher water flow events that may have caused a wash-out of the grease trap contents. Regardless of the specific occurrence that resulted in releases from the grease trap, the TCE was most likely accompanied by substantial quantities of water at all times. Because of this history, it is unlikely that there ever was a release of TCE DNAPL that would have resulted in downward migration of TCE through the water column. The more likely scenario is a release of aqueous-phase TCE along with a quantity of water.

"Once a release from the grease trap occurred, migration of the TCE would have been controlled by surface and subsurface features of the site. The drainage ditch itself would have limited the overland flow to a distinct west-northwest direction during release events. In addition, the contaminants may have migrated westward along the ditch some distance before the surface soils allowed infiltration and downward migration to begin. This could have created the groundwater TCE distribution observed at Spill Site 7 (see Figure 2-12), where the groundwater is not significantly contaminated directly under or immediately near the grease trap, but becomes more contaminated at some distance westward from the source. This "delayed infiltration" model is supported by sampling data from SS7SG19, located approximately 75 to 100 feet west of the grease trap, where soil gas exhibited 26,000 ppbv TCE at a 10-foot depth, but only 560 ppbv TCE at 20 feet (see Figure 2-10).

"An additional potential control on contaminant migration in the vadose zone is the presence of several caliche layers and soils with low permeability at the site (see Figures 2-4 and 2-5). These geologic features limit direct downward percolation of surface water to the groundwater system, and the field observations suggest that the caliche layers are slightly deeper to the west of the former grease trap, which could also explain the westward migration of contaminants before they reached the groundwater. This "geologic control" model is supported by the presence of low permeability caliche horizons with highly contaminated soils directly above them and minimal contamination below them. This relationship is apparent in the borehole log for SS7SB33, located just downstream of the grease trap, where the headspace reading is 231 ppm at 16 feet, just above a "No Recovery" zone signifying caliche. The headspace reading at 22 feet was 10.9 ppm.

"In either of these conceptual models, alone or in concert, water is limited in its movement downward through the soil column, but it can move laterally either along the surface ditch or in a stair-step fashion from one caliche layer to the next until it reaches the groundwater system. Once the water moves through the soil column, and reaches the water table, contaminants would travel with the gradient of the groundwater. An additional factor that may have influenced migration in the vadose zone over the past 10 years is related to preferential flow of precipitation leaching through the soil column along the backfilled trenches from remedial actions during the 1992 Treatability Study.

"Regardless of the combination of mechanisms acting on contaminant migration, the levels of TCE observed in the soil gas and downgradient groundwater suggest that a NAPL may be present as a residual in the soil matrix. Figure 2-13 depicts the occurrence of this residual NAPL, along with the vapor phase in soil gas, sorbed phase on soil particles, and dissolved phase in groundwater. This schematic suggests that the NAPL is not present in sufficient quantity to migrate as a fluid, but will continue to contribute to soil vapor and groundwater contamination into the future unless addressed. The residual NAPL is likely to be present in both the vadose and saturated zones, as depicted on the figure.

"The presence of soil gas contaminants in distant areas north of the drainage ditch may be an artifact of volatilization from the contaminated groundwater. An example of this may be found at MW-151, where the groundwater TCE concentration was 13,170

> *ppb and the soil vapor concentration was 21,000 ppbv. Because there is no historical evidence of a TCE release near MW-151 and neither soil gas data nor groundwater data suggest continuity of contamination between the grease trap area and MW-151, it is most likely that the soil gas contamination is due to upward migration from the contaminated groundwater. MW-151 was constructed using 35 feet of screen and 42 feet of filter pack. It is reasonable to assume that the screen and filter pack are acting as a conduit for migration of VOCs released from the groundwater. This concept will be tested as part of the IRA, where additional soil gas samples will be collected prior to the remedial action to ensure that the soils near MW-151 do not represent a discrete source area."*

EPA Comment 16. Sec. 2.3.2, Subsurface Soil Samples, Page 2-12. The base wide background report numbers are mean values. Determining whether a metal is elevated above background should involve comparing background means (i.e., the 95% upper confidence level of the mean) to means from the site (the 95% UCLM). Low numbers of site samples may not allow such a comparison. In this case, identify the range of background occurrences and the standard deviation of the mean. Compare this to the range of site sample values. If the metal occurs in normal or log-normal distribution in background, EPA and WDEQ have accepted the mean plus two standard deviations as an upper tolerance level to identify whether site samples are elevated above background. Only metals potentially elevated should be considered to contribute to excess risk (and thus the comparison to RBCs or SSLs).

Paragraph two provides values for residential RBCs. However, some values correspond to SSLs rather than residential RBCs according to the Environmental Protection Agency (EPA) Region 3 RBC table (EPA 2001). Some values for RBC appear to be reported too low (exponents on the table were apparently not correctly carried through).

Response Evaluation: EPA may need to clarify. The RTC was relatively a non-response on background values. Whether there was a robust statistical analysis in the Plume Heads RI does not allow the reader to know what realistic ranges and means are for the metals. A brief summary of the information would have been responsive. Not having "background level" defined or described also makes other terms, such as three times background level unknown.

While the SSLs identified and corrected were appropriate, EPA still identifies some differences for RBCs (residential) and SSLs (DAF = 20). The following were consistent through tables from 2000, 2001, and 2002: For CrIII, the RBC is 1.2E+05, the SSL is 2.0E+09 mg/kg; for CrVI, the RBC is 2.3E+02 and the SSL is 4.2E+01; for Cu the RBC is 3.1E+03 and the SSL is 1.1E+04 mg/kg, for Fe the RBC is 23,000 and there is no SSL. In nearly all of these cases, a value an order of magnitude low is reported in the document. This may be a holdover from the risk assessment for the Plume Heads area, where values an order of magnitude low may have been used for the initial screening for COPCs. Conservative screening in this manner is used to assure

chemicals are not inappropriately eliminated in assessing risks, especially where there may be many COPCs.

However, the same numbers are not used to develop preliminary remediation goals (PRGs). PRGs are typically site-specific. Where the scenarios by which the Region 3 RBCs are derived are representative and there are few COCs, the RBC may be directly used.

In comparing corrected values, surface soils may not need to be addressed, based on risk or potential to contaminate ground water. Arsenic and manganese may be within background when the range of detections are considered against the range of background values. Aluminum, barium, cadmium, copper, iron and possibly selenium may be elevated in soils, but do not appear to exceed their respective RBCs or available SSLs. No chromium detections exceed the RBC (CrVI); only one chromium detection in SS7SS02 exceeds an SSL (49 mg/kg compared to an SSL of 42 mg/kg). Most chromium detections are below this.

EPA recommends reviewing ground water data to determine if metals clearly exceed background and standards in the vicinity of SS7. Based on a cursory check, EPA notes aluminum, iron, and manganese exceed the WDEQ standard, but the background value presented (presumably the 95% UCLM) also exceeds the standard for iron and aluminum. Manganese may also be within background when the full range of occurrence in background samples is considered. Barium, chromium, copper, and selenium do not appear to be elevated above background in ground water based on Table 2-8.

VOCs exceed SSLs, which is empirically consistent with high VOC concentrations (particularly TCE) in the SS7 area. This appears to be a viable basis for removal.

> **Response:** This statistical evaluation involving 95 UCL values for site data and background and evaluation of normality was performed as part of the Plume Heads RI report. Because the background study was extensive, the data voluminous, and the statistical evaluation lengthy, it will not be repeated herein. The reader is referred to Section 9.4.1.3 in the Source Areas RI for the statistical evaluation and the "Summary Statistics Tables for Compounds Detected."
>
> In earlier drafts, the values for non-carcinogenic compounds had been adjusted downward in the RBC tables by a factor of 1/10, as indicated on Page 3 of the Memo to RBC Table Users from Jennifer Hubbard, Toxicologist, Region III Superfund Technical Support Section, dated September 25, 2001. However, this method should be reserved for quantitative risk assessment only. Therefore the evaluation, text and tables in the EE/CA have been modified to use and present the actual, un-adjusted RBC values.

A review of groundwater data indicates the following, which was added to Section 2.3.4:

> *"Groundwater data for aluminum, iron, and manganese were compared to background concentrations to fully evaluate whether metals exceeded background and standards at Spill Site 7. Aluminum concentrations fall within the background range in all but one sample collected at Spill Site 7. The ranges of iron and of manganese concentrations fall within the background range of values. The background values for both aluminum and iron exceed the WDEQ standards. Based on this assessment, iron, aluminum, and manganese are not considered to exceed background or standards at Spill Site 7."*

EPA Comment 17. Sec. 2.3.3.1, Soil Screening Levels, Page 2-14. Demonstrate how the dilution attenuation factor (DAF) value of 24 was developed and provide the site-specific SSLs which result. Identify the equation(s), assumptions, and input values used to derive the DAF value. Provide the resultant site-specific SSLs for all of the analytes that exceeded the general EPA Region III SSL criteria and any site-specific SSLs.

Response Evaluation: Considering the revision, the response is appropriate in general, except for showing the calculations.

> **Response:** Appendix B has been added to the EE/CA describing the methodology and results of the site-specific SSLs.

EPA Comment 18. Secs. 2.3.2 through 2.3.3.1. A table summarizing the soil COCs along with their respective levels for risk (residential and industrial) and SSLs would be appropriate. This helps define removal action objectives and may identify where removal objectives may need to change to meet potential remedial action objectives. If a risk or SSL is very low it may be below the ability to accurately measure (i.e., the reporting limit for any acceptable method is above the criteria), it would also be useful to identify because this may become the measure for a removal action objective by default.

Response Evaluation: The objective of the comment was to help define response levels on a chemical-by-chemical basis, which in this document was evaluated using RBCs and SSLs rather than the risk assessment under development for the RI. This would help clarify if surface soils are intended to be addressed based on risk and subsurface soils based on potential for further contamination of ground water from VOCs. From the Source Area RI, EPA notes no COPCs were retained for surface soil and generally concluded no significant (current) exposure risks to human health or ecological risks. Indoor air was qualitatively evaluated in the (draft) Zone D Ground Water RI and found to present a clear potential risk without calculation by partitioning from ground water (the residential RBC is 16 ppbv; soil gas values exceed this by several orders of magnitude).

Response: See response to Comment 5. The remedial action at Spill Site 7 is being driven strictly by the potential for contaminants to migrate to the groundwater or surface water (site-specific SSLs and TCLP values). Evaluation of indoor air is not within the Source RI/FS scope of work, but was addressed in the Zone D Groundwater RI/FS. It is not the intent of this interim response action to address indoor air. Indoor air will continue to be a concern until the groundwater is restored to a point where off-gassing of the groundwater is minimized through source reduction.

EPA Comment 20. Sec. 2.3.5, Surface Water and Sediment, Pages 2-15 through 2-17. Tabulate the data being discussed. Chemical concentrations should compare surface water and sediment data results with RBCs and, in the case of surface water, the values for a Class 2AB stream. This helps define removal action objectives and may identify where removal objectives may need to change to meet potential remedial action objectives.

Response Evaluation: No scope change was intended with the comment. The intent of the comment was to evaluate if a removal action objective pertaining to stream protection due to overland flow would also be appropriate (i.e., would elevated concentrations of inorganics in surface soils present a potential ecological risk compared to SQVs?).

Removing source material (in this case, VOCs) would be in furtherance of a remedial action objective to protect surface water quality. In retrospect, EPA agrees the latter goal can be stated without a specific comparison to standards because ground water to surface water is the major contaminant transport pathway.

Response: Best management practices such as hay bales, silt fencing and run-on/runoff controls will be in place during remedial implementation to further minimize direct runoff of contaminants to Diamond Creek. These best management practices will be detailed in the upcoming work plan and are mentioned throughout the description and evaluation of each alternative.

EPA Comment 22. Sec. 3.2.1, Goals and Objectives of the Removal Action, Pages 3-1 and 3-2. Explicitly identify the COCs as suggested by the EE/CA guidance (EPA 1993) and identify the clean-up levels to be achieved by the removal action. Defining the COCs and the clean-up levels help describe how a removal action objective (RAO) is achieved.

Response Evaluation: The RTC refers to the response for Comment 5. EPA will refer to the Response Evaluation for Comment 5.

Response: See the response to General Comment #5.

EPA Comment 24. Secs. 3.2.3.1.1, 3.2.3.1.2, and 3.2.1.3 ARARs. As a preliminary identifier of ARARs, these discussions should mainly be a listing of key ARARs at this point, with the actual analysis within the context of the Detailed Screening of alternatives. The alternative haven't been described yet. Much of the discussion beyond the listing needs to be addressed in Sec. 4.

Response Evaluation: The RTC refers to changes made later in the document, which includes a statement referring the reader back to this portion of the document as the discussion which also analyses the ARARs. This is incorrect. There is a difference between *listing* potential ARARs and *analyzing* ARARs. This constitutes only a list. Defining/describing the elements of the alternative is a pre-requisite to being able to analyze the ARAR. An ARARs analysis breaks down potential subsets of requirements, and discusses how the alternative is structured to meet the ARAR (or when it cannot be met, the appropriate justification). The later discussion provides a modicum of additional detail in terms of elements of the alternative, but does little to explain how this may comply with a specific ARAR.

> **Response:** Section 3 lists the pertinent ARARs, which are then analyzed in detail in Section 4.0. This analysis is presented in the document in Tables 4-2, 4-3, and 4-4. These tables replace the text in the *Compliance with ARARs* portions of Section 4.4 and are presented in the EE/CA tables.

EPA Comment 25. Sec. 4.0, Identification and Analysis of Removal Actions, Page 4-1. This discussion also needs to address consistency with potential final remedies. Briefly address engineering and institutional controls which will be used during the duration of the removal. Identify that most long-term institutional and land-use controls will be addressed in the Record of Decision for the final remedy for Spill Site 7.

Paragraph 2. This paragraph identifies the area of contamination on which the removal action alternative evaluation is based. However, the use of soil gas readings (and the level of 10,000 ppbv) as the basis for the TCE-related removal action is not adequately linked to either the risk evaluation or to the RAOs. In addition, the removal area is not well defined. Specific items required to adequately evaluate the removal area include: a. identification of the lateral and vertical extent in which the volatile organic COCs exceed the risk-determined and RAO-specified contaminant levels (this area should be supported by figures with analytical results), and

b. identification of the horizontal and vertical extent in which the metal COCs exceed the risk-determined and RAO-specified contaminant levels (this area should be supported by figures with analytical results).

Response Evaluation: Most of the EPA comment stands as written, with elaboration. The engineering/institutional controls to be used during the action is addressed, the remainder is not.

As the document is written, there is still no well-described link to the 10,000 ppbv concentration to values which may threaten ground water quality. A statement of determination is given. Inferentially, there is an earlier reference to a study which indicates residual DNAPL is likely with such soil-gas concentrations. However, a summary of the basis (partitioning calculations, published chart correlating values, etc) has not been provided. The audience for the document includes the general public, who may not be familiar with the reference.

EPA acknowledges a direct correlative link between soil gas, analytical results and the risk-based criteria and SSLs is not apparent, and is probably not feasible. However, certain qualitative links may be established by empirical observation. [Are all of the bulk soil samples which exceed an RBC or SSL within the 10,000 ppbv delineation? If not, then the RBC or SSL criteria should also contribute to defining the volume to be addressed. Are there areas outside the delineated area which also have elevated soil gas which should be included, or deferred to the FS?]

Using the study reference as the basis, the RAO would more accurately be to address the volume of soils in which residual DNAPL is presumably present. While this will certainly reduce concentrations in soils and thus reduce what is available to transport to ground water, the RAO may be misleading as stated. Adsorbed concentrations may remain in soils outside of this area. While the anticipated contribution to ground water contamination is not as great, this potential remains. Focusing on potential residual DNAPL is acceptable in terms of defining scope; it's simply a case of recognizing there may be additional contamination which must be further addressed in the context of the FS.

This relates to the first statement about consistency with the final remedy. A final remedy would need to address this outlying volume of material. When removals are used in conjunction with the remedial process, much of the potential consistencies can be identified by considering what may need to be deferred to the FS and whether the action would preclude other response actions. Nothing in the proposed removal would preclude this volume being addressed in the FS. This may in fact help simplify the FS by removing the uncertainties associated with residual DNAPL. It will not, however, allow the assumption no further alternatives need to be developed for the final remedy.

Check the comparisons for total soil concentrations and TCLP (the twenty times rule). USAF may wish to reassess the presumption of wastes being characteristically hazardous for the surface soils due to metals. Based on a cursory check against maximum actual detections, EPA identified only one value for lead which exceeded the twenty times criteria (168 ppm against 100 ppm in the '20 times'). This alone does not mean the material would qualify as hazardous applying the TCLP. Most lead in SS7 soil samples is on the order of 15 ppm, including samples close to the maximum. Considering lead is in low concentrations in the Table 2-8 ground water samples (0.5 to 2.48 ppb), a significant amount of mobile lead appears unlikely. This does not apply to the VOCs from the higher concentration zone. It is reasonable to presume these materials will indeed be characteristic hazardous waste.

Include a statement that long-term engineering and/or institutional controls will be addressed as elements of the final remedy.

Response: See response to Comments 5 and 6.

Related to the final sentence of EPA's Response Evaluation, the following sentence has been added to Section 4.0, as well as throughout the discussion of each alternative:

> *"Once the remedy is completed, institutional controls will be implemented as appropriate to restrict access."*

EPA Comment 26. Sec. 4.1, Page 4-2. The "Excavation and Off-site Disposal" is not described consistently through the detailed analysis. As described here, the reader will assume only an off-site landfill facility for the wastes. The description in Sec. 4.2.2 includes use of the WCA. The WCA is an on-site facility. It may be simpler to treat this as excavation and disposal alternative with the on- and off-site disposal options described. By similar reasoning, "Excavation and Ex-situ Soil Vapor Extraction" should be more to the effect of "Excavation, Treatment, and Disposal". Disposal options could include the same excavation, WCA, or off-site facility. Identify which was used for cost estimation. SVE would be a presumptive technology for the treatment of VOCs in soils; identify it as such in the document.

Response Evaluation: Well responded, except for the last sentence of EPA's comment. Identifying a presumptive technology is important, because it serves to eliminate having to analyze other treatment options (e.g., thermal desorption) which may be effective, but not necessarily cost-effective. EPA has compiled data from numerous FS and treatability data to identify presumptive technologies, saving the regulated community the need to analyze a wider range of options which are often unlikely to be chosen once the balancing criteria are considered.

Response: The text in Section 4.1 has been modified to read:

> *"This alternative includes stockpiling surface soils from the ditch, collecting two bulk soil samples to determine whether the soils are hazardous based on TCLP, and implementation of in-situ SVE to remove contaminated soil gas, remediating the VOC-contaminated soil. SVE is considered by the EPA to be the "presumptive remedy" for VOC-contaminated soils (EPA 1993b, 1993c)."*

EPA Comment 30. Sec. 4.4.1, Alternative I. 1st paragraph, 2nd sentence. "IRA" should be "removal".

3rd paragraph: If the depth and size of excavation prohibits direct loading, will a staging area be needed? If so, how will the staging area be sited and constructed? This will need to comply with RCRA LDRs, meaning some form of liner if the waste pile is outside the area of contamination.

Will decontamination water be collected and consolidated for disposal?

4th paragraph: Will backfill actually have to be brought in from off-site, or is there a suitable borrow area on base (a determination of which goes directly to the feasibility/implementabiliy of alternatives)? Limiting the size of the excavation is good practice; backfilling prior to confirmation sampling results is not.

5th paragraph: "Trash pumps" should just be "pumps". Will excavation be timed to coincide with lower seasonal water levels or is de-watering expected to allow excavation to a certain elevation?

Response Evaluation: Most of these concerns appear to be addressed, some in the RTC which should be incorporated into the document (e.g., backfill).

Response: Text revisions in Section 4.2.2 within the following paragraph address this issue:

"Excavation and Disposal

"Soil from the ditch will be stockpiled within the CAMU and sampled to determine whether surface soils are to be considered hazardous based on metals concentrations along the ditch. For the purposes of this EE/CA, it is assumed that an area 120 feet long by 5 feet wide will be excavated to a depth of 1 foot. This corresponds to approximately 23 bank cubic yards (BCY) (32 LCY) of soil. The soil will be stockpiled within a lined containment area and sampled. Two five-point composite samples will be analyzed for TCLP metals. If any metals exceed TCLP levels, the soils will be disposed in an appropriate off-site hazardous waste disposal or treatment facility. Those soils exhibiting concentrations below the screening criteria will be used as backfill material. Once metals-contaminated soil is removed and stockpiled, VOC remediation will commence. VOC remediation will be accomplished by excavating an area within the soil gas boundary of 10,000 ppbv (approximately 200 feet by 75 feet with a average depth of 15 feet). Within this 10,000-ppbv boundary lies an area of soil that: 1) may exceed the TCLP criteria for TCE, 2) exceeds site specific SSLs, and 3) has soil gas readings in excess of 100,000 ppbv, which may indicate the presence of NAPL in residual form. This area, with dimensions of 150 feet by 25 feet by 12 feet deep, contains soils that could potentially be characteristically hazardous. This option includes excavating approximately 1,200 BCY (2,400 LCY) of potentially hazardous material, hauling the hazardous soil to an approved off-site

> *landfill, excavating the surrounding 6,300 BCY (9,200 LCY) of non-hazardous soil, hauling that material to the on-base WCA or an approved off-site non-hazardous landfill, and backfilling the entire excavation with an approved clean fill material from an off-site location. The two disposal options are screened in the same manner; the only differences are in final waste disposition and cost. The surface will be restored to match existing site conditions. Long-term monitoring is not required for this option, and no O&M costs would be associated with excavation and off-site disposal. Once the remedy is completed, long-term engineering and/or institutional controls will be implemented, as appropriate, to restrict access."*

Response Evaluation: However, whenever an AOC is used, it needs to be defined if compliance with LDRs is to be established, because LDRs are not violated for consolidation within the AOC. Compliance with the LDRs is better established by defining the necessary surface area of SS7 as a Corrective Action Management Unit (CAMU as defined in RCRA Subpart S) in which excavations, stockpiles, treatment unit, and decontamination areas are all within the CAMU. A CAMU allows greater flexibility in response actions than the AOC. Clarify if stockpile and treatment areas would be bermed and lined (if not, specifically state so). In nearly all cases, strict compliance would require liners. Stockpiles and treatment units would also need to be closed; liners aid in this and preventing leaching through the base of the unit.

Response: The following text has been added to Section 4.0:

> *"Temporary stockpiling of soils, as well as execution of any soil treatment, will occur within the Spill Site 7 contaminated area. The excavation, stockpiling, and treatment within this area will be managed to meet the substantive RCRA requirements for a corrective action management unit (CAMU), which governs LDRs. These requirements include engineering practices, such as the use of berms/liners and confirmation sampling after completion, which will be detailed in the upcoming Spill Site 7 IRA Work Plan."*

Response Evaluation: In order to minimize the amount of decontamination fluids, FE Warren AFB has opted in the past to use dry decontamination periodically while the machinery remains in the unit and use fluids to clean once the vehicle leaves the area. The potential to cross-contaminate media is probably low during excavation of the apparent non-hazardous upper soils; but is likely high where bulk soil concentrations are high and residual DNAPL is suspected. Water from decontamination of these zones is unacceptable for use in dust control. FE Warren would have to follow this up with extensive surface soil sampling and address those soils as part of closure of the unit.

Response: Decontamination fluids will be minimized through the use of dry decontamination. What minimal decon fluids are generated will be either applied to contaminated soil areas (excavation pit, stockpiled soils awaiting treatment, etc.) or will be containerized, tested and disposed appropriately off-site. The following sentence was added to Section 4.4.1, and applied similarly to each alternative to address this issue:

> *"Decontamination water will be collected and used for dust control within contaminated areas (i.e., excavation pit, stockpiled soils awaiting treatment), or will be sampled and disposed of in an appropriate facility."*

EPA Comment 31. Sec. 4.4.1.1, Page 4-11, Effectiveness Evaluation, Paragraph 1. Determination of the cleanup levels is part of the EE/CA and cannot be an "after the fact" determination.

Response Evaluation: In order for the treated soils to be placed back in the excavation, the conditions to be met include: (1) the material cannot be characteristically hazardous (i.e., the characteristic is removed based on TCLP or total concentrations using the "twenty times" rule); (2) potential risk-based concentrations for potential exposure scenarios must be met (compounds with background levels above an appropriate risk level must attain the background level, an RBC is otherwise appropriate), and (3) the material is unlikely to contribute to further contamination of the ground water. Potential contaminants are generally viewed against all of these conditions to establish acceptable levels compound by compound and the level meeting all conditions is the numerical goal. The driving goal can vary contaminant-by-contaminant (e.g., an RBC is likelier to drive a toxic contaminant; a mobile contaminant could be driven by potential to contaminate ground water). An arbitrary "three times background" may not meet these conditions and the goal levels need to be revised.

Response: See response to Comments 5 and 6.

Response Evaluation: Given the limitation of excavating to the water table, samples from the base of the excavation would not be meaningful in terms of confirmation samples. However, the document sometimes presents the depth of excavation as to the water table, in other areas implies excavation will be to within a foot or two (i.e., the capillary fringe) of the water table, where the samples may provide a baseline indicator for the proposed treatability study.

Response: See response to Comments 5 and 13.

Response Evaluation: Excavation remedies also need sidewall confirmation to assure the lateral extent meets the excavation goal/RAO. With the main contaminant likely to be VOCs (primarily TCE), vapor measurements will be useful as a guide to the lateral extent, but do not substitute for analysis of bulk soil samples to establish final results. In this case, vapor measurements should guide to the point where it's believed any residual DNAPL has been removed. 1,000 ppm (1,000,000 ppb) is proposed as this value. Although these are mass to

mass measurements, this appears to be greater than the 10,000 ppb by volume. Convert to consistent units. Inspection of the results from the boring logs are helpful, but may not assure the volume of interest is well-defined.

Bulk soil sample concentrations should be able to confirm only adsorbed concentrations remain. These results will also be useful for the FS to evaluate if soils should be further addressed in the final remedy.

Vapor measurements are not acceptable for determining whether the soil is suitable for placement back in the excavation. However, the innovative approach with the partitioning relationships could be useful to monitor the soils under treatment, and used as an indicator for when to obtain bulk soil samples. The uncertainties associated with VOC analysis for bulk soil is acknowledged. However, similar uncertainties exist for vapor sampling with dilution effects and actual parting coefficients. Drawing in clean(er) air at the edge of the excavation may cause excavation to stop too soon. Open air samples will be diluted with atmospheric air.

Response: See response to Comments 5 and 6.

EPA Comment 32. Sec. 4.4.1.1.2, Compliance with ARARs. This entire discussion can be summarized in the statement "this alternative will meet ARARs". This approach is entirely insufficient where enough of the alternative is developed such that the various actions and requirements can now be related (analyzed). Given this relationship, the ARARs can now be analyzed such that detailed discussion can *describe how* the alternative will meet ARARs.

For example, there are a number of potential actions described, but none of the necessary information or determinations needed. A staging area will need some form of liner to comply with the land disposal restrictions (LDRs) unless it is within the area of contamination (AOC). The ex-situ treatment unit (or emissions treatment) does not require a permit, but the substantive requirements need to be identified along with a description of how these requirements will be met. Because portions of the soils may be hazardous waste, how will the placement of the soils back in the excavation not constitute placement of a hazardous waste? Will meeting the removal action objectives demonstrate the waste is no longer hazardous (or no longer has to be managed as hazardous waste).

Response Evaluation: See also previous RE regarding defining a CAMU. Of issue here is that again, requirements are listed, but little description of HOW the unit/action/activity will be designed or managed to comply with the potential ARAR. Part of this is the generalized nature of the discussion. Part of it is also not relating the unit/action/activity to the rule which may be ARAR.

For example: Stating any waste found to be contaminated above the WHWRR regulatory limits will be managed separately in accordance with the WHWRR requirements is relatively meaningless without elaboration. Which of the activities trigger the WHWRR? Are the WHWRR regulatory limits those which determine whether a waste is hazardous or non-

hazardous (and are the definitions the same as for federal RCRA requirements?). Are there more stringent WHWRR regulatory limits? Is the placement of an the HDPE liner on the ground triggered by a certain level, to avoid the act of "placement" in terms of the LDRs, or is it a general management requirement for any contaminated material? Are stockpiles "temporary" units?

Monitoring for OSHA requirements for worker safety and monitoring general air emissions (for public health and safety) are two different issues. Will Wyoming rules require monitoring or some form of modeling or calculation to establish whether monitoring is required?

What needs to be done to meet storm water regulations? Is this a requirement to be addressed in the system design to control run-on and run-off?

Perhaps the most direct approach to this would be to expand the ARARs tables (Tables 3-2 and 3-3) with the detailed discussion and providing a summary discussion for the alternatives with a reference to the Tables for the reader. In this case, what is meant by "expanding" the tables varies. In some cases, elaboration in the comments may be sufficient (for example, using the NAAQS: Stating CO, NO, ozone, and SO2 will not be generated but dust will identifies to the reader what falls under the regulation. State to which action or alternative this would apply, such as applicable to all excavation alternatives, or applicable to Alternatives 3 and 4, and then identify how the requirement will be met (whether any monitoring will be done and what will be done if a threshold is triggered (such as water will be used for dust suppression). In other cases, what is given as a citation is actually an entire series of requirements (such as the requirements for hazardous waste generation, treatment, and disposal). In the case of the on-site treatment alternative, all of these occur. This section of the rules needs to be broken out and individual requirements discussed.

> **Response:** A more detailed analysis of ARARs has been performed and is presented in the document in Tables 4-2, 4-3, and 4-4. These tables replace the text in the *Compliance with ARARs* portions of Section 4.4 and are attached for review.

EPA Comment 33. Sec. 4.4.1.1.4, Page 4-13, and Sec. 4.4.2.1.4, Page 4-21, Reduction of Toxicity, Mobility, and Volume (TMV). The full criterion is reduction of toxicity, mobility, and volume *through treatment at the site.* In Alternative I, there is no treatment at the site; volume and mobility are nonetheless reduced. Treatment is part of Alternatives II and III which will directly reduce toxicity, mobility, and volume. Discuss the degrees of reduction of TMV, the degree to which treatment will be irreversible, the type and quantity of residuals that will remain after treatment, and whether the alternative will satisfy the preference for treatment (EPA, 1993). Very little of this is addressed.

Response Evaluation: Mostly addressed, however some of the focus needs correction. Because the delivery system is mainly a treatability study, it should not be included in the determinations for the focus of the removal (i.e., the vadose zone).

Response: The text has been changed to include a new Section 7.0, which contains information about the reductive dechlorination pilot study. All references to this study have been removed from the alternatives, including the evaluation and comparison of alternatives. Section 7.0 is presented as follows:

"7.0 Pilot Study – Reductive Dechlorination in the Uppermost Saturated Zone

"A pilot study is being proposed to minimize recontamination of treated soils from gases originating from the groundwater and/or from direct contact from the fluctuating groundwater water table. This pilot study will take advantage of the open hole during excavation to place slotted PVC piping and gravel pack below the remediated soils and use this piping to inject treatment material, such as Hydrogen Release Compound® (HRC®).

"Once sufficient material is excavated, slotted Schedule 80 PVC drain pipe and a 1-foot gravel pack will be placed in the bottom of the excavation. After implementing the removal action and backfilling the excavation, the piping will be used to introduce a hydrogen donor such as HRC or sodium lactate to the capillary fringe to facilitate reductive dechlorination in the saturated soils and associated groundwater. This in-situ application will be conducted to minimize the potential for recontamination of the treated soil through groundwater fluctuations and vapor migration. Approximately 10 rows of the slotted drain pipe will be placed in the excavation. Both ends of the slotted pipe will be fitted with elbows, and a vertical section of Schedule 80 pipe will be installed to approximately 2 feet above grade. Once the sections of piping are installed, a 1-foot gravel pack will be placed over the piping to facilitate the dispersion of the hydrogen donor to protect the PVC during backfill operations and to act as a vapor collection medium.

"Injection of HRC is a demonstrated technology for reducing TCE in saturated soil and groundwater. It is effective at reducing the levels of sorbed and dissolved phase TCE and may be effective on small amounts of residual NAPL as well. Bench-scale testing using sodium lactate has demonstrated that this may be a low-cost alternative to HRC. For planning purposes, HRC will be presented as the selected injection medium. However, based on further bench testing and cost evaluation, FEW may request that sodium lactate be employed instead of HRC.

> *"Approximately 2,300 pounds of HRC will be mixed into a liquid solution and pumped into the drainpipe network. This will address contamination at the top of the saturated soil. Following the HRC injection, the pipe network will be flushed with a surge of clean water in two separate events to force some mixing of the HRC with the material in the upper saturated zone. Nearby wells will be monitored for a 12-month period to assess the need for a re-application of HRC. It is anticipated that a reduction in TCE levels in the groundwater will be apparent within the 6-month monitoring period.*
>
> *"The substantive requirements of the WDEQ's underground injection control program will be met during the injection of the HRC. Because this is not a recurrent injection, it is considered a pilot-scale project with minimal regulatory requirements.*
>
> *"Appendix F contains separate costing for the HRC application."*

EPA Comment 34. Sec. 4.4.2.1.5, Short-term Effectiveness, Page 4-22, Paragraph 2. This paragraph discusses the time until RAOs are achieved and indicates that the response objectives will be met in approximately three years. This time period appears to be inconsistent with the discussion in Sec. 4.4.2.1.3, which states that the long-term effectiveness of in-situ soil vapor extraction (SVE) is questionable in low permeability material. Reconcile the apparent discrepancy.

Response Evaluation: The RTC is generally sound. Clarify how the monitoring for rebound would be done. The ability to determine if rebound actually occurs is questionable, particularly if soil gas is used as an indicator. Vapors from the underlying contaminated ground water could confound identifying the source of an elevated measurement. Are bulk soil samples intended? It's not apparent yet whether the treatability study or another potential remedy successfully reduces ground water concentrations such that this is not a concern. At a minimum, this uncertainty should be identified; such monitoring may also need to be recognized as meaningless due to the surrounding conditions.

Response: The following text was added to Section 4.4.2 for Alternative II:

> *"Rebound will be checked through soil vapor collection using direct push techniques. If no rebound is exhibited, bulk soil samples will be collected at the end of one year and analyzed for VOCs by an off-site laboratory to confirm completion of the IRA. If rebound does occur, the system will be restarted.*

Also, the following edits to 4.4.2.1.5 were made:

> ***"Time Until Response Objectives are Achieved****Surface soil stock piling and removal are anticipated to take three weeks, including laboratory turn-around time (TAT). System installation, including well drilling, installation, piping, trenching, and mechanical installations, is anticipated to take 6 weeks. The exact remedial duration of the in-situ SVE depends on numerous factors, including system efficiency, flow rates, and soil permeability. Based on preliminary assumptions and experience at similar sites, the SVE will be marginally effective; however, to allow for comparable costing, it is anticipated that response objectives will be met within approximately 3 years. An additional year of soil sampling and soil gas monitoring will be required prior to system demobilization to ensure that no contaminant rebound occurs. Thus, the total estimated remediation time for evaluation purposes is approximately 4 years."*

A similar assessment of rebound will be performed as part of Alternative III (ex-situ SVE). As noted in the following additional text for Section 4.4.3 and 6.1:

> *"An additional year of soil vapor monitoring will be required after system termination to ensure that no contaminant rebound occurs. Rebound will be checked through soil vapor collection using direct push techniques. If no rebound is exhibited, bulk soil samples will be collected at the end of one year and analyzed for VOCs by an off-site laboratory to confirm completion of the IRA. If rebound does occur, the system will be re-started."*

EPA Comment 36. Sec. 4.4.3, Alternative III, Pages 4-25 through 4-32. The discussion indicates that the treatment of low permeable soils will be enhanced with ex-situ SVE because the surface area exposed to air flow will be increased. Other enhancements would be useful to consider. Mixing of the soils and/or mixing a bulking agent into the low-permeability soils prior to placement in the treatment cells should be considered in the evaluation and cost estimate as appropriate.

The first paragraph on page 4-26 indicates that the treated soil must meet the SSL criteria for TCE of 0.015 milligrams per kilogram (mg/kg) to be used as backfill. However, the extent of excavation is based on a soil gas reading of 10,000 ppbv. The use of two different criteria, one for excavation and one for treatment, is inconsistent and should be resolved.

In addition, Figures 2-4 and 2-5 suggest that a large quantity of soil will meet this SSL criteria even before treatment. Is a staging of soils planned or needed to sort soils requirement treatment and for those which do not. Clarify how areas of soil in the treatment cell that do not meet the

standard will be identified. (No discussion is provided regarding the sampling of the soil in the ex-situ cells prior to or after treatment, tracking (or mapping) of "known" contaminated soil in the treatment cells.) Because of the concern with placement of contaminated soils back into the excavation and the presence of a large quantity of uncontaminated soil at the start of treatment, this aspect of the alternative needs to be developed, evaluated, and considered in the cost estimate.

Response Evaluation: Response accepted in terms of the bulking agent. The potential to separate or stage soils likely to require treatment from those which would not was not addressed. Presumably, the entire volume excavated for VOCs is intended to be placed on the treatment unit. EPA has already commented on the measurement criteria for placing materials back into the excavation.

> **Response:** All excavated soils (except those from the top 1 foot of the drainage ditch) will be treated in this alternative. See response to Comment 5 for information related to criteria for returning treated soils to the excavation.

EPA Comment 37. Sec. 4.4.3.1.3, Long-term Effectiveness (Alternative III), last sentence. This states post-remedial soil sampling will be used to verify this potential (the potential to verify if elevated soil vapors can re-enter the remediated area). No such statement appears for the other alternatives, which can be treated consistently for this concern. Because the underlying ground water is contaminated with high concentrations of VOCs, it is almost a given vapors will re-enter the soil matrix. Where this becomes important is if this is to the degree vapors can bind to soil in excess of the projected remedial goals and thus re-establishing the risks.

Response Evaluation: Response accepted in general. It's not apparent yet whether the treatability study or another potential remedy will successfully reduce ground water concentrations such that significant vapors will not re-enter the soil matrix. This uncertainty should be identified due to surrounding conditions.

> **Response:** The HRC portion of the IRA has been designated a pilot study and the discussion has been moved to the new Section 7.0. See response to Comment 33 for the text changes. Text has been added to Section 4 addressing the possibility of rebound due to groundwater and saturated soils.
>
> > *"Conditions exist in the saturated soil and groundwater that could lead to recontamination of the vadose zone soils following implementation of this IRA. Therefore for each alternative, an additional year of soil vapor monitoring well be performed to ensure that rebound does not occur. If rebound does not occur, bulk soil samples will be collected at the end of one year and analyzed for VOCs by an off-site laboratory to confirm completion of the IRA. If rebound does occur, additional action may be warranted."*

EPA Comment 40. Sec. 5.4, Conclusions, Page 5-5. The purpose of this section is to summarize the tradeoffs among the alternatives, such that the relative advantages and disadvantages are clear to the reader (i.e., a narrative summary of Table 5-1). Clarify where the alternatives rank similarly and under which criteria there are noteworthy differences.

No alternative should be "eliminated" except on the basis of failing to meet threshold criteria (protectiveness, compliance with ARARs). This Sec. presents the conclusions of the EE/CA and states, "Alternative I . . . is eliminated from consideration as a removal action because of . . . and administrative challenges involved with hauling material off-site." The same administrative challenges apply to Alternatives II and III because of disposal of metal-contaminated soil off-site, but no mention is made of these administrative challenges. Even though Alternative I includes a larger volume of material for off-site disposal because it includes VOC-contaminated soil, the impact of administrative issues should be applied consistently to all of the alternatives and this Sec. should be revised accordingly.

Response Evaluation: Much improved. However, there are once again references to Administrative challenges without identifying what they are. Part of the intent in this type of review process is to identify and address potential challenges early on. Identification of a "show stopper" late in the process results in wasted time and effort. Always describe perceived administrative feasibility issues. In many cases, the perceived issue relates to compliance with ARARs.

> **Response:** The text has been changed to reflect that there are no administrative challenges that would affect the process of any of the alternatives. The following revision from Section 4.4.1.2.2 presents this change in text.
>
> > "*4.4.1.2.2* Administrative Feasibility
> >
> > *"Although permits are not required for this removal action, all substantive requirements of applicable regulations will be followed. No structures will need to be erected for this work; therefore no building permits will be requested. No work is anticipated that will encroach on any surface water body. All material hauled to an off-site facility will be approved by the facility for disposal.*
>
> A similar approach has been taken for each of the alternatives.

EPA Comment 41. Sec. 6.0, Recommended Removal Action Alternative. 2nd paragraph, Implementability. Identify the administrative challenges.

3rd paragraph, Effectiveness, Reduction of mobility. Don't all of the alternatives reduce mobility? If so, explain why Alternative I does more or better.

Most of what is in Section 6.1 actually belongs in the initial description of Alternative III. Similar items need to be included for Alternatives I and II.

Response Evaluation: EPA does not consider any of the described challenges to be administrative challenges. Approval/acceptance to backfill with treated material is acceptable with the appropriate degree of treatment and verification, the criteria for which have been identified. Emitting system effluent air is not prohibited, the question is whether the assumed GAC treatment is necessary (and for the purpose of the development of the document at this stage, has been included). Injection of HRC, or some other acceptable agent, for the purpose of remediation or research towards remediation is indeed allowed. Injection of a regulated substance which would violate protection standards would not be allowed. What may still need to be administratively addressed (negotiated) is the is type and frequency of monitoring and/or sampling surrounding the physical process and decision-points.

> **Response**: See comment 40.

Response Evaluation: Regarding the level of detail of the discussion: EPA did not offer the comment idly. A complete discussion of the elements of the alternative is needed once the full alternative is developed. Reasons for this include: (1) a better up-front description is more complete communication and minimizes the potential for anticipatory questions (take note of the comment volume on the draft version of the document); (2) an element-by-element and stage-by-stage description helps clarify potential technical and administrative feasibility issues as well as decision-points; and (3) allows for a better relationship of actions to requirements for the purpose of ARARs analysis.

> **Response:** Details have been added to each of the alternatives in numerous locations in Section 4 relating to several issues, including: CAMUs, berms, liners, confirmation sampling and rebound assessment.

EPA Comment 43. Table 2.3, 2.4, and 2.5. These tables provide the concentrations of compounds in soil and compares them to RBCs. The notes to the tables indicate that the RBCs are the EPA Region III RBCs for industrial soils. However, the notes do not explain that the non-carcinogenic values on the table are 0.1 times the EPA Region III RBCs to account for possible additive effects. Further explanation of the non-carcinogenic RBCs and should be provided in the notes to the tables. Metals are presumably screened against residential RBCs so these should also be shown.

Response Evaluation: The RTC was responsive. However, this revision of the document identifies a related issue which needs to be addressed. The risk assessment for the final remedy (the Plume Heads RI) was developed after or concurrently with this comparison table. The results of the risk assessment indicate no significant risk. This comparison table is keyed to an order of magnitude conservatism for screening purposes, to prevent screening out of chemicals which should be retained in the risk assessment. Where there are many potential contaminants of concern, the cumulative affects could make an order of magnitude difference. In this case, few

COCs are identified. EPA recommends comparing values to likely risk-based preliminary remediation goals (PRGs) rather than the screening value. This will likely reduce (possibly eliminate) the list of metals which might need to be addressed on the basis of risk, particularly if the same metals do not significantly alter water quality (i.e., above the standard or background where background is above the standard).

[Note: This is a separate issue from the regulatory determination of whether a material may be characteristically hazardous, and should not be taken to mean the material can be considered characteristically non-hazardous on the basis of risk. A waste is legally determined to be characteristically hazardous on the basis of chemical concentrations (or leached concentrations in the TCLP). Risk evaluation includes probabilistic exposures and pathways.]

Response: See comment 16.

References

U.S. Environmental Protection Agency (EPA). 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA.* Office of Emergency and Remedial Response. EPA/540/G-89-004. October.

EPA. 1993. *Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA.* Office of Solid Waste and Emergency Response. EPA540-R-93-057. August.

EPA. 2001. *EPA Region III Risk-based Concentration Table.* Online at http://www.epa.gov/reg3hwmd/risk. September 25.