CAFB 02

DEPARTMENT OF THE AIR FORCE
27TH CIVIL ENGINEER SQUADRON (ACC)
CANNON AIR FORCE BASE NEW MEXICO

27 FEB 2002

HSWA CAFB App I

Major Christopher G. Duffy
Commander
506 N DL Ingram Blvd
Cannon AFB NM 88103-5003

ENTERED

Mr. James Bearzi
Chief, Hazardous Waste Bureau
New Mexico Environment Department
2044 Galisteo Street
PO Box 26110
Santa Fe NM 87502

Dear Mr. Bearzi

Enclosed for your review and approval is the attached Corrective Measures Study (CMS) Report for Solid Waste Management Units (SWMUs) 109, 110, 111, and 112-Fire Training Area Four (FTA4), Cannon AFB.

This document describes the CMS for the four SWMUs that comprise the FTA4 at Cannon AFB. These SWMUs include SWMU 109-Fire Training Pit, SWMU 110-Underground Waste Oil Tank, SWMU 111-Unlined Pit, and SWMU 112-Oil/Water Separator. This CMS report was prepared in accordance with requirements outlined in the United States Environmental Protection Agency (EPA) Resource Conservation and Recovery Act (RCRA) Corrective Action Plan (EPA 1994).

If you have any questions regarding this report, please contact Mr. Denny Timmons of my staff at (505)784-4639.

Sincerely

Christopher G. Duffy

CHRISTOPHER G. DUFFY, Major, USAF

Attachment:
Corrective Measures Study

cc:
NMED (G. von Gonten)
NMED w/o enclosure (J. Jacobs)
EPA Region VI (B. Sturdivant)
HQ ACC/CEVQ (R. Kemether)

CAFB-02-002
LIBRARY COPY

Final Corrective Measures Study Report for SWMUs 109, 110, 111, and 112–Fire Training Area Four Cannon Air Force Base, New Mexico

December 2001

***Prepared for*:**

27 CE/CEV
Cannon Air Force Base
New Mexico

CAFB-02-002

FINAL
CORRECTIVE MEASURES STUDY REPORT
SWMUs 109, 110, 111, AND 112—FIRE TRAINING AREA FOUR

CANNON AIR FORCE BASE, NEW MEXICO

Prepared for:

27 CE/CEV
Cannon Air Force Base, NM
and
HQ ACC/CEV
Langley Air Force Base, VA

Prepared by:

Foster Wheeler Environmental Corporation
143 Union Blvd., Suite 1010
Lakewood, Colorado 80228

Under Contract No. DACW45-94-D-0003
Delivery Order No. 28, Work Authorization Directive 1

U.S. Army Corps of Engineers
Omaha District
Omaha, Nebraska

December 2001

TABLE OF CONTENTS

Section **Page**

LIST OF FIGURES iii

LIST OF TABLES iii

LIST OF ACRONYMS AND ABBREVIATIONS iv

EXECUTIVE SUMMARY ES-1

1.0 INTRODUCTION 1-1
- 1.1 PURPOSE AND SCOPE OF THE CORRECTIVE MEASURES STUDY 1-1
- 1.2 CORRECTIVE MEASURES ALTERNATIVES EVALUATION APPROACH 1-1
- 1.3 SITE DESCRIPTION 1-3
- 1.4 PHYSICAL CONDITIONS 1-3
  - 1.4.1 Soils 1-3
  - 1.4.2 Geology 1-3
  - 1.4.3 Groundwater 1-4
  - 1.4.4 Surface Water 1-4
- 1.5 CONTAMINANT FATE AND TRANSPORT MODELING 1-4
- 1.6 REGULATORY FRAMEWORK 1-6
- 1.7 SUMMARY OF PREVIOUS INVESTIGATIONS 1-7

2.0 SWMU 109—FIRE TRAINING PIT 2-1
- 2.1 CURRENT CONDITIONS 2-1
- 2.2 CORRECTIVE ACTION OBJECTIVES 2-1
- 2.3 SCREENING OF CORRECTIVE MEASURES TECHNOLOGIES 2-1
- 2.4 EVALUATION OF CORRECTIVE MEASURES ALTERNATIVES FOR SWMU 109 2-2
  - 2.4.1 Alternative 1 for SWMU 109: No Action 2-2
  - 2.4.2 Alternative 2 for SWMU 109: Site Controls 2-3
  - 2.4.3 Alternative 3 for SWMU 109: Soil Removal and Off-Site Disposal 2-4
  - 2.4.4 Alternative 4 for SWMU 109: Soil Removal and On-Site Landfarming 2-6
  - 2.4.5 Alternative 5 for SWMU 109: Bioventing 2-8
- 2.5 PRELIMINARY SELECTION OF THE PREFERRED ALTERNATIVE 2-9

3.0 SWMU 110—UNDERGROUND WASTE OIL TANK 3-1
- 3.1 CURRENT CONDITIONS 3-1
- 3.2 CORRECTIVE ACTION OBJECTIVES 3-1
- 3.3 SCREENING OF CORRECTIVE MEASURES TECHNOLOGIES 3-1
- 3.4 EVALUATION OF CORRECTIVE MEASURES ALTERNATIVES 3-1
- 3.5 PRELIMINARY SELECTION OF THE PREFERRED ALTERNATIVE 3-2

4.0 SWMU 111—UNLINED PIT 4-1

4.1 CURRENT CONDITIONS 4-1
4.2 CORRECTIVE ACTION OBJECTIVES 4-1
4.3 SCREENING OF CORRECTIVE MEASURES TECHNOLOGIES 4-1
4.4 EVALUATION OF CORRECTIVE MEASURES ALTERNATIVES 4-1
4.5 PRELIMINARY SELECTION OF THE PREFERRED ALTERNATIVE 4-1

5.0 SWMU 112—OIL/WATER SEPARATOR 5-1

6.0 SUMMARY OF RECOMMENDED ALTERNATIVES 6-1

7.0 REFERENCES 7-1

APPENDICES

Appendix A Contaminant Fate and Transport Modeling
Appendix B Comparison of Soil Sample Results to Soil Screening Levels
Appendix C Alternative Costs
Appendix D Landfarm Confirmation Soil Sampling

LIST OF FIGURES

1-1 Location of Cannon Air Force Base
1-2 Location of Fire Training Area Four
1-3 Soil Boring Locations and TPH Concentrations Exceeding 5,000 mg/kg
2-1 Alternative 2: Site Controls
2-2 Alternative 3: Soil Removal and Off-Site Disposal
2-3 Alternative 4: Soil Removal and On-Site Landfarming
2-4 Alternative 5: Bioventing

LIST OF TABLES

1-1 Factors Considered in the Detailed Evaluation of Alternatives
1-2 Cannon Air Force Base Fire Training Area 4—SWMU Summary
1-3 Summary of RFI and RI Soil Boring Samples with TPH Concentrations Exceeding 5,000 mg/kg
2-1 Technology Screening Table for SWMU 109
2-2 Summary of Alternative Evaluation for SWMU 109
3-1 Technology Screening Table for SWMU 110
3-2 Summary of Alternative Evaluation for SWMU 110
4-1 Technology Screening Table for SWMU 111
4-2 Summary of Alternative Evaluation for SWMU 111

LIST OF ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
bgs	below ground surface
BTEX	total benzene, toluene, ethylbenzene, and xylenes
CAO	corrective action objective
CMS	Corrective Measures Study
COC	chemicals of concern
EPA	United States Environmental Protection Agency
Foster Wheeler Environmental	Foster Wheeler Environmental Corporation
ft	feet
FTA4	Fire Training Area Four
Harza	Harza Environmental Services
HI	Hazard Index
HQ	Hazard Quotient
JP-4	Jet Propellant 4
LF-05	Landfill 5
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
NMED	New Mexico Environment Department
NMEMNRD	New Mexico Energy, Minerals, and Natural Resources Department
Operations Plan	Draft RCRA Part B Permit Application
PCB	polychlorinated biphenyl
PCS	petroleum-contaminated soil
Permit	Hazardous Waste Facility Permit
PID	photoionization detector
Radian	Radian Corporation
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RI	remedial investigation
SB	soil boring
SESOIL	Seasonal Soil Compartment
SSL	soil screening level
SWMU	solid waste management unit

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

TCE	trichloroethylene
TPH	total petroleum hydrocarbons
USACE	United States Army Corps of Engineers
VOC	volatile organic compound
Walk, Haydel, and Associates	Walk, Haydel and Associates, Inc.
Woodward-Clyde	Woodward-Clyde Consultants

EXECUTIVE SUMMARY

This document describes the Corrective Measures Study (CMS) conducted for the four solid waste management units (SWMUs) that comprise Fire Training Area Four at Cannon Air Force Base (AFB), New Mexico. These SWMUs include SWMU 109—Fire Training Pit, SWMU 110—Underground Waste Oil Tank, SWMU 111—Unlined Pit, and SWMU 112—Oil/Water Separator. The primary concern at these SWMUs is soil contaminated with total petroleum hydrocarbons (TPH) as a result of fire training activities in the area.

This CMS Report was prepared in accordance with requirements outlined in the United States Environmental Protection Agency's Resource Conservation and Recovery Act Corrective Action Plan. The purpose of the CMS was to identify and evaluate potential corrective measures alternatives to prevent future impact to human health and the environment. The corrective action objective of attaining the TPH action level of 5,000 milligrams per kilogram was identified for SWMUs 109, 110, and 111. No corrective action objectives were identified for SWMU 112 because all of the soil contamination related to this unit is addressed with SWMU 111.

Five corrective measures alternatives were evaluated for SWMU 109. The preferred alternative is the installation of a bioventing system at an order-of-magnitude cost of $125,000. This alternative was selected because it met all of the corrective measures alternative evaluation criteria and the corrective action objective.

No Action was the only corrective measures alternative evaluated for SWMUs 110 and 111, because all detected concentrations of TPH were below the action level.

No corrective measures alternatives were evaluated for SWMU 112 because the oil/water separator and associated leach field were removed from the site in 1997. Therefore, it is recommended that SWMU 112 be removed from the Cannon AFB Hazardous Waste Facility Permit.

1.0 INTRODUCTION

This document describes the Corrective Measures Study (CMS) conducted for the four solid waste management units (SWMUs) that comprise Fire Training Area Four (FTA4) at Cannon Air Force Base (AFB), New Mexico. These SWMUs include SWMU 109—Fire Training Pit, SWMU 110—Underground Waste Oil Tank, SWMU 111—Unlined Pit, and SWMU 112—Oil/Water Separator. This CMS Report was prepared in accordance with requirements outlined in the United States Environmental Protection Agency (EPA) Resource Conservation and Recovery Act (RCRA) Corrective Action Plan (EPA 1994).

Foster Wheeler Environmental Corporation (Foster Wheeler Environmental) conducted the CMS for the United States Army Corps of Engineers (USACE) under the Total Environmental Restoration Contract No. DACW-45-94-D-0003, Delivery Order 28, Work Authorization Directive 1.

1.1 PURPOSE AND SCOPE OF THE CORRECTIVE MEASURES STUDY

The purpose of this CMS is to identify and evaluate potential corrective measures to prevent future impact to human health and the environment. For each SWMU, the CMS Report includes the following:

- Description of current conditions
- Establishment of corrective action objectives (CAOs)
- Identification and screening of corrective measures technologies and development of alternatives
- Evaluation of corrective measures alternatives against specific criteria
- Selection and justification of a preferred alternative for implementation
- Information to support corrective measures design and implementation

An order-of-magnitude cost for each alternative was also developed and reviewed for purposes of comparing the five alternatives for SWMU 109.

1.2 CORRECTIVE MEASURES ALTERNATIVES EVALUATION APPROACH

Corrective measures alternatives were developed using the EPA RCRA Corrective Action Plan (EPA 1994) and include consideration of the following criteria:

- *Protection of Human Health and the Environment.* Corrective measures alternatives must be protective of human health and the environment. Remedies may include those measures that are needed to be protective but are not directly related to remediation of contaminated media, source control, or management of wastes.
- *Attainment of Media Cleanup Standards.* Corrective measures alternatives are required to attain applicable cleanup standards that are derived from existing state or federal regulations or other standards.

- *Control of Sources of Releases.* Corrective measures alternatives must stop further environmental degradation by controlling or eliminating releases that may pose a threat to human health and the environment. Unless source control measures are taken, efforts to clean up releases may be ineffective or involve an extended cleanup program. Therefore, the implementation of an effective source control program is addressed as necessary to ensure the long-term effectiveness and protectiveness of the corrective action program.
- *Compliance with Applicable Standards for Management of Wastes.* Corrective measures alternatives must comply with all applicable state and federal regulations and Cannon AFB requirements and procedures.

The corrective measures alternatives developed for each SWMU are discussed individually. Each corrective measures alternative was evaluated for its ability to meet the above criteria and the following technical decision factors specified in the EPA guidance (1994):

- *Long-Term Reliability and Effectiveness.* Each corrective measures alternative was evaluated in terms of its projected useful life, depending on whether:
  - Remedial technologies have been used effectively under analogous site conditions.
  - Failure of any one technology included in the alternative will have an immediate impact on receptors.
  - The alternative has the flexibility to deal with uncontrollable changes at the site and it should be noted that most corrective measures require long-term maintenance.
- *Reduction in the Toxicity, Mobility, or Volume of Wastes.* In general, the preferred corrective measures alternatives are those that are capable of eliminating or substantially reducing the toxicity, mobility, or volume of contaminants. The irreversibility of treatment and the quantity and type of residual material are also considered in the evaluation. There may be some situations in which achieving substantial reductions in these characteristics may not be practical or even desirable. The amount of reduction is evaluated by comparing initial site conditions to expected post-corrective measures conditions and estimating how much the alternatives reduce the toxicity, volume, or mobility of wastes.
- *Short-Term Effectiveness.* An alternative's ability to protect the safety of workers, local community, and environment during the construction phase is evaluated. This is particularly relevant when activities are conducted in populated areas or where waste characteristics are such that risks to workers or to the environment are high and special protective measures are needed.
- *Implementability.* The ability to implement a corrective measure alternative will often determine its usefulness. State or local approvals or restrictions may increase implementation time or even preclude a corrective measures alternative. Information considered when assessing implementability includes the following:
  - The administrative activities needed to implement the alternative, such as permits, rights-of-way, off-site approvals, and the length of time required to complete these activities
  - Ease of construction and the time required for implementation
  - The availability of adequate off-site treatment, storage capacity, disposal services, or needed technical services and materials
  - The availability of technologies identified in each alternative

- *Cost Estimate.* Comparative order-of-magnitude costs were calculated for each alternative except the No Action alternative. The estimates are based on an assumed project duration, staffing requirements, work scope, and monitoring requirements.

Factors to be considered for each of the evaluation criteria are summarized in Table 1-1.

1.3 SITE DESCRIPTION

Cannon AFB is located in Curry County, New Mexico, approximately 7 miles west of the city of Clovis (Figure 1-1). Cannon AFB occupies 4,320 acres, primarily consisting of the airfield and associated operations, maintenance, and support facilities that are located northwest of the airfield. Housing facilities are located in the former northwest portion of the Base, west of Highway 277 and north of Highway 60. Additional Base support facilities, such as the wastewater lagoons, munitions storage area, and current fire department training area, are located south and east of the airfield.

FTA4 is located near the southeast corner of Cannon AFB, approximately 2,000 feet (ft) southeast of the end of Runway 31 (Figure 1-2). FTA4 consists of four SWMUs, which are described briefly in Table 1-2; their locations are shown in Figure 1-3.

1.4 PHYSICAL CONDITIONS

1.4.1 Soils

Soils underlying FTA4 consist of sandy loam and loamy sand of the Amarillo soil group. The soils consist primarily of a fine-grained, well-sorted silty/clayey, unconsolidated, brown/reddish-brown sand. Such soils are generally classified as silty sand to clayey sand under the Unified Soil Classification System (Harza 1997).

1.4.2 Geology

FTA4 is underlain by Ogallala Formation fluvial deposits consisting primarily of unconsolidated silty sand to clayey sand. These deposits include sporadic caliche layers and more extensive zones containing caliche-cemented nodules (Harza 1997). The total thickness of the Ogallala Formation beneath the site is not known, as bedrock was not encountered during previous field investigation activities, which were conducted to depths of 90 ft. Based on available regional information, the Ogallala Formation may be as thick as 390 ft at Cannon AFB.

1.4.3 Groundwater

No groundwater was encountered during previous investigations of FTA4 at the maximum drilled depth of 90 ft. Groundwater occurs at depths ranging from 290 to 300 ft at nearby Landfill 5 (LF-05). Occupants of the area surrounding the Base rely primarily on groundwater for irrigation. The nearest downgradient water well is approximately ¼ mile from FTA4.

Groundwater monitoring is conducted twice a year at several sites on the Base, including LF-05, which is downgradient of FTA4. During sampling conducted in March 2000, wells were monitored for volatile organic compounds (VOCs), polychlorinated biphenyls (PCBs), pesticides, and metals. Analytes detected in the downgradient wells included trichloroethylene (TCE), chloroform, and metals. Metals were detected at concentrations that were consistent with background levels in the area (United States Geological Survey 2000). Because Jet Propellant 4 (JP-4) was the fuel used at FTA4 during all but a brief part of its history, TCE and chloroform are not believed to be chemicals of concern (COCs) at this site.

1.4.4 Surface Water

Stream valleys in Curry County tend to be fairly broad and widely spaced. Streams are ephemeral and drainages are poorly developed. No permanent streams exist on or near Cannon AFB (Harza 1997).

Historically, runoff at Cannon AFB has drained into four natural ephemeral playas. The two northern playas were converted into plastic-lined golf course ponds. The southern playa is still intact; however, the surrounding drainage patterns have been altered. The eastern playa, known as the North Playa Lake, was bermed on the north, west, and south sides with topsoil and concrete debris. Drainage ditches at Cannon AFB are concentrated around the developed/landscaped areas of the Base and carry runoff to the playa lakes and golf course ponds. The playa lakes have no surface outlet, and any water they collect is eventually lost to evaporation or infiltration or is used by plants and animals.

1.5 CONTAMINANT FATE AND TRANSPORT MODELING

Fate and transport modeling of representative contaminants was used to simulate contaminant migration through the unsaturated (vadose) zone to determine whether residual contamination could reach the water table. The representative contaminants modeled were toluene, naphthalene, and total xylenes. These three chemicals were selected based on their mobility and elevated concentrations in soil at FTA4. Simulations were performed assuming excessive precipitation to evaluate the transport effects of these chemicals with increased infiltration.

The Seasonal Soil Compartment (SESOIL) model was used for the fate and transport modeling (General Sciences Corporation 1998). The SESOIL model has been used by many local, state, and federal agencies at several sites across the country to evaluate unsaturated zone contaminant migration due to surficial or subsurface source releases.

SESOIL is a one-dimensional vertical transport model designed to simultaneously simulate water transport, sediment transport, and contaminant fate for the unsaturated zone (Wisconsin Department of Natural Resources 1994). Input data include soil physical parameters, contaminant chemical parameters, and meteorological information. The specific input parameters are presented in Appendix A.

The processes simulated by the SESOIL model are categorized into three cycles: hydrology, sediment washload, and pollutant transport; each cycle is a separate subroutine within the SESOIL code (Wisconsin Department of Natural Resources 1994). The SESOIL model is a compartmental model that allows the user flexibility to divide the unsaturated zone into separate layers (if appropriate) and model contaminant release and migration within each layer down to the water table. The result is a calculated leachate concentration that will be introduced to groundwater. The model simulates leaching to groundwater and subsequent mixing that ultimately provides a groundwater concentration as a calculated result.

The simulations performed for the CMS applied conservative assumptions that tend to overestimate the potential for contaminant migration. The greatest concentrations of residual contamination detected in soil samples from FTA4 were used to calculate loading rates for the representative chemicals. The contaminant sources were modeled as instantaneous releases from the top 22 ft of the soil column. Groundwater was modeled as 290 ft below ground surface (bgs). The simulation of normal conditions for each contaminant used climatic data specific to Clovis, New Mexico.

The results of the 30-year simulations for the current, normal conditions at Cannon AFB predicted vertical contaminant migrations of 101, 65, and 94 ft for toluene, naphthalene, and total xylenes, respectively. Within the 30-year period, simulation under normal, current conditions indicated that none of the contaminants would reach groundwater. The increased infiltration from the addition of one 24-hour, 100-year storm per year had a negligible effect on transport of naphthalene and total xylenes, and these contaminants did not reach groundwater. Under increased infiltration, toluene showed a similar trend in vertical migration as depth increased. The modeling indicated that degradation of groundwater from the migration of the contaminants in soil is unlikely under current conditions where infiltration of water into the vadose zone is minimal.

In summary, even where conservative assumptions are used to overestimate the potential for contaminant migration, the model predicts that there will be no adverse effects on groundwater quality due to the transport of residual contamination in the unsaturated zone at FTA4. An extended discussion of the modeling effort, including model output, is presented in Appendix A.

1.6 REGULATORY FRAMEWORK

The New Mexico Environment Department (NMED) is authorized by the EPA to implement the federal RCRA hazardous waste program and oversee the corrective action program activities conducted in accordance with Cannon AFB's Hazardous Waste Facility Permit (Permit). NMED issued a RCRA Permit to Cannon AFB on December 17, 1989. Cannon AFB recently submitted an application to NMED for renewal of the Permit; however, the Permit has not yet been reissued and the Base is operating under the provisions of the original Permit. Cannon AFB's Draft RCRA Part B Permit Application (Operations Plan), submitted in July 1999, refers to the status of various assessment, investigation, and remediation projects for a number of SWMUs on the Base. According to the Operations Plan, SWMUs 109, 110, 111, and 112 were incorporated into one area (FTA4) for the Phase I and Phase II RCRA Facility Investigations (RFIs) based on their proximity and the interrelated nature of their historical operations. Currently, FTA4 is in the CMS phase of the RCRA corrective action process.

Based on the investigations conducted to date, the primary chemicals of concern at FTA4 are petroleum hydrocarbons associated with the storage and use of JP-4 during training exercises. A risk assessment was conducted as part of the Phase II RFI to evaluate risk to human and ecological receptors from exposure to site contaminants (Harza 1997). The risk assessment concluded that human health and ecological risks associated with exposure to contamination at FTA4 are negligible under current conditions.

Since the Phase II RFI risk assessment did not characterize potential risks associated with a residential use scenario, the NMED Technical Background Document for Development of Soil Screening Levels guidance (NMED 2001) was used to identify other COCs that could require corrective action. Data from the Remedial Investigation (RI) conducted in 1992 by Woodward-Clyde Consultants (Woodward Clyde) and the RFI conducted in 1997 by Harza Environmental Services were compared to the NMED soil screening levels. This comparison confirmed that there is no significant human health risk requiring further action at FTA4. The detailed results of this evaluation are presented in Appendix B.

Although no further action is needed to address health risks at this site, NMED is requiring standards for TPH to be met. On July 18, 2000, the NMED Hazardous Waste Bureau issued a draft position paper for RCRA units on the evaluation and determination of cleanup levels for sites impacted by releases of

petroleum hydrocarbons (NMED 2000). The paper refers to a guidance document from the New Mexico Energy, Minerals, and Natural Resources Department (NMEMNRD), Oil Conservation Division *Guidelines for Remediation of Leaks, Spills, and Releases* (NMEMNRD 1993).

For contaminated unsaturated soils, such as those at FTA4, the NMED Hazardous Waste Bureau/NMEMNRD guidelines require the development of a "ranking score." This score is based on three criteria, depth to groundwater, wellhead protection area, and distance to surface water body, to determine the relative threat of TPH and associated contaminants to public health, fresh waters, and the environment. The ranking score is compared to soil cleanup values that include TPH. Application of this scoring methodology to investigation data from FTA4 resulted in the selection of a TPH action level of 5,000 milligrams per kilogram (mg/kg) for soil. This action level was the basis of the CAOs developed for each SWMU.

1.7 SUMMARY OF PREVIOUS INVESTIGATIONS

Previous investigations at FTA4 include the following:

- RI performed by Radian Corporation (Radian) in 1985—This initial RI focused on contamination in the area of SWMU 109. Two soil borings were drilled and from these two soil borings five samples were analyzed for oil and grease, lead, and organic compounds (EPA Method 8010/8020). Samples were collected at depths from 5.5 to 45 ft.

  No TPH data were collected during this investigation (Radian 1988).

- RI conducted by Walk, Haydel, and Associates, Inc. (Walk, Haydel, and Associates) in 1988—This RI included 3 soil borings with 13 samples each (0–101.5 ft bgs) analyzed for total benzene, toluene, ethylbenzene, and xylenes (BTEX); arsenic; barium; cadmium; selenium; and silver. An additional 6 soil borings with 13 samples each (0–101.5 ft bgs) were analyzed for arsenic, barium, cadmium, selenium, and silver. All borings were located near SWMU 110 and the landfarm area associated with the underground waste oil tank removal.

  No TPH data were collected during this investigation (Walk, Haydel, and Associates 1990).

- RI performed by Woodward-Clyde in 1991—This investigation evaluated the nature and extent of contamination at 18 Cannon AFB SWMUs, including FTA4. Four surface soil samples (0 to 0.5 ft bgs) and subsurface samples (61 to 100 ft bgs) were collected at FTA4. TPH concentrations at two soil boring locations (1093 and 1094) located near SWMU 109 exceeded the action level of 5,000 mg/kg at depths ranging from 0 to 6 ft (Woodward-Clyde 1992). A summary of soil boring locations with detected TPH concentrations exceeding 5,000 mg/kg is presented in Figure 1-3 and Table 1-3.

- Phase II RFI conducted by Harza from October 1996 through February 1997—The RFI included a passive soil gas survey, 19 soil borings, and 77 soil samples collected at various locations at FTA4. TPH concentrations in soil detected at two borehole locations (soil boring [SB] 01 and SB11) associated with SWMU 109 exceeded the action level of 5,000 mg/kg (Harza 1997). A summary of soil boring locations with detected TPH concentrations exceeding 5,000 mg/kg is presented in Figure 1-3 and Table 1-3.

2.0 SWMU 109—FIRE TRAINING PIT

2.1 CURRENT CONDITIONS

SWMU 109 was used as a fuel truck cleaning area between 1961 and 1974. An estimated 3,000 to 4,000 gallons of fuel percolated into the ground as a result of these activities (Walk, Haydel, and Associates 1990). In 1974 the site was activated as a fire training area. Commingled waste oils, solvents, and recovered JP-4 were burned during fire training exercises conducted from 1974 to 1975. The underground waste oil tank (SWMU 110) was installed in 1975, and only recovered JP-4 was burned during exercises until 1995. After that time, the SWMU was no longer used as a fire training area (Harza 1997).

The SWMU contained a 40-ft by 70-ft rebar-reinforced concrete-lined pit with a 4-ft berm that was removed in December 2000. The pit was filled with gravel and included internal drainage features that conveyed excess fuel and water to the oil/water separator (SWMU 112) located in the northeast part of the site. These drainage features included an underground pipe running from the pit to the oil/water separator. The separator was removed in 1997; however, the underground pipe is still in place. A mock airplane was formerly located in the center of the pit. Details of pit construction were determined using as-built drawings provided by Cannon AFB. The concrete pit was reportedly saturated with water during some fire training exercises. An aboveground fuel tank supplied fuel to the burn pit via an underground pipeline. The aboveground tank is presently empty and remains on site.

Soil boring samples collected during the RI (Woodward-Clyde 1992) and Phase II RFI (Harza 1997) indicated that TPH concentrations exceeding 5,000 mg/kg were detected at four locations (1093, 1094, SB01, and SB11). Figure 1-3 shows the locations of the soil borings associated with SWMU 109. The maximum TPH concentration (38,500 mg/kg) was detected at a depth of 0 to 0.5 ft at soil boring 1093 (Woodward-Clyde 1992).

2.2 CORRECTIVE ACTION OBJECTIVES

The following CAO was developed for SWMU 109 based on a review of contamination present at the site:

- Meet the TPH action level of 5,000 mg/kg in soil

2.3 SCREENING OF CORRECTIVE MEASURES TECHNOLOGIES

Technologies evaluated for SWMU 109 were chosen to address the TPH contamination and the action level of 5,000 mg/kg in soil. Table 2-1 lists the technologies considered and provides the results of the

technology screening process. Of the ten technologies evaluated, two technologies were rejected and eight technologies were retained for further evaluation.

The technologies rejected include the following:

- Soil or other cover—Rejected because contaminated soil would remain on site
- Enhanced soil vapor extraction—Rejected because of the difficulty to implement

The technologies retained for further evaluation include the following:

- No action
- Site controls
- Bioventing
- Excavation of soil
- Transportation
- On-site landfarming
- Off-site Special Waste landfill disposal
- Backfilling with clean soil

2.4 EVALUATION OF CORRECTIVE MEASURES ALTERNATIVES FOR SWMU 109

Based on the technology screening presented in Table 2-1, the following five alternatives were developed for SWMU 109:

1. No action
2. Site controls
3. Excavation of soil, off-site disposal, and backfilling with clean soil
4. Excavation of soil and on-site landfarming
5. Bioventing

See Table 2-2 for a description of the alternatives and a summary of the alternatives evaluation.

2.4.1 Alternative 1 for SWMU 109: No Action

2.4.1.1 Description of Alternative

Under Alternative 1 no action is taken at the site.

2.4.1.2 Evaluation of Alternative 1

Alternative 1 was evaluated against the criteria presented in Table 1-1. A summary of the evaluation is provided below.

- *Protection of Human Health and the Environment.* Alternative 1 is protective of human health and ecological receptors according to the risk assessment previously prepared for FTA4 (Harza 1997) and the risk-based soil screening-level evaluation completed according to NMED guidance (Appendix B). There is no treatment of contaminated soil other than potential natural attenuation.
- *Attainment of Media Cleanup Standards.* Contaminated soil would be left in place and the TPH action level of 5,000 mg/kg would not be met.
- *Control of Sources of Releases.* Under this alternative there is no source removal; the contaminated soil remains in place.
- *Compliance with Applicable Standards for Management of Wastes.* Alternative 1 complies with all applicable standards for waste management because no management of hazardous wastes is required.
- *Long-Term Reliability and Effectiveness.* The long-term reliability and effectiveness of this alternative is dependent on the extent of natural attenuation in the soil left in place.
- *Reduction in the Toxicity, Mobility, or Volume of Wastes.* There would be no short-term reduction in the toxicity, mobility, or volume of the soil contaminants at the SWMU if Alternative 1 were implemented. Natural attenuation of the petroleum-contaminated soil (PCS) that is left in place is expected to gradually reduce the concentration of petroleum contamination in the soil.
- *Short-Term Effectiveness.* There would be no adverse impact on the environment or nearby communities as a result of implementing this alternative. According to the results of the previously prepared risk assessment (Harza 1997), no short-term measures are needed to protect human or ecological receptors. There are no construction activities associated with this alternative.
- *Implementability.* This alternative is easy to implement because no action is required.
- *Cost Estimate.* There is no additional cost associated with the implementation of this alternative.

2.4.2 Alternative 2 for SWMU 109: Site Controls

2.4.2.1 Description of Alternative 2

Under Alternative 2, site controls consisting of warning signs and a fence would be installed to restrict access to the site. A conceptual design for Alternative 2 is illustrated in Figure 2-1.

2.4.2.2 Evaluation of Alternative 2

Alternative 2 was evaluated against the criteria presented in Table 1-1. A summary of the evaluation is provided below.

- *Protection of Human Health and the Environment.* This alternative provides additional protection of human health and ecological receptors through site controls. Site restrictions (warning signs and a fence) require site workers to contact Cannon AFB security before gaining access to the area and undertaking any activities that would result in potential exposure to contaminated soil. There is no treatment of contaminated soil other than potential natural attenuation.
- *Attainment of Media Cleanup Standards.* This alternative does not meet the TPH action level of 5,000 mg/kg because the contaminated soil is left in place.
- *Control of Sources of Releases.* Under this alternative there is no source removal; the contaminated soil remains in place, but access is restricted.
- *Compliance with Applicable Standards for Management of Wastes.* No management of wastes is required.
- *Long-Term Reliability and Effectiveness.* This alternative is expected to provide long-term reliability and effectiveness. Site restrictions should not be difficult to enforce, as SWMU 109 is located on a military facility with similar restrictions already in place.
- *Reduction in the Toxicity, Mobility, or Volume of Wastes.* Alternative 2 provides no reduction in the toxicity, mobility, or volume of the soil contaminants at the SWMU because it does not treat the soil contamination present at the site. Natural attenuation is expected to gradually reduce the concentration of petroleum contamination in the soil.
- *Short-Term Effectiveness.* There would be no short-term impact of this alternative, because the only construction activity included in this alternative is the installation of warning signs and fencing, which has no adverse impact on the environment. A health and safety plan will be developed to protect site workers. The sign posting and fence installation at SWMU 109 have no effect on nearby communities.
- *Implementability.* This alternative is easy to implement because materials and equipment are readily available. This alternative requires approximately 1 week to complete construction, and maintenance of signs and fencing will be minimal.
- *Cost Estimate.* An order-of-magnitude cost comparison was prepared for this alternative and is presented in Appendix C. The assumptions used to estimate the cost are based on a total project duration of 1 month. For the construction activities, an engineering design, work plan, and a health and safety plan will be prepared. Legal, clerical, and engineering support are included as 15 percent of the total cost. The construction cost for this alternative includes the mobilization/demobilization of a construction contractor, labor, and the materials and equipment necessary to perform the required work. A security fence and warning signs will be installed using portions of the existing fence surrounding the site.

  The order-of-magnitude cost for this alternative is estimated to be $34,000.

2.4.3 Alternative 3 for SWMU 109: Soil Removal and Off-Site Disposal

2.4.3.1 Description of Alternative 3

Under Alternative 3, contaminated soil exceeding the TPH action level of 5,000 mg/kg to a depth of 12 ft, which is the assumed depth of potential human and ecological exposure and the reasonable depth of excavation using a backhoe, would be excavated and transported off site for disposal. It is estimated that

1,900 cubic yards of contaminated soil would be removed from areas where soil boring sample concentrations exceeded the TPH action level. The major activities performed under this alternative are as follows:

- Mobilize excavation and hauling equipment on site
- Excavate, segregate, and stockpile clean soil and contaminated waste using field screening kits, visual inspection, and a photoionization detector (PID)
- Sample excavation sidewalls and bottom and soil stockpiles to confirm that the TPH action level has been met
- Backfill excavated area with clean soil (including clean soil from the site)
- Dispose of contaminated soil off site at an approved off-site disposal facility

The conceptual design for Alternative 3 is illustrated in Figure 2-2.

2.4.3.2 Evaluation of Alternative 3

Alternative 3 was evaluated against the criteria presented in Table 1-1. A summary of the evaluation is presented below.

- *Protection of Human Health and the Environment.* This alternative is protective of human health and ecological receptors according to the risk assessment previously prepared for this site (Harza 1997) and the risk-based soil screening-level evaluation completed according to the NMED guidance (Appendix B). This alternative protects human health and ecological receptors through the removal of contaminated soil and its disposal off site at a facility permitted to receive PCS.
- *Attainment of Media Cleanup Standards.* This alternative only meets media cleanup standards in soil to a depth of 12 ft. The alternative provides for confirmation sampling of excavated soil to ensure that contaminant levels are below the TPH action level of 5,000 mg/kg.
- *Control of Sources of Releases.* Under this alternative residual soil contamination will be removed to a depth of 12 ft. The results of fate and transport modeling of specific contaminants detected in site soils show that contaminant migration is not a concern at this site.
- *Compliance with Applicable Standards for Management of Wastes.* Wastes resulting from implementation of this alternative will be handled and disposed of off site in accordance with applicable federal (EPA), state (NMED), and Cannon AFB requirements.
- *Long-Term Reliability and Effectiveness.* This alternative is reliable and effective in the long term because it permanently removes contamination at concentrations above the cleanup standard in soil. However, this alternative is only reliable and effective to a depth of 12 ft.
- *Reduction in the Toxicity, Mobility, or Volume of Wastes.* Alternative 3 will reduce the volume of contaminated soil present at SWMU 109 because of removal of PCS exceeding the TPH action level of 5,000 mg/kg. However, this alternative will only reduce the volume of contaminated soil to a depth of 12 ft.
- *Short-Term Effectiveness.* Aside from construction, there are no anticipated adverse effects from soil removal and off-site disposal to the workers on Base, the local community, or the environment. A health and safety plan will be developed to protect site workers.

- *Implementability.* This alternative is easy to implement because materials and equipment are typically readily available. This alternative requires approximately 1 month to complete and includes excavation of contaminated soil, confirmation soil sampling, off-site disposal, and excavation backfilling.
- *Cost Estimate.* An order-of-magnitude cost comparison was prepared for this alternative and is presented in Appendix C. The cost for this alternative includes an engineering design, work plan, and a health and safety plan. Mobilization/demobilization of a construction contractor, labor, and materials and equipment will be necessary to perform the required work. Soil will be excavated, segregated, and stockpiled. Clean and contaminated soil stockpiles will be segregated using field screening kits, visual inspection, and a PID. The excavation sidewalls and bottom will be sampled for confirmation of contaminant removal. Clean soil (imported and clean excavated soil) will be backfilled into excavated areas. All contaminated soil will be disposed of off site at a permitted facility that accepts PCS waste. Legal, clerical, and engineering support are included as 15 percent of the total cost.

  The order-of-magnitude cost for this alternative is estimated to be $125,000.

2.4.4 Alternative 4 for SWMU 109: Soil Removal and On-Site Landfarming

2.4.4.1 Description of Alternative 4

Under Alternative 4, contaminated soil with TPH concentrations exceeding the action level of 5,000 mg/kg would be excavated to a depth of 12 ft, which is the assumed depth of potential human and ecological exposure and the reasonable depth of excavation using a backhoe, and landfarmed on site. It is estimated that 1,900 cubic yards of contaminated soil would be removed from areas around soil borings, with concentrations that exceed the TPH action level sampled during previous investigations. The landfarm would be constructed on the abandoned runway to the west of the site, and would be maintained according to NMED regulations. The major activities associated with this alternative are as follows:

- Mobilize excavation and hauling equipment on site
- Excavate and segregate clean and contaminated soil using field screening kits, visual inspection, and a PID
- Construct the landfarm site (using existing runway as liner with a soil berm)
- Sample excavation sidewalls and bottom and soil stockpiles for confirmation of contaminant removal
- Place contaminated excavated soil on the landfarm site to maximum depth of 6 inches
- Place temporary fencing and warning signs around open excavations
- Turn soil every 2 weeks according to NMED regulations
- Soil sampling every 2 months until it meets media cleanup standards
- Conduct landfarm sampling every 6 months until soil meets action level for TPH
- Backfill excavated areas with treated soil from landfarming

The conceptual design for Alternative 4 is illustrated in Figure 2-3.

2.4.4.2 Evaluation of Alternative 4

Alternative 4 was evaluated against the criteria presented in Table 1-1. A summary of the evaluation is presented below.

- *Protection of Human Health and the Environment.* This alternative is protective of human health and ecological receptors, according to the risk assessment previously prepared for this site (Harza 1997) and the risk-based soil screening-level evaluation completed according to the NMED guidance (Appendix B). This alternative protects human health and ecological receptors through the removal of contaminated soil and its disposal off site at a facility permitted to receive PCS.
- *Attainment of Media Cleanup Standards.* This alternative attains media cleanup standards to a depth of 12 ft and includes confirmation sampling of the excavated areas to ensure that contaminant levels are below the TPH action level of 5,000 mg/kg. Soil will be landfarmed on site until the TPH concentration levels are below the action level.
- *Control of Sources of Releases.* Under this alternative residual soil contamination will be removed. Removal of contaminated soil to a depth of 12 ft will reduce migration of petroleum contamination to groundwater. However, the results of contaminant fate and transport modeling show that contaminant migration is not a concern at this site.
- *Compliance with Applicable Standards for Management of Wastes.* This corrective measures alternative complies with applicable standards for management of wastes by requiring that contaminated soil be landfarmed on site and waste generated by personnel protection and equipment decontamination to be disposed of accordingly. Contaminated soil waste will be handled on site by landfarming according to applicable federal (EPA), state (NMED), and Cannon AFB requirements.
- *Long-Term Reliability and Effectiveness.* This alternative has been proven to be effective at other areas on Cannon AFB. The contaminated soil from the site will be removed to a depth of 12 ft and treated at the on-site landfarm. The effectiveness of the landfarm will depend on the level of contamination, weather conditions, and site maintenance.
- *Reduction in the Toxicity, Mobility, or Volume of Wastes.* Removal of contaminated soil will reduce the volume of contamination within the SWMU. Through landfarming, the volume, toxicity, and mobility of the contaminated soil on site will be reduced. However, this alternative will only reduce the volume of contaminated soil to a depth of 12 ft.
- *Short-Term Effectiveness.* Aside from the construction activities, there are no anticipated adverse effects from soil removal and landfarming on the workers, local community, or environment. A health and safety plan will be developed to protect site workers.
- *Implementability.* Alternative 4 is easily implemented because equipment and supplies for construction are readily available and the landfarm can be established on site.
- *Cost Estimate.* An order-of-magnitude cost estimate was prepared for this alternative and is presented in Appendix C. The cost for this alternative includes an engineering design, work plan, and a health and safety plan. Mobilization/demobilization of a construction contractor, labor, and the materials and equipment will be necessary to perform the required work. Soil will be excavated, segregated, and stockpiled (clean and contaminated soil piles will be tested using field screening kits, visual inspection, and a PID). The excavation sidewalls and bottom will be sampled for confirmation of contaminant removal. Temporary fencing and warning signs will be

placed around all open excavations. All contaminated soil will be placed on site in the landfarm established on the abandoned runway. Contaminated soil will be placed to a maximum depth of 6 inches and the runway will be bermed with soil. The landfarm will be tilled and watered every 2 weeks and sampling will be conducted every 6 months until TPH in the soil meets the action level. The estimated time for contaminated soil to meet the action level is 6 months based on the experience of Cannon AFB at similar sites. Treated soil will be backfilled into open excavations. Legal, clerical, and engineering support are included as 15 percent of the total cost.

According to NMED regulations a groundwater discharge permit may be required (Title 20, Chapter 5, Part 1, 20 NMAC 5.1, Section Title, 112 Definitions). Costs associated with the permitting process have been estimated and are included in Appendix C.

The order-of-magnitude cost for this alternative is estimated to be $136,000.

2.4.5 Alternative 5 for SWMU 109: Bioventing

2.4.5.1 Description of Alternative 5

Under Alternative 5, a bioventing system would be installed in the areas where TPH concentrations in soil exceed the action level of 5,000 mg/kg. An estimated 10 wells would be installed to a depth of 30 ft. Small, wind-activated turbines would be used in this alternative to draw air through the soil and out of the wells, allowing for oxygenation of the contaminated vadose-zone soils. Air is drawn through the formation instead of from the atmosphere to reduce the potential for drying the soil, which would impede biodegradation. The initial design depth of the wells is 30 ft and this depth was selected because it treats all contamination above 5,000 mg/kg. The major activities associated with this alternative are as follows:

- Set site up and mobilize drilling equipment
- Drill and install approximately ten 4-inch-diameter bioventing wells to a depth of 30 ft
- Sample drilling core for baseline TPH analysis and waste disposal characterization
- Demobilize drilling equipment
- Install one-way wind-activated valves on each well
- Dispose of drill cuttings and associated soils
- Demobilize from site
- Soil sampling every 5 years until soil meets media cleanup standards

The conceptual design for Alternative 5 is illustrated in Figure 2-4.

2.4.5.2 Evaluation of Alternative 5

Alternative 5 was evaluated against the criteria presented in Table 1-1. A summary of the evaluation is presented below.

- *Protection of Human Health and the Environment.* This alternative is protective of human health and ecological receptors. According to the risk assessment previously prepared for this site

(Harza 1997) and the risk-based soil screening-level evaluation completed according to the NMED guidance (Appendix B), no corrective action is needed. In situ treatment of contaminated soil will not change this conclusion.

- *Attainment of Media Cleanup Standards.* This alternative achieves media cleanup standards over time. Sampling will be performed to determine the effectiveness of treatment and reduction in TPH concentrations in the areas of concern.
- *Control of Sources of Releases.* This alternative controls sources of releases by reducing soil contamination levels over time. The results of contaminant fate and transport modeling show that contaminant migration is not a concern at this site. However, treatment of contaminated soil with this alternative will further reduce the potential for contaminant migration.
- *Compliance with Applicable Standards for Management of Wastes.* Wastes resulting from implementation of this alternative will be handled in accordance with applicable federal (EPA), state (NMED), and Cannon AFB requirements.
- *Long-Term Reliability and Effectiveness.* The contaminated soil at the site will be treated over time and the system will be monitored through soil sampling. The effectiveness of the bioventing system will depend on the level of contamination at the beginning of operation, weather conditions, soil air permeability, and soil porosity.
- *Reduction in the Toxicity, Mobility, or Volume of Wastes.* In situ bioventing treatment of contaminated soil will reduce the volume of contamination within the SWMU. Toxicity and mobility are not concerns at this site.
- *Short-Term Effectiveness.* This alternative provides adequate short-term effectiveness. Aside from construction activities, there are no anticipated adverse effects from bioventing on the workers, local community, or environment. A health and safety plan will be developed to protect site workers.
- *Implementability.* Alternative 5 is relatively easy to implement because equipment and supplies for construction are readily available, but long-term monitoring will be required.
- *Cost Estimate.* An order-of-magnitude cost estimate was prepared for this alternative and is presented in Appendix C. The cost for this alternative includes an engineering design, work plan, and health and safety plan. Mobilization/demobilization of a construction contractor/drillers, labor, and materials and equipment will be necessary to perform the required work.

  The order-of-magnitude cost for this alternative is estimated to be approximately $125,000.

2.5 PRELIMINARY SELECTION OF THE PREFERRED ALTERNATIVE

Based on the corrective measures alternative evaluation presented in Table 2-2, the preferred corrective measures alternative for SWMU 109 is Alternative 5—Bioventing. This alternative was selected because it attains all of the evaluation criteria and meets the CAO for SWMU 109 at the lowest estimated cost. Bioventing is relatively easy to implement and can be conducted on site with periodic maintenance and sampling.

Alternative 1—No Action, and Alternative 2—Site Controls, were not selected because they fail to meet the CAO for SWMU 109. Alternative 3—Soil Removal and Off-Site Disposal, and Alternative 4—Soil

Removal and On-Site Landfarming were not selected because they fail to meet the CAO below a depth of 12 ft and the costs of these alternatives were the same or higher than the initial cost of Alternative 5.

3.0 SWMU 110—UNDERGROUND WASTE OIL TANK

3.1 CURRENT CONDITIONS

The underground waste oil tank (SWMU 110) was a 2,000-gallon storage tank installed in 1975. The tank stored recovered JP-4 fuel for use during fire training exercises. The tank was removed in March 1989, and approximately 204 cubic yards of soil were excavated from around the tank. Data collected during the Phase II RFI at soil boring SB12, drilled in proximity to SWMU 110, indicated low levels of TPH contamination in the upper 30 ft of soil (Harza 1997). The highest concentration of TPH (77.5 mg/kg) occurred at a depth of 10 ft.

At the time of the tank removal, excavated soil was placed on heavy-gauge plastic on a plot adjacent to the abandoned runway for landfarming. Foster Wheeler Environmental conducted confirmation sampling in September 2000 to assess the remaining levels of contamination in the landfarmed soil. Five soil samples were collected in the deeper areas of the landfarm (1 to 1.5 ft) and analyzed for TPH. TPH concentrations in all of the samples were below the TPH action level of 5,000 mg/kg. Figure 1-3 shows the location of the landfarm and the locations where the five confirmation samples were taken (Foster Wheeler Environmental 2000). Results from this sampling event are included in Appendix D. All equipment and structures have been removed from SWMU 110.

3.2 CORRECTIVE ACTION OBJECTIVES

Based on site characteristics and potential contaminant sources, the following CAO was developed for SWMU 110:

- Meet the action level of 5,000 mg/kg for TPH in landfarm soil

3.3 SCREENING OF CORRECTIVE MEASURES TECHNOLOGIES

Table 3-1 lists the two technologies considered for SWMU 110 and provides the results of the technology screening process. Only one technology was retained for further evaluation:

- No Action

3.4 EVALUATION OF CORRECTIVE MEASURES ALTERNATIVES

Based on the screening of technologies shown in Table 3-1, the only alternative developed for SWMU 110 is:

- No Action

Table 3-2 presents a summary of the alternative evaluation.

3.5 PRELIMINARY SELECTION OF THE PREFERRED ALTERNATIVE

The highest concentrations of TPH (77.5 mg/kg detected at SB12 and 330 mg/kg detected in landfarm soil) are well below the action level of 5,000 mg/kg. Therefore, No Action is the preferred corrective measures alternative for SWMU 110. This alternative attains all of the evaluation criteria and meets the CAO for SWMU 110.

4.0 SWMU 111—UNLINED PIT

4.1 CURRENT CONDITIONS

Prior to 1985, the unlined pit (SWMU 111) was used to collect runoff from SWMU 109 after fires were extinguished during the fire training exercises. The pit was backfilled in 1985 prior to the installation of the oil/water separator (SWMU 112). The highest TPH concentration detected at SWMU 111 (from SB14) was 1,040 mg/kg at a depth of 1 ft. All equipment and structures have been removed from SWMU 111.

4.2 CORRECTIVE ACTION OBJECTIVES

Based on site characteristics and potential contaminant sources, the following CAO was developed for SWMU 111:

- Meet the action level of 5,000 mg/kg for TPH in soil

4.3 SCREENING OF CORRECTIVE MEASURES TECHNOLOGIES

Only one technology was considered for SWMU 111. Table 4-1 provides the results of the technology screening process. The technology retained is as follows:

- No Action

4.4 EVALUATION OF CORRECTIVE MEASURES ALTERNATIVES

Based on the technology screening shown in Table 4-1, the only alternative developed for SWMU 111 is the following:

- No Action

Table 4-2 presents a summary of the alternative evaluation.

4.5 PRELIMINARY SELECTION OF THE PREFERRED ALTERNATIVE

The highest TPH concentration detected at SWMU 111 (1,040 mg/kg detected at SB14) is below the TPH action level of 5,000 mg/kg. Therefore, No Action is the preferred corrective measures alternative for SWMU 111. This alternative attains all of the evaluation criteria and meets the CAO for SWMU 111.

5.0 SWMU 112—OIL/WATER SEPARATOR

The oil/water separator (SWMU 112) was activated in 1985 at the location of the former unlined pit (SWMU 111). The oil/water separator received wastewater from the fire training pit that was then discharged to a nearby leach field. The SWMU was removed in 1997 along with the associated leach field. SWMU 112 should be removed from the Permit because the oil/water separator is no longer on site and all related soil contamination is addressed under SWMU 111. Therefore, there were no CAOs identified for SWMU 112.

6.0 SUMMARY OF RECOMMENDED ALTERNATIVES

The CAO developed for SWMUs 109, 110, and 111 was to meet the TPH action level of 5,000 mg/kg in soil. To meet this CAO, technologies were screened, corrective measures alternatives were developed from the technologies, and a preferred corrective measures alternative was selected for each SWMU at FTA4 as summarized below:

- Fire Training Pit (SWMU 109)—Bioventing. The preferred alternative includes installing approximately 10 soil venting wells to allow oxygenation of the contaminated vadose-zone soils and to stimulate bioremediation of the TPH.
- Underground Waste Oil Pit (SWMU 110)—No Action
- Unlined Pit (SWMU 111)—No Action

A CAO was not developed for SWMU 112 because the oil/water separator and associated leach field are no longer on site and all related soil contamination is addressed under SWMU 111. Because no CAO was developed for this SWMU, no corrective measures alternatives were developed or selected. It is recommended that SWMU 112 be removed from Cannon AFB's Hazardous Waste Facility Permit.

7.0 REFERENCES

Foster Wheeler Environmental (Foster Wheeler Environmental Corporation)
2000. Preferred Alternative Justification for the Corrective Measures Study SWMUs 109, 110, 111, 112—Fire Training Area Number Four, Cannon Air Force Base, New Mexico, October.

General Sciences Corporation
1998. SESOIL Reference Guide and User's Guide. Version 3.0.

Harza (Harza Environmental Services)
1997. Phase II RCRA Facility Investigation Report (Draft), Cannon Air Force, New Mexico, August.

Means Environmental Cost Data. 1998.

Means Heavy Construction Cost Data. 1999.

NMED (New Mexico Environment Department)
2001. Technical Background Document for Development of Soil Screening Levels, New Mexico, January.

2000. Draft Position Paper: Use of Total Petroleum Hydrocarbon (TPH) Test Results for Site Characterization, New Mexico, July.

NMEMNRD (New Mexico Energy, Minerals, and Natural Resources Department)
1993. Oil Conservation Division Guidelines for Remediation of Leaks, Spills, and Releases, August.

Radian
1988. Site-Specific Quality Management Plan Installation Restoration Program Fire Protection Training Area, Site 9 Tank Removal, Cannon Air Force Base, New Mexico, August.

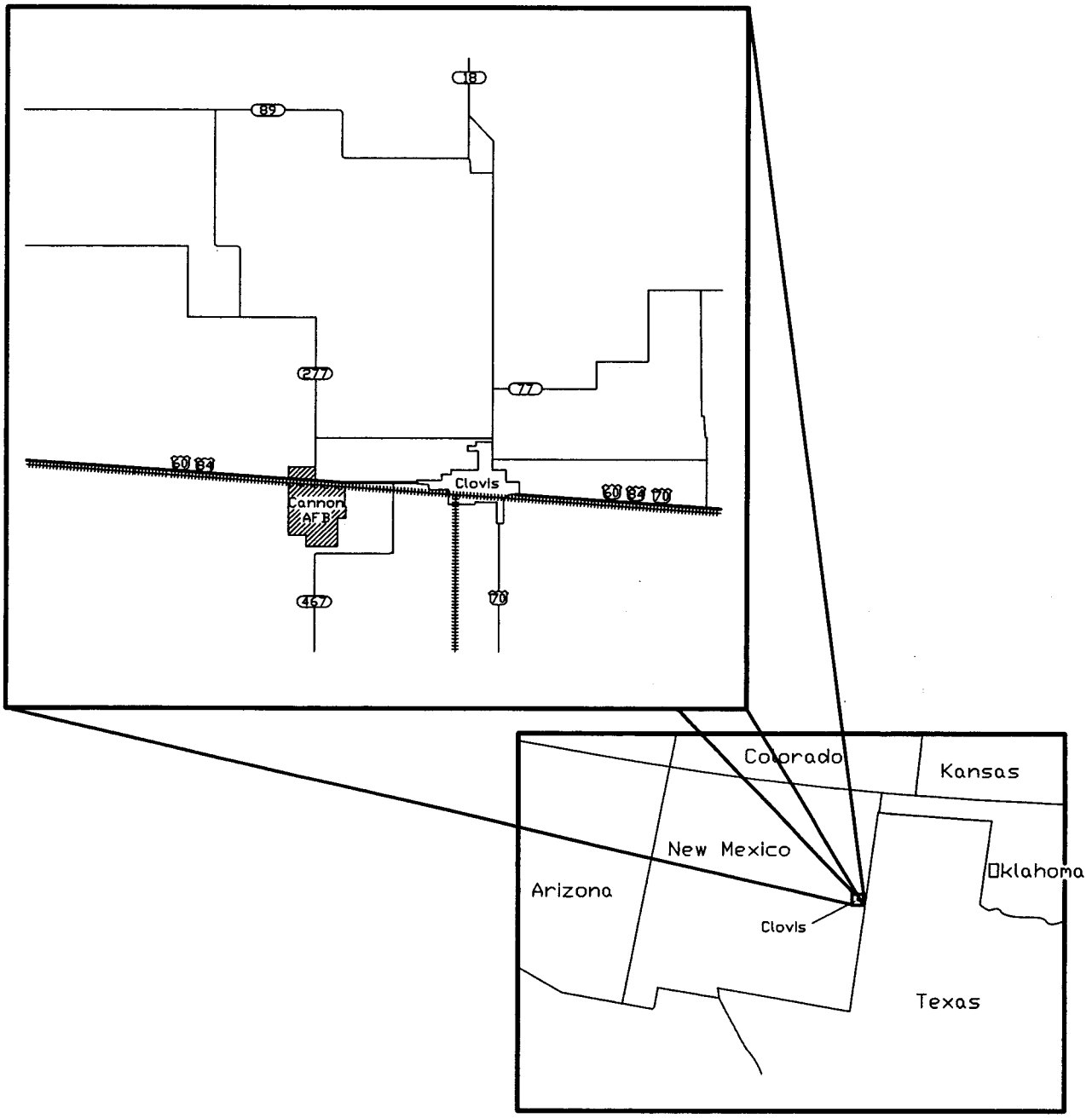
EPA (U.S. Environmental Protection Agency)
1994. RCRA Corrective Action Plan, Final, May 31, 1994.

United States Geological Survey
2000. RCRA Ground-Water Monitoring at Sewage Lagoons and at Landfill 5, Cannon Air Force Base, New Mexico, June.

Walk, Haydel, and Associates (Walk, Haydel, and Associates, Inc.)
1990. Final Installation Restoration Program Remedial Investigation, Cannon Air Force Base, New Mexico, January.

Wisconsin Department of Natural Resources
1994. The New SESOIL User's Guide. Bureau of Solid and Hazardous Waste Management, Emergency and Remedial Response Section. September 14, 1994. PUBL-SW-200-94 (Rev.)

Woodward-Clyde (Woodward-Clyde Consultants)
1992. Remedial Investigation Report for 18 Solid Waste Management Units, Cannon Air Force Base, New Mexico, October.



Not Drawn to Scale

N

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CORRECTIVE MEASURES STUDY REPORT

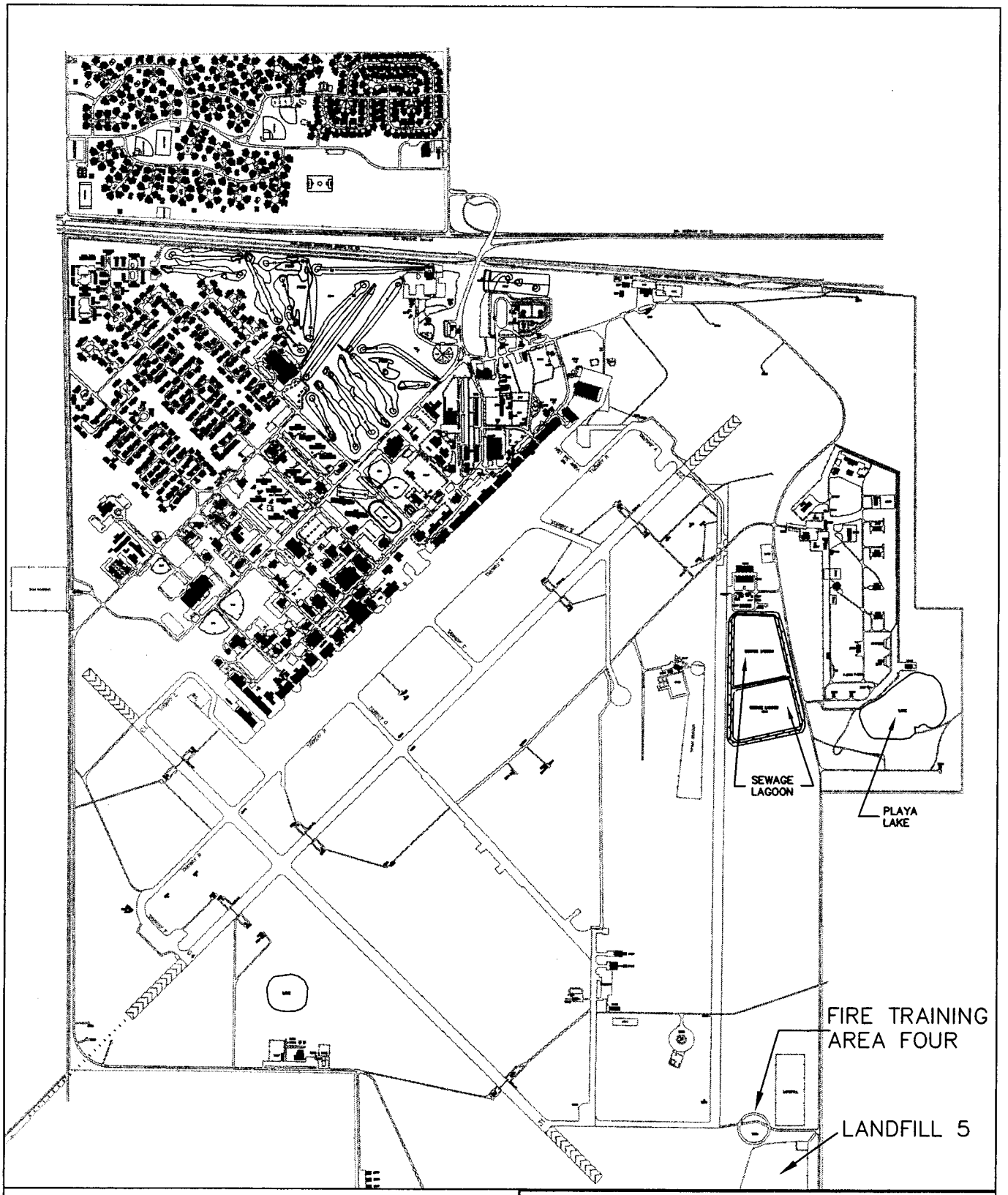
Fire Training Area Four
Cannon Air Force Base, New Mexico
U.S. Army Corps of Engineers, Omaha District

Location of
Cannon Air Force Base

Date: 01/11/01

File Name: J:\[illegible]\DWG\[illegible].DWG

Figure 1-1



Not Drawn to Scale

N

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CORRECTIVE MEASURES STUDY REPORT

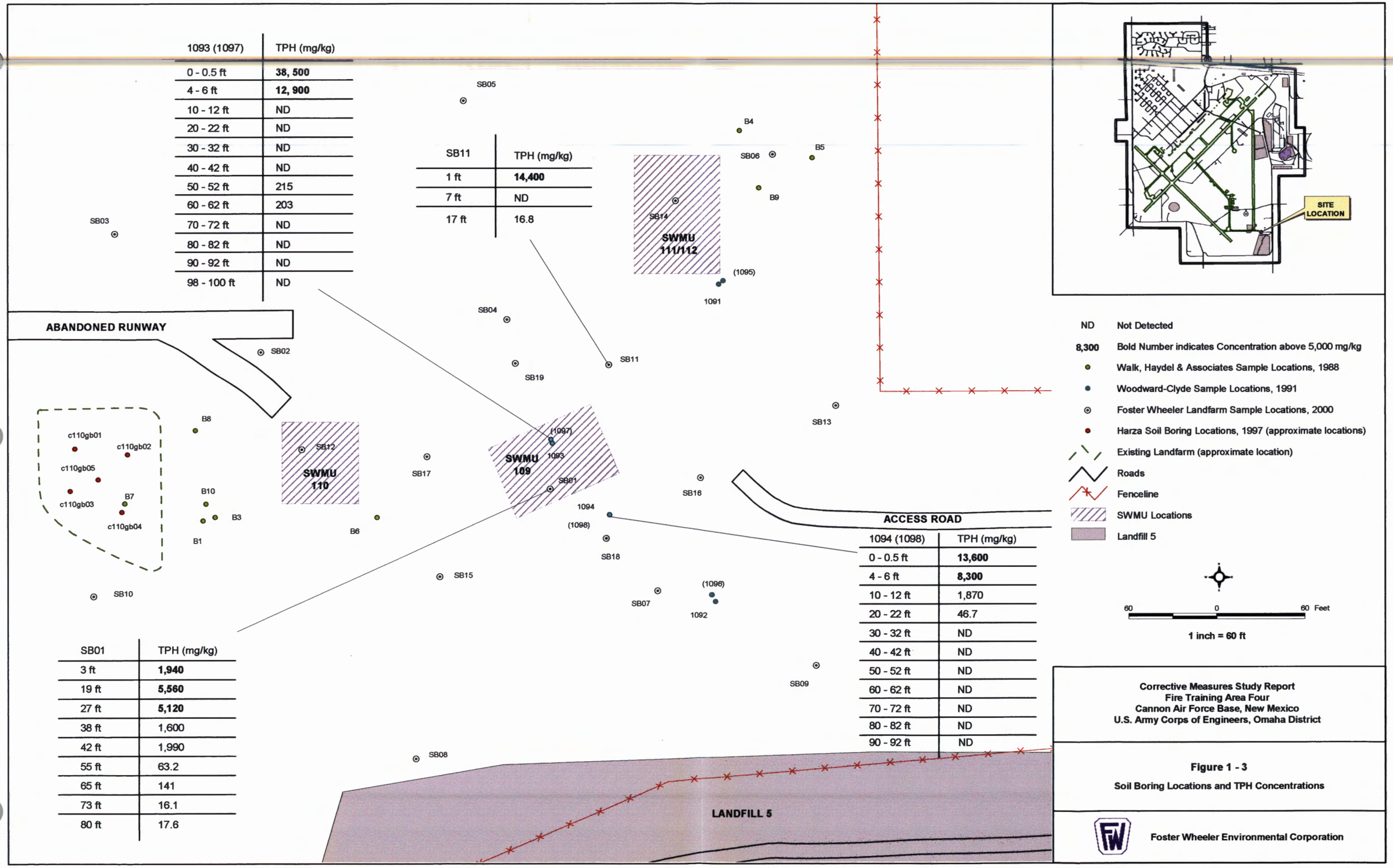
Fire Training Area Four
Cannon Air Force Base, New Mexico
U.S. Army Corps of Engineers, Omaha District

Location of
Fire Training Area Four

Date: 01/11/01

File Name: J:\[illegible]\DWG\[illegible].DWG

Figure 1-2

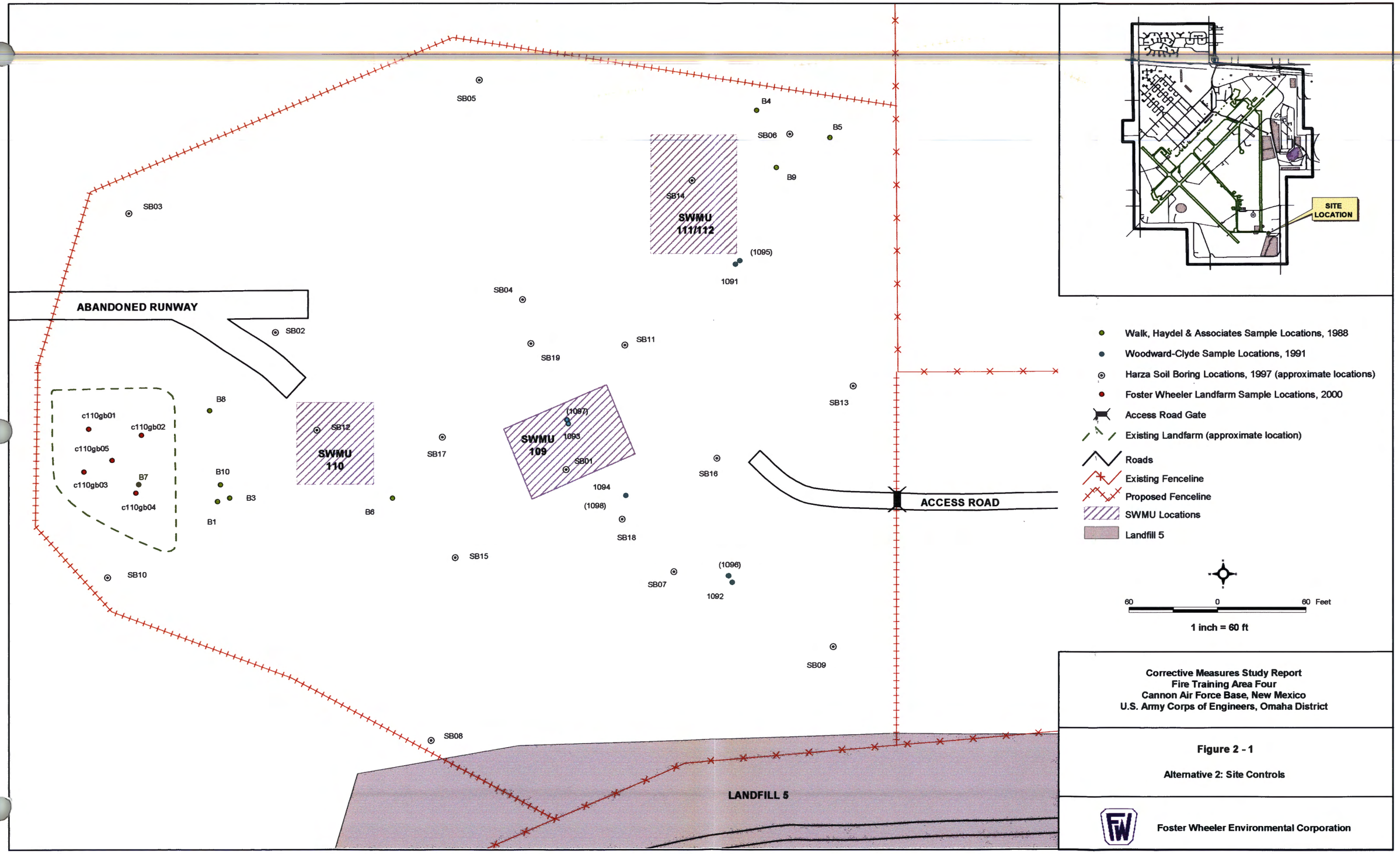


1093 (1097)	TPH (mg/kg)
0 - 0.5 ft	**38, 500**
4 - 6 ft	**12, 900**
10 - 12 ft	ND
20 - 22 ft	ND
30 - 32 ft	ND
40 - 42 ft	ND
50 - 52 ft	215
60 - 62 ft	203
70 - 72 ft	ND
80 - 82 ft	ND
90 - 92 ft	ND
98 - 100 ft	ND

SB11	TPH (mg/kg)
1 ft	**14,400**
7 ft	ND
17 ft	16.8

1094 (1098)	TPH (mg/kg)
0 - 0.5 ft	**13,600**
4 - 6 ft	**8,300**
10 - 12 ft	1,870
20 - 22 ft	46.7
30 - 32 ft	ND
40 - 42 ft	ND
50 - 52 ft	ND
60 - 62 ft	ND
70 - 72 ft	ND
80 - 82 ft	ND
90 - 92 ft	ND

SB01	TPH (mg/kg)
3 ft	**1,940**
19 ft	**5,560**
27 ft	**5,120**
38 ft	1,600
42 ft	1,990
55 ft	63.2
65 ft	141
73 ft	16.1
80 ft	17.6

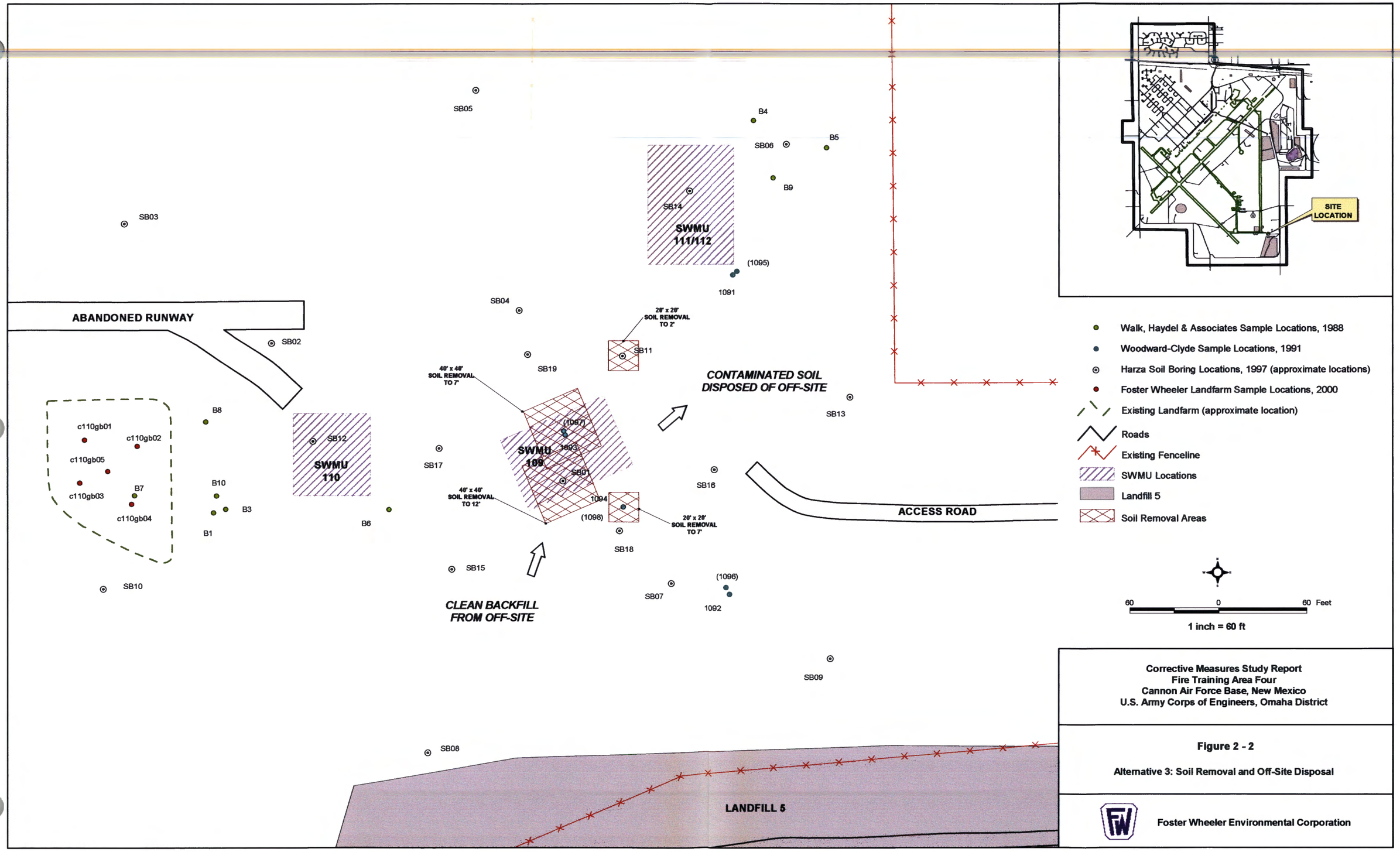


Corrective Measures Study Report
Fire Training Area Four
Cannon Air Force Base, New Mexico
U.S. Army Corps of Engineers, Omaha District

Figure 2 - 1

Alternative 2: Site Controls

Foster Wheeler Environmental Corporation

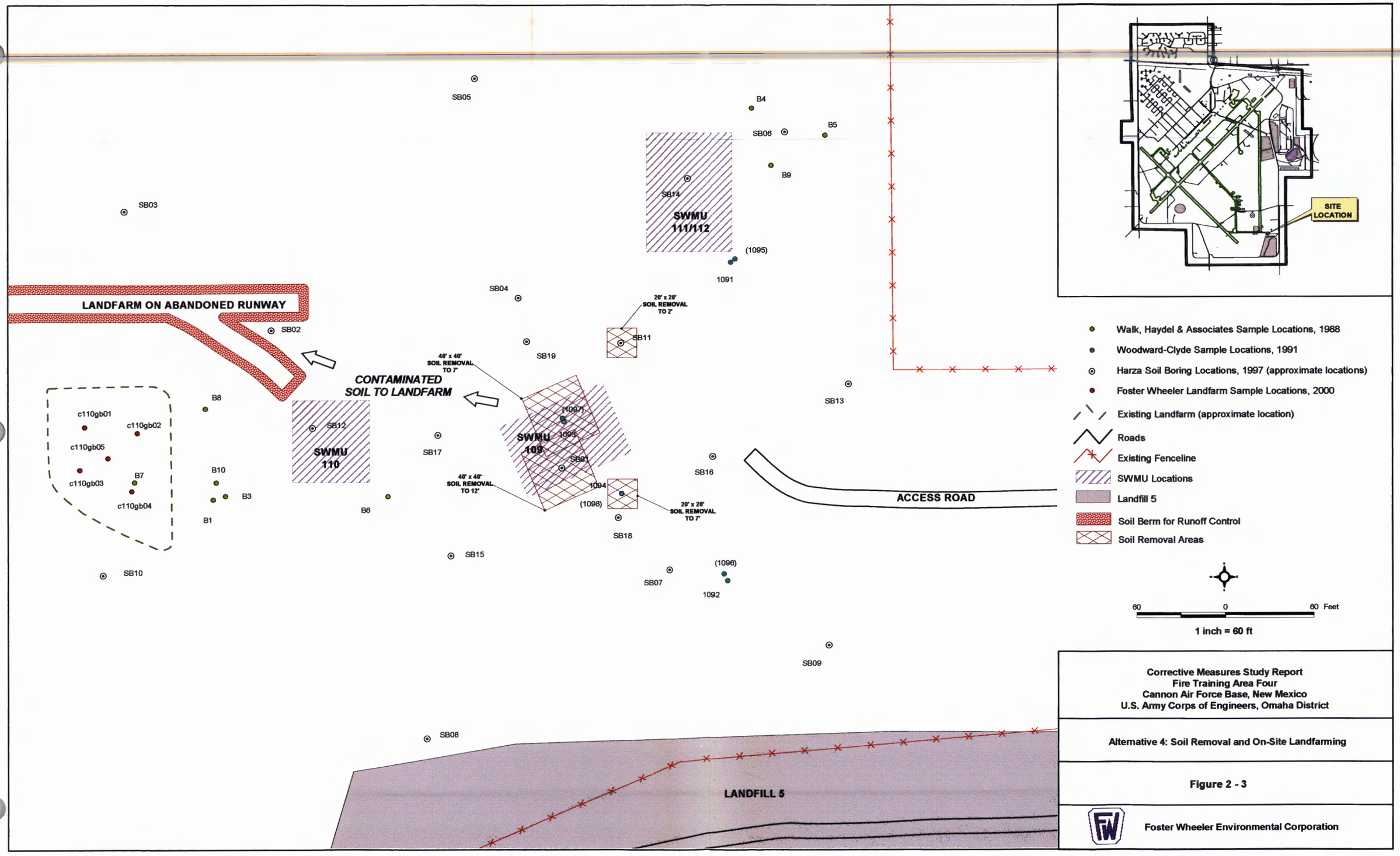


Corrective Measures Study Report
Fire Training Area Four
Cannon Air Force Base, New Mexico
U.S. Army Corps of Engineers, Omaha District

Figure 2 - 2

Alternative 3: Soil Removal and Off-Site Disposal

Foster Wheeler Environmental Corporation

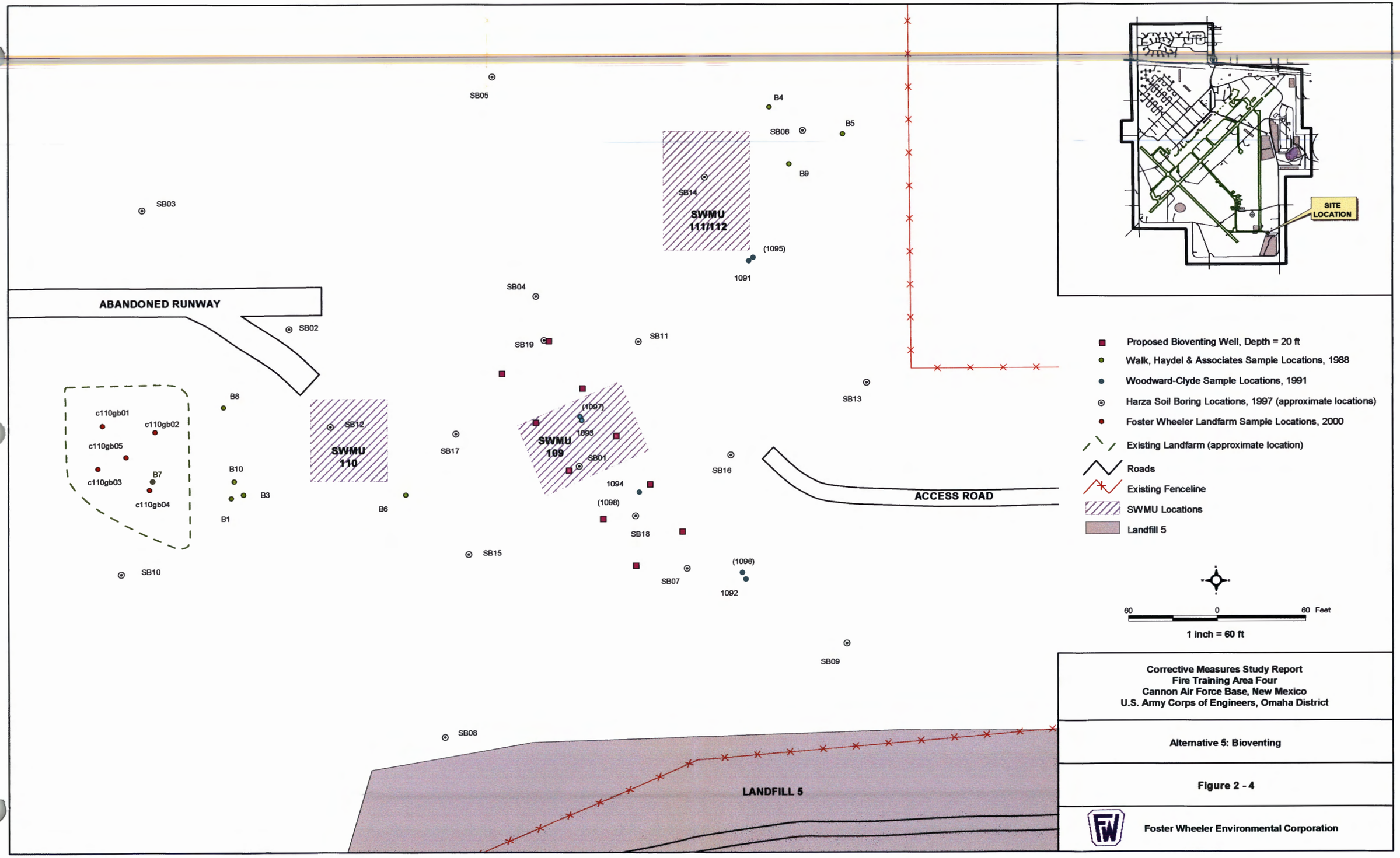


Corrective Measures Study Report
Fire Training Area Four
Cannon Air Force Base, New Mexico
U.S. Army Corps of Engineers, Omaha District

Alternative 4: Soil Removal and On-Site Landfarming

Figure 2 - 3

Foster Wheeler Environmental Corporation



Corrective Measures Study Report
Fire Training Area Four
Cannon Air Force Base, New Mexico
U.S. Army Corps of Engineers, Omaha District

Alternative 5: Bioventing

Figure 2 - 4

Foster Wheeler Environmental Corporation

Table 1-1. Factors Considered in the Detailed Evaluation of Alternatives

Criterion	Description
Protection of human health and the environment	The degree to which an alternative protects human health and the environment. This may include active remediation as well as institutional restrictions and conditions.
Attainment of media cleanup standards	Compliance with media cleanup standards that have been set for a site. These may include federal, state, risk-based, or other types of standards.
Control of sources of releases	How well contaminant sources are controlled, thus preventing releases that could threaten human health and further degrade the environment.
Compliance with applicable standards for management of wastes	How well specific waste management activities during and after remediation comply with all applicable state and federal regulations, and Cannon Air Force Base requirements and procedures.
Long-term reliability and effectiveness	Evaluation of an alternative's long-term reliability, flexibility, and operation and maintenance requirements. This includes the proven effectiveness of the technologies being used.
Reduction in the toxicity, mobility, or volume of wastes	The degree of expected reduction in toxicity, mobility, or volume of wastes, and the degree to which treatment is irreversible. The type and quantities of residuals remaining after treatment are also considered.
Short-term effectiveness	Analysis of the protection of workers, the local community, and the environment during corrective action.
Implementability	Identification of technical and administrative constraints that would block implementation of the project, including time considerations. Availability of needed materials and services is also considered.
Cost estimate	Order-of-magnitude cost estimates based on assumed project duration, staffing requirements, work scope, and monitoring requirements.

Table 1-2. Cannon Air Force Base Fire Training Area 4—SWMU Summary

SWMU No.	SWMU Description
109—Fire Training Pit	This SWMU served as a fuel truck cleaning area and fire training area. Commingled waste oils, solvents, and recovered JP-4 fuel were burned during fire training exercises. The site contained a 40-ft by 70-ft concrete-lined pit with a berm and included internal drainage features to convey excess fuel and water to the oil/water separator (SWMU 112). The pit was removed in December 2000. A mock airplane, consisting of a plane fuselage and supporting struts, was formerly located at the center of the pit. During some fire training exercises the concrete pit was reportedly saturated with water. Soil boring samples taken at the SWMU indicate TPH concentrations exceeding 5,000 mg/kg are present in the soil.
110—Underground Waste Oil Tank	The underground waste oil tank was a 2,000-gallon storage tank installed in 1975. The tank stored recovered JP-4 fuel used during the fire training exercises. The tank was removed in March 1989, and contaminated soil was excavated from around the tank. Soil boring samples taken at this SWMU indicate that TPH contamination is still present at levels below 5,000 mg/kg. Excavated soil from around the tank was placed on heavy-gauge plastic on a plot adjacent to the abandoned runway for landfarming.
111—Unlined Pit	This SWMU was used to collect runoff from SWMU 109 after fires were extinguished during the fire training exercises. The pit was used until 1985, when it was filled and replaced with the oil/water separator (SWMU 112). TPH-contaminated soil is present at this SWMU at levels below 5,000 mg/kg.
112—Oil/Water Separator	The oil/water separator was activated in 1985 at the location of the former unlined pit (SWMU 111). The separator received wastewater from the fire training pit and the water was discharged to a nearby leach field. The separator was removed in 1997, along with the associated leach field. Soil boring samples taken at this SWMU show TPH contamination present at levels below 5,000 mg/kg. Because the oil/water separator is no longer on site, all related soil contamination is addressed with SWMU 111.

Notes:
ft—feet
JP-4—Jet Propellant 4
mg/kg—milligrams per kilogram
SWMU—solid waste management unit
TPH—total petroleum hydrocarbons

Table 1-3. Summary of RFI and RI Soil Boring Samples with TPH Concentrations Exceeding 5,000 mg/kg

Site Location	Depth (ft)	Concentration (mg/kg)	Source
1093	0–0.5	38,500	Woodward-Clyde 1992
1093	4–6	12,900	Woodward-Clyde 1992
1094	0–0.5	13,600	Woodward-Clyde 1992
1094	4–6	8,300	Woodward-Clyde 1992
SB01	19	5,560	Harza 1997
SB01	27	5,120	Harza 1997
SB11	1	14,400	Harza 1997

Notes:
ft—feet
Harza—Harza Environmental Services
mg/kg—milligrams per kilogram
RFI—RCRA Facility Investigation
RI—Remedial Investigation
SB—soil boring
TPH—total petroleum hydrocarbons
Woodward-Clyde—Woodward Clyde Consultants

Table 2-1. Technology Screening Table for SWMU 109

Response Action	Technology	Description	Effectiveness and Implementability	Conclusion
No action	No action	No measures taken.	Easily implemented.	Retain.
Institutional controls	Site controls	Restrictions on site access and ground water use to prevent exposure to potentially contaminated soil and groundwater.	Effectively prevents human exposure to contaminated soil through signage and fencing. Easily implemented. Some restrictions already in place.	Retain.
Containment	Soil or other cover	Cover prevents exposure to contaminated materials; minimizes infiltration and leaching.	Effectively prevents human exposure to contaminated soil through containment. Easily implemented. Limited improvement over no action because soil exposure not a concern. Low precipitation rates result in low potential for leaching.	Reject because contaminated soil would remain on site (limited added benefit for significant added cost).
Removal	Excavation of soil	Removal of TPH contaminated soil exceeding the action level of 5,000 mg/kg to depth of 12 ft. Requires disposal or treatment and backfilling with clean soil.	Effectively prevents human exposure to contaminated soil through removal. Easily implemented.	Retain.
	Transportation	Trucking of PCS.	Effective and easily implemented for PCS.	Retain.
In situ remediation	Enhanced soil vapor extraction	Contaminants physically removed from soil by heat and vacuum.	Effective treatment that is difficult to implement due to shallow depth of TPH contamination; residual TPH likely nonvolatile.	Reject because of difficulty of implementation.
	Bioventing	Contaminants reduced through oxygenation of vadose zone soil.	Effectively prevents human exposure to contaminated soil through treatment. Easily implemented.	Retain.
Ex situ remediation	On-site landfarming	Bioremediation of contaminated soil exceeding the action level of 5,000 mg/kg by placing soil on liner and periodically tilling to aerate waste.	Effective over time and easily implemented.	Retain.
Disposal	Off-site Special Waste landfill disposal	If TPH contamination exceeds the action level of 5,000 mg/kg, soil will be disposed at a landfill permitted to receive Special Waste.	Effective and easily implemented.	Retain.
	Backfilling	If TPH contamination is less than the action level of 5,000 mg/kg, soil will be backfilled.	Effective and easily implemented.	Retain.

Notes:

ft—feet
mg/kg—milligrams per kilogram
PCS—petroleum-contaminated soil
SWMU—solid waste management unit
TPH—total petroleum hydrocarbons

Table 2-2. Summary of Alt ative Evaluation for SWMU 109

Description/Criteria	Alternative				
	1: No Action	2: Site Controls	3: Soil Removal and Off-Site Disposal	4: Soil Removal and On-Site Landfarming	5: Bioventing
Protection of human health and the environment	Protective because risk assessment shows site is safe under current conditions.	Protective because risk assessment shows site is safe under current conditions.	Protective because risk assessment shows site is safe under current conditions.	Protective because risk assessment shows site is safe under current conditions.	Protective because risk assessment shows site is safe under current conditions.
Attainment of media cleanup standards	Does not attain standard because contaminated soil is left in place.	Does not attain standard because contaminated soil is left in place.	Cleanup achieved to action level of 5,000 mg/kg for TPH to a depth of 12 feet.	Cleanup achieved to action level of 5,000 mg/kg for TPH to a depth of 12 feet.	Cleanup achieved to action level of 5,000 mg/kg for TPH by treating soil contamination over time.
Control of the sources of releases	No source removal.	No source removal but access is restricted.	Primary contamination source removed to a depth of 12 feet.	Primary contamination source removed to a depth of 12 feet.	Primary contaminant source treated through bioremediation.
Compliance with applicable standards for management of wastes	No associated waste.	No associated waste.	In compliance with waste removal regulations.	In compliance with treatment regulations.	In compliance with waste removal regulations.
Long-term reliability and effectiveness	Not reliable or effective because site exceeds the action level of 5,000 mg/kg for TPH.	Provides long-term protection through restricted access.	Provides long-term protection through contaminant removal. Only reliable and effective to a depth of 12 feet.	Provides long-term protection through contaminant removal. Only reliable and effective to a depth of 12 feet.	Provides long-term contaminant treatment.
Reduction in the toxicity, mobility, or volume of wastes	Volume reduction limited to natural attenuation processes.	Volume reduction limited to natural attenuation processes.	Volume reduction achieved as contaminated soil removed from the site.	Contaminated soil removed and contaminant volume reduction induced by air exposure.	Contaminant volume reduction by oxygenation of vadose-zone to enhance bioremediation.
Short-term effectiveness	No adverse impacts to environment or nearby communities.	No adverse impacts to environment or nearby communities.	No adverse impacts to environment or nearby communities aside from normal construction activities. Health and safety plan will discuss mitigation of construction hazards.	No adverse impacts to environment or nearby communities aside from common construction activities. Health and safety plan will discuss mitigation of construction hazards.	No adverse impacts to environment or nearby communities aside from common construction activities. Health and safety plan will discuss mitigation of construction hazards.
Implementability	Easily implemented. No action required.	Easily implemented. May involve deed restrictions.	Implementable. Off-site disposal required.	Implementable. Requires regular maintenance.	Implementable. Requires regular maintenance and monitoring.
Cost estimate	No additional cost—$0	Low—$34,000	High—$125,000	High—$136,000	High—$125,000
Conclusion	Reject. Does not meet the CAO (action level of 5,000 mg/kg for TPH in soil).	Reject. Does not meet the CAO (action level of 5,000 mg/kg for TPH in soil).	Reject. Does not meet the CAO below a depth of 12 feet.	Reject. Does not meet the CAO below a depth of 12 feet.	Retain. Meets the CAO (action level of 5,000 mg/kg for TPH in soil).

Notes:
CAO—corrective action objective mg/kg—milligrams per kilogram SWMU—solid waste management unit TPH—total petroleum hydrocarbons

Table 3-1. Technology Screening Table for SWMU 110

Response Action	Technology	Description	Effectiveness and Implementability	Conclusion
No action	No action	No measures taken.	Easily implemented. No active source control. Effective given site conditions do not exceed the TPH action level.	Retain.
Institutional controls	Site controls	Restrictions on site access and groundwater use to prevent exposure.	No improvement over no action because restrictions already in place for continued military use.	Reject because restrictions are already in place for continued military use, and there is no additional improvement over No Action.

Notes:
SWMU—solid waste management unit
TPH—total petroleum hydrocarbons

Table 3-2. Summary of Alternative Evaluation for SWMU 110

Description/Criteria	Alternative No Action
Protection of human health and the environment	Protective of human health and environment (Harza 1997).
Attainment of media cleanup standards	No remaining contaminated soil.
Control of the sources of releases	Tank previously removed. Source no longer present.
Compliance with applicable standards for management of wastes	Compliant; no wastes are generated.
Long-term reliability and effectiveness	Reliable and effective since contaminated soil has been removed previously.
Reduction in the toxicity, mobility, or volumes of wastes	Reduction limited to natural attenuation processes.
Implementability	Easily implemented.
Cost estimate	No additional cost—$0.
Conclusion	Retain. Meets the CAO.

Notes:
CAO—corrective action objective
Harza—Harza Environmental Services
SWMU—solid waste management unit

Table 4-1. Technology Screening Table for SWMU 111

Response Action	Technology	Description	Effectiveness and Implementability	Conclusion
No Action	No Action	No measures implemented.	No source control or contaminant reduction other than by natural attenuation. Effective given site conditions do not exceed the TPH action level.	Retain.

Notes:
SWMU—solid waste management unit
TPH—total petroleum hydrocarbons

Table 4-2. Summary of Alternative Evaluation for SWMU 111

Description/Criteria	Alternative No Action
Protection of human health and the environment	Protective of human health and environment (Harza 1997).
Attainment of media cleanup standards	Contaminant levels do not exceed the action level of 5,000 mg/kg in soil.
Control of the sources of releases	No sources present.
Compliance with applicable standards for management of wastes	Meets the action level of 5,000 mg/kg for TPH in soil.
Long-term reliability and effectiveness	Reliable and effective. No active remediation.
Reduction in the toxicity, mobility, or volumes of wastes	Reduction limited to natural attenuation processes.
Implementability	Easily implemented.
Cost estimate	No additional cost—$0.
Conclusion	Retain. Meets the CAO and media cleanup standards.

Notes:
CAO—corrective action objective
Harza—Harza Environmental Services
mg/kg—milligrams per kilogram
SWMU—solid waste management unit
TPH—total petroleum hydrocarbons

APPENDIX A

CONTAMINANT FATE AND TRANSPORT MODELING

1.0 INTRODUCTION

The fate and transport of representative contaminants through the unsaturated zone was simulated representing a 30-year period at the Fire Training Area Four (FTA4) Solid Waste Management Unit (SWMU) 109, located on the Cannon Air Force Base (AFB) in Clovis, New Mexico. The environmental model, Seasonal Soil Compartment (SESOIL) model for Windows (Version 2.5), was used to estimate the migration of the representative contaminants.

The SESOIL model is a one-dimensional, vertical transport model for the unsaturated vadose zone. It simulates water transport, sediment transport, and contaminant fate for constituents introduced into the system either instantaneously or continuously. This model was developed for use by the United States Environmental Protection Agency (EPA) and Department of Energy. It has been revised and refined over time for application as a screening-level model to aid in exposure assessments and remediation projects by utilizing fewer input parameters for soil, climate, and chemical constituents than similar models (General Services Corporation 1998).

2.0 METHODOLOGY

2.1 DETERMINATION OF THE REPRESENTATIVE CONTAMINANTS

Soil samples were obtained from Soil Boring 01 (SB01) at FTA4 during a previous investigation conducted by Harza Environmental Services, Inc. (1997). Samples with the highest concentrations of the representative contaminants were collected from 19 to 27 feet (ft) below ground surface (bgs). The samples were analyzed in the laboratory for contaminants including organics, pesticides, and metals. Initially, any constituent detected was considered a candidate for modeling to simulate downward migration to groundwater. Contaminants were eliminated from the candidate list if they did not have a federal or New Mexico groundwater standard. Contaminant concentrations were then compared to Base-wide background levels. Contaminant concentrations exceeding background levels were included in the modeling effort selection process. Finally, the physical characteristics of the contaminants were considered prior to inclusion in the fate and transport modeling. For example, arsenic, barium, chromium, and lead met all criteria for representative contaminants; however, because of the insolubility of these metals, they were not included in the model simulations. The chemicals simulated in the fate and transport modeling were toluene, naphthalene, and total xylenes. These three chemicals were selected based on their high mobility and elevated concentrations at FTA4.

3.1 SOIL COMPARTMENTS

The SESOIL model allows the user to compartmentalize the unsaturated and saturated soil column into discrete intervals based on the intrinsic soil characteristics or site-specific exposure scenarios. Geologic characteristics for the site were taken from the site-specific geotechnical data. The saturated zone was assumed to occur at a depth of 290 ft and is in the peripheral region of the Ogallala Formation.

For FTA4, the soil column was subdivided into three layers. Two layers represent the unsaturated zone at depth intervals of 0 to 22 ft for Layer 1 and 22 to 290 ft for Layer 2; Layer 3 represents the saturated zone from 290 ft to 390 ft. Table A-6 provides the soil parameter input and Figure A-1 shows a typical cross section of the model. Soil parameters required for the model include the following (Table A-1):

Table A-1. Soil Parameters for the SESOIL Model

Parameter	Value	Site-Specific Data?
Bulk density	1.63 grams per cubic centimeter (3.16 slug per cubic foot)	Yes
Intrinsic permeability	1.79E-9 square centimeters (2.77E-10 square inches)	Yes
Intrinsic permeability	1.79E-9 square centimeters (2.77E-10 square inches)	Yes
Disconnectedness index	9	Yes
Effective porosity	0.33	Yes
Organic carbon content	0.17%	Yes
Cation exchange capacity	0	No
Freundlich equation exponent	1	No

Note: Use of the SESOIL model requires input in metric units and provides output in metric units.

The SESOIL User's Guide was followed to determine disconnectedness index values. Based on the soil classification from field samples, appropriate index values were assigned and averaged (General Sciences Corporation 1998). Assumptions were made to determine the effective porosity. Density values from field data and assumed values of specific gravity were used to calculate the porosity of the soil samples. Porosity values were reduced 15 percent to represent the effective porosity of the samples. The final values of effective porosity were averaged among the samples to represent the entire unsaturated layer. The cation exchange capacity and the Freundlich exponent were assumed values based on recommendations from the SESOIL User's Guide (General Sciences Corporation 1998).

3.3 CHEMISTRY

Analyte-specific information was input for the pollutant cycle of the model. Model runs were completed for toluene, naphthalene, and total xylenes. The following parameters were entered into the model for each contaminant (Table A-3):

Table A-3. Chemical Parameters for SESOIL Model

Parameter	Value	Chemical-Specific Data?
Solubility	Chemical-specific See Table A-9	Yes
K_h (diffusion coefficient)		Yes/No
Henry's constant		Yes/No
K_{oc} (carbon adsorption coefficient)		Yes/No
K_d (soil adsorption coefficient)		Yes/No
Molecular weight		Yes
Hydrolysis and biodegradation		No
Complexation		No

Note: References for chemical-specific values and assumptions are listed in Table A-9.

3.4 POLLUTANT LOAD

The algorithm used by the SESOIL model for the pollutant load requires the user to determine the pollutant load concentration, the layer that will receive the pollutant, and the area of pollutant application. The pollutant load was calculated for the model as a function of concentration, soil bulk density, and soil intrinsic permeability. The maximum detected concentrations of each contaminant were used to calculate pollutant load. This practice tends to overestimate the potential for the contaminants to migrate to the water table.

The second layer of the soil column (22 to 90 ft) was designated to receive the pollutant. This is consistent with actual data collected from SWMU 109 (SB01) that indicate the highest concentrations of chemicals occur at a soil depth of 19 to 27 ft. Since contaminant releases are no longer occurring at FTA4, the model was set up to simulate the migration of residual contamination detected in the subsurface. Assuming an instantaneous release of the contaminant within the second layer during the first month of model simulation is a realistic approach to modeling these actual conditions at the site.

The pollutant application area was calculated as the 20-ft by 20-ft aerial extent of the concrete pad at SWMU 109. For each model run, the area of pollutant application was 371,747 cm^2.

normal conditions. Additional precipitation was added on Simulation 2 to evaluate the effects on transport of the contaminants as infiltration increases during periods of high precipitation. Simulation 2 included the SESOIL database monthly precipitation and the precipitation from a 100-year, 24-hour storm for the first month of each year. The rainfall produced for a 100-year, 24-hour storm was determined to be 6 inches (15.24 centimeters) for the region (National Oceanic and Atmospheric Administration 2000).

4.0 MODEL SIMULATIONS

A descriptive summary of the simulations follows:

- Simulation 1—Current, normal climate conditions
- Simulation 2—Normal climate with the addition of the precipitation from one 100-year, 24-hour storm, every year.

Each simulation was performed independently for each particular contaminant for a total of three model executions per simulation condition. Other than the precipitation, the variables remained the same for all simulations for each contaminant. The simulations were performed for a duration of 30 years.

4.1 RESULTS OF MODEL SIMULATIONS

Various input parameters and the corresponding maximum pollution depths are presented in Table A-12.

4.1.1 Simulation 1

Pollution depth versus time plots are presented for each contaminant for the first simulation (current, normal conditions) in Figures A-2 through A-4. None of the contaminants migrated to groundwater during the 30-year simulation. Toluene is very soluble and extremely mobile and migrates deeper within the vadose zone compared to the other contaminants, as illustrated in Figure A-2.

4.1.2 Simulation 2

The results of the second set of simulations are presented in Figures A-5 through A-7 in the same format as described for the first simulations. The difference between Simulations 1 and 2 is the addition of one 100-year, 24-hour storm event the first month of each year for the second simulation. None of the contaminants reach the groundwater after 30 years of simulation, despite the assumption that precipitation is much greater than average during the entire simulation period.

The results of the simulations are summarized in Table A-5. The effects of contamination over 100 years were modeled but showed no adverse impact on groundwater. These plots are not included.

Cannon AFB
1997. Naturally Occurring Concentrations of Inorganics and Background Concentrations of Pesticides at Cannon Air Force Base, New Mexico. September, 1997.

Foster Wheeler Environmental (Foster Wheeler Environmental Corporation).
2001. Corrective Measures Study for SWMU 101–Sewage Lagoon, Revised Final, Appendix A–Geotechnical Analysis and Laboratory Test Results, April 2001.

General Science Corporation
1998. Seasonal Soil Compartment Model (SESOIL), Version 2.5. January 1995.
1994. Seasonal Soil Compartment Model (SESOIL), Workshop Manual. November 1994.

Harza Environmental Services, Inc.
1997. Phase II RCRA Facility Investigation Report (Draft). Fire Training Area No. 4, Cannon AFB, Clovis, New Mexico. August 1007.

National Oceanic and Atmospheric Administration
2000. Atlas 2, Volume IV, Figure 30, 2000. Inc.

Table A-6. Cannon AFB FTA4 SESOIL Soil Parameters Input

Soil	Model Units	Model Input	Assumption	Reference
Bulk density	g/cm^3	1.63		Average of samples tested from the site, Western Technologies Inc. 2000
Intrinsic permeability	cm^2	1.79E-09		Calculated from permeability of field samples
Disconnectedness index		9		General Sciences Corporation 1995
Effective porosity		0.33		15% reduction from calculated porosity, based on an assumed specific gravity
Organic carbon content	%	0.1667		Average value of tested field samples
Cation exchange capacity	meq/100 g	0	yes	
Freundlich equation exponent		1	yes	
Model Compartments				
# Layers	3			
Layer-Specific Data	Layer 1	Layer 2	Layer 3	Reference
Composition	Soil	Soil	Soil	
Thickness	670.5 cm (22 ft)	2,073 cm (68 ft)	6,096 cm (200 ft)	
Condition	Unsaturated	Unsaturated	Unsaturated	

Notes:

Use of the SESOIL model requires input in metric units and provides output in metric units.

cm–centimeters

cm^2–centimeters squared

ft–feet

g–grams

g/cm^3–grams per cubic centimeter

meq–milliequivalence

Table A-7. Cannon AFB FTA4 SESOIL Climate Database Input

Clovis 3 SSW - SESOIL Climate Data

Climate	Units	October	November	December	January	February	March	April	May	June	July	August	September
Air temperature	degrees C	13.78	7.06	2.89	1.83	3.94	6.83	12.5	17.39	22.33	24.44	23.67	19.72
Cloud cover		0.40	0.40	0.50	0.55	0.50	0.50	0.50	0.50	0.40	0.55	0.35	0.30
Humidity		0.5	0.55	0.55	0.5	0.55	0.5	0.45	0.45	0.45	0.55	0.55	0.5
Albedo		0.25	0.26	0.27	0.28	0.27	0.27	0.26	0.25	0.25	0.25	0.25	0.25
Evapotranspiration	cm/day	0	0	0	0	0	0	0	0	0	0	0	0
Precipitation	cm	3.43	1.39	1.05	0.98	1.17	1.32	1.69	4.14	5.56	7.04	6.53	4.3
Storm duration	days	0.33	0.2	0.27	0.23	0.29	0.25	0.19	0.2	0.23	0.22	0.23	0.29
# Storms		2.34	1.47	1.51	1.09	1.38	1.76	1.67	3.13	3.76	4.42	4.38	2.63
Length	days	30.4	30.4	30.4	30.4	30.4	30.4	30.4	30.4	30.4	30.4	30.4	30.4

Notes:

AFB–Air Force Base
C–Celcius
cm–centimeters
cm/day–centimeters per day
FTA4–Fire Training Area Four
SSW–South Southwest

Table A-8. Cannon AFB FTA4 SESOIL Climate Input (used for comparison to SESOIL database)

Climate	Units	October	November	December	January	February	March	April	May	June	July	August	September	Assumption
Air temperature (1)	degrees C	14.61	11.04	4.04	6.76	8.28	10.38	12.71	18.66	23.22	24.94	24.52	19.79	no
Cloud cover (2)		0.25	0.25	0.25	0.20	0.20	0.20	0.30	0.30	0.20	0.40	0.50	0.40	yes
Humidity (3)		0.552	0.523	0.633	0.555	0.437	0.685	0.517	0.593	0.639	0.607	0.613	0.698	no
Albedo (4)		0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	yes
Evapotranspiration (5)	cm/day	0	0	0	0	0	0	0	0	0	0	0	0	yes
Precipitation (6)	cm	0.9398	0.0254	1.3208	3.7592	0	2.794	5.8928	6.4262	3.2766	6.4008	10.6172	6.1976	no
Storm duration (2)	days	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	yes
# Storms (7)		1	1	6	1	0	2	5	7	7	3	7	3	no
Length (8)	days	31	30	31	31	28	31	30	31	30	31	31	30	yes

Notes:

(1) WRCC—Clovis, New Mexico, Average of daily maximum and minimum for 1999

(2) Estimated

(3) WRCC—Multiple readings daily, Clovis, New Mexico, 1999

(4) Eagleson 1980

(5) Conservatively assumed 0.0 as an initial value; SESOIL calculated evapotranspiration rates at approximately 15% of reported average class A pan rates from 1951 to 1995

(6) WRCC—Clovis, New Mexico, 1999

(7) Each daily precipitation record considered as one storm

(8) Days of the month

AFB–Air Force Base

C–Celcius

cm–centimeters

cm/day–centimeters per day

FTA4–Fire Training Area Four

WRCC–Western Regional Climate Center

Table A-9. Cannon AFB FTA4 SESOIL Chemical Parameters Input

Decision Matrix for Assessing Contaminants to be Used in SESOIL Modeling
Cannon AFB FTA4

Selection Criteria:
1. Contaminants that have a defined groundwater standard (state or federal)
2. Solubility in water

Chemical	Range (µg/kg)	3 ft (µg/kg)	19 ft (µg/kg)	27 ft (µg/kg)	38 ft (µg/kg)	42 ft (µg/kg)	55 ft (µg/kg)	65 ft (µg/kg)
VOCs								
toluene	17.4–4,370	NA	4370	4190	298	2290	NA	17.4
ethylbenzene	34.6–7,230	1780	7230	6450	993	2100	NA	34.6
m/p - xylenes	166–34,100	4130	24200	34100	14700	29900	NA	166
o-xylene	81.1–18,900	NA	12800	18900	9780	17400	NA	81.1
isopropylbenzene	16.6–1,940	1430	1780	1940	970	1800	NA	16.6
n-propylbenzene	29.3–4,450	3320	3190	4450	2020	3640	NA	29.3
1,3,5-trimethylbenzene	92.6–15,500	9250	11200	15500	7670	12700	NA	92.6
1,2,4-trimethylbenzene	11.2–41,800	22800	21000	41800	19500	35300	11.2	188
sec-butylbenzene	15.6	NA	NA	NA	NA	NA	NA	15.6
p-isopropyltoluene	51.8–9,530	7030	6280	9530	3330	5250	NA	51.8
n-butylbenzene	26.2–4,620	4620	3630	NA	NA	NA	NA	26.2
naphthalene	10.7–8,580	4830	3530	8580	3430	5510	10.7	28
2-butanone	89.8	NA	NA	NA	NA	NA	NA	89.8
SVOCs								
naphthalene	586–3,800	2200	3800	586	2400	2390	NA	NA
2-methylnaphthalene	3,500–11,700	4860	11700	3500	9650	8610	104	139

Contaminant	Solubility (mg/L-water)	Kh (diff. In air) (cm^2/sec)	Henry's Constant (m^3-atm/mole)	K_{oc} (ads. on carbon)	Kd (ads. on soil)	Molecular Weight (g/mole)	$_{Log}K_{ow}$
Toluene	[A]526	[2]0	[A]0.0066	[D]140	[C]0	[A]92	[A]2.79
Naphthlene	[A]31	[2]0	[A]0.00048	[E]1191	[F]0	[A]128.16	[A]3.29
m/p-Xylenes	[1]185	[2]0	[1]0.0067	[1]196	[4]0	[1]106	[3]2.77

*Use Kd or Koc

Notes:
AFB–Air Force Base
FTA4–Fire Training Area Four
NA–not available
µg/kg–micrograms per kilogram
VOC–volatile organic compound
Highlighted values indicate maximum concentrations.
Source: Harza 1997.

[A]EPA Handbook of RCRA Ground-Water Monitoring Constitiuents, September 1992
[1]EPA Region 9 PRG Table, October 1998
[2]GSC 1994 (assume soil-to-air diffusion does not occur)
[3]Mabey et al. 1982, EPA 1992
[4]GSC 1994 (if using K_{oc}, set K_d to zero)
[C]Calculated from: $\log K_d = 1.01 \log K_{ow} - 0.36$; EPA Soil Screening Guidance: Technical Background Document, May 1996, PB96-963502
[D]Calculated from: $\ln K_{oc} = \ln K_{ow} - 0.7301$; Fetter 1993, "Contaminant Hydrogeology," pg. 134, equation (T9)
[E]Calculated from: $\log K_{oc} = 0.544 \log K_{ow} + 1.377$; Fetter 1993 "Contaminant Hydrogeology," pg. 134, equation (T4)
[F]EPA TA-0016, June, 1987, Processes, Coefficients, and Models for Simulating Toxic Organics and Heavy Metals in Surface Waters
[G]*CRC Handbook of Chemistry and Physics*, 65th edition, 1985, CRC Press, pg. B-72, values listed for ammonium nitrate

Table A-10. Cannon AFB FTA4 Site-Specific Pollutant Load Values

Application Area	Model Units	Model Input	Assumption	Reference
# Years		30	Yes	
# Soil layers		3	Yes	
Application area	cm^2	371,747	No	Site drawing
Latitude	degrees N	34.4	No	

Loading Type (choose one)		
Instantaneous	X	Entered for 1st month of 1st year in second layer
Continuous		

Pollutant Added to Layer 2	Concentration µg/g	Load $mg/cm^2/month$
Toluene	4.37	0
Napthalene	8.58	0
Total xylenes	53	0

Notes:

AFB–Air Force Base

cm^2–centimeters squared

FTA4–Fire Training Area Four

$mg/cm^2/month$–milligrams per square centimeter per month

N–north

µg/g–micrograms per gram

Table A-11. Cannon AFB FTA4 SESOIL Groundwater Mixing Output

Application	Model Units	Model Input	Assumption	Reference
Saturated hydraulic conductivity	cm/day	15	No	Geotechnical data, April 2000
Horizontal hydraulic gradient	cm/cm	0.002	No	Cannon AFB 1999
Thickness of groundwater mixing zone	cm	610.0	Yes	Well screen interval = 20 ft
Width of contaminated zone Perpendicular to groundwater flow direction	cm	28,956	No	Widest point of south lagoon
Background concentration of the Contaminant in the aquifer	µg/mL	0	Yes	

Summer's Model Groundwater Mixing

Notes:

AFB–Air Force Base
cm–centimeters
cm/day–centimeters per day
ft–feet
FTA4–Fire Training Area Four
µg/ml–micrograms per milliliter

Table A-12. Cannon AFB FTA4 SESOIL Simulations

Simulation Desc.	Chemical	Climate Data From SESOIL Database	One 24-hr, 100-yr Storms per Year	30-yr Simulation	Depth to Groundwater 290 ft	Max. Pollution Depth (m)	Max. Pollution Depth (ft)	Groundwater Concentration µg/mL
1	Toluene	X		X	X	30.69	100.66	0
1	Naphthalene	X		X	X	19.83	65.04	0
1	Total xylenes	X		X	X	28.77	94.37	0
2	Toluene	X	X	X	X	31.95	104.80	0
2	Naphthalene	X	X	X	X	20.16	66.12	0
2	Total xylenes	X	X	X	X	29.73	97.51	0

Notes:

Simulation 1 - Current conditions

Simulation 2 - One 24-hour, 100-year storm per year

AFB–Air Force Base

ft–feet

FTA4–Fire Training Area Four

hr–hour

m–meters

µg/mL–micrograms per milliliter

yr–year

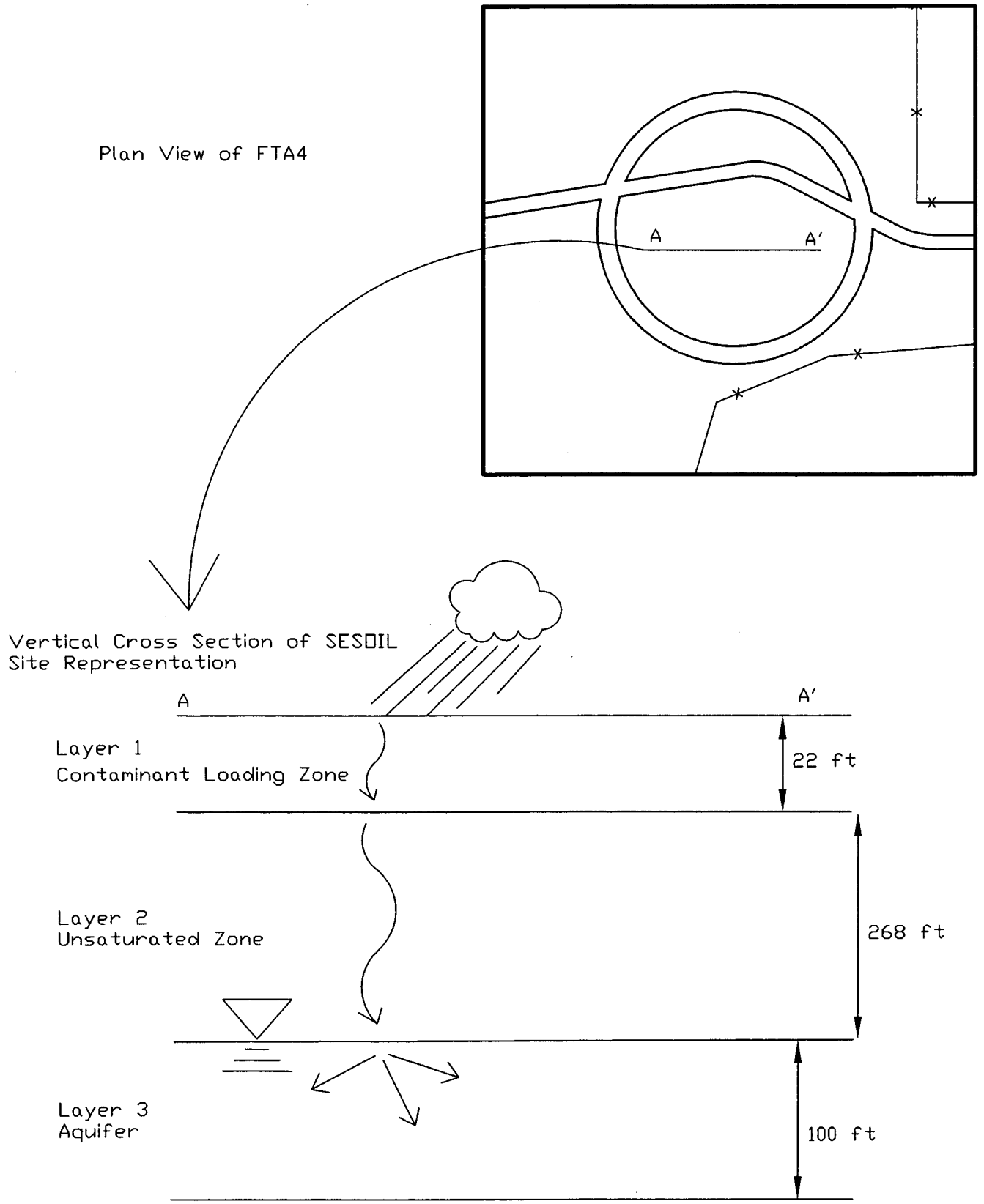
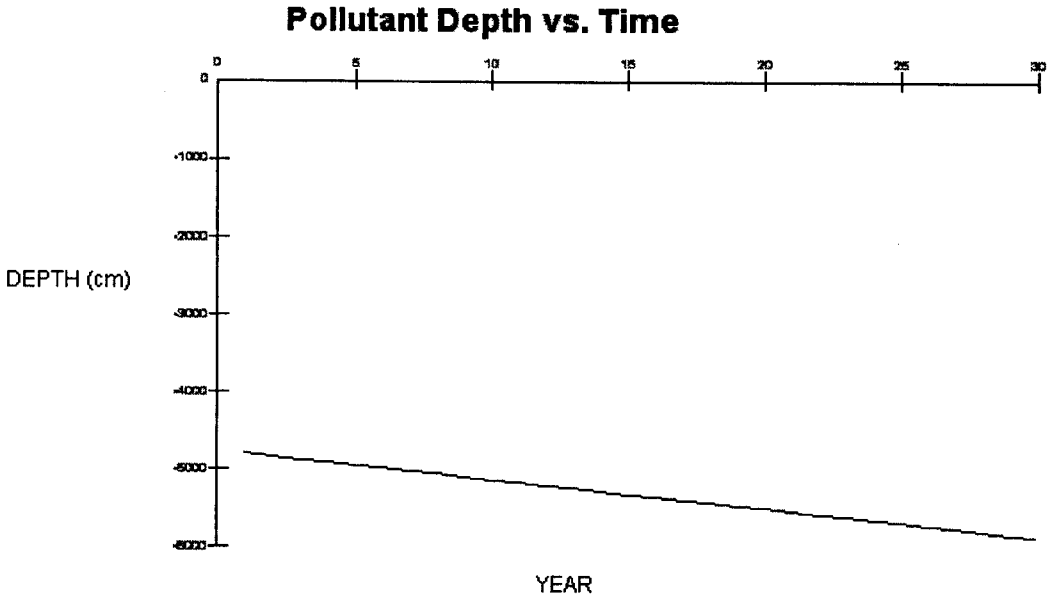


Figure A-1. Conceptual Model of SESOIL Geometry

I:\51552801\DWG\A.1_Draw.dwg

Figure A-2. Simulation 1—Current Conditions
Depth to Water Table = 290 ft = 8,838 cm

Toluene (30 years)



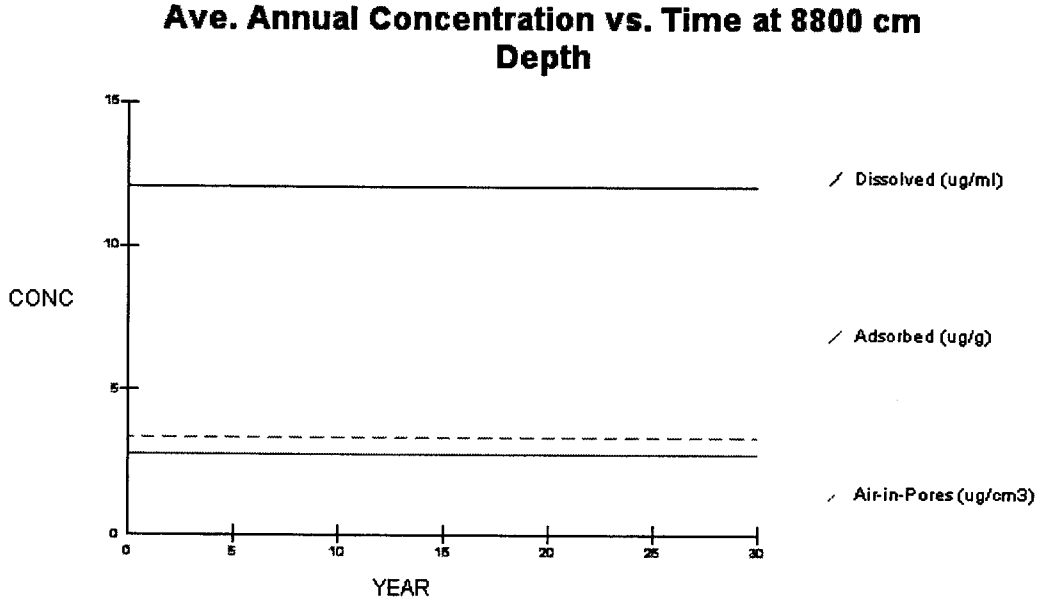
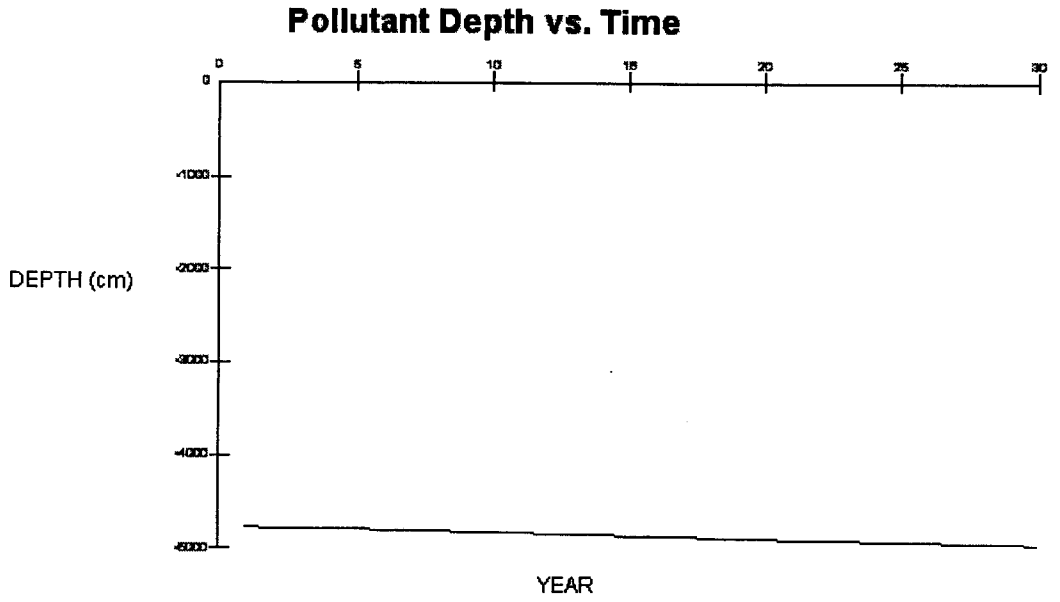


Figure A-3. Simulation 1—Current Conditions
Depth to Water Table = 290 ft = 8,838 cm

Naphthalene (30 years)



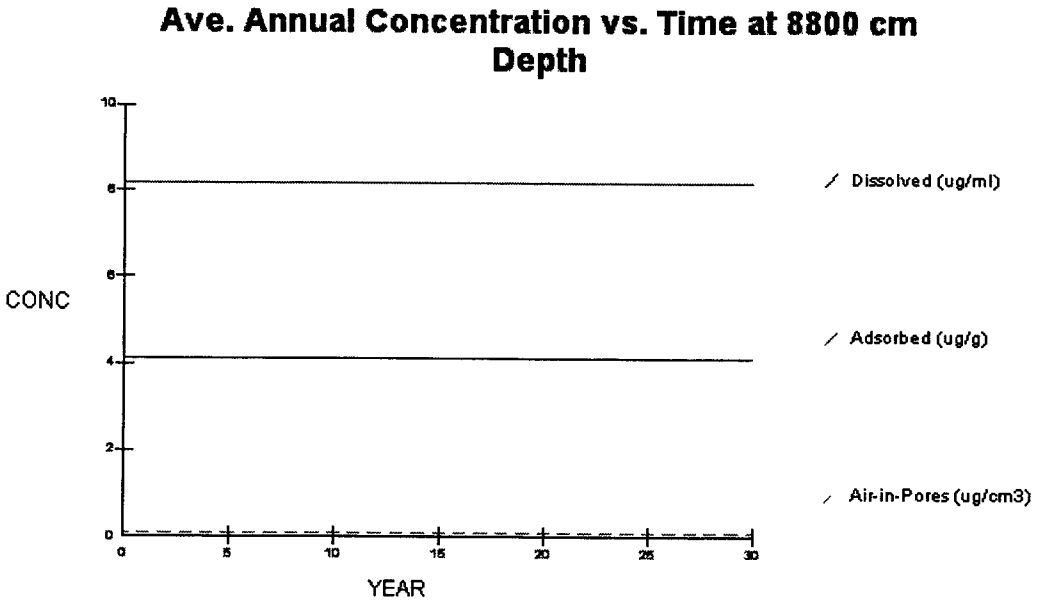
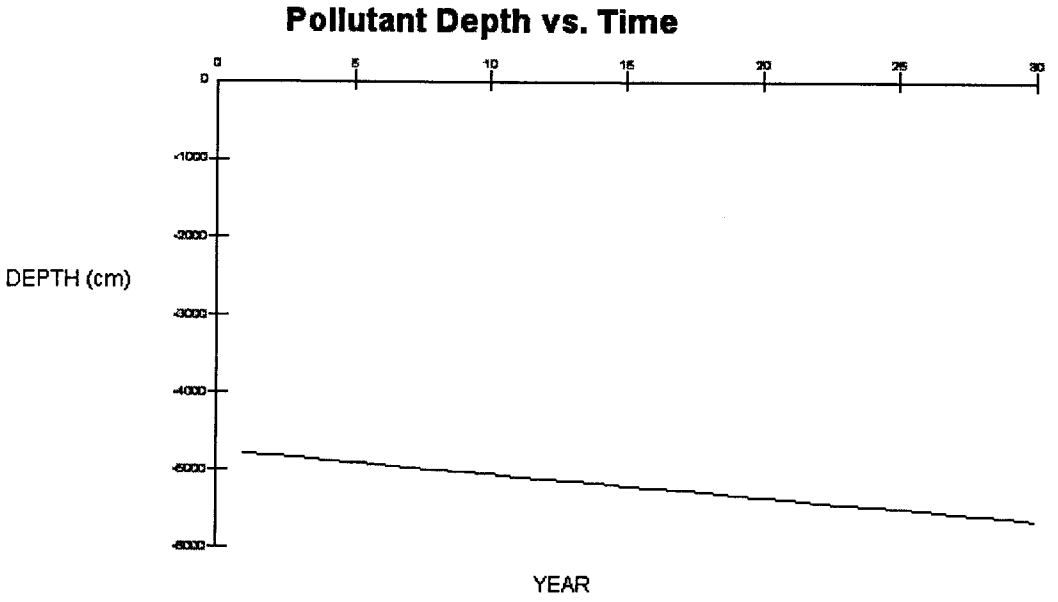


Figure A-4. Simulation 1—Current Conditions
Depth to Water Table = 290 ft = 8,838 cm

Total Xylenes (30 years)



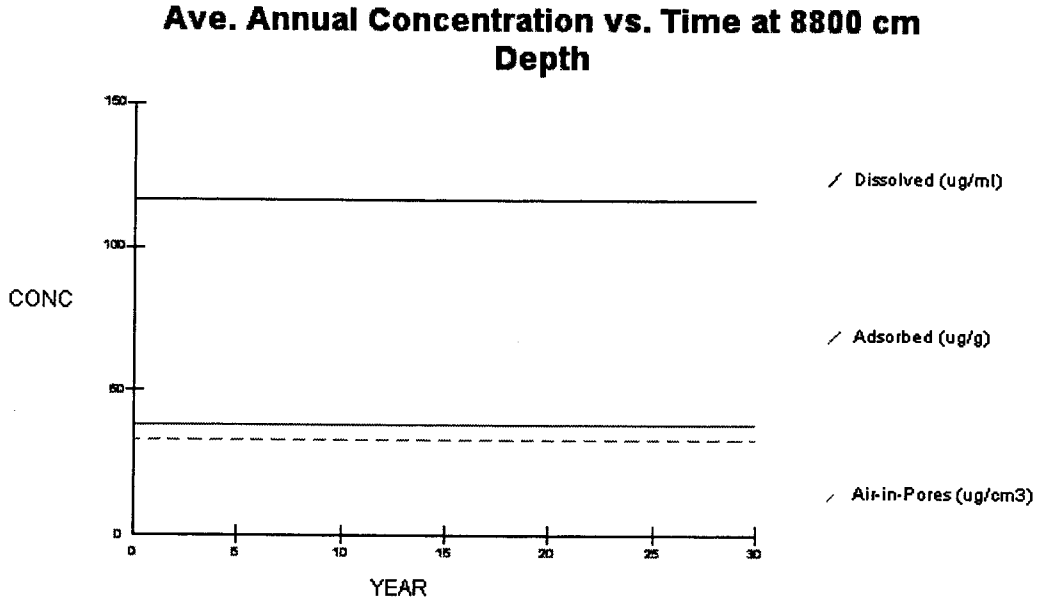
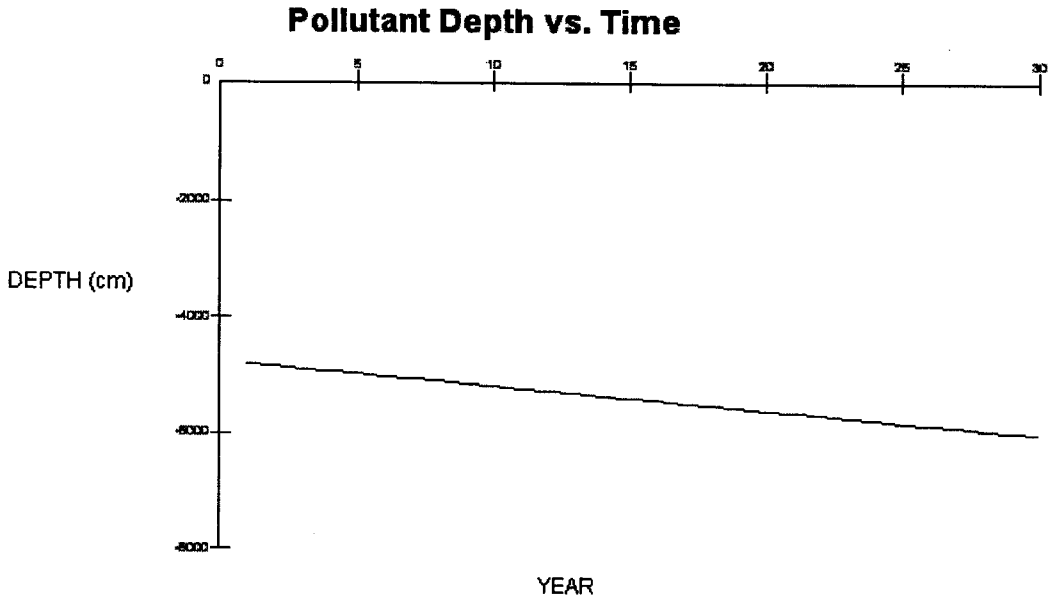
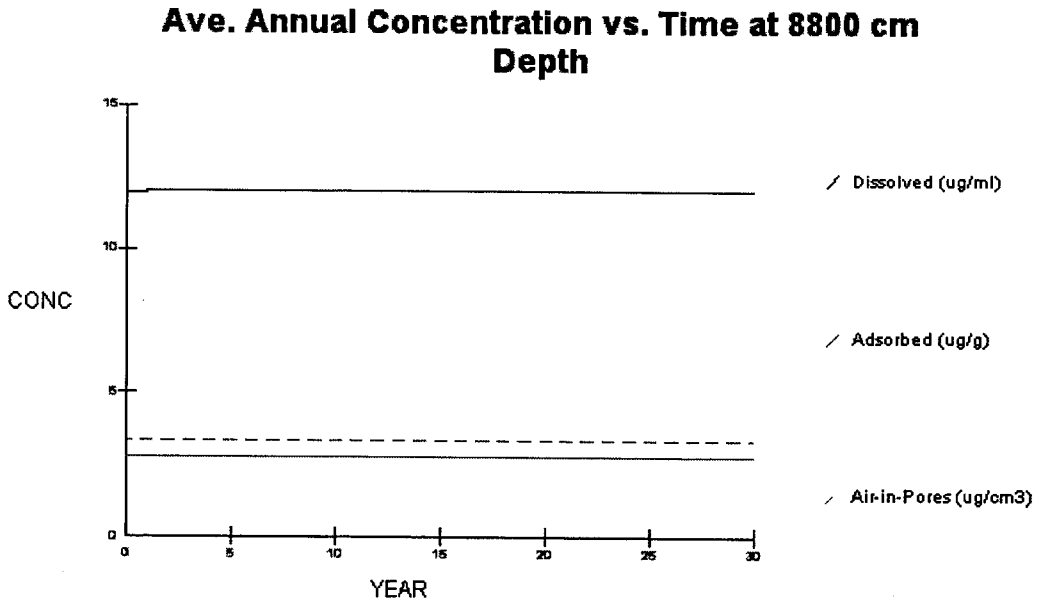


Figure A-5. Simulation 2—One 24-Hour, 100-Year Storm Per Year
Depth to Water Table = 290 ft = 8,838 cm

Toluene (30 years)

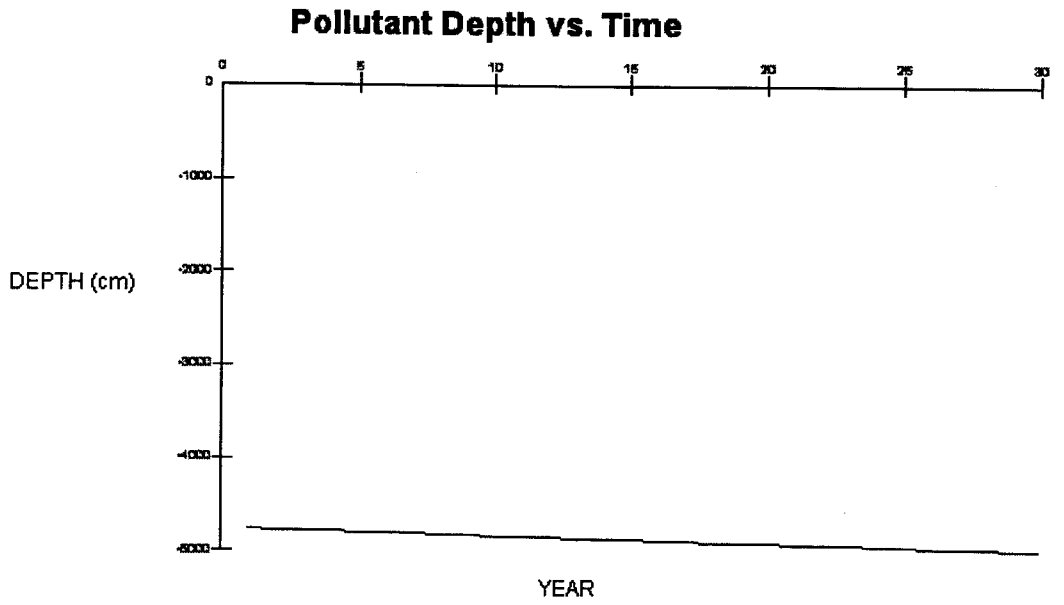




Toluene (30 years)

Figure A-6. Simulation 2—One 24-Hour, 100-Year Storm Per Year
Depth to Water = 290 ft = 8,838 cm

Naphthalene (30 years)



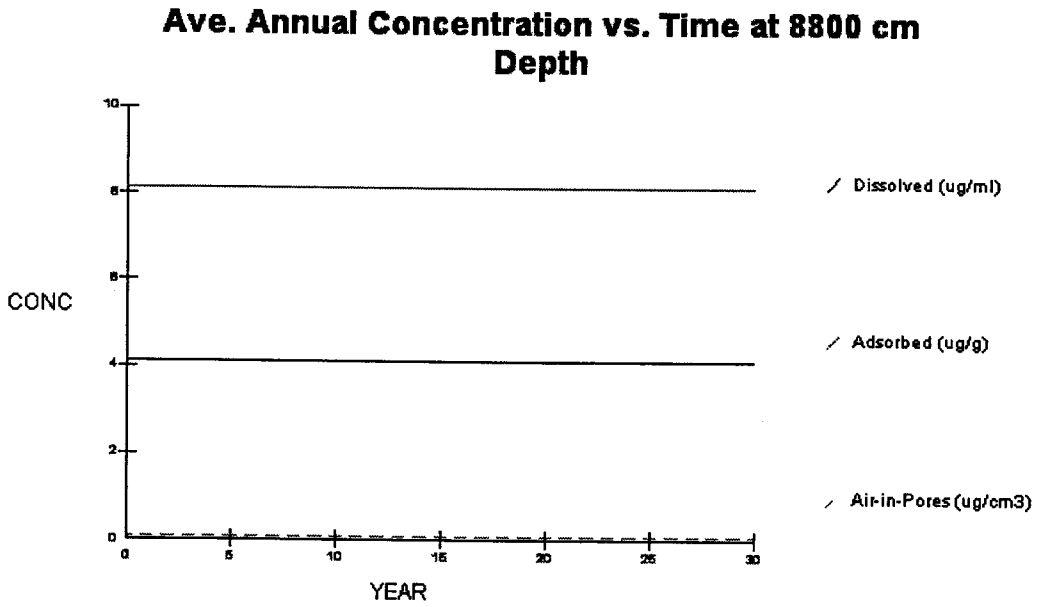
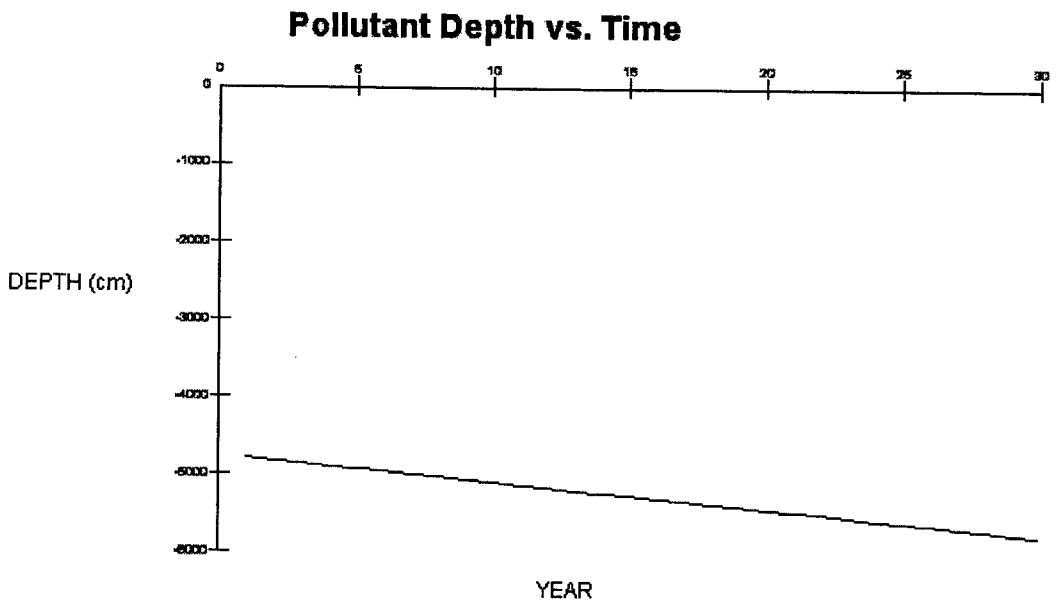
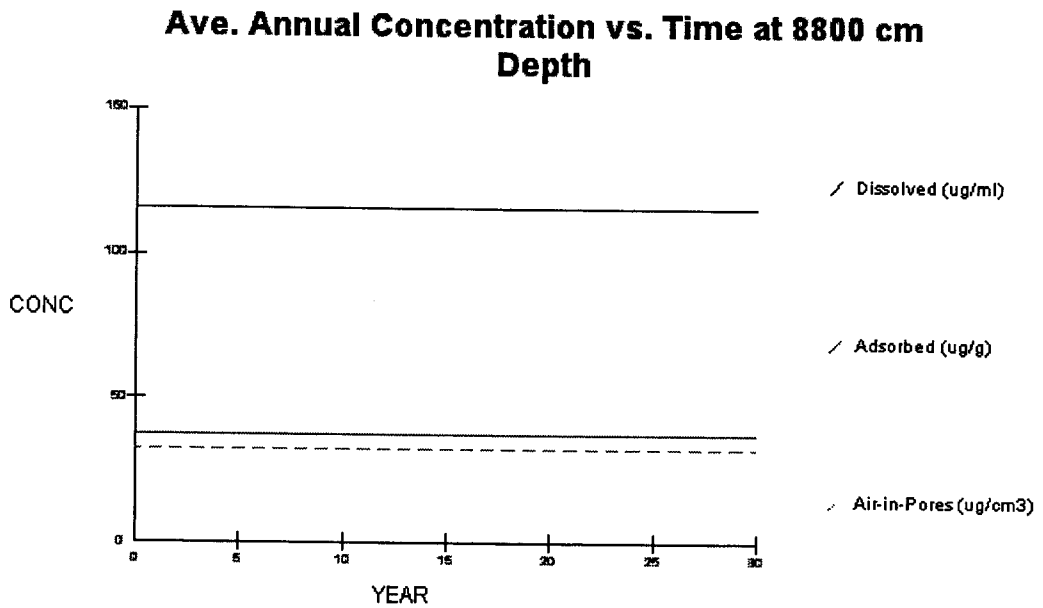


Figure A-7. Simulation 2—One 24-Hour, 100-Year Storm Per Year
Depth to Water = 290 ft = 8,838 cm

Total Xylenes (30 years)





APPENDIX B

COMPARISON OF SOIL SAMPLE RESULTS TO SOIL SCREENING LEVELS

1.0 INTRODUCTION

A risk-based screening-level evaluation was performed using New Mexico Environment Department (NMED) soil screening guidance (NMED 2001) and information provided by NMED on May 3, 2001, at Kirtland Air Force Base (AFB). This screening-level evaluation was conducted to assist in corrective action decision-making as part of the Corrective Measures Study (CMS) for Fire Training Area 4 (FTA4) at Cannon AFB. Prior to the CMS, investigations of this site included Remedial Investigations (RIs) in 1988 (Walk, Haydel, and Associates 1990) and 1991 (Woodward-Clyde 1992) and a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) in 1997 (Harza 1997).

2.0 DATA USABILITY

For this risk screening, data from the 1990 and 1992 RIs and the RFI were evaluated for usability based on their ability to meet current data quality objectives. Data for metals detected in samples collected for the 1990 RI had elevated method detection limits because of matrix interference. As the detection limits are higher than some of the chemical-specific soil screening levels (SSLs) in the NMED guidance (NMED 2001), these data cannot be compared to the SSLs. Therefore, only data from the 1992 RI and 1997 RFI reports were used in the risk screening.

Soil samples have been collected at FTA4 from depths up to 80 feet (ft) below ground surface (bgs). For comparison to background values and to the risk-based SSLs, only those samples collected between 0 and 12 ft bgs were used. It is assumed that humans are not exposed to soils below 12 ft.

3.0 SCREENING LEVEL EVALUATION

The maximum detected concentrations of metals in soil were compared to background values for Cannon AFB provided in the 1997 background geochemistry report (Woodward-Clyde 1997). Only thallium was detected during the RFI at concentrations below the background value and eliminated from further evaluation. The screening-level evaluation used the residential SSLs provided in NMED guidance (NMED 2001) for carcinogens (based on a cancer risk of 1×10^{-5}) and noncarcinogens (based on a hazard quotient of 1.0).

For organic analytes and metals detected at levels exceeding background, the corresponding SSLs were adjusted to account for potential cumulative effects. Eight carcinogenic analytes were detected in soil during the RFI, while no carcinogens were detected in soil during the 1992 RI. Twenty noncarcinogenic analytes were detected in soil during the RFI and two noncarcinogens were detected in soil during the 1992 RI. According to NMED guidance, the SSLs for carcinogens were divided by the number of

Cannon Air Force Base Fire Training Area 4

Table B-2. Comparison of Risk-Based Soil-Screening Levels to 1992 Remedial Investigation Soil Sample Results

Chemical	Residential SSL[1] (mg/kg)	Unadjusted SSLs (mg/kg)	Effect Endpoint	Background Values at Cannon Air Force Base[2] (mg/kg)	Maximum Soil Boring Concentration (Woodward-Clyde 1992) (mg/kg)	Samples Above Background Levels?	Samples Above SSL?	Hazard Quotient	Cancer Risk
Chromium VI[3]	115	230	nc	6.6	10.5	Yes	No	0.046	--
Ethylbenzene	68	68	sat	NA	19	No	No	--	--
Lead	400	400	nc	5.3	6.8	Yes	No	--	--
Xylenes[4]	63	63	sat	NA	290	No	Yes	--	--
							Total Hazard Index	**0.046**	--
							Total Cancer Risk	--	**0.0E+00**

nc Noncarcinogen
NA Chemicals not analysed as part of the background study
sat Constituent for wh
SSL Soil-sceening level

Notes:

[1] The SSL was adjusted by the number of noncarcinogens or carcinogens detected above background levels, with the exception of lead, per New Mexico Guidance (NMED 2001).

[2] The lower of surface and subsurface data was conservatively used.

[3] Chemical data was analyzed for total chromium and this value was conservatively screened against chromium VI.

[4] Only xylenes exceeded the Residential SSL.

Table B-3. Comparison of Risk-Based Soil Screening Levels to 1997 RFI Soil Sample Results

Chemical	Residential SSL[1] (mg/kg)	Unadjusted SSLs (mg/kg)	Effect Endpoint	Background Values at Cannon Air Force Base[2] (mg/kg)	Maximum Soil Boring Concentration (Harza 1997) (mg/kg)	Samples Above Background Levels	Samples Above SSL	Hazard Quotient	Cancer Risk
Aluminum	3700	74000	nc	6432	9990	Yes	Yes	1.4E-01	--
Antimony	1.5	30	nc	3.15	6.2	Yes	Yes	2.1E-01	--
Arsenic	0.4875	3.9	ca	2.4	3.3	Yes	Yes	--	8.5E-06
Barium	260	5200	nc	177	1250	Yes	Yes	2.4E-01	--
Benzo(a)anthracene	0.775	6.2	ca	NA	0.565	No	No	--	9.1E-07
Benzo(a)pyrene	0.0775	0.62	ca	NA	0.75	No	Yes	--	1.2E-05
Benzo(b)fluoranthene	0.775	6.2	ca	NA	0.895	No	Yes	--	1.4E-06
Benzo(k)fluoranthene	7.75	62	ca	NA	0.636	No	No	--	1.0E-07
Beryllium	7.5	150	nc	0.4	0.74	Yes	No	4.9E-03	--
2-Butanone	1850	37000	nc	NA	0.0898	No	No	2.4E-06	--
Chromium VI[3]	11.5	230	nc	6.6	20.9	Yes	Yes	9.1E-02	--
Chrysene	76.25	610	ca	NA	0.688	No	No	--	1.1E-08
Cobalt	225	4500	nc	3.1	5.4	Yes	No	1.2E-03	--
Copper	140	2800	nc	4.5	14.6	Yes	No	5.2E-03	--
Di(2-ethylhexyl) phthalate	43.75	350	ca	NA	0.274	No	No	--	7.8E-09
Ethylbenzene	68	68	sat	NA	7.23	No	No	--	--
Fluoranthene	115	2300	nc	NA	1.23	No	No	5.3E-04	--
Fluorene	105	2100	nc	NA	0.238	No	No	1.1E-04	--
Indeno(1,2,3-c,d)pyrene	0.775	6.2	ca	NA	0.224	No	No	--	3.6E-07
Iron	1150	23000	nc	6181	10700	Yes	Yes	4.7E-01	--
Lead	400	400	nc	5.3	21.5	Yes	No	--	--
Manganese	390	7800	nc	117	1350	Yes	Yes	1.7E-01	--
Naphthalene	2.65	53	nc	NA	8.58	No	Yes	1.6E-01	--
Nickel	75	1500	nc	6.4	28.3	Yes	No	1.9E-02	--
Phenanthrene	90	1800	nc	NA	0.559	No	No	3.1E-04	--
Pyrene	90	1800	nc	NA	1.34	No	No	7.4E-04	--
Selenium	19	380	nc	0.26	0.69	Yes	No	1.8E-03	--
Silver	19	380	nc	0.4	25.1	Yes	Yes	6.6E-02	--
Thallium	0.305	6.1	nc	0.6	0.12	No	No	--	--
Toluene	180	180	sat	NA	4.37	No	No	--	--
Vanadium	26.5	530	nc	16.3	24.7	Yes	No	4.7E-02	--
Xylenes	63	63	sat	NA	34.1	No	No	--	--
Zinc	1150	23000	nc	14.5	27.6	Yes	No	1.2E-03	--
							Total Hazard Index	**1.54E+00**	--
							Total Cancer Risk	--	**2.2E-05**

c Carcinogen
mg/kg milligrams/kilograms
nc Noncarcinogen
NA Chemicals not analyzed as part of the background study
sat Constituent for which the toxicity is evaluated at its saturation limit
SSL Soil-screening level

Notes:
1 The SSL was adjusted by the number of noncarcinogens or carcinogens detected above background levels, with the exception of lead, per New Mexico Guidance (NMED 2001).
2 The lower value of surface and subsurface data was conservatively used.
3 Chemical data were analyzed for total chromium and this value was conservatively screened against chromium VI .

7.0 REFERENCES

Harza (Harza Environmental Services)

1997. Phase II RCRA Facility Investigation Report (Draft), Cannon Air Force, New Mexico. August.

NMED (New Mexico Environment Department)

2001. Technical Background Document For Development of Soil Screening Levels. January.

Walk, Haydel, and Associates

1990. Final Installation Restoration Program Remedial Investigation, Cannon Air Force Base, New Mexico. January.

Woodward-Clyde (Woodward-Clyde Consultants)

1997. Naturally Occurring Concentrations of Inorganics and Background Concentrations of Pesticides at Cannon Air Force Base, New Mexico. September.

1991. Remedial Investigation Report for 18 Solid Waste Management Units, Cannon Air Force Base, New Mexico, October.

APPENDIX C

ALTERNATIVE COSTS

Alternative 2 for SWMU 109: Site Controls

Item	Item/Estimate Source	Task	Unit	Quantity	Unit Cost (dollars)	Total Cost
1	**Install Permanent Fencing**					
1a	Site Superintendent/ESS - Engineering Estimate	Site Personnel	hour	40	87.00	$3,480.00
1b	Government Per Diem - Cannon AFB	Site Personnel Per Diem	day	4	85.00	$340.00
1c	Means 015.304.0100	Fencing and Signage Installation	linear feet	2000	10.90	$21,800.00
1d	Additional Laborers - Engineering estimate	Site Personnel	hours	80	43.00	$3,440.00
1e	Field Truck - Means 016.420.7200	Truck Rental	week	1	350.00	$350.00
1f	Means - 016.420.3700	Concrete Mixer	day	4	38.55	$154.20
					Item Subtotal	**$29,564.20**

Notes: Estimates from Means Heavy Construction Cost Data, 1999
ESS - Environmental Safety Supervisor

Corrective Action Subtotal	$29,564.20
Engineering, Legal, and Administration Fees (15%)	$4,400.00
Total	**$34,000.00**

Alternative 3 for SWMU 109: Soil Removal and Off-Site Disposal

Item	Item/Estimate Source	Task	Unit	Quantity	Unit Cost (dollars)	Total Cost
1	**Mobilization excavation and hauling equipment on site**	Assumptions: 2 laborers, 1 operator, site superindent, fencing, barricades, signs, toilets, rental truck (1 day, 10 hrs.)				
1a	Engineering Estimate	Set up site	lump sum	1	3,000.00	$3,000.00
1b	Field Truck - Means 016.420.7200	Truck rental	week	1	350.00	$350.00
					Item Subtotal	**$3,350.00**
2	**Excavate, segregate, and stockpile clean and contaminated waste using field screening kits, visual inspection, and Photoionization detector**					
2a	Site Superintendent/ESS - Engineering Estimate	Site Personnel	hour	30	87.00	$2,610.00
2b	Site Engineer - Engineering Estimate	Site Personnel	hour	30	72.00	$2,160.00
2d	Government Per Diem - Cannon AFB	Site Personnel Per Diem	day	6	85.00	$510.00
2e	Means 022.238.0300 (3cy cap.)	Excavation Equip., operator	cubic yards	1900	2.36	$4,484.00
2f	Testing Equipment - TRPH field screening kit (12 samp ea.)	Soil Testing	each	5	500.00	$2,500.00
2g	Misc. PPE/Decontamination Supplies	Decontamination of Equipment	each	1	3,000.00	$3,000.00
2h	PID	Testing	each/week	2	250.00	$500.00
					Item Subtotal	**$15,764.00**
3	**Sample excavation sidewalls and bottom and soil stockpiles for confirmation**	10% field samples split to off-site laboratory				
3a	Site Superintendent/ESS - Engineering Estimate	Site Personnel	hour	10	87.00	$870.00
3b	Site Engineer - Engineering Estimate	Site Personnel	hour	10	72.00	$720.00
3c	Government Per Diem - Cannon AFB	Site Personnel Per Diem	day	2	85.00	$170.00
3d	Vendor Estimate	Laboratory Analysis	each	30	70.00	$2,100.00
					Item Subtotal	**$2,990.00**
4	**Backfill excavated area with clean soil (including clean soil from the site)**	Assumes all excavated soil is contaminated and full 1900 cy of clean fill soil is required.				
4a	Site Superintendent/ESS - Engineering Estimate	Site Personnel	hour	10	87.00	$870.00
4b	Site Engineer - Engineering Estimate	Site Personnel	hour	10	72.00	$720.00
4c	Government Per Diem - Cannon AFB	Site Personnel Per Diem	day	2	85.00	$170.00
4d	Clean Fill Soil - Means* 17.03.0423	Acquire, transport clean fill soil to site	cubic yards	1900	7.40	$14,060.00
4e	Means 022.208.3020	Backfill clean soil into excavated area	cubic yards	1900	0.76	$1,444.00
4f	Compactor, Grader - Means 022.226.5600	Compact and grade backfilled area	cubic yards	1900	0.46	$874.00
					Item Subtotal	**$18,138.00**
5	**Dispose of contaminated soil off site**					
5a	Vendor Estimate	Transport and disposal	cubic yards	1900	36.00	$68,400.00
					Item Subtotal	**$68,400.00**

Notes: Estimates from Means Heavy Construction Cost Data, 1999
*Estimated from Means Environmental Remediation Cost Data, 1998
ESS - Environmental Safety Supervisor

Corrective Action Subtotal	$108,642.00
Engineering, Legal, and Administration Fees (15%)	$16,300.00
Total	**$125,000.00**

Alternative 4 for SWMU 109: Soil Removal and Landfarming

	Estimate Source	Task	Unit	Quantity	Unit Cost (dollars)	Total Cost
1	**Mobilization excavation and hauling equipment on site**	Assumptions: 2 laborer, 1 operator, site superintendent, fencing, barricades, signs, toilets, rental truck (1 day, 10 hrs.)				
1a	Engineering Estimate	Set up site	lump sum	1	3,000.00	$3,000.00
1b	Field Truck - Means 016.420.7200	Truck rental	week	1	350.00	$350.00
					Item Subtotal	**$3,350.00**
2	**Excavate, segregate, and stockpile clean and contaminated waste using field screening kits, visual inspection, and Photoionization detector**					
2a	Site Superintendent/Health and Safety - Engineering Estimate	Site Personnel	hour	30	87.00	$2,610.00
2b	Site Engineer - Engineering Estimate	Site Personnel	hour	30	72.00	$2,160.00
2c	Government Per Diem - Cannon AFB	Site Personnel Per Diem	day	6	85.00	$510.00
2d	Means 022.238.0300 (3cy cap.)	Excavation Equip., operator	cubic yards	1900	2.36	$4,484.00
2e	Testing Equipment - TRPH field screening kit (12 samp ea.)	Soil Testing	each	5	500.00	$2,500.00
2f	Misc. PPE/Decontamination Supplies	Decontamination of Equip	each	1	3,000.00	$3,000.00
2g	PID	Testing	each/week	2	250.00	$500.00
					Item Subtotal	**$15,764.00**
3	**Construct the landfarm site (using existing runway as a liner with a soil berm)**					
3a	Site Superintendent/Health and Safety - Engineering Estimate	Site Personnel	hours	40	87.00	$3,480.00
3b	Site Engineer - Engineering Estimate	Site Personnel	hours	40	72.00	$2,880.00
3c	Government Per Diem - Cannon AFB	Site Personnel Per Diem	day	8	85.00	$680.00
3d	Clean Soil Berm - Means* 17.03.0423	Soil for berm (assume 160x160' landfarm, 3'x4'berm)	cubic yards	300	7.40	$2,220.00
3e	Laborer - Means 010.036.0160	Construction	hours	40	43.00	$1,720.00
3f	Form and Compact Berm - Means 022.216.4070, 022.226.5600	Construction of soil berm	cubic yards	200	9.71	$1,942.00
					Item Subtotal	**$12,922.00**
4	**Sample excavation sidewalls and bottom and soil stockpiles for confirmation**					
4a	Site Superintendent/Health and Safety - Engineering Estimate	Site Personnel	hours	10	87.00	$870.00
4b	Site Engineer - Engineering Estimate	Site Personnel	hours	10	72.00	$720.00
4c	Government Per Diem - Cannon AFB	Site Personnel Per Diem	day	2	85.00	$170.00
4d	Laboratory Analysis	Laboratory Analysis	each	30	70.00	$2,100.00
					Item Subtotal	**$3,860.00**
5	**Place contaminated excavated soil on the landfarm site in maximum of 6-inch lifts and set up temporary site controls around open excavations**					
	Site Engineer - Engineering Estimate	Site Personnel	hours	20	72.00	$1,440.00
	Government Per Diem - Cannon AFB	Site Personnel Per Diem	day	2	85.00	$170.00
5c	Haul - Means 022.266.0400	Transport contaminated soil to landfarm	cubic yards	1900	4.20	$7,980.00
5d	Means - 022.216.4070	Spread contaminated soil in max 6-in lifts	cubic yards	1900	9.25	$17,575.00
					Item Subtotal	**$25,555.00**
6	**Turn soil every 2 weeks according to NMED regulations**					
6a	Site Superintendent/Health and Safety - Engineering Estimate	Site Personnel	hours	10	87.00	$870.00
6b	Laborer - Means 010.036.0160	Construction	hours	10	43.00	$430.00
5b	Government Per Diem - Cannon AFB	Site Personnel Per Diem	day	2	85.00	$170.00
6c	Tractor/tiller - Means 029.200.6100 2 passes	Tilling	SY	2900	0.36	$1,044.00
6d	Fertilizer - Means 029.204.4150	Bioremediate	MSF	25.6	6.90	$176.64
					Cost Per Event	$2,690.64
					Assumed # Events	12
					Item Subtotal	**$32,287.68**
7	**Conduct landfarm sampling every 2 months until soil meets media cleanup standards**					
7a	Site Engineer - Engineering Estimate	Sampling	hours	40	72.00	$2,880.00
7b	Testing Equipment - TRPH field screening kit (12 samp ea.)	Soil testing	each	2	500.00	$1,000.00
7c	Laboratory Analysis	Laboratory Analysis	each	5	70.00	$350.00
7d	Letter report with analytical results	Reporting	lump sum	1	2,100.00	$2,100.00
					Cost Per Event	$6,330.00
					Assumed # Events	3
					Item Subtotal	**$18,990.00**
8	**Permitting**					
8a	Filing Fee - Title 20, Chapter 6, Part 2, Subpart III, NMAC 6.2	Permitting	each	1	100.00	$100.00
8b	Flat Fee - Title 20, Chapter 6, Part 2, Subpart III, NMAC 6.2	Permitting	each	1	1,380.00	$1,380.00
8c	Environmental Comliance Specialist - Means 010.036.0120 (converted to daily rate)	Site Personnel	hours	40	112.00	$4,480.00
					Item Subtotal	**$5,960.00**

Notes: Estimates from Means Heavy Construction Cost Data, 1999
All estimates from Means include O & P
*Estimated from Means Environmental Remediation Cost Data, 1998

Corrective Action Subtotal	$118,688.68
Engineering, Legal, and Administration Fees (15%)	$17,800.00
Total	**$136,000.00**

Item	Item/Estimate Source	Task	Unit	Quantity	Unit Cost (dollars)	Total Cost
1	**Drilling Oversight**					
1a	Mobilization/demobilization [A]	Set up site	lump sum	1	2,000.00	$2,000.00
1b	Site Geologist/ESS [A]	Site Personnel	hour	60	72.00	$4,320.00
1c	Government Per Diem - Cannon AFB	Site Personnel Per Diem	day	5	85.00	$425.00
1d	Field Truck - Vendor Estimate	Truck Rental	week	1	350.00	$350.00
1e	PID - Vendor Estimate	Testing	each/week	1	250.00	250.00
					Item Subtotal	**$7,345.00**
2	**Well Drilling and Installation**					
2a	Mobilization/Demobilization of drilling equipment B39- Vendor Estimate	Drilling set up	lump sum	1	2,500.00	$2,500.00
2b	Well Drilling and Installation of 4-inch PVC - Vendor Estimate	4-inch PVC	feet	300	55.00	$16,500.00
					Item Subtotal	**$19,000.00**
3	**Installation of Biovents**					
3a	Site Superintendent/ESS [B]	Site Personnel	hours	30	70.00	$2,100.00
3b	Site Engineer [B]	Site Personnel	hours	30	72.00	$2,160.00
3c	Government Per Diem - Cannon AFB	Site Personnel Per Diem	day	6	85.00	$510.00
3d	Field Truck - Vendor Estimate	Truck Rental	day	3	100.00	$300.00
3e	Ventilators/Wind-Assisted Blower [A]	Bioremediate	each	10	300.00	$3,000.00
3f	Pipes adapters [A]	Piping attachement	each	10	200.00	$2,000.00
					Item Subtotal	**$10,070.00**
4	**Construct Barbed Wire Fence**					
4a	Site Superintendant/ESS [B]	Fence construction	hour	50	70.00	$3,500.00
4b	Craft labor [B]	Site personnel (3)	hour	150	23.00	$3,450.00
4c	Government Per Diem - Cannon AFB	Site Personnel Per Diem	day	5	85.00	$425.00
4d	Materials/supplies [B]	Fencing supplies	lump sum	1	900.00	$900.00
					Item Subtotal	**$8,275.00**
5	**Dispose of contaminated soil off site**					
5a	Vendor Estimate	Transport and disposal	cubic yards	20	36.00	$720.00
					Item Subtotal	**$720.00**
6	**Report Preparation**					
6a	Draft and Final Design Report [A]	Reporting	lump sum	1	11,600.00	$11,600.00
6b	Draft and Final Work Plan [A]	Reporting	lump sum	1	7,800.00	$7,800.00
6c	Draft and Final Completion Report [A]	Reporting	lump sum	1	9,400.00	$9,400.00
					Item Subtotal	**$28,800.00**
7	**Conduct sampling every 5 years until soil meets media cleanup standards [C, D, E]**					
7a	Site Geologist/ESS [A]	Site Personnel	hour	20	112.50	$2,250.00
7b	Operator [B]	Site Personnel	hour	20	31.50	$630.00
7c	Mobilization/demobilization [A]	Drilling set up	each	1	2,700.00	$2,700.00
7d	Field Trailer - Vendor Estimate	Trailer Rental	week	1	651.00	$651.00
7e	DPT Rid - Vendor Estimate D	DPT Rig Rental	week	1	4,500.00	$4,500.00
7f	Sampling tools - Vendor Estimate	Tools rental	week	1	379.50	$379.50
7g	Consumable sampling equpment - Vendor Estimate	Testing	each	1	573.75	$573.75
7h	Laboratory Analysis	Laboratory Analysis	each	50	70.00	$3,500.00
7i	Letter report with analytical results	Reporting	lump sum	1	2,100.00	$2,100.00
					Cost Per Event	$17,284.25
					Assumed # Events	2
					Item Subtotal	**$34,568.50**

Notes:
[A] Foster Wheeler Environmental estimate based on vendor quotes and Means Construction Cost Data (1999)
[B] Foster Wheeler Environmental estimate based on work completed at Cannon AFB (2000, 2001)
[C] Sampling to take place in 2007 and 2012 collecting 8 borings to 30 ft
[D] Escalation on equipment is 8% each year
[E] Escalation on labor is 4% each year
ESS - Environmental Safety Supervisor
PVC - Polyvinyl chloride

Corrective Action Subtotal	$108,778.50
Engineering, Legal, and Administration Fees (15%)	$16,300.00
Total	**$125,000.00**

APPENDIX D

LANDFARM CONFIRMATION SOIL SAMPLING

THIS INFORMATION WILL BE USED FOR REPORTING/BILLING* (SEE BELOW)

COMPANY: OSTER WHEELER

ADDRESS: 241 ARKANSAS ST BEHIND RV STORAGE AREA H.A.F.B. NM

ATTENTION: DAVE RIZZUTO

PROJECT NAME: FTA 4 SWMU 110

PROJECT CONTACT: DAVE RIZZUTO

TELEPHONE: (505)479-0576 FAX: (505)479-2081

JOB/P.O. NO.: D028 WAD 1

CHAIN OF CUSTODY RECORD

2227

SDG # FCA03

PAGE 1 OF 1

WORK ORDER ID# 0009821

Laucks Testing Laboratories, Inc.

SUBMITTED AT: ☒ 940 South Harney St., Seattle, WA 98108 (206) 767-5060 FAX 767-5063
☐ 1106 Ledwich Ave., Yakima, WA 98902 (509) 248-4695 FAX 452-1265

TESTS TO PERFORM

LAB SA#	SAMPLE ID / LOCATION	DATE	TIME	MATRIX: WATER, SOIL OR SPECIFY	NO. OF CONTAINERS	TPH 418.1	OBSERVATIONS, COMMENTS, SPECIAL INSTRUCTIONS
1	C11ØGBØ1	12Sept00	Ø81Ø	SOIL	1	✓	UPS Shipper #
2	C11ØGBØ2	12Sept00	Ø815	SOIL	1	✓	1Z5290W4220002-
3	C11ØGBØ3	12Sept00	Ø82Ø	SOIL	1	✓	5460
4	C11ØGBØ4	12Sept00	Ø825	SOIL	1	✓	PLEASE FAX
5	C11ØGBØ5	12Sept00	Ø83Ø	SOIL	1	✓	RESULTS TO
							(505)479-2081

1 2 3

A. A standard turnaround time is assumed unless otherwise marked.

B. The laboratory may not be responsible for missed holding time for samples received with less than 50% of the analytical hold time remaining. Please contact the laboratory for further information.

INSTRUCTIONS

1. USE ONE LINE PER SAMPLE.
2. BE SPECIFIC IN TEST REQUESTS.
3. CHECK OFF TESTS TO BE PERFORMED FOR EACH SAMPLE.

* BILLING INFORMATION, IF DIFFERENT THAN ABOVE

NAME ADDRESS

ATTN: CITY, STATE, ZIP

* RUSH TURNAROUND IS SUBJECT TO PRIOR LABORATORY APPROVAL

TOTAL NO. OF CONTAINERS

TURNAROUND REQUEST

☐ STD. 10-14 WORKING DAYS
* ☐ 24-48 HRS. (100% SUR)
* ☐ 72 HRS. (75% SUR)
* ☐ 5 DAYS (50% SUR)
☐ OTHER:
☐ TEMP:

CUSTODY SEAL: ☐ Y ☐ N ☐ N/A

RELINQUISHED BY (SIGN AND PRINT)	DATE / TIME	RECEIVED BY (SIGN AND PRINT)	DATE / TIME
Rafe Jones / Rafe Jones	12Sept00 / 1100	MICHAEL A. BAXTER	9/15/00 / 0940

FINAL REPORT COPY

INORGANICS ANALYSIS DATA SHEET

Lab Name: Laucks Testing Labs
SDG No. : FCA03
Matrix : SOIL

Sample ID : C110GB01
Lab Sample ID: 0009321-01
Date Received: 09/13/00

Analyte	Result	Units	Prepped	Analyzed	Limit	Method
TPH (418.1)	210.	mg/kg DB	09/25/00	09/26/00	20.	EPA 418 1
Total Solids	97.3	%	09/15/00	09/15/00	0.1	SM209A

INORGANICS ANALYSIS DATA SHEET

Lab Name: Laucks Testing Labs
SDG No. : FCA03
Matrix : SOIL

Sample ID : C110GB02
Lab Sample ID: 0009321-02
Date Received: 09/13/00

Analyte	Result	Units	Prepped	Analyzed	Limit	Method
TPH (418.1)	170.	mg/kg DB	09/25/00	09/26/00	20.	EPA 418 1
Total Solids	97.5	%	09/15/00	09/15/00	0.1	SM209A

INORGANICS ANALYSIS DATA SHEET

Lab Name: Laucks Testing Labs
SDG No. : FCA03
Matrix : SOIL

Sample ID : C110GB03
Lab Sample ID: 0009321-03
Date Received: 09/13/00

Analyte	Result	Units	Prepped	Analyzed	Limit	Method
TPH (418.1)	330.	mg/kg DB	09/25/00	09/26/00	20.	EPA 418 1
Total Solids	97.7	%	09/15/00	09/15/00	0.1	SM209A

INORGANICS ANALYSIS DATA SHEET

Lab Name: Laucks Testing Labs
SDG No. : FCA03
Matrix : SOIL

Sample ID : C110GB04
Lab Sample ID: 0009321-04
Date Received: 09/13/00

Analyte	Result	Units	Prepped	Analyzed	Limit	Method
TPH (418.1)	300.	mg/kg DB	09/25/00	09/26/00	20.	EPA 418 1
Total Solids	83.6	%	09/15/00	09/15/00	0.1	SM209A

INORGANICS ANALYSIS DATA SHEET

Lab Name: Laucks Testing Labs
SDG No. : FCA03
Matrix : SOIL

Sample ID : C110GB05
Lab Sample ID: 0009321-05
Date Received: 09/13/00

Analyte	Result	Units	Prepped	Analyzed	Limit	Method
TPH (418.1)	24.	mg/kg DB	09/25/00	09/26/00	20.	EPA 418 1
Total Solids	77.6	%	09/15/00	09/15/00	0.1	SM209A

2.0