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May 17, 1994

Mr. Howard E. Moffitt
Deputy Base Civil Engineer
49 CES/CEV
550 Tabosa Ave.
Holloman Air Force Base, NM 88330-8458

Dear Mr. Moffitt:

The New Mexico Environment Department is in process of reviewing the Draft Final Feasibility Study for 29 Waste Sites, dated December 1993. We understand from telephone conversations with your staff that there is some urgency to beginning work on the soil remediation at Sites 2&5 (AOC-T), the POL Spill Site. Accordingly, we approve the remedial actions proposed in the Feasibility Study at Sites 2&5.

We are still considering the actions proposed at Sites 8 and 14. Our concerns at these sites primarily involve questions about the appropriateness of approving less stringent corrective actions at essentially industrial sites, as compared to the actions that would be required at residential sites. These issues are under active discussion with our management and we hope to have comments about your proposals for Sites 8 and 14 soon. We appreciate your patience.

Sincerely,

Steve Pullen
Environmental Specialist, DSMOA
Hazardous and Radioactive Materials Bureau

xc: David Morgan, NMED GWPRB
Lowell Seaton, EPA Region 6

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Headquarters, Air Combat Command
Langley Air Force Base,
Virginia

Draft Final

Feasibility Study Investigation, Study and Recommendation for 29 Waste Sites

December 1993

49th FIGHTER WING

49 CES/CEV
Holloman Air Force Base,
New Mexico

PURPOSE OF DOCUMENT

a. The Feasibility Study (FS) documents the process through which remedial alternatives were selected for IRP Sites 2&5 (AOC-T), 8 (SWMU No. 82), and 14 (SWMU No. 197) at Holloman Air Force Base (AFB). Sites 2&5, 8, and 14 were recommended for inclusion in the FS on the basis of the results of a remedial investigation (RI). This document was prepared for, and in cooperation with, the Base Environmental Office: 49 CES/CEV, 550 Tabosa Avenue, Holloman AFB, NM, 505/479-3931.

b. The FS was prepared to comply with Section IV, Part O of Holloman AFB's Hazardous and Solid Waste Amendments (HSWA) Permit.

c. The FS identifies appropriate remedial alternatives to reduce the risk to human health and the environment at Sites 2&5, 8, and 14. On the basis of an evaluation of overall protection of human health and the environment, effectiveness, implementability, and cost, the report recommends specific remedial alternatives for each of the sites.

DCN 93-269-004-16-11
RCN 269-004-16-08

FEASIBILITY STUDY (FS)

INVESTIGATION, STUDY AND RECOMMENDATION FOR 29 WASTE SITES HOLLOMAN AIR FORCE BASE, NEW MEXICO

DRAFT FINAL

Prepared for:

49 CES/CEV
Holloman Air Force Base, NM
and
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U.S. Army Corps of Engineers
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December 1993

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HOLLOMAN AFB FS GLOSSARY OF TERMS

AFB	Air Force Base
AOC	Area of Concern
ARARs	Applicable or Relevant and Appropriate Requirements
BTEX	Benzene, Toluene, Ethyl benzene, and Xylene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMS	Corrective Measures Study
CORA	Cost of Remedial Action Model
FS	Feasibility Study
GAC	Granulated Activated Carbon
HSWA	Hazardous and Solid Waste Amendments
IRP	Installation Restoration Program
NMSWMR	New Mexico Solid Waste Management Regulations
O&M	Operating and Maintenance
OSHA	Occupational Safety and Health Administration
POL	Petroleum, Oil, and Lubricants
RAOs	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SVE	Soil Vapor Extraction
SWMU	Solid Waste Management Unit
TBC	To Be Considered
TCLP	Toxicity Characteristic Leaching Procedure
TPH	Total Petroleum Hydrocarbons
TSD	Treatment, Storage, and Disposal
USACE	U.S. Army Corps of Engineers
VOCs	Volatile Organic Compounds

EXECUTIVE SUMMARY

Purpose

This feasibility study (FS) was prepared for three sites at Holloman Air Force Base (AFB), New Mexico, to comply with Section IV, Part O of the Base's Resource Conservation and Recovery Act (RCRA) Hazardous and Solid Waste Amendments (HSWA) Permit. This report describes the process by which remedial alternatives were selected for each of the three sites.

Background

Holloman AFB is subject to the requirements of the RCRA corrective action program and the Installation Restoration Program (IRP). Both the IRP and the RCRA corrective action program are ultimately intended to ensure remediation of contaminated sites that pose an actual or potential threat to human health and the environment. Both programs are implemented through similarly phased approaches to identify, investigate, and remediate these sites. To promote consistency throughout this project, the IRP format and terminology have been and will be used. However, all the requirements of the RCRA corrective action program were incorporated in each phase of the IRP. All terms in this report are IRP terminology.

A remedial investigation (RI) was conducted on a total of 29 sites at Holloman AFB. The results of the RI are presented in the *Remedial Investigation (RI) Report - Investigation, Study and Recommendation for 29 Waste Sites* (Radian, 1992), which recommended three sites for the FS phase. The IRP site ID and name, and RCRA solid waste management unit (SWMU) number are listed below for each of the three sites addressed in the FS:

- Sites 2&5--POL Spill Sites No. 1 and No. 2 (AOC-T);

- Site 8--Refuse Collection Truck Washrack (SWMU 82); and
- Site 14--Former Entomology Shop Area (SWMU 197).

At Sites 2&5, spills of JP-4 and Avgas occurred in the period from the early 1960s through the late 1970s. Analyses of soil samples collected from this site indicate the presence of petroleum hydrocarbons. The volume of contaminated soil at the site is estimated to be 5150 cu yd.

At Site 8, pesticides were routinely sprayed inside refuse collection trucks for fly control during the 1970s. The pesticides were washed onto the soil in the area of the Refuse Collection Truck Washrack. Analyses of soil samples collected from the area indicate the presence of several types of pesticides as well as lead, cadmium, and mercury at concentrations above background levels. The volume of contaminated soil at the site is estimated to be 1610 cu yd.

At Site 14, pesticide spraying and washing equipment was rinsed out in the area from 1968 to 1977. Pesticides were also stored in this area. Analyses of soil samples indicate the presence of several types of pesticides. The volume of contaminated soil at the site is estimated to be 740 cu yd.

The *Corrective Measures Study (CMS) Plan - Investigation, Study and Recommendations for 29 Waste Sites* (Radian, 1992) was submitted to the New Mexico Environment Department (NMED) and the U.S. Environmental Protection Agency (U.S. EPA) Region VI in November 1992. The CMS Plan (Radian, 1992) was a requirement of the RCRA corrective action program and Section IV.M.2 of Holloman AFB's HSWA permit. The CMS plan describes the plan to be followed for this FS and is included in its entirety with this report.

The objectives of the CMS Plan (Radian, 1992) were to describe the general approach to the investigation and potential remedies, define the overall objectives of the

study, specify plans for evaluating remedies to ensure compliance with remedy standards, provide a schedule for conducting the FS, and propose a format for the FS. The CMS Plan (Radian, 1992) presented the remedial action objectives (RAOs). Cleanup criteria presented in the RAOs provide the primary basis for evaluating alternatives developed in the FS and for ensuring compliance with the RAOs. For the sites that pose a threat to human health (Sites 8 and 14), cleanup criteria were determined on the basis of the proposed RCRA Corrective Action Rules (40 CFR Part 264 Subpart S) guidance. Acceptable carcinogenic risk was established at 1E-6 for individual chemicals and 1E-4 for cumulative risk posed by multiple contaminants, and acceptable noncarcinogenic risk was set at a hazard index value of 1 for cumulative risk posed by multiple chemicals. The risk assessments conducted for the respective sites were 10-4 nup criteria. For sites that require remediation due to petroleu 25), cleanup criteria were based on standards of the NMED est The RAOs for all three sites are summarized in Table ES-1.

Description of the FS Process

The FS consisted of the following phases:

- Compilation of site-specific information;
- Development of a CMS plan;
- Identification and screening of technologies;
- Development and screening of alternatives;
- Detailed analysis of alternatives; and
- Recommendation of alternatives.

These phases are documented in this report and described in the paragraphs that follow.

Table ES-1

Site-Specific Remedial Action Objectives

Objective	Exposure Route and Receptor	Criteria	Contaminant	Acceptable Level
SITES 2&5				
Soil:				
Prevent future contamination of groundwater	NA	NMED standard for Holloman AFB	TPH	1000 mg/kg
SITE 8				
Soil:				
Prevent dermal contact with contaminated soil	Dermal contact with contaminated soil by on-site workers	Acceptable health risk	4,4'-DDD	4000 µg/kg
			4,4'-DDE	3300 µg/kg
Prevent inhalation of contaminated soil	Inhalation of contaminated soil by on-site workers	Acceptable health risk	4,4'-DDT	1100 µg/kg
			Cadmium	0.290 mg/kg
			Chlordane	0.140 mg/kg
			Lead	12.000 mg/kg
			Mercury	0.016 mg/kg
SITE 14				
Soil:				
Prevent dermal contact with contaminated soil	Dermal contact with contaminated soil by current on-site occupational adults	Acceptable health risk	4,4'-DDD	1500 µg/kg
			4,4'-DDE	1000 µg/kg
			4,4'-DDT	1300 µg/kg
			Aldrin	10 µg/kg
			Chlordane	200 µg/kg
			Heptachlor	100 µg/kg
			Gamma BHC	700 µg/kg

Note: NMED = New Mexico Environment Department.

NA = Not Applicable.

Site-specific information that included the background, the RAOs, and the extent of contamination was compiled for each of the three sites. General response actions were identified that had the potential to meet the RAOs for each site. Potentially applicable technology types and technology process options were identified for each general response action. Technology types and process options that were not implementable were screened out. For each general response action, representative technology types and process options were selected for use in developing alternatives for each of the sites. Alternatives for each site were then assembled from the process options.

The assembled alternatives were screened to eliminate those that were least effective. Alternatives were screened on the basis of their effectiveness, implementability, and cost. For Sites 2&5, two of the seven assembled alternatives (no action and soil vapor extraction) were recommended for detailed analysis. For Site 8, four of the six alternatives (no action, source containment, off-site thermal treatment, and excavation/ treatment/disposal) continued to the detailed analysis phase. For Site 14, four of the six alternatives (no action, source containment, off-site thermal treatment, and excavation/disposal) passed the screening.

During the detailed analysis phase, the remaining alternatives for each site were evaluated on the basis of the following criteria:

- Overall protection of human health and the environment;
- Compliance with applicable or relevant and appropriate requirements (ARARs);
- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume through treatment;
- Short-term effectiveness;
- Implementability; and
- Cost.

Regulatory agency and community acceptance will be presented in decision documents once comments on the RI/FS reports and the proposed plan have been received.

For each site, a comparative analysis of the alternatives was performed to highlight the relative advantages and disadvantages of each alternative. One alternative was recommended for each site on the basis of the results of the comparative analysis. A summary of the recommended alternatives for the three sites is shown below.

Site	Recommended Alternative	Estimated Cost
2&5	Soil Vapor Extraction/Bioventing	$540,000
8	Source Containment (Asphalt Capping)	$360,000
14	Source Containment (Asphalt Capping)	$230,000

1.0 INTRODUCTION

As shown in Figure 1-1, Holloman Air Force Base (AFB) is situated in south-central New Mexico, approximately 75 miles northeast of El Paso, Texas, and about 7 miles west of Alamogordo, New Mexico. A remedial investigation (RI) was conducted at 29 sites at Holloman AFB. The results of this investigation are presented in the *Remedial Investigation (RI) Report - Investigation, Study and Recommendation for 29 Waste Sites* (Radian, 1992). Data collected in the RI were also evaluated to determine site-specific risk to human health and the environment. The findings of the risk assessment are found in the *Risk Assessment Report for the Remedial Investigation Report - Investigation, Study and Recommendation for 29 Waste Sites* (Radian, 1992) and were used to determine which sites require remedial action. At a meeting in Dallas, Texas, on 9 December 1991, the U.S. Environmental Protection Agency (U.S. EPA), Region VI and New Mexico Environment Department (NMED) agreed that the risk assessment could be used to determine which sites require remedial action and which sites require no action.

The RI report recommended that three sites be included in the feasibility study (FS). The Installation Restoration Program (IRP) numbers for these sites are 2&5, 8, and 14. The IRP names and numbers and corresponding Resource Conservation and Recovery Act (RCRA) solid waste management unit (SWMU) names and numbers of the three sites are listed in Table 1-1.

A predesign investigation (PDI) was conducted in May 1993 at Sites 2&5 and 8 to provide more complete information regarding the nature and extent of the contamination at those sites. The results of the PDI are combined with the results of the RI in Section 2.0.

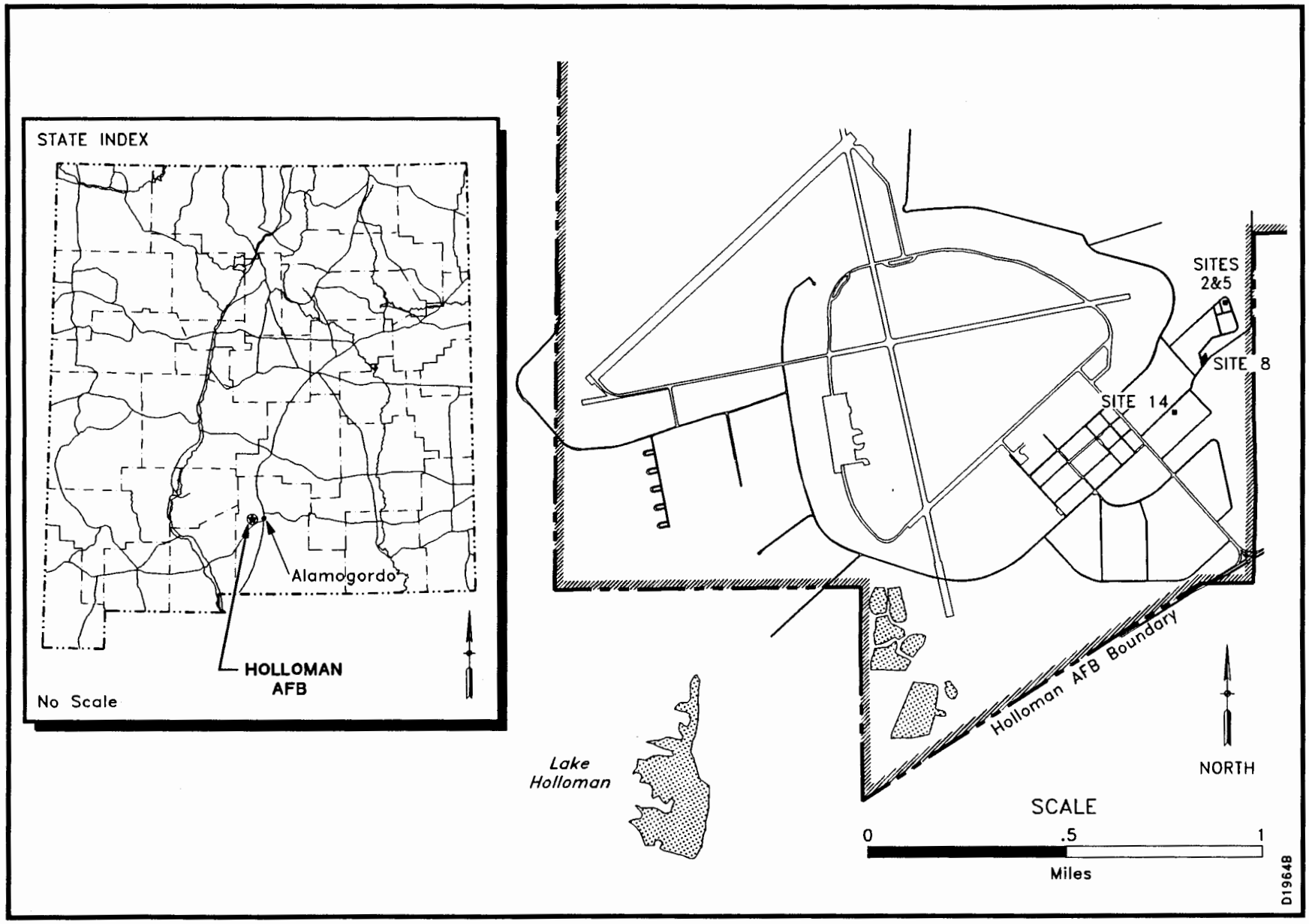

Figure 1-1. Location of Holloman Air Force Base and Sites 2&5, 8, and 14

Table 1-1

Cross Reference of IRP Sites and RCRA SWMUs

IRP No.	IRP Name	SWMU No.	SWMU Name
2&5	POL Spill Sites No. 1 and No. 2	AOC-T	POL Storage Tank Leaks
8	Refuse Collection Washrack	82	Building 131 Washrack
14	Former Entomology Shop Area	197[1]	Former Entomology Shop

[1]The Former Entomology Shop, was originally identified in the RCRA Facility Assessment (RFA) Report (A.T. Kearney, Inc., 1988) as SWMU 197. However, the permit issued in August 1991 identified the Former Entomology Shop as SWMU 229. Holloman AFB submitted a Class 1 permit modification to correct the permit reference from SWMU 229 to SWMU 197 in July 1993.

1.1 Objectives

The objectives of the RI/FS, as defined in the project scope of work, were "to investigate multiple contaminated sites at Holloman AFB, New Mexico, and to make recommendations regarding site remediation where contaminants exceed the accepted safe level for humans and/or the environment" [U.S. Army Corps of Engineers (USACE) Scope of Services, December 1990]. The FS focuses on the recommendations for site remediation. The primary purpose of the FS is to provide relevant information that decision makers may use to select a remedial action.

1.2 Background

The remedial investigation and feasibility study (RI/FS) process was developed in response to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). Guidance for performing a CERCLA RI/FS is given in *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (U.S. EPA, 1988). The fundamental purpose of an RI/FS is to characterize the nature and extent of contamination, determine potential risks posed by an uncontrolled hazardous waste site, and evaluate potential remedial options. The first part of the RI/FS for the 29 sites at Holloman AFB is documented in the following reports:

- *Remedial Investigation (RI) Report - Investigation, Study and Recommendation for 29 Waste Sites* (Radian, 1992);
- *Risk Assessment Report for the Remedial Investigation - Investigation, Study and Recommendation for 29 Waste Sites* (Radian, 1992); and
- *Corrective Measures Study (CMS) Plan - Investigation, Study and Recommendation for 29 Waste Sites* (Radian, 1992).

1.3 Regulatory Background

Holloman AFB applied for a RCRA hazardous waste management permit to authorize the operation of an on-site storage facility for currently generated hazardous wastes. As a result, the Base is subject to the requirements of the RCRA corrective action program. The Base's Hazardous and Solid Waste Amendments (HSWA) permit, administered by U.S. EPA, Region VI, requires Holloman AFB to conduct a RCRA facilities investigation (RFI) at SWMUs listed in the permit.

In addition, Holloman AFB is subject to the requirements of the U.S. Air Force's IRP. The IRP essentially follows the CERCLA remedial action program. A comparison of the phases of the IRP (CERCLA) and RCRA corrective action program is presented in Figure 1-2.

As part of the IRP, Holloman AFB performed an RI at 27 sites (two additional sites were addressed in a CERCLA preliminary assessment). Many of the sites included in the RI are also SWMUs listed in Table 1 of Holloman AFB's HSWA permit. Therefore, the investigation of the 27 sites was structured to meet all of the permit requirements for an RFI and the CERCLA requirements of an RI. To avoid confusion and promote consistency throughout the project, the reports associated with the investigation of the 27 sites were presented in CERCLA RI format and terminology, and the IRP site names and numbers were used.

Similar to the RI, the FS phase of the IRP is structured to meet all the requirements of a RCRA corrective action program corrective measures study (CMS).

1.4 Integration of IRP (CERCLA) and RCRA Program

Both the IRP and RCRA corrective action programs are ultimately intended to ensure the remediation of contaminated sites that pose an actual or potential threat to

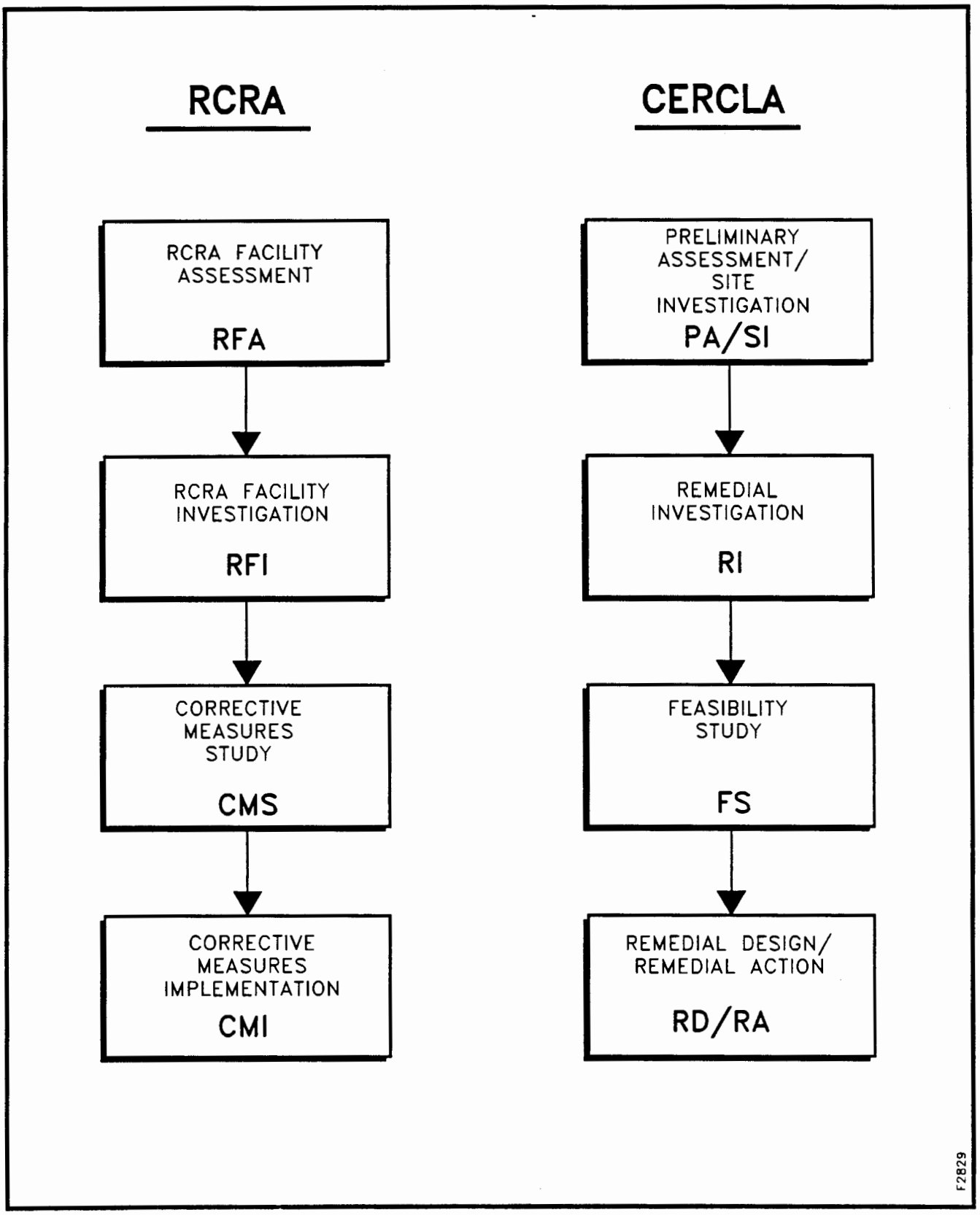

Figure 1-2. Comparison of RCRA Corrective Action and IRP (CERCLA) Phases

public health, welfare, or the environment. Both programs are implemented through phased approaches to identify, investigate, and remediate these sites. A detailed comparison of the two programs was presented in the RI Report (Radian, 1992).

The purpose of an FS and a CMS is essentially the same: to identify and develop alternatives for remedial action/corrective measures, to evaluate the alternatives, and to justify and recommend specific alternatives based on accepted criteria. FS requirements are based on the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (Interim Final), EPA/540/G-89/004* (U.S. EPA, 1988); CMS requirements are based on the *RCRA Corrective Action Plan (Interim Final), EPA/530-SW-88-028* (U.S. EPA, 1988) and Holloman AFB's HSWA permit requirements for a CMS. The U.S. EPA has also published proposed corrective action rules (40 CFR Subpart S), which are considered in this report.

1.4.1 CMS Plan

The CMS Plan (Radian, 1992) was submitted to NMED and U.S. EPA, Region VI in November 1992, and was a requirement of the RCRA corrective action program and Section IV.M.2 of Holloman AFB's HSWA permit. The CMS Plan was reviewed and approved by NMED. To date, no comments have been provided by U.S. EPA, Region VI.

The CMS Plan discussed the RI and risk assessment results for each site in detail. The remedial action objectives (RAOs) were developed for each site and specific cleanup criteria were presented. The FS briefly summarizes the information in the CMS Plan, which is included in its entirety with the FS for reference.

1.4.2 Incorporation of CMS Requirements in FS

Similar to the RI report, the format of this document is consistent with the CERCLA FS program. Table 1-2 provides a cross-reference for applicable RCRA corrective action CMS requirements from Holloman AFB's HSWA permit and references where these requirements can be found in this FS report.

In addition, the RCRA corrective action requirements are discussed in each section of the report to provide a clearer understanding of how the requirements are satisfied in this report. In general, the RCRA corrective action discussion reflects the requirements established in Holloman AFB's HSWA permit. Requirements from the proposed corrective action rules (Subpart S) are viewed as to-be-considered (TBC) material, and are discussed accordingly.

1.5 Organization of Report

Section 2.0 provides site-specific information for the sites that are included in the FS, including investigation results, remedial action objectives (RAOs), and a description of the extent of contamination. Section 3.0 presents the identification and screening of technologies. Section 4.0 presents the development of screening of alternatives for each site. Section 5.0 provides a detailed analysis of alternatives. Section 6.0 presents a discussion of the recommended alternative for each site.

Table 1-2

Directory of Responses to HSWA Permit Requirements for a CMS

Section	Permit Requirement	Location in FS Report
TASK VI: IDENTIFICATION AND DEVELOPMENT OF THE CORRECTIVE ACTION ALTERNATIVE OR ALTERNATIVES		
A. Description of Current Conditions	Describe the current situation at the facility and the known nature and extent of the contamination. Update previous response activities and any interim measures that have been or are being implemented at the facility. Provide a facility-specific statement of the purpose for the response, on the basis of the RFI results. Identify the actual or potential exposure pathways that should be addressed by corrective measures.	Sections 2.2 through 2.4--Site Background
B. Establishment of Corrective Action Objectives	Establish site-specific objectives for the corrective action.	Sections 2.2 through 2.4--Remedial Action Objectives
C. Laboratory- and Bench-Scale Study	Conduct laboratory- and/or bench-scale studies to determine the applicability of a corrective measure technology or technologies to the facility conditions. Analyze the technologies, based on literature review, vendor contacts, and past experience to determine the testing requirements. Develop a testing plan identifying the type(s) and goal(s) of the study(ies), the level of effort needed, and the procedures to be used for data management and interpretation. Evaluate the testing results to assess the technology or technologies with respect to the site-specific questions identified in the test plan. Prepare a report summarizing the testing program and its results, both positive and negative.	NA
D. Screening of Corrective Measure Technologies		
1. Site Characteristics	Review site data to identify conditions that may limit or promote the use of certain technologies.	Section 3.3
2. Waste Characteristics	Identify waste characteristics that limit the effectiveness or feasibility of technologies	Section 3.3
3. Technology Limitations	Identify the level of technology development; performance record; and inherent construction, operation, and maintenance problems for each technology considered.	Section 3.3, Table 3-3

Table 1-2

(Continued)

Section	Permit Requirement	Location in FS Report
E. Identification of the Corrective Measure Alternatives	Develop the corrective measure alternatives on the basis of the corrective measure objectives and analysis of preliminary corrective measures technologies. Document the reasons for excluding technologies, identified in Task I, as supplemented in the development of the alternative.	Section 3.3 Tables 4-1, 4-2, and 4-3
TASK VII: EVALUATION OF THE CORRECTIVE MEASURE ALTERNATIVE OR ALTERNATIVES		
A. Technical/Environmental/Human Health/Institutional	Provide a description of each corrective measure alternative that includes, but is not limited to, the following: preliminary process flow sheets; preliminary sizing and type of construction for buildings and structures; and rough quantities of utilities required. Evaluate each alternative in the four following areas:	Sections 4.2, 5.2, 5.3, and 5.4
1. Technical	Evaluate each corrective measure alternative based on performance, reliability, implementability, and safety.	(Evaluation) Sections 4.2, 5.2, 5.3, and 5.4
1.a	Evaluate performance based on the effectiveness and useful life of the corrective measure.	(Evaluation) Sections 5.2, 5.3, and 5.4
1.a(i)	Evaluate effectiveness in terms of the ability to perform intended functions such as containment, diversion, removal, destruction, or treatment. Determine the effectiveness of each corrective measure either through design specifications or by performance evaluation. Consider any specific waste or site characteristics that could potentially impede effectiveness. The evaluation should also consider the effectiveness of combinations of technologies.	(Reduction of Toxicity, Mobility, and Volume through Treatment) Sections 5.2, 5.3, and 5.4
1.a(ii)	Evaluate each corrective measure in terms of the projected service lives of its component technologies. Consider resource availability in the future life of the technology, as well as appropriateness of the technologies, in estimating the useful life of the project.	(Long-Term Effectiveness and Permanence and Short-Term Effectiveness) Sections 5.2, 5.3, and 5.4
1.b	Provide information on the reliability of each corrective measure, including its operation and maintenance requirements and its demonstrated reliability.	(Long-Term Effectiveness and Permanence) Sections 5.2, 5.3, and 5.4
1.b(i)	Consider operation and maintenance requirements. Consider the availability of labor and materials to meet these requirements.	(Implementability) Sections 4.2, 5.2, 5.3, and 5.4

Table 1-2

(Continued)

Section	Permit Requirement	Location in FS Report
1.b(ii)	Evaluate whether the technologies have been used effectively under analogous conditions; whether the combination of technologies has been used together effectively; whether failure of any one technology has an immediate impact on receptors; and whether the corrective measure has the flexibility to deal with uncontrollable changes at the site.	(Implementability) Sections 5.2, 5.3, and 5.4
1.c	Describe the implementability of each corrective measure including the relative ease of installation (constructibility) and the total time required to achieve a given level of response.	(Implementability and Short-Term Effectiveness) Section 5.2, 5.3, and 5.4
1.c(i)	Evaluate measures that can be taken to facilitate construction under certain conditions, including the need for special permits or agreements, equipment availability, and the location of suitable off-site treatment or disposal facilities.	(Implementability and Compliance with ARARs) Sections 5.2, 5.3, and 5.4
1.c(ii)	Evaluate the time it takes to implement a corrective measure and the time it takes to actually see beneficial results.	(Long-Term Effectiveness and Permanence) Sections 5.2, 5.3, and 5.4
1.d	Evaluate each corrective measure alternative with regard to safety.	(Short-Term Effectiveness) Sections 5.2, 5.3, and 5.4
2. Environmental	Include, at a minimum, an evaluation of the short- and long-term beneficial and adverse effects of the response alternative; any adverse effects on environmentally sensitive areas; and an analysis of measures to mitigate adverse impacts. Perform an environmental assessment for each alternative.	(Long-Term Effectiveness and Permanence Overall Protection of Human Health and the Environment Short-Term Effectiveness) Sections 5.2, 5.3, and 5.4
3. Human Health	Assess each alternative in terms of the extent that it mitigates short- and long-term potential exposure to any residual contamination and protects human health both during and after implementation of the corrective measure.	(Long-Term Effectiveness and Permanence Overall Protection of Human Health and the Environment Short-Term Effectiveness) Sections 5.2, 5.3, and 5.4
4. Institutional	Assess relevant institutional needs for each alternative.	(Compliance with ARARs) Sections 5.2, 5.3, and 5.4
B. Cost Estimate	Develop an estimate of the cost of each corrective measure alternative (and for each phase or segment of the alternative).	(Evaluation) Section 4.2 and (Cost) Sections 5.2, 5.3, and 5.4

Table 1-2

(Continued)

Section	Permit Requirement	Location in FS Report
TASK VIII. JUSTIFICATION AND RECOMMENDATION OF THE CORRECTIVE MEASURE OR MEASURES		
A. Technical	Justify and recommend a corrective measure alternative using technical, human health, and environmental criteria. Include summary tables that allow the alternative or alternatives to be understood easily. Highlight tradeoffs among health risks, environmental effects, and other pertinent factors.	Section 5.5 and Tables 5-10, 5-11, and 5-12 Sections 6.1, 6.2, and 6.3
1. Performance	Corrective measure or measures that are most effective at performing their intended functions and maintaining the performance over extended periods of time will be preferred.	Section 5.5 Sections 6.1, 6.2, and 6.3
2. Reliability	Corrective measure or measures that do not require frequent or complex operation and maintenance activities and have proved effective under waste and facility conditions similar to those anticipated will be preferred.	Section 5.5 Sections 6.1, 6.2, and 6.3
3. Implementability	Corrective measure or measures that can be constructed and operated to reduce levels of contamination to attain or exceed applicable standards in the shortest period of time will be preferred.	Section 5.5 Sections 6.1, 6.2, and 6.3
4. Safety	Corrective measure or measures that pose the least threat to the safety of nearby residents and environments as well as workers during implementation will be preferred.	Section 5.5 Sections 6.1, 6.2, and 6.3
B. Human Health	Comply with existing U.S. EPA criteria, standards, or regulations for the protection of human health.	Section 5.5 Sections 6.1, 6.2, and 6.3
C. Environmental	The corrective measure or measures posing the least adverse impact (or greatest improvement) on the environment over the shortest period of time will be favored.	Section 5.5 Sections 6.1, 6.2, and 6.3

2.0 SITE-SPECIFIC INFORMATION

This section provides a summary of the background information from the RI and the risk assessment for each site. This information was used to establish RAOs that were in turn used to determine the area of contamination to be addressed at each site for remedial purposes.

2.1 Establishing Remedial Action Objectives

RAOs specify the contaminants and media of interest, exposure pathways, and preliminary remediation goals that will permit a range of treatment and containment alternatives to be developed for each site. The basis for determining cleanup criteria for Holloman AFB was discussed during a meeting between U.S. EPA, Region VI, NMED, Holloman AFB, USACE, and Radian in Santa Fe, New Mexico, on 28 July 1992. For sites that are contaminated from releases of petroleum spills (Sites 2&5), cleanup criteria established and agreed on by both Holloman AFB and NMED were selected. For the other sites (Sites 8 and 14), which are related to other types of contamination (pesticides and metals), cleanup criteria were based on acceptable risk to human health. A more detailed discussion of the selection of cleanup criteria and development of RAOs is presented in Section 3.0 of the CMS Plan (Radian, 1992).

2.1.1 Overall Remedial Action Objectives

The overall RAOs for Holloman AFB are presented in Table 2-1. These objectives were discussed at the July 1992 meeting in Santa Fe and fundamentally agreed on by U.S. EPA, Region VI, NMED, and Holloman AFB. As discussed in the *Risk Assessment Report for the Remedial Investigation -Investigation, Study and Recommendation for 29 Waste Sites* (Radian, 1992), the groundwater at Holloman AFB is designated as unfit for human consumption based on the New Mexico Water Quality Control Commission regulations, because it exceeds New Mexico Human Health Standards for total dissolved

Table 2-1

Remedial Action Objectives

Objective	Criteria
Prevent Contact with Contaminated Soil	Acceptable Health or Environmental Risk
Prevent Inhalation of Contaminated Soil	Acceptable Health or Environmental Risk
Prevent Future Contamination of Groundwater	NMED Standards

solids and sulfate. For this reason, restoration of groundwater was not considered as an RAO. At this point, there are no data suggesting that groundwater releases to surface water through seeps and springs. Therefore, exposure to contaminated groundwater is not anticipated and was not evaluated in a risk assessment. Further discussion of groundwater releases is provided on a site-specific basis.

2.1.2 NMED Standards

Standards were established for Holloman AFB for the remediation of sites contaminated with petroleum products and were agreed on by both Holloman AFB and NMED. These standards were used at IRP Sites 2&5, POL (petroleum, oil, and lubricants) Spill Sites No. 1 and No. 2. In a letter from Steven J. Cary to Howard E. Moffit dated 22 July 1992 (Appendix A), NMED recommended that soil exceeding concentrations of 1000 mg/kg total petroleum hydrocarbons (TPH) be remediated to that level. In a letter from James B. Bearzi to Howard E. Moffitt dated 2 November 1992 (Appendix A), NMED approved the 1000-mg/kg TPH cleanup standard requested by Holloman AFB. Groundwater remediation, beyond removal of any floating hydrocarbon, is not required for sites contaminated with petroleum product (letter from Steven J. Cary to Howard E. Moffit).

2.2 Sites 2&5--POL Spill Sites No. 1 and No. 2

2.2.1 Site Background

POL Spill Sites No. 1 and No. 2 are located in the vicinity of 14 former 25,000-gal. aboveground storage tanks in a former bermed area. Because of the proximity of these spill sites to each other, the investigations for IRP Site 2 and IRP Site 5 were combined; the sites will be referred to as Sites 2&5. IRP Sites 2&5 are also an Area of Concern (AOC) listed on Table 1 of Holloman's HSWA Permit. The corresponding RCRA name and reference are POL Storage Tank Leaks, AOC-T (both IRP sites are considered one AOC). Figure 2-1 illustrates the site layout and features. Figure 2-2 shows a geologic cross section of the site.

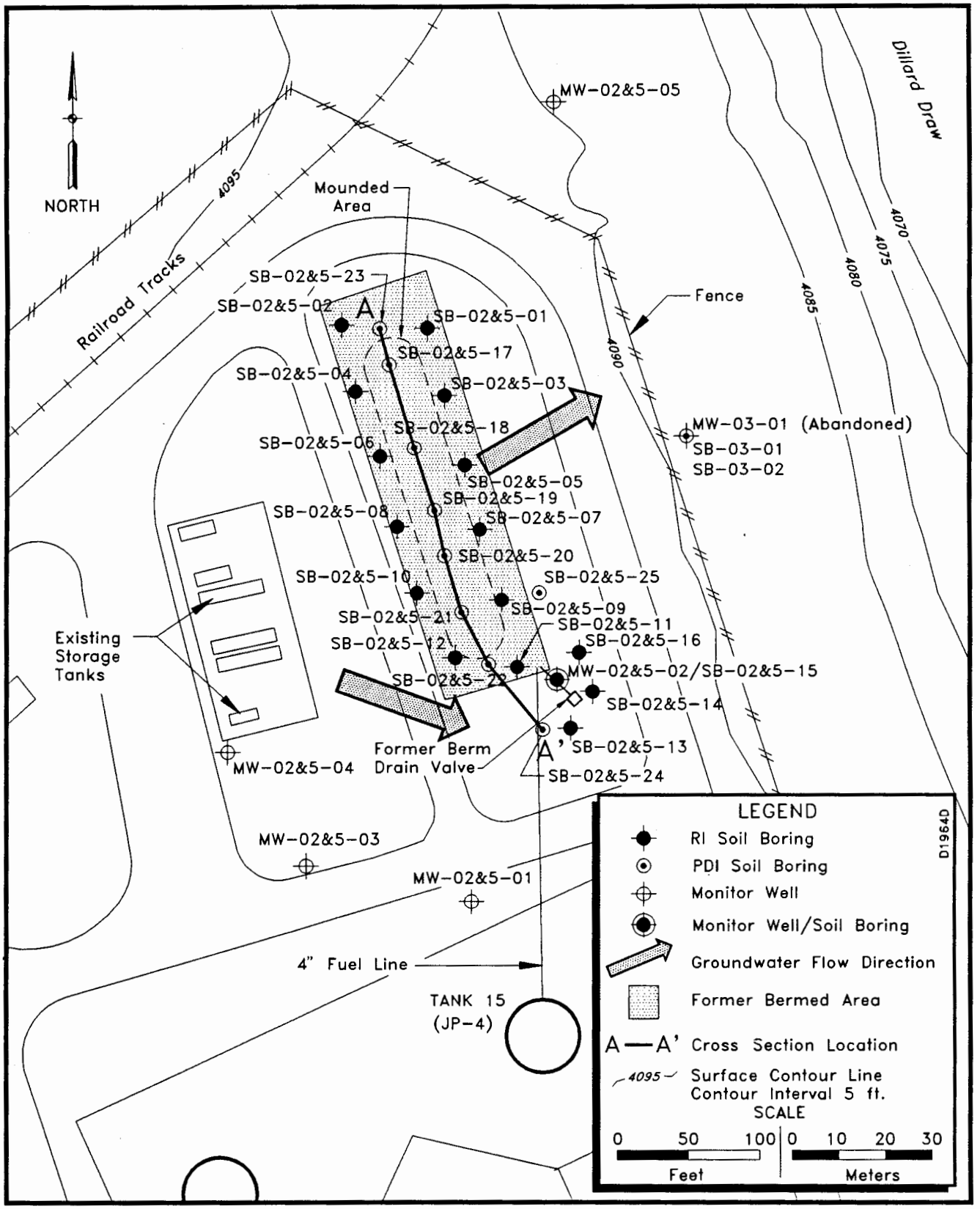

Figure 2-1. Illustration of Sites 2&5

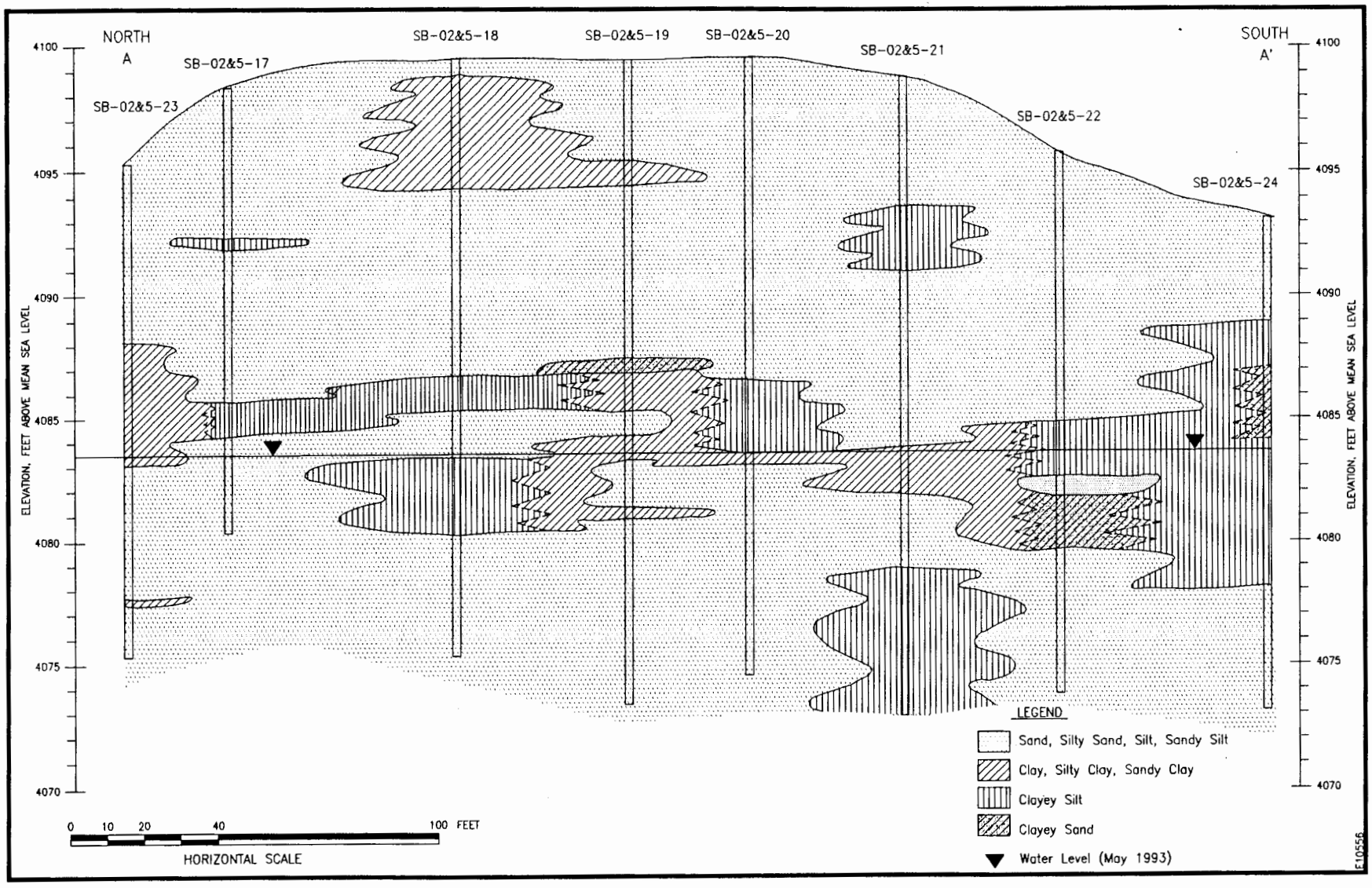

Figure 2-2. Geologic Cross Section of Sites 2&5

At Site 2, the former 25,000-gal. fuel tanks were periodically overtopped between the early 1960s and the late 1970s. Spills of JP-4 and Avgas occurred throughout the unlined bermed area; however, the amount of fuel spilled is not known. The tanks were removed in 1987, but the tank saddles were left in place and covered with a 4-ft-high soil mound, which included the soil that had been previously used for the berm.

At Site 5, approximately 30,000 gal. of JP-4 fuel were spilled in 1978, when a drain valve for the 4-in. fuel line was accidentally left open. The fuel line was used for filling the former 25,000-gal. tanks with JP-4 from Tank 15. Interviews with POL personnel indicated that the 30,000-gal. spill accumulated primarily in the southeast corner of the former unlined bermed area, with fuel draining to a low point southeast of the berm through the berm drain valve. The personnel also indicated that approximately 95% of the fuel was recovered, with the remainder of the fuel seeping into the gravel base of the POL storage area. An estimated 1500 gal. were not recovered and no remedial activity has been performed.

During the RI, five monitor wells were installed at Sites 2&5, and one monitor well was installed nearby at Site 3. Benzene was detected at concentrations greater than 2 mg/L in monitor wells downgradient of the suspected source.

2.2.2 Remedial Action Objective, Sites 2&5

On the basis of the site description and the NMED recommendations for remediation of sites contaminated with petroleum hydrocarbons (Section 2.1.2), an RAO was established for Sites 2&5 and is presented in Table 2-2. The cleanup criterion for the soil is 1000 mg/kg for TPH. In the CMS Plan, a cleanup criterion of 25 mg/kg for benzene was proposed for Sites 2&5, based on a 28 July 1992 discussion of cleanup standards between EPA Region VI, NMED, and Holloman AFB. Subsequently, NMED approved the cleanup standard for petroleum product-contaminated sites at Holloman AFB as 1000 mg/kg TPH (letter from James B. Bearzi to Howard E. Moffitt, 2 November 1992).

Table 2-2

Remedial Action Objective, Sites 2&5

Objective	Criteria	Contaminant	Cleanup Criterion
Prevent future contamination of groundwater	NMED standard for Holloman AFB	TPH	1000 mg/kg

Note--TPH by EPA Method 418.1

2.2.3 Extent of Contamination

As part of the RI, soil samples were collected from 16 soil borings (SB-02&5-01 through SB-02&5-16) at Sites 2&5. During the PDI, soil samples were collected from nine additional soil borings (SB-02&5-17 through SB-02&5-25). Table 2-3 shows the concentrations of TPH above the cleanup criterion in the soil samples.

For samples collected during the RI, TPH levels above the cleanup criterion were detected only in samples from SB-02&5-09 and SB-02&5-12 at depths of 15 to 17 ft below ground level (bgl). The groundwater level at the site ranges from 11 to 15 ft bgl (15 to 19 ft below the mound surface. For samples collected during the RI, TPH levels exceed the cleanup criterion only in samples collected from below the water table. All RI samples were collected from the area surrounding the soil mound, as shown in Figure 2-1. Table 2-4 lists the TPH concentrations for all samples collected during the RI and the PDI.

During the PDI, samples were collected from the soil beneath the mounded area. Sample locations were determined on the basis of a soil gas survey conducted at the site. The results of the soil gas survey are included in Appendix F. TPH levels above the cleanup criterion were detected in samples from beneath the mounded area (borings SB-02&5-17 through SB-02&5-21) at depths from 4 to 18 ft below the mound surface, which is equivalent to 0 to 14 ft bgl. It is believed that TPH concentrations in the lower 2 ft of the 4-ft-high soil mound may also exceed the cleanup criterion. The soil mound is approximately 250 ft long and 50 ft wide.

The zone of concentrations greater than 1000 mg/kg is estimated to be 15 ft thick (-2 to 13 ft bgl). No TPH concentrations above the cleanup criterion were detected for soil samples collected above the water level at the north and sound ends of the mounded area (SB-02&5-23 and SB-02&5-22, respectively).

Table 2-3

Concentrations of TPH Above Cleanup Criterion, Sites 2&5

Location	Depth (ft) [a]	TPH [b] (mg/kg)
SB-02&5-9 (RI)	15 - 17	17500
SB-02&5-12 (RI)	15 - 17	5220
SB-02&5-17	14 - 16	1140
SB-02&5-18	10 - 12	2020
	16 - 18	5050
SB-02&5-19	4 - 6	5810
	8 - 10	5600
	12 - 14	3300
	16 - 18	3790
SB-02&5-20	8 - 10	2590
	12 - 14	2420
	18 - 20	1720
SB-02&5-21	6 - 8	9930
	10 - 12	5160
	14 - 16	1520
	16 - 18	8550
SB-02&5-22	14 - 16	2340
SB-02&5-24	0 - 2	1440

[a] Depths for SB-02&5-17 through SB-02&5-21 are measured from the top of the mounded area, which is 4 ft above adjacent ground level.

[b] TPH analysis by EPA Method 418.1

RI - Sample collected during RI

Table 2-4

Concentrations of TPH, Sites 2&5

Location	Depth (ft)[a]	TPH[b] (mg/kg)	Location	Depth (ft)[a]	TPH[b] (mg/kg)
SB-02&5-01	5 - 7	ND	SB-02&5-15	5 - 7	42
	10 - 12	ND	SB-02&5-16	2.5 - 4.5	ND
SB-02&5-02	0 - 2	59		7.5 - 9.5	ND
	2.5 - 4.5	138	SB-02&5-17	8 - 10	198
SB-02&5-03	0 - 2	ND		14 - 16	1140
	10 - 12	ND	SB-02&5-18	8 - 10	491
SB-02&5-04	0 - 2	766		10 - 12	2020
	2.5 - 4.5	488		16 - 18	5050
SB-02&5-05	2 - 4	ND	SB-02&5-19	4 - 6	5810
	8 - 10	ND		8 - 10	5600
SB-02&5-06	10 - 12	ND		12 - 14	3300
	15 - 17	517		16 - 18	3790
SB-02&5-07	2.5 - 4.5	ND	SB-02&5-20	8 - 10	2590
	7.5 - 9.5	50		12 - 14	2420
SB-02&5-08	10 - 12	ND		18 - 20	1720
	15 - 17	ND	SB-02&5-21	6 - 8	9930
SB-02&5-09	5 - 7	378		10 - 12	5160
	15 - 17	17500		14 - 16	1520
SB-02&5-10	5 - 7	ND		16 - 18	8550
	15 - 17	546	SB-02&5-22	8 - 10	ND
SB-02&5-11	2.5 - 4.5	ND		14 - 16	2340
	10 - 12	ND	SB-02&5-23	6 - 8	ND
SB-02&5-12	10 - 12	ND		14 - 16	55
	15 - 17	5220	SB-02&5-24	0 - 2	1440
SB-02&5-13	0 - 2	16		6 - 8	ND
	10 - 12	40		10 - 12	305
SB-02&5-14	5 - 7	ND	SB-02&5-25	4 - 6	ND
	10 - 12	ND		14 - 16	ND
SB-02&5-15	0 - 2	14			

Note--Samples from SB-02&5-01 through SB-02&5-16 were collected during the RI. Samples from SB-02&5-17 through SB-02&5-25 were collected during the PDI.

[a] Depths for SB-02&5-17 through SB-02&5-21 are measured from the top of the mounded area, which is 4 ft above adjacent ground level.

[b] TPH analysis by EPA Method 418.1.

ND - Not detected or below method detection limit.

Toxicity Characteristic Leaching Procedure (TCLP) analyses for volatile organic compounds (VOCs) were performed on samples collected during the PDI from SB-02&5-20 and SB-02&5-21 at depths of 12 to 14 ft and 10 to 12 ft below the mound surface (8 to 10 ft and 6 to 8 ft bgl), respectively. Benzene was not detected in the TCLP analysis for the sample from SB-02&5-20. The TCLP benzene concentration was 16.2 μg/L for the sample from SB-02&5-21. These results indicate that the soil at Sites 2&5 is not likely to be hazardous, since the regulatory level for benzene is 500 μg/L.

The area with TPH concentrations above the cleanup criterion is located beneath the mounded area covering the former tank saddles, as shown in Figures 2-3 and 2-4. The area is estimated to cover 9200 sq ft. As required by the RAO, the soil above the water table is addressed to prevent future contamination of the groundwater. The volume of soil with TPH concentrations above the cleanup criterion is estimated to be 5100 cu yd.

TPH levels above the cleanup criterion were also detected in surface (0 to 2 ft bgl) samples collected from SB-02&5-24. The soil with TPH levels greater than 1000 mg/kg is believed to be limited to a depth of 4 ft bgl and to an area of approximately 325 sq ft, as shown in Figure 2-3. The volume of soil with TPH concentrations above the cleanup criterion is estimated to be 50 cu yd, yielding a total volume of 5150 cu yd for Sites 2&5.

2.3 Site 8--Refuse Collection Truck Washrack

2.3.1 Site Background

The Refuse Collection Truck Washrack is located southwest of the POL Storage Area and east of the Main Base Area. IRP Site 8 contains two SWMUs listed on Table 1 of Holloman AFB's HSWA Permit. The corresponding RCRA name and reference are Building 131 Washrack, SWMU No. 82. The washrack has been located in the same place since the beginning of Base operations. Figure 2-5 illustrates the features of the site.

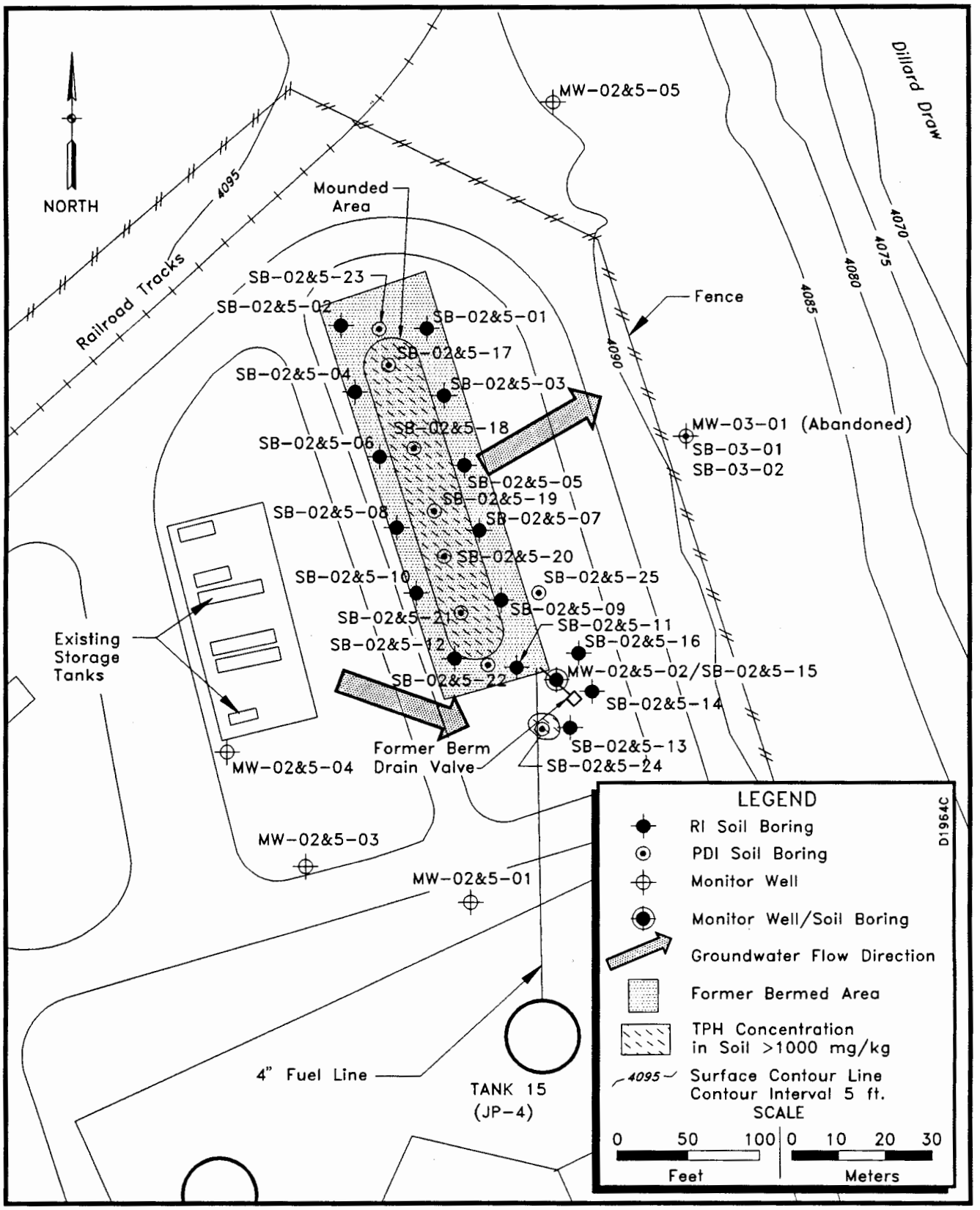

Figure 2-3. Area of TPH Concentrations Above Cleanup Criterion, Sites 2&5

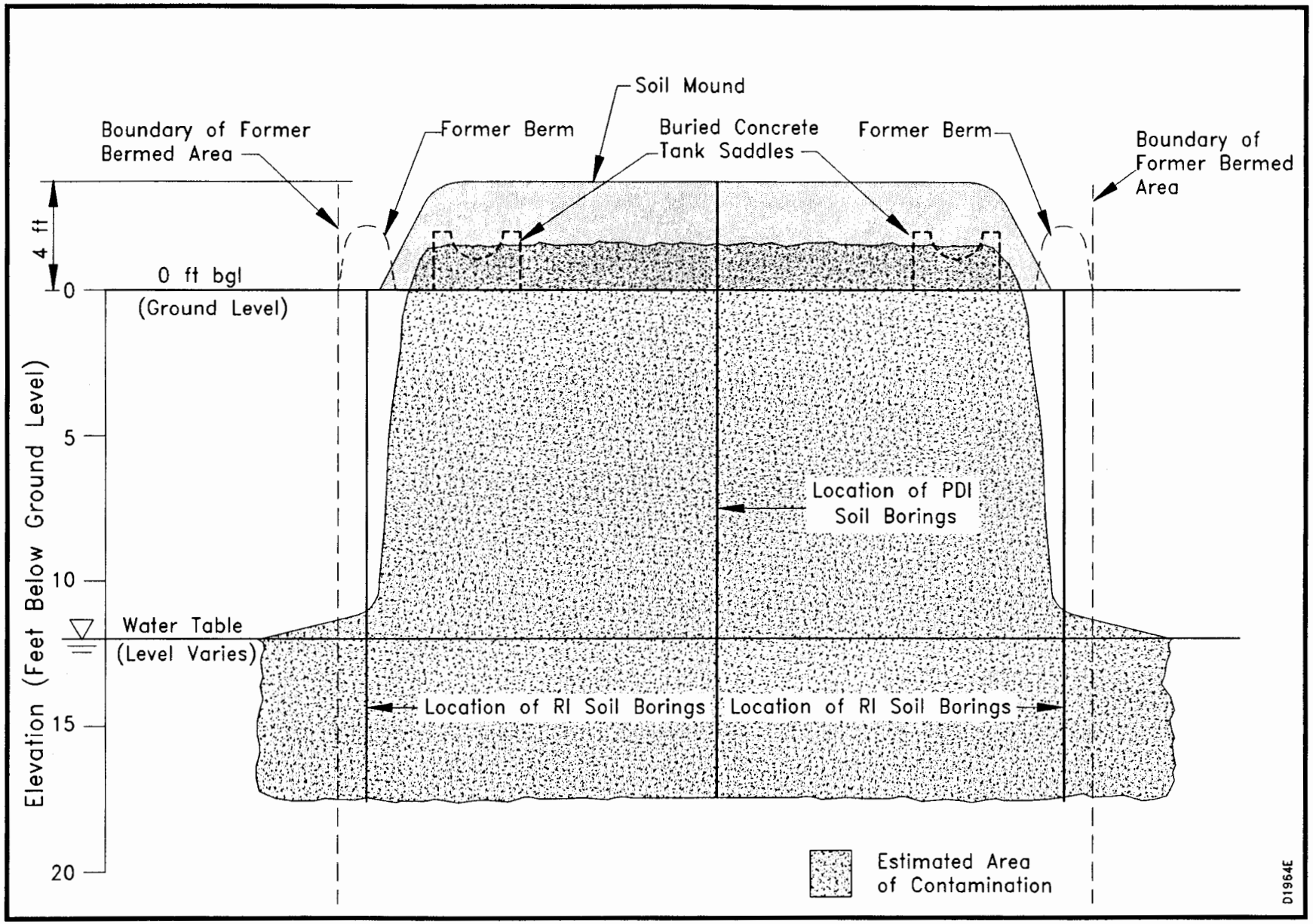

Figure 2-4. East-West Cross Section of Contamination at Sites 2&5

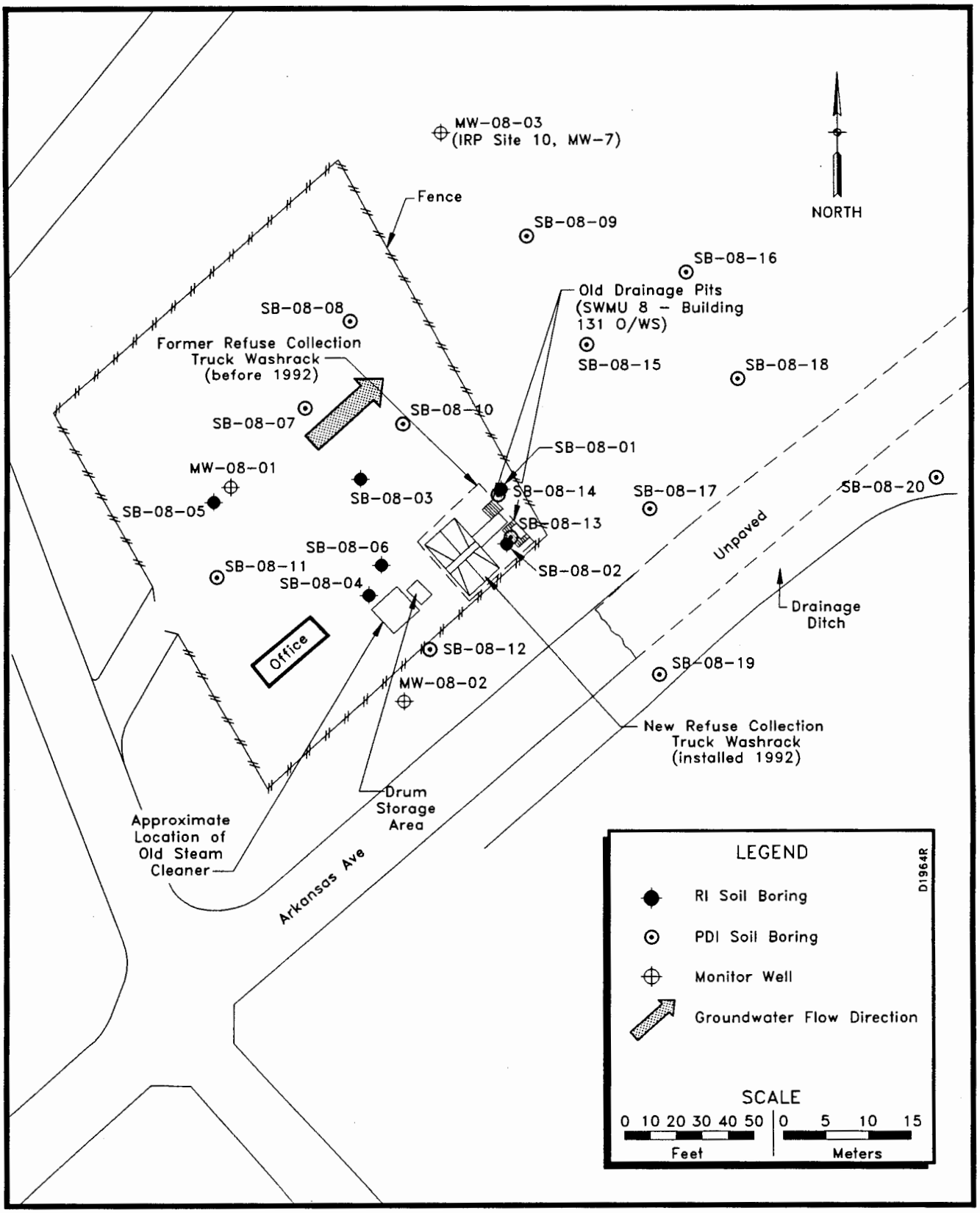

Figure 2-5. Illustration of Site 8

At the washrack, refuse collection trucks and equipment are washed with soap and water, and the rinse water is discharged to the Base sewer system. Records indicate that pesticides were routinely sprayed inside the trucks during the 1970s for fly control. However, this is not a current practice, nor has it been since 1981. The current refuse collection foreman indicated that it was common for the sewer line from the washrack to clog, causing the sump and oil/water separator to overflow at the northwest end of the washrack. Other areas of concern include an engine oil drum storage basin, cracks in the concrete of the washrack, and general stains in the soil throughout the yard. The yard area was also used to wash trucks and should be considered a potential source of contamination. Subsequent to the field investigation in July 1991, the cracked washrack was replaced with a new washrack in the same location.

The results of the RI indicated that metals (above background concentrations) and organochlorine pesticides are present in the surface soil at this site. Organochlorine pesticides and VOCs were detected in the groundwater at the site. The highest concentrations detected were VOCs; however, they were detected in the monitor well upgradient of the site. The VOCs in the groundwater are considered to be the result of another source of contamination. This other source will be investigated under a separate investigation, as recommended in the final RI Report (Radian, 1992).

2.3.2 Remedial Action Objectives, Site 8

On the basis of the site description and the results of the risk assessment as presented in the CMS Plan, RAOs were established for Site 8 and are presented in Table 2-5. Cleanup criteria were determined for surface soils using methods discussed in Section 2.1.

Table 2-5

Remedial Action Objectives, Site 8

Objective	Exposure Route and Receptor	Criteria	Contaminant	Cleanup Criteria
Prevent dermal contact with contaminated soil	Dermal contact with contaminated soil by on-Base workers	Acceptable health risk	4,4'-DDD	4000 μg/kg
			4,4'-DDE	3300 μg/kg
Prevent inhalation of contaminated soil	Inhalation of contaminated soil by on-Base workers	Acceptable health risk	4-4'-DDT	1100 μg/kg
			Chlordane	140 μg/kg
			Cadmium	0.290 mg/kg
			Lead	12.000 mg/kg
			Mercury	0.016 mg/kg

2.3.3 Extent of Contamination

During the RI, six soil borings (SB-08-01 through SB-08-06) were drilled to groundwater in areas of suspected contamination. During the PDI, an additional 14 soil borings (SB-08-07 through SB-08-20) were drilled at Site 8 to better define the area of contamination. Table 2-6 lists the locations and concentrations of metals and pesticides above the cleanup criteria. Table 2-7 lists the concentrations of cadmium, lead, and mercury; Table 2-8 lists the concentrations of pesticides of concern in soil samples from Site 8.

TCLP pesticides and metals analyses were performed on samples from SB-08-10, SB-08-13, and SB-08-17. Analytical results (included in Appendix F) indicate that the constituent concentrations in these samples did not exceed the regulatory levels for the toxicity characteristic. No levels of lead, mercury, or chlordane were detected in the TCLP analyses. Cadmium was detected at a concentration of 0.0182 mg/L (the regulatory level is 1.0 mg/L). The maximum detected concentration of heptachlor (or its epoxide) was 0.106 μg/L (the regulatory level is 8 μg/L).

Although the TCLP analytical results do not indicate the soil at Site 8 is hazardous, the concentrations of contaminants detected in total organochlorine pesticides and metals analyses indicate that some of the soil at Site 8 may be considered a hazardous waste for disposal purposes. On the basis of a conservative estimate that the maximum TCLP concentration of a compound may be 20 times lower than the total soil concentration of the compound, the TCLP concentrations of lead and chlordane for soil from some areas at Site 8 may exceed the regulatory levels. Since the maximum detected lead concentration was 370 mg/kg, the TCLP lead level for some soil may be as high as 18.5 mg/L, which exceeds the regulatory level of 5 mg/L. Since the maximum detected chlordane concentration was 4000 μg/kg, the TCLP chlordane level for some soil may be as high as 200 μg/L, which exceeds the regulatory level of 30 μg/L.

Table 2-6

Concentrations of Contaminants Above Cleanup Criteria, Site 8

Location	Depth (ft)	Metals (mg/kg)			Pesticides (µg/kg)			
		Cadmium	Lead	Mercury	4,4'-DDD	4,4'-DDE	4,4'-DDT	Chlordane
SB-08-01	0 - 2	0.920	50.000	0.490				950
SB-08-02	0 - 2	1.800	370.000	2.200	4000	5600	9300	4000
SB-08-03	0 - 2		19.000	0.110				230
SB-08-04	0 - 2			0.800				730
	2 - 4		18.000					
SB-08-06	2.5 - 4.5	0.920	69.900					
SB-08-10	0 - 2	3.710	50.600	0.297				263 B
SB-08-11	0 - 2			0.068				
	2 - 4	NA	NA	NA				238
SB-08-12	0 - 2	NA	NA	NA			2740	
SB-08-13	0 - 2	NA	NA	NA			4210	386
	xx	40	NA	20	3000	2000	2000	500

Note--Samples from SB-08-01 through SB-08-06 were collected during the RI. Samples from SB-08-07 through SB-08-20 were collected during the PDI.

NA--Not analyzed.
B--Analyte detected in method blank.

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Table 2-7

Concentrations of Metals Analytes, Site 8

Location	Depth (ft)	Analyses (results in mg/kg)		
		SW6010--Cadmium	SW7421--Lead	SW7471--Mercury
SB-08-01	0 - 2	0.920	50.000	0.490
	6 - 8	ND	1.100	ND
SB-08-02	0 - 2	1.800	370.000	2.200
	5 - 7	ND	2.300	ND
SB-08-03	0 - 2	ND	19.000	0.110
	10 - 12	ND	0.300	ND
SB-08-04	0 - 2	ND	8.100	0.800
	2 - 4	ND	18.000	ND
SB-08-05	2 - 4	ND	2.000	ND
	6 - 8	ND	0.750	ND
SB-08-06	2.5 - 4.5	0.920	1.000	ND
	7.5 - 9.5	ND	1.300	ND
SB-08-07	0 - 2	ND	9.220	ND
SB-08-10	0 - 2	3.710	69.900	0.297
SB-08-11	0 - 2	ND	10.600	0.068
SB-08-12	2 - 4	ND	2.800	ND
SB-08-13	2 - 4	ND	9.110	ND
SB-08-14	2 - 4	ND	7.250	ND
SB-08-17	0 - 2	ND	7.440	ND
SB-08-19	0 - 2	ND	0.726	ND

Note--Samples from SB-08-01 through SB-08-06 were collected during the RI. Samples from SB-08-07 through SB-08-20 were collected during the PDI. Only those analytes included in the RAOs are listed.

ND--Not detected or detected below method detection limit.

Table 2-8

Concentrations of Pesticides Analytes, Site 8

Location	Depth (ft)	Analyses--SW8080 Pesticides (µg/kg)				
		4,4'-DDD	4,4'-DDE	4,4'-DDT	Chlordane	Heptachlor
SB-08-01	0 - 2	110.0	410.0	400.0	950.0	6.3
	6 - 8	ND	ND	ND	ND	0.3
SB-08-02	0 - 2	4000.0	5600.0	9300.0	4000.0	56.0
	5 - 7	1.0X	10.0	12.0	20.0	0.9
SB-08-03	0 - 2	28.0	86.0	26.0	230.0	ND
	10 - 12	ND	ND	ND	ND	0.9
SB-08-04	0 - 2	230.0	530.0	500.0	730.0	12.0
	2 - 4	ND	3.3	ND	ND	0.3
SB-08-05	2 - 4	ND	1.0	ND	ND	0.4
	6 - 8	ND	ND	ND	ND	ND
SB-08-06	2.5 - 4.5	3.2	ND	1.3	17.0	ND
	7.5 - 9.5	4.0	0.8X	2.0	32.0	ND
SB-08-07	0 - 2	56.4	52.1	46.7	89.5B	4.1
SB-08-08	0 - 2	9.4	8.1	5.6	85.9	3.3
SB-08-09	0 - 2	3.4	9.0	8.3	3.6	ND
SB-08-10	0 - 2	116.0	88.4	82.5	263.0B	8.9P
	2 - 4	1.5	1.4	2.6	2.9B	ND
SB-08-11	0 - 2	21.0	23.3	20.6	57.7B	493.0
	2 - 4	ND	ND	ND	238.0	343.0
SB-08-12	0 - 2	65.0P	1850.0	2740.0	51.1B	ND
	2 - 4	ND	12.0	7.9	ND	ND
SB-08-13	0 - 2	492.0P	2500.0	4210.0	386.0	7.8
	2 - 4	1.8P	1.8	15.6	23.4	2.5
	4 - 6	4.9	12.1	18.4	1.8	ND
SB-08-14	2 - 4	ND	2.9	3.7	1.2	ND
	4 - 6	1.0	5.9	6.0	2.9	ND
SB-08-15	0 - 2	1.7	6.1	3.5	3.4	ND
	2 - 4	1.9	4.0	4.0	2.2	ND
SB-08-16	0 - 2	1.5	10.2	8.1	ND	ND
SB-08-17	0 - 2	ND	106.0	29.6	ND	ND
	2 - 4	ND	8.9	4.4	ND	ND
SB-08-18	0 - 2	91.2	696.0	707.0	21.6B	ND
SB-08-19	0 - 2	1.3	1.2	3.4	2.8	ND
	2 - 4	ND	ND	ND	ND	ND
SB-08-20	0 - 2	ND	7.8	10.0	ND	ND
	2 - 4	ND	ND	ND	ND	ND

Note--Samples from SB-08-01 through SB-08-06 were collected during the RI. Samples from SB-08-07 through SB-08-20 were collected during the PDI. Only those analytes included in the RAOs are listed.

ND--Not detected, detected below method detection limit, or detected below reporting limit.
B--Analyte detected in method blank.
P--Analyte not confirmed.
X--Presence of analyte confirmed by 2nd column analysis, but quantitation not confirmed.

Although no cleanup level is specified for heptachlor in the RAOs, elevated levels (up to 493 μg/kg) of the compound were detected in samples from SB-08-11. On the basis of a conservative estimate, the TCLP concentration of heptachlor may be as high as 25 μg/L. Since the regulatory level for heptachlor is 8 μg/L, some of the soil at Site 8 could potentially be considered characteristically hazardous for heptachlor. Because the total concentrations of contaminants vary significantly in samples from different areas of the site, the soil in some areas is considered to be potentially hazardous, although TCLP results did not indicate that regulatory levels were exceeded.

On the basis of the analytical results, the area to be addressed for Site 8 is estimated to be 20,800 sq ft as shown in Figure 2-6. The area includes the truck washrack, the drum storage area, the area surrounding the former steam cleaner location, the old drainage pits, the new oil-water separator, and uninvestigated sections of the yard surrounding the office. On the basis of data presented in Tables 2-6 through 2-8, contamination is inferred to extend only 2 ft bgl except in the immediate vicinity (10-ft radius) of SB-08-04, SB-08-06, and SB-08-11, where contamination is inferred to extend to a depth of 4 ft bgl. The volume of contaminated soil is estimated to be 1540 cu yd for the surface soil (0 to 2 ft bgl) plus 70 cu yd for the soil contaminated in the 2- to 4-ft bgl interval, yielding a total volume of 1610 cu yd for this site.

2.4 Site 14--Former Entomology Shop Area

2.4.1 Site Background

Site 14, the Former Entomology Shop Area, is located inside the civil engineering yard and adjacent to existing Building 66. The corresponding RCRA name and reference are Former Entomology Shop, SWMU No. 197. Figure 2-7 provides an illustration of the area. It is bounded on the northwest by the civil engineering yard

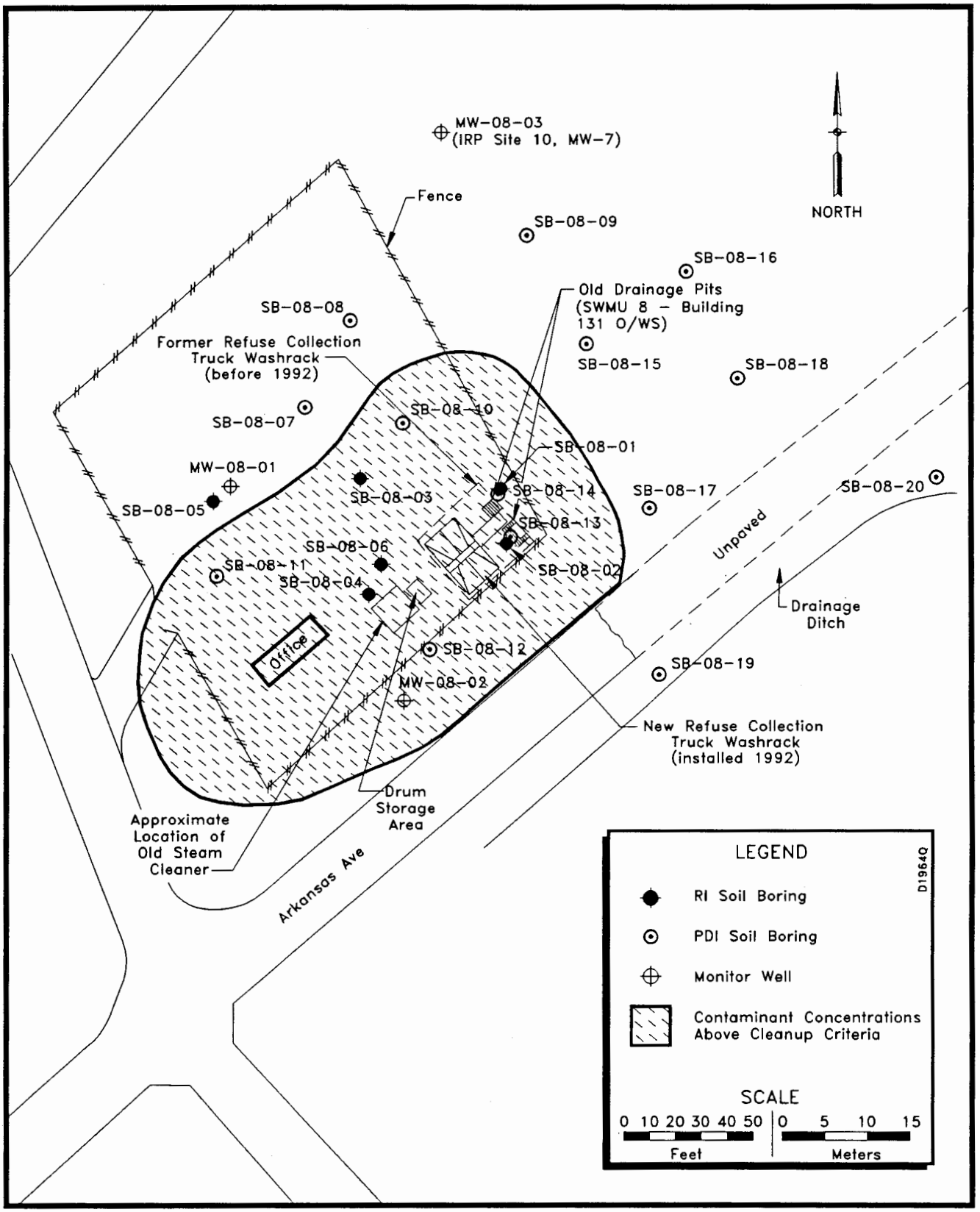

Figure 2-6. Area of Soil Above Cleanup Criteria, Site 8

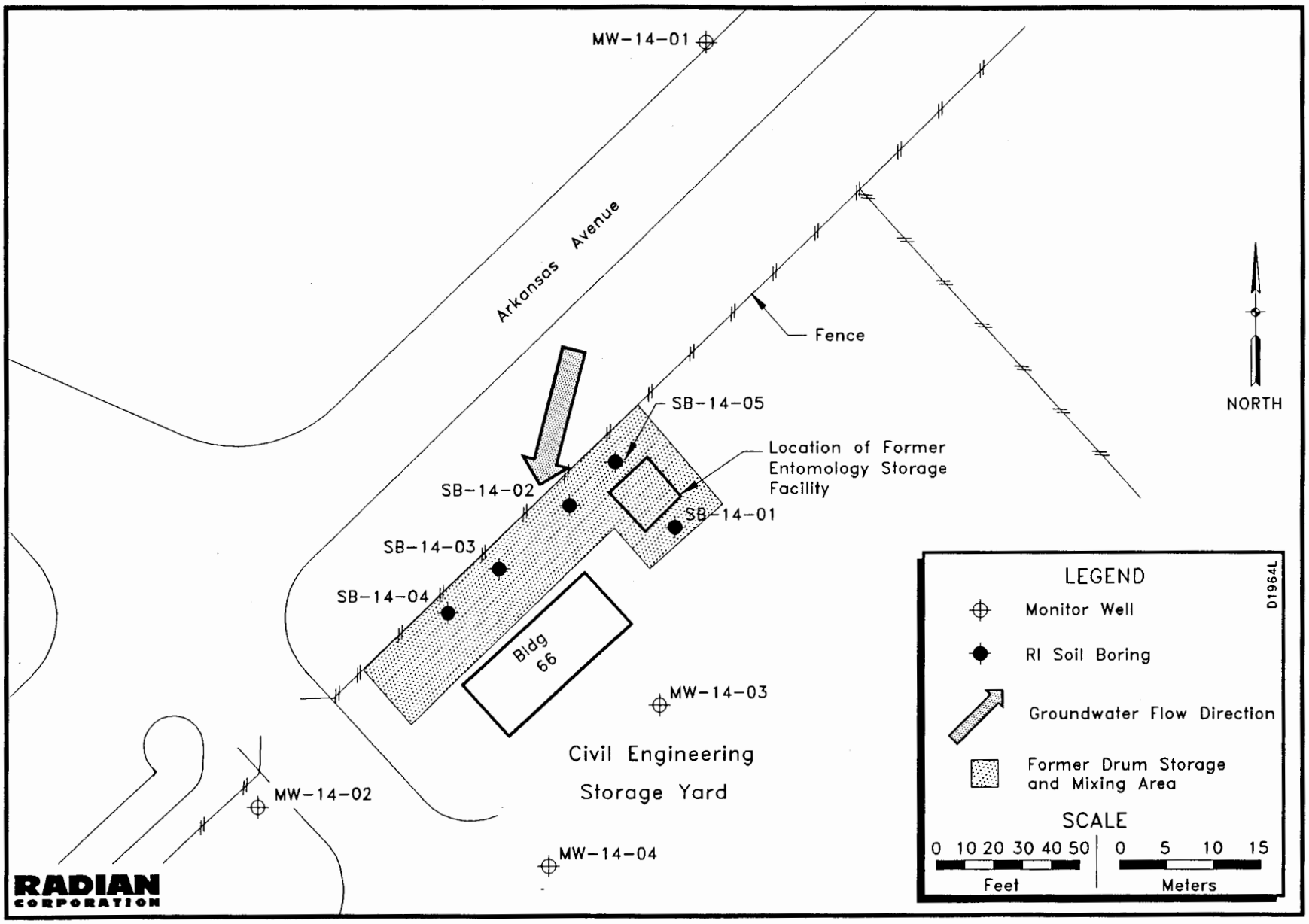

Figure 2-7. Illustration of Site 14

fence and on the southeast by Building 66. The approximate location was determined in the field with the use of historical photos. Although the Former Entomology Office was located in Building 67, mixing and drum storage were conducted at the area located adjacent to Building 66. Pesticides commonly used at this site included DDT and chlordane. Diesel fuel was routinely used to solubilize the pesticides.

The RI revealed that the predominant constituents in the soils at Site 14 were 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, aldrin, and chlordane. Because the area was used for storage, it is possible that the contamination is not homogeneous, and "hot spots" of contamination of certain chemicals may exist. Groundwater analytical results confirm that the pesticides have not migrated downward, because no organochlorine or organophosphorous pesticides were detected.

2.4.2 Remedial Action Objective, Site 14

On the basis of the site description and the risk assessment, an RAO was established for Site 14 and is presented in Table 2-9.

2.4.3 Extent of Contamination

During the RI, five soil borings were drilled to groundwater at the Former Entomology Shop. Two samples were collected from each of the borings: one from 0 to 2 ft bgl, the other from 2 to 4 ft bgl. Table 2-10 lists the contaminants detected at levels above the cleanup criteria. Contaminants at concentrations above the cleanup criteria were detected in surface samples (0 to 2 ft bgl) from all soil borings except SB-14-05. Only in a sample from SB-14-02 were pesticides--specifically, aldrin and chlordane--detected above the cleanup criteria at a depth greater than 2 ft bgl. Table 2-11 lists all concentrations of organochlorine pesticides in samples from Site 14. No additional investigation at Site 14 was conducted during the PDI, since existing data were adequate for the FS.

Table 2-9

Remedial Action Objective, Site 14

Objective	Exposure Route and Receptor	Criteria	Contaminant	Cleanup Criteria ($\mu g/kg$)
Prevent dermal contact with contaminated soil	Dermal contact with contaminated soil by current on-Base occupational adults	Acceptable health risk	4,4'-DDD	1500
			4,4'-DDE	1000
			4,4'-DDT	1300
			Aldrin	10
			Chlordane	200
			Heptachlor	100
			gamma-BHC	700

Table 2-10

Concentrations of Pesticides Above Cleanup Criteria, Site 14

Location	Depth	Analyses--SW8080 Pesticides (µg/kg)						
		4,4'-DDD	4,4'-DDE	4,4'-DDT	Aldrin	Chlordane	Heptachlor	gamma-BHC
SB-14-01	0 - 2					1100		
SB-14-02	0 - 2	3100	3900	6500	640X	17000	150	2800
	2 - 4				52X	1300		
SB-14-03	0 - 2	10000	6100	36000	160X	4500		
SB-14-04	0 - 2				1700X	34000	770	
XX		3000	2000	2000	40	500	200	

X - Presence of analyte confirmed by second column analysis, but quantitation not confirmed.

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Table 2-11

Concentrations of Organochlorine Pesticides, Site 14

Location	Depth (ft)	Analyses-SW8080 Pesticides (µg/kg)						
		4,4'-DDD	4,4'-DDE	4,4'-DDT	Aldrin	Chlordane	Heptachlor	gamma-BHC
SB-14-01	0 - 2	180	160	320	26X	1100	ND	5.7X
	2.5 - 4.5	ND	ND	ND	ND	ND	ND	ND
SB-14-02	0 - 2	3100	3900	6500	640X	17000	150	2800
	2 - 4	230	250	460	52X	1300	12	190
SB-14-03	0 - 2	10000	6100	36000	160X	4500	20	ND
	2.5 - 4. 5	16	13	41	2.7X	56	ND	0.68
SB-14-04	0 - 2	3200	2200	4400	1700X	34000	770	10
	2 - 4	6.0	3.9	9.1	3.8X	78	1.0	ND
SB-14-05	0 - 2	35	30	130	ND	ND	ND	ND
	2 - 4	6.6	12	19	ND	17	ND	0.81

Note--Table presents only analytes included in RAO.

ND--Not detected or detected below method detection limit.

X--Presence of analyte confirmed by second column analysis, but quantitation not confirmed.

An estimated area of contaminant concentrations above the cleanup criteria is shown in Figure 2-8. The area includes the former Drum Storage and Mixing Area, the Old Entomology Storage Facility, and surrounding areas affected by rainwater runoff that may have transported contaminants. It is assumed that contamination extends to the parking lot along Arkansas Avenue on the northwest side and to the driveway on the southwest side. The area surrounding SB-14-05 is included in the area to be addressed, although contaminant concentrations in samples from the soil boring were not above the cleanup criteria. It is assumed that concentrations in the soil surrounding the soil boring may be above the cleanup criteria.

The area of contamination is estimated to be 9300 sq ft. Analyses indicate that contamination generally extends from the surface to a depth of 2 ft bgl. Therefore, the volume of contaminated surface soil is estimated to be 690 cu yd. In addition, soil in the vicinity of SB-14-02 contains aldrin and chlordane above the cleanup criteria to a depth of 4 ft bgl. The additional area is estimated to be confined to a 15-ft radius (710 sq ft) and the additional soil volume is estimated to be 50 cu yd, yielding a total soil volume of 740 cu yd to be addressed for Site 14.

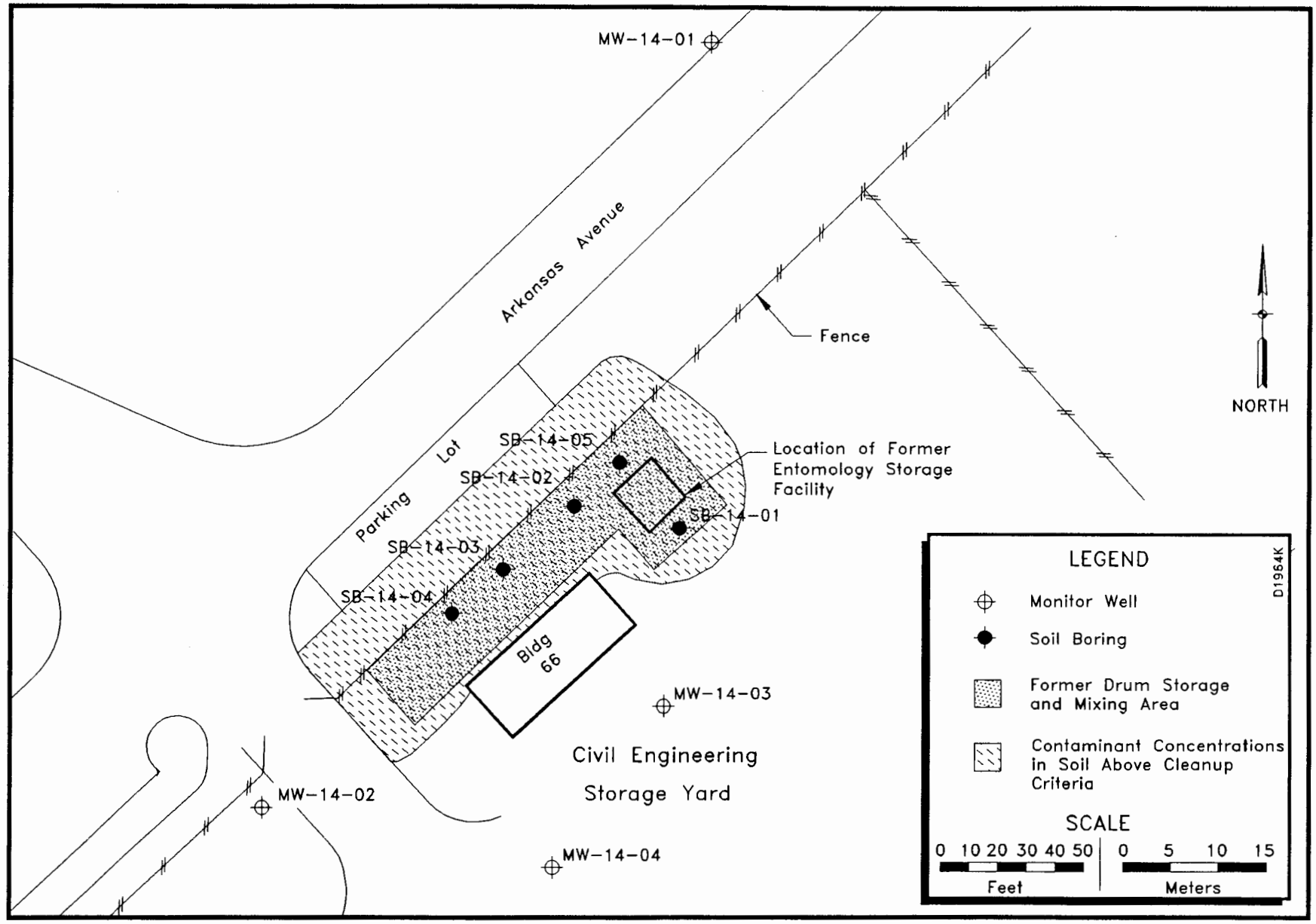

Figure 2-8. Area of Soil Above Cleanup Criteria, Site 14

3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section describes the processes by which potential remedial technologies to address the contaminated soils at Sites 2&5, 8, and 14 were identified and screened. Section 3.1 contains a description of the general response actions chosen to satisfy the RAOs. Section 3.2 describes the identification and screening of the remedial technology types and process options that are potentially applicable for the sites. Section 3.3 explains the processes through which remedial technologies were evaluated and representative technology types and process options were selected.

3.1 General Response Actions

General response actions refer to actions that will satisfy the RAOs presented in Section 2.0. A combination of several general response actions also may be used to meet the RAOs. The general response actions are to be applied to the volumes and areas of contaminated soil described in Section 2.0. A summary of the general response actions, applicable technology types, and process options is shown in Table 3-1. As described below, the general response actions cover a range of possible process options for Sites 2&5, 8, and 14.

3.1.1 No Action

This response action provides for no source control actions. Although the no-action response may involve some type of environmental monitoring, it does not include any actions to reduce the potential for exposure.

3.1.2 Institutional Action

Institutional action may be implemented to prevent exposure to contaminants in the soil. It does not provide for any active remediation. Institutional action may include

Table 3-1

Remedial Action Objectives and General Response Actions for Soil

Remedial Action Objectives	General Response Actions (for all remedial action objectives)	Remedial Technology Types	Process Options
For Human Health:	No Action	None	
Prevent dermal contact Prevent inhalation of contaminated soil	Institutional Action	Access restrictions	Land use restrictions, deed restrictions
		Monitoring	Groundwater monitoring
Prevent Future Contamination of Groundwater	Containment	Surface controls	Sediment control, dust control
		Capping	Bentonite and soil, clay, asphalt, concrete, multi-media
		Vertical barriers	Slurry wall, grout curtain, vibrating beam, sheet pile wall
		Subsurface horizontal barriers	Grout injection, block displacement
	In Situ Treatment	Physical treatment	Soil vapor extraction, in situ air stripping, soil flushing, fixation/solidification
		Thermal treatment	Radio frequency heating, in situ vitrification, in situ steam stripping
		Chemical treatment	Chemical oxidation
		Biological treatment (aerobic)	Biosparging, bioremediation
		Biological treatment (anaerobic)	Anaerobic biodegradation
	Excavation/Disposal		
	Excavation	Excavation	Backhoe, front-end loader, clam shell, drag line
		Soil replacement	Backfill with clean soil
	Disposal	On-site disposal	RCRA landfill, industrial solid waste landfill
		Off-site disposal	RCRA landfill, industrial solid waste landfill

Table 3-1

(Continued)

Remedial Action Objectives	General Response Actions (for all remedial action objectives)	Remedial Technology Types	Process Options
	Excavation/Treatment/ Disposal		
	Excavation	Excavation	Backhoe, front-end loader, clam shell, drag line
		Soil replacement	Backfill with treated soil, backfill with clean soil
	Treatment	Physical treatment	Soil washing, steam stripping, air stripping/vacuum extraction
		Thermal Treatment	Low-temperature thermal treatment, infrared thermal desorption, rotary kiln incineration, fluidized-bed incineration, infrared incineration, circulating bed combustor, codisposal, pyrolysis
		Chemical treatment	Stabilization/solidification, encapsulation, solvent extraction, supercritical solvent extraction, acid extraction, chemical oxidation, chemical dechlorination
		Biological treatment (aerobic)	Slurry phase bioreactor, solid phase bioreactor, composting
		Land treatment	Land farming
	Disposal	On-site disposal	RCRA landfill, industrial solid waste landfill
		Off-site disposal	RCRA landfill, debris landfill, industrial solid waste landfill

access restrictions such as land use restrictions or deed restrictions. This action may also include some type of environmental monitoring.

3.1.3 Containment

Containment involves the prevention or minimization of the escape of contaminants from the site through leaching and/or dust migration. Containment technologies may include surface controls, capping, vertical barriers, and subsurface horizontal barriers. As in the no-action and institutional action response, no active remediation is provided. However, containment may reduce the potential risk to human health and the environment by preventing exposure pathways.

3.1.4 In Situ Treatment

In situ treatment is a response action that allows treatment to be effected without excavation of the contaminated soil. Categories of in situ treatment technologies include physical treatment, thermal treatment, chemical treatment, and biological treatment. Combinations of in situ treatment technologies may be used under this response action.

3.1.5 Excavation/Disposal

The excavation/disposal response action involves excavation and disposal of contaminated soils. Excavation technology is well developed and the sites of concern at Holloman AFB allow direct application of excavation methods. This general response action would result in removal of the contaminants from the site and could achieve the acceptable cleanup levels specified in the RAOs. Options for disposal under this general response action may include disposal of contaminated soils in either an on-site or off-site landfill. The excavated area could be backfilled with clean soil.

3.1.6 Excavation/Treatment/Disposal

This general response action is similar to the excavation/disposal response action. However, this action provides for treatment of the contaminated soils prior to disposal. Categories of treatment technologies under this response action include physical treatment, on-site thermal treatment, off-site thermal treatment, chemical treatment, and biological treatment. Under this response action, it may be possible to backfill the excavated area either with treated soil or with clean soil.

3.2 Identification and Screening of Remedial Technology Types and Process Options

This section describes the remedial technology types and process options that are potentially applicable to the sites. The two-step screening process includes initial screening and evaluation of the technologies. In the initial screening, those technologies that were not technically implementable were eliminated from further consideration. A summary of the screening of the technology types identified for potential application at Sites 2&5, 8, and 14 is presented in Table 3-2.

As stated in the RAOs, the contaminants of concern are as follows: Sites 2&5, TPH; Site 8, pesticides and metals; and Site 14, pesticides. The applicability of the technologies to these contaminants is listed in Table 3-2.

3.2.1 Identification and Screening of Technologies

For each general response action identified in Section 3.1, remedial technology types that may potentially be implemented as part of the response action were identified. Furthermore, specific process options were identified for each of these remedial technology types. The term "technology types" refers to general categories of technologies, such as

Table 3-2

Description and Initial Screening of Process Options for Soil

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments	Contaminant Applicability
No Action	None	Not applicable	No action.	Potentially applicable	TPH, Pesticides, Metals
Institutional Action	Access restrictions	Land use restrictions	Fence with controlled access surrounding the contaminated areas.	Potentially applicable	TPH, Pesticides, Metals
		Deed restrictions	Deeds for property in the area of influence would include restrictions on use.	Potentially applicable	TPH, Pesticides, Metals
	Monitoring	Groundwater monitoring	Monitor groundwater for contaminants.	Potentially applicable	TPH, Pesticides, Metals
Containment	Surface controls	Sediment control	Collection of runoff water that may contain contaminated sediments.	Potentially applicable	TPH, Pesticides, Metals
		Dust control	Suppression of airborne particulate matter.	Potentially applicable	TPH, Pesticides, Metals
	Capping	Bentonite and soil	Application of a bentonite/soil/water mixture over areas of contamination to prevent contact with contaminated soils.	Potentially applicable	TPH, Pesticides, Metals
		Clay	Compacted clay with vegetative cover over areas of contamination to prevent infiltration.	Potentially applicable	TPH, Pesticides, Metals
		Asphalt	Application of a layer of asphalt over areas of contamination to prevent infiltration.	Potentially applicable	TPH, Pesticides, Metals
		Concrete	Installation of a concrete slab over areas of contamination to prevent infiltration.	Potentially applicable	TPH, Pesticides, Metals
		Multimedia	Combination of clay and synthetic membrane covered by soil over areas of contamination to prevent infiltration.	Potentially applicable	TPH, Pesticides, Metals
	Vertical barriers	Slurry wall	Trench around areas of contamination is filled with a soil (or cement) bentonite slurry.	Not applicable; no formation to key into	NA
		Grout curtain	Pressure injection of grout in a regular pattern of drilled holes around contaminated area.	Not applicable; no formation to key into	NA
		Vibrating beam	Vibrating force to advance beams into the ground with injection of slurry as beam is withdrawn.	Not applicable; no formation to key into	NA
		Sheet pile wall	Series of interconnected sheet piles driven into soil and left in place.	Not applicable; no formation to key into	NA

Table 3-2

(Continued)

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments	Contaminant Applicability
Containment (cont.)	Subsurface horizontal barriers	Grout injection	Pressure injection of grout at depth below contaminated zone through closely spaced drilled holes.	Not applicable; no formation to key into	NA
		Block displacement	In conjunction with vertical barriers, injection of slurry in notched injection holes to totally isolate the bottom and the perimeter of contaminated zone.	Not applicable; no formation to key into	NA
In Situ Treatment	Physical treatment	Soil vapor extraction	Negative pressure applied to soil to enhance volatilization of organic compounds. Collection and treatment of gases and condensate. Forced air injection may be used to achieve higher removal rates.	Potentially applicable	TPH
		In situ air stripping	Injecting air into soils to enhance volatilization, coupled with collection and treatment of gases and condensate.	Potentially applicable	TPH
		Soil flushing	Flushing soil with solution to mobilize contaminants for extraction and treatment.	Potentially applicable	TPH, Pesticides, Metals
		Stabilization/solidification	Use of portland cement, clays, fly ash, and/or kiln dust to adsorb contaminants and solidify soils with pozzolanic effect.	Potentially applicable	TPH, Pesticides, Metals
	Thermal treatment	Radio frequency heating	Heating soil mass to enhance volatilization and cause chemical bond cleavage, coupled with collection and treatment of gases and condensate.	Potentially applicable	TPH, Pesticides
		In situ vitrification	Electrodes inserted into soil to melt soil and volatilize organics, coupled with collection and treatment of gases.	Potentially applicable	TPH, Pesticides, Metals
		In situ steam stripping	Injecting steam into soil to enhance volatilization coupled with collection and treatment of gases and condensate.	Potentially applicable	TPH, Pesticides
	Chemical treatment	Chemical oxidation	System of injection wells or trenches to deliver oxidizing agents to contaminated soils.	Potentially applicable	TPH, Pesticides
	Biological treatment (aerobic)	Biosparging	Injecting air into saturated soils to enhance aerobic degradation of organics by microorganisms.	Potentially applicable	TPH
		Bioremediation	Extracting, adding nutrients and oxidants to, and reinjecting groundwater to enhance aerobic degradation of organics in soils.	Potentially applicable	TPH, Pesticides
	Biological treatment (anaerobic)	Anaerobic biodegradation	Degradation of organics using microorganisms in an anaerobic environment.	Potentially applicable	TPH, Pesticides

Table 3-2

(Continued)

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments	Contaminant Applicability
Excavation/Disposal					
Excavation	Excavation	Backhoe	Hydraulically operated bucket for scooping soils.	Potentially applicable	TPH, Pesticides, Metals
		Front-end loader	Conventional loader with hydraulically controlled bucket on front.	Potentially applicable	TPH, Pesticides, Metals
		Clam shell	A bucket with two jaws that clamp together to load by their own weight.	Potentially applicable	TPH, Pesticides, Metals
		Drag line	Cable controlled bucket.	Potentially applicable	TPH, Pesticides, Metals
	Soil replacement	Backfill with clean soil	Use of clean soil to backfill excavated areas.	Potentially applicable	TPH, Pesticides, Metals
Disposal	On-site disposal	RCRA landfill	Placement of untreated excavated soil in a yet-to-be-constructed on-site, permitted hazardous waste landfill.	Potentially applicable	TPH, Pesticides, Metals
		Industrial solid waste landfill	Placement of untreated excavated soil in a yet-to-be constructed on-site industrial solid waste landfill.	Potentially applicable	TPH, Pesticides, Metals
	Off-site disposal	RCRA landfill	Placement of untreated excavated soil in an existing off-site permitted hazardous waste landfill.	Potentially applicable	TPH, Pesticides, Metals
		Industrial solid waste landfill	Placement of untreated excavated soil in an existing off-site industrial solid waste landfill.	Potentially applicable	TPH, Pesticides, Metals
Excavation/Treatment/Disposal					
Excavation	Excavation	Backhoe	Hydraulically operated bucket for scooping soils.	Potentially applicable	TPH, Pesticides, Metals
		Front-end loader	Conventional loader with hydraulically controlled bucket on front.	Potentially applicable	TPH, Pesticides, Metals
		Clam shell	A bucket with two jaws that clamp together to load by their own weight.	Potentially applicable	TPH, Pesticides, Metals
		Drag line	Cable controlled bucket.	Potentially applicable	TPH, Pesticides, Metals

Table 3-2

(Continued)

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments	Contaminant Applicability
Excavation (cont.)	Soil replacement	Backfill with treated soil	Use of treated soil to backfill excavated areas (i.e., excavate, treat, and replace).	Potentially applicable	TPH, Pesticides, Metals
		Backfill with clean soil	Use of clean soil to backfill excavated areas.	Potentially applicable	TPH, Pesticides, Metals
Treatment	Physical treatment	Soil washing	Mixing contaminated soil with a flushing solution to rinse out contaminants. Appropriate for granular soils.	Potentially applicable	TPH, Pesticides, Metals
		Steam stripping	Passing steam through contaminated soil to drive off volatile contaminants.	Potentially applicable	TPH, Pesticides
		Air stripping/vacuum extraction	Forcing or pulling air through contaminated soil to remove volatile contaminants.	Potentially applicable	TPH
	On-site thermal treatment	Low-temperature thermal treatment	Low-temperature heating and agitation to drive off volatile contaminants. Coupled with collection and treatment of gases and condensate.	Potentially applicable	TPH, Pesticides
		Infrared thermal desorption	Higher temperature heating by infrared heaters to drive off volatile and semivolatile contaminants. Coupled with collection and treatment of gases and condensate.	Potentially applicable	TPH, Pesticides
	Off-site thermal treatment	Rotary kiln incineration	Combustion in a horizontally rotating cylinder designed for uniform heat transfer.	Potentially applicable	TPH, Pesticides
		Fluidized-bed incineration	Incineration in "fluidized" bed of granular material.	Potentially applicable	TPH, Pesticides
		Infrared incineration	Incineration in a combustion chamber with infrared heating elements.	Potentially applicable	TPH, Pesticides
		Circulating bed combustor	Incineration using high velocity air to suspend bed materials.	Potentially applicable	TPH, Pesticides
		Codisposal	Use of contaminated soil as a fuel source or a raw material in existing thermal processes.	Not applicable; Btu value of soil too low	NA
		Pyrolysis	Combustion without oxygen in refractory lined chamber.	Potentially applicable	TPH, Pesticides

Table 3-2

(Continued)

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments	Contaminant Applicability
Treatment (cont.)	Chemical treatment	Stabilization/solidification	Use of fly ash, portland cement, clays, or kiln dust to immobilize contaminants and solidify soils.	Potentially applicable	TPH, Pesticides, Metals
		Encapsulation	Enclosure or coating with a new substance to prevent leaching.	Potentially applicable	TPH, Pesticides, Metals
		Solvent extraction	Use of solvents to extract contaminants.	Potentially applicable	TPH, Pesticides, Metals
		Supercritical solvent extraction	Use of solvents at or above their critical point to extract contaminants.	Potentially applicable	TPH, Pesticides, Metals
		Acid extraction	Washing of soil with an acid to remove heavy metals from contaminated soil.	Potentially applicable	Metals
		Chemical oxidation	Use of ozone, hydrogen peroxide, and/or UV light to oxidize contaminants.	Potentially applicable	Pesticides
		Chemical dechlorination	Removal of chlorine from organic contaminants in soil to reduce biological toxicity.	Potentially applicable	Pesticides
	Biological treatment (Aerobic)	Slurry phase bioreactor	Biodegradation of soils mixed with water.	Not applicable for low-strength wastes	NA
		Solid phase bioreactor	Biodegradation of soils in a batch reactor.	Potentially applicable	TPH
		Composting	Use of naturally occurring microorganisms to degrade contaminants in soils.	Potentially applicable	TPH, Pesticides
	Land treatment	Landfarming	Incorporation of contaminated soil or waste in surface soil for natural biodegradation processes.	Potentially applicable	TPH, Pesticides

Table 3-2

(Continued)

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments	Contaminant Applicability
Disposal	On-site disposal	RCRA landfill	Placement of treated soil in a yet-to-be constructed on-site permitted hazardous waste landfill.	Potentially applicable	TPH, Pesticides, Metals
		Industrial solid waste landfill	Placement of treated soil in a yet-to-be-constructed on-site industrial solid waste landfill.	Potentially applicable	TPH, Pesticides, Metals
	Off-site disposal	RCRA landfill	Placement of treated soil in an existing off-site permitted hazardous waste landfill.	Potentially applicable	TPH, Pesticides, Metals
		Debris landfill	Placement of treated soil in an existing off-site construction debris landfill.	Not applicable due to regulatory restrictions	NA
		Industrial solid waste landfill	Placement of treated soil in an existing off-site permitted industrial solid waste landfill.	Potentially applicable	TPH, Pesticides, Metals

[ ] Indicates process options that have been screened out due to lack of technical implementability.

NA = Not applicable.

capping, chemical treatment, and in situ biological treatment. The term "technology process options" refers to specific processes within each technology type. For example, the chemical treatment technology type would include such process options as stabilization/solidification, encapsulation, and chemical dechlorination. To aid in the identification and screening of remedial technology types and process options, the following documents were consulted:

- *Technology Screening Guide for Treatment of CERCLA Soils and Sludges* (U.S. EPA, 1988);
- *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final* (U.S. EPA, 1988);
- *Guide to Treatment Technologies for Hazardous Wastes at Superfund Sites* (U.S. EPA, 1989);
- *Handbook on In Situ Treatment of Hazardous Waste-Contaminated Soils* (U.S. EPA, 1990); and
- *The Superfund Innovative Technology Evaluation Program: Technology Profiles,* 4th edition (U.S. EPA, 1991).

After the remedial technology types and process options were identified, the individual process options were reviewed on the basis of their technical implementability in an initial screening process. The process options were determined to be either potentially applicable or not applicable. This initial screening considered the influence of the type of contaminants (e.g., TPH, pesticides, metals) and physical constraints (e.g., depth of contamination, type of soil, subsurface conditions, etc.). For example, some process options were screened from further consideration because they were not applicable to any of the contaminants at the sites. Others were screened because they were not implementable because of the subsurface conditions at the sites.

3.2.2 Technology Process Options Screened Out

This section provides the reasons for screening specific process options. The individual process options that are shaded in Table 3-2 were not considered to be technically

implementable at the sites. Therefore, these process options were eliminated from further consideration.

Vertical Barriers

The use of vertical barriers (e.g., slurry wall, grout curtain, vibrating beam, and sheet pile wall) was screened from further consideration because vertical barriers were not considered to be effective for the subsurface conditions present at the sites. There are no impermeable subsurface formations to connect with the vertical barriers. Therefore, contaminants could migrate under the vertical barriers.

Subsurface Horizontal Barriers

The use of subsurface horizontal barriers was screened from further consideration because the subsurface conditions at the sites of concern do not allow the contaminated zone to be isolated by this method. These barriers would not be effective in preventing migration of the contaminants.

Codisposal

This process option involves the use of waste material as a fuel source or a raw material in industrial processes such as cement kilns, asphalt plants, and steel blast furnaces. Codisposal was screened from further consideration because the heat of combustion of the contaminated soils at the sites is too low for the soils to be used as a secondary fuel source. Also, the soil may not be a suitable raw material for these industrial processes. Acceptance of hazardous soils would be unlikely.

Slurry Phase Bioreactor

This process option involves biological treatment of a slurry mixture of soils and water. Because slurry phase bioreactors are not appropriate for the treatment of low-strength wastes, this process option was screened from further consideration.

Disposal in Debris Landfills

The disposal of soils in off-site construction debris landfills was screened from further consideration. This technology process option is not implementable because of regulatory restrictions that prohibit the disposal of contaminated soils in debris landfills.

3.3 Evaluation of Technologies and Selection of Representative Technology Types and Process Options

Technology process options remaining after the initial screening were evaluated on the basis of their effectiveness, implementability, and cost. A summary of the evaluation of the process options is shown in Table 3-3.

For this evaluation, the criteria used to determine the effectiveness of technologies were: 1) the potential effectiveness of the process option for handling the estimated areas and volumes of soil and for meeting the remediation goals established in the RAOs, 2) the potential impacts to human health and the environment during the construction and implementation phases, and 3) the reliability of the process with respect to the contaminants and conditions at the sites.

The implementability for each process option was based on both the technical and administrative feasibility of implementing the process. Since technical implementability was used in the initial screening of technology types and process options, the evaluation of

Table 3-3

Summary of Evaluation of Process Options for Soil

General Response Action	Remedial Technology	Process Options	Effectiveness	Implementability	Capital Cost	O&M Cost
No Action	None	Not applicable	Does not achieve remedial action objectives.	Not acceptable	None	None
Institutional Action	Access restrictions	Land use restrictions	Effectiveness depends on continued future implementation. Does not reduce contamination.	Legal requirements. Restrictions may be difficult to enforce.	Low	NA
		Deed restrictions	Effectiveness depends on continued future implementation. Does not reduce contamination.	Legal requirements. Requires issuance of a deed.	Moderate	NA
	Monitoring	Groundwater monitoring	Useful to document conditions. Does not reduce contamination.	Readily implemented.	Moderate	Moderate
Containment	Surface controls	Sediment control	Effective. Does not reduce contaminant concentrations.	Readily implemented.	Low	Low
		Dust control	Effective. Does not reduce contaminant concentrations.	Readily implemented.	Low	Low
	Capping	Bentonite and soil	Effective in preventing infiltration of rainwater and exposure to contaminants. Cracks self sealing. Does not reduce contaminant concentrations.	Readily implemented. Future land use restrictions.	Low	Low
		Clay	Effective in preventing infiltration of rainwater and exposure to contaminants. Susceptible to weathering and cracking. Does not reduce contaminant concentrations.	Readily implemented. Future land use restrictions.	Low	Low
		Asphalt	Effective in preventing infiltration of rainwater and exposure to contaminants. Susceptible to weathering and cracking. Cracks repairable. Does not reduce contamination.	Readily implemented. Future land use restrictions.	Low	Low

Table 3-3

(Continued)

General Response Action	Remedial Technology	Process Options	Effectiveness	Implementability	Capital Cost	O&M Cost
Containment (cont.)	Capping (cont.)	Concrete	Effective in preventing infiltration of rainwater and exposure to contaminants. Susceptible to weathering and cracking. Cracks repairable. Does not reduce contamination.	Readily implemented. Future land use restrictions.	Moderate	Low
		Multi-media	Effective in preventing infiltration of rainwater and exposure to contaminants. Does not reduce contaminant concentrations.	Readily implemented. Future land use restrictions.	Moderate	Low
In Situ Treatment	Physical treatment	Soil vapor extraction	Effective for removing volatile organic contaminants.	Readily implemented in unsaturated soils.	Low	Moderate
		In situ air stripping	Effective for removing volatile organic contaminants.	Readily implemented.	Moderate	Moderate
		Soil flushing	Effective. Potential for mobilized contaminants to escape site.	Readily implemented.	Moderate	High
		Stabilization/solidification	Effective and reliable.	Readily implemented.	Moderate	Low
	Thermal treatment	Radio frequency heating	Effective for small areas.	Readily implemented in unsaturated soils.	Moderate	High
		In situ vitrification	Effective destruction of organics and binding of inorganic contaminants.	Readily implemented in unsaturated soils.	High	Very high
		In situ steam stripping	Effective for removing organic contaminants.	Readily implemented.	Moderate	High
	Chemical treatment	Chemical oxidation	Effective destruction of organics.	Readily implemented.	Moderate	Moderate
	Biological treatment (aerobic)	Biosparging	Effective for degrading organic contaminants.	Readily implemented.	Moderate	Moderate
		Bioremediation	Effective for degrading organics.	Readily implemented.	Moderate	Moderate
	Biological treatment (anaerobic)	Anaerobic biodegradation	Effective for some organic contaminants.	Readily implemented.	Moderate	Moderate

Table 3-3

(Continued)

General Response Action	Remedial Technology	Process Options	Effectiveness	Implementability	Capital Cost	O&M Cost
Excavation/Disposal						
Excavation	Excavation	Backhoe	Effective and reliable.	Readily implemented.	Low	Low
		Front-end loader	Effective and reliable.	Readily implemented.	Low	Low
		Clam shell	Effective and reliable.	Readily implemented.	High	High
		Drag line	Effective and reliable.	Readily implemented.	High	High
	Soil replacement	Backfill with clean soil	Effective.	Readily implemented.	Moderate	Low
Disposal	On-site disposal	On-site RCRA landfill	Effective disposal method.	Difficult to implement due to permit requirements and land-ban restrictions	High	Moderate
		On-site industrial solid waste landfill	Effective disposal method.	Readily implemented for non-hazardous wastes. Land-ban restrictions.	Moderate	Low
	Off-site disposal	RCRA landfill	Effective disposal method.	Readily implemented for non-land-banned wastes.	High transportation costs.	High disposal costs
		Industrial solid waste landfill	Effective disposal method.	Readily implemented for non-hazardous wastes. Land-ban restrictions. Some contaminants may not be accepted.	Moderate transportation costs	Low disposal costs
Excavation/Treatment/Disposal						
Excavation	Excavation	Backhoe	Effective and reliable.	Readily implemented.	Low	Low
		Front-end loader	Effective and reliable.	Readily implemented.	Low	Low
		Clam shell	Effective and reliable.	Readily implemented.	High	High
		Drag line	Effective and reliable.	Readily implemented.	High	High
	Soil replacement	Backfill with treated soil	Effective.	Readily implemented.	Low	Low
		Backfill with clean soil	Effective.	Readily implemented.	Moderate	Low
Treatment	Physical treatment	Soil washing	Effective for organic and inorganic contaminants.	Readily implemented.	Moderate	High
		Steam stripping	Effective removal of organic contaminants.	Materials handling limitations.	High	High
		Air stripping/vacuum extraction	Effective removal of volatile organic contaminants.	Materials handling limitations.	Moderate	Moderate

Table 3-3

(Continued)

General Response Action	Remedial Technology	Process Options	Effectiveness	Implementability	Capital Cost	O&M Cost
Treatment (cont.)	On-site thermal treatment	Low-temperature thermal treatment	Effective removal of volatile organic contaminants.	Readily implemented.	Moderate	Moderate
		Infrared thermal desorption	Effective removal of organic contaminants	Readily implemented.	High	High
	Off-site thermal treatment	Rotary kiln incineration	Effective and reliable destruction of organics.	Readily implemented.	High transportation costs	High treatment costs
		Fluidized-bed incineration	Effective and reliable.	Readily implemented.	High transportation costs	High treatment costs
		Infrared incineration	Effective and reliable.	Readily implemented.	High transportation costs	High treatment costs
		Circulating bed combustor	Effective and reliable destruction of organics.	Readily implemented.	High transportation costs	High treatment costs
		Pyrolysis	Effective and reliable destruction of organics.	Readily implemented.	High transportation costs	High treatment costs
	Chemical treatment	Stabilization/solidification	Effective.	Readily implemented.	Moderate	Moderate
		Encapsulation	Not effective for some organics.	Difficult to implement.	Moderate	Low
		Solvent extraction	Effective removal of organics and metals.	Readily implemented.	Moderate	Moderate
		Supercritical solvent extraction	Effective removal of organics and metals.	Readily implemented.	High	Moderate
		Acid extraction	Effective removal of metals.	Readily implemented.	Moderate	Moderate
		Chemical oxidation	Effective destruction of organics.	Readily implemented.	Moderate	Moderate
		Chemical dechlorination	Effective destruction of chlorinated organics.	Readily implemented.	Moderate	Moderate
	Biological treatment (aerobic)	Solid phase bioreactor	Effective removal of organics in soils.	Readily implemented.	Moderate	Moderate
		Composting	Limited effectiveness for removal of organics in soils.	Difficult to implement.	Moderate	Low
	Land treatment	Landfarming	Limited effectiveness for removal of organics in soils.	Difficult to implement. Requires large areas.	Moderate	Low

Table 3-3

(Continued)

General Response Action	Remedial Technology	Process Options	Effectiveness	Implementability	Capital Cost	O&M Cost
Disposal	On-site disposal	On-site RCRA landfill	Effective disposal method.	Difficult to implement due to permit requirements and land-ban restrictions.	High	Moderate
		On-site industrial solid waste landfill	Effective disposal method.	Readily implemented for non-hazardous wastes. Land-ban restrictions.	Moderate	Low
	Off-site disposal	RCRA landfill	Effective disposal method.	Readily implemented for non-land-banned wastes.	High transportation costs	High disposal costs
		Industrial solid waste landfill	Effective disposal method.	Readily implemented for non-hazardous wastes. Land-ban restrictions. Some contaminants may not be accepted.	Moderate transportation costs	Low disposal costs

implementability conducted in this section placed greater emphasis on the institutional aspects, such as the ability to obtain necessary permits; the availability of treatment, storage, and disposal (TSD) facilities; and the availability of equipment and skilled workers required to implement the technology.

Cost played a limited role in the evaluation of the individual process options. Instead of detailed estimates, very high, high, moderate, and low capital and operation and maintenance (O&M) costs were assigned to the process options relative to the other process options within the same technology type.

From the general response actions discussed in Tables 3-2 and 3-3, remedial technology types and representative process options were chosen for use in developing remedial alternatives. The technology types most suitable for the particular sites were chosen for use in alternative development. Likewise, the process options that were most applicable to the conditions at the sites were chosen to represent the other process options within each technology type. In selecting the appropriate representative process options, Sites 2&5, 8, and 14 were considered separately, since the types of contaminants in the soil differ. The combination of technology types with process options (Tables 3-2 and 3-3) from one or more general response actions formed multiple alternatives for remediation of contaminated soils.

Representative process options are shown in Tables 3-4, 3-5, and 3-6 for Sites 2&5, 8, and 14, respectively. These representative process options provide the basis for developing performance specifications during the preliminary design. However, the specific process options actually used to implement the remedial alternative may not be selected until the remedial design phase, since the process options represent multiple options within the same technology type. The following paragraphs describe the reasons certain technology types were chosen and specific process options were selected to represent others within the technology type.

Table 3-4

Selected Remedial Technologies and Representative Process Options for Sites 2&5

General Response Action	Remedial Technology	Representative Process Option
No Action	No action	Groundwater monitoring
Containment	Capping	Clay cap
In Situ Treatment	Aerobic biological treatment	Biosparging
	Physical Treatment	Soil vapor extraction
Excavation/Disposal		
Excavation	Excavation	Backhoe
Disposal	Off-site disposal (nonhazardous)	Industrial solid waste landfill
Excavation/Treatment/Disposal		
Excavation	Excavation	Backhoe
On-Site Treatment	Thermal treatment	Low-temperature thermal treatment
Disposal	On-site disposal	Use of treated soil to backfill excavation

Table 3-5

Selected Remedial Technologies and Representative Process Options for Site 8

General Response Action	Remedial Technology	Representative Process Option
No Action	No action	Groundwater monitoring
Institutional Action	Access restrictions	Land use restrictions
Containment	Capping	Asphalt cap
Excavation/Disposal (for nonhazardous soil)		
Excavation	Excavation	Front-end loader
Disposal	Off-site disposal	Industrial solid waste landfill
Excavation/Treatment/Disposal (for hazardous soil)		
Excavation	Excavation	Front-end loader
Off-Site Treatment	Thermal treatment	Rotary kiln incineration
Off-Site Treatment	Chemical treatment	Fixation/stabilization
Disposal	Off-site disposal	RCRA landfill

Table 3-6

Selected Remedial Technologies and Representative Process Options for Site 14

General Response Action	Remedial Technology	Representative Process Option
No Action	No action	Not applicable
Institutional Action	Access restrictions	Land use restrictions
Containment	Capping	Asphalt cap
Excavation/Disposal		
Excavation	Excavation	Front-end loader
Disposal	Off-site disposal	RCRA landfill
Excavation/Treatment/Disposal		
Excavation	Excavation	Front-end loader
On-Site Treatment	Thermal treatment	Infrared thermal desorption
Off-Site Treatment	Thermal treatment	Rotary kiln incineration
Disposal	On-site disposal	Use treated soil to backfill excavation
	Off-site disposal (for soil treated on site)	Industrial solid waste landfill
	Off-site disposal (for soil treated off site)	RCRA landfill

3.3.1 Technology Types and Representative Process Options for Soil at Sites 2&5

No Action

This response action was included to provide for the evaluation of a no-action alternative. The no-action response is used as a baseline against which other response actions and technologies can be compared.

Institutional Action

Institutional action was not considered in developing remedial alternatives. Since there is no risk at Sites 2&5, access restrictions would not be an appropriate technology for this site.

Containment

Capping was chosen for this response action because it is the most readily implemented technology type. Clay capping was selected as the representative process option for constructing a cap over the contaminated area at Sites 2&5 because it would be resistant to organics that may volatilize and reach the surface. A clay cap would be reliable in preventing infiltration of water through the contaminated soil, and would have little detrimental impact on human health and the environment during its construction and implementation. The cap would also allow vehicles to be driven onto the area.

In Situ Treatment

Aerobic biological treatment was chosen for an in situ treatment response action because of two advantages. It is potentially effective for degrading organic contaminants and has moderate capital and O&M costs. Biosparging was selected as the representative option for the technology type because of its ability to aggressively enhance

biodegradation of contaminants such as petroleum hydrocarbons. This process option could be effective in preventing future groundwater contamination.

Physical treatment through soil vapor extraction (SVE) was also chosen as a separate in situ treatment response action for Sites 2&5. SVE is effective in removing volatile contaminants from soils and may be operated to enhance in situ bioremediation. Capital and O&M costs are also moderate for this process option.

Excavation/Disposal

Excavation by backhoe was selected as the representative option because of its effectiveness and reliability. This option was determined to be appropriate for the depths to which soil may need to be excavated (0 to 13 ft bgl). The off-site disposal technology type was selected because of the administrative difficulties in implementing on-site disposal options. On the basis of TCLP results, soil samples were not characteristically hazardous. Therefore, disposal of soils in an off-site industrial solid waste landfill was chosen as the representative process option. The excavation is backfilled with clean soil.

Excavation/Treatment/Disposal

Excavation by backhoe was selected as the representative option because of its effectiveness and reliability. This option was determined to be appropriate for the depths to which soil may need to be excavated. On-site thermal treatment was selected for the treatment technology under this response action because of its effectiveness and reliability in removing and/or destroying organic contaminants. Low-temperature thermal treatment was selected as the representative process option for on-site treatment because of its effectiveness in removing volatile organic contaminants. Use of the treated soil to backfill the excavation was selected as the disposal option because it was determined to be feasible and economical.

3.3.2 Technology Types and Representative Process Options for Soil at Site 8

No Action

This response was included to provide for the evaluation of a no-action alternative. The no-action response is used as a baseline against which other response actions can be compared.

Institutional Action

The use of access restrictions was the technology type selected to represent this response action. The use of land use restrictions was the process option selected to represent the technology type, because of the difficulty in implementing deed restrictions.

Containment

Capping was chosen for this response action because it is the most readily implemented technology type. Asphalt capping was selected as the representative process option for constructing a cap over the contaminated areas at Site 8, although different capping materials are very similar in their effectiveness and implementability. Asphalt capping would allow vehicles and equipment to be driven onto the area regularly. All of the process options for capping technology would be reliable in preventing exposure to contaminants. All capping process options would have little detrimental impact on human health and the environment during the construction phase.

In Situ Treatment

In situ treatment was determined to be impractical at Site 8, since the contamination was estimated to extend to a depth of only 2 ft bgl in most areas. Consequently,

no technology types and process options from this general response action were selected for inclusion in remedial alternatives.

Excavation/Disposal

This general response action is feasible for soil determined to be nonhazardous. Excavation by front-end loader was selected as the representative option because of its effectiveness and reliability. This option was determined to be the most appropriate method, considering the shallow depths to which soil may need to be excavated (between 2 and 4 ft bgl). The off-site disposal technology type was selected because of the administrative and regulatory requirements for implementing on-site disposal options. Disposal of the soil in an industrial solid waste landfill was selected as the representative option because it was determined to be feasible and economical for nonhazardous soils. The excavation is backfilled with clean soil.

Excavation/Treatment/Disposal

This general response action is required for soil determined to be hazardous. Excavation by front-end loader was selected as the representative option because of the effectiveness and reliability of the method. This option was determined to be the most appropriate, considering the shallow depths to which soil may need to be excavated.

Off-site incineration was selected as a treatment technology. Incineration may be required if the soil at Site 8 is hazardous with respect to chlordane and/or heptachlor and if these chemicals becomes subject to the land-ban regulations. Rotary kiln incineration was selected as the representative process option because of its proven effectiveness and the availability of facilities. The treated soil is stabilized and disposed of in an off-site RCRA hazardous waste landfill.

Off-site chemical treatment was also selected as a treatment technology under this response action. Stabilization/solidification was selected as the representative process option for off-site chemical treatment because of its effectiveness in binding metals. Also, by varying the amounts of solidifying agents and the curing time, the desired degree of chemical stabilization and compressive strength can be achieved without an excessive increase in volume. Stabilization/solidification could be used for hazardous soil that is not subject to the land-ban regulations or for residue from land-banned soil after it has been incinerated.

The off-site disposal technology type was selected because of the administrative difficulties in implementing on-site disposal options. Disposal of soils in an off-site RCRA landfill was chosen as the representative process option because disposal in an industrial solid waste landfill would not be feasible for hazardous soil. The excavation is backfilled with clean soil.

3.3.3 Technology Types and Representative Process Options for Soil at Site 14

No Action

This response was included to provide for the evaluation of a no-action alternative. The no-action response is used as a baseline against which other response actions can be compared.

Institutional Action

The use of access restrictions was the technology type selected to represent this response action. The use of land use restrictions was the process option selected to represent the technology type, because of the difficulty in implementing deed restrictions.

Containment

Capping was chosen for this response action because it is the most readily implemented technology type. Asphalt capping was selected as the representative process option for constructing a cap over the contaminated areas at Site 14, although different capping materials are very similar in their effectiveness and implementability. Asphalt capping would allow vehicles and equipment to be driven onto the area regularly. All of the process options for capping technology would be reliable in preventing exposure to contaminants. All capping process options would have little detrimental impact on human health and the environment during the construction and implementation phases.

In Situ Treatment

In situ treatment was determined to be impractical at Site 14, since the contamination was estimated to extend to a depth of only 2 ft bgl in most areas. Consequently, no technology types and process options from this general response action were selected for inclusion in remedial alternatives.

Excavation/Disposal

Excavation by front-end loader was selected as the representative option because of its effectiveness and reliability. This option was determined to be the most appropriate method, considering the shallow depths to which soil may need to be excavated (between 2 and 4 ft bgl). The off-site disposal technology type was selected because of the administrative and regulatory requirements for implementing on-site disposal options. Disposal of soil in an off-site RCRA hazardous waste landfill was chosen as the representative process option. Although soil samples from the site were not analyzed by TCLP methods, concentrations of chlordane in the samples indicate that the soil is likely to be considered hazardous. The excavation is backfilled with clean soil.

Excavation/Treatment/Disposal

Excavation by front-end loader was selected as the representative option because of its effectiveness and reliability. This option was determined to be the most appropriate, considering the shallow depths to which soil may need to be excavated. On- and off-site thermal treatment were selected for the treatment technologies under this response action. Infrared thermal desorption was selected as the representative process option for on-site treatment because of its effectiveness in removing organic contaminants. Two disposal options were chosen for use with on-site treatment: 1) the use of treated soil to backfill the excavation, and 2) disposal of the soil in an off-site industrial solid waste landfill. For the latter option, the excavation is backfilled with clean soil.

Rotary kiln incineration was selected as the representative process option for off-site thermal treatment because of its proven effectiveness. The treated soil is disposed of in an off-site RCRA hazardous waste landfill. The excavation is backfilled with clean soil.

4.0 IDENTIFICATION AND SCREENING OF ALTERNATIVES

This section describes the development of remedial action alternatives to address the contaminated soil at Sites 2&5, 8, and 14. The alternatives were developed from combinations of the selected representative process options previously identified in Section 3.0. The assumptions and rationale used in developing the alternatives are discussed in Section 4.1. A description and evaluation of each alternative are presented in Section 4.2. The evaluation is based on effectiveness, implementability, and cost. In Section 4.3, the most promising alternatives are recommended for detailed analysis.

4.1 Development of Alternatives

Alternatives were developed to address each of the three sites of concern: Sites 2&5, 8, and 14. Soil was the only medium that was considered in developing the alternatives, since no media other than soil were identified in the RAOs. Each set of alternatives includes a no-action alternative and a limited action alternative, as well as alternatives that involve other general response actions, including containment, in situ treatment, excavation, treatment, and disposal.

Alternatives for Sites 2&5, 8, and 14 were developed by combining the representative process options presented in Tables 3-4, 3-5, and 3-6, respectively. All of the sites will be addressed in this section and in the section providing the detailed analysis of alternatives (Section 5.0).

One of the primary objectives for all sites was to develop alternatives that included a range of containment, in situ treatment, excavation, ex situ treatment, and disposal options.

A number of assumptions were used in the development of alternatives for each site. These assumptions provided the basis for combining the representative technologies into alternatives.

4.1.1 Development of Alternatives for Sites 2&5

In developing the alternatives for this site, it was necessary to make certain assumptions, since complete data were not available. The following assumptions were made for the remedial action alternatives for Sites 2&5:

- Soil is the only medium to be addressed.
- The primary area of contamination is beneath the soil mound, which is 235 ft long and 40 ft wide.
- The area of contamination is 9200 sq ft and has a volume of 5100 cu yd, as presented in Section 2.2.3. Also, a 325-sq ft area surrounding SB-02&5-24 is contaminated to a depth of 4 ft bgl, yielding an additional volume of 50 cu yd.
- The lower 2 ft of soil in the soil mound has TPH concentrations that exceed the cleanup criterion.
- The upper 2 ft of soil in the soil mound is not contaminated, but will be removed for alternatives that implement excavation as a remedial alternative. It has a volume of 700 cu yd.
- The soil beneath the mound is contaminated to a depth of 13 ft bgl.
- The total volume of contaminated soil is 5150 cu yd.
- The soil cleanup level for TPH is 1000 mg/kg.
- The alternatives for Sites 2&5 are intended to address the RAO for the site, which is to prevent future contamination of the groundwater.
- The soil is nonhazardous as indicated by results of TCLP VOC analyses performed on samples collected at Sites 2&5 during the PDI (May 1993).

- For alternatives involving excavation, a bulking factor of 15% is added to the volume of excavated soil to account for the greater volume the soil will occupy after excavation.

- The bulk density of the soil is assumed to be 1.25 tons per cu yd.

- Groundwater monitoring will be carried out as part of the Base-wide groundwater monitoring program. Therefore, groundwater monitoring costs are not included in the costs for the alternatives except for in situ treatment alternatives that include additional monitoring.

4.1.2 Development of Alternatives for Site 8

In developing the alternatives for this site, it was necessary to make certain assumptions, since complete data were not available. The following assumptions were made for the remedial action alternatives for Site 8:

- Soil is the only medium to be addressed.

- The area of contamination is 20,800 sq ft, as presented in Section 2.3.3.

- The volume of contaminated soil is 1610 cu yd.

- The contaminants to be addressed by the alternatives are based on the results of a risk assessment that was conducted using analytical results from the RI.

- The soil cleanup levels (mg/kg) for the contaminants are as follows:

4,4'-DDD	4.0
4,4'-DDE	3.3
4,4'-DDT	1.1
Cadmium	0.29
Chlordane	0.14
Lead	12.0
Mercury	0.016.

- The alternatives for Site 8 are intended to address the RAOs for the site, which are to prevent dermal contact with, and inhalation of, contaminated soil.

- For alternatives involving excavation, a bulking factor of 15% is added to the volume of excavated soil to account for the greater volume the soil will occupy after excavation.

- The bulk density of the soil is assumed to be 1.25 tons per cu yd.

- Groundwater monitoring will be carried out as part of the Base-wide groundwater monitoring program. Therefore, monitoring costs are not included in the costs for the alternatives.

- On the basis of data from the RI and the PDI, chlordane (Waste Code D020), heptachlor (Waste Code D031), and lead have the potential to cause the excavated soils to be characterized as hazardous waste (i.e., results of TCLP analyses may exceed the limits set in 40 CFR Section 261.24).

- For the purpose of this FS, two options (nonhazardous and hazardous) have been presented and discussed for each alternative in which waste classification impacts the implementability of the alternative. For example, if the alternative includes excavation and disposal in a landfill, Option A would reflect disposal in a nonhazardous waste landfill and Option B would reflect disposal in a RCRA landfill. The options are evaluated and costed separately.

4.1.3 Development of Alternatives for Site 14

In developing the alternatives for this site, it was necessary to make certain assumptions, since complete data were not available. The following assumptions were made for the remedial action alternatives for Site 14:

- Soil is the only medium to be addressed.

- The area of contamination is 9300 sq ft, with approximate dimensions of 170 ft by 55 ft.

- The volume of contaminated soil is 740 cu yd, as presented in Section 2.4.3.

- The contaminants to be addressed by the alternatives are based on the results of a risk assessment that was conducted using analytical results from the RI.

- The soil cleanup levels (mg/kg) for the contaminants are as follows:

4,4'-DDD	1.5
4,4'-DDE	1.0
4,4'-DDT	1.3
Aldrin	0.01
Chlordane	0.2
Heptachlor	0.1
Gamma BHC	0.7.

- The alternatives for Site 14 are intended to address the RAO for the site, which is to prevent dermal contact with contaminated soil.

- For alternatives involving excavation, a bulking factor of 15% is added to the volume of excavated soil to account for the greater volume the soil will occupy after excavation.

- The bulk density of the soil is assumed to be 1.25 tons per cu yd.

- Groundwater monitoring will be carried out as part of the Base-wide groundwater monitoring program. Therefore, monitoring costs are not included in the costs for the alternatives.

- On the basis of data from the RI, chlordane (Waste Code D020) and heptachlor (Waste Code D031) are likely to cause the excavated soils to be characterized as hazardous waste (i.e., results of TCLP analyses may exceed the limits set in 40 CFR Section 261.24). For the purpose of this FS, the soil is assumed to be hazardous by toxicity characteristic for chlordane and heptachlor.

4.2 Screening of Alternatives

The assembled alternatives were evaluated on the basis of their effectiveness, implementability, and cost. The following paragraphs describe the criteria used in the evaluation.

Effectiveness--Each of the alternatives was evaluated as to its effectiveness in protecting human health and the environment. The effectiveness includes consideration of level of protection that the alternative will provide and the degree to which it will reduce the toxicity, mobility, or volume of contaminants. Each alternative was also evaluated as

to its potential to comply with RAOs. In this document, both short- and long-term effectiveness were evaluated. For this evaluation, the short-term effectiveness refers to risk reduction during the construction and implementation period; the long-term effectiveness refers to risk reduction after completion of the remedial action.

Implementability--Each of the alternatives was also evaluated on the basis of its implementability. The evaluation of implementability included consideration of both the technical and administrative feasibility of the alternative. Technical feasibility, in this case, refers to the feasibility of constructing and reliably operating the technologies until the completion of the remedial action. Technical feasibility includes operation and maintenance of components of an alternative until remedial action is completed. Administrative feasibility includes the feasibility of obtaining permits and approvals from regulatory agencies, the availability of TSD facilities, and the availability of special equipment and specially trained technicians. A presentation of Applicable or Relevant and Appropriate Requirements (ARARs) that pertain to chemical-, technological-, and location-specific parameters is included as Appendix B.

The proposed Subpart S rules outline the general requirements for selection of remedies for corrective action at RCRA facilities. As structured, Subpart S establishes four basic standards that all remedies must meet. The standards require any alternatives to: 1) protect human health and the environment; 2) attain the cleanup criteria; 3) control the sources of releases so as to reduce further releases that may pose a threat to human health and the environment; and 4) comply with waste management standards. Although the evaluation of each alternative does not specifically discuss these standards, alternatives that did not meet these standards were not chosen for detailed analysis. The only exception to this approach is the no-action alternative for each site, which is included to provide a baseline of comparison for other alternatives.

Cost--An evaluation of the cost of each of the alternatives was also performed. Sources of data for cost estimating included vendor information, cost-estimating guides, and

the Cost of Remedial Action Model (CORA) developed by the U.S. EPA. The CORA model provides cost estimates with an accuracy of an order of magnitude. Thus, the cost estimates may not have the preferred accuracy of +50 to -30 percent. In most cases, unit costs for each technology process option were determined and applied to the estimates of the area and/or volume at each of the sites. The items that controlled the capital and O&M costs were identified for each alternative. Additional costs for startup and indirect costs were also included in the cost evaluation for each alternative.

For appropriate process options, O&M costs were estimated. The estimated O&M costs were converted into present worth costs to allow the costs for the different alternatives to be compared on a common basis. For the present worth costs, a long-term interest rate of 5% was used. The remediation time frames differed according to the process option. The equal series present worth factors used to determine present worth estimates of O&M costs were as follows:

- (P/A,5%,3) = 2.7232;
- (P/A,5%,5) = 4.3295;
- (P/A,5%,10) = 7.7217; and
- (P/A,5%,30) = 15.3725,

where (P/A,x%,y) designates the present worth factor of an annual uniform disbursement at x percent per year for y years. The conversion of the annual O&M costs to present worth values yielded significant total O&M costs. In some cases, the O&M costs control the cost of the alternatives.

Calculations for the preliminary design and cost estimate for each alternative are included in Appendix C.

4.2.1 Screening of Alternatives for Sites 2&5

This section provides a brief description of each remedial action alternative developed to address the RAO at Sites 2&5. A summary of the process options included in the alternatives is presented in Table 4-1. Also provided for each alternative is an evaluation of the effectiveness, implementability, and cost for the alternative. The area of contamination for Sites 2&5 is shown in Figure 4-1.

4.2.1.1 Alternative No. 1--No Action

Description--The no-action alternative provides a baseline for comparison of the other alternatives. This alternative does not institute any type of remedial action to reduce the potential for exposure at Sites 2&5, nor does it include institutional action, containment, excavation, treatment, or disposal technologies. The no-action alternative relies entirely on natural processes for any reduction in the concentration of contaminants.

Evaluation--Alternative No. 1 would not significantly reduce the toxicity, mobility, or volume of the contaminated soil within an acceptable time. Since no active remediation would occur, the alternative would have a protracted period of implementation. Since the no-action alternative would not prevent future contamination of groundwater at the site, it would not meet the RAO for the site.

The no-action alternative is readily implementable. There are no known regulatory restrictions that would prevent the actions under this alternative.

Alternative No. 1 has no capital or O&M costs associated with it.

Table 4-1

Assembled Alternatives for Sites 2&5

	Alternative Number					
	1	2	3	4	5	6
Representative Process Option						
Groundwater Monitoring			✓	✓		
Clay Capping		✓				
In Situ Biosparging				✓		
Soil Vapor Extraction			✓	✓		
Excavation by Backhoe					✓	✓
Backfill with Clean Soil						✓
Low-Temperature Thermal Treatment					✓	
Rotary Kiln Incinerator						
On-Site Disposal of Treated Soil (backfill)					✓	
Off-Site Industrial Solid Waste Landfill						✓
Off-Site RCRA Hazardous Waste Landfill						
Description of Alternatives						
1. No action						
2. Containment (clay capping)						
3. In situ treatment (soil vapor extraction/bioventing)						
4. In situ treatment (biosparging/soil vapor extraction)						
5. Excavation/on-site treatment (low-temperature thermal treatment)/backfill with treated soil						
6. Excavation/disposal (off-site industrial solid waste landfill)						

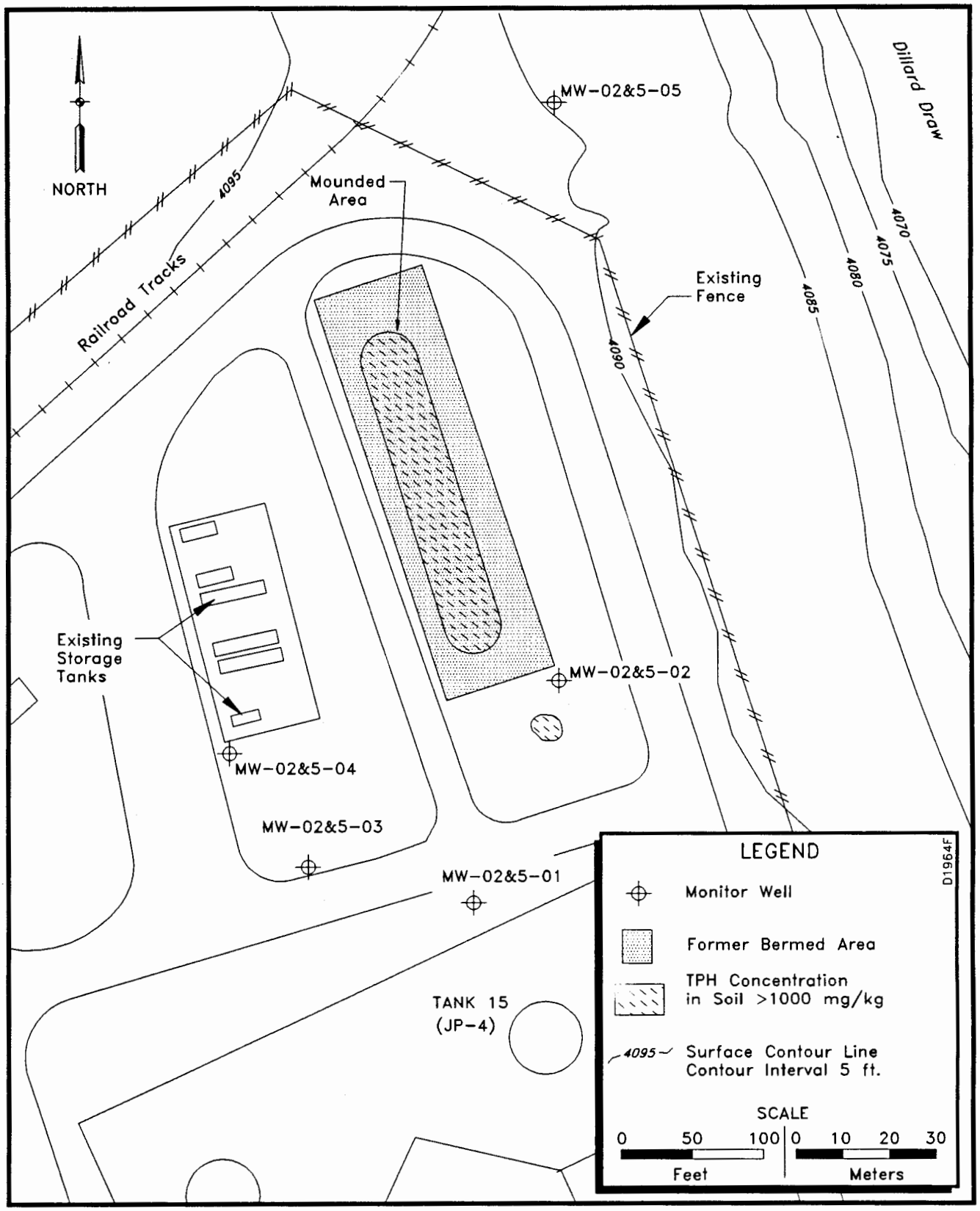

Figure 4-1. Estimated Area of Contamination for Sites 2&5

4.2.1.2 Alternative No. 2--Source Containment

Description--This alternative involves capping the area of contamination with a clay cap to prevent rainwater from infiltrating the soil and causing contaminants to leach into the groundwater. The clay cap covers the entire 24,000 sq ft of the former bermed area, as shown in Figure 4-2. No excavation, treatment, or disposal technologies are included in this alternative. This alternative relies entirely on natural processes for any reduction in the concentration of contaminants.

For this alternative, the contaminated soil surrounding SB-02&5-24 is excavated and disposed of. A front-end loader is used to excavate the 325-sq ft area to a depth of 4 ft bgl. Approximately 50 cu yd (58 cu yd allowing for a 15% bulking factor) is excavated, loaded onto trucks, and sent off site for disposal. For costing purposes it is assumed that the soil is disposed of in the Nu-Mex Landfill in Sunland Park, New Mexico. The excavation is backfilled with clean soil obtained from other areas of the Base.

Evaluation--The source containment alternative would not significantly reduce the toxicity or volume of the contaminated soil within an acceptable period. The alternative could be minimally effective in preventing contaminants from migrating into the groundwater since it would decrease percolation of rainwater into the soil. This alternative would have a protracted period of remediation, since only remediation by natural attenuation would occur. Some of the contamination at Sites 2&5 is at the vadose zone/groundwater interface; therefore, this alternative would not satisfy the RAO, since capping would be only minimally effective in preventing future contamination of groundwater.

The actions to be instituted under the source containment alternative are readily implementable. Installation of the cap would allow vehicles to drive over the site if necessary. Adequate materials and labor resources exist to meet the requirements of this

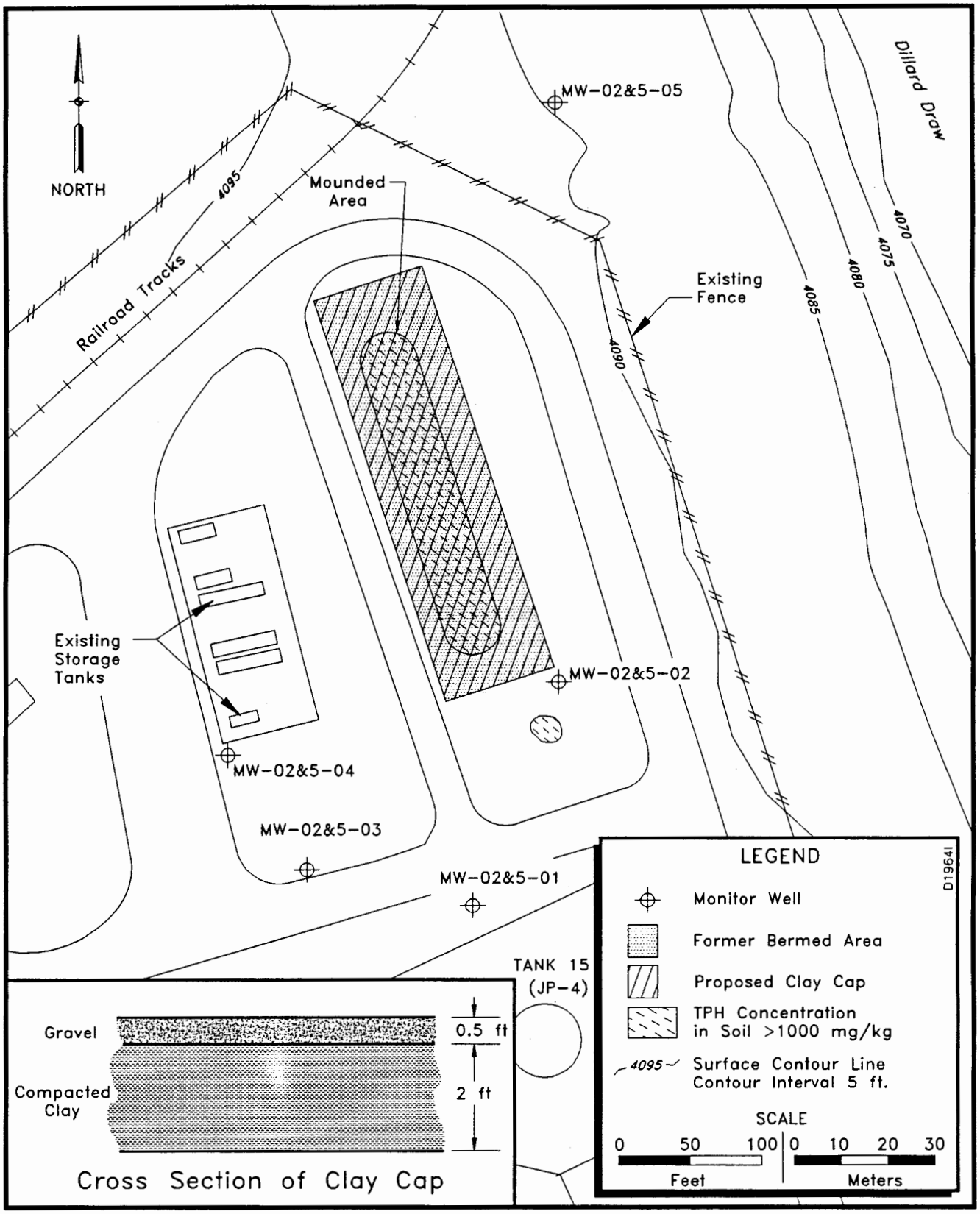

Figure 4-2. Sites 2&5 Alternative No. 2 Site Plan

alternative. There are no known regulatory restrictions that would preclude implementing any of these proposed actions.

The capital cost for this alternative is estimated to be $53,000. The major component for the capital cost is the clay cap. Capping could be completed within one year after design completion. A 30-year period of performance is assumed for this alternative. The annual O&M costs are estimated to be $5300, yielding a total present worth cost of $130,000 for this alternative.

4.2.1.3 Alternative No. 3--In Situ Treatment Soil Vapor Extraction/Bioventing

Description--This alternative uses SVE to reduce the TPH concentrations in the unsaturated soil. Under this alternative, two additional groundwater monitoring wells are installed in the proposed locations shown in Figure 4-3. Groundwater samples from the two additional wells, as well as from monitoring wells MW-02&5-02 and MW-02&5-03, are analyzed for TPH and benzene by U.S. EPA Methods 418.1 and 8020, respectively.

As shown in Figure 4-3, four SVE wells are installed. Each SVE well is assumed to have a diameter of influence of 75 ft. The SVE wells are drilled to a depth of 13 ft bgl and screened in the vadose zone in the interval from 8 to 12 ft bgl. The depth of the water table varies from approximately 11 to 15 ft bgl. The flow through each SVE well is approximately 10 to 20 cfm. The off gas from the extraction system is treated by a vapor-phase granular activated carbon (GAC) adsorption unit to remove VOCs. Condensate from the SVE system is collected, analyzed, and, if determined to be nonhazardous, disposed of in the Base wastewater treatment plant. If the condensate is determined to be hazardous, it is disposed of in a RCRA-permitted facility. Approximately 350 ft of piping is required for the SVE system. A 6-in clay cap is installed over the former bermed area (24,000 sq ft) to prevent the soil vacuum from causing channeling in certain areas.

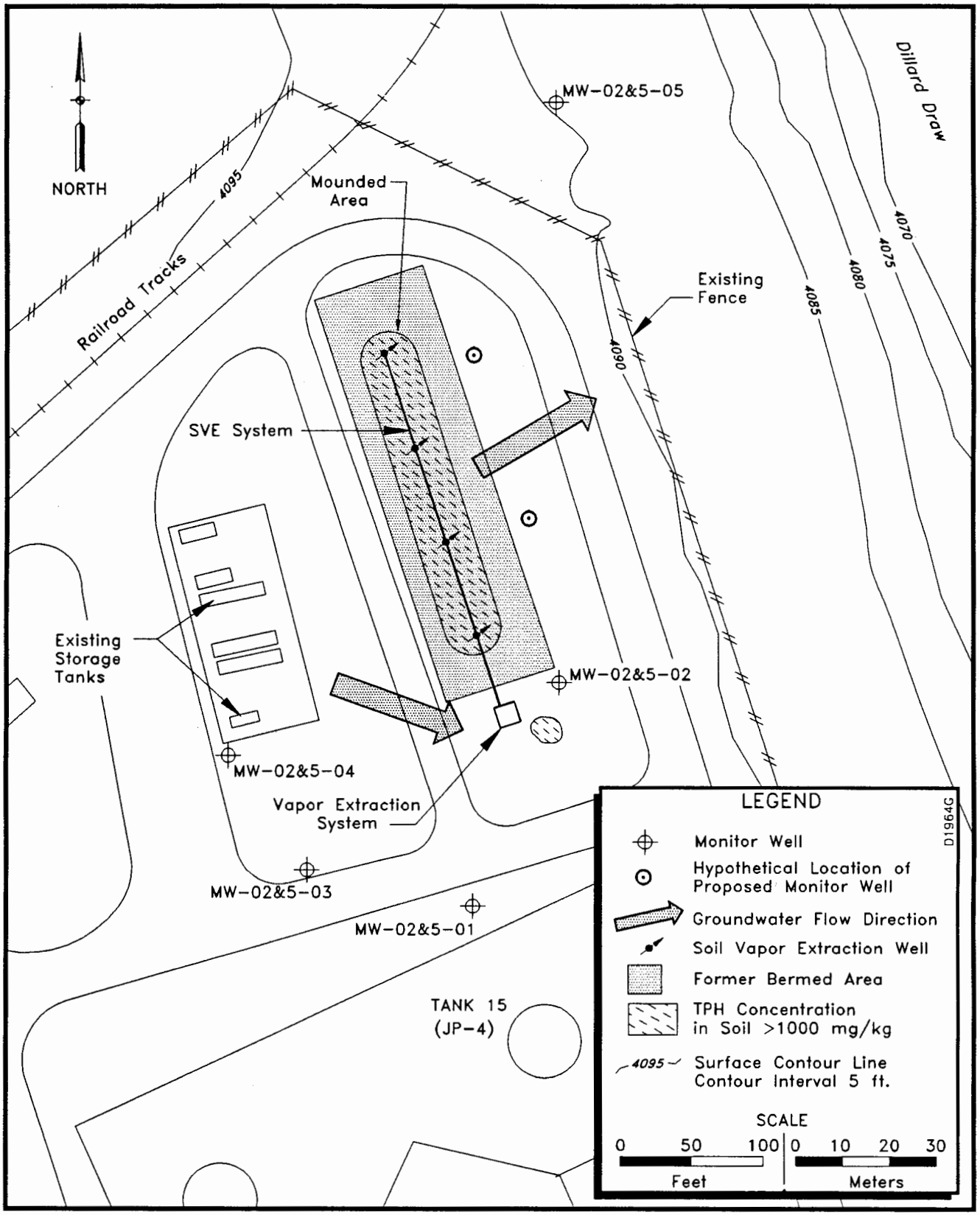

Figure 4-3. Sites 2&5 Alternative No. 3 Site Plan

Without modification of the subsurface conditions, biodegradation under the SVE alternative could be minimal. Analyses of three soil samples collected during the PDI indicated that few indigenous microorganisms [300 to 2100 colony forming units per gram (CFU/g) of soil] and no hydrocarbon-utilizing bacteria were present in the subsurface. This situation could be caused by the low levels of nutrients detected in the soil. Ammonia and nitrate were not detected in the soil samples. The maximum detected phosphate concentration was 8.0 mg/kg. Under this alternative, nutrients and oxygen are added to the subsurface through soil vents to promote biodegradation of petroleum hydrocarbons.

For this alternative, the contaminated soil surrounding SB-02&05-24 is excavated and disposed of. A front-end loader is used to excavate the 325-sq ft area to a depth of 4 ft bgl. Approximately 50 cu yd (58 cu yd allowing for a 15% bulking factor) is excavated, loaded onto trucks, and sent off site for disposal. For costing purposes, it is assumed that the soil is disposed of in the Nu-Mex Landfill in Sunland Park, New Mexico. The excavation is backfilled with clean soil obtained from other areas of the Base.

Evaluation--SVE alone would not be effective in reducing the toxicity and mobility of the contaminants. However, it could be effective in reducing the volume and concentration of volatile petroleum hydrocarbons. Furthermore, modification of the subsurface to enhance bacterial growth could allow this alternative to reduce the TPH concentrations to the cleanup level. Alternative No. 3 could have both short- and long-term effectiveness in protecting human health and the environment. Because it could decrease the concentration of TPH, it could help prevent future contamination of the groundwater. This alternative has good potential to satisfy the RAO.

Alternative No. 3 is considered to be readily implementable. SVE technology has proved to be reliable and has been demonstrated in full-scale remediation projects. There are no known regulatory restrictions that would prevent the proposed actions. Adequate equipment and labor resources are available to meet the requirements of this alternative.

The total present worth of the alternative is approximately $510,000. It is estimated that remediation using SVE could be completed within approximately four years after design completion. Groundwater monitoring would continue annually for a total of three years while the system is in operation. The estimated capital cost for this alternative is $290,000, most of which is due to installation of the SVE system. The annual O&M cost is estimated to be $82,000. The major O&M cost components are the costs associated with labor, utilities, and replacement carbon for the GAC unit.

4.2.1.4 Alternative No. 4--In Situ Treatment (Biosparging)

Description--This alternative uses in situ biosparging and SVE. For this alternative, air is sparged into the saturated soil to provide a suitable environment for indigenous microorganisms. In a suitable environment, the indigenous microorganisms degrade the biodegradable contaminants. The air flow rate in the biosparging system can be controlled so that biodegradation, rather than volatilization, is the primary means of remediation. Some volatile products of biodegradation and other VOCs (e.g., benzene) will be removed in the off gas and treated by the SVE system.

Under this alternative, two additional groundwater monitoring wells are installed in the proposed locations shown in Figure 4-4. Groundwater samples from the two additional wells, as well as from monitoring wells MW-02&5-02 and MW-02&5-03, are analyzed for TPH and benzene by U.S. EPA Methods 418.1 and 8020, respectively.

As shown in Figure 4-4, the biosparging system includes 12 air injection wells, which are located within the areas of greatest contamination. Each injection well is assumed to have a diameter of influence of 50 ft. The biosparging wells are drilled through the 4-ft-high mound of soil to a depth of 27 ft bgl and screened in the interval from 24 to 27 ft bgl. The flow through each sparging well is approximately 4 cfm. Approximately 800 ft of piping is required for the biosparging system. Nitrate and phosphate are added to

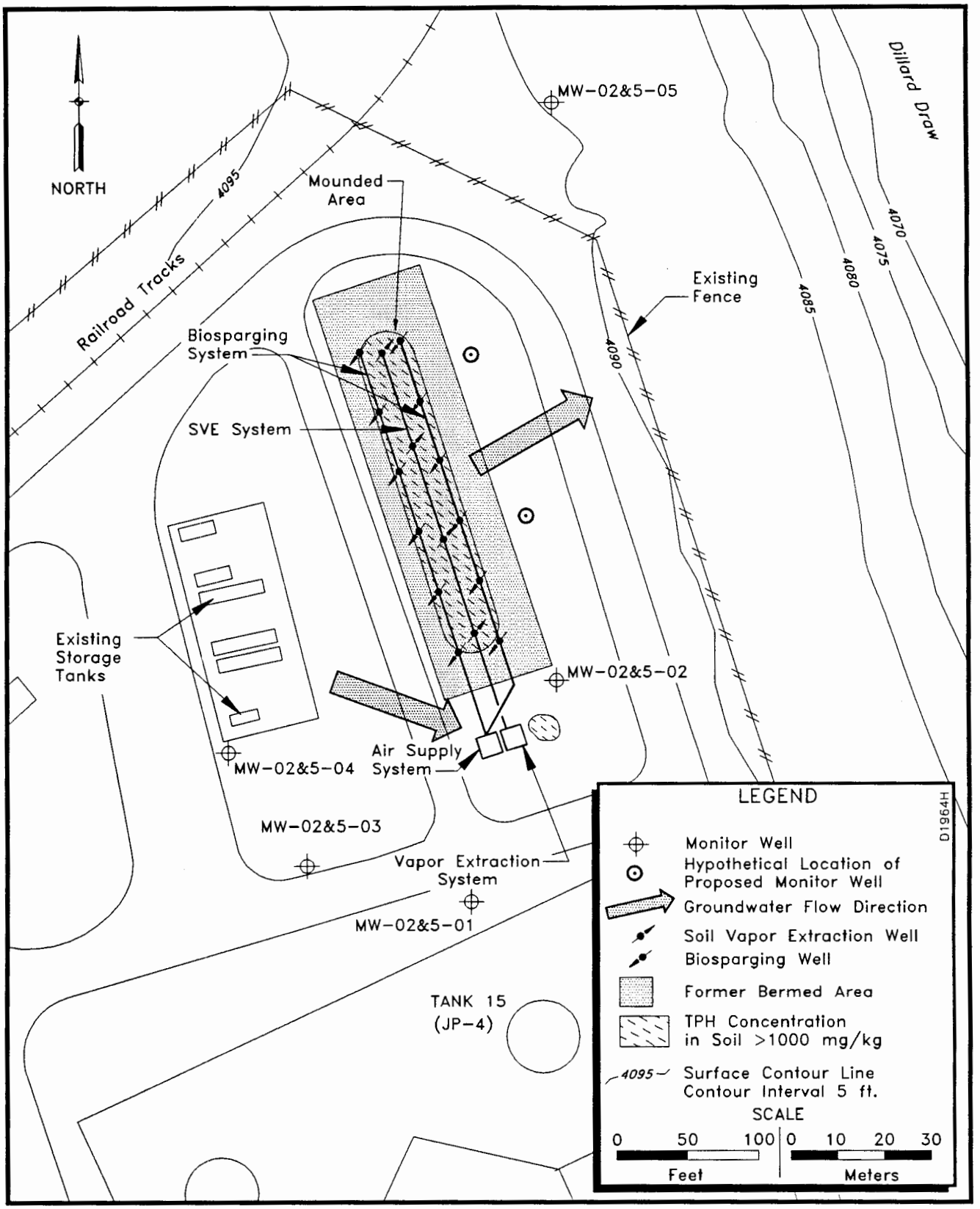

Figure 4-4. Sites 2&5 Alternative No. 4 Site Plan

the soil through the sparging system to allow effective biodegradation, since the concentrations of nutrients were found to be very low during the PDI.

In addition to the air injection wells, four SVE wells are installed to extract any volatilized compounds. Each SVE well is assumed to have a diameter of influence of 75 ft. The SVE wells are drilled to a depth of 13 ft bgl and screened in the vadose zone in the interval from 8 to 12 ft bgl. The depth of the water table varies from approximately 11 to 15 ft bgl. The flow through each SVE well is approximately 10 to 20 cfm. The off gas from the extraction system is treated by a vapor-phase GAC adsorption unit to remove VOCs. Condensate from the SVE system is collected, analyzed, and, if determined to be nonhazardous, disposed of in the Base wastewater treatment plant. If the condensate is determined to be hazardous, it is disposed of in a RCRA-permitted facility. Approximately 350 ft of piping is required for the SVE system. A 6-in clay cap is installed over the former bermed area (24,000 sq ft) to prevent the soil vacuum from causing channeling in certain areas.

For this alternative, the contaminated soil surrounding SB-02&5-24 is excavated and disposed of. A front-end loader is used to excavate the 325-sq ft area to a depth of 4 ft bgl. Approximately 50 cu yd (58 cu yd allowing for a 15% bulking factor) is excavated, loaded onto trucks, and sent off site for disposal. For costing purposes, it is assumed that the soil is disposed of in the Nu-Mex Landfill in Sunland Park, New Mexico. The excavation is backfilled with clean soil obtained from other areas of the Base.

Evaluation--The in situ biosparging alternative would not be effective in reducing the mobility of the contaminants. The alternative could be effective in reducing the volume and, possibly, the toxicity of the contaminants. However, the alternative is expected to be effective primarily because of the SVE system. It is not certain that the biosparging system would induce more effective biodegradation of contaminants, because the clay layer at lower sections of the unsaturated zone may prevent sparged air from rising

from the saturated zone into the unsaturated zone to promote biodegradation of the capillary fringe.

This alternative could be effective in reducing the concentration of TPH in the soil to the cleanup level. The alternative could have both short- and long-term effectiveness in protecting human health and the environment. Because it could decrease the concentration of contaminants, it could help prevent future contamination of the groundwater. This alternative has good potential to satisfy the RAO.

This alternative is considered to be implementable. However, the reliability of biosparging for the subsurface conditions of the site is not certain. There are no known regulatory restrictions that would prevent the proposed actions. Adequate equipment and labor resources are available to meet the requirements of this alternative.

Alternative No. 4 is estimated to have a present worth cost of approximately $850,000. It is estimated that remediation could be completed within approximately four years after design using in situ biosparging and SVE. Groundwater monitoring would continue annually for a total of three years while the system is in operation. The estimated capital cost of this alternative is $500,000, most of which is due to installation of the biosparging and SVE systems. The annual O&M cost is estimated to be $130,000. The major O&M cost components are the costs associated with labor, utilities, and replacement carbon for the GAC unit.

4.2.1.5 Alternative No. 5--On-Site Treatment

Description--This alternative involves excavation and on-site treatment of the contaminated soil. A backhoe is used to excavate through the mounded area to a depth of 13 ft bgl. Also, soil is excavated to a depth of 4 ft bgl in a 325-sq ft area surrounding SB-02&5-24. Because of the depth of the main excavation, side slopes and bracing are required. Aboveground as well as underground fuel lines will be rerouted as necessary to

allow excavation. Approximately 5800 cu yd is excavated at the mounded area. However, it is assumed that only the 5100 cu yd (5865 cu yd allowing for a 15% bulking factor) of contaminated soil is treated. The remaining 700 cu yd of soil associated with the upper 2 ft of the soil mound has contaminant concentrations below the cleanup levels. Including 50 cu yd from the area around SB-02&5-24, the total volume of soil to be treated is 5150 cu yd (5920 cu yd allowing for bulking). The excavated soil is treated in a portable low-temperature thermal treatment unit located on the Base. The excavation is backfilled with the treated soil and the soil from the upper part of the mound.

The portable low-temperature treatment unit is used to remove VOCs and any semivolatile organic compounds from the soil. The unit does not use combustion of the waste as the treatment method. Instead, heat is applied indirectly to the soil through a hot oil heat transfer system to volatilize the organics. The heat transfer oil heater system can be heated by propane, natural gas, or other fuels. Part of the flue gas from the heating system flows into the screw conveyor and maintains the purge gas temperature above 300°F to prevent condensation of vaporized organics and moisture. Combustion does not occur because no oxygen is present in the chamber. The vapor-phase contaminants are then condensed and removed as a liquid that is sent to an off-site RCRA facility for incineration. The noncondensable vapors exiting the condenser pass through a vapor-phase activated carbon adsorption system. The spent carbon is sent to a permitted, off-site regeneration facility.

Evaluation--The on-site treatment alternative could reduce the toxicity and volume of the contaminants in the soil, but it would not reduce the mobility. This alternative could be effective in reducing the concentrations of TPH in the soil to the cleanup levels. The alternative should have both short- and long-term effectiveness in protecting human health and the environment. Although volatilization of some contaminants may occur during excavation, implementation of health and safety procedures could protect workers from exposure. The alternative has good potential for complying with

the RAO, since removal of the contaminants from the soil could prevent future contamination of the groundwater.

Implementation of this alternative may be difficult, since the presence of buried concrete tank saddles and piping may impede excavation. Sufficient equipment, skilled technicians, and labor resources exist to satisfy the requirements for this alternative.

This alternative is estimated to cost $1,800,000. It is estimated that remediation could be completed within one year after design completion. The capital cost is estimated to be $1,800,000, which is due to excavation and low-temperature thermal treatment costs. Since this alternative includes a one-year period of operation, no long-term O&M costs are associated with it.

4.2.1.6 Alternative No. 6--Off-Site Disposal

Description--This alternative involves excavation of the contaminated soil and disposal in an off-site industrial solid waste landfill. A backhoe is used to excavate through the mounded area to a depth of 13 ft bgl. Also, soil is excavated to a depth of 4 ft bgl in a 325-sq ft area surrounding SB-02&5-24. Because of the depth of the main excavation, side slopes and bracing will be required. Aboveground as well as underground fuel lines will be rerouted as necessary to allow excavation. Approximately 5800 cu yd is excavated at the mounded area. However, it is assumed that only the 5100 cu yd (5865 cu yd allowing for a 15% bulking factor) of contaminated soil is sent off site for disposal. The remaining 700 cu yd of soil associated with the upper 2 ft of the soil mound has contaminant concentrations below the cleanup levels. Including 50 cu yd from the area around SB-02&5-24, the total volume of soil to be disposed of is 5150 cu yd (5920 cu yd allowing for a bulking factor). The excavated soil is loaded into roll-off containers, which are loaded onto trucks and transported to the landfill. Analyses are necessary to characterize the waste for disposal purposes. For costing purposes, it is assumed that the soil is disposed of in the Nu-Mex landfill in Sunland Park, New Mexico, since this is the nearest industrial solid waste

landfill permitted to accept the soil. The excavation is backfilled with soil from the upper part of the soil mound as well as with clean soil obtained from other areas of the Base.

Evaluation--This alternative would not reduce the toxicity, mobility, and volume of the contaminants in the soil. However, the remaining soil should have concentrations of TPH below the cleanup levels. The alternative should have both short- and long-term effectiveness in protecting human health and the environment. Although volatilization of contaminants may occur during excavation, implementation of health and safety procedures could protect workers from exposure. Since the contaminants are removed, this alternative has excellent potential to comply with the RAOs by preventing future contamination of the groundwater.

Implementation of this alternative may be difficult, since the presence of buried concrete tank saddles and piping may interfere with excavation. Sufficient equipment, disposal facilities, and labor resources exist to satisfy the requirements for this alternative.

This alternative is estimated to cost $1,500,000. It is estimated that remediation could be completed within one year after design completion. The capital cost is estimated to be $1,500,000, which is due to costs for excavation, transport, and disposal of the soil. No annual O&M costs are associated with this alternative.

4.2.2 Screening of Alternatives for Site 8

This section provides a brief description of each remedial action alternative developed to address the RAOs for Site 8. A summary of the process options included in the alternatives is presented in Table 4-2. Also provided for each alternative is an evaluation of the effectiveness, implementability, and cost for the alternative. Figure 4-5 shows the estimated area of contamination at Site 8.

Table 4-2

Assembled Alternatives for Site 8

	Alternative Number						
	1	2	3	4	5	6A	6B
Representative Process Option							
Land Use Restrictions		✓	✓	✓			
Asphalt Capping			✓	✓			
Excavation by Front-End Loader					✓	✓	✓
Backfill with Clean Soil					✓	✓	✓
Rotary Kiln Incineration					✓		
Stabilization/Solidification (off site)					✓		✓
Off-Site Industrial Solid Waste Landfill						✓	
Off-Site RCRA Hazardous Waste Landfill					✓		✓
Description of Alternatives							
1. No action							
2. Limited action (land use restrictions)							
3. Limited action (asphalt capping of work area)							
4. Source containment (asphalt capping of entire area)							
5. Excavation/off-site treatment (incineration)/disposal (off-site RCRA hazardous waste landfill).							
6A. Excavation/disposal (off-site industrial solid waste landfill) for nonhazardous soil							
6B. Excavation/off-site treatment (stabilization/solidification)/disposal (off-site RCRA hazardous waste landfill) for hazardous soil							

Note--Since it is not certain whether the soil at Site 8 is nonhazardous or hazardous, Alternative No. 6 was divided into Alternatives 6A and 6B, which provide for disposal of the soil as nonhazardous and hazardous, respectively.

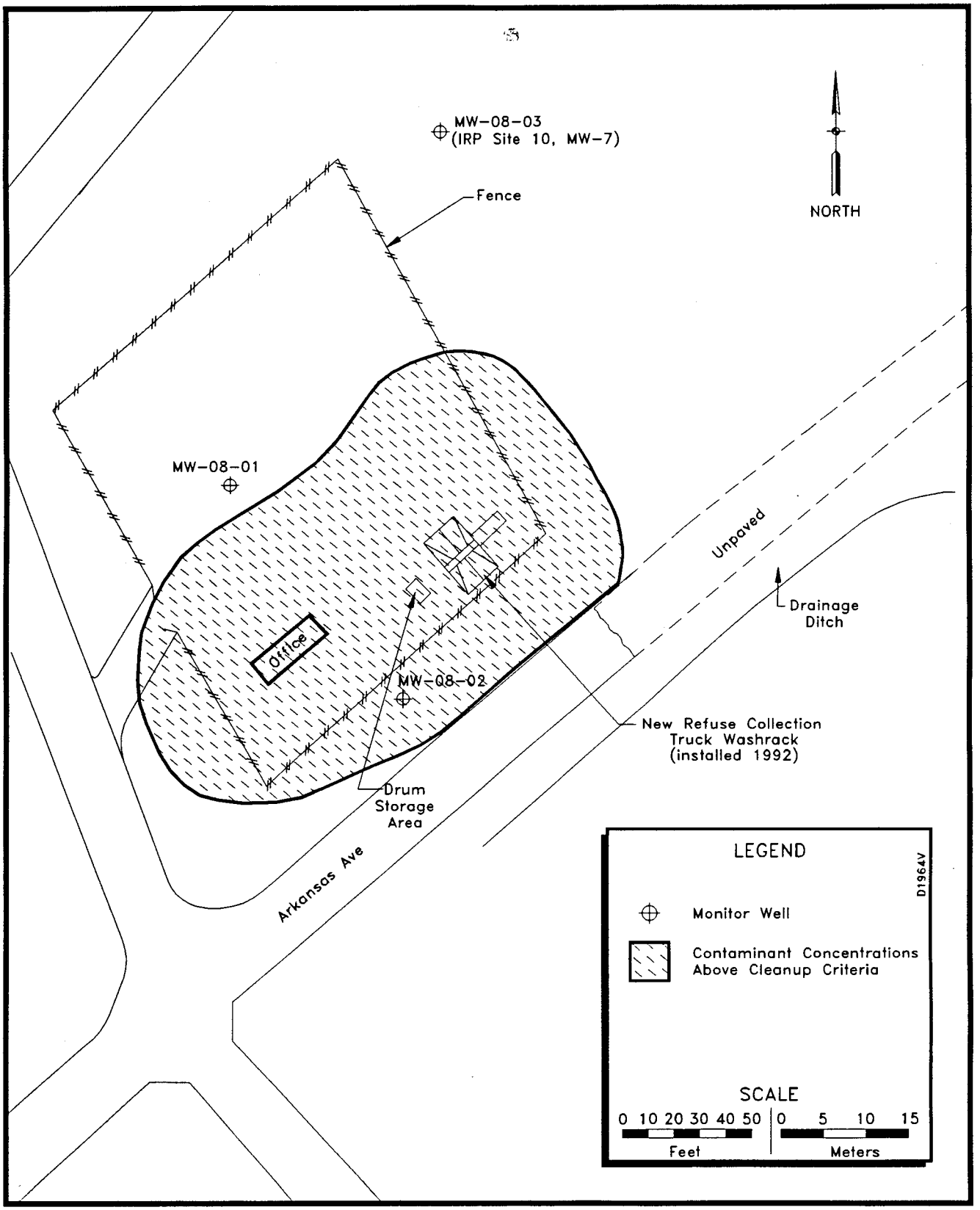

Figure 4-5. Estimated Area of Contamination at Site 8

4.2.2.1 Alternative No. 1--No Action

Description--The no-action alternative provides a baseline for comparison of the other alternatives. This alternative does not institute any type of remedial action to reduce the potential for exposure at Site 8, nor does it include institutional action, containment, excavation, treatment, or disposal technologies. This alternative depends entirely on natural processes for any reduction in the concentration of contaminants.

Evaluation--The no-action alternative would not significantly reduce the toxicity, mobility, or volume of the contaminated soil. Since no active remediation would take place, the alternative would have a protracted period of implementation. It would not protect human health or the environment. All current and potential risks would remain. The no-action alternative would not meet the RAOs.

The no-action alternative is readily implementable. Sufficient resources are available to meet the requirements of this alternative. Regulatory restrictions would not prevent the actions under this alternative.

Alternative No. 1 has no capital or O&M costs associated with it.

4.2.2.2 Alternative No. 2--Limited Action

Description--The limited action alternative institutes land use restrictions for Site 8. Land use restrictions prohibit certain uses of the land as well as extraction of groundwater from the area. Under this alternative, work could not continue at the area. As shown in Figure 4-6, a fence surrounds the area restricts access. Approximately 500 linear ft of additional fencing are required to enclose the area. As with the no-action alternative, the limited action alternative depends entirely on natural processes for any reduction in the concentration of contaminants.

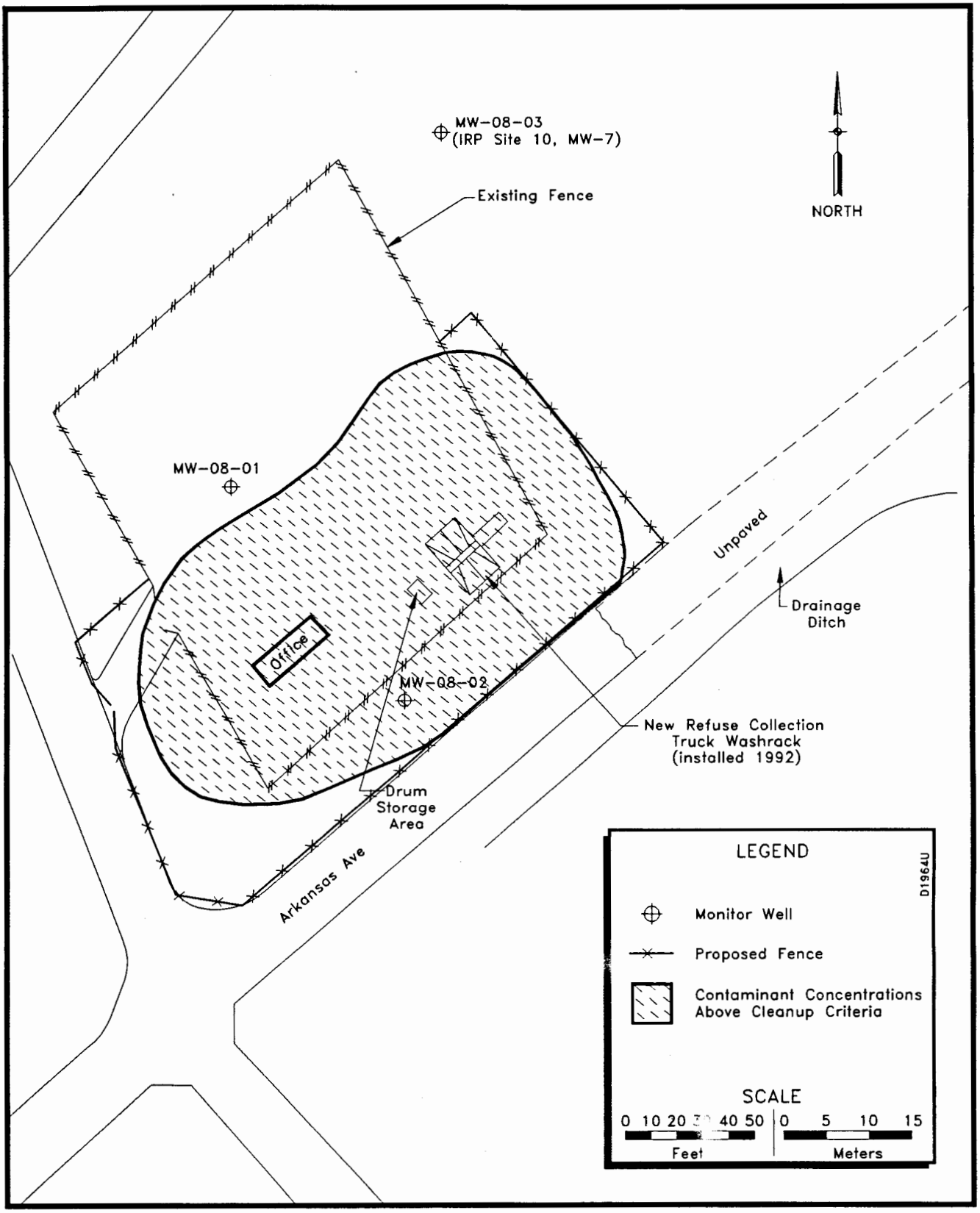

Figure 4-6. Site 8 Alternative No. 2 Site Plan

Evaluation--The limited action alternative would not reduce the toxicity, mobility, or volume of the contaminated soil. Land use restrictions would be only minimally effective in preventing either dermal contact or inhalation of volatiles. The time frame for this alternative is not acceptable. This alternative would not meet the RAOs.

The actions to be instituted in Alternative No. 2 are readily implementable. Adequate materials, equipment, and labor resources exist to meet the requirements of this alternative. There are no known regulatory restrictions that would prevent implementing these actions.

The cost for this alternative is estimated to be $16,000. The major component for the capital cost is the fence construction. No O&M costs are associated with this alternative.

4.2.2.3 Alternative No. 3--Limited Action (Capping)

Description--This alternative calls for installing an asphalt cap over the work areas at the Truck Washrack Area in addition to implementing the land use restrictions described in Alternative No. 2. Alternative No. 3 also provides for 500 ft of additional fencing to restrict access. This alternative allows work to continue at the Refuse Collection Truck Area. Capping could be completed within one year after design completion. The area that is capped under this alternative is shown in Figure 4-7. Approximately 13,050 sq ft of asphalt capping is required.

Evaluation--This alternative would not reduce the toxicity, mobility, or volume of the contaminants. It could be somewhat effective in protecting human health and the environment for the short term. However, the long-term effectiveness would depend on continued maintenance of the asphalt cap. The alternative could be moderately effective in preventing dermal contact with contaminated soil by on-site personnel, but it would not be effective in preventing inhalation of contaminated soil, since some contaminated areas

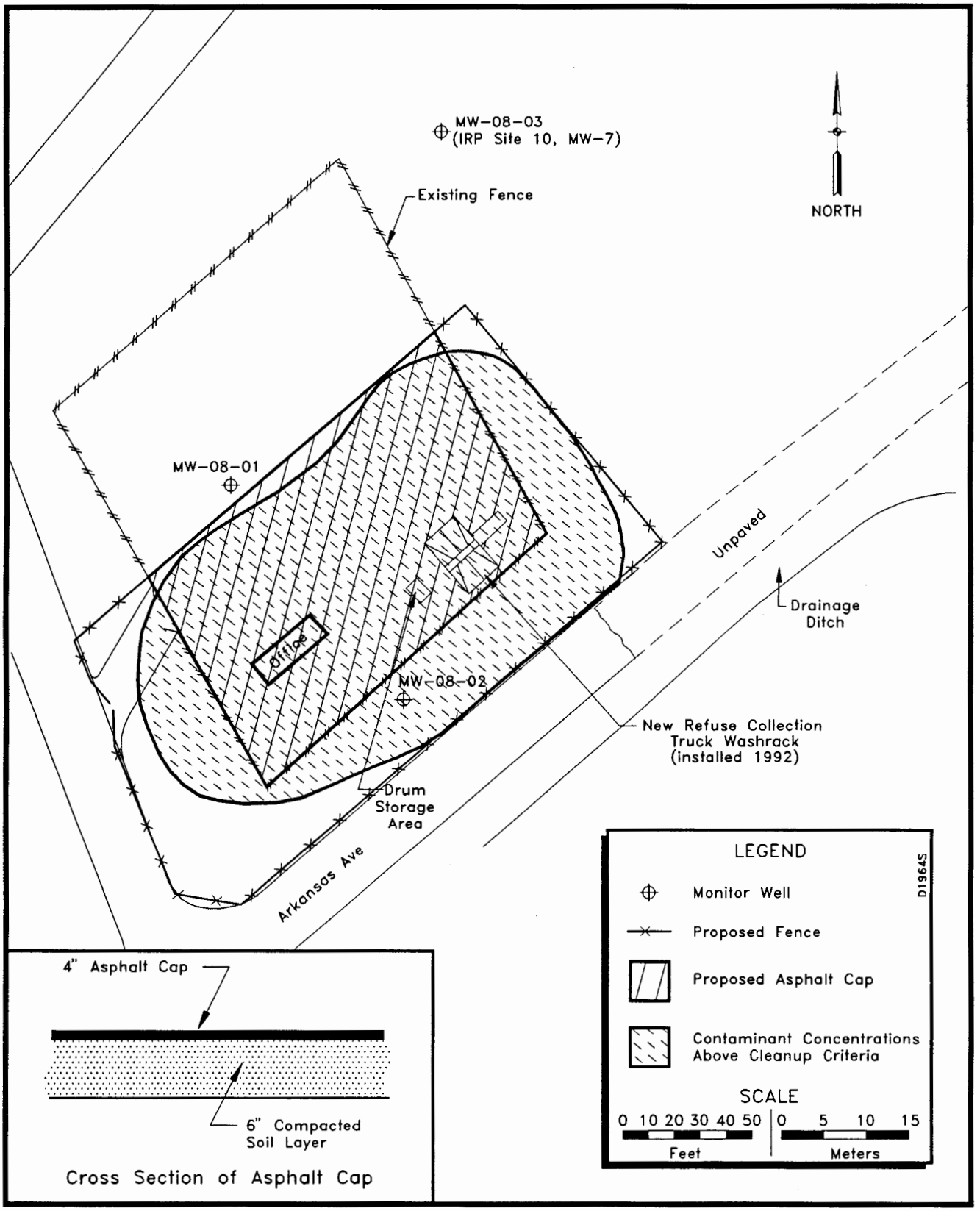

Figure 4-7. Site 8 Alternative No. 3 Site Plan

are not capped. Workers could still be exposed to contaminated soil if they worked on the uncapped areas or if the wind blew contaminated dust in the direction of the capped work areas. Thus, this alternative has low potential for complying with the RAOs.

Alternative No. 3 is readily implementable. Adequate equipment, materials, and labor are available to meet the requirements of the alternative. There are no known regulatory restrictions that would prevent the proposed actions.

The capital cost for this alternative is estimated to be $110,000. The major component for the capital cost is the asphalt capping. Maintenance of the asphalt cap drives the O&M costs. A period of performance of 30 years is assumed. The annual O&M costs are estimated to be $6700, yielding a present worth of $210,000 for this alternative.

4.2.2.4 Alternative No. 4--Source Containment

Description--This alternative involves asphalt capping of the entire area of contamination at Site 8 as well as capping of the entire Refuse Collection Yard. This alternative also provides for land use restrictions as described in Alternative No. 2. The area that is capped under this alternative is shown in Figure 4-8. An area of approximately 41,000 sq ft is covered with an asphalt cap. Approximately 800 linear ft of additional fencing is installed to restrict access. Capping could be completed within one year after design completion.

Evaluation--This alternative would not reduce the toxicity, mobility, or volume of the contaminants. It could be somewhat effective in protecting human health and the environment for the short term. After implementation, the alternative could be effective in preventing dermal contact with, and inhalation of, volatiles by site personnel. However, the long-term effectiveness depends on the continued maintenance of the asphalt cap. The alternative has good potential for meeting the RAOs.

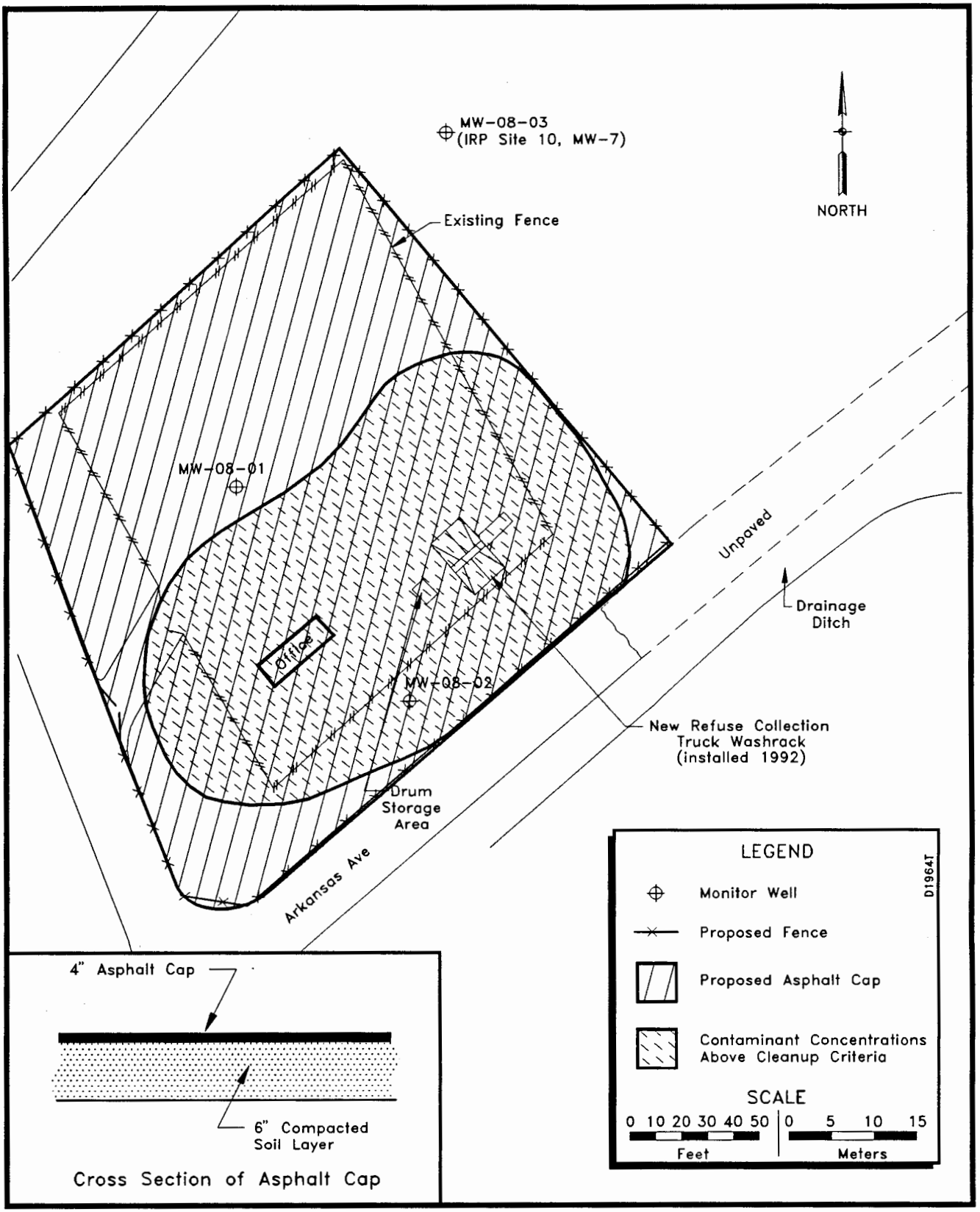

Figure 4-8. Site 8 Alternative No. 4 Site Plan

Alternative No. 4 is readily implementable. Adequate equipment, materials, and labor are available to meet the requirements of the alternative. There are no known regulatory restrictions that would prevent the proposed actions.

The capital cost for this alternative is estimated to be $180,000. The major component for the capital cost is the asphalt capping. The activities and services associated with maintaining the asphalt cap drive the O&M costs. A period of performance of 30 years is assumed. The annual O&M costs are estimated to be $7700, yielding a net present worth of $300,000 for this alternative.

4.2.2.5 Alternative No. 5--Off-Site Treatment (for Hazardous Soil)

Description--This alternative is based on the assumption that the soil at Site 8 is considered a hazardous waste. This alternative includes excavation of the contaminated soils and incineration at an off-site RCRA facility. A front-end loader is used to excavate the soil to a depth of 2 to 4 ft bgl. Approximately 1610 cu yd of soil is excavated. Allowing for a 15% bulking factor, the volume of soil to be treated is approximately 1850 cu yd. The soil is loaded into roll-off containers, which are loaded onto trucks and transported to the RCRA facility. The RCRA facility is responsible for stabilization and disposal of the ash in a RCRA landfill. For costing purposes, it is assumed that the incinerator operated by APTUS in Aragonite, Utah, is used. Analyses are necessary to characterize the waste before it is accepted for incineration. It is also necessary to track the soil by the hazardous waste manifest system. The excavation is backfilled with clean soil obtained from other areas of the Base.

Evaluation--This alternative could reduce the toxicity, mobility, and volume of the pesticide contaminants in the soil. It could reduce the mobility of the metals in the soil. This alternative could also be effective in reducing the concentrations of pesticides and metals in the remaining soil to the cleanup levels. The alternative should have both short- and long-term effectiveness in protecting human health and the environment. Although

some contaminants could become airborne during excavation, implementation of health and safety procedures could protect workers against exposure. Since this alternative involves removal of the contaminants, it has excellent potential for meeting the cleanup levels specified in the RAO.

This alternative is considered to be readily implementable. There are no known regulatory restrictions that would prevent any of the proposed actions. Sufficient incinerator capacity, equipment, transportation, and labor resources exist to satisfy the requirements for this alternative.

This alternative is estimated to cost $4,100,000. Remediation could be completed within one year after design. The capital cost is estimated to be $4,100,000, which is due to costs for excavation and incineration of the soil. Since remediation will occur within a one-year period, no long-term O&M costs are associated with this alternative.

4.2.2.6 Alternative No. 6A--Off-Site Disposal (for Nonhazardous Soil)

Description--This alternative is based on the assumption that the contaminated soil at Site 8 is nonhazardous. The alternative includes excavation and disposal of the contaminated soil. A front-end loader is used to excavate the soil to a depth of 2 to 4 ft bgl. Excavation yields a soil volume of approximately 1610 cu yd (1850 cu yd allowing for a 15% bulking factor). The excavated soil is disposed of in an off-site industrial solid waste landfill. The soil is loaded into roll-off containers, which are loaded onto trucks and transported to the landfill. For costing purposes, it is assumed that the soil is disposed of in the Nu-Mex Landfill in Sunland Park, New Mexico, which is the nearest industrial solid waste landfill that is permitted to accept the contaminated soil. Analyses are necessary to characterize the waste for disposal purposes. The excavation is backfilled with clean soil obtained from other areas of the Base.

Evaluation--This alternative would not reduce the toxicity, mobility, and volume of the contaminants. However, the remaining soil should have contaminant concentrations below the cleanup levels. This alternative could be effective in protecting human health and the environment, and could prevent dermal contact with, and inhalation of, contaminated soil. The alternative has excellent potential to meet the RAOs.

This alternative is technically feasible. The necessary equipment, labor, analytical services, and disposal facilities are available. This alternative should also be implementable on the basis of administrative feasibility, since no regulations are known to preclude the proposed actions. If the soils are determined to be hazardous waste, this alternative is not applicable.

The capital cost for this alternative is estimated to be $350,000. The major components for the capital cost are the costs associated with excavation, management, and disposal. Remediation could be completed within one year after design completion. There are no O&M costs, so the total cost for this alternative is $350,000.

4.2.2.7 Alternative No. 6B--Off-Site Treatment/Disposal (for Hazardous Soil)

Description--This alternative is based on the assumption that the contaminated soil at Site 8 is hazardous and that the lead and chlordane concentrations exceed the TCLP limit. The alternative involves excavation of the contaminated soil. The excavated soil is stabilized at an off-site RCRA facility and disposed of in an off-site RCRA hazardous waste landfill. A front-end loader is used to excavate the soil to a depth of 2 to 4 ft bgl. Excavation yields a soil volume of approximately 1610 cu yd (1850 cu yd allowing for a 15% bulking factor). The soil is loaded into roll-off containers, which are loaded onto trucks and transported to the RCRA facility. Analyses are necessary to characterize the waste prior to transportation to the facility. It is necessary to track the soil by the hazardous waste manifest system. For costing purposes, it is assumed that the soil is stabilized at the TECO, Inc. facility in Robstown, Texas, and disposed of in the hazardous waste landfill at the same

facility. The excavation is backfilled with clean soil obtained from other areas of the site.

Evaluation--This alternative would not reduce the toxicity and volume of the contaminants. However, the remaining soil should have contaminant concentrations below the cleanup levels. Stabilization could reduce the mobility of the contaminants in the soil that is landfilled. This alternative could be effective in protecting human health and the environment for the short and long term. Although some contaminants may become airborne during excavation, implementation of health and safety procedures could protect workers against exposure. The alternative should be effective and reliable in preventing dermal contact with, and inhalation of, contaminated soil by on-site personnel. It has excellent potential to satisfy the RAOs.

Alternative No. 6B is readily implementable. Adequate equipment, treatment and disposal facilities, labor, and analytical services are available to meet the requirements of the alternative. If the soils are determined to be hazardous waste due to chlordane (D020), there are no problems with disposing of the waste in a hazardous waste landfill because Waste Code D020 is not land disposal restricted at this time. If the soils are determined to be hazardous waste due to lead (D008), they would have to be stabilized prior to landfilling to meet the land disposal restrictions. There are no known regulatory restrictions that would prevent the implementation of this alternative.

The capital cost for this alternative is estimated to be $1,200,000. The major components for the capital cost are excavation, treatment, disposal, and transportation. Remediation could be completed within one year after design completion. There are no O&M costs, so the total cost for this alternative is $1,200,000.

4.2.3 Screening of Alternatives for Site 14

This section provides a brief description of each remedial action alternative developed to address the RAO for Site 14. A summary of the process options included in

the alternatives is presented in Table 4-3. Also provided for each alternative is an evaluation of the effectiveness, implementability, and cost for the alternative. The estimated area of contamination at Site 14 is shown in Figure 4-9.

4.2.3.1 Alternative No. 1--No Action

Description--The no-action alternative provides a baseline for comparison of the other alternatives. This alternative does not institute any type of remedial action to reduce the potential for exposure at Site 14, nor does it include monitoring, institutional action, containment, excavation, treatment, or disposal technologies. This alternative would rely entirely on natural processes for any reduction in the concentration of contaminants.

Evaluation--The no-action alternative would not significantly reduce the toxicity, mobility, or volume of the contaminated soil within an acceptable time. Since only remediation by natural attenuation would take place, the alternative would have a protracted period of implementation. It would not protect human health or the environment. All current and potential risks would remain. The no-action alternative would not meet the RAO.

The no-action alternative is readily implementable. There are no known regulatory restrictions that would prevent the proposed actions under this alternative.

No capital or O&M costs are associated with Alternative No. 1.

4.2.3.2 Alternative No. 2--Limited Action

Description--The limited action alternative institutes land use restrictions for Site 14. Land use restrictions prohibit certain uses of the land as well as extraction of groundwater from the area. As shown in Figure 4-10, a fence surrounds the area to restrict access. Approximately 500 linear ft of fencing is required to enclose the 13,300-sq-ft area.

Table 4-3

Assembled Alternatives for Site 14

	Alternative Number						
	1	2	3	4A	4B	5	6
Representative Process Option							
Land Use Restrictions		✓	✓				
Asphalt Capping			✓				
Excavation by Front-End Loader				✓	✓	✓	✓
Backfill with Clean Soil					✓	✓	✓
Infrared Thermal Desorption				✓	✓		
Rotary Kiln Incineration						✓	
On-Site Disposal of Treated Soil (Backfill)				✓			
Off-Site Industrial Solid Waste Landfill					✓		
Off-Site RCRA Hazardous Waste Landfill						✓	✓
Description of Alternatives							
1. No action							
2. Limited action (land use restrictions)							
3. Source containment (asphalt capping of entire area)							
4A. Excavation/on-site treatment (infrared thermal desorption)/backfill with treated soil							
4B. Excavation/on-site treatment (infrared thermal desorption)/disposal (off-site industrial solid waste landfill)/backfill with clean soil							
5. Excavation/off-site treatment (incineration)/disposal (off-site RCRA hazardous waste landfill)							
6. Excavation/disposal (off-site RCRA hazardous waste landfill)							

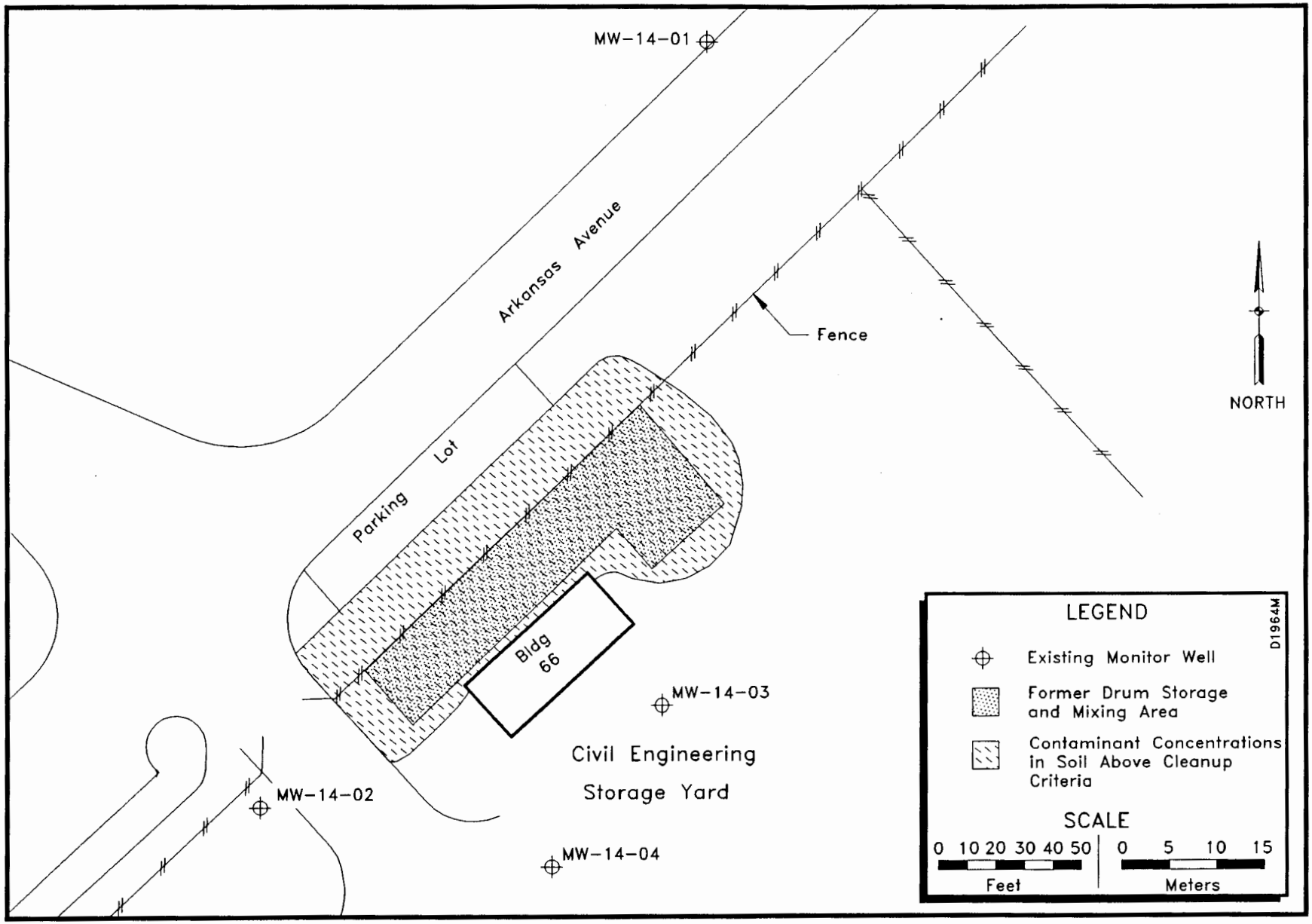

Figure 4-9. Estimated Area of Contamination at Site 14

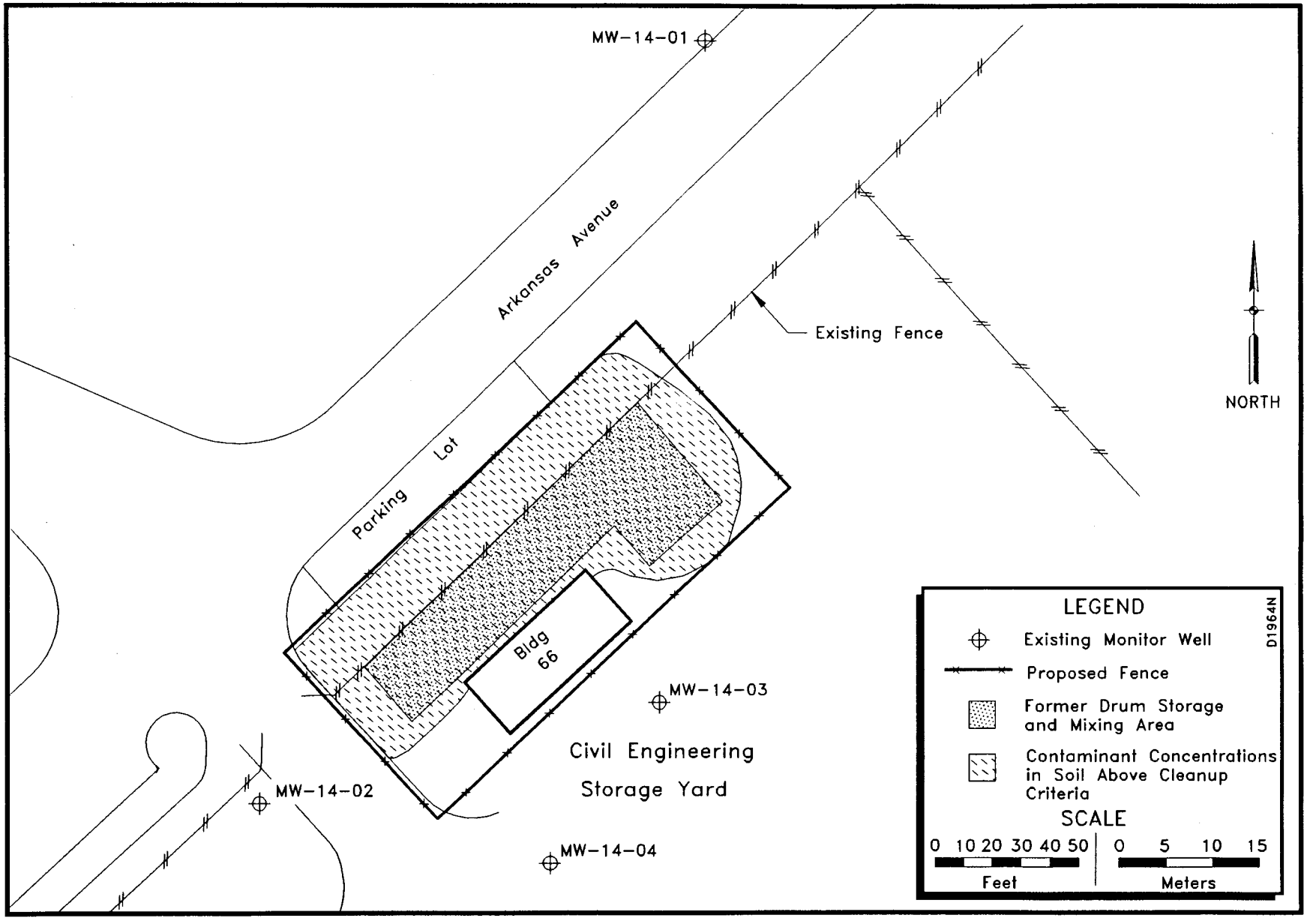

Figure 4-10. Site 14 Alternative No. 2 Site Plan

As with the no-action alternative, the limited action alternative depends entirely on natural processes for any reduction in the concentration of contaminants.

Evaluation--The limited action alternative would not reduce the toxicity, mobility, or volume of the contaminated soil. Land use restrictions could be only minimally effective in preventing dermal contact with the soil by site personnel. The time frame for this alternative is not acceptable. The alternative would not comply with the RAO.

The actions to be instituted in Alternative No. 2 are readily implementable. Adequate materials and labor resources exist to meet the requirements of this alternative. There are no known regulatory restrictions that would preclude implementation of these actions.

The capital cost for this alternative is estimated to be $15,000. The major component for the capital cost is the fencing. A period of performance of 30 years is assumed. There are no O&M costs, so the total cost for this alternative is $15,000.

4.2.3.3 Alternative No. 3--Source Containment

Description--This alternative involves capping the entire area of contamination with an asphalt cap to prevent dermal contact with the contaminants by on-site workers. Land use restrictions are also applied to the entire area. Land use restrictions prohibit certain uses of the land as well as extraction of groundwater from the area. As shown in Figure 4-11, an area of approximately 12,000 sq ft is capped with asphalt. This alternative could allow work to continue at the site.

Evaluation--This alternative would not reduce the toxicity, mobility, or volume of the contaminants. It could be moderately effective in protecting human health and the environment for the short term. It could also be effective in preventing dermal contact with the contaminated soil by on-site personnel. However, the long-term effectiveness depends

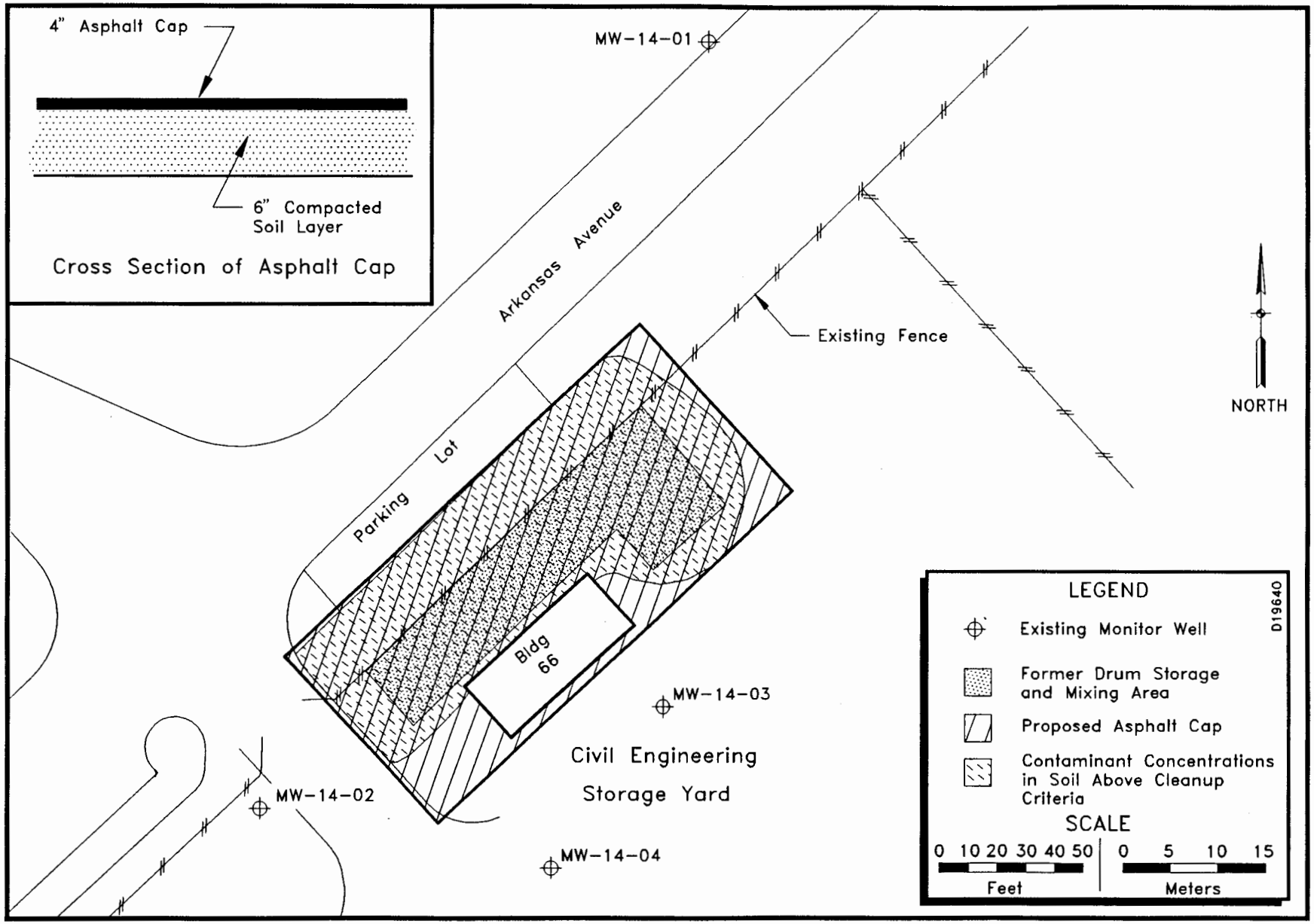

Figure 4-11. Site 14 Alternative No. 3 Site Plan

on the continued maintenance of the cap. The alternative has good potential to satisfy the RAO.

Alternative No. 3 is readily implementable. Adequate equipment, materials, and labor are available to meet the requirements of the alternative. There are no known regulatory restrictions that would prevent the proposed actions.

The capital cost for this alternative is estimated to be $100,000. The major component for the capital cost is the asphalt capping. The activities and services associated with maintaining the asphalt cap represent the major portion of the O&M costs. Capping could be completed within one year after design completion. A period of performance of 30 years is assumed. The annual O&M costs are estimated to be $6700, yielding a total of $200,000 for this alternative.

4.2.3.4 Alternative No. 4A--On-Site Treatment/Backfill with Treated Soil

Description--This alternative involves excavation and on-site treatment of the contaminated soil at Site 14. A front-end loader is used to excavate to a depth of 2 to 4 ft bgl. Approximately 740 cu yd of soil is excavated. Allowing for a 15% bulking factor, the volume of soil to be treated is approximately 850 cu yd. The excavated soil is treated in a portable infrared thermal desorption unit located on the Base. The treated soil is used to backfill the excavation.

The portable infrared thermal desorption unit is used to remove semivolatile organic pesticides from the soil. The unit does not use combustion of the waste as the treatment method. Instead, heat is applied to the soil by infrared heaters to volatilize the organic pesticides. Combustion does not occur because no oxygen is present. The soil is transported by a conveyor into the desorption chamber where the organics are volatilized. Steam is used to sweep the volatilized compounds from the chamber. The steam and vapor-phase contaminants pass through a heat exchanger where most of the vapors are condensed.

Contaminants are removed from the remaining gas stream when it passes through a scrubber, then through a vapor-phase carbon adsorption unit. The condensate from the condenser passes through an oil/water separator and a liquid-phase carbon adsorption unit where the contaminants are removed. The residue from the oil/water separator and the carbon from both adsorption units are sent to an off-site RCRA facility for incineration; the condensed steam is recycled. The treated soil is used as backfill for the excavation.

Evaluation--This alternative could reduce the toxicity, volume, and mobility of the contaminants. High-temperature thermal desorption using infrared heaters has good potential to be effective in removing pesticides from soils. This alternative could have short- and long-term effectiveness in preventing dermal contact with the contaminated soil. Although some contaminants may become airborne during excavation, the implementation of health and safety procedures could protect workers against exposure. The alternative has good potential for meeting cleanup levels specified in the RAO.

This alternative is considered to be implementable. However, infrared thermal desorption technology has not been widely tested in full-scale remediation projects. Adequate equipment, labor, and analytical services exist to implement the proposed actions under this alternative. Since the excavated soil is likely to be hazardous waste, the Base's RCRA permit will require modification to include the treatment unit, unless the treatment unit is covered by an existing permit (i.e., the company leasing a mobile unit has a RCRA permit). This alternative would not be implementable if the chlordane concentration in the soil exceeds the TCLP standard and if chlordane becomes a land-banned compound.

Costs for this alternative are estimated to be $580,000. The capital cost is estimated to be $580,000, most of which is due to the cost associated with operating and maintaining the thermal desorption system. No long-term O&M costs are associated with this alternative. Remediation could be completed within one year after design completion.

4.2.3.5 Alternative No. 4B--On-Site Treatment/Off-Site Disposal

Description--This alternative involves excavation of the contaminated soil at Site 14. A front-end loader is used to excavate to a depth of 2 to 4 ft bgl. Approximately 740 cu yd of soil is excavated. Allowing for a 15% bulking factor, the volume of soil to be treated is approximately 850 cu yd. The excavated soil is treated in a portable thermal desorption unit located on the Base. The treated soil is loaded into roll-off containers, which are loaded onto trucks and transported to an off-site industrial solid waste landfill for disposal. For costing purposes, it is assumed that the treated soil is disposed of in the Nu-Mex Landfill in Sunland Park, New Mexico, which is the nearest industrial solid waste landfill that is likely to accept the soil. The excavation is backfilled with clean soil obtained from other areas of the Base.

The portable infrared thermal desorption unit is used to remove semivolatile organic pesticides from the soil. The unit does not use combustion of the waste as the treatment method. Instead, heat is applied to the soil by infrared heaters to volatilize the organic pesticides. Combustion does not occur because no oxygen is present. The soil is transported by a conveyor into the desorption chamber where the organics are volatilized. Steam is used to sweep the volatilized compounds from the chamber. The steam and vapor-phase contaminants pass through a heat exchanger where most of the vapors are condensed. Contaminants are removed from the remaining gas stream when it passes through a scrubber then through a vapor-phase carbon adsorption unit. The condensate from the condenser passes through an oil/water separator and a liquid-phase carbon adsorption unit where the contaminants are removed. The residue from the oil/water separator and the carbon from both adsorption units are sent to an off-site RCRA facility for incineration; the condensed steam is recycled. The treated soil is transported to and disposed of in an off-site industrial solid waste landfill.

Evaluation--This alternative could reduce the toxicity, volume, or mobility of the contaminants. High-temperature thermal desorption using infrared heaters has good

potential to be effective in removing pesticides from soils. This alternative could have short- and long-term effectiveness in preventing dermal contact with the contaminated soil. This alternative has good potential for meeting the cleanup levels specified in the RAO.

This alternative is considered to be implementable. However, infrared thermal desorption has not been widely proved in full-scale remediation projects. Adequate equipment, landfill capacity, labor, and analytical services exist to implement the proposed actions under this alternative. Since the excavated soil is likely to be a hazardous waste, the Base's RCRA permit will require modification to include the treatment unit unless the treatment unit is covered by an existing permit (i.e., the company leasing a mobile unit has a RCRA permit). This alternative would not be implementable if the chlordane concentration exceeds the TCLP standard and if chlordane becomes a land-banned compound.

The capital cost is estimated to be $630,000, most of which is due to the cost associated with operating and maintaining the thermal desorption system. No long-term O&M costs are associated with this alternative. Remediation could be completed within one year after design. The total cost for this alternative is $630,000.

4.2.3.6 Alternative No. 5--Off-Site Treatment

Description--This alternative is based on the assumption that the soil at Site 14 is considered a hazardous waste. This alternative includes excavation of the contaminated soils and incineration at an off-site RCRA facility. A front-end loader is used to excavate the soil to a depth of 2 to 4 ft bgl. Approximately 740 cu yd of soil is excavated. Allowing for a 15% bulking factor, the volume of soil to be treated is approximately 850 cu yd. The soil is loaded into roll-off containers, which are loaded onto trucks and transported to the RCRA facility. The RCRA facility is responsible for stabilization and disposal of the ash in a RCRA landfill. For costing purposes, it is assumed that the incinerator operated by APTUS in Aragonite, Utah, is used. Analyses are necessary to

characterize the waste before it is accepted for incineration. It is also necessary to track the soil by the hazardous waste manifest system. The excavation is backfilled with clean soil obtained from other areas of the Base.

Evaluation--This alternative could reduce the toxicity, mobility, and volume of the contaminants in the soil. This alternative could also be effective in reducing the concentrations of pesticides in the remaining soil to the cleanup levels. The alternative should have both short- and long-term effectiveness in protecting human health and the environment. Although some contaminants could become airborne during excavation, implementation of health and safety procedures could protect workers against exposure. Since this alternative involves removal of the contaminants, it has excellent potential for meeting the cleanup levels specified in the RAO.

This alternative is considered to be readily implementable. There are no known regulatory restrictions that would prevent any of the proposed actions. Sufficient incinerator capacity, equipment, transportation, and labor resources exist to satisfy the requirements for this alternative.

This alternative is estimated to cost $1,800,000. Remediation could be completed within one year after design completion. The capital cost is estimated to be $1,800,000, which is due to costs for excavation and incineration of the soil. No long-term O&M costs are associated with this alternative.

4.2.3.7 Alternative No. 6--Off-Site Disposal

Description--This alternative is based on the assumption that the soil at Site 14 is considered a hazardous waste. This alternative includes excavation of the contaminated soil and disposal in an off-site RCRA hazardous waste landfill. A front-end loader is used to excavate the soil to a depth of 2 to 4 ft bgl. Approximately 740 cu yd of soil is excavated. Allowing for a 15% bulking factor, the volume of soil to be disposed of

is approximately 850 cu yd. The soil is loaded into roll-off containers, which are loaded onto trucks and transported to the RCRA hazardous waste landfill. For costing purposes, it is assumed that the soil is disposed of in the TECO, Inc. landfill in Robstown, Texas. Analyses are necessary to characterize the waste for disposal purposes. It is necessary to track the soil by the hazardous waste manifest system. The excavation is backfilled with clean soil obtained from other areas of the Base.

Evaluation--This alternative would not reduce the toxicity, mobility, and volume of the contaminants in the soil at Site 14. However, the contaminant concentrations in the remaining soil should be below the cleanup levels. The alternative should have short- and long-term effectiveness in protecting human health and the environment. Although some contaminants could become airborne during excavation, implementation of health and safety procedures could protect workers against exposure. It is estimated that remediation under this alternative could be completed within one year after design completion. The alternative could prevent dermal contact with the contaminants. Since this alternative involves removal of the contaminants, it has excellent potential to meet the cleanup levels specified in the RAO.

This alternative is considered to readily implementable. Sufficient equipment, labor resources, transportation resources, and landfill capacity exist to meet the requirements of this alternative. Even if the soils are determined to be hazardous waste [i.e., chlordane (D024) or heptachlor (D031) exceed the TCLP limit], there are no problems with disposing of the waste in the landfill because Waste Codes D024 and D031 are not land disposal restricted at this time.

Alternative No. 6 is estimated to have a present worth of $610,000. Remediation could be completed within one year following design completion. The capital cost is estimated to be $610,000, which is due to the costs for landfilling the contaminated soil. No long-term O&M costs are associated with this alternative.

4.3 Alternatives Recommended for Detailed Analysis

In this section, the most promising alternatives for each of Sites 2&5, 8, and 14 are identified and recommended for detailed analysis. The reasons for recommending these alternatives and the reasons for not selecting other alternatives are discussed.

4.3.1 Alternatives Recommended for Sites 2&5

The following alternatives for Sites 2&5 are recommended for detailed analysis:

Alternative No. 1--No action; and

Alternative No. 3--SVE/bioventing.

Alternative No. 1 (no action) was selected for detailed analysis to provide a baseline for comparison of the other alternatives. Alternative No. 3 is considered to be the most promising alternative for reasons summarized in Table 4-4 and discussed below. The remaining alternatives were screened from further consideration.

Alternative No. 2 (source containment) was not selected because it would not be effective in preventing future contamination of the groundwater at Sites 2&5. Although this alternative provides a clay cap, which could reduce the infiltration of rainwater, it would not adequately prevent future contamination of the groundwater, because some of the contamination is currently located at the vadose zone/groundwater interface. Fluctuating groundwater levels would solubilize contamination on the capillary fringe of the vadose zone. The alternative would not satisfy the RAO.

Alternative No. 3 (SVE/bioventing) was determined to have good potential for satisfying the RAO at Sites 2&5, since removal of the contaminants could prevent future contamination of the groundwater. This alternative could also achieve the cleanup levels

Table 4-4

Summary of Evaluations and Recommendations for Sites 2&5 Alternatives

Alternative	Effectiveness	Implementability	Cost ($)	Recommended for Detailed Analysis
1	Would not meet RAO.	Readily implemented.	0	√
2	Would not meet RAO.	Readily implemented.	130,000	
3	Good potential for satisfying RAO.	Readily implemented. Proven technology.	510,000	√
4	Good potential for satisfying RAO.	Readily implemented. Technology not widely proved.	850,000	
5	Good potential for satisfying RAO.	Excavation difficult due to subsurface obstructions.	1,800,000	
6	Excellent potential for satisfying RAO.	Excavation difficult due to subsurface obstructions.	1,500,000	

specified in the RAO. The remedial actions under this alternative would not require excavation of the soils in the main area of contamination. Also, the cost for the alternative is lower than the costs for the in situ biosparging alternative, the excavation and treatment alternative, and the excavation and disposal alternative. Over time, in situ biodegradation could be stimulated through SVE to remediate the less volatile petroleum hydrocarbons. A biomonitoring program is necessary to determine the viability of biodegradation in the vadose zone at this site. SVE has been widely demonstrated in full-scale remediation projects and has proved to be effective for removal of VOCs. Biodegradation has been proved to be effective for remediation of sites contaminated with petroleum hydrocarbons.

Alternative No. 4 (in situ biosparging with SVE) would have good potential for satisfying the RAO but, because of site conditions, it may not be much more effective than SVE. The cost for this alternative is significantly higher than that for Alternative No. 3. Also, biosparging has not been proved extensively in full-scale remediation projects.

Alternative Nos. 5 (on-site treatment) and 6 (excavation/disposal) were not selected because they would be difficult to implement because of the subsurface obstructions at the site. Concrete tank saddles and pipelines buried at the site would make it very difficult to excavate the contaminated soil. If the difficulties in excavating the soil could be overcome, Alternative No. 6 would have the highest potential for complying with the RAO.

4.3.2 Alternatives Recommended for Site 8

The following alternatives for Site 8 are recommended for detailed analysis:

Alternative No. 1--No action;

Alternative No. 4--Asphalt capping of the entire refuse collection area and land use restrictions;

Alternative No. 5--Excavation and incineration in an off-site RCRA facility;

Alternative No. 6A--Excavation and disposal of nonhazardous soil in an off-site industrial solid waste landfill; and

Alternative No. 6B--Excavation, stabilization of hazardous soil in an off-site RCRA hazardous waste facility, and disposal of soil in a RCRA hazardous waste landfill.

Alternative No. 1 (no action) was selected for detailed analysis to provide a baseline for comparison of the other alternatives. Alternative Nos. 4, 5, 6A, and 6B are considered to be the most promising alternatives for reasons summarized in Table 4-5 and discussed below. The remaining alternatives were screened from further consideration.

Alternative No. 2 (limited action) was not selected because it would not meet the RAOs. Although it could offer some protection against exposure, it would not be effective in preventing dermal contact with, or inhalation of, contaminated soil. Land use restrictions under this alternative would also prevent current work activities from being carried out at Site 8.

Alternative No. 3 (limited action--capping) was screened because risks of exposure would exist after the remedial actions were carried out. On-site personnel may occasionally work around the contaminated areas located outside the existing fence. Under Alternative No. 3, workers could still be exposed to risks through dermal contact with, or inhalation of, the contaminated soil. For example, personnel working on the capped area could be exposed to risk from inhalation of the contaminated soil if the wind blew dust from the contaminated area in their direction. This alternative has poor potential for meeting the RAOs.

Alternative No. 4 (source containment--capping) has good potential to meet the RAOs. It could prevent the on-site workers from exposure through dermal contact with, and inhalation of, contaminated soils. It is also expected to be effective in the long term.

Alternative Nos. 5 (excavation/incineration), 6A (excavation/disposal for nonhazardous soil), and 6B (excavation/treatment/disposal for hazardous soil) were determined to have excellent potential for satisfying the RAOs at Site 8. Since the alternatives involve

Table 4-5

Summary of Evaluations and Recommendations for Site 8 Alternatives

Alternative	Effectiveness	Implementability	Cost ($)	Recommended for Detailed Analysis
1	Would not meet RAOs.	Readily implemented.	0	√
2	Would not meet RAOs.	Readily implemented.	16,000	
3	Poor potential for satisfying RAOs.	Readily implemented.	210,000	
4	Good potential for satisfying RAOs.	Readily implemented.	300,000	√
5	Excellent potential for satisfying RAOs.	Readily implemented.	4,100,000	√
6A	Excellent potential for satisfying RAOs.	Readily implemented.	350,000	√
6B	Excellent potential for satisfying RAOs.	Readily implemented.	1,200,000	√

removal of the soil, the risks of exposure from dermal contact with, and inhalation of, contaminated soils could be decreased. The alternatives should have excellent long-term effectiveness.

4.3.3 Alternatives Recommended for Site 14

The following alternatives for Site 14 are recommended for detailed analysis:

Alternative No. 1--No action;

Alternative No. 3--Asphalt capping and land use restrictions;

Alternative No. 5--Excavation and incineration in an off-site RCRA facility ; and

Alternative No. 6--Excavation and disposal in an off-site RCRA hazardous waste landfill.

Alternative No. 1 (no action) was selected for detailed analysis to provide a baseline for comparison of the other alternatives. Alternative Nos. 3, 5, and 6 are considered to be the most promising alternatives for reasons listed in Table 4-6 and discussed below. The remaining alternatives were screened from further consideration.

Alternative No. 2 (limited action) was not selected because it would not meet the RAO. Since this alternative would provide only land use and access restrictions, it would not be effective in preventing dermal contact with the contaminated soil by on-site personnel.

Alternative No. 3 (source containment--capping) was selected for evaluation in the detailed analysis because it has good potential for complying with the RAO for Site 14. Capping could be effective in preventing the on-site workers from risks of exposure from dermal contact with the contaminated soil. It would also be less costly to implement than the infrared thermal desorption (Alternative Nos. 4A and 4B), incineration (Alternative No. 5), and excavation/disposal (Alternative No. 6) options.

Table 4-6

Summary of Evaluations and Recommendations for Site 14 Alternatives

Alternative	Effectiveness	Implementability	Cost ($)	Recommended for Detailed Analysis
1	Would not meet RAOs.	Readily implemented.	0	√
2	Would not meet RAOs.	Readily implemented.	15,000	
3	Good potential for satisfying RAOs.	Readily implemented.	200,000	√
4A	Good potential for satisfying RAOs.	Readily implemented.	580,000	
4B	Good potential for satisfying RAOs.	Readily implemented.	630,000	
5	Excellent potential for satisfying RAOs.	Readily implemented.	1,800,000	√
6	Excellent potential for satisfying RAOs.	Readily implemented.	610,000	√

Alternative Nos. 4A and 4B have good potential for meeting the RAO. These alternatives also have the advantage of reducing the toxicity, mass, and volume of the contaminants. They would be more costly to implement than Alternative No. 3, which also is capable of meeting the RAO. Further, the treatment of pesticide-contaminated soils by infrared thermal desorption has not been widely proved, while Alternatives Nos. 5 and 6 are reliable and have superior potential for meeting the RAO.

Alternative No. 5 (excavation/off-site incineration) has excellent potential for meeting the RAO. Also, it may be the only soil removal alternative that would be implementable if the concentration of either chlordane or heptachlor exceeds the TCLP limits and if the compounds become subject to land-ban regulations. Therefore, it was selected for detailed analysis.

Alternative No. 6 also was determined to have excellent potential for satisfying the RAO. Since this alternative involves removal of the contaminated soil, it could be effective in preventing on-site workers from being exposed to risks from dermal contact with the contaminated soil. The costs to implement the alternative would be comparable to those for Alternative Nos. 4A and 4B, and significantly lower than the costs for Alternative No. 5. Although Alternative No. 6 does not reduce the toxicity, mobility, or volume of the contaminants, the concentrations of contaminants in the remaining soil would be below the cleanup levels. The alternative is also readily implementable. Therefore, it was selected for detailed analysis.

5.0 DETAILED ANALYSIS OF ALTERNATIVES

This section presents a detailed analysis of each of the alternatives recommended in Section 4.3 for Sites 2&5, 8, and 14. The detailed analysis expands on the preliminary evaluations developed during the screening phase. Section 5.1 presents the evaluation criteria used for the detailed analysis. In Sections 5.2, 5.3, and 5.4, detailed descriptions of the alternatives, followed by analyses of the alternatives based on the evaluation criteria are provided for Sites 2&5, 8, and 14, respectively. Section 5.5 presents a comparative analysis of the alternatives for each site. This comparative analysis differs from the individual analyses in that alternatives are evaluated in comparison to each other in Section 5.5 rather than being evaluated solely on the basis of the evaluation criteria. The objective of Section 5.5 is to identify the relative strengths and weaknesses of alternatives for each site.

5.1 Introduction

The specific evaluation criteria used for the detailed analysis are discussed in this section. The evaluation criteria are those listed in *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (U.S. EPA, 1988).

5.1.1 FS Evaluation Criteria

According to the CERCLA guidance, the detailed analysis for an FS focuses on the following nine criteria:

- Overall protection of human health and the environment;
- Compliance with ARARs;
- Long-term effectiveness and permanence;

- Reductions in toxicity, mobility, and volume through treatment;
- Short-term effectiveness;
- Implementability;
- Cost;
- State acceptance; and
- Community acceptance.

State and community acceptance will be addressed in the Decision Document after comments on the FS and the Proposed Plan have been received. This detailed analysis addresses the first seven criteria as discussed below.

Overall Protection of Human Health and the Environment--This criterion draws on evaluations of other evaluation criteria, in particular, long- and short-term effectiveness and compliance with ARARs. This criterion provides for consideration of whether an alternative has any unacceptable short-term consequences.

Compliance with ARARs--This criterion includes the potential for an alternative to meet the chemical-, action-, and location-specific ARARs, as well as the RAOs. A presentation of ARARs is provided in Appendix B.

Long-Term Effectiveness and Permanence--This criterion allows consideration of the risk remaining at a site after remedial action is complete. The remaining risk may include risk associated with untreated waste or residuals from treatment. The adequacy and reliability of controls (e.g., source containment systems) used to manage untreated waste or residuals from treatment are also assessed.

Reductions in Toxicity, Mobility, and Volume Through Treatment--This criterion addresses the following:

- Treatment processes used and materials treated;
- Quantities of hazardous materials destroyed or treated;
- Expected percentage reduction in toxicity, mobility, and volume;
- Degree to which treatment is irreversible; and
- Type and quantity of residuals remaining after treatment.

Short-Term Effectiveness--This criterion considers the impacts on human health and the environment of the alternative during the construction and implementation phase of the remedial action. The following factors are addressed:

- Protection of community during remedial actions;
- Protection of workers during remedial actions;
- Environmental impacts during remedial actions; and
- Time requirements to achieve RAOs.

Implementability--This criterion considers the technical and administrative feasibility and availability of services and materials. The following factors are addressed:

- Feasibility of construction and operation;
- Reliability of the technology;
- Ease of carrying out additional remedial action, if needed;
- Ability to monitor effectiveness of remedial actions;
- Activities needed to coordinate with other offices and agencies;
- Availability of TSD facilities;
- Availability of required equipment and specialists;

- Availability of required materials and services; and
- Availability of prospective technologies.

Cost--This criterion includes a detailed assessment of the costs for each alternative. This criterion includes consideration of the following:

- Direct capital costs;
- Indirect capital costs;
- O&M costs; and
- Present worth analysis.

These criteria will be used to evaluate the alternatives for all three sites. Calculations for the design and cost estimate for each alternative are provided in Appendix D.

5.1.2 Evaluation Criteria Specified in HSWA Permit

Holloman AFB's HSWA permit specifies that the following criteria be used in the evaluation of a corrective measure:

- Technical:

  --Performance,

  --Reliability,

  --Implementability, and

  --Safety;
- Environmental;
- Human Health;

- Institutional; and
- Cost.

Table 5-1 provides a comparison of how each of the criteria specified in the HSWA permit is addressed in the seven evaluation criteria used in this FS.

5.1.3 Proposed Subpart S Evaluation Criteria

The proposed RCRA Subpart S rules specify that the following criteria be considered in the selection of an alternative:

- Long-term reliability and effectiveness;
- Reduction of toxicity, mobility, or volume;
- Short-term effectiveness;
- Implementability; and
- Cost.

Table 5-1 also provides a comparison of how the Subpart S criteria are addressed by the seven evaluation criteria used in this FS.

5.2 Individual Analysis of Alternatives for Sites 2&5

This section provides detailed descriptions and evaluations for the alternatives selected for Sites 2&5.

5.2.1 Alternative No. 1--No Action

A no-action alternative was considered in the detailed analysis for each site. Evaluation of this alternative provides a baseline for comparison of the other alternatives.

Table 5-1

Comparison of Evaluation Criteria

FS Evaluation Criteria	Holloman AFB's HSWA Permit Evaluation Criteria	Proposed Subpart S Evaluation Criteria
Overall protection of human health and the environment	Safety (evaluate threats to nearby communities and the environment) Environmental (evaluate adverse effects on environmentally sensitive areas and measures to mitigate adverse effects) Human health (protects human health before and after implementation of alternative)	
Compliance with ARARs	Institutional (evaluate the effects of public health standards, regulations, guidance, advisories, ordinances, or community relations)	Implementability (evaluate need to coordinate with and obtain necessary approvals and permits from regulatory agencies)
Long-term effectiveness and permanence	Technical performance (evaluate the ability of the alternative to perform intended functions and the useful life of the technologies in the alternative) Environmental (evaluate long-term beneficial and adverse effects of the response)	Long-term reliability and effectiveness (evaluate the magnitude of residual risk, requirements for long-term management, potential for exposure to residual wastes, and long-term reliability of engineering and institutional controls)

Table 5-1

(Continued)

FS Evaluation Criteria	Holloman AFB's HSWA Permit Evaluation Criteria	Proposed Subpart S Evaluation Criteria
Reductions in toxicity, mobility, and volume through treatement	Technical performance (evaluate the ability of the alternative to perform intended functions and the useful life of the technologies in the alternative)	Reduction of toxicity, mobility, or volume (evaluate the treatment processes, amount of hazardous wastes destroyed or treated, degree to which the treatment is irreversible, and residuals remaining after treatment)
Short-term effectiveness	Safety (evaluate threats to workers during implementation) Environmental (evaluate short-term beneficial and adverse effects of the response) Institutional (evaluate the effects of regulations, guidance, advisories, ordinances, and community relations)	Short-term effectiveness (evaluate the reduction of existing risks, short-term risks for community, workers, or environment, and time until full protection is achieved)
Implementability	Technical reliability (evaluate the operation and maintenance requirements; the reliability under analogous conditions; the effectiveness of combinations of technologies; and the flexibility to respond to site changes)	Implementability (evaluate the constructability of technology, operational reliability, need for permits or approvals, availability of necessary equipment and specialists, available location and capacity of needed TSD facilities)
Cost	Cost (include direct and indirect capital costs, O&M costs)	Cost (include capital, operation and maintenance, NPV of capital and O&M), and potential future remedial action costs)

5.2.1.1 Description

The no-action alternative does not implement any remedial action at Sites 2&5 to achieve the RAO, nor does it include any institutional action, containment, excavation, treatment, or disposal technologies. Under the no-action alternative, any reduction in the concentration of contaminants occurs through natural processes (e.g., biodegradation by naturally occurring microorganisms, dilution, etc.). Figure 5-1 shows the area of contamination at Sites 2&5.

5.2.1.2 Evaluation

Overall Protection of Human Health and the Environment--The no-action alternative would not protect human health and the environment. The alternative would not prevent future contamination of the groundwater at Sites 2&5.

Compliance with ARARs--Since the alternative would neither reduce the concentration of contaminants to the cleanup levels nor prevent future contamination of the groundwater, it would not comply with the RAO. No location-specific ARARs were identified for this site. Since no action is taken under this alternative, action-specific ARARs do not apply.

Long-Term Effectiveness and Permanence--The no-action alternative does not diminish the contamination at the site. No long-term management controls are instituted to provide protection from the contamination or any residuals. The contaminants in the soil would continue to pose a risk of future contamination of the groundwater. A five-year review is required to reassess the risks to human health and the environment.

Reduction of Toxicity, Mobility, and Volume Through Treatment--The no-action alternative provides no treatment to reduce the toxicity, mobility, or volume of the contaminants in the soil at Sites 2&5. All currently contaminated soils would remain. This

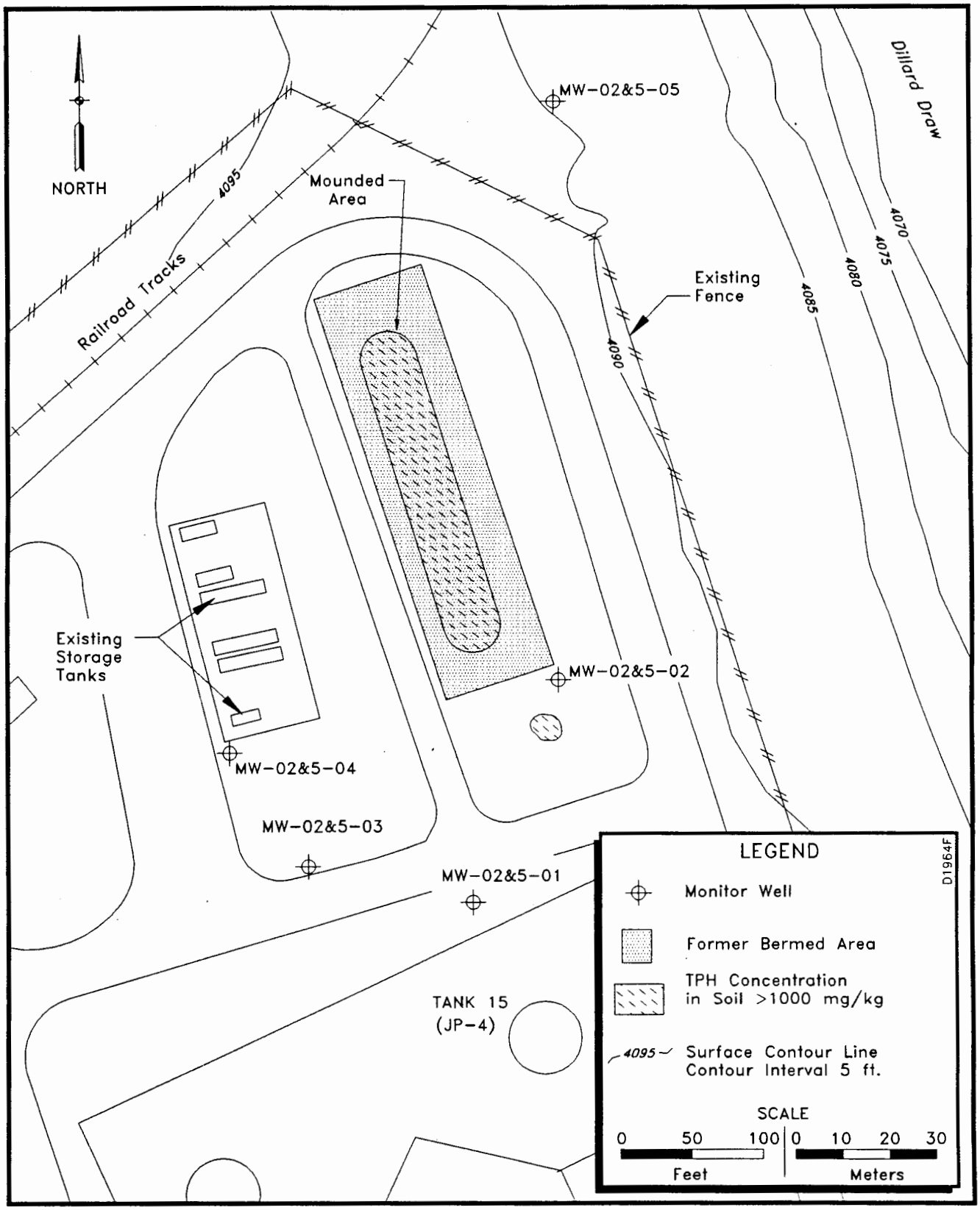

Figure 5-1. Estimated Area of Contamination at Sites 2&5

alternative does not meet the statutory preference for treatment to reduce hazards posed by the principal threats at the site.

Short-Term Effectiveness--No additional short-terms risks to the community, to workers, or to the environment would occur because of implementation of the no-action alternative. The time until the RAO is achieved would be indefinite.

Implementability--The no-action alternative is considered to be implementable. There are no limitations due to technical feasibility. There are no known regulatory restrictions that would prevent implementation of this alternative. Also, there are no limitations due to availability of equipment, materials, facilities, or services. Groundwater monitoring provisions in the Base-wide groundwater monitoring program are adequate to monitor the conditions at the site. There are no migration pathways that could not be monitored effectively.

Cost--The no-action alternative is estimated to have a 30-year present worth cost of $0. There are no capital or O&M costs associated with this alternative.

5.2.2 Alternative No. 3--Soil Vapor Extraction/Bioventing

This alternative involves implementation of SVE in the vadose zone. Groundwater monitoring is provided during the period of remediation.

5.2.2.1 Description

Under this alternative, four SVE wells are installed as shown in Figure 5-2. The SVE wells are drilled through the soil mound into the vadose zone to a depth of 13 ft bgl and screened above the water table in the interval from 8 to 12 ft bgl. The level of the water table fluctuates between approximately 11 and 15 ft bgl. A schematic of the SVE system is shown in Figure 5-3. Each SVE well is assumed to have a diameter of influence

of 75 ft. The flow rate through each of the four SVE wells is approximately 15 to 25 cfm, yielding a flow rate of 60 to 100 cfm through the entire SVE system. A common header connects the SVE wells to the blower in the vacuum system. A vapor-phase carbon adsorption system is included to remove VOCs from the extracted vapors. The spent carbon is sent to a licensed regeneration facility. Condensate from the SVE system is collected, analyzed, and, if determined to be nonhazardous, disposed of in the Base wastewater treatment plant. If the condensate is determined to be hazardous, it is disposed of in a RCRA-permitted facility. Approximately 400 ft of piping is required for the soil SVE system. A 6-in. clay cap is installed over the former bermed area (24,000 sq ft) to prevent the soil vacuum from causing channeling in certain areas. The total treatment time for this alternative is estimated to be five years. At the completion of the remedial actions, analyses of soil samples for TPH are performed to confirm that the contaminant concentrations in the soil are below the cleanup levels.

Under this alternative, two additional groundwater monitoring wells are installed in the proposed locations shown in Figure 5-2. The groundwater beneath Sites 2&5 is monitored annually for five years while the SVE system is in operation. Groundwater samples are analyzed for TPH and volatile aromatics by U.S. EPA Methods 418.1 and 8020, respectively. Also, four soil gas monitoring probes are installed along the perimeter of the mounded area to monitor the effectiveness of the SVE system operation.

Soil gas is monitored for oxygen, carbon dioxide, VOCs, and biological activity stimulated over time by inducement of oxygen flow into the vadose zone. Nutrients will be injected periodically through soil vents and the effects of these nutrients on biological growth will be monitored. These activities will allow determination of the degree to which in situ biodegradation can be stimulated through SVE. Laboratory testing of soil samples contaminated with TPH will be conducted to determine the optimal range of nutrient concentrations to maintain the biological activity in the vadose zone. The operation and monitoring program for in situ biodegradation could be developed within the first year of SVE operation.

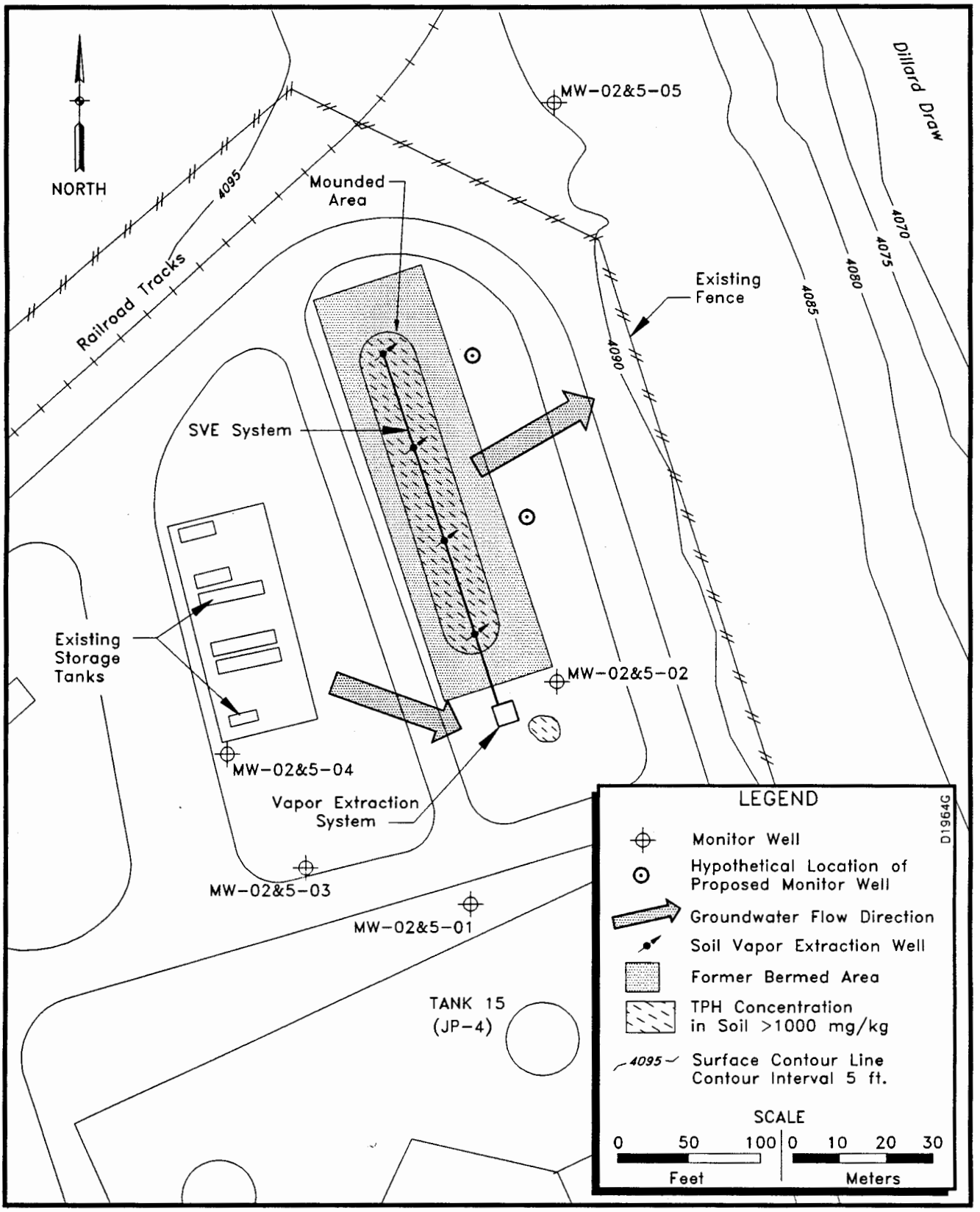

Figure 5-2. Site Plan for Sites 2&5 Alternative No. 3

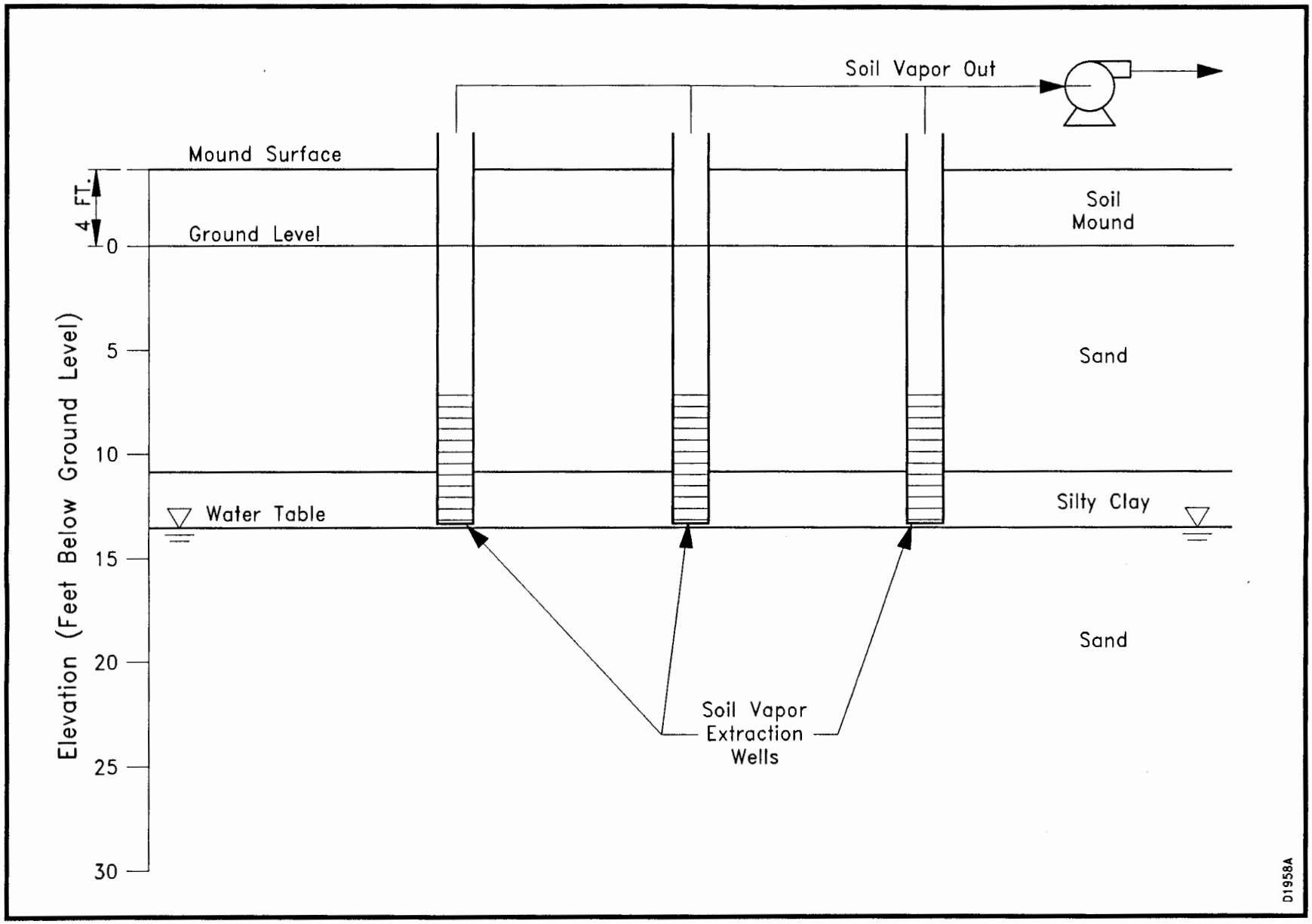

Figure 5-3. Schematic of Soil Vapor Extraction Wells for Sites 2&5 Alternative No. 3

The contaminated soil surrounding SB-02&5-24 is excavated and disposed of. A front-end loader is used to excavate the 325-sq ft area to a depth of 4 ft bgl. Approximately 50 cu yd (58 cu yd allowing for a 15% bulking factor) is excavated and loaded into roll-off containers that are transported by truck to an industrial solid waste landfill. The waste materials are covered before the trucks leave the site. For costing purposes, it is assumed that the soil is disposed of in the Nu-Mex Landfill in Sunland Park, New Mexico, approximately 90 miles from the Base. This landfill is the nearest industrial solid waste landfill to the Base. The landfill is permitted to accept nonhazardous soil contaminated with petroleum hydrocarbons. Analyses are necessary to characterize the waste for disposal purposes. The excavation is backfilled with clean soil obtained from other areas of the Base.

General services are also required for this alternative. An administrative office trailer is located on site for use by personnel coordinating the remedial actions. A separate trailer is provided for other site workers. A health and safety program is implemented at the site to reduce the risks of injuries and exposure to health risks. Appropriate personnel and personal protective equipment are supplied at the site as part of the program. Decontamination areas for personnel and equipment are established. A parking area is also established to provide space for vehicles used by workers, supervisors, administrators, and site visitors.

After the remedial actions are completed, the site is restored to its previous condition. All equipment and temporary buildings are removed from the site. The site is then graded to allow stormwater to run off of the site. Finally, all areas are covered with a layer of gravel.

5.2.2.2 Evaluation

Overall Protection of Human Health and the Environment--Alternative No. 3 should protect human health and the environment. This alternative is expected to reduce

the TPH concentrations in the soil to below 1000 mg/kg, which is the cleanup level specified in the RAO. Implementation of the in situ treatment alternative could prevent future contamination of the groundwater. This alternative should not pose unacceptable short-term risks.

Compliance with ARARs--This alternative should comply with the RAO. It should also comply with the chemical- and action-specific ARARs. No location-specific ARARs were identified for Sites 2&5.

Long-Term Effectiveness and Permanence--After remedial actions are completed, the concentration of TPH in the soil should be below 1000 mg/kg. The residual contaminants should not pose a significant risk of future contamination of the groundwater at Sites 2&5. A five-year review should be performed to determine the degree to which remediation has been successful. SVE systems have been implemented extensively and have been widely proved in full-scale remediation projects. It is likely that the SVE system will be effective in removing VOCs from the contaminated soil. Further, bioremediation of soils contaminated with petroleum hydrocarbons has been demonstrated to be effective. The degree of confidence that the proposed remediation system would meet the estimated performance specifications is high.

Since this alternative is expected to achieve remediation of the contaminated soil within six years after design completion, long-term management should not be required. It is not likely that major equipment would require replacement during the period of remediation. All mechanical components would have an expected operating life of at least 10 years, whereas the operation of the SVE system is expected to continue for approximately 5 years.

The controls used under this alternative to manage residuals from treatment are adequate and reliable. The contaminated soil surrounding SB-02&5-24 is to be excavated and, along with cuttings generated during drilling, will be disposed of in an

industrial solid waste landfill. There should be few uncertainties associated with land disposal of the soil and cuttings.

Reduction of Toxicity, Mobility, and Volume Through Treatment--The SVE process used under this alternative is expected to address the principal threats at Sites 2&5. This alternative would significantly reduce the mass and volume of the contaminants in the soil at Sites 2&5. It is estimated that approximately 75% of the organic compounds from the fuel would be removed or degraded in lowering the TPH concentration from an average of approximately 4000 mg/kg to below 1000 mg/kg. The SVE and biodegradation processes are irreversible.

Some organic compounds may remain in the soil at the end of the remediation period. The remaining contaminants will exist in concentrations below the cleanup level (1000 mg/kg for TPH). The toxicity of the remaining waste should be decreased through biodegradation. The mobility of the untreated waste would not be reduced through this alternative.

Excavated soil, drilling cuttings, and spent carbon will have to be disposed of. The excavated soil and cuttings will be disposed of in an industrial solid waste landfill. The spent carbon will be sent to a licensed regeneration facility. These residuals pose very little risk. This alternative meets the statutory preference for treatment to reduce hazards posed by the principal threats at the site.

Short-Term Effectiveness--Since this alternative implements in situ treatment of the contaminated soil, there should be very little potential for exposure for the community or the workers during implementation of the alternative.

There could be some degree of potential exposure to the workers during the drilling and excavation activities. The workers may be exposed to risks from VOCs and other contaminants present in the drilling cuttings and in the excavated soil. The exposure

could be minimized by contracting with experienced contractors and by ensuring that the workers wear appropriate personal protective equipment.

There could also be a small degree of potential exposure to the community and to the workers associated with transporting the cuttings and the excavated soil to a landfill. The risks of exposure could be minimized by contracting with experienced and reputable transportation and disposal contractors. Also, the risks of exposure can be reduced by making sure all workers are properly trained. There are no risks to the community or to workers that could not be readily controlled.

Under this alternative, the remedial actions should have minimal environmental impacts. It is possible that drilling activities could cause the contaminants adsorbed onto the soil to leach into the groundwater. There are no adverse environmental impacts that could not be avoided or minimized under this alternative. The remedial actions should not have adverse effects on wildlife or vegetation.

Under this alternative, operation of the SVE system would be required for approximately five years for protection against the threats of future contamination of groundwater. The cleanup levels specified in the RAO could be achieved within six years after design completion.

Implementability--Alternative No. 3 is considered to be readily implementable. The reliability of SVE systems for in situ treatment of contaminated soils has been widely demonstrated. Only minor schedule delays are expected to occur since there are few uncertainties associated with the SVE technology. However, the time required for initiation of effective biodegradation at the site is uncertain.

Drilling technologies are well proven and demonstrated for installing wells similar to those proposed under this alternative. However, some difficulties may arise in drilling the SVE wells. Since concrete tank saddles and pipelines are buried at the site, the

drilling contractor will have to take special precautions during drilling activities. The presence of the subsurface obstructions could lead to minor schedule delays.

It is possible that additional SVE wells may have to be installed if the initial treatment system does not achieve the effectiveness that is expected. It is also possible that a biosparging system may need to be installed to facilitate biodegradation of the petroleum hydrocarbons in the capillary fringe. It should be relatively easy to implement the additional remedial actions. New wells could be drilled easily. The original blowers may have sufficient capacity to handle the additional load for the SVE system. Additional blowers for the SVE and/or biosparging system could be installed easily, if required.

No known migration or exposure pathways exist that could not be monitored sufficiently. Even if monitoring should prove insufficient to detect failure, very little risk of exposure would be presented.

Sufficient equipment and materials are available to implement this alternative. Technical specialists, remediation contractors, drilling contractors, and services are available to carry out all of the actions under this alternative. The SVE technology is readily available for use in full-scale applications. Several vendors for the technology will be available to provide competitive bids.

Administrative concerns with this alternative are expected to be minimal. It will be necessary to coordinate with NMED and U.S. EPA, Region VI. No difficulties are likely in disposing of the drilling cuttings or the excavated soil. Adequate transportation services and landfill capacity exist to carry out these activities.

Cost--This alternative would have a present worth cost of approximately $540,000. Remediation could be completed within six years from design completion; the capital cost would be $270,000, and the annual O&M cost would be approximately $63,000.

The major capital cost would be due to the costs associated with the installation of the SVE wells. The major O&M cost would be that associated with the operation of the SVE system. Table 5-2 provides a summary of costs for this alternative.

5.3 Individual Analysis of Alternatives for Site 8

This section provides detailed descriptions and evaluations for the Site 8 alternatives selected for detailed analysis. It also presents the common elements included for all alternatives.

5.3.1 Common Elements

The following are common elements for all Site 8 alternatives except the no-action alternative:

Site Preparation--Some site preparation is required prior to implementation of remedial actions under the alternatives developed for Site 8. It may be necessary to remove brush from the contaminated areas at which remedial actions are to be implemented. A 6-ft-high chain-link fence is installed around contaminated areas at which work is to occur. The fence includes gates to allow equipment and workers to pass through and to prevent Base and other personnel from being exposed to contaminants or hazards during remediation.

General Services--An administrative office trailer is located on site for use by personnel coordinating the remedial actions. A separate trailer is provided for other site workers. A health and safety program is implemented at the site to reduce the risks of injuries and exposure to health risks. Appropriate personnel and personal protective equipment are supplied at the site as part of the program. Decontamination areas for

Table 5-2

Costs: Sites 2&5 Alternative 3--Soil Vapor Extraction

CAPITAL COSTS	
Process Option	**Capital Cost ($)**
Groundwater Monitoring	14,000
Clay Cap	9,600
Soil Vapor Extraction	130,000
Soil Gas Monitoring	0
Granular Activated Carbon	0
Soil Excavation	2,500
Disposal of Wastes	1,300
Transportation of Wastes	2,000
Construction Subtotal	159,400
Bid Contingencies, 15%	23,910
Scope Contingencies, 20%	31,880
Construction Total	215,190
Engineering and Design, 10%	21,519
Permitting and Legal, 5%	10,760
Bonding and Insurance, 3%	6,456
Construction Oversight, 5%	10,760
Field and Laboratory Testing, 3%	6,456
Total Capital Cost	271,139

Table 5-2

(Continued)

OPERATION AND MAINTENANCE COSTS				
	Annual O&M Costs	Process Option Service Time (years)	Present Worth Factor	Present Worth Cost
Groundwater Monitoring	3,050	5	4.3294	13,205
Clay Cap	960	5	4.3294	4,156
Soil Vapor Extraction	34,000	5	4.3294	147,200
Soil Gas Monitoring	7,200	5	4.3294	31,172
Granular Activated Carbon	8,660	5	4.3294	37,493
Soil Excavation	0			0
Disposal of Wastes	0			0
Transportation of Wastes	0			0
Subtotal	53,870	5	4.3294	233,225
Reserve Fund (1% of Capital Costs)	2,711	5	4.3294	11,739
5-Yr Site Reviews (2% of O&M Costs)	1,077	5	4.3294	4,664
Administration (5% of O&M Costs)	2,694	5	4.3294	11,661
Contingencies (5% of O&M Costs)	2,694	5	4.3294	11,661
Total Annual O&M Cost	63,046			272,950
NET PRESENT VALUE				
Capital Cost				271,139
Present Worth O&M Cost				272,950
Total Cost for Alternative				544,090

personnel and equipment are established. A parking area is also established to provide space for vehicles used by workers, supervisors, administrators, and site visitors.

Stormwater Control--For alternatives that include excavation, it is necessary to divert stormwater flows away from the site during construction. A 2-ft-deep ditch is constructed around the contaminated areas for this purpose.

Site Restoration--After the remedial actions have been completed, the site is restored to its previous condition. All equipment and temporary buildings used for the remedial actions are removed from the site. Unpaved areas are graded to allow stormwater to run off of the site. Also for unpaved areas, a vegetative cover is established to prevent the erosion of the soil by wind and stormwater.

5.3.2 Alternative No. 1--No Action

A no-action alternative was considered in the detailed analysis for each site. Evaluation of this alternative provides a baseline for comparison of the other alternatives.

5.3.2.1 Description

The no-action alternative does not involve implementing any remedial action at Site 8 to reduce the potential for exposure or to achieve the RAOs, nor does it include any institutional action, containment, excavation, treatment, or disposal technologies. Any reduction in the concentration of contaminants occurs solely through natural physical, chemical, or biological processes. Groundwater monitoring is conducted as part of the Base-wide groundwater monitoring program. Figure 5-4 shows the estimated area of contamination at Site 8.

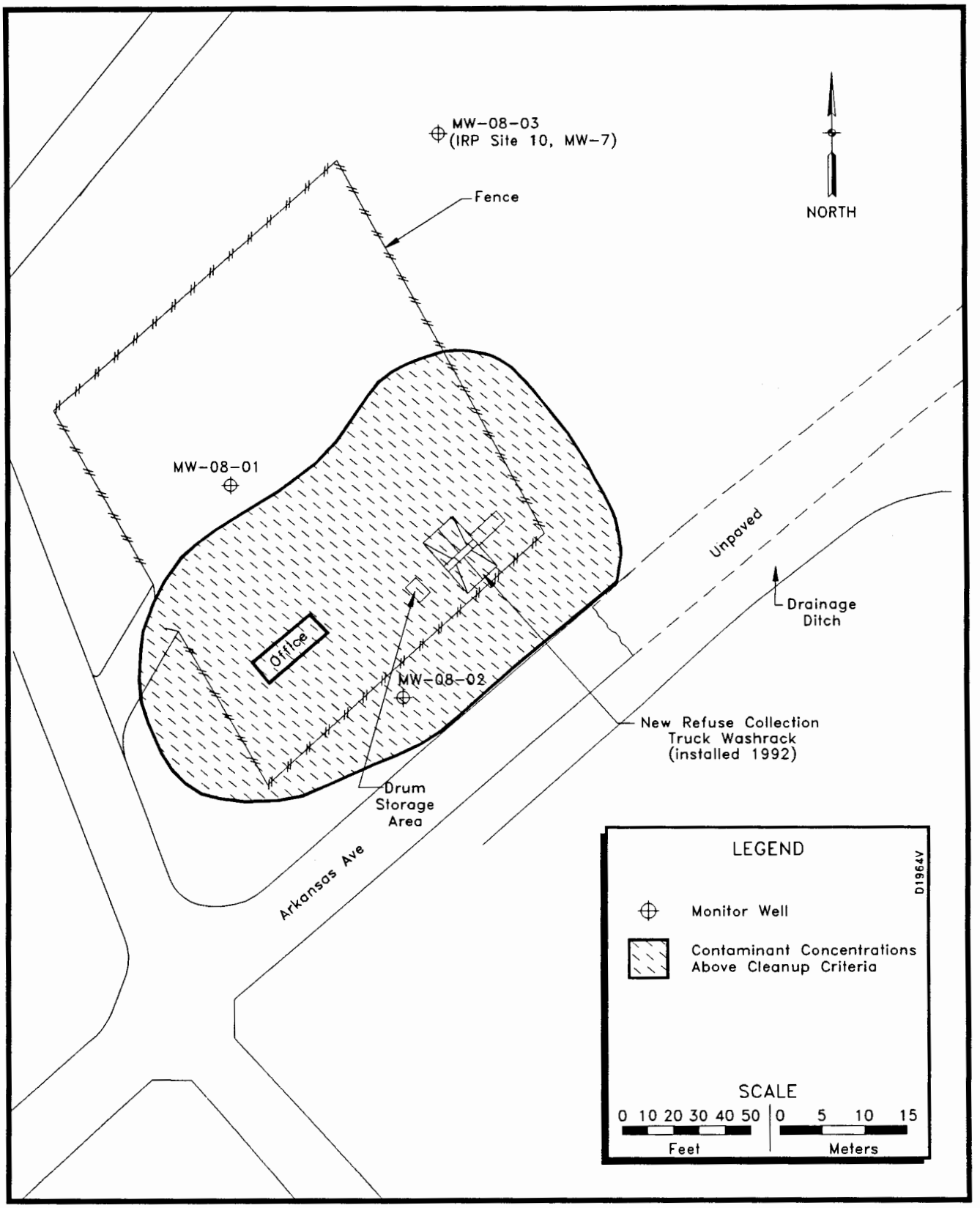

Figure 5-4. Estimated Area of Contamination at Site 8

5.3.2.2 Evaluation

Overall Protection of Human Health and the Environment--The no-action alternative would not protect human health and the environment. The alternative would not prevent dermal contact or inhalation of volatiles. Under this alternative, all current and potential risks would remain.

Compliance with ARARs--Since the alternative would not reduce the concentration of contaminants to the cleanup levels, nor dermal contact with, or inhalation of, contaminated soil, it would not comply with the RAOs. No location-specific ARARs were identified for this site. Since no action is taken under this alternative, there are no action-specific ARARs.

Long-Term Effectiveness and Permanence--The no-action alternative does not diminish the risk at the site. No long-term management controls are instituted to provide protection from the contamination or any residuals.

Reduction of Toxicity, Mobility, and Volume Through Treatment--The no-action alternative provides no treatment to reduce the toxicity, mobility, or volume of the contaminants in the soil at Site 8. No residuals will have to be disposed of. This alternative does not meet the statutory preference for treatment to reduce hazards posed by the principal threats at the site.

Short-Term Effectiveness--No additional short-term risks to the community or to workers will occur because of implementation of the no-action alternative. No adverse environmental impacts will occur. The time until the RAOs are achieved would be indefinite.

Implementability--The no-action alternative is considered to be implementable. There are no limitations due to technical or administrative feasibility. Since no remedial

actions are included in this alternative, there are no limitations due to availability of equipment, materials, specialists, or facilities. The Base-wide groundwater monitoring program is adequate to monitor the conditions at the site. There are no migration pathways that could not be monitored effectively.

Cost--The no-action alternative will have a 30-year present worth cost of $0. No capital or O&M costs are associated with the no-action alternative.

5.3.3 Alternative No. 4--Source Containment (Capping)

Alternative No. 4 involves installation of an asphalt cap to cover the entire area of contamination at Site 8. The alternative also implements land use restrictions. Additional fencing is installed to restrict access at the site.

5.3.3.1 Description

This alternative calls for installation of an asphalt cap over the entire area of contamination as well as the Refuse Collection Yard, excluding the washrack. Alternative No. 4 also provides for 800 ft of additional fencing to restrict access further. This alternative allows work to continue at the Refuse Collection Area after completion of the remedial action. The area that is capped under this alternative is shown in Figure 5-5. Approximately 41,000 sq ft of asphalt capping is required.

5.3.3.2 Evaluation

Overall Protection of Human Health and the Environment--Alternative No. 4 should protect human health and the environment, and could prevent exposure to workers from dermal contact with, and inhalation of, the contaminated soil. Environmental impacts

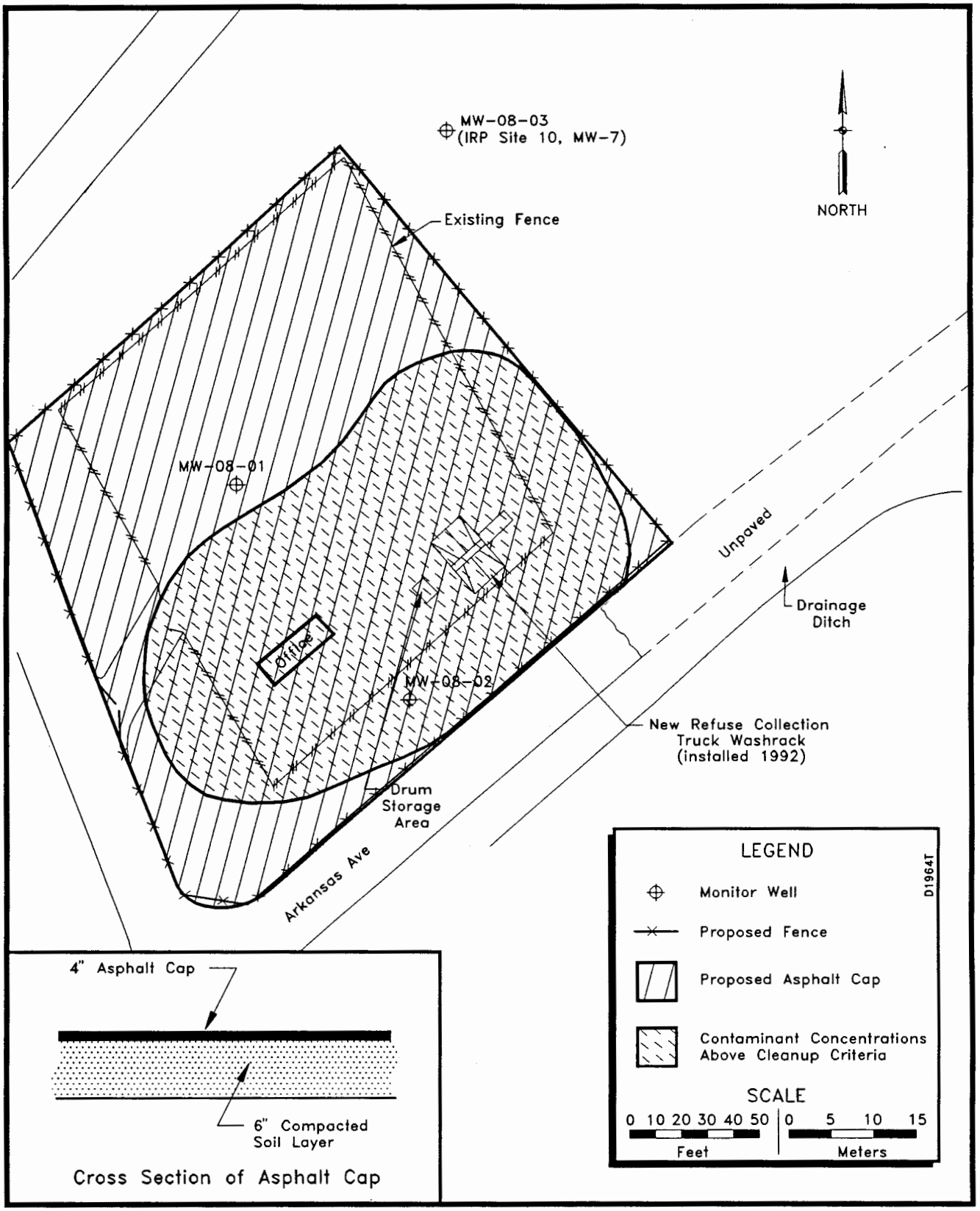

Figure 5-5. Site Plan for Site 8 Alternative No. 4

under this alternative should be minimal. This alternative should not provide any unacceptable short-term impacts.

Compliance with ARARs--This alternative could satisfy the action-specific ARARs; no location-specific ARARs were identified for this site. The remedial actions under this alternative would not reduce the concentrations of the contaminants in the soil. However, the alternative could comply with the RAOs, since the concentration of contaminants at the surface of the asphalt cap, which is considered to be the point of compliance, would be below the cleanup level. The alternative would prevent dermal contact with, and inhalation of, contaminated soil.

Long-Term Effectiveness and Permanence--Following the completion of the remedial actions proposed under this alternative, some potential risk will remain since the contaminants are not removed. Workers could be exposed to the contaminants if the asphalt cap and the contaminated soil were excavated or if the cap was allowed to deteriorate. Annual inspections of the cap and a five-year review are required to determine whether the alternative is complying with the RAOs.

Asphalt capping technology is a very well-developed method of capping. The technology has been demonstrated to be effective. It is very likely that the asphalt capping will meet the required performance specifications.

Maintenance of the asphalt cap will be required since the cap may be damaged slightly when trucks drive over it regularly. Should the asphalt cap require replacement, some risks of exposure to workers could arise. Controls, such as ensuring that all workers are trained and wear personal protective equipment, could adequately diminish the potential for exposure. If part of the original capping material had to be removed, the removed portion of the cap would need to be treated and/or disposed of. Although it may contain contaminants, it is not likely that the removed asphalt would be considered hazardous waste.

There should be few uncertainties associated with the land disposal of the materials. It is possible that a new layer of asphalt capping could be installed over the initial layer.

Reduction of Toxicity, Mobility, and Volume Through Treatment--Alternative No. 4 would address the principal risks at the site that include dermal contact with, and inhalation of, contaminated soil. This alternative would not reduce the toxicity or volume of the contaminants since no contaminants are treated or destroyed. However, in reducing the infiltration of water into the soil, it could reduce the future migration of contaminants. Although the remedial actions would not produce treatment residuals, the existing amounts of untreated soil would remain. Under this alternative, the remaining untreated soil would not pose significant risks because it should be isolated and risks of exposure should be minimized. This alternative would not meet the statutory preference for treatment to reduce hazards posed by the principal threats at the site.

Short-Term Effectiveness--Implementation of this alternative should not pose substantial risks of exposure to the community. The on-site workers could be exposed to some risks during the construction phase of the remedial action. All workers would have to be properly trained and outfitted with appropriate personal protective equipment to protect them from exposure to the contaminants. There are no risks to the community or to the workers that cannot be adequately controlled.

Environmental impacts from implementation of this alternative are expected to be minimal. Dust control methods could be used to ensure that contaminated soils are not blown away from the site. There are no environmental impacts that could not be avoided by implementing the appropriate controls.

Under this alternative, remediation could achieve the RAOs for Site 8 within one year after design completion. Much of this time would probably be spent in the contracting, mobilization, site preparation, and demobilization phases. The actual capping work could be completed within approximately two months.

Implementability--Alternative No. 4 is considered to be readily implementable. The remedial actions proposed under the alternative are technically feasible. Since asphalt capping is a well-developed technology, the level of confidence in the effectiveness of the technology is high. Capping activities are reliable, and it is unlikely that technical problems would cause any delays in the schedule. This alternative could be implemented fairly easily. If further risks develop or are identified at the site, it may be necessary to implement additional remedial actions in the future. If migration of the contaminants were to occur in the future, additional actions may include excavation and disposal of the contaminated soil. It should be relatively easy to implement the additional remedial actions. Known exposure or migration pathways could be monitored adequately.

Administrative concerns with this alternative are expected to be minimal. It will be necessary to coordinate with the NMED and the U.S. EPA, Region VI.

Adequate equipment, materials, asphalt contractors, and labor resources are available to implement all of the remedial actions proposed under this alternative. No additional development of technologies is required prior to implementation of the remedial actions.

Cost--Table 5-3 provides a summary of costs for Alternative No. 4. The alternative has an estimated capital cost of $230,000. The annual O&M cost would be approximately $8300. The total present worth cost for the alternative is approximately $360,000. Remediation could be completed within one year after design completion. The major capital cost is associated with the asphalt capping. The O&M cost includes one site visit per year for inspection and/or maintenance of the asphalt cap.

5.3.4 Alternative No. 5--Off-Site Treatment (for Hazardous Soil)

This alternative is based on the assumption that the contaminated soil at Site 8 is hazardous (i.e., the lead, chlordane, and/or heptachlor concentrations exceed the TCLP

Table 5-3

Costs: Site 8 Alternative 4--Source Containment

CAPITAL COSTS				
Process Option				Capital Cost ($)
Site Access Restrictions				40,000
Site Preparation				3,700
Asphalt Cap				93,000
Construction Subtotal				136,700
Bid Contingencies, 15%				20,505
Scope Contingencies, 20%				27,340
Construction Total				184,545
Engineering and Design, 10%				18,455
Permitting and Legal, 5%				9,227
Bonding and Insurance, 3%				5,536
Construction Oversight, 5%				9,227
Field and Laboratory Testing, 3%				5,536
Total Capital Cost				232,527
OPERATION AND MAINTENANCE COSTS				
	Annual O&M Cost	Process Option Service Time (years)	Present Worth Factor	Present Worth Cost
Site Access Restrictions	0			0
Site Preparation	0			0
Asphalt Cap	5,330	30	15.3725	81,935
Annual O&M Cost Subtotal	5,330	30	15.3725	81,935
Reserve Fund (1% of Capital Costs)	2,325	30	15.3725	35,745
5-Yr Site Reviews (2% of O&M Costs)	107	30	15.3725	1,639
Administration (5% of O&M Costs)	267	30	15.3725	4,097
Contingencies (5% of O&M Costs)	267	30	15.3725	4,097
Total Annual O&M Cost	8,295			127,513
NET PRESENT VALUE				
Capital Cost				232,527
Present Worth O&M Cost				127,513
Total Cost for Alternative				360,040

limits). Alternative No. 5 involves excavation of the contaminated soil followed by incineration at an off-site RCRA facility. Additional elements of this alternative, including site preparation, general services, stormwater diversion, and site restoration, are discussed in Section 5.3.1.

5.3.4.1 Description

A front-end loader is used to excavate the soil to a depth of 2 to 4 ft bgl. Excavation yields a soil volume of approximately 1610 cu yd (1850 cu yd allowing for a 15% bulking factor). The soil is loaded into roll-off containers that are transported by truck to a RCRA facility. The roll-off containers are covered and the outside of the containers are decontaminated prior to transport from the site. Assuming 20 cy yd per load, 93 loads are required. Excavation and removal of the soil from the site could be accomplished within approximately 10 days, assuming an excavation rate of 25 cu yd per hour and a transport rate of 10 loads per day. At the completion of excavation activities, analyses of soil borings are performed to confirm that the soil is cleaned up to the acceptable levels. The excavation is backfilled with clean soil from other areas of the Base.

Analyses are necessary to characterize the waste prior to transportation to the facility. It is also necessary to track the soil by the hazardous waste manifest system. For costing purposes it is assumed that the soil is transported to the incinerator operated by APTUS in Aragonite, Utah. The RCRA facility is responsible for stabilization and disposal of the ash in a RCRA landfill.

5.3.4.2 Evaluation

Overall Protection of Human Health and the Environment--Since Alternative No. 5 involves removal of the contaminants from the site, it should be protective of human health and the environment. The alternative should comply with the RAOs for the site, since the concentrations of contaminants in the remaining soil should be below the cleanup

levels. There may be some minimal, short-term impacts to wildlife and vegetation. This alternative should comply with ARARs that ensure protection of human health and the environment.

Compliance with ARARs--No location-specific ARARs were identified for this site. The alternative should comply with action-specific ARARs. Regulations applicable to the generation and transportation of hazardous wastes would be followed under the alternative. The D008 waste code (lead) is currently land disposal restricted, and therefore the stabilization of the waste would have to meet the concentration standards specified in 40 CFR Part 268 (5.0 mg/L lead for TCLP analysis). Waste Code D020 (chlordane) and Waste Code D031 (heptachlor) are not currently land disposal restricted. This alternative would satisfy the treatment requirements if either of these waste codes become land disposal restricted. This alternative should satisfy the RAOs.

Long-Term Effectiveness and Permanence--The remaining risk at the site after remedial actions should be minimal after remedial actions are complete. Most of the contaminants would be excavated, transported off site, and incinerated. There would be no treatment residuals and the concentration of contaminants in the remaining soil should be below the cleanup levels as specified in the RAOs. A five-year review would be necessary to ensure that no further risks to human health and the environment occur.

Under this alternative, the excavation, removal, and treatment technologies could comply with the RAOs by meeting the acceptable remediation levels. Long-term management should not be required under this alternative. Furthermore, O&M functions would not be required at the site. Since no treatment processes are implemented at the site under this plan, there would be no potential need for replacement of equipment or technical components.

Reduction of Toxicity, Mobility, and Volume Through Treatment--The remedial actions address the principal threats at the site. Since the alternative involves removal of the soil containing the contaminants, it could significantly reduce the mass and volume of contaminants remaining on site. All soil with contaminant concentrations above the cleanup levels would be removed, whereas the remaining soil should have concentrations of contaminants that are below the cleanup levels specified in the RAOs. Furthermore, stabilization after incineration could reduce the mobility of the contaminants remaining in the ash. The effects of the remedial actions are not reversible since they involve removal of the contaminated soil. The excavation and off-site treatment alternative follows the statutory preference for treatment to be used to reduce hazards posed by principal threats. The alternative does not meet the statutory preference for on-site management of wastes.

Short-Term Effectiveness--Some risks could be posed to the nearby residents during implementation of the alternative. Although it is unlikely, some dust could be blown to the residential areas during the excavation and transportation stages. There could be potential for exposure through inhalation of the contaminated soil. The potential for exposure could be addressed by implementing appropriate dust controls. Also, contaminated soil could be transported from the site in sealed bins in compliance with the ARARs for transportation. Risks to the community could be readily avoided.

Risks could be posed to workers during the implementation phase. Workers could be exposed to risks through dermal contact with, and inhalation of, contaminated soil. The potential for exposure could be addressed by ensuring that the workers are properly trained and outfitted with appropriate personal protective equipment. There could be potential risks to the workers associated with working around heavy construction equipment. The risks could be decreased by ensuring that the contractor has developed and implemented adequate Occupational Safety and Health Administration (OSHA)-approved health and safety procedures. The workers could also receive appropriate safety training in operating and working around heavy equipment. Risks to the workers could be readily controlled.

Implementation of the remedial actions under this alternative should have only minimal environmental impacts. The excavation, loading, and transportation activities could have some minor short-term impacts on the wildlife and vegetation at or near the site. The impacts on the environment could be minimized by worker training and construction management. Some minimal impacts to vegetation may be unavoidable.

Since this alternative involves removal of the contaminated soil, protection against the principal threats being addressed could be achieved at the conclusion of the excavation and disposal phases (within one year after design completion). The RAOs should be achieved by that time.

Implementability--This alternative is readily implementable. No difficulties are anticipated for the implementation phase of this alternative. Excavation technologies are well developed and the depth of excavation should not present any difficulties. Few uncertainties would exist regarding implementation of the alternative. Since excavation technologies involving front-end loaders are proven and reliable, it is not likely that technical problems would lead to schedule delays. If it is later discovered that additional soil volumes are contaminated, it should be relatively easy to implement additional excavation activities to address the situation.

In accordance with RCRA regulations, the hazardous waste management system would be used to track the waste. Certified transporters would be used to transport the waste to a RCRA incineration facility. Facilities are available that are permitted under RCRA to landfill hazardous waste.

Adequate treatment facilities are available to handle the volume of soils excavated under this alternative. Implementation is not likely to be limited because of insufficient capacity. The equipment, transportation services, analytical services, labor resources, and specialists required under this alternative are available. All of the technologies included in this alternative are readily available and sufficiently proven for the

specific application proposed under this alternative. Several vendors should be available to provide competitive bids.

Cost--The one-year present worth of this alternative would be approximately $4,500,000. No O&M costs are associated with this alternative. Remediation could be completed within one year after design completion. The main items that contribute to the capital cost include excavation, transportation, and incineration of contaminated soils. Table 5-4 provides a summary of the costs for this alternative.

5.3.5 Alternative No. 6A--Excavation and Disposal (for Nonhazardous Soils)

This alternative assumes that the contaminant levels are below the TCLP limits, and therefore, the contaminated soil at Site 8 is nonhazardous. The alternative involves excavation of the contaminated soil and disposal in an off-site industrial solid waste landfill. Additional elements of this alternative, including site preparation, general services, stormwater diversion, and site restoration, are discussed in Section 5.3.1

5.3.5.1 Description

This alternative includes the use of a front-end loader to excavate the contaminated soil to a depth of 2 to 4 ft bgl. To remove the contaminated soil, excavation of a soil volume of approximately 1610 cu yd (1850 cu yd allowing for a 15% bulking factor) is required. The soil is loaded into roll-off containers that are transported by truck to an industrial solid waste landfill. The waste materials are covered before the trucks leave the site. Assuming 20 cu yd per load, 93 loads are required. Excavation and disposal of the soil is accomplished within approximately 10 days, assuming an excavation rate of 25 cu yd per hour and a transport rate of 10 loads per day.

Table 5-4

Costs: Site 8 Alternative 5--Excavation and Incineration (Hazardous)

CAPITAL COSTS	
Process Option	**Capital Cost ($)**
Site Access Restrictions	22,000
Surface Water Controls	3,700
Excavation	100,000
Treatment: Off-Site Incinerator	2,315,000
Transportation: Off-Site Incinerator	185,200
Construction Subtotal	2,625,900
Bid Contingencies, 15%	393,885
Scope Contingencies, 20%	525,180
Construction Total	3,544,965
Engineering and Design, 10%	354,497
Permitting and Legal, 5%	177,248
Bonding and Insurance, 3%	106,349
Construction Oversight, 5%	177,248
Field and Laboratory Testing, 3%	106,349
Total Capital Cost	4,466,656

OPERATION AND MAINTENANCE COSTS				
Process Option	**Annual O&M Cost**	**Process Option Service Time (years)**	**Present Worth Factor**	**Present Worth Cost**
Site Access Restrictions	0			0
Surface Water Controls	0			0
Excavation	0			0
Treatment: Off-Site Incinerator	0			0
Transportation: Off-Site Incinerator	0			0
Annual O&M Cost Subtotal	0			0
Total Annual O&M Cost	0			0

NET PRESENT VALUE	
Capital Cost	4,466,656
Present Worth O&M Cost	0
Total Cost for Alternative	4,466,656

For costing purposes, it is assumed that the soil is disposed of in the Nu-Mex Landfill in Sunland Park, New Mexico, approximately 90 miles from the Base. This landfill is the nearest industrial solid waste landfill to the Base. The landfill is also capable of accepting the contaminated soil if it is nonhazardous. Analyses are necessary to characterize the waste for disposal purposes. At the completion of the remedial actions, analyses of soil borings are performed to confirm that the soil complies with the cleanup levels. The excavation is backfilled with clean soil obtained from other areas of the Base.

5.3.5.2 Evaluation

Overall Protection of Human Health and the Environment--Since this alternative involves removal of the contaminants, it should be protective of human health and the environment. Since the alternative could reduce the concentration of contaminants in the remaining soil to the cleanup levels, it should comply with the RAOs for the site. There could be some minimal, short-term impacts to wildlife and vegetation. This alternative could also comply with ARARs that ensure protection of human health and the environment.

Compliance with ARARs--No location-specific ARARs were identified for this site. The alternative will comply with the action-specific ARARs. The transportation and disposal of the soils should comply with New Mexico Solid Waste Management Regulations (NMSWMRs). This option would not be considered if the soils are determined to be hazardous. Alternative No. 6A could satisfy the RAOs.

Long-Term Effectiveness and Permanence--After remedial actions under this alternative are complete, the remaining risk at the site should be minimal. Most of the contaminants should be excavated and disposed of off site. There should be no treatment residuals and the concentration of contaminants in the remaining soil should be below the cleanup levels specified in the RAOs. A five-year review would be necessary to ensure that no further risks to human health and the environment occur at the site.

This alternative should achieve the acceptable cleanup levels and, thus, should comply with the RAOs. Long-term management should not be required under this alternative. Furthermore, O&M functions should not be required. Since no treatment processes are implemented at the site under this plan, there should be no potential need for replacement of equipment or technical components.

Reduction of Toxicity, Mobility, and Volume Through Treatment--Under this alternative, the remedial actions address the principal threats at the site. Since this alternative involves removal of the soil containing the contaminants, it could significantly reduce the mass and volume of contaminants remaining on site. All soil with contaminant concentrations above the cleanup levels should be removed so the remaining soil should have concentrations of contaminants that are below the cleanup levels specified in the RAOs. The effects of the remedial actions are not reversible since they involve removal of the contaminated soil. Excavation and off-site disposal does not follow the statutory preference for treatment to be used to reduce hazards posed by principal threats nor does it meet the preference for on-site management of wastes.

Short-Term Effectiveness--Some risks could be posed to the nearby residents of the community during implementation of the alternative. Although the distances make it very unlikely, some dust could be blown to the residential areas during the excavation and transportation stages. There could be potential for exposure through inhalation of contaminated soil. The potential for exposure could be addressed by implementing appropriate dust controls. Also, contaminated soil could be transported from the site in sealed bins to comply with ARARs for transportation. Risks to the community can be readily controlled.

Risks could also be posed to the workers during the implementation phase. Workers could be exposed to risks through dermal contact with, and inhalation of, contaminated soil. The potential for exposure could be addressed by ensuring that the workers are trained properly and outfitted with appropriate personal protective equipment.

There could also be potential risks to the workers associated with working around heavy construction equipment. The risks could be mitigated by ensuring that the contractor has in place adequate OSHA-approved health and safety procedures to avoid injuries to workers. The workers could also receive appropriate safety training in operating and working around heavy equipment. No risks to the workers could not be readily controlled through the development and implementation of appropriate health and safety procedures.

Implementation of the remedial actions under this alternative should have only minimal environmental impacts. The excavation, loading, and transportation activities could have some minor short-term impacts on wildlife and vegetation at and near the site. Appropriate worker training and construction management could minimize the impacts. Some minimal impacts to vegetation may be unavoidable under this alternative.

Since this alternative involves removal of the contaminated soil, protection against the principal threats being addressed should be achieved at the conclusion of the excavation and disposal phases (within one year after design completion). The cleanup levels specified in the RAOs should also be addressed by that time.

Implementability--This alternative is considered to be readily implementable. No difficulties are anticipated for the implementation phase of this alternative. Excavation technologies are well developed and the depth of excavation should not present any difficulties. Few uncertainties would exist regarding implementation of the alternative. Since excavation technologies involving front-end loaders are proven and reliable, there is very little likelihood that technical problems would lead to schedule delays. If it is later found that additional soil volumes are contaminated, it would be easy to implement additional excavation activities to address the situation. No administrative difficulties are anticipated for this alternative.

Exposure pathways could be monitored easily under this alternative. There should be very little risk of exposure due to insufficient monitoring.

Adequate treatment and disposal facilities are available to handle the volume of soils excavated under this alternative. Therefore, implementation would not be limited by insufficient capacity. The equipment, transportation services, landfill capacity, analytical services, labor resources, and specialists required under this alternative are available. All of the technologies under consideration for this alternative are readily available and sufficiently proven for the specific application proposed under this alternative. Several vendors will be available to provide competitive bids.

Cost--The present worth cost of this alternative would be approximately $410,000, all of which would be capital cost. Table 5-5 provides a summary of costs for this alternative. Remediation could be completed within one year after design completion. The primary capital cost items include the excavation, transportation, and disposal of the contaminated soils.

5.3.6 Alternative No. 6B--Excavation and Disposal (for Hazardous Soils)

This alternative is based on the assumption that the contaminated soil at Site 8 is hazardous (i.e., the lead, chlordane, and/or heptachlor concentrations exceed the TCLP limits). Alternative No. 6B involves excavation of the contaminated soil followed by off-site stabilization to immobilize the metals and disposal in a RCRA hazardous waste landfill. Additional elements of this alternative, including site preparation, general services, stormwater diversion, and site restoration, are discussed in Section 5.3.1

5.3.6.1 Description

A front-end loader is used to excavate the soil to a depth of 2 to 4 ft bgl. Excavation yields a soil volume of approximately 1610 cu yd (1850 cu yd allowing for a 15%

Table 5-5

Costs: Site 8 Alternative 6A--Excavation and Disposal (Nonhazardous)

CAPITAL COSTS	
Process Option	**Capital Cost ($)**
Site Access Restrictions	22,000
Surface Water Controls	3,700
Excavation	100,000
Disposal: Off-Site Nonhazardous Landfill	51,000
Transportation: Off-Site Nonhazardous Landfill	63,000
Construction Subtotal	239,700
Bid Contingencies, 15%	35,955
Scope Contingencies, 20%	47,940
Construction Total	323,595
Engineering and Design, 10%	32,360
Permitting and Legal, 5%	16,180
Bonding and Insurance, 3%	9,708
Construction Oversight, 5%	16,180
Field and Laboratory Testing, 3%	9,708
Total Capital Cost	407,730

OPERATION AND MAINTENANCE COSTS				
Process Option	**Annual O&M Cost**	**Process Option Service Time (years)**	**Present Worth Factor**	**Present Worth Cost**
Site Access Restrictions	0			0
Surface Water Controls	0			0
Excavation	0			0
Disposal: Off-Site Nonhazardous Landfill	0			0
Transportation: Off-Site Nonhazardous Landfill	0			0
Annual O&M Cost Subtotal	0			0
Total Annual O&M Cost	0			0

NET PRESENT VALUE	
Capital Cost	407,730
Present Worth O&M Cost	0
Total Cost for Alternative	407,730

bulking factor) landfill. The soil is loaded into roll-off containers that are transported by truck to a RCRA landfill. The roll-off containers are covered and the outside of the containers are decontaminated prior to transport from the site. Assuming 20 cu yd per load, 93 loads are required. Excavation and disposal of the soil could be accomplished within approximately 10 days, assuming an excavation rate of 25 cu yd per hour and a transport rate of 10 loads per day. Analyses are necessary to characterize the waste prior to transportation to the facility. It is also necessary to track the soil by the hazardous waste manifest system.

For costing purposes, it is assumed that the soil is stabilized at the TECO, Inc. facility in Robstown, Texas, and disposed of in the hazardous waste landfill at the same facility. The TECO facility is one of the nearest hazardous waste treatment and disposal facilities. The facility also has permits that allow it to accept, stabilize, and landfill the contaminated soils from Site 8. At the completion of the remedial actions, analyses of soil borings are performed to confirm that the soil is cleaned up to the acceptable levels. The excavation is backfilled with clean soil.

5.3.6.2 Evaluation

Overall Protection of Human Health and the Environment--Since this alternative involves removal of the contaminants, it should protect human health and the environment. Since the concentration of contaminants in the remaining soil should be below the cleanup levels, the alternative should comply with the RAOs for the site. There may be some minimal, short-term impacts to wildlife and vegetation. This alternative should also comply with ARARs that ensure protection of human health and the environment.

Compliance with ARARs--No location-specific ARARs were identified for this site; the alternative should comply with the action-specific ARARs. Regulations applicable to the generation and transportation of hazardous wastes would be followed under this alternative. Waste Code D008 (lead) is currently land disposal restricted, and therefore the

stabilization of the waste would have to meet the concentration standards specified in 40 CFR Part 268 (5.0 mg/L lead for TCLP analysis). Waste Code D020 (chlordane) and Waste Code D031 (heptachlor) are not currently land disposal restricted. This alternative should satisfy the RAOs.

Long-Term Effectiveness and Permanence--After remedial actions under this alternative are complete, the remaining risk at the site should be minimal. Most of the contaminants would be excavated and disposed of off site. There would be no treatment residuals and the concentration of contaminants in the remaining soil should be below the cleanup levels as specified in the RAOs. A five-year review would be necessary to ensure that no further risks to human health and the environment occur.

Under this alternative, the excavation and disposal technologies could comply with the RAOs by meeting the acceptable remediation levels. Long-term management should not be required under this alternative. Furthermore, O&M functions would not be required. Since no treatment processes are implemented at the site under this plan, there would be no potential need for replacement of equipment or technical components.

Reduction of Toxicity, Mobility, and Volume Through Treatment--Under this alternative, the remedial actions address the principal threats at the site. Since this alternative involves removal of the soil containing the contaminants, it could significantly reduce the mass and volume of contaminants remaining on site. All soil with contaminant concentrations above the cleanup levels would be removed so the remaining soil should have concentrations of contaminants that are below the cleanup levels specified in the RAOs. Furthermore, stabilization could reduce the mobility of the contaminants in the excavated soil. The effects of the remedial actions are not reversible since they involve removal of the contaminated soil. Excavation and off-site disposal does not follow the statutory preference for treatment to be used to reduce hazards posed by principal threats nor does it meet the statutory preference for on-site management of wastes.

Short-Term Effectiveness--Some risks could be posed to the nearby residents of the community during implementation of the alternative. Although the distances make it very unlikely, some dust could be blown to the residential areas during the excavation and transportation stages. There could be potential for exposure through inhalation of contaminated soil. The potential for exposure could be addressed by implementing appropriate dust controls. Also, contaminated soil could be transported from the site in sealed bins in compliance with ARARs for transportation. Risks to the community could be readily controlled.

Risks could also be posed to the workers during the implementation phase. Workers could be exposed to risks through dermal contact with, and inhalation of, contaminated soil. The potential for exposure could be addressed by ensuring that the workers are trained properly and outfitted with appropriate personal protective equipment. There could also be potential risks to the workers associated with working around heavy construction equipment. The risks could be mitigated by ensuring that the contractor has developed and implemented adequate OSHA-approved health and safety procedures. The workers could also receive appropriate safety training in operating and working around heavy equipment. Risks to the workers could be readily controlled.

Implementation of the remedial actions under this alternative should have only minimal environmental impacts. The excavation, loading, and transportation activities could have some short-term impacts on wildlife and vegetation at and near the site. Appropriate worker training and construction management could minimize the impacts. Some minimal impacts to vegetation may be unavoidable under this alternative.

Since this alternative involves removal of the contaminated soil, protection against the principal threats being addressed could be achieved at the conclusion of the excavation and disposal phases (within one year after design completion). The RAOs should be achieved by that time.

Implementability--This alternative is considered to be readily implementable. No difficulties are anticipated for the implementation phase of this alternative. Excavation technologies are well developed and the depth of excavation should not present any difficulties. Few uncertainties would exist regarding implementation of the alternative. Since excavation technologies involving front-end loaders are proven and reliable, there is little likelihood that technical problems would lead to schedule delays. If it is later found that additional soil volumes are contaminated, it should be easy to implement additional excavation activities to address the situation.

Exposure pathways could be monitored easily under this alternative. There should be little risk of exposure due to insufficient monitoring.

In accordance with RCRA regulations, the hazardous waste manifest system would be used to track the waste. Certified transporters would be used to transport the waste to a RCRA hazardous waste landfill. Facilities are available that are permitted under RCRA to landfill hazardous wastes.

Adequate treatment and disposal facilities are available to handle the volume of soils excavated under this alternative. Implementation should not be limited by insufficient capacity. The equipment, transportation services, analytical services, labor resources, and specialists required under this alternative are available. All of the technologies under consideration for this alternative are readily available and sufficiently proven for the specific application proposed under this alternative. Several vendors should be available to provide competitive bids.

Cost--The present worth cost of this alternative would be approximately $1,600,000, all of which would be capital cost. Remediation could be completed within one year after design completion. The primary capital cost items include the excavation,

transportation, and disposal of the contaminated soils. Table 5-6 provides a summary of costs for this alternative.

5.4 Individual Analysis of Alternatives for Site 14

This section provides detailed descriptions and evaluations for the Site 14 alternatives selected for detailed analysis. It also presents the common elements included for all alternatives.

5.4.1 Common Elements

The following are common elements for alternatives developed for Site 14.

Site Preparation--Some site preparation is required prior to implementation of remedial actions under the alternatives developed for Site 14. A 6-ft-high chain-link fence is installed around contaminated areas at which work is to occur. The fence includes gates to allow equipment and workers to pass through and to prevent Base and other personnel from being exposed to contaminants or hazards during remedial actions.

General Services--An administrative office trailer is located on site for use by personnel coordinating the remedial actions. A separate trailer is provided for other site workers. A health and safety program is implemented at the site to reduce the risks of injuries and exposure to health risks. Appropriate personnel and personal protective equipment are supplied at the site as part of the program. Decontamination areas for personnel and equipment are established. A parking area is also established to provide space for vehicles used by workers, supervisors, administrators, and site visitors.

Stormwater Control--For alternatives that include excavation, it is necessary to divert stormwater runoff away from the site during construction. A 2-ft-deep ditch is constructed around the contaminated areas for this purpose.

Table 5-6

Costs: Site 8 Alternative 6B--Excavation and Disposal (Hazardous)

CAPITAL COSTS	
Process Option	**Capital Cost ($)**
Site Access Restrictions	22,000
Surface Water Controls	3,700
Excavation	100,000
Disposal: Off-Site RCRA Landfill	389,000
Transportation: Off-Site RCRA Landfill	440,000
Construction Subtotal	954,700
Bid Contingencies, 15%	143,205
Scope Contingencies, 20%	190,940
Construction Total	1,288,845
Engineering and Design, 10%	128,885
Permitting and Legal, 5%	64,442
Bonding and Insurance, 3%	38,665
Construction Oversight, 5%	64,442
Field and Laboratory Testing, 3%	38,665
Total Capital Cost	1,623,945

OPERATION AND MAINTENANCE COSTS				
Process Option	**Annual O&M Cost**	**Process Option Service Time (years)**	**Present Worth Factor**	**Present Worth Cost**
Site Access Restrictions	0			0
Surface Water Controls	0			0
Excavation	0			0
Disposal: Off-Site RCRA Landfill	0			0
Transportation: Off-Site RCRA Landfill	0			0
Annual O&M Cost Subtotal	0			0
Total Annual O&M Cost	0			0

NET PRESENT VALUE	
Capital Cost	1,623,945
Present Worth O&M Cost	0
Total Cost for Alternative	1,623,945

Site Restoration--After the remedial actions are completed, the site is restored to its previous condition. All equipment and buildings are removed from the site, and the temporary fence is removed. The unpaved areas of the site are graded to allow stormwater to run off of the site.

5.4.2 Alternative No. 1--No Action

A no-action alternative was considered in the detailed analysis for all sites. Evaluation of this alternative provides a baseline against which the other alternatives can be compared.

5.4.2.1 Description

The no-action alternative involves implementing no remedial action at Site 14 to achieve the RAO. This alternative does not include any institutional action, monitoring, containment, excavation, treatment, or disposal technologies. Under the no-action alternative, any reduction in the concentration of contaminants occurs through natural processes (e.g., biodegradation by naturally occurring microorganisms, dilution, etc.). The area of contamination at Site 14 is shown in Figure 5-6.

5.4.2.2 Evaluation

Overall Protection of Human Health and the Environment--The no-action alternative would not protect human health and the environment, nor would it prevent dermal contact with the contaminants at Site 14. Under this alternative, all current and potential risks would remain.

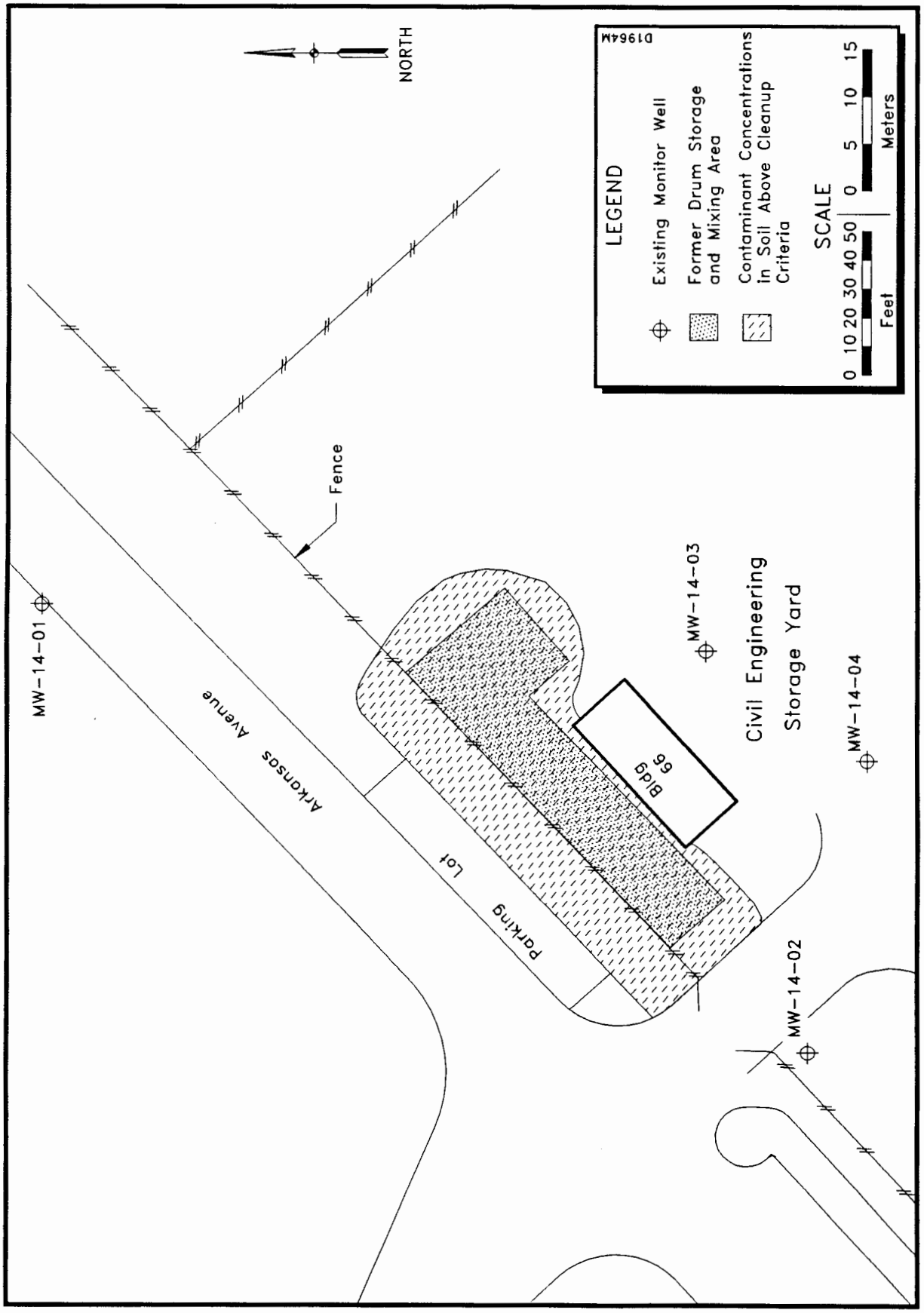

Figure 5-6. Estimated Area of Contamination at Site 14

Compliance with ARARs--Since the alternative would neither reduce the concentration of contaminants nor prevent dermal contact with the contaminants, it would not comply with the RAO. No location-specific ARARs were identified for this site. Since no action is taken under this alternative, there are no action-specific ARARs.

Long-Term Effectiveness and Permanence--The no-action alternative does not diminish the risk at the site. No long-term management controls are instituted to provide protection from the contamination or any residuals.

Reduction of Toxicity, Mobility, and Volume Through Treatment--The no-action alternative provides no treatment to reduce the toxicity, mobility, or volume of the contaminants in the soil at Site 14.

Short-Term Effectiveness--No additional short-term risks to the community, to workers, or to the environment will occur because of implementation of the no-action alternative. The time until the RAO is achieved would be indefinite.

Implementability--The no-action alternative is considered to be implementable. There are no limitations due to technical or administrative feasibility. Since no remedial actions are included, there are no limitations due to availability of equipment, materials, facilities, or services. The Base-wide groundwater monitoring program is adequate to monitor the conditions at the site. There are no migration pathways that could not be monitored effectively.

Cost--The no-action alternative is estimated to have a 30-year present worth cost of $0.

5.4.3 Alternative No. 3--Source Containment (Capping)

Alternative No. 3 involves the installation of asphalt capping to cover the entire area of contamination at Site 14. The alternative also implements land use restrictions. Additional elements of this alternative, including site preparation, general services, and site restoration, are discussed in Section 5.4.1.

5.4.3.1 Description

This alternative involves capping the entire area of contamination with an asphalt cap to prevent dermal contact with the contaminants by on-site workers. Land use restrictions are also applied to the entire area. The land use restrictions prohibit certain uses of the land as well as extraction of groundwater from the area. As shown in Figure 5-7, an area of approximately 12,000 sq ft is capped. This alternative allows routine work to be carried out at the site.

5.4.3.2 Evaluation

Overall Protection of Human Health and the Environment--Alternative No. 3 should protect human health and the environment. It could prevent exposure to workers from dermal contact and inhalation of the contaminated soil. Environmental impacts under this alternative should be minimal. This alternative should not cause any unacceptable short-term impacts to human health and the environment.

Compliance with ARARs--This alternative could satisfy the action-specific ARARs; no location-specific ARARs were identified for this site. This alternative would not reduce the concentrations of the contaminants in the soil. However, it could comply with the RAO, since the concentration of the contaminants at the surface of the asphalt cap,

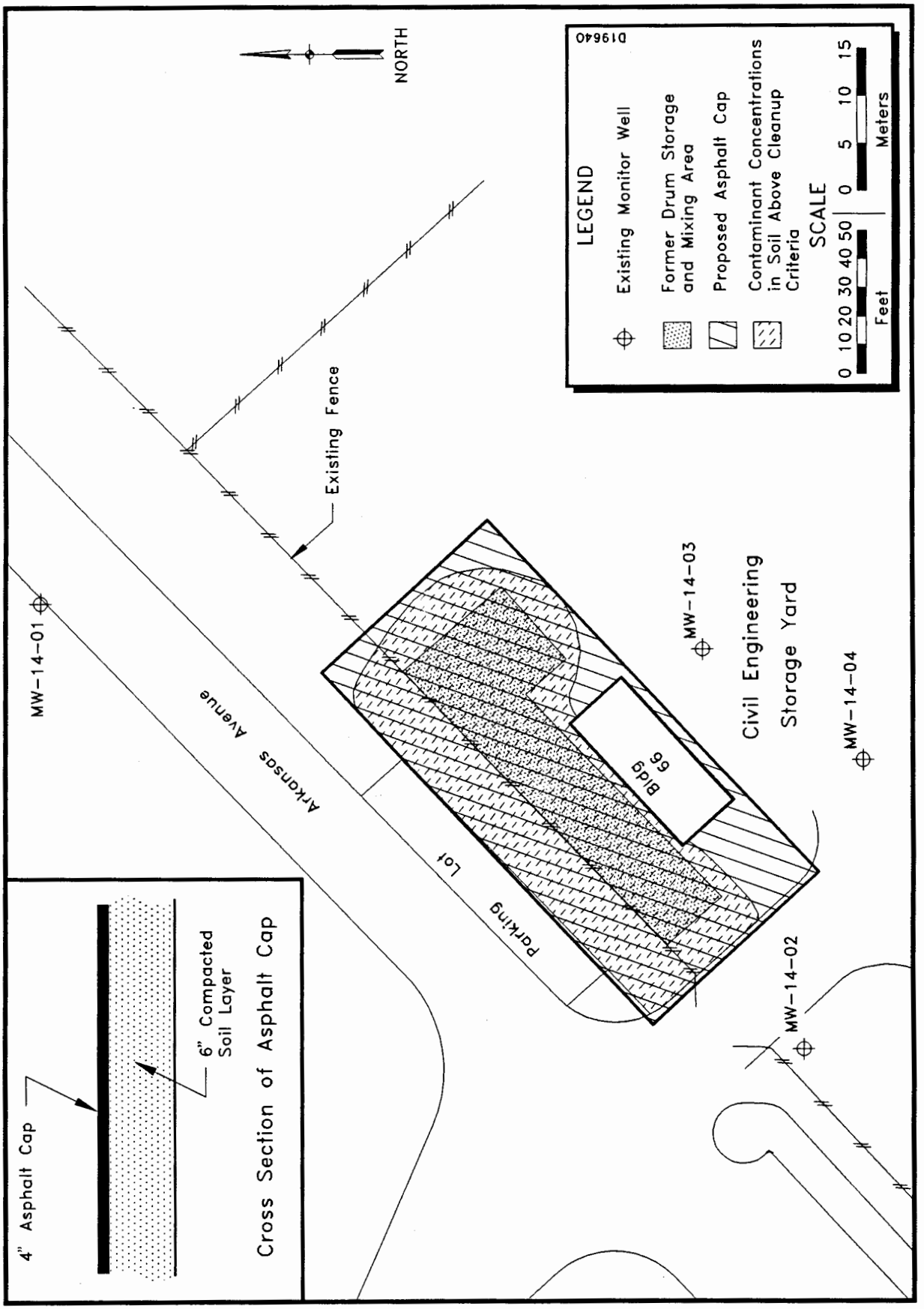

Figure 5-7. Site Plan for Site 14 Alternative No. 3

which is considered to be the point of compliance, would be below the cleanup levels. The alternative could prevent dermal contact with the soil.

Long-Term Effectiveness and Permanence--Following the completion of the remedial actions proposed under this alternative, some potential risk would remain since the contaminants are not removed. Workers could be exposed to the contaminants if the asphalt cap and the contaminated soil were excavated or if the cap were allowed to deteriorate. Annual inspections of the cap and a five-year review are required.

Asphalt capping technology is an effective and well-developed method of capping. It is very likely that the asphalt capping will meet the required performance specifications.

Maintenance of the asphalt cap may be required since the cap may be damaged if trucks drive over it regularly. Should the asphalt cap require replacement, some risks of exposure to workers could arise. Controls, such as ensuring that all workers are trained and wear personal protective equipment, could adequately diminish the potential for exposure. If part of the original capping material had to be removed, the removed portion of the cap would need to be treated and/or disposed of properly. Although it may contain contaminants, it is not likely that the removed asphalt would be hazardous. There should be few uncertainties associated with the land disposal of the materials. It is possible that a new layer of asphalt capping could be installed over the initial layer.

Reduction of Toxicity, Mobility, and Volume Through Treatment--Alternative No. 3 would address the principal risk at the site, which is associated with the potential for dermal contact with contaminated soil. This alternative would not reduce the toxicity or volume of the contaminants, since none of the contaminants are treated or destroyed. However, it could decrease the migration of contaminants due to percolation of rainwater through the soil. Although the remedial actions would not produce treatment residuals, the existing amounts of contaminated soil would remain. Under this alternative, the remaining

untreated soil should not pose significant risks because it has been isolated. Exposure should be minimized. This alternative does not meet the statutory preference for treatment to reduce the hazards posed by the principal threats.

Short-Term Effectiveness--Implementation of this alternative should not pose substantial risks of exposure to the community. The on-site workers could be exposed to minimal risks during the construction phase of the remedial action. All workers would have to be properly trained and outfitted with appropriate personal protective equipment to protect them from any exposure to the contaminants. There are no risks to the community or to the workers that could not be adequately controlled through the development and implementation of appropriate health and safety procedures.

Environmental impacts from implementation of this alternative are expected to be minimal. Dust control methods could be used to ensure that contaminated soils are not blown away from the site. There are no environmental impacts that could not be avoided by the appropriate controls.

Under this alternative, it is expected to take approximately one year of remedial action after design completion to achieve the RAO for Site 14. Much of this time would probably be spent in the contracting, mobilization, site preparation, and demobilization phases. The actual capping could be accomplished within approximately one month or less.

Implementability--Alternative No. 3 is considered to be readily implementable. The remedial actions proposed under the alternative are technically feasible. Since asphalt capping is a well-developed technology, the level of confidence in the effectiveness of the technology is high. Capping activities are reliable, and it is unlikely that technical problems would cause any delays in the schedule. This alternative could be implemented easily. If migration of the contaminants were to occur in the future, additional actions may include

excavation and disposal of the contaminated soil. It would be relatively easy to implement the additional remedial actions.

Administrative concerns with this alternative are expected to be minimal. It would be necessary to coordinate with the NMED and the U.S. EPA, Region VI.

Adequate equipment, materials, asphalt capping contractors, and labor resources are available to implement all of the remedial actions proposed under this alternative. No additional development of technologies is required prior to implementation of the remedial actions.

Cost--This alternative has an estimated capital cost of $140,000. The annual O&M cost would be approximately $6200. The 30-year present worth cost for the alternative is approximately $230,000. Remedial actions could be completed within one year after design completion. The major capital cost is associated with installation of the asphalt capping. The O&M cost includes one site visit per year for inspection and/or maintenance of the asphalt cap. Table 5-7 presents a summary of the costs for this alternative.

5.4.4 Alternative No. 5--Off-Site Treatment

This alternative is based on the assumption that the contaminated soil at Site 14 is hazardous (i.e., the chlordane and/or heptachlor concentrations exceed the TCLP limits). Alternative No. 5 involves excavation of the contaminated soil followed by incineration at an off-site RCRA facility. Additional elements of this alternative, including site preparation, general services, stormwater diversion, and site restoration, are discussed in Section 5.4.1.

Table 5-7

Costs: Site 14 Alternative 3--Source Containment

CAPITAL COSTS	
Process Option	**Capital Cost ($)**
Site Access Restrictions	14,000
Asphalt Cap	67,000
Construction Subtotal	81,000
Bid Contingencies, 15%	12,150
Scope Contingencies, 20%	16,200
Construction Total	109,350
Engineering and Design, 10%	10,935
Permitting and Legal, 5%	5,468
Bonding and Insurance, 3%	3,281
Construction Oversight, 5%	5,468
Field and Laboratory Testing, 3%	3,281
Total Capital Cost	137,781

OPERATION AND MAINTENANCE COSTS				
Process Option	**Annual O&M Cost**	**Process Option Service Time (years)**	**Present Worth Factor**	**Present Worth Cost**
Site Access Restrictions	0			0
Asphalt Cap	4300	30	15.3725	66,102
Annual O&M Cost Subtotal	4,300	30	15.3725	66,102
Reserve Fund (1% of Capital Costs)	1,378	30	15.3725	21,180
5-Yr Site Reviews (2% of O&M Costs)	86	30	15.3725	1,322
Administration (5% of O&M Costs)	215	30	15.3725	3,305
Contingencies (5% of O&M Costs)	215	30	15.3725	3,305
Total Annual O&M Cost	6,194			95,214

NET PRESENT VALUE	
Capital Cost	137,781
Present Worth O&M Cost	95,214
Total Cost for Alternative	232,995

5.4.4.1 Description

A front-end loader is used to excavate the soil to a depth of 2 to 4 ft bgl. Excavation yields a soil volume of approximately 740 cu yd (850 cu yd allowing for a 15% bulking factor). The soil is loaded into roll-off containers that are transported by truck to a RCRA facility. The roll-off containers are covered and the outside of the containers are decontaminated prior to transport from the site. Assuming 20 cy yd per load, 43 loads are required. Excavation and removal of the soil from the site could be accomplished within approximately five days, assuming an excavation rate of 25 cu yd per hour and a transport rate of 10 loads per day. At the completion of excavation activities, analyses of soil borings are performed to confirm that the soil is cleaned up to the acceptable levels. The excavation is backfilled with clean soil from other areas of the Base.

Analyses are necessary to characterize the waste prior to transportation to the facility. It is also necessary to track the soil by the hazardous waste manifest system. For costing purposes it is assumed that the soil is transported to the incinerator operated by APTUS in Aragonite, Utah. The RCRA facility is responsible for stabilization and disposal of the ash in a RCRA landfill.

5.4.4.2 Evaluation

Overall Protection of Human Health and the Environment--Since Alternative No. 5 involves removal of the contaminants from the site, it should protect human health and the environment. The alternative should comply with the RAO for the site, since the concentrations of contaminants in the remaining soil should be below the cleanup levels. This alternative should comply with ARARs that ensure protection of human health and the environment.

Compliance with ARARs--No location-specific ARARs were identified for this site. The alternative should comply with the action-specific ARARs. Regulations applicable to the generation and transportation of hazardous wastes would be followed under the alternative. Waste Code D020 (chlordane) and Waste Code D031 (heptachlor) are not currently land disposal restricted. This alternative would satisfy the treatment requirements if either of these waste codes become land disposal restricted. This alternative should satisfy the RAO.

Long-Term Effectiveness and Permanence--The remaining risk at the site after remedial actions are complete should be minimal. Most of the contaminants would be excavated, transported off site, and incinerated. There would be no treatment residuals and the concentration of contaminants in the remaining soil should be below the cleanup levels as specified in the RAO. A five-year review would be necessary to ensure that no further risks to human health and the environment occur.

Under this alternative, the excavation, removal, and treatment technologies could comply with the RAO by meeting the acceptable remediation levels. Long-term management should not be required under this alternative. Furthermore, O&M functions would not be required at the site. Since no treatment processes are implemented at the site under this plan, there would be no potential need for replacement of equipment or technical components.

Reduction of Toxicity, Mobility, and Volume Through Treatment--The remedial actions address the principal threats at the site. Since the alternative involves removal of the soil containing the contaminants, it could significantly reduce the mass and volume of contaminants remaining on site. All soil with contaminant concentrations above the cleanup levels would be removed so the remaining soil should have concentrations of contaminants that are below the cleanup levels specified in the RAO. Furthermore, stabilization after incineration could reduce the mobility of the contaminants in the remaining ash. The effects of the remedial actions are not reversible since they involve removal of the contaminated

soil. Excavation and off-site treatment follows the statutory preference for treatment to be used to reduce hazards posed by principal threats. The alternative does not meet the statutory preference for on-site management of wastes.

Short-Term Effectiveness--Some risks could be posed to the nearby residents during implementation of the alternative. Although the distances make it very unlikely, some dust could be blown into the residential areas during the excavation and transportation stages, which could pose potential exposure through inhalation of the contaminated soil. The potential for exposure could be addressed by implementing appropriate dust controls. Also, contaminated soil could be transported from the site in sealed bins in compliance with the ARARs for transportation. Risks to the community could be readily avoided.

Risks could be posed to workers during the implementation phase. Workers could be exposed to risks through dermal contact with, and inhalation of, contaminated soil. The potential for exposure could be addressed by ensuring that the workers are properly trained and outfitted with appropriate personal protective equipment. There could be potential risks to the workers associated with working around heavy construction equipment. The risks could be decreased by ensuring that the contractor has developed and implemented adequate OSHA-approved health and safety procedures. The workers could also receive appropriate safety training in operating and working around heavy equipment. Risks to the workers could be readily controlled.

Implementation of the remedial actions under this alternative should not have adverse environmental impacts. The excavation, loading, and transportation activities are not likely to have any short-term impacts on the wildlife and vegetation at or near the site.

Since this alternative involves removal of the contaminated soil, protection against the principal threats being addressed could be achieved at the conclusion of the

excavation and treatment phases (within one year after design completion). The RAO should be achieved by that time.

Implementability--This alternative is readily implementable. No difficulties are anticipated for the implementation phase of this alternative. Excavation technologies are well developed and the depth of excavation should not present any difficulties. Few uncertainties would exist regarding implementation of the alternative. Since excavation technologies involving front-end loaders are proven and reliable, it is not likely that technical problems would lead to schedule delays. If it is later discovered that additional soil volumes are contaminated, it should be relatively easy to implement additional excavation and treatment activities to address the situation.

In accordance with RCRA regulations, the hazardous waste management system would be used to track the waste. Certified transporters would be used to transport the waste to a RCRA incineration facility. Facilities are available that are permitted under RCRA to landfill hazardous waste.

Adequate treatment facilities are available to handle the volume of soils excavated under this alternative. Implementation is not likely to be limited because of insufficient capacity. The equipment, transportation services, analytical services, labor resources, and specialists required under this alternative are available. All of the technologies included in this alternative are readily available and sufficiently proven for the specific application proposed under this alternative. Several vendors should be available to provide competitive bids.

Cost--The present worth cost for this alternative would be approximately $2,100,000; no O&M costs are associated with this alternative. Remediation could be completed within one year after design completion. The main items that contribute to the

capital cost include excavation, transportation, and incineration of contaminated soils. Table 5-8 provides a summary of the costs for this alternative.

5.4.5 Alternative No. 6--Excavation and Disposal

Alternative No. 6 is based on the assumption that the concentrations of contaminants in the soil exceed the TCLP limits, and therefore, the soil at Site 14 is classified as a hazardous waste. The alternative implements excavation of the contaminated soil and disposal in an off-site RCRA hazardous waste landfill. Additional elements of this alternative, including site preparation, general services, stormwater diversion, and site restoration, are discussed in Section 5.4.1.

5.4.5.1 Description

A front-end loader is used to excavate the soil to a depth of 2 to 4 ft bgl. Excavation of a soil volume of approximately 740 cu yd (850 cu yd allowing 15% for a bulking factor) is required to remove all soil with concentrations of contaminants above the acceptable levels. The soil is loaded into roll-off containers that are transported by truck to the RCRA hazardous waste landfill. Assuming 20 cu yd per load, 43 loads are required. Excavation and disposal of the soil is accomplished within approximately five days, assuming an excavation rate of 25 cu yd per hour and a transport rate of 10 loads per day.

The roll-off containers are covered and the outside of the containers are decontaminated prior to being transported from the site. Analyses are necessary to characterize the waste for disposal purposes. It is necessary to track the soil by the hazardous waste manifest system. At the completion of the remedial actions, analyses of soil borings are performed to confirm that the soil complies with the cleanup levels. The excavation is backfilled with clean soil obtained from other areas of the Base.

Table 5-8

Costs: Site 14 Alternative 5--Excavation and Incineration

CAPITAL COSTS	
Process Option	**Capital Cost ($)**
Site Access Restrictions	14,000
Surface Water Controls	17,000
Excavation	73,000
Treatment: Off-Site Incinerator	1,068,000
Transportation: Off-Site Incinerator	85,000
Construction Subtotal	1,257,000
Bid Contingencies, 15%	188,550
Scope Contingencies, 20%	251,400
Construction Total	1,696,950
Engineering and Design, 10%	169,695
Permitting and Legal, 5%	84,848
Bonding and Insurance, 3%	50,909
Construction Oversight, 5%	84,848
Field and Laboratory Testing, 3%	50,909
Total Capital Cost	2,138,157

OPERATION AND MAINTENANCE COSTS				
Process Option	**Annual O&M Cost ($)**	**Process Option Service Time (years)**	**Present Worth Factor**	**Present Worth Cost**
Site Access Restrictions	0			0
Surface Water Controls	0			0
Excavation	0			0
Treatment: Off-Site Incinerator	0			0
Transportation: Off-Site Incinerator	0			0
Annual O&M Cost Subtotal	0			0
Total Annual O&M Cost	0			0
NET PRESENT VALUE				
Capital Cost				2,138,157
Present Worth O&M Cost				0
Total Cost for Alternative				2,138,157

For costing purposes, it is assumed that the soil is be disposed of in the TECO, Inc. hazardous waste landfill in Robstown, Texas. The TECO facility is one of the nearest hazardous waste disposal facilities. The facility also has permits that allow it to accept and landfill the contaminated soils from Site 14.

5.4.5.2 Evaluation

Overall Protection of Human Health and the Environment--Since this alternative involves removal of the contaminants, it should protect human health and the environment. Since the alternative could reduce the concentration of contaminants in the remaining soil to the cleanup levels, it could comply with the RAO for the site. This alternative should also comply with ARARs that ensure protection of human health and the environment.

Compliance with ARARs--No location-specific ARARs were identified for this site. The alternative would comply with the action-specific ARARs. Regulations applicable to the generation, transportation, and disposal of hazardous wastes would be followed under this alternative. It should also satisfy the RAO. Waste Codes D020 and D031 are not currently land disposal restricted; therefore, there are no concentration or treatment-based standards.

Long-Term Effectiveness and Permanence--After remedial actions under this alternative are complete, the remaining risk at the site should be minimal. Most of the contaminants would be excavated and disposed of off site. There would be no treatment residuals and the concentration of contaminants in the remaining soil should be below the cleanup levels specified in the RAO. A five-year review would be necessary to ensure that remedial actions are successful.

Under this alternative, the excavation and disposal technologies should comply with the RAO by meeting the acceptable remediation levels. Neither long-term management nor long-term monitoring should be required under this alternative. O&M functions would not be required. Since no treatment processes are implemented at the site under this plan, there would be no potential need for replacement of equipment or technical components.

Reduction of Toxicity, Mobility, and Volume Through Treatment--Under this alternative, the remedial actions address the principal threats at the site. Since this alternative involves removal of the soil containing the contaminants, it could significantly reduce the mass and volume of contaminants remaining on site. All soil with contaminant concentrations above the cleanup levels would be removed so the remaining soil would have concentrations of contaminants that are below the cleanup levels specified in the RAO. The effects of the remedial actions are not reversible since they involve removal of the contaminated soil. There are no risks associated with residuals since no treatment residuals are generated. Excavation and off-site disposal does not follow the statutory preference for treatment to be used to reduce hazards posed by principal threats nor does it meet the statutory preference for on-site treatment of wastes.

Short-Term Effectiveness--Some risks could be posed to the nearby residents of the community during implementation of the alternative. Although the distances make it very unlikely, some dust could be blown into the residential areas during the excavation and transportation stage. The potential for exposure could be addressed by implementing appropriate dust controls. Also, contaminated soil would be transported from the site in sealed bins in compliance with ARARs for transportation. Risks to the community could be readily controlled.

Risks could also be posed to the workers during the implementation phase. Workers could be exposed to risks through dermal contact with the contaminated soil. The

potential for exposure could be addressed by ensuring that the workers are trained properly and outfitted with appropriate personal protective equipment. There could also be potential risks to the workers from working around heavy construction equipment. The risks could be mitigated by ensuring that the contractor has developed and implemented OSHA-approved health and safety procedures. The workers could also receive appropriate safety training in operating and working around heavy equipment. Risks to the workers could be readily controlled.

Implementation of this alternative should not have detrimental impact on the environment. The excavation, loading, and transportation activities are not likely to adversely impact wildlife or vegetation.

Since this alternative involves removal of the contaminated soil, protection against the principal threats being addressed could be achieved at the conclusion of the excavation and disposal phases. Remediation could be completed within one year of design completion. The cleanup levels specified in the RAO should be achieved by that time.

Implementability--This alternative is considered to be readily implementable. No difficulties are anticipated for the implementation phase of this alternative. Excavation technologies are well developed and the depth of excavation should not present any difficulties. Few uncertainties should exist regarding implementation of the alternative. Since excavation technologies involving front-end loaders are proven and reliable, there is very little likelihood that technical problems would lead to schedule delays. If it is later found that additional soil volumes are contaminated, it should be easy to implement additional excavation activities to address the situation.

In accordance with RCRA regulations, the hazardous waste manifest system would be used to track the waste. Certified transporters would be used to transport the

waste to a RCRA hazardous waste landfill. Facilities are available that are permitted under RCRA to landfill hazardous wastes. No known regulatory restrictions should prevent implementation of the remedial actions in this alternative.

Adequate hazardous waste disposal facilities are available to handle the volume of soils excavated under this alternative. Implementation should not be limited by insufficient capacity. The equipment, transportation services, labor resources, and specialists required under this alternative are available. All of the technologies under consideration for this alternative are readily available and sufficiently proven for the specific application proposed under this alternative. Several vendors will be available to provide competitive bids.

Cost--This alternative has a present worth cost of approximately $770,000, all of which represents capital costs. The primary capital cost items are the excavation, transportation, and disposal of the soils. Table 5-9 presents a summary of costs for Alternative No. 6.

5.5 Comparative Analysis

This section presents site-specific comparative analyses of the alternatives for Sites 2&5, 8, and 14 that were evaluated in Sections 5.2, 5.3, and 5.4, respectively. In the individual analysis, each alternative was evaluated independently, not in comparison with the other alternatives. However, in the comparative analysis, the alternatives for each site are evaluated according to their relative performance regarding the specific evaluation criteria. The comparative analysis allows identification of the advantages and disadvantages of each alternative.

Table 5-9

Costs: Site 14 Alternative 6--Excavation and Disposal

CAPITAL COSTS	
Process Option	**Capital Cost ($)**
Site Access Restrictions	14,000
Surface Water Controls	17,000
Excavation	73,000
Treatment: Off-Site RCRA Landfill	159,000
Transportation: Off-Site RCRA Landfill	190,000
Construction Subtotal	453,000
Bid Contingencies, 15%	67,950
Scope Contingencies, 20%	90,600
Construction Total	611,550
Engineering and Design, 10%	61,155
Permitting and Legal, 5%	30,578
Bonding and Insurance, 3%	18,347
Construction Oversight, 5%	30,578
Field and Laboratory Testing, 3%	18,347
Total Capital Cost	770,553

OPERATION AND MAINTENANCE COSTS				
	Annual O&M Cost	**Process Option Service Time (years)**	**Present Worth Factor**	**Present Worth Cost**
Site Access Restrictions	0			0
Surface Water Controls	0			0
Excavation	0			0
Treatment: Off-Site RCRA Landfill	0			0
Transportation: Off-Site RCRA Landfill	0			0
Annual O&M Cost Subtotal	0			0
Total Annual O&M Cost	0			0
NET PRESENT VALUE				
Capital Cost				770,553
Present Worth O&M Cost				0
Total Cost for Alternative				770,553

5.5.1 Comparison of Alternatives for Sites 2&5

A comparison of Sites 2&5 Alternatives Nos. 1 and 3 for each of the seven evaluation criteria is presented below. A summary of these analyses is presented in Table 5-10.

Overall Protection of Human Health and the Environment--Alternative No. 1 (no action) does not reduce the existing risks of future contamination of groundwater at the site. The no-action alternative would not achieve the cleanup levels specified in the RAO. On the other hand, Alternative No. 3 (SVE/bioventing) could reduce the contaminant concentration to the acceptable levels specified in the RAO and should prevent future contamination of the groundwater.

Compliance with ARARs--Alternative No. 1 would not meet the chemical-specific ARARs. Alternative No. 3 could satisfy the chemical-specific ARARs and RAO within six years after design completion.

Long-Term Effectiveness and Permanence--The no-action alternative does not provide long-term effectiveness regarding prevention of future contamination of the groundwater. Alternative No. 3 could be effective in removing VOCs from the soil. The alternative could also reduce the TPH concentration through biogradation. Monitoring of the groundwater would be required during operation, but long-term management would not be necessary.

Reduction of Toxicity, Mobility, and Volume Through Treatment--Alternative No. 1 would not reduce the toxicity, mobility, or volume of the contaminants. Alternative No. 3 would remove or degrade approximately 75% of the organic compounds in the soil. The SVE and biodegradation treatment processes are irreversible. The alternative would also meet the statutory preference for treatment to reduce the principal threats.

Table 5-10

Comparative Analysis of Alternatives for Sites 2&5

Evaluation Criteria	Alternative No. 1 No Action	Alternative No. 3 Soil Vapor Extraction/Bioventing
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT		
Protection of Human Health	Protective of human health, since no risk exists currently.	Protective of human health.
Protection of Environment	Would allow future contamination of groundwater.	Should prevent future contamination of groundwater.
COMPLIANCE WITH ARARS		
Chemical-Specific ARARs	Would not meet ARARs.	Could meet ARARs and RAO within 6 years after design completion.
Location-Specific ARARs	Not relevant. There are no location-specific ARARs.	Not relevant. There are no location-specific ARARs.
Action-Specific ARARs	No action-specific ARARs were identified, since this is the no-action alternative.	Should meet action-specific ARARs.
Other Criteria and Guidance	No other criteria.	No other criteria.
LONG-TERM EFFECTIVENESS AND PERMANENCE		
Magnitude of Residual Risk	No reduction in risk of contamination of groundwater.	Should reduce residual risk of contamination to acceptable levels.
Adequacy and Reliability of Controls	No controls over existing contamination. No reliability.	Risk to groundwater is controlled through SVE, which has been well proved in full-scale remediation projects.
Need for 5-Year Review	Review would be required.	Review would be required to ensure that remediation actions are successful.
REDUCTION OF TOXICITY, MOBILITY, AND VOLUME THROUGH TREATMENT		
Treatment Process Used	None.	SVE and in situ biodegradation
Amount of Hazardous Materials Destroyed or Treated	None.	Approximately 75% of the organic contaminants could be destroyed or removed.
Reduction of Toxicity, Mobility or Volume	None.	The volume of organic contaminants could be reduced by 75%. Concentrations could be reduced to cleanup levels.
Irreversibility of Treatment	Not applicable.	SVE and biodegradation are irreversible technologies.
Type and Quantity of Residuals Remaining After Treatment	No treatment residuals.	Soil with contaminant concentrations below acceptable levels would remain. Hazardous residuals (excavated soil and spent carbon) would be removed from the site.
Statutory Preference for Treatment	Does not satisfy.	Satisfies.
Statutory Preference for On-Site Management of Waste	Satisfies.	Satisfies.

Table 5-10

(Continued)

Evaluation Criteria	Alternative No. 1 No Action	Alternative No. 3 Soil Vapor Extraction/Bioventing
SHORT-TERM EFFECTIVENESS		
Protection of Community	No change in risk to the community.	Drilling may release some dust and odors to the air.
Protection of Workers	No risk to workers.	Protection required against dermal contact with, and inhalation of, VOCs and dust during construction and drilling for the SVE systems.
Environmental Impacts	Continued impact to groundwater from existing conditions.	No adverse environmental impacts expected.
Time Requirements to Achieve RAOs	Indefinite.	SVE and biodegradation complete within six years after design completion. Could meet RAOs within six years after design completion.
IMPLEMENTABILITY		
Ability to Construct and Operate	No construction or operation.	SVE requires construction. Buried concrete tank saddles may cause difficulties in drilling. Some difficulties in operation may be encountered.
Reliability of Technology	No technologies are used.	SVE is a proven technology. Biodegradation of petroleum hydrocarbons has also been demonstrated to be effective.
Ease of Carrying Out Additional Remedial Action If Necessary	No action would not significantly hinder implementation of future remedial actions.	SVE could be expanded to cover a larger area if deemed necessary. Proposed actions should not substantially hinder implementation of other technologies.
Ability to Monitor Effectiveness of Remedial Actions	Base-wide groundwater monitoring program would allow adequate monitoring of site conditions.	Proposed actions should allow adequate monitoring of site conditions.
Ability to Obtain Approvals and Coordinate with Other Agencies	No approval necessary.	Need approval from EPA and NMED. Should not be difficult to obtain.
Availability of TDS facilities	Not applicable.	Needed disposal facilities for drilling cuttings and excavated soils are readily available. Regeneration facilities are available for spent carbon.
Availability of Required Equipment and Specialists	Not applicable.	Needed equipment and specialists are available.
Availabiliity of Required Materials and Services	Not applicable.	Needed materials and services are available.
Availability of Prospective Technologies	No remedial technolgies required.	SVE technologies are available from several vendors.
COST		
Capital Cost	$0	$270,000
Annual O&M Cost	$0	$63,000
Present Worth Cost	$0	$540,000

Short-Term Effectiveness--The no-action alternative would not increase the risks to the community and to workers. It would have an indefinite period of remediation. Alternative No. 3 could achieve the RAO within approximately six years after design completion. It should not pose substantial risks to the community or workers. All risks could be controlled.

Implementability--Under Alternative No. 1, no activities are implemented. Alternative No. 3 is also considered to be implementable. All necessary equipment, materials, and services are available.

Cost--A comparison of the present worth costs was performed for each of the alternatives. U.S. EPA's CORA model was used in developing the costs for the alternatives. The CORA model provides cost estimates with an accuracy of an order of magnitude. Thus, the cost estimates may not have the preferred accuracy of +50 percent to -30 percent. A summary of the costs is included in Table 5-10. The present worth costs of Alternative Nos. 1 and 3 are $0 and $540,000, respectively.

5.5.2 Comparison of Alternatives for Site 8

A comparison of Site 8 Alternative Nos. 1, 4, 5, 6A, and 6B for each of the seven evaluation criteria is presented below. A summary of these analyses is presented in Table 5-11.

Overall Protection of Human Health and the Environment--Alternative No. 1 (no action) does not reduce the existing risks at the site. Also, the alternative does not protect human health and the environment. Alternative No. 4 (source containment) could reduce the risks of dermal contact with, and inhalation of, contaminated soil and should minimize migration caused by percolation of rainwater through the soil. Alternative Nos.

Table 5-11

Comparative Analysis of Alternatives for Site 8

Evaluation Criteria	Alternative No. 1 No Action	Alternative No. 4 Source Containment	Alternative No. 5 Excavation/Incineration (for Hazardous Soil)	Alternative No. 6A Excavation/Disposal (for Nonhazardous Soil)	Alternative No. 6B Excavation/Disposal (for Hazardous Soil)
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT					
Protection of Human Health	No reduction in risk. Would not prevent dermal contact with, or inhalation of, contaminated soil.	Could reduce the risk of dermal contact with, and inhalation of, contaminated soil.	Could significantly reduce the risk of dermal contact with, and inhalation of, contaminated soil.	Could significantly reduce the risk of dermal contact with, and inhalation of, contaminated soil.	Could significantly reduce the risk of dermal contact with, and inhalation of, contaminated soil.
Protection of Environment	Would not prevent impacts to the environment.	Should curtail migration of contaminants caused by erosion and by percolation of rainwater through the soil	Should protect the environment.	Should protect the environment.	Should protect the environment.
COMPLIANCE WITH ARARS					
Chemical-Specific ARARs	Could not meet ARARs or RAOs.	Would meet RAOs.	Could reduce contaminant concentrations in remaining soil to cleanup levels specified in RAOs.	Could reduce contaminant concentrations in remaining soil to cleanup levels specified in RAOs.	Could reduce contaminant concentrations in remaining soil to cleanup levels specified in RAOs.
Location-Specific ARARs	Not relevant. There are no location-specific ARARs.	Not relevant. There are no location-specific ARARs.	Not relevant. There are no location-specific ARARs.	Not relevant. There are no location-specific ARARs.	Not relevant. There are no location-specific ARARs.
Action-Specific ARARs	No action-specific ARARs were identified since this is the no-action alternative.	No action-specific ARARs were identified.	Should meet action-specific ARARs.	Should meet action-specific ARARs.	Should meet action-specific ARARs.
Other Criteria and Guidance	No other criteria.	No other criteria.	No other criteria.	No other criteria.	No other criteria.

Table 5-11

(Continued)

Evaluation Criteria	Alternative No. 1 No Action	Alternative No. 4 Source Containment	Alternative No. 5 Excavation/Incineration (for Hazardous Soil)	Alternative No. 6A Excavation/Disposal (for Nonhazardous Soil)	Alternative No. 6B Excavation/Disposal (for Hazardous Soil)
LONG-TERM EFFECTIVENESS AND PERMANENCE					
Magnitude of Residual Risk	No reduction in risk.	Could reduce risk to acceptable levels.	Could reduce risk to acceptable levels.	Could reduce risk to acceptable levels.	Could reduce risk to acceptable levels.
Adequacy and Reliability of Controls	No controls over existing contamination. No reliability.	Reliability of cap would be high if maintained.	Should be adequate and reliable since contaminated soils would be taken off site and treated.	Should be adequate and reliable since contaminated soils would be taken off site.	Should be adequate and reliable since contaminated soils would be taken off site and treated.
Need for 5-Year Review	Review would be required.	Review would be required to ensure that protection of human health was maintained.	Review would be required to ensure that remedial actions are successful.	Review would be required to ensure that remedial actions are successful.	Review would be required to ensure that remedial actions are successful.
REDUCTION OF TOXICITY, MOBILITY, AND VOLUME THROUGH TREATMENT					
Treatment Process Used	None.	Asphalt capping.	Excavation by front-end loader. Incineration, stabilization, and disposal in RCRA facilities.	Excavation by front-end loader. Disposal in an industrial solid waste landfill.	Excavation by front-end loader. Stabilization for metals. Disposal in a RCRA hazardous waste landfill.
Amount of Hazardous Materials Destroyed or Treated	Would not treat or destroy any hazardous materials.	Would not treat or destroy any hazardous materials.	Excavated soil (approximately 1850 bulk cu yd) would be incinerated.	Would not treat or destroy any hazardous materials.	Excavated soil (approximately 1850 bulk cu. yd) would be stabilized.
Reduction of Toxicity, Mobility, or Volume	None.	Would not reduce the toxicity, mobility, or volume of the contaminants.	Could remove all soil with contaminant concentrations above cleanup levels. Contaminants in remaining soil should be below cleanup levels. Would reduce toxicity, mobility, and volume of contaminants.	Could remove all soil with contaminant concentrations above cleanup levels. Contaminants in remaining soil should be below cleanup levels. However, no net reduction of toxicity, mobility, or volume of contaminants.	Could remove all soil with contaminant concentrations above cleanup levels. Stabilization should decrease mobility of contaminants. Contaminants in remaining soil would be below cleanup levels. However, no net reduction of toxicity, or volume of contaminants.

Table 5-11

(Continued)

Evaluation Criteria	Alternative No. 1 No Action	Alternative No. 4 Source Containment	Alternative No. 5 Excavation/Incineration (for Hazardous Soil)	Alternative No. 6A Excavation/Disposal (for Nonhazardous Soil)	Alternative No. 6B Excavation/Disposal (for Hazardous Soil)
Irreversibility of Treatment	Not applicable.	Not irreversible.	Irreversible.	Irreversible.	Irreversible.
Type and Quantity of Residuals Remaining After Treatment	No treatment residuals.	No treatment residuals. 1610 cu. yd of contaminated soils remain on site.	Approximately 1850 cu yd of ash remaining after incineration.	No treatment residuals. No remaining soil with contaminant concentrations above cleanup levels.	No treatment residuals. No remaining soil with contaminant concentrations above cleanup levels.
Statutory Preference for Treatment	Does not satisfy.	Does not satisfy.	Satisfies.	Does not satisfy.	Does not satisfy.
Statutory Preference for On-Site Management of Waste	Does not satisfy.	Does not satisfy.	Does not satisfy.	Does not satisfy.	Does not satisfy.
SHORT-TERM EFFECTIVENESS					
Protection of Community	No additional risk to the community.	No additional risk to the community.	Slight risk during excavation and transportation of soils due to possible release of dust and semivolatile organics to the air.	Slight risk during excavation and transportation of soils due to possible release of dust and semivolatile organics to the air.	Slight risk during excavation and transportation of soils due to possible release of dust and semivolatile organics to the air.
Protection of Workers	No increased risk to workers.	Protection against dermal contact with, and inhalation of, contaminated soil during asphalt cap construction required.	Protection against dermal contact with, and inhalation of, contaminated soil during excavation and transportation activities required.	Protection against dermal contact with, and inhalation of, contaminated soil during excavation and transportation activities required.	Protection against dermal contact with, and inhalation of, contaminated soil during excavation and transportation activities required.
Environmental Impacts	None.	None.	Slight environmental impacts from excavation activities.	Slight environmental impacts from excavation activities.	Slight environmental impacts from excavation activities.
Time Requirements to Achieve RAOs	Indefinite.	Asphalt cap installed within 1 year. Could achieve RAOs within 1 year after design completion.	Excavation, incineration, stabilization, and disposal within 1 year. Could achieve RAOs within 1 year after design completion.	Excavation and disposal completed within 1 year. Could achieve RAOs within 1 year after design completion.	Excavation, stabilization, and disposal within 1 year. Could achieve RAOs within 1 year after design completion.

Table 5-11

(Continued)

Evaluation Criteria	Alternative No. 1 No Action	Alternative No. 4 Source Containment	Alternative No. 5 Excavation/Incineration (for Hazardous Soil)	Alternative No. 6A Excavation/Disposal (for Nonhazardous Soil)	Alternative No. 6B Excavation/Disposal (for Hazardous Soil)
IMPLEMENTABILITY					
Ability to Construct and Operate	Not applicable.	Simple to construct.	Simple to implement.	Simple to implement.	Simple to implement.
Reliability of Technology	Not applicable.	Asphalt capping technology is reliable.	Excavation, incineration, stabilization, and disposal technologies are reliable.	Excavation and disposal technologies are reliable.	Excavation, stabilization, and disposal technologies are reliable.
Ease of Carrying Out Additional Remedial Action If Necessary	No action would not significantly hinder implementation of future remedial actions.	Simple to extend asphalt cap. Only slight difficulties should be encountered if excavation were needed later.	Simple to extend remedial action.	Simple to extend remedial action.	Simple to extend remedial action.
Ability to Monitor Effectiveness of Remedial Actions	Base-wide groundwater monitoring program should allow adequate monitoring of site conditions.	Base-wide groundwater monitoring program should allow adequate monitoring of site conditions.	Confirmation sampling should be adequate to determine the effectiveness of remedial actions. Base-wide groundwater monitoring program should allow adequate monitoring of site conditions.	Confirmation sampling should be adequate to determine the effectiveness of remedial actions. Base-wide groundwater monitoring program should allow adequate monitoring of site conditions.	Confirmation sampling should be adequate to determine the effectiveness of remedial actions. Base-wide groundwater monitoring program should allow adequate monitoring of site conditions.
Ability to Obtain Approvals and Coordinate with Other Agencies	No approval necessary.	No approval necessary.	Approval required for incineration of soil at the off-site RCRA facility. No difficulties are expected.	Approval may be required for disposal at the off-site industrial solid waste landfill.	Approval required for disposal of soil at the off-site RCRA hazardous waste landfill.
Availability of TSD facilities	Not applicable.	Not applicable.	RCRA incineration facilities are readily available.	Disposal facilities are readily available.	Stabilization and disposal facilities are readily available.
Availability of Required Equipment and Specialists	Not applicable.	Equipment and specialists are available.	Equipment and specialists are available.	Equipment and specialists are available.	Equipment and specialists are available.

Table 5-11

(Continued)

Evaluation Criteria	Alternative No. 1 No Action	Alternative No. 4 Source Containment	Alternative No. 5 Excavation/Incineration (for Hazardous Soil)	Alternative No. 6A Excavation/Disposal (for Nonhazardous Soil)	Alternative No. 6B Excavation/Disposal (for Hazardous Soil)
Availabiliity of Required Materials and Services	Not applicable.	Materials and services are widely available.	Materials and services are widely available.	Materials and services are widely available.	Materials and services are widely available.
Availability of Prospective Technologies	No remedial technolgies required.	Asphalt capping technology is readily available.	Excavation, incineration, stabilization, and land disposal technologies are available.	Excavation and land disposal technologies are readily available.	Excavation, stabilization, and land disposal technologies are readily available.
COST					
Capital Cost	$0	$230,000	$4,500,000	$441,000	$1,600,000
Annual O&M Cost	$0	$8,300	$0	$0	$0
Present Worth Cost	$0	$360,000	$4,500,000	$441,000	$1,600,000

5 (excavation and incineration), 6A (excavation and disposal, nonhazardous), and 6B (excavation and disposal, hazardous) could significantly reduce the risks of dermal contact with, and inhalation of, the contaminated soil. Alternative Nos. 5, 6A, and 6B could provide the greatest protection of human health and the environment.

Compliance with ARARs--Alternative No. 1 would not meet the chemical-specific ARARs or the RAOs, since it would not reduce the volume of contaminants remaining on site. Alternative Nos. 4, 5, 6A, and 6B could meet the ARARs and RAOs. These alternatives could also meet the action-specific ARARs.

Long-Term Effectiveness and Permanence--Alternative No. 1 would not provide long-term effectiveness. Alternative No. 4 could be effective over the long term if the asphalt cap were properly and continuously maintained. Long-term management for this alternative would be required. Alternative Nos. 5, 6A, and 6B could have excellent long-term effectiveness because they involve removal of the soil from the site. Long-term management should not be required for these alternatives.

Reduction of Toxicity, Mobility, and Volume Through Treatment--Alternative Nos. 1 and 4 would not reduce the toxicity or the volume of the contaminants. However, Alternative No 4. would decrease the mobility of contaminants by reducing infiltration into the soil. No treatment processes are used for Alternative Nos. 1, 4, and 6A. Alternative Nos. 6A and 6B could reduce the mass and volume of contaminants remaining on site, since all soil with contaminant concentrations above the cleanup levels should be removed. However, there would be no actual reduction in toxicity or volume of the contaminants. Under Alternative No. 6B, the stabilization process could reduce the mobility of the contaminants in the excavated soil. Alternative No. 5 should reduce the toxicity, mobility, and volume of the contaminants. Under Alternative Nos. 5, 6A, and 6B, the remaining soil should have contaminant concentrations below the cleanup levels.

Short-Term Effectiveness--Alternative No. 1 would not increase the risks to the community or to workers. The alternative would have an indefinite period of remediation. Alternative No. 4 would require that workers be protected against dermal contact with, and inhalation of, contaminated soil during asphalt cap construction. Remediation under Alternative No. 4 could be completed within one year. The RAOs should also be achieved by that time.

Alternative Nos. 5, 6A, and 6B could cause a slight risk to the community during excavation and transportation activities. Workers would have to be protected against dermal contact with, and inhalation of, the soil during excavation and transportation activities. It is expected to take less than one year after design completion to complete the remedial actions and achieve the RAOs.

Implementability--All of the remedial actions under Alternative Nos. 1, 4, 5, 6A, and 6B are considered to be implementable. Also, the required equipment, materials, facilities, and services for all of the alternatives are readily available. All of the technologies specified in the alternatives are reliable.

Cost--A comparison of the present worth costs was performed for each of the alternatives. U.S. EPA's CORA model was used in developing the costs for the alternatives. The CORA model provides cost estimates with an accuracy of an order of magnitude. Thus, the cost estimates may not have the preferred accuracy of +50 to -30 percent. A summary of the costs is included in Table 5-11. The present worth costs for Alternative Nos. 1, 4, 5, 6A, and 6B are $0, $360,000, $4,500,000, $410,000, and $1,600,000, respectively.

5.5.3 Comparison of Alternatives for Site 14

A comparison of Site 14 Alternative Nos. 1, 3, 5, and 6 for each of the seven evaluation criteria is presented below. A summary of these analyses is presented in Table 5-12.

Table 5-12

Comparative Analysis of Alternatives for Site 14

Evaluation Criteria	Alternative No. 1 No Action	Alternative No. 3 Source Containment	Alternative No. 5 Excavation/Incineration	Alternative No. 6 Excavation/Disposal
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT				
Protection of Human Health	No reduction in risk. Would not prevent dermal contact with contaminated soil.	Could reduce the risk of dermal contact with contaminated soil.	Could significantly reduce the risk of dermal contact with contaminated soil.	Could significantly reduce the risk of dermal contact with contaminated soil.
Protection of Environment	Would not prevent impacts to the environment.	Could curtail migration of contaminants caused by erosion and by percolation of rainwater through the soil.	Should protect the environment.	Should protect the environment.
COMPLIANCE WITH ARARS				
Chemical-Specific ARARs	Would not meet ARARs or RAO.	Would meet RAO.	Could reduce contaminant concentrations in remaining soil to cleanup levels specified in RAO.	Could reduce contaminant concentrations in remaining soil to cleanup levels specified in RAO.
Location-Specific ARARs	Not relevant. There are no location-specific ARARs.	Not relevant. There are no location-specific ARARs.	Not relevant. There are no location-specific ARARs.	Not relevant. There are no location-specific ARARs.
Action-Specific ARARs	No action-specific ARARs were identified since this is the no-action alternative.	No action-specific ARARs were identified.	Should meet action-specific ARARs.	Should meet action-specific ARARs.
Other Criteria and Guidance	No other criteria.	No other criteria.	No other criteria.	No other criteria.
LONG-TERM EFFECTIVENESS AND PERMANENCE				
Magnitude of Residual Risk	No reduction in risk.	Could reduce risk to acceptable levels.	Could reduce risk to acceptable levels.	Could reduce risk to acceptable levels.
Adequacy and Reliability of Controls	No controls over existing contamination. No reliability.	Reliability of cap would be high if maintained.	Should be adequate and reliable, since contaminated soils would be taken off site.	Should be adequate and reliable, since contaminated soils would be taken off site.
Need for 5-Year Review	Review would be required.	Review would be required to ensure that protection of human health was maintained.	Review would be required to ensure that remedial actions are successful.	Review would be required to ensure that remedial actions are successful.

Table 5-12

(Continued)

Evaluation Criteria	Alternative No. 1 No Action	Alternative No. 3 Source Containment	Alternative No. 5 Excavation/Incineration	Alternative No. 6 Excavation/Disposal
REDUCTION OF TOXICITY, MOBILITY, AND VOLUME THROUGH TREATMENT				
Treatment Process Used	None.	Asphalt capping.	Excavation by front-end loader. Incineration, stabilization, and disposal in RCRA facilities.	Excavation by front-end loader. Disposal in a RCRA hazardous waste landfill.
Amount of Hazardous Materials Destroyed or Treated	Would not treat or destroy any hazardous materials.	Would not treat or destroy any hazardous materials.	Excavated soil (approximately 850 bulk cu yd) would be incinerated.	Would not treat or destroy any hazardous materials.
Reduction of Toxicity, Mobility, or Volume	None.	Would not reduce the toxicity, mobility, or volume of the contaminants.	Would reduce toxicity, mobility, and volume of contaminants in excavated soil. Remaining contaminants should be within acceptable levels.	Could remove all soil with contaminant concentrations above acceptable levels. Remaining contaminants should be within acceptable levels.
Irreversibility of Treatment	Not applicable.	Action not irreversible.	Irreversible.	Irreversible.
Type and Quantity of Residuals Remaining After Treatment	None. No treatment residuals.	No treatment residuals. 740 cu yd of contaminated soils remain.	Approximately 850 cu yd of ash remaining after incineration. No remaining soil with contaminant concentrations above cleanup levels.	No treatment residuals. No remaining soil with contaminant concentrations above cleanup levels.
Statutory Preference for Treatment	Does not satisfy.	Does not satisfy.	Does not satisfy.	Does not satisfy.
Statutory Preference for On-Site Management of Waste	Does not satisfy.	Does not satisfy.	Satisfies.	Does not satisfy.

Table 5-12

(Continued)

Evaluation Criteria	Alternative No. 1 No Action	Alternative No. 3 Source Containment	Alternative No. 5 Excavation/Incineration	Alternative No. 6 Excavation/Disposal
SHORT-TERM EFFECTIVENESS				
Protection of Community	No change in risk to community.	No substantial risks to community.	Slight risk during excavation and transportation of soils from possible release of dust and semi-volatile organics to the air.	Slight risk during excavation and transportation of soils from possible release of dust and semivolatile organics to the air.
Protection of Workers	No significant risk to workers.	Protection against dermal contact with contaminated soil required during asphalt cap construction.	Protection against dermal contact with contaminated soil required during excavation and transportation activities.	Protection against dermal contact with contaminated soil required during excavation and transportation activities.
Environmental Impacts	No significant environmental impact from taking no action.	Should have minimal environmental impacts.	Should have minimal environmental impacts.	Should have minimal environmental impacts.
Time Requirements to Achieve RAOs	Indefinite.	Asphalt cap installed within 1 year. Could achieve RAO within 1 year after design completion.	Excavation and incineration of soil completed within 1 year. Could achieve RAO within 1 year after design completion.	Excavation and disposal of soil completed within 1 year. Could achieve RAO within 1 year after design completion.
IMPLEMENTABILITY				
Ability to Construct and Operate Reliability of Technology	No construction or operation. No technology used.	Simple to construct and operate. Asphalt capping technology is reliable.	Simple to implement. Excavation and disposal technologies are reliable.	Simple to implement. Excavation and disposal technologies are reliable.
Ease of Carrying Out Additional Remedial Action If Necessary	No action should not significantly hinder implementation of future remedial actions.	Simple to extend asphalt cap. Only slight difficulties would be encountered if excavation were needed later.	Simple to extend remedial action.	Simple to extend remedial action.
Ability to Monitor Effectiveness of Remedial Actions	No monitoring provided.	No monitoring provided.	Confirmation sampling should be adequate to determine the effectiveness of remedial actions.	Confirmation sampling should be adequate to determine the effectiveness of remedial actions.
Ability to Obtain Approvals and Coordinate with Other Agencies	No approval necessary.	No approval necessary.	Approval may be required for incineration at the off-site RCRA facility.	Approval required for disposal of soil at the off-site RCRA hazardous waste landfill.

Table 5-12

(Continued)

Evaluation Criteria	Alternative No. 1 No Action	Alternative No. 3 Source Containment	Alternative No. 5 Excavation/Incineration	Alternative No. 6 Excavation/Disposal
Availability of TSD facilities	Not applicable.	Not applicable.	Incineration and disposal facilities are readily available.	Disposal facilities are readily available.
Availability of Required Equipment and Specialists	Not applicable.	Equipment and specialists are available.	Equipment and specialists are available.	Equipment and specialists are available.
Availabiliity of Required Materials and Services	Not applicable.	Materials and services are widely available.	Materials and services are widely available.	Materials and services are widely available.
Availability of Prospective Technologies	Not applicable.	Asphalt capping technology is readily available.	Excavation, incineration, and land disposal technologies are readily available.	Excavation and land disposal technologies are readily available.
COST				
Capital Cost	$0	$140,000	$2,100,000	$770,000
Annual O&M Cost	$0	$6,200	$0	$0
Present Worth Cost	$0	$230,000	$2,100,000	$770,000

Overall Protection of Human Health and the Environment--Alternative No. 1 (no action) does not reduce the existing risks at the site. Also, the alternative would not protect human health and the environment. Alternative No. 3 (source containment) could reduce the risks of dermal contact with the contaminated soil. Alternative Nos. 5 (excavation and incineration) and 6 (excavation and disposal) could significantly reduce the risks of dermal contact with the contaminated soil. Alternative Nos. 5 and 6 could provide the greatest protection of human health and the environment.

Compliance with ARARs--Alternative No. 1 would not meet the chemical-specific ARARs or the RAO and they would not reduce the volume of contaminants remaining on site. Alternative Nos. 3, 5, and 6 could meet the ARARs and the RAO. These alternatives could also meet the action-specific ARARs.

Long-Term Effectiveness and Permanence--Alternative No. 1 would not provide long-term effectiveness. Alternative No. 3 could be effective over the long term if the asphalt cap were properly maintained. Long-term management for this alternative would be required. Alternative Nos. 5 and 6 could have excellent long-term effectiveness because they involve removal of the soil from the site. Long-term management should not be required for these alternatives.

Reduction of Toxicity, Mobility, and Volume Through Treatment--Alternative Nos. 1 and 3 would not reduce the toxicity and volume of the contaminants. However, Alternative No. 3 would reduce the mobility of the contaminants because it would reduce infiltration into the soil. No treatment processes are used for Alternative Nos. 1 and 3. Under Alternative No. 5, the toxicity, mobility, and volume of contaminants would be reduced. Alternative No. 6 could reduce the mass and volume of contaminants remaining on site, since all soil with contaminant concentrations above the cleanup levels should be removed. However, under Alternative No. 6, there is no actual reduction of toxicity,

mobility, and volume of contaminants. For Alternative Nos. 5 and 6, the remaining soil should have contaminant concentrations below the cleanup levels.

Short-Term Effectiveness--Alternative No. 1 would not change the risk to the community or to the workers. The alternative would have an indefinite period of remediation. Alternative No. 3 would require that workers be protected against dermal contact with the contaminated soil during asphalt cap construction. The activities under Alternative No. 3 could be completed within one year after design completion. The alternative could also achieve the RAO by that time.

Alternative Nos. 5 and 6 could cause a slight risk to the community during excavation and transportation activities. Workers could be protected against dermal contact with the soil during excavation, transportation, and disposal activities. It should take less than one year from design completion to complete the remedial actions and achieve the RAOs.

Implementability--All of the remedial actions under Alternative Nos. 1, 3, 5, and 6 are considered to be implementable. Also, the required equipment, materials, facilities, and services for all of the alternatives are readily available. All of the technologies specified in the alternatives are reliable.

Cost--A comparison of the present worth costs was performed for each of the alternatives. U.S. EPA's CORA model was used in developing the costs for the alternatives. The CORA model provides cost estimates with an accuracy of an order of magnitude. Thus, the cost estimates may not have the preferred accuracy of +50 to -30 percent. A summary of the costs of the alternatives is presented in Table 5-12. The present worth costs for Alternative Nos. 1, 3, 5, and 6 are $0, $230,000, $2,100,000, and $770,000, respectively.

6.0 RECOMMENDATIONS

This section provides recommendations of alternatives for Sites 2&5, 8, and 14. On the basis of the results of the comparative analyses described in Section 5.5 of this report, a specific alternative was recommended for each individual site. The justification for recommending the alternatives for Sites 2&5, 8, and 14 is presented in Sections 6.1, 6.2, and 6.3, respectively.

6.1 Recommended Alternative for Sites 2&5

This section discusses the justification for the recommended alternative for Sites 2&5. This section also outlines an approximate schedule for the implementation of the alternative.

On the basis of the comparison of alternatives for Sites 2&5, Alternative No. 3, which involves remediation by SVE and biodegradation, is recommended. The reasons for this recommendation are described below.

Alternative No. 3 was determined to be the best alternative on the basis of the seven evaluation criteria. The alternative would protect human health and the environment and would comply with the chemical- and action-specific ARARs. The alternative should also meet the RAO, which is to prevent future contamination of the groundwater. SVE has been widely proved in full-scale remediation projects and is expected to be effective over the long term. Further, biodegradation has been proved to be effective for remediation of petroleum hydrocarbons.

SVE and biodegradation could irreversibly remove or destroy 75% of the organic compounds in the soil, reducing the TPH concentration from an average of 4000 mg/kg to below the cleanup level of 1000 mg/kg. As well, the alternative could satisfy the statutory preference for treatment to reduce the principal threats at Sites 2&5 and the

statutory preference for on-site management of waste. Remediation of the soil to the cleanup levels specified in the RAO could be achieved within approximately six years after design completion.

It is recommended that a biodegradation study be conducted prior to operation of the SVE system. Laboratory testing of TPH-contaminated soil from Sites 2&5 should be conducted to determine the range of nutrient concentrations that will optimize biological activity. The study should also determine the degree to which appropriate conditions will stimulate the indigenous microorganisms. After operation of the SVE system begins, nutrients should be added to the soil in the vadose zone and the effects of the nutrients on the levels of biological activity should be monitored through analyses of the soil gas.

Alternative No. 3 should pose little threat to the safety of the community or to the workers. The alternative is considered to be implementable: All necessary technology, equipment, and services are available.

The net present worth for Alternative No. 3 is estimated to be $540,000. An approximate schedule was developed for implementation of this alternative. It was determined that the design phase for this alternative would last approximately three months. Construction could be accomplished within six months. Operation of the SVE system would continue for approximately five years.

6.2 Recommended Alternative for Site 8

This section discusses the justification for the recommended alternative for Site 8. This section also outlines an approximate schedule for the implementation of the alternative.

On the basis of the comparison of alternatives for Site 8, Alternative No. 4, which involves source containment, is recommended. The reasons that Alternative No. 4 is recommended are discussed below.

Alternative No. 4 was determined to be the best alternative for Site 8 on the basis of its performance in the detailed evaluation according to the seven criteria. Source containment could protect human health and the environment since it would eliminate the exposure route. Also, the alternative would meet the RAOs.

The source containment alternative should be effective over the long term. No additional risks to the community would occur. Risks to the workers should be significantly reduced. Although the alternative would not satisfy the statutory preference for treatment, it would satisfy the statutory preference for on-site management of waste. Under this alternative, the RAOs could be achieved within approximately one year after design completion.

This alternative is considered to be readily implementable: All necessary technology, equipment, and labor are available. Asphalt capping is a reliable and proven technology. With a net present worth for Alternative No. 4 estimated to be $360,000, Alternative No. 4 is the least expensive alternative that meets the RAOs for Site 8.

An approximate schedule was developed for implementing the recommended alternative. It was estimated that the design phase for this alternative would last approximately three months. The asphalt capping activities could be completed within approximately two to four months following the completion of the design.

6.3 Recommended Alternative for Site 14

This section discusses the justification for the recommended alternative for Site 14. This section also outlines an approximate schedule for the implementation of the alternative.

On the basis of the comparison of alternatives for Site 14, Alternative No. 3, which involves source containment, is recommended. Alternative No. 3 was determined to be the best alternative for Site 14 on the basis of its performance in the detailed evaluation according to the seven criteria. The alternative could protect human health and the environment since it would eliminate the exposure route. It would also meet the RAO.

The source containment alternative was determined to have long-term effectiveness and permanence. No additional risks to the community would occur. Risks to the workers should be significantly reduced. Although this alternative would not satisfy the statutory preference for treatment, it would satisfy the statutory preference for on-site management of waste. Under this alternative, the RAO could be achieved within approximately one year after design completion.

This alternative is considered to be readily implementable: All necessary technology, equipment, and labor are available. Asphalt capping technology is considered to be reliable and proven. The net present worth for Alternative No. 3 is estimated to be $230,000, making it the least expensive alternative that meets the RAO for Site 14.

An approximate schedule was developed for implementing the recommended alternative. It was estimated that the design phase for this alternative would last approximately two months. The asphalt capping activities could be completed within approximately two to three months after the completion of the design.

7.0 REFERENCES

1. Radian Corporation. *Remedial Investigation (RI) Report - Investigation, Study and Recommendation for 29 Waste Sites*. 1992.

2. Radian Corporation. *Risk Assessment Report for the Remedial Investigation - Investigation, Study and Recommendation for 29 Waste Sites*. 1992.

3. Radian Corporation. *Corrective Measures Study (CMS) Plan - Investigation, Study and Recommendation for 29 Waste Sites*. 1992.

4. U.S. Environmental Protection Agency. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (Interim Final)*. EPA/540/G-89/004. 1988.

5. U.S. Environmental Protection Agency. *RCRA Corrective Action Plan (Interim Final)*. EPA/530-SW-88-028. 1988.

6. U.S. Environmental Protection Agency. *Corrective Action for Solid Waste Management Units at Hazardous Waste Facilities (proposed rule)*. Federal Register, Vol. 55, No. 145, pp. 30798-30884, 27 July 1990.

7. U.S. Environmental Protection Agency. *Technology Screening Guide for the Treatment of CERCLA Soils and Sludges*. EPA/540/2-88/004. September 1988.

8. U.S. Environmental Protection Agency. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final*. EPA/540/G-89-004. October 1988.

9. U.S. Environmental Protection Agency. *Guide to Treatment Technologies for Hazardous Wastes at Superfund Sites*. EPA/540/2-89/052. March 1989.

10. U.S. Environmental Protection Agency. *Handbook on In Situ Treatment of Hazardous Waste-Contaminated Soils*. January 1990.

11. U.S. Environmental Protection Agency. *The Superfund Innovative Technology Evaluation Program: Technology Profiles, 4th ed*. EPA/540/5-91/008. November 1991.

12. U.S. Environmental Protection Agency. *Thermal Desorption Guidance Document for Treating Petroleum Contaminated Soils*. January 1992.

13. U.S. Environmental Protection Agency. *Remedial Action Costing Procedures Manual*. EPA/600/5-87/049. October 1987.

14. U.S. Environmental Protection Agency. *Cost of Remedial Action Model Manual*. Version 3.0.

APPENDIX A

CORRESPONDENCE

STATE OF NEW MEXICO
ENVIRONMENT DEPARTMENT

Rec'd CE 10 Nov 92

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

November 2, 1992

Mr. Howard E, Moffitt
Deputy Base Civil Engineer
49 CES/CEV
Holloman AFB, NM 88330-5000

RE: APPROVAL FOR CLEANUP OF SOILS CONTAMINATED WITH GREATER THAN 1000 PARTS PER MILLION TOTAL PETROLEUM HYDROCARBONS

Dear Mr. Moffitt:

The New Mexico Environment Department (NMED) has received your letter dated August 7, 1992 in which you requested a soil cleanup level of 1000 ppm TPH in lieu of remediating all "highly contaminated" soils (as they are defined in Section 1201G of the Underground Storage Tank Regulations) at Holloman AFB. As you mentioned in your letter, 1000 ppm, by weight, of diesel or gasoline is apparently a lower level of contamination than is "highly contaminated". The Environment Department approves your requested 1000 ppm TPH cleanup standard with the following stipulations:

1. determination of contaminant levels will be by laboratory analyses and not by field methods,

2. analysis for aromatic volatile organics by gas chromatograph and a photo-ionization detector will be done where soils are contaminated by gasoline, and analysis for non-halogenated semi-volatile organics by gas chromatograph and a flame-ionization detector will be done where the contaminant is a heavier-than-gasoline petroleum hydrocarbon,

3. samples will be taken from the areas of highest apparent (visual determination method) saturation, or contamination if the area is not saturated, and

4. an NMED representative will be notified prior to the cleanup to observe the removal of soils.

Please advise us when you've decided on the means for determining the lateral extent of contaminated soils, which method(s) you'll be using to remediate and dispose of the soils, and how you intend to sample the soils for contaminant levels.

Bruce King
Governor
Judith M. Espinosa
Secretary

If you have questions please contact Mr. Robert Sweeney at (505) 827-0214.

Sincerely,

James P. Bearzi
Acting Bureau Chief
Underground Storage Tank Bureau

cc: Bob Sweeney, UST Bureau
Steven Cary, GWPRB
David Morgan, GWPRB
NMED District III Office
NMED Alamogordo Field Office

STATE OF NEW MEXICO
ENVIRONMENT DEPARTMENT

Bruce King
Governor

July 22, 1992

Mr. Howard E. Moffitt, Deputy Base Civil Engineer
49 CES/CEV
Holloman Air Force Base, NM 88330-5000

Dear Mr. Moffitt:

Under the auspices of the Defense-State Memorandum of Agreement concerning IRP sites at Holloman Air Force Base, I am responding to your letter of May 28 to Kathleen M. Sisneros concerning ground water remediation and soil cleanup standards for petroleum product releases at Holloman AFB.

Your understanding is correct that ground water remediation at these sites will not be required. As discussed verbally and mentioned in correspondence relating specifically to underground storage tank sites, any floating hydrocarbon must be removed from the ground water surface, and all "highly contaminated soil" must be removed or remediated. Dissolved phase hydrocarbon contamination of the ground water beneath the base need not be remediated.

The Underground Storage Tank Bureau does not believe it to be feasible at present to assign a numerical value to the regulatory definition of "highly contaminated soil" because of the many site-specific variables that can influence the determination.

As a method of settling this issue, we propose that Holloman AFB staff who will be in Santa Fe on July 28 to discuss the current Remedial Investigation report for IRP sites bring with them a kilogram or two of dry soil known to be representative of that beneath the hydrocarbon release sites. NMED staff will procure a small amount of gasoline and diesel fuel, 1000 ppm of both products can be added to the soil in our laboratory, and the resulting mixture can be evaluated by UST Bureau personnel to determine whether 1000 ppm is less than "highly contaminated". If so, NMED has no objection to its use as the appropriate soil cleanup level.

If you have any questions concerning any of this please contact David Morgan at 505-827-2754.

Sincerely,

Steven J. Cary, Chief
Ground Water Protection and Remediation Bureau

c: Edward Horst, NMED HRMB
Bob Sweeney, NMED USTB

14 August 1992

Mr. Rich Mayer (GH-PS)
U.S.EPA Region VI
1445 Ross Avenue
Dallas, Texas 75202

Dear Rich:

At our meeting with Dave Morgan of the New Mexico Environment Department (NMED) and yourself, Radian presented the results of the RI/RFI for the 29 Sites at Holloman Air Force Base (AFB), New Mexico. During the presentation we discussed our findings that a total of eight sites (2&5, 3, 8, 9, 14, 30&33, 37, and 39) appeared to have concentrations of contaminants that might warrant remediation, and therefore a Feasibility Study (FS) would be needed. We discussed in general terms the remedial action objectives for these sites, and the methods to be used to establish the objectives.

As we discussed, Holloman AFB plans to develop health risk-based cleanup objectives for the six sites that pose a risk to human health (2&5, 3, 8, 9, 14, and 30&33). These cleanup objectives will be based on site-specific information such as exposure pathways, potential contact locations with contaminated media, and potentially exposed populations. A specific cleanup criterion will be determined separately for each contaminant in each medium in which it is found.

In order to determine health risk-based cleanup criteria, the level of acceptable risk must be specified. In the Preamble to the proposed Corrective Action Program, Subpart S of 40 CFR Part 264 (55 Fed. Reg. 30798-30873, July 27, 1990), EPA discusses the development of media cleanup standards. In general, EPA prefers an excess lifetime cancer risk of 1×10^{-6} as the point of departure for development of cleanup standards. However, our past experience indicates that EPA is willing to accept cleanup standards associated with risk levels as high as 1×10^{-4} under certain circumstances. As you know, many of the sites at Holloman contain more than one contaminant. EPA discusses this issue in the Preamble on page 30827: "The cumulative risk posed by multiple contaminants should not exceed a 1×10^{-4} cancer risk."

Subpart S has not yet been adopted formally by EPA. However we understand that the proposed rule is being implemented as policy by most EPA Regional offices until such time as the rule is adopted. Therefore Holloman proposes to determine cleanup standards in accordance with the proposed rule as follows:

- Media cleanup standards will be developed such that the cumulative risk posed by multiple contaminants will not exceed a 1×10^{-4} cancer risk; and

- The cleanup standard for a single chemical will result in an associated cancer risk in the range of 1×10^{-4} to 1×10^{-6}.

The cleanup standards for specific contaminants are critical to preparation of the FS because remedy selection and development of cost estimates requires information on the level of a contaminant that can be left in place. Therefore, it is important that we receive your concurrence with these proposed acceptable risks so that we can complete the FS. In order to prepare the Corrective Measures Study (CMS) Plan that is required by Section IV.M of our permit, we would like to receive concurrence on these proposed acceptable risks by 20 August 1992. Following this, we will submit the CMS Plan to the EPA Region VI and NMED by 8 September 1992 and would appreciate review comments by 22 September 1992.

Thank you in advance for your cooperation in expediting the review of the proposed acceptable risks and the CMS Plan schedule. If you have any questions, please call Rodger Wilkson or Warren Neff at 505/479-5878.

Howard E. Moffitt
Deputy Base Civil Engineer

cc: Ron Stirling/USACE, Omaha
Wally Hise, Radian
David Morgan / NMED

CONFIRMATION NOTICE NO. 23

TO:	U.S. Army Engineer District ATTN: CEMRO-ED-EA (Ron Stirling) 215 North 17th Street Omaha, Nebraska 68102-4978
CONTRACTOR:	Sirrine Environmental Consultants, Inc.
SUBCONTRACTOR:	Radian Corporation
CONTRACT NUMBER:	DACW45-89-D-0515
DELIVERY ORDER NUMBER:	5023. Radian DO #16
TITLE:	RI/FS at 29 Sites Holloman AFB, New Mexico
DATE OF THIS REPORT:	13 December 1991
SUBJECT:	**Investigation Report Format Meeting**
PARTICIPATING PERSONNEL:	See Attached List

On 9 December 1991, Radian personnel attended a meeting at the USAF Regional Environmental Office in Dallas, Texas to discuss the format and content of the remedial investigation report. Also in attendance were representatives from Holloman AFB, USACE, New Mexico Environment Department (NMED), and EPA Region VI. Following is a summary of the meeting.

I. Introduction

Mr. Roger Wilkson of HAFB provided a brief introduction and background to the project. He outlined the meeting objectives as: 1) to inform regulatory agencies of the present activities at IRP/SWMU sites and discuss discrepancies between the IRP investigation and Table 1 of Holloman's HSWA permit; and 2) to determine how to satisfy requirements of CERCLA and RCRA without duplication of effort and expense.

II. Summary of Field Program

Mr. Tom Holcomb of Radian provided a brief overview of the field program recently completed for the 29 waste sites, and then gave a detailed presentation of the work conducted at each site. Mr. Rich Mayer of EPA Region VI indicated that although the

project plans (CDAP and SSHP) were verbally approved, an approval letter had not yet been prepared by EPA.

III. Report Format

Mr. Wallace Hise of Radian gave a brief summary of the intended format for the site investigation report.

Rich Mayer suggested that information for each site (figures, data summary tables, conclusions, and recommendations) be grouped together for ease of reading. Site-specific discussions may focus on only compounds detected as long as the result(s) and corresponding detection limit(s) are specified in data summary tables, and a complete copy of analytical data is provided in an appendix. Mr. David Morgan of NMED indicated that the RCRA Division currently has no specific reporting format requirements.

It was agreed that a draft final report will be submitted to EPA Region VI and NMED by 30 June 1992 for review and comment. By this date, investigation results for all sites on Table 1 of Holloman's permit should be submitted. This deliverable date will be reflected in a letter to be drafted by Rich Mayer approving the site investigation plans. Rich Mayer also requested that quarterly reports be prepared and submitted by HAFB to track the progress of SWMU investigations and document significant findings.

Action Items:

1. HAFB will coordinate submittal of results for all Table 1 sites, including those not covered under Radian's current investigation. [Note that several sites were previously investigated under other IRP work efforts or dealt with under the Base's Rapid Response Program.] This may include a narrative to clarify where information is presented for each individual site.

2. HAFB may choose to submit a permit modification to move several sites that have not been investigated from Table 1 to Table 2. Additionally, IRP Sites 37, 39, and 43 (SWMU nos. 165, 179, AOC L, and AOC G) listed on Table 2 are currently being investigated and can be moved to Table 1. These changes to the permit will facilitate scoping of future work activities and provide a comprehensive work effort for all Table 1 and Table 2 sites.

3. HAFB will prepare and submit progress reports for all activities associated with the HSWA permit.

IV. Determination of Remedial Action

The standard Feasibility Study/Corrective Measures Study approach to determine remedial action will be acceptable to both agencies. The final corrective action clean up levels will be determined through coordination by EPA Region VI and NMED.

V. Risk Assessment

Wallace Hise presented Radian's proposed approach to using a risk assessment for individual sites. In summary, a receptor and pathway identification will be completed for each of the 29 sites. This step will fulfill RCRA requirements under the RFI program. Then each site will be screened to determine the level of contamination. The following three scenarios are possible:

- For "grossly" contaminated sites (preliminary screen indicates a risk $\geq 10^{-4}$), remediation will be required and therefore no comprehensive risk assessment will be prepared;

- For "clean" sites (preliminary screen indicates a risk $\leq 10^{-6}$), a site-specific risk assessment will be prepared to justify a recommendation of no further action; and

- For "in between" sites (preliminary screen indicates a risk between 10^{-4} and 10^{-6}), a site-specific risk assessment will be prepared to accurately determine the risk, and facilitate selection of a remedial action or treatment alternative.

This approach will effectively combine CERCLA risk assessment techniques to satisfy RCRA requirements and meet objectives of the proposed Subpart S corrective action program. Both EPA and NMED agreed that this approach will be acceptable.

VI. Summary and Recommended Approach

The site investigation report will be presented in a CERCLA RI format with a narrative discussing applicable RCRA requirements and where they are located within the document. In general, neither the EPA nor RCRA Division of NMED are concerned with the report title or format.

Site-specific recommendations will be provided in the RI report, with reference to the stand-alone risk assessment for back-up documentation. The following three scenarios are anticipated for individual sites:

- No further action;
- Additional investigation to fill in data gaps or provide support for remedial design; and
- Site remediation.

9 December 1991

Investigation, Study, and
Recommendation for 29 Waste Sites
Holloman Air Force Base, NM

Name	Organization	Phone No.
Richard Mayer	EPA Region VI	214-655-6775
Wally Hise	Radian Corp.	512-454-4797
Ron Stirling	USACE - Omaha	402-221-3761
Sandy Frye	USACE - Omaha	402-221-7642
Roger Wilkson	Holloman AFB	505-479-5878
David Morgan	NMED	505-827-2754
Sharon Moore	Holloman AFB	505-479-3931
Tom Holcomb	Radian Corp.	512-454-4797
Ron Jahns	AFCEE/ESD	214-767-4648

Table 1 From Holloman AFB Hazardous Waste Permit[a]

SWMU Name	SWMU No.	IRP Site No.	Status
Building 1 Waste Accumulation Area	42	9	√
Acid Trailer Disposal Site	102	4	√
Former Army Landfill	104	29	√
Golf Course Landfill	105	19	√
Main Base Landfill	106	1	X
Main Base Substation PCB Disposal Area	107	11	√
MOBSS Landfill Disposal Trench	108	23	√
Old Main Base Landfill	109	10	X
Sludge Disposal Trenches	113	20,30,33	√
TEL Disposal Site	114	3	√
West Area Landfill #1 PCB Disposal Area	115	22	√
West Area Landfill #2	116	21	√
Fire Department Training Area 1	170	31	X
Fire Department Training Area 2	171	31	X
Building 1191 Fuel Runoff Pits	178	36	√
Building 824 Waste Accumulation Area	212	28	√
Taxiway 4 Tank 28	130	46	X
Building 21 Entomology Leachfield	132	16	√
Building 1166 Test Track Drainfield	137	38	√
Building 1166 Oil/Water Separator Drainage Pit	138	--	*
Lake Holloman, which includes the earthen ditch carrying discharge from Lagoon G to Lake Holloman	139	-SL	**
Lake Stinky	140	-SL	**
Building 21 Pesticide Rinsewater Spill Area	AOC-A	16	√

(Continued)

SWMU Name	SWMU No.	IRP Site No.	Status
Building 882 Spills	AOC-D	26	√
Building 296 Fuel Tank Leaks	AOC-O	45	•
Building 301 Fuel Tank Leaks	AOC-P	44	X
POL Storage Tank Leaks	AOC-T	2 & 5	√
Pad 9 Drainage Pit	141	--	*
Former Entomology Shop	229	14	√
Building 131 O/WS	4	8	√
Building 131 Washrack	82	8	√
Building 702 O/WS	21	47	•
Radioactive Waste Disposal Area	111	42	√
Building 702 Waste Oil Tank	122	47	•
Building 703 Washrack Discharge Area	133	47	•
Buildings 920-924 Drainage Ditch	134	24	√
Coco Blockhouse Disposal Well	192	41	√

[a] = Reference HSWA Permit issued 22 August 1991 by EPA Region VI.

√ = Site is currently being investigated under the IRP Program.

X = Remedial Investigation has already been completed. Decision Documents to close the sites have been submitted.

• = No activities to date.

•• = Already investigated with the Base Sewage Treatment Lagoons.

• = Sites are being investigated under the Base's Rapid Response Program.

Sites Investigated by Radian Corporation

IRP Site Name	IRP Site No.	SWMU No.	Permit Table No.[a]
POL Spill Site No. 1	2	AOC T	1
Tetraethyl Lead Disposal Area	3	114	1
Acid Trailer Burial Site	4	102	1
POL Spill Site No. 2	5	AOC T	1
Refuse Collection Truck Washrack	8	4, 82	--
Waste POL Drum Storage/Spill Area	9	42	1
Main Base Electrical Substation	11	107	1
Former Entomology Shop Area	14	197	1
Existing Entomology Shop Area	16	132 118* AOC A	1 2* 1
Golf Course Landfill	19	105	1
Wastewater Treatment Plant Grit Burial Site	20	113	1
West Area Landfill No. 2	21	115	1
West Area Landfill No. 1	22	116	1
MOBSS Landfill	23	108	1
Former Equipment Maintenance Area	24	134	1
Possible Missile Fuel Spill Site	26	AOC D	1
Former North Area Washrack Site	28	212	1
Former Army Landfill	29	104	1
Grease Trap Disposal Pits	30	113	1
Cooking Grease Disposal Trenches	33	113	1
Unconventional Fuels Area Spill Site	36	178 129	1 2
Early Missile Testing Site	37	AOC L	2
Sled Test Maintenance Area	38	137	1

(Continued)

IRP Site Name	IRP Site No.	SWMU No.	Permit Table No.[a]
Missile Fuel Spill Area	39	165	2
		167	--
		177	2
		179	2
		181	2
		185	--
Coco Blockhouse Borehole Disposal Site	41	192	1
Radioactive Waste Burial Pit	42	111	1
Atlas Electrical Substations	43	AOC G	2
Waste Disposal Pit	50	--	--
Primate Research Institute/-Borehole Disposal Pit	51	--	--

[a]Reference HSWA Permit issued 22 August 1991 by EPA Region VI.

*Groundwater monitoring wells installed around entire IRP site.

IRP - SWMU DISCREPANCIES

IRP ID	SWMU ID
2	AOC T
5	AOC T
20	113
30	113
33	113
39	167
--	165
--	177
--	179
--	181
--	185

RESOLUTION OF DISCREPANCIES

- IRP 2 & 5 (AOC T) - Combined
- IRP 20 (SWMU 113) - Separated
- IRP 30 & 33 (SWMU 113) - Combined
- IRP 39 (SWMU 167) - Added SWMUs 165, 177, 179, 181, and 185

APPENDIX B

ARARS

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B.1. INTRODUCTION

The Superfund Amendments and Reauthorization Act (SARA) of 1986 mandated that the level or standard of control specified in a remedial action at a CERCLA (Superfund) site for the site-specific pollutants be "at least that of any applicable or relevant and appropriate (ARAR) standard, requirement, criteria, or limitation under any federal environmental law, or any more stringent standard, requirement, criteria, or limitation promulgated pursuant to a state environmental statute." The key components of this concept are defined as follows:

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Applicable requirements are those that would be legally applicable if the remedial action had not been taken under CERCLA; the concept implies that all jurisdictional prerequisites to applicability of the particular statute have been met.

Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under a federal or state law that, while not legally "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site.

To-be-considered material (TBCs) are non-promulgated advisories or guidance issued by the federal or state governments that are not legally binding and do not have the status of potential ARARs. However, pursuant to USEPA CERCLA guidance TBCs can be considered along with ARARs as part of the site risk assessment and may be used in

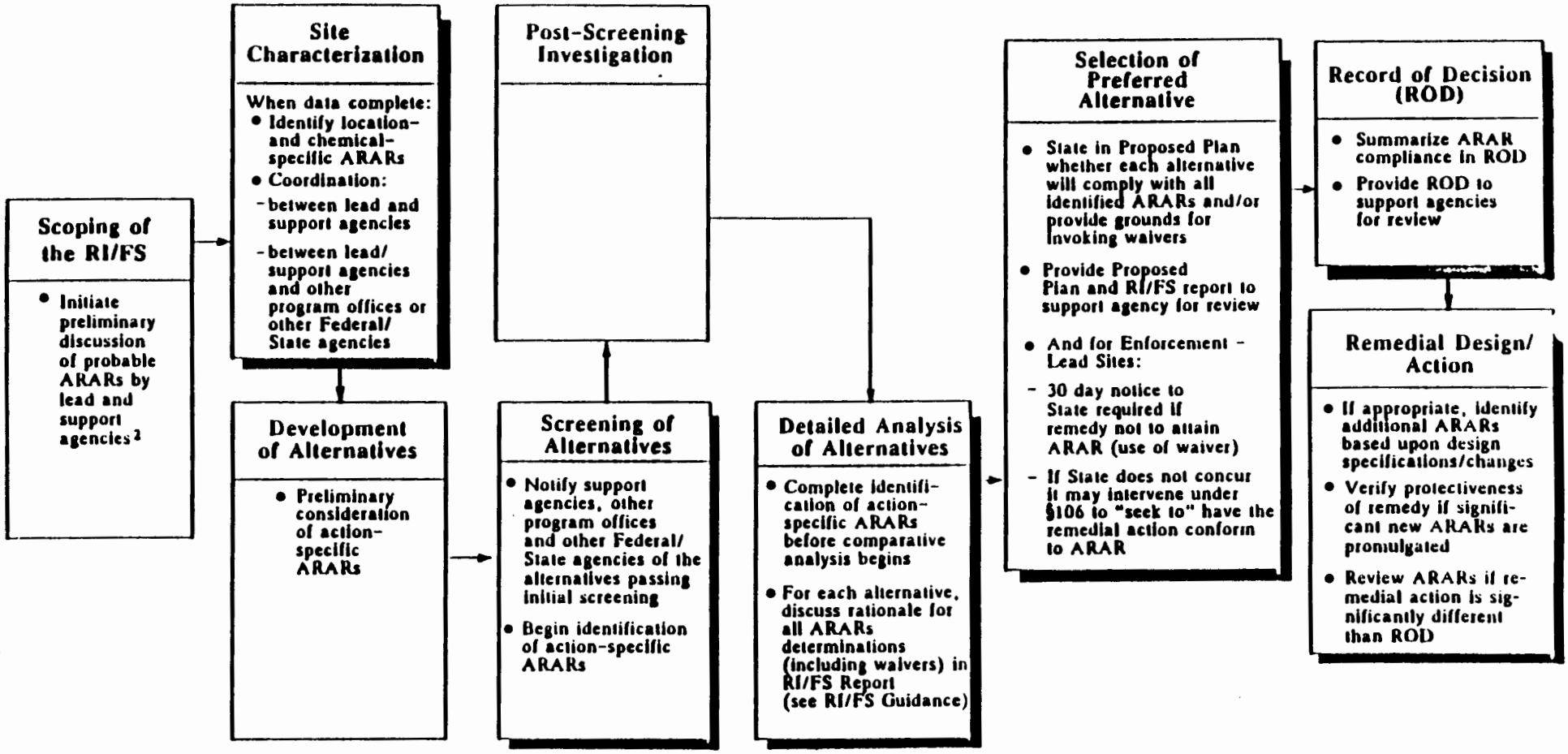
determining the necessary level of cleanup for protection of human health or the environment.

The ARAR identification, selection, and documentation process is depicted in Figure H.1-1. The ARAR identification process begins during the RI stage; as greater certainty about the site and the contaminants present is secured through the RI/FS process, ARARs are redeveloped and redefined. The process is, therefore, an iterative one. Ultimately, the preferred remedial action alternative will be assessed against the statutory cleanup criteria, which include attainment of ARARs. The Record of Decision for the site must document ARAR compliance.

The ARARs for Holloman AFB described below were identified in accordance with *CERCLA Compliance with Other Laws Manual* (EPA/540/G-89/006 and EPA/540/G-89/009) and *Guidance for Conducting Remedial Investigations Under CERCLA, Interim Final* (EPA/540/G-89/004). These ARARs were originally developed during the RI stage and have been expanded during the FS stage. The ARARs will be reassessed in subsequent stages of the IRP at the installation and, as needed, expanded or refined.

The following preliminary ARAR identification is divided into three categories of ARARs: 1) ambient or chemical-specific requirements; 2) locational standards; and 3) performance, design, or other action-specific requirements.

Remedial Investigation:



Feasibility Study:

[1] *This chart highlights critical points for communication between lead and support agencies in identifying ARARs and TBCs. As noted, EPA and the State should provide opportunities for consultation with other Federal/State program offices, and with other Federal/State agencies as appropriate to assist in identification of ARARs: The Region or State may determine that the RI/FS report, Proposed Plan, or ROD should be shared with other EPA/State program offices or other Federal agencies. In general, Federal and State agencies should assume responsibility for coordinating the involvement of their respective program offices and other agencies in developing information on ARARs. The appropriate procedures for such consultation should be developed by EPA Regional offices and by the Federal and State programs/agencies respectively.*

[2] *Copies of draft and final RI/FS workplan sent to other EPA/State offices as appropriate.*

Figure B.1-1. Points Where ARARs are Identified and Communicated[1]

B.2 CHEMICAL-SPECIFIC ARARs

Chemical-specific ARARs are typically health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values. These values, in turn, establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the environment (soil, groundwater, surface water, or air) as a result of the remedial action implementation. Potential chemical-specific ARARs for the Holloman AFB sites are: 1) Clean Water Act (CWA) Ambient Surface Water Quality Criteria (AWQC) for Protection of Aquatic Life; 2) EPA Drinking Water Standards -- Maximum Contaminant Levels (MCLs); 3) New Mexico Human Health Standards (HHS) for drinking water; 4) EPA proposed RCRA Subpart S Corrective Action Media Action Levels and Protection (i.e., cleanup) Standards; 5) regulated concentrations for polychlorinated biphenyls (PCBs) under 40 Code of Federal Regulations (CFR) Part 761 [promulgated under the federal Toxic Substances Control Act (TSCA)]; and 6) total petroleum hydrocarbons (TPHs) under the New Mexico Underground Storage Tank (UST) Regulations. In the event that air stripping is employed in remediation, chemical-specific ARARs from the federal Clean Air Act (CAA) and New Mexico Air Quality Control Regulation 752 (AQCR 752) will be applicable.

B.2.1 CWA Ambient Surface Water Quality Criteria (AWQC) for Protection of Aquatic Life

Quality Criteria for Water 1986, EPA 440/5-86-001, May 1, 1986.

Surface water quality criteria establish acceptable in-stream concentrations of pollutants. Federal water quality criteria are not legally enforceable standards because they have not been promulgated by EPA, but are potentially relevant and appropriate to CERCLA actions. Several sites have the potential to contaminate groundwater entering Malone Draw, where it surfaces at seeps and springs along the course of Lost River. A New

Mexico threatened species, the White Sands pupfish, is found on Malone Draw. Groundwater, potentially contaminated at other sites, also enters Lake Holloman, where two federal endangered species (peregrine falcon and least tern) are known to occur. The AWQCs are relevant and appropriate criteria for the protection of these species.

Acceptable concentrations of pollutants that may be present in surface or ground sources of drinking water are derived from MCLs established by EPA under the federal Safe Drinking Water Act (see Section B.2.4) and the New Mexico Human Health Standards (HHS) (see Section 2.5). Table B.2-1 depicts the quantitative AWQCS, MCLs, and New Mexico HHS for the pollutants of interest at Holloman AFB.

B.2.2 EPA RCRA Corrective Action Media Action Levels

40 CFR Part 264, Subpart S, Section 264.521 (proposed July 27, 1990, 55 *Federal Register* 30798 *et seq.*)

The proposed Subpart S regulations contain methodology and criteria for calculating action levels for contaminants in soil, water, and air. Action levels derived according to these criteria represent valid, reasonable estimates of levels in media at or below which corrective action is unlikely to be necessary. Action levels are not, however, cleanup standards; an exceedance of a media action level potentially triggers the need for a corrective measure study (CMS) for a SWMU. RCRA corrective action cleanup standards (media protection standards) are established at the CMS stage and may be less stringent than the action levels depending on site-specific conditions, such as land use.

Action levels for Holloman AFB (TBC material) were calculated using recommended exposure assumptions from Appendix D of the proposed rule, equations from Appendix E of the proposed rule, and reference doses (RfDs) or carcinogenic slope factors (SFs) available from the EPA. Concentrations used as action levels for carcinogens are

Table B.2-1

State and Federal ARARs for Surface and Drinking Water

Chemical	Freshwater AWQCs		Drinking Water MCLs (mg/L)	N.M. HHS (mg/L)
	Acute (µg/l)	Chronic (µg/l)		
2,4,5-T	-	-	-	-
2,4-D	-	-	7.0E-02	-
2,4-DB	-	-	-	-
4,4'-DDD	-	-	-	-
4,4'-DDE	1.05E+03	-	-	-
4,4'-DDT	1.10E+00	1.00E-03	-	-
Acetone	-	-	-	-
Aldrin	3.00E+00	-	-	-
Anthracene	-	-	-	3.0E-02
Antimony	8.80E+01	3.00E+01	1.0E-02 [a]	-
Arsenic	3.60E+02	1.90E+02	5.0E-02	1.0E-01
Benzene	5.30E+03	-	5.0E-03	1.0E-02
Benzoic acid	-	-	-	-
Benzo(b)fluoranthene	-	-	2.0E-04	3.0E-02
Benzo(k)fluoranthene	-	-	2.0E-04	3.0E-02
Beryllium	1.30E+02	5.30E+00	1.0E-03	-
alpha-BHC	1.00E+02	-	-	-
beta-BHC	-	-	-	-
delta-BHC	1.00E+02	-	-	-
gamma-BHC	2.00E+00	8.00E-02	2.0E-04	-
Bis(2-ethylhexyl)phthalate	4.00E+02	3.60E+02	4.0E-03 [a]	-
Bromodichloromethane	1.10E+04	-	1.0E-01	-

Table B.2-1

(Continued)

Chemical	Freshwater AWQCs		Drinking Water MCLs (mg/L)	N.M. HHS (mg/L)
	Acute (µg/l)	Chronic (µg/l)		
Butylbenzylphthalate	-	-	1.0E-02	-
Cadmium (air)	-	-	-	-
Cadmium (food)	-	-	-	-
Cadmium (water)	3.90E+00	1.10E+00	5.0E-03	1.0E-02
Carbon disulfide	-	2.00E+00	-	-
Carbon tetrachloride	3.52E+04	-	5.0E-03	1.0E-02
Chlordane	2.40E+00	4.30E-03	2.0E-03	-
alpha Chlordane	-	-	-	-
gamma Chlordane	-	-	-	-
Chlorobenzene	2.50E+02	5.00E+01	1.0E-01 [a]	-
Chlorofluoromethane	-	-	-	-
Chloroform	2.89E+04	1.24E+03	1.0E-01	1.0E-01
Chloromethane	-	-	-	-
Chromium III	-	-	1.0E-01	5.0E-02
Chromium VI	1.60E+01	1.10E+01	1.0E-01	-
Copper	9.20E+00	6.50E+00	1.3E+00	1.0E+00
Dibutylphthalate	9.40E+02	3.80E+00	-	-
Dibromochloromethane	1.10E+04	-	1.0E-01 [a]	-
Dicamba	-	-	-	-
Dichlorobenzene, 1,2-	-	-	6.0E-01	-
Dichlorobenzene, 1,3-	-	-	6.0E-01	-
Dichloroethane, 1,1-	1.80E+04	-	-	2.5E-02

Table B.2-1

(Continued)

Chemical	Freshwater AWQCs		Drinking Water MCLs (mg/L)	N.M. HHS (mg/L)
	Acute (µg/l)	Chronic (µg/l)		
Dichloroethane, 1,2-	1.80E+04	2.00E+04	5.0E-03	1.0E-02
Dichloroethene, 1,1-	1.16E+04	-	7.0E-03	5.0E-03
Dichloroethene, t-1,2-	-	-	1.0E-01	-
Dichloroprop	-	-	-	-
Dichloropropane, 1,2-	-	-	5.0E-03	-
Dieldrin	1.00E+00	1.90E-03	-	-
Dinoseb	-	-	-	-
Di-n-octylphthalate	-	-	-	-
Endosulfan I	-	-	-	-
Endosulfan II	-	-	-	-
Endosulfan sulfate	-	-	-	-
Endrin	1.80E-01	2.30E-03	2.0E-03	-
Endrin aldehyde	-	-	-	-
Endrin ketone	-	-	-	-
Ethylbenzene	3.20E+04	-	7.0E-01	7.5E-01
Fluorene	-	-	-	3.0E-02
Fluorine (fluorides)	-	-	4.0E+00	-
Heptachlor	3.80E-03	5.20E-01	4.0E-04	-
Heptachlor epoxide	3.80E-03	5.20E-01	2.0E-04	-
Heptanoic acid	-	-	-	-
Hexane, n-	-	-	-	-
Hexanone, 2-	-	-	-	-

Table B.2-1

(Continued)

Chemical	Freshwater AWQCs		Drinking Water MCLs (mg/L)	N.M. HHS (mg/L)
	Acute (µg/l)	Chronic (µg/l)		
Isodrin	-	-	-	-
Lead	8.20E+01	3.20E+00	none [a]	5.0E-02
MCPA	-	-	-	-
MCPP	-	-	-	-
Mercury	2.40E+00	1.20E-02	2.0E-03	2.0E-03
Methyl cyclohexane	-	-	-	-
Methyl ethyl ketone	-	-	-	-
Methyl parathion	-	-	-	-
Methylene chloride	1.10E+04	-	-	1.0E-01
Methylnaphthalene, 1-	-	-	-	3.0E-02
Methylnaphthalene, 2-	-	-	-	3.0E-02
Methylphenol, 4-	-	-	-	-
MIBK	-	-	-	-
Naphthalene	2.30E+03	6.20E+02	-	3.0E-02
Nickel	1.40E+03	1.60E+02	1.0E-01	2.0E-01
Nitropropane, 2-	-	-	-	-
Nonane	-	-	-	-
Octane	-	-	-	-
Octanol	-	-	-	-
PCB-1242	2.00E+00	1.40E-02	5.0E-04	1.0E-03
PCB-1254	2.00E+00	1.40E-02	5.0E-04	1.0E-03
PCB-1260	2.00E+00	1.40E-02	5.0E-04	1.0E-03

Table B.2-1

(Continued)

Chemical	Freshwater AWQCs		Drinking Water MCLs (mg/L)	N.M. HHS (mg/L)
	Acute (µg/l)	Chronic (µg/l)		
Phenanthrene	3.00E+01	6.30E+00	-	3.0E-02
Phenol	1.02E+04	2.56E+03	-	5.0E-03
Pyrene	-	-	-	3.0E-02
Selenium	2.00E+01	5.00E+00	5.0E-02	5.0E-02
Silver	9.20E-01	1.20E-01	-	5.0E-02
Styrene	-	-	1.0E-01 [a]	-
Tetrachloroethane, 1,1,2,2-	9.32E+03	2.40E+03	-	1.0E-02
Tetrachloroethene	5.28E+03	8.40E+02	5.0E-03	2.0E-02
Tetrahydrofuran	-	-	-	-
Toluene	1.75E+04	-	1.0E+00	7.5E-01
Trichloroethane, 1,1,1-	1.80E+04	-	2.0E-01	6.0E-02
Trichloroethane, 1,1,2-	1.80E+04	9.40E+03	5.0E-03	1.0E-02
Trichloroethene	4.50E+04	2.19E+04	5.0E-03	1.0E-01
Xylenes	-	-	1.0E+01	6.2E-01
Zinc	1.20E+02	1.10E+02	-	1.0E+01

[a] IRIS, January, 1992.

associated with a 1 x 10^{-6} upperbound excess cancer risk for Class A and B carcinogens, and a 1 x 10^{-5} upperbound excess cancer risk for Class C carcinogens; and action levels for systemic toxicants are based on concentrations at which the human population could be exposed on a daily basis without appreciable risk of adverse effects. Action levels for soil, air, and water, as derived using the proposed corrective action rule methodology, are presented in Table B.2-2.

The RfDs and SFs used were verified on the EPA's Integrated Risk Information System (IRIS) in January, 1992. Values not listed in IRIS were taken from EPA's Health Effects Assessment Summary Tables (HEAST) FY-1991 or were derived from MCLs. The source of all values used is documented in Table B.2-3.

B.2.3 RCRA Corrective Action Media Protection (Cleanup) Standards

40 CFR Part 264, Subpart S, Section 264.525(d) (proposed July 27, 1990, 55 *Federal Register* 30798 *et seq.*)

Media cleanup standards are contaminant concentrations that remedies must achieve. They are considered as TBC material for Holloman AFB. Media cleanup standards must:

- Ensure protection of human health and the environment;
- Be set for each medium of concern during the remedy selection process;
- Must be met at the "point of compliance" specified in Section 264.525(e) of Subpart S (proposed rule).

Table B.2-2

RCRA Subpart S Action Levels

Chemical	Soil Action Level		Air Action Level		Water Action Level	
	(noncarc) (mg/kg)	(carc) (mg/kg)	(noncarc) ($\mu g/m^3$)	(carc) ($\mu g/m^3$)	(noncarc) (mg/L)	(carc) (mg/L)
2,4,5-T	8.00E+03	-	-	-	3.50E+00	-
2,4-D	2.40E+02	-	-	-	1.05E-01	-
2,4-DB	6.40E+02	-	-	-	2.80E-01	-
4,4'-DDD	-	2.92E+00	-	-	-	1.46E-04
4,4'-DDE	-	2.06E+00	-	-	-	1.03E-04
4,4'-DDT	4.00E+01	2.06E+00	-	1.03E-02	1.75E-02	1.03E-04
Acetone	8.00E+03	-	-	-	3.50E+00	-
Aldrin	2.40E+00	4.12E-02	-	2.04E-04	1.05E-03	2.06E-06
Anthracene	2.40E+04	-	-	-	1.05E+01	-
Antimony	3.20E+01	-	-	-	1.40E-02	-
Arsenic	2.40E+01	-	-	2.33E-04	1.05E-02	-
Benzene	-	2.41E+01	-	1.20E-01	-	1.21E-03
Benzoic acid	3.20E+05	-	-	-	1.40E+02	-
Benzo(b)fluoranthene	-	4.38E-01	-	-	-	2.19E-05
Benzo(k)fluoranthene	-	9.21E-01	-	-	-	4.61E-05
Beryllium	4.00E+02	1.63E-01	-	4.17E-04	1.75E-01	8.14E-06
alpha-BHC	-	1.11E-01	-	5.56E-04	-	5.56E-06
beta-BHC	-	3.89E+00	-	1.89E-02	-	1.94E-04
delta-BHC	-	-	-	-	-	-
gamma-BHC	2.40E+01	5.38E-01	-	-	1.05E-02	2.69E-05
Bis(2-ethylhexyl) phthalate	1.60E+03	5.00E+01	-	-	7.00E-01	2.50E-03
Bromodichloromethane	1.60E+03	5.38E+00	-	-	7.00E-01	2.69E-04
Butylbenzylphthalate	1.60E+04	-	-	-	7.00E+00	-
Cadmium (air)	NA	NA	-	5.56E-04	NA	NA

Table B.2-2

(Continued)

Chemical	Soil Action Level		Air Action Level		Water Action Level	
	(noncarc) (mg/kg)	(carc) (mg/kg)	(noncarc) ($\mu g/m^3$)	(carc) ($\mu g/m^3$)	(noncarc) (mg/L)	(carc) (mg/L)
Cadmium (food)	8.00E+01	-	NA	NA	NA	NA
Cadmium (water)	NA	NA	NA	NA	1.75E-02	-
Carbon disulfide	8.00E+03	-	1.00E+01	-	3.50E+00	-
Carbon tetrachloride	5.60E+01	5.38E+00	-	6.67E-02	2.45E-02	2.69E-04
Chlordane	4.80E+00	5.38E-01	-	2.70E-03	2.10E-03	2.69E-05
alpha Chlordane	-	-	-	-	-	-
gamma Chlordane	-	-	-	-	-	-
Chlorobenzene	1.60E+03	-	2.00E+01	-	7.00E-01	-
Chlorofluoromethane	-	-	-	-	-	-
Chloroform	8.00E+02	1.15E+02	-	4.35E-02	3.50E-01	5.74E-03
Chloromethane	-	5.38E+02	-	5.56E+00	-	2.69E-02
Chromium III	8.00E+04	-	2.00E-03	-	3.50E+01	-
Chromium VI	4.00E+02	-	2.00E-03	8.33E-05	1.75E-01	-
Copper	3.20E+03	-	-	-	1.40E+00	-
Dibutylphthalate	8.00E+03	-	-	-	3.50E+00	-
Dibromochloro-methane	1.60E+03	8.33E+01	-	-	7.00E-01	4.17E-03
Dicamba	2.40E+03	-	-	-	1.05E+00	-
Dichlorobenzene, 1,2-	7.20E+03	-	-	-	3.15E+00	-
Dichlorobenzene, 1,3-	-	-	-	-	-	-
Dichloroethane, 1,1-	8.00E+03	-	5.00E+02	-	3.50E+00	-
Dichloroethane, 1,2-	-	7.69E+00	-	3.85E-02	-	3.85E-04
Dichloroethene, 1,1-	7.20E+02	1.17E+01	-	2.00E-01	3.15E-01	5.83E-04
Dichloroethene, t-1,2-	1.60E+03	-	-	-	7.00E-01	-
Dichloroprop	-	-	-	-	-	-

Table B.2-2

(Continued)

Chemical	Soil Action Level		Air Action Level		Water Action Level	
	(noncarc) (mg/kg)	(carc) (mg/kg)	(noncarc) ($\mu g/m^3$)	(carc) ($\mu g/m^3$)	(noncarc) (mg/L)	(carc) (mg/L)
Dichloropropane, 1,2-	-	1.03E+01	4.00E+00	-	-	5.15E-04
Dieldrin	4.00E+00	4.38E-02	-	2.17E-04	1.75E-03	2.19E-06
Dinoseb	8.00E+01	-	-	-	3.50E-02	-
Di-n-octylphthalate	1.60E+03	-	-	-	7.00E-01	-
Endosulfan I	4.00E+00	-	-	-	1.75E-03	-
Endosulfan II	4.00E+00	-	-	-	1.75E-03	-
Endosulfan sulfate	-	-	-	-	-	-
Endrin	2.40E+01	-	-	-	1.05E-02	-
Endrin aldehyde	-	-	-	-	-	-
Endrin ketone	-	-	-	-	-	-
Ethylbenzene	8.00E+03	-	1.00E+03	-	3.50E+00	-
Fluorene	3.20E+03	-	-	-	1.40E+00	-
Fluorine (fluorides)	4.80E+03	-	-	-	2.10E+00	-
Heptachlor	4.00E+01	1.56E-01	-	7.69E-04	1.75E-02	7.78E-06
Heptachlor epoxide	1.04E+00	7.69E-02	-	3.85E-04	4.55E-04	3.85E-06
Heptanoic acid	-	-	-	-	-	-
Hexane, n-	4.80E+03	-	2.00E+02	-	2.10E+00	-
Hexanone, 2-	-	-	-	-	-	-
Isodrin	-	-	-	-	-	-
Lead	3.2E+01	-	-	-	1.5E-02	-
MCPA	4.00E+01	-	-	-	1.75E-02	-
MCPP	8.00E+01	-	-	-	3.50E-02	-
Mercury	2.40E+01	-	3.00E-01	-	1.05E-02	-
Methyl cyclohexane	-	-	-	-	-	-

Table B.2-2

(Continued)

Chemical	Soil Action Level		Air Action Level		Water Action Level	
	(noncarc) (mg/kg)	(carc) (mg/kg)	(noncarc) ($\mu g/m^3$)	(carc) ($\mu g/m^3$)	(noncarc) (mg/L)	(carc) (mg/L)
Methyl ethyl ketone	4.00E+03	-	3.00E+02	-	1.75E+00	-
Methyl parathion	2.00E+01	-	-	-	8.75E-03	-
Methylene chloride	4.80E+03	9.33E+01	3.00E+03	2.13E+00	2.10E+00	4.67E-03
Methylnaphthalene, 1-	-	-	-	-	-	-
Methylnaphthalene, 2-	-	-	-	-	-	-
Methylphenol, 4-	4.00E+03	-	-	-	1.75E+00	-
MIBK	4.00E+03	-	8.00E+01	-	1.75E+00	-
Naphthalene	3.20E+02	-	-	-	1.40E-01	-
Nickel	1.60E+03	-	-	-	7.00E-01	-
Nitropropane, 2-	-	7.37E-02	-	-	-	3.68E-06
Nonane	-	-	-	-	-	-
Octane	-	-	-	-	-	-
Octanol	-	-	-	-	-	-
PCB-1242	-	9.09E-02	-	-	-	4.55E-06
PCB-1254	-	9.09E-02	-	-	-	4.55E-06
PCB-1260	-	9.09E-02	-	-	-	4.55E-06
Phenanthrene	-	-	-	-	-	-
Phenol	4.80E+04	-	-	-	2.10E+01	-
Pyrene	2.40E+03	-	-	-	1.05E+00	-
Selenium	4.00E+02	-	-	-	1.75E-01	-
Silver	4.00E+02	-	-	-	1.75E-01	-
Styrene	1.60E+04	2.33E+01	-	-	7.00E+00	1.17E-03
Tetrachloroethane, 1,1,2,2-	-	3.50E+01	-	1.72E-01	-	1.75E-03
Tetrachloroethene	8.00E+02	1.37E+01	-	1.92E+00	3.50E-01	6.86E-04

Table B.2-2

(Continued)

Chemical	Soil Action Level		Air Action Level		Water Action Level	
	(noncarc) (mg/kg)	(carc) (mg/kg)	(noncarc) ($\mu g/m^3$)	(carc) ($\mu g/m^3$)	(noncarc) (mg/L)	(carc) (mg/L)
Tetrahydrofuran	-	-	-	-	-	-
Toluene	1.60E+04	-	-	-	7.00E+00	-
Trichloroethane, 1,1,1-	7.20E+03	-	1.00E+03	-	3.15E+00	-
Trichloroethane, 1,1,2-	3.20E+02	1.23E+02	-	6.06E-01	1.40E-01	6.14E-03
Trichloroethene	-	6.36E+01	-	5.88E-01	-	3.18E-03
Xylenes	1.60E+05	-	3.00E+02	-	7.00E+01	-
Zinc	1.60E+04	-	-	-	7.00E+00	-

Table B.2-3

EPA Health-Based Criteria for the Calculation of Action Levels

Chemical	EPA Carc. Class	Oral RfD (mg/kg/d)	Inhalation RfC mg/m^3	Oral SF 1/(mg/kg/d)	Inhalation Unit Risk 1/(µg/m^3)
2,4,5-T	-	1.0E-01 [a]	-	-	-
2,4-D	-	3.0E-03 [a]	-	-	-
2,4-DB	-	8.0E-03 [b]	-	-	-
4,4'-DDD	B2	-	-	2.40E-01 [b]	-
4,4'-DDE	B2	-	-	3.40E-01 [b]	-
4,4'-DDT	B2	5.0E-04 [b]	-	3.40E-01 [b]	9.70E-05 [b]
Acetone	D	1.0E-01 [b]	-	-	-
Aldrin	B2	3.0E-05 [b]	-	1.70E+01 [b]	4.90E-03 [b]
Anthracene	D	3.0E-01 [a]	-	-	-
Antimony	D	4.0E-04 [b]	-	-	-
Arsenic	A	3.0E-04 [b]	-	-	4.30E-03 [b]
Benzene	A	-	-	2.90E-02 [b]	8.30E-06 [b]
Benzoic acid	-	4.0E+00 [a]	-	-	-
Benzo(b)fluoranthene	B2	-	-	1.60E+00 [c]	-
Benzo(k)fluoranthene	B2	-	-	7.60E-01 [c]	-
Beryllium	B2	5.0E-03 [b]	-	4.30E+00 [b]	2.40E-03 [b]
alpha-BHC	B2	-	-	6.30E+00 [b]	1.80E-03 [b]
beta-BHC	C	-	-	1.80E+00 [a]	5.30E-04 [a]
delta-BHC	D	-	-	-	-
gamma-BHC	B2/C	3.0E-04 [b]	-	1.30E+00 [a]	-
Bis(2-ethylhexyl)phthalate	B2	2.0E-02 [b]	-	1.40E-02 [b]	-
Bromodichloromethane	B2	2.0E-02 [b]	-	1.30E-01 [b]	-
Butylbenzylphthalate	C	2.0E-01 [b]	-	-	-
Cadmium (air)	B1	-	-	-	1.80E-03 [b]
Cadmium (food)	B1	1.0E-03 [a]	-	-	-
Cadmium (water)	B1	5.0E-04 [b]	-	-	-

Table B.2-3

(Continued)

Chemical	EPA Carc. Class	Oral RfD (mg/kg/d)	Inhalation RfC mg/m^3	Oral SF 1/(mg/kg/d)	Inhalation Unit Risk 1/(μg/m^3)
Carbon disulfide	D	1.0E-01 [b]	1.0E-02 [a]	-	-
Carbon tetrachloride	B2	7.0E-04 [b]	-	1.30E-01 [b]	1.50E-05 [b]
Chlordane	B2	6.0E-05 [b]	-	1.30E+00 [b]	3.70E-04 [b]
alpha Chlordane	-	-	-	-	-
gamma Chlordane	-	-	-	-	-
Chlorobenzene	D	2.0E-02 [b]	2.0E-02 [a]	-	-
Chlorofluoromethane	-	-	-	-	-
Chloroform	B2	1.0E-02 [b]	-	6.10E-03 [b]	2.30E-05 [b]
Chloromethane	C	-	-	1.30E-02 [a]	1.80E-06 [a]
Chromium III	-	1.0E+00 [a]	2.0E-06 [a]	-	-
Chromium VI	A	5.0E-03 [b]	2.0E-06 [a]	-	1.20E-02 [b]
Copper	D	4.0E-02 [d]	-	-	-
Dibutylphthalate	D	1.0E-01 [b]	-	-	-
Dibromochloromethane	C	2.0E-02 [b]	-	8.40E-02 [b]	-
Dicamba	D	3.0E-02 [b]	-	-	-
Dichlorobenzene, 1,2-	-	9.0E-02 [a]	-	-	-
Dichlorobenzene, 1,3-	-	-	-	-	-
Dichloroethane, 1,1-	C	1.0E-01 [a]	5.0E-01 [a]	-	-
Dichloroethane, 1,2-	B2	-	-	9.10E-02 [b]	2.60E-05 [b]
Dichloroethene, 1,1-	C	9.0E-03 [b]	-	6.00E-01 [b]	5.00E-05 [a]
Dichloroethene, t-1,2-	D	2.0E-02 [a]	-	-	-
Dichloroprop	-	-	-	-	-
Dichloropropane, 1,2-	B2	-	4.0E-03 [b]	6.80E-02 [a]	-
Dieldrin	B2	5.0E-05 [b]	-	1.60E+01 [b]	4.60E-03 [b]
Dinoseb	-	1.0E-03 [a]	-	-	-
Di-n-octylphthalate	-	2.0E-02 [a]	-	-	-

Table B.2-3

(Continued)

Chemical	EPA Carc. Class	Oral RfD (mg/kg/d)	Inhalation RfC mg/m^3	Oral SF 1/(mg/kg/d)	Inhalation Unit Risk 1/(μg/m^3)
Endosulfan I	D	5.0E-05 [a]	-	-	-
Endosulfan II	D	5.0E-05 [a]	-	-	-
Endosulfan sulfate	-	-	-	-	-
Endrin	D	3.0E-04 [b]	-	-	-
Endrin aldehyde	-	-	-	-	-
Endrin ketone	-	-	-	-	-
Ethylbenzene	D	1.0E-01 [b]	1.0E+00 [a]	-	-
Fluorene	-	4.0E-02 [b]	-	-	-
Fluorine (fluorides)	-	6.0E-02 [a]	-	-	-
Heptachlor	B2	5.0E-04 [b]	-	4.50E+00 [b]	1.30E-03 [b]
Heptachlor epoxide	B2	1.3E-05 [b]	-	9.10E+00 [b]	2.60E-03 [b]
Heptanoic acid	-	-	-	-	-
Hexane, n-	-	6.0E-02 [a]	2.0E-01 [b]	-	-
Hexanone, 2-	-	-	-	-	-
Isodrin	-	-	-	-	-
Lead	B2	4.0E-04 [f]	-	-	-
MCPA	E	5.0E-04 [b]	-	-	-
MCPP	-	1.0E-03 [b]	-	-	-
Mercury	D	3.0E-04 [a]	3.0E-04 [a]	-	-
Methyl cyclohexane	-	-	-	-	-
Methyl ethyl ketone	D	5.0E-02 [a]	3.0E-01 [a]	-	-
Methyl parathion	D	2.5E-04 [b]	-	-	-
Methylene chloride	B2	6.0E-02 [b]	3.0E+00 [a]	7.50E-03 [b]	4.70E-07 [b]
Methylnaphthalene, 1-	-	-	-	-	-
Methylnaphthalene, 2-	-	-	-	-	-
Methylphenol, 4-	C	5.0E-02 [a]	-	-	-

Table B.2-3

(Continued)

Chemical	EPA Carc. Class	Oral RfD (mg/kg/d)	Inhalation RfC mg/m^3	Oral SF 1/(mg/kg/d)	Inhalation Unit Risk 1/(μg/m^3)
MIBK	D	5.0E-02 [a]	8.0E-02 [a]	-	-
Naphthalene	D	4.0E-03 [a]	-	-	-
Nickel	D	2.0E-02 [b]	-	-	-
Nitropropane, 2-	B2	-	-	9.50E+00 [a]	-
Nonane	-	-	-	-	-
Octane	-	-	-	-	-
Octanol	-	-	-	-	-
PCB-1242	B2	-	-	7.70E+00 [b]	-
PCB-1254	B2	-	-	7.70E+00 [b]	-
PCB-1260	B2	-	-	7.70E+00 [b]	-
Phenanthrene	D	-	-	-	-
Phenol	D	6.0E-01 [b]	-	-	-
Pyrene	D	3.0E-02 [b]	-	-	-
Selenium	D	5.0E-03 [b]	-	-	-
Silver	D	5.0E-03 [b]	-	-	-
Styrene	B2	2.0E-01 [b]	-	3.00E-02 [a]	-
Tetrachloroethane, 1,1,2,2-	C	-	-	2.00E-01 [b]	5.80E-05 [b]
Tetrachloroethene	B2	1.0E-02 [b]	-	5.10E-02 [a]	5.20E-07 [a]
Tetrahydrofuran	-	-	-	-	-
Toluene	D	2.0E-01 [b]	-	-	-
Trichloroethane, 1,1,1-	D	9.0E-02 [a]	1.0E+00 [a]	-	-
Trichloroethane, 1,1,2-	C	4.0E-03 [b]	-	5.70E-02 [b]	1.65E-05 [b]
Trichloroethene	B2	-	-	1.10E-02 [a]	1.70E-06 [a]
Xylenes	D	2.0E+00 [b]	3.0E-01 [a]	-	-
Zinc	D	2.0E-01 [a]	-	-	-

Table B.2-3

(Continued)

[a] US EPA Health Effects Assessment Summary Tables, FY1991.

[b] IRIS, January, 1992.

[c] Calculated with comparative potency approach in EPA (1988).

[d] Calculated based on drinking water MCL (EPA, April, 1991).

[e] Calculated based on NM HHS.

[f] Calculated based on water action level (EPA, June 1991).

The EPA is proposing to set media cleanup standards within the overall context of the remedy selection process. For the Holloman AFB sites, media cleanup standards will be set during the CERCLA FS process, which is a parallel to the RCRA corrective action CMS. Media cleanup standards will be based on action levels in conjunction with site-specific risk assessments.

B.2.4 EPA Drinking Water Standards

40 CFR Part 141

The National Primary Drinking Water Regulations establish MCLs which are used as action levels under the Subpart S proposed rule. Groundwater at Holloman AFB is unpotable due to naturally occurring high salinity, but the action levels are to be considered because groundwater may be desalinated and used as drinking water in the future. MCLs for contaminants detected in Holloman AFB groundwater are presented in Table B.2-1.

B.2.5 New Mexico Human Health Standards (HHSs)

New Mexico Water Quality Control Commission Regulations (NMWQCCR)

New Mexico HHSs establish acceptable concentrations of pollutants in drinking water and are used as action levels under the Subpart S proposed rule. They are to be considered standards due to the possible future use of groundwater as drinking water. HHSs for the contaminants detected in Holloman AFB groundwater are presented in Table B.2-1.

B.2.6 Polychlorinated Biphenyls (PCBs)

40 CFR Part 761, Subpart G

The EPA has established regulations for the management of PCBs at 40 CFR Part 761. Generally, these rules apply to PCBs present in concentrations of 50 ppm or greater.

B.2.6.1 PCB Spill Cleanup

In 1987, EPA adopted amendments to the PCB regulations establishing spill cleanup requirements. These requirements only apply to PCB spills which occur after the effective date of the rule (4 May 1987). Existing spills (i.e., spills that occurred before the effective date of the policy) are excluded from the scope of the rules; cleanup requirements at these sites are established at the discretion of EPA, through its regional offices.

The 1987 regulatory amendments do apply to the cleanup of PCBs in concentrations less than 50 ppm if the material that was originally spilled contained concentrations greater than 50 ppm.

B.2.6.2 PCB Cleanup Criteria

EPA's PCB spill cleanup rules use a risk-based approach which requires cleanup to different levels depending upon: 1) spill location; 2) the potential for exposure to residual PCBs remaining after cleanup; 3) the concentration of PCBs initially spilled; and 4) the nature and size of the population at risk of exposure.

Requirements for the cleanup of high-concentration PCB spills (containing 500 ppm or greater PCBs) and low concentration spills involving one pound or more PCBs by weight are contained in 40 CFR Section 761.125.

Restricted Access Areas

Requirements for cleanup of PCB spills in outdoor electrical substations are contained in 40 CFR Sections 761.125 (c)(2)(i) and (ii). Contaminated solid surfaces (both impervious and nonimpervious) will be cleaned to a PCB concentration of 100 $\mu g/100\ cm^2$. Contaminated soil will be cleaned either to 25 or 50 ppm PCBs by weight provided that a label or notice is visibly placed in the area.

Other restricted access (nonsubstation) locations are "areas other than electrical substations that are at least 0.1 kilometer (km) from a residential/commercial area and limited by man-made barriers (i.e., fences and walls)...[or] substantially limited by naturally occurring barriers such as mountains, cliffs, or rough terrain. These areas generally include industrial facilities and extremely remote rural locations" (40 CFR Section 761.123). In accordance with these guidelines and definitions, most Holloman AFB sites where PCB contamination occurs are considered to be "other restricted access areas." Cleanup criteria for PCB spills in other restricted access areas are 10 $\mu g/100\ cm^2$ for high-contact solid surfaces; 10 $\mu g/100\ cm^2$ for low-contact, indoor, impervious surfaces; 10 $\mu g/100\ cm^2$, or 100 $\mu g/100\ cm^2$ with encapsulation for low-contact, indoor, nonimpervious surfaces; 100 $\mu g/100\ cm^2$ for low-contact outdoor surfaces; and 25 ppm by weight for soil.

Nonrestricted Access Areas

Requirements for cleanup of PCB spills in "nonrestricted access areas" are contained in 40 CFR Sections 761.125 (c)(4)(i)-(v). "Nonrestricted access areas" are defined in 40 CFR Section 761.123 as "any area other than restricted access, outdoor electrical

substations, and other restricted access locations...in addition to residential/commercial areas, these areas include unrestricted access rural areas." In accordance with this definition, the area outside the substation fence at Site 11 is considered a "nonrestricted access area." Soil cleanup criteria for PCB spills in nonrestricted access areas are 10 ppm by weight provided the soil is excavated to a minimum depth of 10 inches. The excavated soil will be replaced with clean soil (less than 1 ppm PCBs).

The rules state that in exceptional spill situations, site-specific risk factors may warrant additional cleanup to more stringent numerical decontamination levels. Site-specific characteristics such as shallow depth of groundwater, type of soil, or the presence of a shallow well may pose an exceptionally high potential for groundwater contamination by PCBs. Under these circumstances the Regional Administrator may require additional cleanup in order to avoid unreasonable risk.

B.2.7 Total Petroleum Hydrocarbons (TPHs)

Three standards, established by the New Mexico Environment Department (NMED) are ARARs for petroleum contaminated soils at Holloman AFB. These standards are discussed in the following sections.

B.2.7.1 New Mexico Special Waste Regulations

New Mexico Special Waste Management Rules, Part VII--Special Waste Requirements

The New Mexico Solid Waste Management Regulations, Part VII (Special Waste Requirements Regulations) establish standards for handling contaminated soils (Section 708). All soils suspected of petroleum contamination must be analyzed for TRPH.

Remediation of petroleum-contaminated soils must be completed until the most heavily contaminated soil meets the following conditions:

- The sum of benzene, toluene, ethylbenzene, and xylene isomer concentrations is less than 500 mg/kg, with benzene individually less than 100 mg/kg; and
- The TRPH concentration is less than 1,000 mg/kg.

This standard may be relevant and appropriate for cleanup of petroleum contaminated soils at Holloman AFB.

B.2.7.2 New Mexico UST Regulations

New Mexico Underground Storage Tank Regulations Section 1209-Treatment of Highly Contaminated Soils

The New Mexico UST Regulations state that remediation of soil contamination at UST sites will be considered complete when:

1. Soil contamination has been reduced to a level which will not contaminate groundwater;

2. No highly contaminated soils remain in the ground; and

3. An analysis of what appears to be the most contaminated soil reveals, for soils contaminated by jet aviation fuel or other heavy petroleum product, that the total petroleum hydrocarbon value is less than 100 ppm, total aromatic hydrocarbon value is less than 50 ppm, and the benzene concentration is less than 10 ppm using an appropriate

laboratory test in areas where the underlying groundwater contains 10,000 milligrams per liter or less total dissolved solids and the contaminated soil is 50 feet or less above the seasonal high static groundwater level.

These standards may be relevant and appropriate for cleanup of petroleum contaminated soils at Holloman AFB, however, the NMED has established a standard for all petroleum contaminated soils at Holloman AFB in a letter dated 2 November 1992 (Appendix A). This establishes a level of 1000 mg/kg TRPH in lieu of remediating all "highly contaminated" soils. This standard is considered applicable for all remediation at Holloman AFB.

B.3 LOCATION-SPECIFIC ARARs

Location-specific ARARs are regulations that affect the management of hazardous constituents or the units in which they are managed due to their location. Some examples of sensitive locations include wetlands, floodplains, historic areas, and wildlife refuges.

Several potential location-specific ARARs have been identified: 1) the federal Endangered Species Act of 1973; 2) the New Mexico Wildlife Conservation Act; 3) the National Historic Preservation Act; 4) the Resource Conservation and Recovery Act (RCRA); and 5) the federal Clean Water Act, Section 404.

B.3.1 Federal Endangered Species Act of 1973

50 CFR Part 17

The federal Endangered Species Act (ESA) provides a means for conserving species that are threatened with extinction. Section 9(a)(1)(B) of the ESA makes it unlawful for any person to take any endangered species of fish and wildlife within the United States or the territorial sea of the United States. The term "take" is defined in the law to include "to harass, harm, pursue, hunt, shoot, wound, kill, capture or collect, or to attempt to engage in such conduct." An endangered species is defined in the law as "any species which is in danger of extinction throughout all or a significant portion of its range...," and a threatened species is defined as "any species which is likely to become an endangered species within the foreseeable future...." Critical habitats are also defined in the ESA, but none have been designated in the Holloman AFB area (50 CFR Sections 17.95 and 17.96). Two federal endangered species (the peregrine falcon and the least tern) are known to occur in the vicinity of Holloman AFB. In addition, there are several candidates for federal listing: the snowy plover, mountain plover, long-billed curlew, white-faced ibis, and ferruginous hawk.

If, at any point, the conclusion is reached that endangered species will not be affected ("taken"), no further action is required. However, if it is determined during informal consultation with the US Fish and Wildlife Service (FWS) that an endangered species may be impacted by site activities, preparation of a biological assessment (BA) is necessitated. The intent of the BA is to examine any possible impacts of a proposed action upon the affected species in the project area. Based upon the BA conclusions, appropriate action will be determined in consultation with the FWS.

B.3.2 New Mexico Wildlife Conservation Act

Sections 17-2-37 through 17-2-46 NMSA 1978; amended listing of Endangered Wildlife of New Mexico (Reg. No. 692)

The White Sands pupfish is listed as an Endangered, Group 2 species. "Endangered, Group 2," is defined as "any species or subspecies whose prospects of survival or recruitment in New Mexico are likely to be in jeopardy within the foreseeable future" (Reg. No. 682). The White Sands pupfish inhabits Malone Draw, and contaminants in groundwater which surfaces at seeps and springs in Malone Draw must be at levels which ensure its conservation. The federal AWQCs (Section 2.1) are non-enforceable guidelines which are relevant and appropriate for the protection of aquatic life. Federal AWQCs for contaminants detected in Holloman AFB groundwater are presented in Table 2-1.

B.3.3 National Historic Preservation Act

36 CFR Part 800

Pursuant to an agreement with the federal Advisory Council on Historic Preservation, each state has responsibility for ensuring implementation of Section 106 of the National Historic Preservation Act, 16 U.S.C. Sec. 470 *et seq.* The Act "requires a federal agency head with jurisdiction over a federal, federally assisted, or federally licensed undertaking to take into account the effects of the agency's undertaking on properties included in or eligible for the National Register of Historic Places and, prior to approval of an undertaking, to afford the Advisory Council on Historic Preservation [or authorized state agency] a reasonable opportunity to comment on the undertaking." This law could potentially be triggered if, during site investigation or remediation, archaeological resources are discovered.

The Section 106 review and comment process, including that of authorized state agencies, is governed by the regulations found at 36 CFR Part 800. Essentially, the program consists of: 1) the initial assessment of information and data needs necessary to the identification of potential historic (historic includes archaeological) properties; 2) the identification and location of historic properties potentially eligible for the National Register; and 3) the evaluation of whether the properties are eligible for the Register. If, as a result of these steps, it is determined that no historic properties will be affected by the undertaking, the Section 106 process is completed.

If there are historic properties present at the site, but the site investigation or remediation will not affect these properties, the Section 106 process is also concluded. If an adverse effect on such properties is likely, the state shall, with the input of other interested agencies and the public, develop ways to avoid or mitigate the effects. The end

result of this process is sometimes the development of a Memorandum of Agreement between the agencies which incorporate avoidance or mitigation measures.

B.3.4 Resource Conservation and Recovery Act (RCRA)

40 CFR Part 264, Subpart B, Section 264.18

The Resource Conservation and Recovery Act sets location standards for hazardous waste treatment, storage, or disposal facilities (TSDFs). The standards include siting restrictions for areas of seismic activity, floodplains, salt dome and bed formations, and underground mines and caves. New TSDFs must not be located within 200 feet of a fault which has had displacement in Holocene time. Facilities located in a 100-year floodplain must also be designed, constructed, operated and maintained to prevent washout or any hazardous waste by a 100-year flood. Finally, noncontainerized bulk liquid hazardous waste cannot be placed in any salt dome formation, salt bed formation, underground mine or cave. These location standards could potentially come into play if new hazardous waste management units needed to be constructed for site remediation.

B.3.5 Clean Water Act (CWA)-Section 404 Dredge and Fill Permit Program

33 CFR Parts 320, 323, 325

Section 404 of the CWA requires a permit from the USACE for the discharge of dredged or fill material into waters of the U.S. and the implementation of mitigation measures. The definition of "waters of the U.S." is very expansive, including essentially all dry gullies and creeks and wetlands. The types of activities intended to be covered by this program include site-development fills for any type of use; dams or dikes; property protection and/or reclamation devices such as riprap, groins; levees; and road fills. Section

404 compliance might be triggered by site remediation which involved land disturbance in dry or wet arroyos, creeks, gullies, or ponds.

B.4 ACTION-SPECIFIC ARARs

Action-specific ARARs are technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy. Since there are several possible remedial alternatives and/or actions for any site, different requirements can come into play, depending on the specific action.

The potential action-specific ARARs for Holloman AFB fall under six major regulations: 1) the Safe Drinking Water Act; 2) the Clean Water Act; 3) the Resource Conservation and Recovery Act (RCRA); 4) New Mexico Solid Waste Management Regulations; 5) the Clean Air Act (CAA); and 6) the Toxic Substances Control Act (TSCA).

B.4.1 Safe Drinking Water Act (40 CFR Parts 144 through 147)

The Safe Drinking Water Act (SDWA) establishes classifications of underground injection wells and regulates the use of these wells. Any remedial action which requires the use of an underground injection well for disposal of liquid wastes would have to meet the requirements of 40 CFR Parts 144 through 147.

B.4.2 Clean Water Act

The objective of the Clean Water Act (CWA) is to restore and maintain the chemical, physical, and biological integrity of U.S. waters. The CWA achieves this goal by establishing both discharge management requirements and numerical standards. Remedial actions at CERCLA sites which generate a wastewater discharge must comply with the appropriate requirements of CWA.

B.4.2.1 National Pollutant Discharge Elimination System (NPDES)

The NPDES program is the national program for issuing, monitoring, and enforcing permits for direct discharges. Any remedial action at a CERCLA site that generates a wastewater stream that must be discharged to a surface water body is subject to regulations under this program. Wastewater treatment technologies must meet the best conventional pollutant control technology (BCT) for conventional pollutants (i.e., biochemical oxygen demand (BOD) and total suspended solids (TSS), fecal coliform, oil and grease, and pH) and best available technology economically achievable (BAT) for toxic and nonconventional pollutants (e.g., benzene, chloroform, total organic carbon, etc). For CERCLA sites, the BCT/BAT technology-based treatment requirements are determined on a case-by-case basis.

B.4.2.2 National Pretreatment Standards

The national pretreatment program controls the indirect discharge of pollutants to publicly owned treatment works (POTW). The national pretreatment standards can be found at 40 CFR Part 403. These standards specify quantities or concentrations of pollutants or pollutant properties that may be discharged to a POTW by an industrial user in specific industrial categories. Although, these categories do not include CERCLA remedial action sites, the standards may be relevant and appropriate if the considerations underlying the categorical standard are sufficiently similar to the conditions of the substance found at the remedial site.

B.4.3 Resource Conservation and Recovery Act (RCRA)

The action-specific ARARs for Holloman AFB that have been promulgated under RCRA consist of standards which fall into five categories: 1) the RCRA general management standards for generators of hazardous waste; 2) the RCRA technical standards

identified in 40 CFR Parts 264 and 265 for waste management units (tanks, waste piles, container storage areas, land disposal units) that may be used or constructed during the remedial action; 3) the RCRA closure and post-closure options identified in 40 CFR Parts 264 and 265; 4) the RCRA land disposal restrictions; and 5) the proposed RCRA corrective action rules (Subpart S). Some of these requirements may be legally applicable; for example, if the remedial action specifies the construction of a new land disposal unit on site to dispose of wastes excavated from the IRP sites and the wastes, as excavated, are RCRA characteristically hazardous or listed wastes, then the new disposal unit is a RCRA hazardous waste management unit and the Parts 264 and 265 technical standards are legally applicable. If the excavated wastes are not RCRA hazardous, the RCRA technical standards may be relevant and appropriate.

B.4.3.1 RCRA Management Standards for Generators of Hazardous Waste

The following sections discuss the management standards that RCRA establishes for generators of hazardous waste and owner/operators of hazardous waste facilities. Remedial action at a CERCLA site may generate hazardous wastes which must be managed in accordance with appropriate standards.

Hazardous Waste Generator Standards

Hazardous Waste Identification--Generators of solid wastes are required to determine if that waste is hazardous per 40 CFR Part 261 (Identification and Listing of Hazardous Waste). The generator must determine whether the waste is either: 1) excluded from regulation; 2) listed in Subpart D of 40 CFR Part 261; or 3) identified in Subpart C of 40 CFR Part 261 by either analyzing the waste according to methods outlined in Subpart C or applying process knowledge of the waste in light of the materials or processes used. If wastes are generated during a remedial action (i.e., excavation and disposal), the generator must determine if the waste is a hazardous waste.

Hazardous Waste Transportation--Transporters of hazardous wastes must obtain an identification number from the EPA and comply with the requirements in 40 CFR Part 263. In addition, all shipments of hazardous waste must be accompanied by a hazardous waste manifest. The generator, transporter, and disposal facility must comply with the manifesting requirements of 40 CFR Part 263. These requirements include following appropriate Department of Transportation (DOT) shipping requirements. If a remedial action includes the off-site transportation of hazardous wastes, the generator must ensure compliance with the hazardous waste transportation requirements.

Owner/Operator of Hazardous Waste Facilities Standards

Waste Analysis--Facilities which store, treat, or dispose of hazardous wastes must provide a detailed chemical and physical analysis of a representative sample of the waste prior to storage, treatment, or disposal of the waste. If the storage, treatment, or disposal of the waste occurs at a facility other than the generator's facility, this detailed analysis must be provided to the off-site facility.

Contingency Plans and Preparedness and Prevention--Facilities which store, treat, or dispose of hazardous waste must comply with the preparedness and prevention requirements of 40 CFR Part 264 Subpart C and maintain a contingency plan as required by 40 CFR Part 264 Subpart D.

B.4.3.2 RCRA Technical Standards for Waste Management Units

The following sections discuss the technical standards that RCRA establishes for waste management units which store, treat, or dispose of a hazardous waste. Remedial action at a CERCLA site may require storage of hazardous wastes, and the container storage or tank requirements of RCRA may be applicable. If a remedial action involves the treatment or disposal of a hazardous waste, the requirements for tanks, surface impound-

ments, waste piles, and/or land treatment may be applicable. The RCRA land disposal restrictions would also be applicable to any disposal activity in a land disposal unit.

Container Storage Areas--(40 CFR Part 264, Subpart I)

If a remedial action at a CERCLA site requires that hazardous wastes be stored in a container storage area, the requirements of 40 CFR Subpart I will be applicable. Wastes which are containerized and must be stored prior to off-site disposal may be stored in container storage areas. Requirements for these facilities include construction of a containment system with an impervious base free of cracks and gaps which is sloped to drain liquids away from the containers. The system must have sufficient volume to contain 10% of the volume of the containers or the volume of the largest container. The system must also prevent run-on or contain any run-on which might enter the system. Containers holding ignitable or flammable waste must be located at least 50 feet from the facility property line.

Tanks--(40 CFR Part 264, Subpart J and Subpart BB)

Tanks may be required for short- or long-term storage of hazardous waste as a result of a remedial action. Requirements for hazardous waste storage tanks are found at 40 CFR Part 264 Subpart J and include a written assessment reviewed and certified by an independent, qualified registered professional engineer that attests to the tank system's integrity. This assessment includes design standards, hazardous characteristics of the wastes, corrosion effects, and foundation considerations. The installation of the tank must also be certified by an independent, qualified installation inspector or an independent, qualified registered professional engineer. New tanks and ancillary equipment must be tightness tested prior to being put in use and ancillary equipment must be supported and protected against physical damage and excessive stress due to settlement, vibration, expansion, or contraction. The tank must have a secondary containment system which is constructed or lined with material that is compatible with the wastes, provided with a leak detection system,

and sloped to remove liquids. Ancillary equipment must also be provided with secondary containment. The tank must also b provided with spill and overfill prevention controls. The owner/operator of a tank which contains organic wastes in concentrations of at least 10% by weight must also implement an air emission control program of monitoring, inspection, and repair for equipment leaks as required in 40 CFR Part 264, Subpart BB.

Land Disposal Units--(40 CFR Part 264, Subparts K, L, M, N, and 40 CFR Part 268)

Wastes from a remedial action may require disposal in a land disposal unit (surface impoundment, waste pile, land treatment facility, or landfill). If the wastes are hazardous, the land disposal requirements at 40 CFR Part 264, Subparts K, L, M, or N may apply. Subparts K, L, M, and N establish the technical requirements for surface impoundments, waste piles, land treatment facilities, and landfills, respectively. Requirements for surface impoundments, waste piles, and landfills include liners and leachate collection systems, while land treatment facilities must demonstrate that waste can be degraded, transformed, or immobilized in the treatment zone through monitoring of both the saturated and unsaturated zone.

B.4.3.3 RCRA Closure and Post Closure Options and Standards

Excavation, consolidation, and other similar actions that are considered disposal may trigger the RCRA closure requirements for the units into which the waste is being disposed. For example, if excavated soil containing hazardous wastes is disposed of in a landfill, RCRA closure requirements will be applicable to the landfill. RCRA provides for three basic types of closure, which are discussed in the following sections.

Clean Closure--(40 CFR Sections 264.111, 264.178, 264.197, 264.228, and 264.258)

Clean closure requires all waste residues and contaminated containment system components (e.g., liners), contaminated subsoils, and structures and equipment contaminated with waste and leachate to be removed and managed as hazardous waste or decontaminated before the site management is completed. The basic intent of this approach is to allow the site to remain without care and supervision after clean closure has been completed. The EPA realizes that limited quantities of hazardous constituents may remain in the subsoil without presenting significant risks to human health and the environment and therefore some constituents are allowed to remain in place as long as it can be demonstrated that the concentrations are below federal health-based standards. The demonstration procedure is waste-specific and site-specific, considers all potential exposure pathways, and assumes no attenuation.

Closure as a Landfill--(40 CFR Sections 264.111, 264.197, 264.228, 264.258, 264.280, 264.310, and 264.601-603)

Closure as a landfill requires the site to be capped with a final cover designed and constructed to provide long-term minimization of the migration of liquids through the capped area, and to maintain its integrity over time while functioning with minimum maintenance. This type of closure anticipates post-closure care and maintenance at the facility for at least 30 years after closure. Post-closure care includes maintaining the integrity and effectiveness of the cover, maintaining and monitoring the groundwater monitoring system, and preventing run-on and run-off from damaging the cover.

Delay of Closure--(40 CFR Sections 264.112 and 264.113)

In certain circumstances, landfills, surface impoundments, and land treatment facilities may delay closure to continue receipt of nonhazardous wastes. A unit for which delay of closure is requested must demonstrate that: 1) the unit has sufficient capacity to continue to receive waste; 2) there is a reasonable likelihood that non-hazardous wastes will be received in the unit within one year of the final receipt of hazardous waste; 3) non-hazardous wastes received will be compatible with any other wastes remaining in the unit; 4) closure of the unit is incompatible with continued operation of the facility; and 5) the facility will continue to be operated in compliance with all applicable permit or interim status requirements. The units which request delay of closure must operate under the full permit requirements of 40 CFR Part 264.

B.4.3.4 RCRA Land Disposal Restrictions--(40 CFR Part 268)

RCRA establishes requirements for the land disposal of hazardous wastes in 40 CFR Part 268. Essentially, the land disposal of hazardous waste is prohibited unless the waste meets treatment standards that are protective of human health and the environment and are achieved using the best demonstrated available treatment technologies (BDAT). For each type of waste (characteristic or listed), a concentration level is set for each constituent and/or a treatment technology is specified for the waste. The EPA sets these treatment standards for each hazardous waste and the standards are found at 40 CFR Part 268. For any newly listed hazardous wastes, the EPA will set the land disposal standards at a subsequent date. The EPA also has the authority to grant a capacity variance for certain hazardous wastes if sufficient treatment capacity (for a specific treatment technology) does not exist. For any hazardous wastes excavated during a remedial activity, disposal of the wastes must comply with the land disposal restrictions.

The USEPA proposed the "universal treatment standards" on 14 September 1993 (*Federal Register*, pg 48092). This proposed rule includes treatment standards for toxicity characteristic wastes with waste codes D018 through D043 and also proposes alternative treatment standards for soil contaminated with hazardous constituents. Because these rules are proposed, these standards are "to be considered" material.

B.4.3.5 Proposed RCRA Corrective Action (Subpart S)--Technical Standards

The proposed RCRA Corrective Action Rules provide standards for the selection of a remedy for corrective action sites. The remedy must meet the following standards, at a minimum:

- Long-term reliability and effectiveness;
- Reduction of toxicity, mobility, or volume;
- Short-term effectiveness;
- Implementability; and
- Cost.

Because these rules are proposed, they are "to be considered" material.

B.4.3.6 Corrective Action Units--(40 CFR Sections 264.552 and 264.553)

The USEPA has established rules that provide for two types of waste management units: temporary units and corrective action management units.

Temporary Units [40 CFR Section 264.553]--The design, operation, or closure requirements for temporary units (tanks and containers) may be replaced by alternative requirements that are protective of human health and the environment. Temporary units

must meet the following requirements: 1) be located within facility boundaries; 2) be used only for treatment or storage of remediation wastes; and 3) be operated for a period less than one year (unless an extension is granted by the Regional Administrator of the EPA).

Corrective Action Management Units (CAMUs) [40 CFR Section 264.552]-- The USEPA allows the establishment of CAMUs that incorporate soils from one or more contaminated areas. These units can allow waste to be moved or managed within the CAMU without triggering the land disposal restrictions.

B.4.4 New Mexico Solid Waste Management Regulations

The NMED established rules for solid waste disposal in the state of New Mexico. These rules prevent the disposal of solid waste and special waste (industrial nonhazardous waste) in any facility that does not have a permit issued under the New Mexico Solid Waste Management Regulations (NMSWMR). These regulations have specific requirements for solid waste disposal facilities. The NMED issues a permit to each facility that will dispose of solid or special wastes. These permits may restrict a facility from accepting certain types of solid or special wastes. For example, a nonhazardous industrial waste landfill may be prohibited from accepting wastes with pesticides or PCBs because of their permit, although this is not a requirement of the NMSWMR.

B.4.5 Clean Air Act

The Clean Air Act regulates emissions into the air for the purpose of protecting and enhancing the quality of the nation's air resources. The regulations regarding new source performance standards for incinerators and storage of volatile organic compounds may be applicable or relevant and appropriate to remedial actions at a CERCLA site.

The EPA established new source performance standards (NSPS) for certain classes of stationary sources of air pollution. The NSPS limit the emissions of a number of different pollutants. Although NSPS are not generally considered applicable at a CERCLA site, they may be considered relevant and appropriate for a remedial action which involves a technology (e.g. incinerators, storage of volatile organic compounds) which is sufficiently similar to the pollutant and source category regulated by NSPS.

B.4.6 New Mexico Air Quality Standards and Regulations (NMAQSR)

The NMED established rules for air emissions in the State of New Mexico. The standards and regulations prevent the construction or operation of any stationary source which has a potential emission rate greater than 10 pounds per hour or 25 tons per year of any regulated air contaminant without a permit issued by the NMED. Regulated air contaminants include any contaminants for which there is a National or New Mexico Ambient Air Quality Standard or toxic air pollutant listed in NMAQSR.

B.4.7 Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) is applicable for disposal of material contaminated with PCBs at concentrations of 50 ppm or greater. If a spill or a solid waste management unit contains PCB contamination where the source of the PCBs cannot be identified (and consequently, the PCB concentration of the source cannot be identified), the Regional Administrator of the EPA determines whether the cleanup or the excavated materials (if applicable) are regulated under TSCA. For materials which are regulated under TSCA, certain storage, treatment and disposal requirements apply (40 CFR Part 761).

B.4.7.1 Storage Requirements

At a CERCLA site, any materials which are subject to regulation under TSCA may have to be stored in compliance with TSCA storage requirements. TSCA specifies that any PCBs or PCB items (e.g. contaminated soil) must be disposed of within one year after being placed in storage for disposal. The regulations (40 CFR Section 761.65) also specify structural requirements for facilities used for the storage of PCB items, requirements for the containers used to store PCBs, the requirement to prepare and implement a Spill Prevention Control and Countermeasure (SPCC) Plan, and the requirement to check all PCB articles and containers for leaks at least every 30 days, among other requirements.

B.4.7.2 Disposal Requirements

In addition to storage requirements, TSCA specifies certain requirements for the disposal of PCBs and PCB items. Depending on the type of PCB source (e.g. dielectric fluid, mineral oil in electrical equipment), TSCA specifies that the PCBs must be disposed of in a TSCA-approved incinerator, TSCA-approved chemical waste landfill, a high efficiency boiler, or by a TSCA-approved alternative disposal method.

APPENDIX C

SCREENING CALCULATIONS

DESIGN CALCULATIONS--SCREENING

HAZARDOUS WASTE CHARACTERIZATION
LGY 11/12/92

Chemical	Highest Soil Concentration (mg/kg)	Possible TCLP levels (mg/L)[1]	TCLP Standard (mg/L)	Hazardous Waste	Land Banned
Sites 2&5					
Benzene	48	2.4	0.5	Possible	No
Lead	2.3	0.12	5.0	No	N/A
Site 8					
Cadmium	1.8	0.09	1.0	No	N/A
Lead	370	18.5	5.0	Possible	Yes
Mercury	2.2	0.11	0.2	No	N/A
Chlordane	1.18	0.06	0.03	Possible	No
Heptachlor epoxide	0.074	0.004	0.008	No	N/A
Site 14					
Chlordane	34	1.7	0.03	Possible	No
Heptachlor	0.77	0.04	0.008	Possible	No

1 Possible TCLP levels were determined by assuming that there is a dilution factor of at least 20 between total chemical in the soil (mg/kg) and chemical in the leachate (mg/L).

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 2

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB FS JOB NO. _____

SUBJECT VOLUMES + AREAS - SITES 2+5 SHEET 1 OF 1 SHEETS

AREA OF CONTAMINATION = 9200 ft^2 AT MOUNDED AREA

DEPTH = 13 ft + 2 ft OF MOUND = 15 ft

VOLUME = 5100 yd^3 + 50 yd^3 (SB-02+5-24) = 5150 yd^3

FORMER BERMED AREA

80' x 300' = 24,000 ft^2

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 3

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB FS JOB NO. _____

SUBJECT SITES 2 + 5 - BIOSPARGING FLOW RATES SHEET 1 OF 1 SHEETS

VAPOR EXTRACTION RATE

ACCORDING TO "APPLICATION OF BIOREMEDIATION FUNDAMENTALS TO THE DESIGN OF IN-SITU SOIL BIOVENTING SYSTEMS," R. RYAN DUPONT, 85TH ANNUAL MTG + EXHIBITION — AIR + WASTE MANAGEMENT ASSOCIATION, KANSAS CITY, MO, JUNE 21-26, 1992,

VAPOR EXTRACTION OF 0.5 PORE VOLUMES/DAY HAS PROVEN TO BE SUCCESSFUL.

PORE VOLUME = 80' x 300' x 17' x 30% POROSITY = 122,400 ft³

122,400 ft³ x 0.5/DAY x 1 DAY/24 hr x 1 hr/60 min = 42.5 cfm

42.5 cfm ÷ 4 WELLS ≅ 11 cfm/WELL

BIOSPARGING RATE

USE SAME AIR FLOW RATE

42.5 cfm ÷ 12 WELLS ≅ 4 cfm/WELL

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 4

SIGNATURE ROBERT MICHNA DATE 10-13-92 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB FS JOB NO. _____

SUBJECT AREAS, DISTANCES — SITE 8 SHEET 1 OF 1 SHEETS

FENCING

ALTERNATIVES 2 + 3 - 500 FT

ALTERNATIVE 4 - 800 FT

CAPPING AREA

ALTERNATIVE 3 — 13,050 ft^2

ALTERNATIVE 4 — 41,000 ft^2

KADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 5

SIGNATURE ROBERT MICHNA DATE 12/11/92 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB FS JOB NO. _____

SUBJECT AREAS AND DISTANCES - SITE 14 SHEET 1 OF 1 SHEETS

FENCING

(168' x 2) + (78' x 2) = 492' ROUND TO 500 FT

CAPPING

168' x 78' - (25' x 60')BLDG 66 = 11,600 ft²

ROUND TO

12,000 ft²

10-88-30702

COST CALCULATIONS--SCREENING

COST CALCULATIONS--SCREENING
SITES 2&5

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 1

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN FS JOB NO. _____

SUBJECT SITES 2+5 – ALT 1 SHEET 1 OF 1 SHEETS

ALTERNATIVE 1 — NO ACTION

ASSUMPTIONS:

- NO INSTITUTIONAL ACTION
- NO GW MONITORING
- NO CONTAINMENT
- NO EXCAVATION
- NO TREATMENT OR DISPOSAL

CAPITAL = $0

O+M = $0

NET PV = $0

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 2

SIGNATURE Robert Michna DATE 10-13-93 CHECKED _____ DATE _____

PROJECT Holloman AFB JOB NO. _____

SUBJECT Sites 2+5 – Alt 2 SHEET 1 OF 8 SHEETS

ALTERNATIVE 2 – SOURCE CONTAINMENT

ASSUMPTIONS:

- CAP FORMER BERMED AREA WITH CLAY CAP (24,000 sq ft)
- NO GW MONITORING
- EXCAVATE 50 cu yd AROUND SB-02+5-24
- DISPOSE OF SOIL IN OFF-SITE INDUSTRIAL SW LANDFILL

2'-THICK CAP: $1.48/ft² × 24,000 ft² = $35,520

ESTIMATE O+M = 10% OF CAPITAL => $3552

COST SUMMARY

CAPITAL: $53,000

O+M : $ 5300
(P/A, 5%, 30): 15.372
$81,000

NET PV : $134,000

***** VERSION 3.0 DRAFT *****

DATE: 10/11/93
TIME: 14:33:34

CAPITAL COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITES 2&5-SCREEN
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT 2--SOURCE CONTAINMENT

OFFSITE SOLID WASTE LANDFILL	1,500
TRANSPORTATION TO OFFSITE SOLID WASTE LANDFILL	2,000
USER-SUPPLIED COSTS	39,000
SUBTOTAL	43,000

SITE COSTS

SITE PREPARATION	0
SITE ADMINISTRATION	0

GENERAL CONDITIONS

START-UP COSTS	0
CONSTRUCTION SUBTOTAL	43,000
BID CONTINGENCIES	8,600
SCOPE CONTINGENCIES	1,400
CONSTRUCTION TOTAL	53,000
PERMITTING AND LEGAL COSTS	70
SERVICES DURING CONSTRUCTION	70
TOTAL CAPITAL SITES 2&5-SCREEN	53,000
TOTAL SITE CAPITAL COST	53,000

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 10/11/93
TIME: 14:33:35

OPERATION AND MAINTENANCE COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITES 2&5-SCREEN
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT 2--SOURCE CONTAINMENT

OFFSITE SOLID WASTE LANDFILL	0
TRANSPORTATION TO OFFSITE SOLID WASTE LANDFILL	0
USER-SUPPLIED COSTS	3,600
SUBTOTAL	3,600

SITE COSTS

SITE PREPARATION	0

GENERAL CONDITIONS

INSURANCE AND PERMIT RENEWAL	540
SUBTOTAL	4,100

INDIRECT COSTS

ADMINISTRATION	620
CONTINGENCIES	620
TOTAL O & M SITES 2&5-SCREEN	5,300
TOTAL SITE O & M COST	5,300

OPERATION AND MAINTENANCE COST DEVELOPMENT -- PAGE 2 DATE: 10/11/93
S NAME: HOLLOMAN 29 SITES REGION: 06 TIME: 14:33:36

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 10/11/93
TIME: 14:24:26

CORA USER-SUPPLIED COSTS COST MODULE (505)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITES 2&5-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT 2--SOURCE CONTAINMENT
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
EXCAVATION OF 50 CY		CAPITAL COST	2,500
Capital cost	2500	O & M COSTS	0
O & M cost	0		
Percentage of labor	0		
Percentage of contingency	30		
Average temp (degrees F)	70		
Protection level	C		

NOTES:

2' CLAY CAP AND EXCAVATION OF 50 CY OF SOIL

***** VERSION 3.0 DRAFT *****

DATE: 10/05/93
TIME: 12:16:18

CORA OFFSITE SOLID WASTE LANDFILL COST MODULE (404)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITES 2&5-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT 2--SOURCE CONTAINMENT
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Waste volume (CY)	58	SOLID WASTE LANDFILL	
Miles to landfill	90	CAPITAL COST	1,500
Landfill cost per CY	25.00	O & M COSTS	0
Confidence level	M		
Demurrage time/load (hrs)	2	TRANSPORTATION	
Capital or O&M landfill cost?	C	CAPITAL COST	2,000
		O & M COSTS	0
Capital or O&M transport cost?	C		

*** Landfill costs are generally assessed in tons. CORA assumes a material density of 90 lb/cubic foot.

***** VERSION 3.0 DRAFT *****

DATE: 10/11/93
TIME: 14:24:26

CORA USER-SUPPLIED COSTS COST MODULE (505)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITES 2&5-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT 2--SOURCE CONTAINMENT
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
CLAY CAP		CAPITAL COST	36,000
Capital cost	35520	O & M COSTS	3,600
O & M cost	3600		
Percentage of labor	0		
Percentage of contingency	0		
Average temp (degrees F)	70		
Protection level	D		

NOTES:

2' CLAY CAP AND EXCAVATION OF 50 CY OF SOIL

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 3

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT [illegible] FS JOB NO. _____

SUBJECT SITES 2+5 - ALT 3 SHEET 1 OF 12 SHEETS

ALTERNATIVE 3 — SOIL VAPOR EXTRACTION

ASSUMPTIONS

- 4 EXTRACTION WELLS
- DIAMETER OF INFLUENCE = 75 ft/WELL
- DEPTH = 13 FT, SCREENED 8-12 ft
- FLOW RATE = 10 TO 20 CFM/WELL

- EXCAVATE 50 yd^3 AT SB-02+5-24
- DISPOSE OF SOIL IN OFF-SITE INDUSTRIAL S/W LANDFILL

- INSTALL 2 GW MONITORING WELLS
- MONITOR ANNUALLY FOR 3 YEARS
- ANALYZE FOR TPH AND BENZENE

COST SUMMARY

CAPITAL = $290,000

O+M = $ 82,000
(P/A, 5%, 3) 2.7232
$223,000

NET PV = $ 513,000

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 3

SIGNATURE Robert Michna DATE 10-13-93 CHECKED _____ DATE _____

PROJECT Holloman AFB-FS JOB NO. _____

SUBJECT Sites 2 & 5 - Alts 3 & 4 - Volatiles SHEET 2 OF 12 SHEETS

5150 yd^3 soil x 1.25 tons/bulk yd^3 x 1.15 bulking factor

= 7403 tons x 229.5 mg/kg BTEX = 1.7 tons volatiles

(Note: Assume all volatiles are BTEX)

1.7 tons x 2000 lbs/ton = 3400 lbs volatiles

Use Ventsorb canisters (carbon) at 200 lbs carbon each

BTEX loading on carbon ≅ 30%

3400 lbs volatiles x $\frac{1 \text{ lb carbon}}{0.3 \text{ lb volatiles}}$ = 11,300 lbs carbon

⇒ 57 Ventsorb canisters

Ventsorb unit cost = $636 ÷ 200 lbs = $3.18/lb

Regeneration/freight = $0.65/lb

Total carbon cost = $3.83/lb

11,300 lbs x $3.83/lb = $43,280

O&M Costs

3-yrs treatment = $14,430/yr

5-yrs treatment = $8,660/yr

17-01	0	206	28	633	867
17-02	260	8600	2320	15900	27080
18-01	39	5420	378	21500	27337
18-02	194	6010	1350	21600	29154
19-01	0	3440	0	86000	89440
19-02	1060	87000	41900	332000	461960
19-03	498	49200	15400	126000	191098
20-01	0	2770	2280	134000	139050
20-02	323	74500	131000	242000	447823
21-01	3950	135000	78800	500000	717750
21-02	1620	81100	42300	208000	333020
21-03	146	8070	1860	279000	289076

avg. 229471.25

***** VERSION 3.0 DRAFT *****

DATE: 10/11/93
TIME: 14:33:54

CAPITAL COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITES 2&5-SCREEN
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT ~~4~~ 3--SOIL VAPOR EXTRACT

SOIL VAPOR EXTRACTION	130,000
GROUNDWATER MONITORING	13,000
OFFSITE SOLID WASTE LANDFILL	1,500
TRANSPORTATION TO OFFSITE SOLID WASTE LANDFILL	2,000
USER-SUPPLIED COSTS	12,000
SUBTOTAL	160,000

SITE COSTS

SITE PREPARATION	0
SITE ADMINISTRATION	7,300

GENERAL CONDITIONS

START-UP COSTS	6,500
CONSTRUCTION SUBTOTAL	180,000
BID CONTINGENCIES	36,000
SCOPE CONTINGENCIES	55,000
CONSTRUCTION TOTAL	270,000
PERMITTING AND LEGAL COSTS	7,200
SERVICES DURING CONSTRUCTION	10,000
TOTAL CAPITAL SITES 2&5-SCREEN	290,000

CAPITAL COST DEVELOPMENT -- PAGE 2 DATE: 10/11/93
S : NAME: HOLLOMAN 29 SITES REGION: 06 TIME: 14:33:55

TOTAL SITE CAPITAL COST	290,000

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 10/11/93
TIME: 14:33:55

OPERATION AND MAINTENANCE COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITES 2&5-SCREEN
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT 3 4--SOIL VAPOR EXTRACT

SOIL VAPOR EXTRACTION	34,000
GROUNDWATER MONITORING	6,100
OFFSITE SOLID WASTE LANDFILL	0
TRANSPORTATION TO OFFSITE SOLID WASTE LANDFILL	0
USER-SUPPLIED COSTS	15,000
SUBTOTAL	55,000

SITE COSTS

SITE PREPARATION	0

GENERAL CONDITIONS

INSURANCE AND PERMIT RENEWAL	8,300
SUBTOTAL	63,000

INDIRECT COSTS

ADMINISTRATION	9,500
CONTINGENCIES	9,500
TOTAL O & M SITES 2&5-SCREEN	82,000
TOTAL SITE O & M COST	82,000

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 10/05/93
TIME: 16:57:30

CORA SOIL VAPOR EXTRACTION COST MODULE (305)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITES 2&5-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT 4--SOIL VAPOR EXTRACT
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
Soil: Mixed sandy, silty, clayey	
Site area (square ft)	24000
Well spacing (ft)	75
Average length of well screen per well (ft)	3
Well depth (ft)	18
Vapor flow per well per length of well screen	4
VOCs on site (lbs)	0.00
Protection level for well drilling & installation	D
Protection level for above grade construction	C
Average temp (degrees F)	70
Confidence level	L

RESULTS

Component	Total
CAPITAL COST	130,000
O & M COSTS	34,000
TOTAL VAPOR FLOW (CFM)	48
NUMBER OF WELLS	4
VOCs (LBS/DAY)	0.00
BYPRODUCTS FOR TRANSPORT/DISPOSAL:	
WELL CUTTINGS (CY)	3
(SWELL FACTOR = 1.25)	

***** VERSION 3.0 DRAFT *****

DATE: 09/11/93
TIME: 17:12:30

CORA GROUNDWATER MONITORING COST MODULE (503)

SITE NAME: HOLLOMAN29
OPERABLE UNIT: SITES 2&5-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT 34--SOIL VAPOR EXTRACT
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
Number of wells to install	2
Average well depth (ft)	17
Protection during setup of drill rig & installation of above-grade piping	D
Protection during drilling	C
Average temp (degrees F)	70
Confidence level	M
Number of wells to monitor	4
Monitoring frequency	1
Monitoring requirements:	
Plasma Metals	N
st/PCB	N
GC-BN	N
GC-Acid	N
HSLORG	N
VOA GC/MS	Y
Acid GC/MS	N
B/N GC/MS	N

RESULTS

Component	Total
CAPITAL COST	13,000
O & M COSTS	6,100

***** VERSION 3.0 DRAFT *****

DATE: 10/11/93
TIME: 14:31:51

CORA USER-SUPPLIED COSTS COST MODULE (505)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITES 2&5-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT 4--SOIL VAPOR EXTRACT
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
EXCAVATION AND VGAC		CAPITAL COST	2,500
Capital cost	2500	O & M COSTS	14,000
O & M cost	14000		
Percentage of labor	0		
Percentage of contingency	30		
Average temp (degrees F)	70		
Protection level	C		

NOTES:

6" CLAY CAP, VGAC, AND EXCAVATION OF 50 CY OF SOIL

***** VERSION 3.0 DRAFT *****

DATE: 10/05/93
TIME: 12:28:12

CORA OFFSITE SOLID WASTE LANDFILL COST MODULE (404)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITES 2&5-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT 4--SOIL VAPOR EXTRACT
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Waste volume (CY)	58	SOLID WASTE LANDFILL	
Miles to landfill	90	CAPITAL COST	1,500
Landfill cost per CY	25.00	O & M COSTS	0
Confidence level	M		
Demurrage time/load (hrs)	2	TRANSPORTATION	
Capital or O&M landfill cost?	C	CAPITAL COST	2,000
		O & M COSTS	0
Capital or O&M transport cost?	C		

* Landfill costs are generally assessed in tons. CORA assumes a material density of 90 lb/cubic foot.

***** VERSION 3.0 DRAFT *****

DATE: 10/11/93
TIME: 14:31:50

CORA USER-SUPPLIED COSTS COST MODULE (505)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITES 2&5-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT 4--SOIL VAPOR EXTRACT
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
6"-CLAY CAP		CAPITAL COST	9,600
Capital cost	9600	O & M COSTS	960
O & M cost	960		
Percentage of labor	0		
Percentage of contingency	0		
Average temp (degrees F)	70		
Protection level	D		

NOTES:

6" CLAY CAP, VGAC, AND EXCAVATION OF 50 CY OF SOIL

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 4

GNATURE Robert Michael DATE 10-13-93 CHECKED _____ DATE _____

PROJECT Holloman AFB JOB NO. _____

SUBJECT Sites 2+5 - Alt 4 SHEET 1 OF 15 SHEETS

ALTERNATIVE 4 - BIOSPARGING/SVE

ASSUMPTIONS:

BIOSPARGING

- 12 AIR INJECTION WELLS
- DEPTH = 27 ft, SCREENED 24 TO 27 ft
- FLOW ≅ 4 cfm/well
- WELL SPACING = 50 ft

NOTE: THE CORA MODEL DOES NOT HAVE A BIOSPARGING COST MODULE. THEREFORE, THE SVE COST MODULE WAS USED TO APPROXIMATE COSTS FOR THE BIOSPARGING SYSTEM.

SVE

- 4 EXTRACTION WELLS
- DIAMETER OF INFLUENCE = 75 ft
- CONTAMINATED AREA = 9200 ft^2
- DEPTH OF WELL = 13 ft, SCREENED 8-12 ft
- FLOW = 10 TO 20 CFM/WELL

G W MONITORING

- INSTALL 2 WELLS
- MONITOR ANNUALLY FOR 3 YEARS
- ANALYZE FOR TPH AND BENZENE

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 4

SIGNATURE Robert Michna DATE 10-13-93 CHECKED _____ DATE _____

PROJECT Hollomon AFS-FS JOB NO. _____

SUBJECT Sites 2+5-Alts 3+4-Volatiles SHEET 2 OF 15 SHEETS

5150 yd^3 soil x 1.25 tons/bulk yd^3 x 1.15 bulking factor

= 7403 tons x 229.5 mg/kg BTEX = 1.7 tons volatiles

(Note: Assume all volatiles are BTEX)

1.7 tons x 2000 lbs/ton = 3400 lbs volatiles

Use Ventsorb canisters (Calgon) at 200 lbs carbon each

BTEX loading on carbon ≅ 30%

3400 lbs volatiles x $\frac{1 \text{ lb carbon}}{0.3 \text{ lb volatiles}}$ = 11,300 lbs carbon

⇒ 57 Ventsorb canisters

Ventsorb unit cost = $636 ÷ 200 lbs = $3.18/lb

Regeneration/freight = $0.65/lb

Total carbon cost = $3.83/lb

11,300 lbs x $3.83/lb = $43,280

O+M Costs

3-yrs treatment = $14,430/yr

5-yrs treatment = $8,660/yr

Lim	B	T	E	X	Total BTEX
17-01	0	206	28	633	867
[illegible]2	260	8600	2320	15900	27080
[illegible]-01	39	5420	378	21500	27337
18-02	194	6010	1350	21600	29154
19-01	0	3440	0	86000	89440
19-02	1060	87000	41900	332000	461960
19-03	498	49200	15400	126000	191098
20-01	0	2770	2280	134000	139050
20-02	323	74500	131000	242000	447823
21-01	3950	135000	78800	500000	717750
21-02	1620	81100	42300	208000	333020
21-03	146	8070	1860	279000	289076

avg. 229471.25

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 4

SIGNATURE Robert Michna DATE 10-13-93 CHECKED _____ DATE _____

PROJECT Holloman AFB FS JOB NO. _____

SUBJECT Sites 2+5 Alt 4 SHEET 4 OF 15 SHEETS

Cost Summary

CAPITAL: $500,000

O+M: $130,000
(P/A, 5%, 3) 2.723
$354,000

NET PV: $854,000

***** VERSION 3.0 DRAFT *****

DATE: 10/05/93
TIME: 16:51:10

CORA SOIL VAPOR EXTRACTION COST MODULE (305)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITES 2&5-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT 3--IN SITU BIOSPARG.
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
Soil: Mixed sandy, silty, clayey	
Site area (square ft)	24000
Well spacing (ft)	50
Average length of well screen per well (ft)	4
Well depth (ft)	31
Vapor flow per well per length of well screen	1
VOCs on site (lbs)	0.00
Protection level for well drilling & installation	C
Protection level for above grade construction	D
Average temp (degrees F)	70
Confidence level	L

RESULTS

Component	Total
CAPITAL COST	170,000
O & M COSTS	34,000
TOTAL VAPOR FLOW (CFM)	36
NUMBER OF WELLS	9
VOCs (LBS/DAY)	0.00
BYPRODUCTS FOR TRANSPORT/DISPOSAL:	
WELL CUTTINGS (CY)	10
(SWELL FACTOR = 1.25)	

NOTES:

Biosparging Estimate

***** VERSION 3.0 DRAFT *****

DATE: 10/11/93
TIME: 14:33:43

CAPITAL COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITES 2&5-SCREEN
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT 3--IN SITU BIOSPARG.

SOIL VAPOR EXTRACTION	130,000
GROUNDWATER MONITORING	13,000
USER-SUPPLIED COSTS	180,000
OFFSITE SOLID WASTE LANDFILL	1,500
TRANSPORTATION TO OFFSITE SOLID WASTE LANDFILL	2,000
SUBTOTAL	330,000

SITE COSTS

SITE PREPARATION	0
SITE ADMINISTRATION	7,300

GENERAL CONDITIONS

START-UP COSTS	6,500
CONSTRUCTION SUBTOTAL	350,000
BID CONTINGENCIES	70,000
SCOPE CONTINGENCIES	58,000
CONSTRUCTION TOTAL	480,000
PERMITTING AND LEGAL COSTS	7,200
SERVICES DURING CONSTRUCTION	10,000
TOTAL CAPITAL SITES 2&5-SCREEN	500,000

CAPITAL COST DEVELOPMENT -- PAGE 2 DATE: 10/11/93
E NAME: HOLLOMAN 29 SITES REGION: 06 TIME: 14:33:44

TOTAL SITE CAPITAL COST	500,000

NOTES

*** All costs are rounded to two significant figures.

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***** VERSION 3.0 DRAFT *****

DATE: 10/11/93
TIME: 14:33:45

OPERATION AND MAINTENANCE COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITES 2&5-SCREEN
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT 3--IN SITU BIOSPARG.

SOIL VAPOR EXTRACTION	34,000
GROUNDWATER MONITORING	6,100
USER-SUPPLIED COSTS	49,000
OFFSITE SOLID WASTE LANDFILL	0
TRANSPORTATION TO OFFSITE SOLID WASTE LANDFILL	0
SUBTOTAL	89,000

SITE COSTS

SITE PREPARATION	0

GENERAL CONDITIONS

INSURANCE AND PERMIT RENEWAL	13,000
SUBTOTAL	100,000

INDIRECT COSTS

ADMINISTRATION	15,000
CONTINGENCIES	15,000
TOTAL O & M SITES 2&5-SCREEN	130,000
TOTAL SITE O & M COST	130,000

NOTES

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***** VERSION 3.0 DRAFT *****

DATE: 10/05/93
TIME: 16:40:49

CORA SOIL VAPOR EXTRACTION COST MODULE (305)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITES 2&5-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT4B--IN SITU BIOSPARG.
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
Soil: Mixed sandy, silty, clayey	
Site area (square ft)	24000
Well spacing (ft)	75
Average length of well screen per well (ft)	3
Well depth (ft)	18
Vapor flow per well per length of well screen	4
VOCs on site (lbs)	0.00
Protection level for well drilling & installation	D
Protection level for above grade construction	C
Average temp (degrees F)	70
Confidence level	L

RESULTS

Component	Total
CAPITAL COST	130,000
O & M COSTS	34,000
TOTAL VAPOR FLOW (CFM)	48
NUMBER OF WELLS	4
VOCs (LBS/DAY)	0.00
BYPRODUCTS FOR TRANSPORT/DISPOSAL:	
WELL CUTTINGS (CY)	3
(SWELL FACTOR = 1.25)	

***** VERSION 3.0 DRAFT *****

DATE: 09/11/93
TIME: 17:08:11

CORA GROUNDWATER MONITORING COST MODULE (503)

SITE NAME: HOLLOMAN29
OPERABLE UNIT: SITES 2&5-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT 4--IN SITU BIOSPARG.
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
Number of wells to install	2
Average well depth (ft)	17
Protection during setup of drill rig & installation of above-grade piping	D
Protection during drilling	C
Average temp (degrees F)	70
Confidence level	M
Number of wells to monitor	4
Monitoring frequency	1
Monitoring requirements:	
Plasma Metals	N
Pest/PCB	N
GC-BN	N
GC-Acid	N
HSLORG	N
VOA GC/MS	Y
Acid GC/MS	N
B/N GC/MS	N

RESULTS

Component	Total
CAPITAL COST	13,000
O & M COSTS	6,100

***** VERSION 3.0 DRAFT *****

DATE: 10/11/93
TIME: 14:29:41

CORA USER-SUPPLIED COSTS COST MODULE (505)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITES 2&5-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT 3--IN SITU BIOSPARG.
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
BIOSPARGING & VGAC		CAPITAL COST	170,000
Capital cost	170000	O & M COSTS	48,000
O & M cost	48000		
Percentage of labor	0		
Percentage of contingency	0		
Average temp (degrees F)	70		
Protection level	D		

NOTES:

BIOSPARGING, VGAC, 6" CLAY CAP, AND EXCAVATION OF 50 CY OF SOIL

***** VERSION 3.0 DRAFT *****

DATE: 10/11/93
TIME: 14:29:41

CORA USER-SUPPLIED COSTS COST MODULE (505)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITES 2&5-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT 3--IN SITU BIOSPARG.
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
6" CLAY CAP		CAPITAL COST	9,600
Capital cost	9600	O & M COSTS	960
O & M cost	960		
Percentage of labor	0		
Percentage of contingency	30		
Average temp (degrees F)	70		
Protection level	D		

NOTES:

BIOSPARGING, VGAC, 6" CLAY CAP, AND EXCAVATION OF 50 CY OF SOIL

***** VERSION 3.0 DRAFT *****

DATE: 10/11/93
TIME: 14:29:42

CORA USER-SUPPLIED COSTS COST MODULE (505)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITES 2&5-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT 3--IN SITU BIOSPARG.
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
EXCAVATION OF 50 CY		CAPITAL COST	2,500
Capital cost	2500	O & M COSTS	0
O & M cost	0		
Percentage of labor	0		
Percentage of contingency	30		
Average temp (degrees F)	70		
Protection level	C		

NOTES:

BIOSPARGING, VGAC, 6" CLAY CAP, AND EXCAVATION OF 50 CY OF SOIL

***** VERSION 3.0 DRAFT *****

DATE: 10/05/93
TIME: 12:17:30

CORA OFFSITE SOLID WASTE LANDFILL COST MODULE (404)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITES 2&5-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT 3--IN SITU BIOSPARG.
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
Waste volume (CY)	58
Miles to landfill	90
Landfill cost per CY	25.00
Confidence level	M
Demurrage time/load (hrs)	2
Capital or O&M landfill cost?	C
Capital or O&M transport cost?	C

RESULTS

Component	Total
SOLID WASTE LANDFILL	
CAPITAL COST	1,500
O & M COSTS	0
TRANSPORTATION	
CAPITAL COST	2,000
O & M COSTS	0

** Landfill costs are generally assessed in tons. CORA assumes a material density of 90 lb/cubic foot.

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 5

SIGNATURE Robert Michna DATE 10-13-93 CHECKED _____ DATE _____

PROJECT Holloman AFB FS JOB NO. _____

SUBJECT Sites 2+5 — Alt 5 SHEET 1 OF 10 SHEETS

ALTERNATIVE No. 5 — On-Site Treatment

ASSUMPTIONS

- Mobile Thermal Screw Treatment Unit
- Use Costs from "Thermal Desorption Guidance Document for Treating Petroleum-Contaminated Soils" Troxler, et al.

5150 yd^3 (in place)

1.25 ton/yd^3 (excavated)

Remediation Time = 1 year

Soil Mass = 5150 yd^3 × 1.15 Bulking Factor × 1.25 ton/yd^3

= 7403 tons

Unit Costs include fixed + operating costs:

- Fuel
- Labor
- Utilities
- Analytical
- Capital Depreciation
- Travel
- Transportation
- Rental

Use 30% moisture cutoff: ≅ $70/ton

7403 tons × $70/ton = $518,000

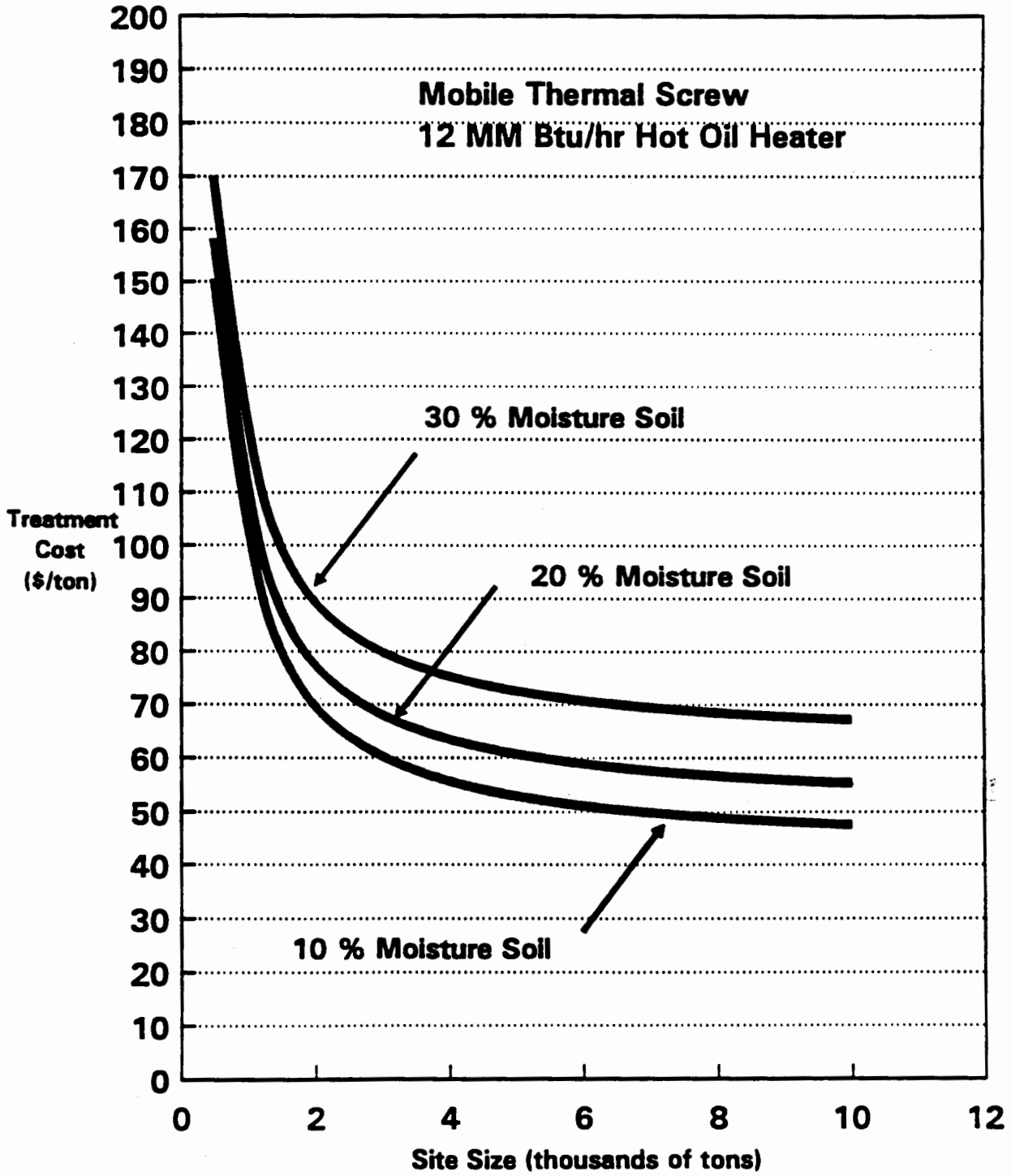

Figure 5-3. Mobile Thermal Screw Treatment Costs
(From "THERMAL DESORPTION GUIDANCE DOCUMENT FOR TREATING PETROLEUM CONTAMINATED SOILS" USEPA, 1992)

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 5

SIGNATURE Robert Michna DATE 10-13-93 CHECKED _____ DATE _____

PROJECT Holloman AFB FS JOB NO. _____

SUBJECT Site 245 — Alt 5 SHEET 3 OF 10 SHEETS

ALT 5 — ON-SITE TREATMENT

OFF-SITE DISPOSAL OF TREATED SOIL

$9 TO $25/yd³

AVG = $17/yd³

COST SUMMARY

CAPITAL:	$1,800,000
O+M:	0
NET PV:	$1,800,000

***** VERSION 3.0 DRAFT *****

DATE: 10/05/93
TIME: 12:40:00

CAPITAL COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITES 2&5-SCREEN
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT 5--ON-SITE TREATMENT

SOIL EXCAVATION	570,000
USER-SUPPLIED COSTS	520,000
SUBTOTAL	1,100,000

SITE COSTS

SITE PREPARATION	0
SITE ADMINISTRATION	4,800

GENERAL CONDITIONS

START-UP COSTS	0
CONSTRUCTION SUBTOTAL	1,100,000
BID CONTINGENCIES	220,000
SCOPE CONTINGENCIES	410,000
CONSTRUCTION TOTAL	1,700,000
PERMITTING AND LEGAL COSTS	29,000
SERVICES DURING CONSTRUCTION	40,000
TOTAL CAPITAL SITES 2&5-SCREEN	1,800,000
TOTAL SITE CAPITAL COST	1,800,000

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 10/05/93
TIME: 12:40:01

OPERATION AND MAINTENANCE COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITES 2&5-SCREEN
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT 5--ON-SITE TREATMENT

SOIL EXCAVATION	0
USER-SUPPLIED COSTS	0
SUBTOTAL	0

SITE COSTS

SITE PREPARATION	0

GENERAL CONDITIONS

INSURANCE AND PERMIT RENEWAL	0
SUBTOTAL	0

INDIRECT COSTS

ADMINISTRATION	0
CONTINGENCIES	0
TOTAL O & M SITES 2&5-SCREEN	0
TOTAL SITE O & M COST	0

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 10/05/93
TIME: 12:34:35

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITES 2&5-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT 5--ON-SITE TREATMENT
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
SITES 2&5	
Soil type	1
Depth of excavation (ft)	17
1. Steel sheeting or	
2. side slope?	1
Horizontal component	0
Length of excavation (ft)	309
Width of excavation (ft)	30
Depth of cover above contaminated materials (ft)	2
Depth of contaminated excav. w/o continuous sampling (ft)	0
Depth of contaminated excav. w/continuous sampling (ft)	15
Thickness of lifts (inches)	24
Number of drums	0
Pct. of contaminated zone	0
Base air monitoring required?	N
Pct. of backfill available onsite	100

RESULTS

Component	Total
BYPRODUCTS FOR TRANSPORT/DISPOSAL:	
DRUMS	0
CONTAMINATED SOIL (CY) (SWELL FACTOR=1.15)	5,923

***** VERSION 3.0 DRAFT *****

DATE: 10/05/93
TIME: 12:34:36

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITES 2&5-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT 5--ON-SITE TREATMENT
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Protection level for:		COST FOR ALL EXCAVATIONS	
Uncontaminated materials	D		
Contaminated materials	C	CAPITAL COST	570,000
Temperature (degrees F)	70	O & M COSTS	0
Confidence level	M		

*** Excavation depth cannot exceed 25 feet. For excavations deeper than 25 feet, complex site-specific sheeting, bracing, dewatering, terracing and haul roads may be required. Excavation for depths deeper than 25 feet should be scoped and costed on a site-specific basis.

***** VERSION 3.0 DRAFT *****

DATE: 10/05/93
TIME: 12:37:30

CORA USER-SUPPLIED COSTS COST MODULE (505)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITES 2&5-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT 5--ON-SITE TREATMENT
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
ON SITE THERMAL		CAPITAL COST	520,000
Capital cost	518000	O & M COSTS	0
O & M cost	0		
Percentage of labor	0		
Percentage of contingency	30		
Average temp (degrees F)	70		
Protection level	C		

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 6

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB ES JOB NO. _____

SUBJECT SITES 2+5 ALT 6 SHEET 1 OF 8 SHEETS

ALTERNATIVE 6 — OFF-SITE DISPOSAL

ASSUMPTIONS

- EXCAVATE WITH BACKHOE
- 5150 yd^3 (IN PLACE)
- 1.25 TON/yd^3 (EXCAVATED)
- 7403 TONS

INDUSTRIAL SW LANDFILL

- NU-MEX LANDFILL, SUNLAND PARK, NM
- \$9 TO \$25 / yd^3
- DISTANCE = 90 MILES

COST SUMMARY

CAPITAL: \$1,500,000

O+M : 0

NET PV : \$1,500,000

***** VERSION 3.0 DRAFT *****

DATE: 10/05/93
TIME: 12:40:13

CAPITAL COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITES 2&5-SCREEN
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT 7A--OFF-SITE DISP-NHZ

SOIL EXCAVATION	570,000
OFFSITE SOLID WASTE LANDFILL	150,000
TRANSPORTATION TO OFFSITE SOLID WASTE LANDFILL	180,000
SUBTOTAL	900,000

SITE COSTS

SITE PREPARATION	0
SITE ADMINISTRATION	4,800

GENERAL CONDITIONS

START-UP COSTS	0
CONSTRUCTION SUBTOTAL	900,000
BID CONTINGENCIES	180,000
SCOPE CONTINGENCIES	290,000
CONSTRUCTION TOTAL	1,400,000
PERMITTING AND LEGAL COSTS	36,000
SERVICES DURING CONSTRUCTION	47,000
TOTAL CAPITAL SITES 2&5-SCREEN	1,500,000
TOTAL SITE CAPITAL COST	1,500,000

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 10/05/93
TIME: 12:40:14

OPERATION AND MAINTENANCE COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITES 2&5-SCREEN
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT ~~7A~~ 6--OFF-SITE DISP-NHZ

SOIL EXCAVATION	0
OFFSITE SOLID WASTE LANDFILL	0
TRANSPORTATION TO OFFSITE SOLID WASTE LANDFILL	0
SUBTOTAL	0

SITE COSTS

SITE PREPARATION	0

GENERAL CONDITIONS

INSURANCE AND PERMIT RENEWAL	0
SUBTOTAL	0

INDIRECT COSTS

ADMINISTRATION	0
CONTINGENCIES	0
TOTAL O & M SITES 2&5-SCREEN	0
TOTAL SITE O & M COST	0

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 10/05/93
TIME: 12:38:38

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITES 2&5-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT6~~7A~~--OFF-SITE DISP-NHZ
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
SITES 2&5	
Soil type	1
Depth of excavation (ft)	17
1. Steel sheeting or	
2. side slope?	1
Horizontal component	0
Length of excavation (ft)	309
Width of excavation (ft)	30
Depth of cover above contaminated materials (ft)	2
Depth of contaminated excav. w/o continuous sampling (ft)	0
Depth of contaminated excav. w/continuous sampling (ft)	15
Thickness of lifts (inches)	24
Number of drums	0
Pct. of contaminated zone	0
Base air monitoring required?	N
Pct. of backfill available onsite	100

RESULTS

Component	Total
BYPRODUCTS FOR TRANSPORT/DISPOSAL:	
DRUMS	0
CONTAMINATED SOIL (CY) (SWELL FACTOR=1.15)	5,923

***** VERSION 3.0 DRAFT *****

DATE: 10/05/93
TIME: 12:38:39

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITES 2&5-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT6~~7A~~--OFF-SITE DISP-NHZ
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Protection level for:		COST FOR ALL EXCAVATIONS	
Uncontaminated materials	D		
Contaminated materials	C	CAPITAL COST	570,000
Temperature (degrees F)	70	O & M COSTS	0
Confidence level	M		

*** Excavation depth cannot exceed 25 feet. For excavations deeper than 25 feet, complex site-specific sheeting, bracing, dewatering, terracing and haul roads may be required. Excavation for depths deeper than 25 feet should be scoped and costed on a site-specific basis.

***** VERSION 3.0 DRAFT *****

DATE: 10/05/93
TIME: 12:39:10

CORA OFFSITE SOLID WASTE LANDFILL COST MODULE (404)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITES 2&5-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT6a--OFF-SITE DISP-NHZ
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Waste volume (CY)	5923	SOLID WASTE LANDFILL	
Miles to landfill	90	CAPITAL COST	150,000
Landfill cost per CY	25.00	O & M COSTS	0
Confidence level	M		
Demurrage time/load (hrs)	2	TRANSPORTATION	
Capital or O&M landfill cost?	C	CAPITAL COST	180,000
		O & M COSTS	0
Capital or O&M transport cost?	C		

*** Landfill costs are generally assessed in tons. CORA assumes a material density of 90 lb/cubic foot.

COST CALCULATIONS--SCREENING

SITE 8

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 1

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB - FS JOB NO. _____

SUBJECT SITE 8 - ALT 1 SHEET 1 OF 1 SHEETS

ALTERNATIVE NO. 1 — NO ACTION

ASSUMPTIONS

- NO INSTITUTIONAL ACTION
- NO GW MONITORING
- NO CONTAINMENT
- NO EXCAVATION
- NO TREATMENT / DISPOSAL

COST SUMMARY

CAPITAL = $0

O + M = $0

NET PV = $0

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 2

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB FS JOB NO. _____

SUBJECT SITE 8 - ALT 2 SHEET 1 OF 6 SHEETS

ALTERNATIVE NO. 2 — LIMITED ACTION (FENCING)

ASSUMPTIONS

- LAND USE RESTRICTIONS
- SITE ACCESS RESTRICTIONS
- NO GW MONITORING

COST SUMMARY

CAPITAL = $16,000

O+M = $0

NET PV = $16,000

***** VERSION 3.0 DRAFT *****

DATE: 09/14/93
TIME: 18:57:53

CAPITAL COST DEVELOPMENT

SITE NAME: HOLLOMAN29 REGION: 06

OPERABLE UNIT: SITE 8-SCREEN
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT-2 LIMITED ACTION FENC

SITE ACCESS RESTRICTIONS	11,000
SUBTOTAL	11,000

SITE COSTS

SITE PREPARATION	0
SITE ADMINISTRATION	0

GENERAL CONDITIONS

START-UP COSTS	0
CONSTRUCTION SUBTOTAL	11,000
BID CONTINGENCIES	2,200
SCOPE CONTINGENCIES	1,500
CONSTRUCTION TOTAL	15,000
PERMITTING AND LEGAL COSTS	550
SERVICES DURING CONSTRUCTION	770
TOTAL CAPITAL SITE 8-SCREEN	16,000
TOTAL SITE CAPITAL COST	16,000

CAPITAL COST DEVELOPMENT -- PAGE 2 DATE: 09/14/93
S NAME: HOLLOMAN29 REGION: 06 TIME: 18:57:54

NOTES

*** All costs are rounded to two significant figures.

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***** VERSION 3.0 DRAFT *****

DATE: 09/14/93
TIME: 18:57:54

OPERATION AND MAINTENANCE COST DEVELOPMENT

SITE NAME: HOLLOMAN29 REGION: 06

OPERABLE UNIT: SITE 8-SCREEN
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT-2 LIMITED ACTION FENC

SITE ACCESS RESTRICTIONS	0
SUBTOTAL	0

SITE COSTS

SITE PREPARATION	0

GENERAL CONDITIONS

INSURANCE AND PERMIT RENEWAL	0
SUBTOTAL	0

INDIRECT COSTS

ADMINISTRATION	0
CONTINGENCIES	0
TOTAL O & M SITE 8-SCREEN	0
TOTAL SITE O & M COST	0

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 09/15/93
TIME: 14:56:19

CORA SITE ACCESS RESTRICTIONS COST MODULE (504)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITE 8-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT-2 LIMITED ACTION FENC
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
Site perimeter (ft)	500
Permanent fence required?	Y
Temporary fence required?	N
Lighting required?	N
Security guard required?	N
Access points req. guard	0
Guards per access point	0
Number of shifts	0
Temporary guardhouses	0
Vehicles required	0
Confidence level	M

RESULTS

Component	Total
CAPITAL COST	11,000
O & M COSTS	0

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 3

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB FS JOB NO. _____

SUBJECT SITE 8 – ALT 3 SHEET 1 OF 7 SHEETS

ALTERNATIVE NO. 3 — LIMITED ACTION (CAPPING)

ASSUMPTIONS

- CAP WORKING AREA
- SITE ACCESS RESTRICTIONS
- NO GW MONITORING
- 500 FT FENCING
- AREA TO BE CAPPED = 13,050 ft^2 × $\frac{1 \text{ ACRE}}{43,560 \, ft^2}$ = 0.3 ACRES
- 4" ASPHALT CAP WITH 6" COMPACTED SOIL BASE

COST SUMMARY

CAPITAL COST = $110,000

O+M COST = $ 6700 (COST FOR 1 SITE VISIT/YR = CORA COST ÷ 3)
(P/A, 5%, 30) = 15.372
PV O+M = $102,000

NET PV = $212,000

2 of 7

***** VERSION 3.0 DRAFT *****

DATE: 09/11/93
TIME: 17:56:21

CAPITAL COST DEVELOPMENT

SITE NAME: HOLLOMAN29 REGION: 06

OPERABLE UNIT: SITE 8-SCREEN
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT-3 LMTD ACTION (CAP)

ASPHALT CAP	53,000
SITE ACCESS RESTRICTIONS	11,000
SUBTOTAL	64,000

SITE COSTS

SITE PREPARATION	0
SITE ADMINISTRATION	11,000

GENERAL CONDITIONS

START-UP COSTS	0
CONSTRUCTION SUBTOTAL	75,000
BID CONTINGENCIES	15,000
SCOPE CONTINGENCIES	9,400
CONSTRUCTION TOTAL	99,000
PERMITTING AND LEGAL COSTS	3,300
SERVICES DURING CONSTRUCTION	4,500
TOTAL CAPITAL SITE 8-SCREEN	110,000
TOTAL SITE CAPITAL COST	110,000

CAPITAL COST DEVELOPMENT -- PAGE 2 DATE: 09/11/93
S. NAME: HOLLOMAN29 REGION: 06 TIME: 17:56:22

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 09/11/93
TIME: 17:56:22

OPERATION AND MAINTENANCE COST DEVELOPMENT

SITE NAME: HOLLOMAN29 REGION: 06

OPERABLE UNIT: SITE 8-SCREEN
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT-3 LMTD ACTION (CAP)

ASPHALT CAP	13,000/3
SITE ACCESS RESTRICTIONS	0
SUBTOTAL	13,000

SITE COSTS

SITE PREPARATION	0

GENERAL CONDITIONS

INSURANCE AND PERMIT RENEWAL	2,000
SUBTOTAL	15,000

INDIRECT COSTS

ADMINISTRATION	2,300
CONTINGENCIES	2,300
TOTAL O & M SITE 8-SCREEN	20,000
TOTAL SITE O & M COST	20,000/3

= 6,700

NOTES

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*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 09/11/93
TIME: 17:47:30

CORA ASPHALT CAP COST MODULE (102)

SITE NAME: HOLLOMAN29
OPERABLE UNIT: SITE 8-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT-3 LMTD ACTION (CAP)
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Area of site (acres)	0.30	CAPITAL COST	53,000
Leveling layer (ft)	1.00	O & M COSTS	13,000
Protection level	D		
Average temp (degrees F)	80		
Confidence level	M		

*** Costs for areas larger than 50 acres do not take into account potential variations for material availability.

Costs for this module are sensitive to the material costs for the soil barrier and top soil. Material costs used to develop the algorithm are $21.50/cy for the soil barrier (clay) and $14.00/cy for top soil. Should local costs vary, the estimate should be adjusted to reflect the local economy.

***** VERSION 3.0 DRAFT *****

DATE: 09/11/93
TIME: 17:48:07

CORA SITE ACCESS RESTRICTIONS COST MODULE (504)

SITE NAME: HOLLOMAN29
OPERABLE UNIT: SITE 8-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT-3 LMTD ACTION (CAP)
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
Site perimeter (ft)	500
Permanent fence required?	Y
Temporary fence required?	N
Lighting required?	N
Security guard required?	N
Access points req. guard	0
Guards per access point	0
Number of shifts	0
Temporary guardhouses	0
Vehicles required	0
Confidence level	L

RESULTS

Component	Total
CAPITAL COST	11,000
O & M COSTS	0

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 4

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB ES JOB NO. _____

SUBJECT SITE 8 — ALT 4 SHEET 1 OF 7 SHEETS

ALTERNATIVE NO. 4 — SOURCE CONTAINMENT

ASSUMPTIONS

- CAP ENTIRE AREA OF REFUSE COLLECTION YARD
- SITE ACCESS RESTRICTIONS (800 FT FENCING)
- AREA TO BE CAPPED = 41,000 ft^2 = 0.94 ACRES

COST SUMMARY

CAPITAL = $180,000

ANNUAL O&M = $ 7700
(P/A, 5%, 3) = 15.372
$118,000

NET PV = $298,000

***** VERSION 3.0 DRAFT *****

DATE: 10/06/93
TIME: 16:08:18

CAPITAL COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITE 8-SCREEN
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT 4-SOURCE CONT (CAP)

ASPHALT CAP	93,000
SITE ACCESS RESTRICTIONS	18,000
SUBTOTAL	110,000

SITE COSTS

SITE PREPARATION	0
SITE ADMINISTRATION	18,000

GENERAL CONDITIONS

START-UP COSTS	0
CONSTRUCTION SUBTOTAL	130,000
BID CONTINGENCIES	26,000
SCOPE CONTINGENCIES	16,000
CONSTRUCTION TOTAL	170,000
PERMITTING AND LEGAL COSTS	5,600
SERVICES DURING CONSTRUCTION	7,800
TOTAL CAPITAL SITE 8-SCREEN	180,000
TOTAL SITE CAPITAL COST	180,000

CAPITAL COST DEVELOPMENT -- PAGE 2 DATE: 10/06/93
E NAME: HOLLOMAN 29 SITES REGION: 06 TIME: 16:08:19

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 10/06/93
TIME: 16:08:19

OPERATION AND MAINTENANCE COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITE 8-SCREEN
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT 4-SOURCE CONT (CAP)

ASPHALT CAP	16,000/3
SITE ACCESS RESTRICTIONS	0
SUBTOTAL	16,000

SITE COSTS

SITE PREPARATION	0

GENERAL CONDITIONS

INSURANCE AND PERMIT RENEWAL	2,400
SUBTOTAL	18,000

INDIRECT COSTS

ADMINISTRATION	2,700
CONTINGENCIES	2,700
TOTAL O & M SITE 8-SCREEN	23,000
TOTAL SITE O & M COST	23,000/3 =

$7,700

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 10/06/93
TIME: 15:53:33

CORA ASPHALT CAP COST MODULE (102)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITE 8-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT 4-SOURCE CONT (CAP)
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Area of site (acres)	0.99	CAPITAL COST	93,000
Leveling layer (ft)	1.00	O & M COSTS	16,000
Protection level	D		
Average temp (degrees F)	70		
Confidence level	M		

*** Costs for areas larger than 50 acres do not take into account potential variations for material availability.

Costs for this module are sensitive to the material costs for the soil barrier and top soil. Material costs used to develop the algorithm are $21.50/cy for the soil barrier (clay) and $14.00/cy for top soil. Should local costs vary, the estimate should be adjusted to reflect the local economy.

***** VERSION 3.0 DRAFT *****

DATE: 09/11/93
TIME: 17:50:09

CORA SITE ACCESS RESTRICTIONS COST MODULE (504)

SITE NAME: HOLLOMAN29
OPERABLE UNIT: SITE 8-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT 4-SOURCE CONT (CAP)
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
Site perimeter (ft)	800
Permanent fence required?	Y
Temporary fence required?	N
Lighting required?	N
Security guard required?	N
Access points req. guard	0
Guards per access point	0
Number of shifts	0
Temporary guardhouses	0
Vehicles required	0
Confidence level	L

RESULTS

Component	Total
CAPITAL COST	18,000
O & M COSTS	0

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 5

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB FS JOB NO. _____

SUBJECT SITE 8 - ALT 5 SHEET 1 OF 8 SHEETS

ALTERNATIVE NO. 5 — OFF-SITE TREATMENT (INCINERATION)

ASSUMPTIONS

- EXCAVATE SOIL WITH FRONT-END LOADER
- 207 ft x 105 ft
- VOLUME = 1610 yd^3 (IN PLACE); 1850 bulk cu yd.
- 1.25 TON/yd^3
- ASSUME SANDY GRAVEL
- INCINERATION AT RCRA FACILITY
  $1000/TON (APTUS - ARAGONITE, UT)
  $80/TON TRANSPORTATION (800 MILES)

SOIL MASS = 1.25 TON/yd^3 x 1850 yd^3 = 2315 TONS

INCINERATION

2315 TONS x $1000/TON = $2,315,000

TRANSPORTATION

2315 TONS x $80/TON = $ 185,200

$2,500,000

COST SUMMARY

CAPITAL = $ 4,100,000

O+M = $ 0

NET PV = $ 4,100,000

***** VERSION 3.0 DRAFT *****

DATE: 10/06/93
TIME: 16:36:30

CAPITAL COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITE 8-SCREEN
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT 6--EXCV & INCINERATE

SOIL EXCAVATION	150,000
USER-SUPPLIED COSTS	2,500,000
SUBTOTAL	2,700,000

SITE COSTS

SITE PREPARATION	0
SITE ADMINISTRATION	4,900

GENERAL CONDITIONS

START-UP COSTS	0
CONSTRUCTION SUBTOTAL	2,700,000
BID CONTINGENCIES	540,000
SCOPE CONTINGENCIES	880,000
CONSTRUCTION TOTAL	4,100,000
PERMITTING AND LEGAL COSTS	7,500
SERVICES DURING CONSTRUCTION	11,000
TOTAL CAPITAL SITE 8-SCREEN	4,100,000
TOTAL SITE CAPITAL COST	4,100,000

NOTES

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***** VERSION 3.0 DRAFT *****

DATE: 10/06/93
TIME: 16:36:31

OPERATION AND MAINTENANCE COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITE 8-SCREEN
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT 6--EXCV & INCINERATE

SOIL EXCAVATION	0
USER-SUPPLIED COSTS	0
SUBTOTAL	0

SITE COSTS

SITE PREPARATION	0

GENERAL CONDITIONS

INSURANCE AND PERMIT RENEWAL	0
SUBTOTAL	0

INDIRECT COSTS

ADMINISTRATION	0
CONTINGENCIES	0
TOTAL O & M SITE 8-SCREEN	0
TOTAL SITE O & M COST	0

NOTES

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*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 10/06/93
TIME: 16:04:38

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITE 8-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT 6--EXCV & INCINERATE
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
SITE 8	
Soil type	1
Depth of excavation (ft)	2
1. Steel sheeting or	
2. side slope?	1
Horizontal component	0
Length of excavation (ft)	207
Width of excavation (ft)	105
Depth of cover above contaminated materials (ft)	0
Depth of contaminated excav. w/o continuous sampling (ft)	0
Depth of contaminated excav. w/continuous sampling (ft)	2
Thickness of lifts (inches)	24
Number of drums	0
Pct. of contaminated zone	0
Base air monitoring required?	N
Pct. of backfill available onsite	100

RESULTS

Component	Total
BYPRODUCTS FOR TRANSPORT/DISPOSAL:	
DRUMS	0
CONTAMINATED SOIL (CY) (SWELL FACTOR=1.15)	1,852

***** VERSION 3.0 DRAFT *****

DATE: 10/06/93
TIME: 16:04:39

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITE 8-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT 6--EXCV & INCINERATE
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Protection level for:		COST FOR ALL EXCAVATIONS	
Uncontaminated materials	D		
Contaminated materials	C	CAPITAL COST	150,000
Temperature (degrees F)	70	O & M COSTS	0
Confidence level	M		

*** Excavation depth cannot exceed 25 feet. For excavations deeper than 25 feet, complex site-specific sheeting, bracing, dewatering, terracing and haul roads may be required. Excavation for depths deeper than 25 feet should be scoped and costed on a site-specific basis.

***** VERSION 3.0 DRAFT *****

DATE: 10/06/93
TIME: 16:36:15

CORA USER-SUPPLIED COSTS COST MODULE (505)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITE 8-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT 6--EXCV & INCINERATE
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
OFF SITE INCINERATOR		CAPITAL COST	2,500,000
Capital cost	2500000	O & M COSTS	0
O & M cost	0		
Percentage of labor	0		
Percentage of contingency	30		
Average temp (degrees F)	70		
Protection level	C		

NOTES:

Off site incineration (quote: Aptus-Aragonite, UT)

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 6

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB FS JOB NO. _____

SUBJECT SITE 8 – ALT 6 SHEET 1 OF 15 SHEETS

ALTERNATIVE NO. 6 – EXCAVATION + DISPOSAL

ASSUMPTIONS

- EXCAVATE WITH FRONT-END LOADER
- VOLUME = 1610 yd^3 (1852 BULK yd^3)
- 1.25 TON/yd^3 BULK DENSITY
- ASSUME SANDY GRAVEL
- CORA MODEL ASSUMES RECTANGULAR AREA
- APPROXIMATE DIMENSIONS = 207 ft X 105 ft

OPTION A – NONHAZARDOUS WASTE

- NU-MEX – SUNLAND PARK, NM (INDUSTRIAL SW LANDFILL)
- \$30/yd^3 FOR PESTICIDE-CONTAMINATED SOIL; 90 MILES

OPTION B – HAZARDOUS WASTE

- TECO LANDFILL – ROBSTOWN, TX; 800 MILES
- \$125/TON
- 1852 yd^3 X 1.25 TON/yd^3 = 2,315 TONS

COST SUMMARY

OPTION A – NONHAZARDOUS WASTE

CAPITAL = \$350,000; O+M = \$0; NET PRESENT VALUE = \$350,000

OPTION B – HAZARDOUS WASTE

CAPITAL = \$1,200,000; O+M = \$0; NET PRESENT VALUE = \$1,200,000

***** VERSION 3.0 DRAFT *****

DATE: 10/06/93
TIME: 16:08:26

CAPITAL COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITE 8-SCREEN
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT-6A EXCV & DISP (NONH

SOIL EXCAVATION	110,000
OFFSITE SOLID WASTE LANDFILL	56,000
TRANSPORTATION TO OFFSITE SOLID WASTE LANDFILL	57,000
SUBTOTAL	220,000

SITE COSTS

SITE PREPARATION	0
SITE ADMINISTRATION	4,900

GENERAL CONDITIONS

START-UP COSTS	0
CONSTRUCTION SUBTOTAL	220,000
BID CONTINGENCIES	44,000
SCOPE CONTINGENCIES	64,000
CONSTRUCTION TOTAL	330,000
PERMITTING AND LEGAL COSTS	7,800
SERVICES DURING CONSTRUCTION	10,000
TOTAL CAPITAL SITE 8-SCREEN	350,000
TOTAL SITE CAPITAL COST	350,000

CAPITAL COST DEVELOPMENT -- PAGE 2 DATE: 10/06/93
SITE NAME: HOLLOMAN 29 SITES REGION: 06 TIME: 16:08:27

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 10/06/93
TIME: 16:08:27

OPERATION AND MAINTENANCE COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITE 8-SCREEN
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT-6A EXCV & DISP (NONH

SOIL EXCAVATION	0
OFFSITE SOLID WASTE LANDFILL	0
TRANSPORTATION TO OFFSITE SOLID WASTE LANDFILL	0
SUBTOTAL	0

SITE COSTS

SITE PREPARATION	0

GENERAL CONDITIONS

INSURANCE AND PERMIT RENEWAL	0
SUBTOTAL	0

INDIRECT COSTS

ADMINISTRATION	0
CONTINGENCIES	0
TOTAL O & M SITE 8-SCREEN	0
TOTAL SITE O & M COST	0

OPERATION AND MAINTENANCE COST DEVELOPMENT -- PAGE 2 DATE: 10/06/93
E NAME: HOLLOMAN 29 SITES REGION: 06 TIME: 16:08:29

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 10/06/93
TIME: 16:02:13

CORA OFFSITE SOLID WASTE LANDFILL COST MODULE (404)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITE 8-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT-6A EXCV & DISP (NONH
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Waste volume (CY)	1852	SOLID WASTE LANDFILL	
Miles to landfill	90	CAPITAL COST	56,000
Landfill cost per CY	30.00	O & M COSTS	0
Confidence level	M		
Demurrage time/load (hrs)	2	TRANSPORTATION	
Capital or O&M landfill cost?	C	CAPITAL COST	57,000
		O & M COSTS	0
Capital or O&M transport cost?	C		

*** Landfill costs are generally assessed in tons. CORA assumes a material density of 90 lb/cubic foot.

***** VERSION 3.0 DRAFT *****

DATE: 10/06/93
TIME: 16:01:22

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITE 8-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT-8A EXCV & DISP (NONH
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
SITE 8	
Soil type	1
Depth of excavation (ft)	2
1. Steel sheeting or	
2. side slope?	0
Horizontal component	0
Length of excavation (ft)	207
Width of excavation (ft)	105
Depth of cover above contaminated materials (ft)	0
Depth of contaminated excav. w/o continuous sampling (ft)	0
Depth of contaminated excav. w/continuous sampling (ft)	2
Thickness of lifts (inches)	24
Number of drums	0
Pct. of contaminated zone	0
Base air monitoring required?	N
Pct. of backfill available onsite	100

RESULTS

Component	Total
BYPRODUCTS FOR TRANSPORT/DISPOSAL:	
DRUMS	0
CONTAMINATED SOIL (CY) (SWELL FACTOR=1.15)	1,852

***** VERSION 3.0 DRAFT *****

DATE: 10/06/93
TIME: 16:01:23

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITE 8-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT-6A EXCV & DISP (NONH
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Protection level for:		COST FOR ALL EXCAVATIONS	
Uncontaminated materials	D		
Contaminated materials	C	CAPITAL COST	110,000
Temperature (degrees F)	70	O & M COSTS	0
Confidence level	M		

*** Excavation depth cannot exceed 25 feet. For excavations deeper than 25 feet, complex site-specific sheeting, bracing, dewatering, terracing and haul roads may be required. Excavation for depths deeper than 25 feet should be scoped and costed on a site-specific basis.

***** VERSION 3.0 DRAFT *****

DATE: 10/06/93
TIME: 16:08:35

CAPITAL COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITE 8-SCREEN
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT-6B EXCV & DISP (HAZ)

SOIL EXCAVATION	110,000
OFFSITE RCRA LANDFILL	353,000
TRANSPORTATION TO OFFSITE RCRA LANDFILL	400,000
SUBTOTAL	860,000

SITE COSTS

SITE PREPARATION	0
[illegible] ADMINISTRATION	4,900

GENERAL CONDITIONS

START-UP COSTS	0
CONSTRUCTION SUBTOTAL	860,000
BID CONTINGENCIES	170,000
SCOPE CONTINGENCIES	170,000
CONSTRUCTION TOTAL	1,200,000
PERMITTING AND LEGAL COSTS	21,000
SERVICES DURING CONSTRUCTION	23,000
TOTAL CAPITAL SITE 8-SCREEN	1,200,000
TOTAL SITE CAPITAL COST	1,200,000

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 10/06/93
TIME: 16:08:37

OPERATION AND MAINTENANCE COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITE 8-SCREEN
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT-6B EXCV & DISP (HAZ)

SOIL EXCAVATION	0
OFFSITE RCRA LANDFILL	0
TRANSPORTATION TO OFFSITE RCRA LANDFILL	0
SUBTOTAL	0

SITE COSTS

SITE PREPARATION	0

GENERAL CONDITIONS

INSURANCE AND PERMIT RENEWAL	0
SUBTOTAL	0

INDIRECT COSTS

ADMINISTRATION	0
CONTINGENCIES	0
TOTAL O & M SITE 8-SCREEN	0
TOTAL SITE O & M COST	0

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 10/06/93
TIME: 16:03:48

CORA OFFSITE RCRA LANDFILL COST MODULE (401)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITE 8-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT-6B EXCV & DISP (HAZ)
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value	Unit Cost
RCRA AND NON-PCB SOLIDS:		
Bulk (Tons) *	2315	125.00
Mixed debris (CY) *	0	139.00
Drums (55-gallon)	0	66.50
Lab packs	0	110.00
Bulk waste requiring stabilization (Tons)**	0	225.00
Waste requiring stabilization (Drums)**	0	135.00
PCB/TOXIC SOLIDS:		
Bulk (Tons)*	0	237.00
Mixed debris (CY) *	0	222.00
Drums (55-gallon)	0	127.00
Tax per drum		8.95
Tax per cubic yard		27.00
Tax per ton		27.00
Level of confidence	M	
Miles to offsite facility	800	
Demurrage time/load (hrs)	2	
Capital or O&M landfill cost?	C	
Capital or O&M transportation cost?	C	

RESULTS

Component	Total
RCRA LANDFILL	
DISPOSAL COST	290,000
TAX	63,000
CAPITAL COST	353,000
O & M COSTS	0
TRANSPORTATION	
CAPITAL COST	400,000
O & M COSTS	0

* These materials will be charged at minimum rate of 2,000 lbs/cy. When converting tons to CY, CORA assumes a density of 90 lbs/cubic foot.

** Heavy/soft hammer wastes that have not been stabilized on site

***** VERSION 3.0 DRAFT *****

DATE: 10/06/93
TIME: 16:03:14

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITE 8-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT-6B EXCV & DISP (HAZ)
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
SITE 8	
Soil type	1
Depth of excavation (ft)	2
1. Steel sheeting or	
2. side slope?	0
Horizontal component	0
Length of excavation (ft)	207
Width of excavation (ft)	105
Depth of cover above contaminated materials (ft)	0
Depth of contaminated excav. w/o continuous sampling (ft)	0
Depth of contaminated excav. w/continuous sampling (ft)	2
Thickness of lifts (inches)	24
Number of drums	0
Pct. of contaminated zone	0
Base air monitoring required?	N
Pct. of backfill available onsite	100

RESULTS

Component	Total
BYPRODUCTS FOR TRANSPORT/DISPOSAL:	
DRUMS	0
CONTAMINATED SOIL (CY) (SWELL FACTOR=1.15)	1,852

***** VERSION 3.0 DRAFT *****

DATE: 10/06/93
TIME: 16:03:15

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITE 8-SCREEN ESTIMATED START: MID FY 1994
SCENARIO: ALT-6B EXCV & DISP (HAZ)
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Protection level for:		COST FOR ALL EXCAVATIONS	
Uncontaminated materials	D		
Contaminated materials	C	CAPITAL COST	110,000
Temperature (degrees F)	70	O & M COSTS	0
Confidence level	M		

*** Excavation depth cannot exceed 25 feet. For excavations deeper than 25 feet, complex site-specific sheeting, bracing, dewatering, terracing and haul roads may be required. Excavation for depths deeper than 25 feet should be scoped and costed on a site-specific basis.

COST CALCULATIONS--SCREENING

SITE 14

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 1

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB-FS JOB NO. _____

SUBJECT SITE 14- ALT 1 SHEET 1 OF 1 SHEETS

ALTERNATIVE NO 1 — NO ACTION

- NO INSTITUTIONAL ACTION
- NO CONTAINMENT
- NO GW MONITORING
- NO EXCAVATION
- NO TREATMENT/DISPOSAL

CAPITAL = $0
O+M = $0

NET PRESENT VALUE = $0

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 2

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB FS JOB NO. _____

SUBJECT SITE 14 – ALT 2 SHEET 1 OF 6 SHEETS

ALTERNATIVE No. 2 – LIMITED ACTION

- LAND USE RESTRICTIONS
- SITE ACCESS RESTRICTIONS
- NO GW MONITORING
- 500 FT FENCE

CAPITAL COST = $15,000
O+M COST = $ 0

NET PRESENT VALUE = $15,000

***** VERSION 3.0 DRAFT *****

DATE: 09/15/93
TIME: 10:43:15

CAPITAL COST DEVELOPMENT

SITE NAME: HOLLOMAN29 REGION: 06

OPERABLE UNIT: SITE 14
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT 2--LIMITED ACTION

SITE ACCESS RESTRICTIONS	11,000
SUBTOTAL	11,000

SITE COSTS

SITE PREPARATION	0
SITE ADMINISTRATION	0

GENERAL CONDITIONS

START-UP COSTS	0
CONSTRUCTION SUBTOTAL	11,000
BID CONTINGENCIES	2,200
SCOPE CONTINGENCIES	1,200
CONSTRUCTION TOTAL	14,000
PERMITTING AND LEGAL COSTS	550
SERVICES DURING CONSTRUCTION	770
TOTAL CAPITAL SITE 14	15,000
TOTAL SITE CAPITAL COST	15,000

CAPITAL COST DEVELOPMENT -- PAGE 2 DATE: 09/15/93
E NAME: HOLLOMAN29 REGION: 06 TIME: 10:43:16

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 09/15/93
TIME: 10:43:16

OPERATION AND MAINTENANCE COST DEVELOPMENT

SITE NAME: HOLLOMAN29 REGION: 06

OPERABLE UNIT: SITE 14
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT 2--LIMITED ACTION

SITE ACCESS RESTRICTIONS	0
SUBTOTAL	0

SITE COSTS

SITE PREPARATION	0

GENERAL CONDITIONS

INSURANCE AND PERMIT RENEWAL	0
SUBTOTAL	0

INDIRECT COSTS

ADMINISTRATION	0
CONTINGENCIES	0
TOTAL O & M SITE 14	0
TOTAL SITE O & M COST	0

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 09/15/93
TIME: 11:05:02

CORA SITE ACCESS RESTRICTIONS COST MODULE (504)

SITE NAME: HOLLOMAN29
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 2--LIMITED ACTION
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
Site perimeter (ft)	500
Permanent fence required?	Y
Temporary fence required?	N
Lighting required?	N
Security guard required?	N
Access points req. guard	0
Guards per access point	0
Number of shifts	0
Temporary guardhouses	0
Vehicles required	0
Confidence level	H

RESULTS

Component	Total
CAPITAL COST	11,000
O & M COSTS	0

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 3

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB - FS JOB NO. _____

SUBJECT SITE 14 - ALT 3 SHEET 1 OF 7 SHEETS

ALTERNATIVE NO. 3 — SOURCE CONTAINMENT

ASSUMPTIONS

- CAP ENTIRE AREA (12,000 ft^2, 0.28 ACRES)
- NO GW MONITORING
- SITE ACCESS RESTRICTIONS (500 FT FENCING)
- 4" ASPHALT CAP, 6" COMPACTED SOIL LAYER

COST SUMMARY

CAPITAL COSTS = $100,000

O+M (ANNUAL) = $ 6700
(P/A, 5%, 30) = 15.372
PV O+M = $102,000

NET PRESENT VALUE = $ 202,000

***** VERSION 3.0 DRAFT *****

DATE: 09/15/93
TIME: 10:43:24

CAPITAL COST DEVELOPMENT

SITE NAME: HOLLOMAN29 REGION: 06

OPERABLE UNIT: SITE 14
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT 3--SOURCE CONTAINMENT

ASPHALT CAP	51,000
SITE ACCESS RESTRICTIONS	11,000
SUBTOTAL	62,000

SITE COSTS

SITE PREPARATION	0
SITE ADMINISTRATION	10,000

GENERAL CONDITIONS

START-UP COSTS	0
CONSTRUCTION SUBTOTAL	72,000
BID CONTINGENCIES	14,000
SCOPE CONTINGENCIES	8,400
CONSTRUCTION TOTAL	94,000
PERMITTING AND LEGAL COSTS	3,200
SERVICES DURING CONSTRUCTION	4,400
TOTAL CAPITAL SITE 14	100,000
TOTAL SITE CAPITAL COST	100,000

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 09/15/93
TIME: 10:43:26

OPERATION AND MAINTENANCE COST DEVELOPMENT

SITE NAME: HOLLOMAN29 REGION: 06

OPERABLE UNIT: SITE 14
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT 3--SOURCE CONTAINMENT

ASPHALT CAP	13,000/3
SITE ACCESS RESTRICTIONS	0
SUBTOTAL	13,000

SITE COSTS

SITE PREPARATION	0

GENERAL CONDITIONS

INSURANCE AND PERMIT RENEWAL	2,000
SUBTOTAL	15,000

INDIRECT COSTS

ADMINISTRATION	2,300
CONTINGENCIES	2,300
TOTAL O & M SITE 14	20,000
TOTAL SITE O & M COST	20,000/3 = 6,700

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 09/15/93
TIME: 10:23:44

CORA ASPHALT CAP COST MODULE (102)

SITE NAME: HOLLOMAN29
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 3--SOURCE CONTAINMENT
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Area of site (acres)	0.28	CAPITAL COST	51,000
Leveling layer (ft)	1.00	O & M COSTS	13,000
Protection level	D		
Average temp (degrees F)	70		
Confidence level	M		

*** Costs for areas larger than 50 acres do not take into account potential variations for material availability.

Costs for this module are sensitive to the material costs for the soil barrier and top soil. Material costs used to develop the algorithm are $21.50/cy for the soil barrier (clay) and $14.00/cy for top soil. Should local costs vary, the estimate should be adjusted to reflect the local economy.

***** VERSION 3.0 DRAFT *****

DATE: 09/15/93
TIME: 10:24:10

CORA SITE ACCESS RESTRICTIONS COST MODULE (504)

SITE NAME: HOLLOMAN29
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 3--SOURCE CONTAINMENT
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
Site perimeter (ft)	500
Permanent fence required?	Y
Temporary fence required?	N
Lighting required?	N
Security guard required?	N
Access points req. guard	0
Guards per access point	0
Number of shifts	0
Temporary guardhouses	0
Vehicles required	0
Confidence level	H

RESULTS

Component	Total
CAPITAL COST	11,000
O & M COSTS	0

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 4

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB - FS JOB NO. _____

SUBJECT SITE 14 - ALT 4 SHEET 1 OF 16 SHEETS

ALTERNATIVE No 4 - EXCAVATION/ON-SITE TREATMENT

- 2 FT TO 4 FT IN DEPTH
- 740 yd^3 IN PLACE $\times$ 1.15 = 850 bulk $yd^3 \times 1.25 \frac{TON}{yd^3}$ = 1060 TONS
- SANDY GRAVEL
- USE THERMAL DESORPTION
- \$ 300/TON (BASED ON WESTINGHOUSE QUOTE)

  INCLUDES
  - FUEL
  - LABOR
  - UTILITIES
  - MOB/DEMOB
  - RENTAL COST
  - DISPOSAL OF CONTAMINATED RESIDUALS

OPTION A: BACKFILL WITH TREATED SOIL

OPTION B: BACKFILL WITH CLEAN SOIL; DISPOSE OF TREATED SOIL IN OFF-SITE, INDUSTRIAL SOLID WASTE LANDFILL

ESTIMATED DIMENSIONS (FOR CORA): 170 ft X 59 ft

SOIL VOLUME FROM CORA = 854 $yd^3 \times 1.25$ = 1068 TONS

COST SUMMARY

1068 TONS X \$300/TON = \$320,400

OPTION A

CAPITAL = \$580,000; O + M = \$0

NET PRESENT VALUE = \$580,000

OPTION B

CAPITAL = \$630,000; O+M = \$0

NET PRESENT VALUE = \$630,000

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 17:37:14

CAPITAL COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITE 14
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT 4--ON-SITE TREAT&DISP

SOIL EXCAVATION	67,000
USER-SUPPLIED COSTS	320,000
SUBTOTAL	390,000

SITE COSTS

SITE PREPARATION	0
SITE ADMINISTRATION	3,600

GENERAL CONDITIONS

START-UP COSTS	0
CONSTRUCTION SUBTOTAL	390,000
BID CONTINGENCIES	78,000
SCOPE CONTINGENCIES	98,000
CONSTRUCTION TOTAL	570,000
PERMITTING AND LEGAL COSTS	3,400
SERVICES DURING CONSTRUCTION	4,700
TOTAL CAPITAL SITE 14	580,000
TOTAL SITE CAPITAL COST	580,000

CAPITAL COST DEVELOPMENT -- PAGE 2 DATE: 10/04/93
E NAME: HOLLOMAN 29 SITES REGION: 06 TIME: 17:37:15

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 17:37:15

OPERATION AND MAINTENANCE COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITE 14
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT 4--ON-SITE TREAT&DISP

SOIL EXCAVATION	0
USER-SUPPLIED COSTS	0
SUBTOTAL	0

SITE COSTS

SITE PREPARATION	0

GENERAL CONDITIONS

INSURANCE AND PERMIT RENEWAL	0
SUBTOTAL	0

INDIRECT COSTS

ADMINISTRATION	0
CONTINGENCIES	0
TOTAL O & M SITE 14	0
TOTAL SITE O & M COST	0

OPERATION AND MAINTENANCE COST DEVELOPMENT -- PAGE 2 DATE: 10/04/93
SITE NAME: HOLLOMAN 29 SITES REGION: 06 TIME: 17:37:16

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 17:21:02

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 4--ON-SITE TREAT&DISP
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
SITE 14	
Soil type	1
Depth of excavation (ft)	2
1. Steel sheeting or	
2. side slope?	0
Horizontal component	0
Length of excavation (ft)	170
Width of excavation (ft)	59
Depth of cover above contaminated materials (ft)	0
Depth of contaminated excav. w/o continuous sampling (ft)	0
Depth of contaminated excav. w/continuous sampling (ft)	2
Thickness of lifts (inches)	24
Number of drums	0
Pct. of contaminated zone	0
Base air monitoring required?	N
Pct. of backfill available onsite	100

RESULTS

Component	Total
BYPRODUCTS FOR TRANSPORT/DISPOSAL:	
DRUMS	0
CONTAMINATED SOIL (CY) (SWELL FACTOR=1.15)	854

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 17:21:03

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 4--ON-SITE TREAT&DISP
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Protection level for:		COST FOR ALL EXCAVATIONS	
Uncontaminated materials	D		
Contaminated materials	D	CAPITAL COST	67,000
Temperature (degrees F)	70	O & M COSTS	0
Confidence level	M		

*** Excavation depth cannot exceed 25 feet. For excavations deeper than 25 feet, complex site-specific sheeting, bracing, dewatering, terracing and haul roads may be required. Excavation for depths deeper than 25 feet should be scoped and costed on a site-specific basis.

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 17:22:29

CORA USER-SUPPLIED COSTS COST MODULE (505)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 4--ON-SITE TREAT&DISP
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
THERMAL DESORPTION		CAPITAL COST	320,000
Capital cost	320000	O & M COSTS	0
O & M cost	0		
Percentage of labor	0		
Percentage of contingency	20		
Average temp (degrees F)	70		
Protection level	D		

NOTES:

On site thermal desorption (quote: Westinghouse)

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 17:37:25

CAPITAL COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITE 14
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT 4B--ON/TREAT OFF/DISP

SOIL EXCAVATION	67,000
USER-SUPPLIED COSTS	320,000
OFFSITE SOLID WASTE LANDFILL	15,000
TRANSPORTATION TO OFFSITE SOLID WASTE LANDFILL	26,000
SUBTOTAL	430,000

SITE COSTS

SITE PREPARATION	0
SITE ADMINISTRATION	3,600

GENERAL CONDITIONS

START-UP COSTS	0
CONSTRUCTION SUBTOTAL	430,000
BID CONTINGENCIES	86,000
SCOPE CONTINGENCIES	100,000
CONSTRUCTION TOTAL	620,000
PERMITTING AND LEGAL COSTS	4,200
SERVICES DURING CONSTRUCTION	5,500
TOTAL CAPITAL SITE 14	630,000

CAPITAL COST DEVELOPMENT -- PAGE 2
SITE NAME: HOLLOMAN 29 SITES REGION: 06

DATE: 10/04/93
TIME: 17:37:26

TOTAL SITE CAPITAL COST	630,000

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 17:37:27

OPERATION AND MAINTENANCE COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITE 14
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT 4B--ON/TREAT OFF/DISP

SOIL EXCAVATION	0
USER-SUPPLIED COSTS	0
OFFSITE SOLID WASTE LANDFILL	0
TRANSPORTATION TO OFFSITE SOLID WASTE LANDFILL	0
SUBTOTAL	0

SITE COSTS

S PREPARATION	0

GENERAL CONDITIONS

INSURANCE AND PERMIT RENEWAL	0
SUBTOTAL	0

INDIRECT COSTS

ADMINISTRATION	0
CONTINGENCIES	0
TOTAL O & M SITE 14	0
TOTAL SITE O & M COST	0

OPERATION AND MAINTENANCE COST DEVELOPMENT -- PAGE 2 DATE: 10/04/93
SITE NAME: HOLLOMAN 29 SITES REGION: 06 TIME: 17:37:28

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 17:24:33

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 4B--ON/TREAT OFF/DISP
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
SITE 14	
Soil type	1
Depth of excavation (ft)	2
1. Steel sheeting or	
2. side slope?	0
Horizontal component	0
Length of excavation (ft)	170
Width of excavation (ft)	59
Depth of cover above contaminated materials (ft)	0
Depth of contaminated excav. w/o continuous sampling (ft)	0
D h of contaminated excav. w/ continuous sampling (ft)	2
Thickness of lifts (inches)	24
Number of drums	0
Pct. of contaminated zone	0
Base air monitoring required?	N
Pct. of backfill available onsite	100

RESULTS

Component	Total
BYPRODUCTS FOR TRANSPORT/DISPOSAL:	
DRUMS	0
CONTAMINATED SOIL (CY) (SWELL FACTOR=1.15)	854

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 17:24:34

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 4B--ON/TREAT OFF/DISP
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Protection level for:		COST FOR ALL EXCAVATIONS	
Uncontaminated materials	D		
Contaminated materials	D	CAPITAL COST	67,000
Temperature (degrees F)	70	O & M COSTS	0
Confidence level	M		

*** Excavation depth cannot exceed 25 feet. For excavations deeper than 25 feet, complex site-specific sheeting, bracing, dewatering, terracing and haul roads may be required. Excavation for depths deeper than 25 feet should be scoped and costed on a site-specific basis.

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 17:27:25

CORA USER-SUPPLIED COSTS COST MODULE (505)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 4B--ON/TREAT OFF/DISP
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
THERMAL DESORPTION		CAPITAL COST	320,000
Capital cost	320000	O & M COSTS	0
O & M cost	0		
Percentage of labor	0		
Percentage of contingency	20		
Average temp (degrees F)	70		
Protection level	D		

NOTES:

On site thermal desorption (quote: Westinghouse)

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 17:25:36

CORA OFFSITE SOLID WASTE LANDFILL COST MODULE (404)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 4B--ON/TREAT OFF/DISP
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Waste volume (CY)	854	SOLID WASTE LANDFILL	
Miles to landfill	90	CAPITAL COST	15,000
Landfill cost per CY	17.00	O & M COSTS	0
Confidence level	M		
Demurrage time/load (hrs)	2	TRANSPORTATION	
Capital or O&M landfill cost?	C	CAPITAL COST	26,000
		O & M COSTS	0
Capital or O&M transport cost?	C		

*** Landfill costs are generally assessed in tons. CORA assumes a material density of 90 lb/cubic foot.

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 5

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB - FS JOB NO. _____

SUBJECT SITE 14 — ALT 5 SHEET 1 OF 8 SHEETS

ALTERNATIVE NO. 5 - OFF-SITE TREATMENT (INCINERATION)

ASSUMPTIONS

- EXCAVATE SOIL WITH FRONT-END LOADER
- VOLUME = 740 yd^3 (IN PLACE) x 1.15 = 850 BULK yd^3
- DEPTH = 2 FT TO 4 FT
- APPROXIMATE DIMENSIONS = 170 ft x 60 ft
- BULK DENSITY = 1.25 TON/yd^3
- SANDY GRAVEL
- INCINERATION AT RCRA FACILITY
  - $1000/TON (APTUS, ARAGONITE, UT)
  - $80/TON TRANSPORTATION (800 MILES)

VOLUME OF SOIL (FROM CORA) = 854 yd^3
SOIL MASS = 854 yd^3 x 1.25 TON/yd^3 = 1068 TONS

COST SUMMARY

INCINERATION

1068 TONS x $1000/TON = $1,068,000

TRANSPORTATION

1068 TONS x $80/TON = $85,000

CAPITAL COST = $1,800,000; O+M = 0
NET PRESENT VALUE = $1,800,000

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 17:37:36

CAPITAL COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITE 14
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT 5--OFF-SITE INCINERAT

SOIL EXCAVATION	67,000
USER-SUPPLIED COSTS	1,200,000
SUBTOTAL	1,300,000

SITE COSTS

SITE PREPARATION	0
SITE ADMINISTRATION	3,600

GENERAL CONDITIONS

START-UP COSTS	0
CONSTRUCTION SUBTOTAL	1,300,000
BID CONTINGENCIES	260,000
SCOPE CONTINGENCIES	280,000
CONSTRUCTION TOTAL	1,800,000
PERMITTING AND LEGAL COSTS	3,400
SERVICES DURING CONSTRUCTION	4,700
TOTAL CAPITAL SITE 14	1,800,000
TOTAL SITE CAPITAL COST	1,800,000

CAPITAL COST DEVELOPMENT -- PAGE 2 DATE: 10/04/93
'E NAME: HOLLOMAN 29 SITES REGION: 06 TIME: 17:37:37

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 17:37:38

OPERATION AND MAINTENANCE COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITE 14
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT 5--OFF-SITE INCINERAT

SOIL EXCAVATION	0
USER-SUPPLIED COSTS	0
SUBTOTAL	0

SITE COSTS

SITE PREPARATION	0

GENERAL CONDITIONS

INSURANCE AND PERMIT RENEWAL	0
SUBTOTAL	0

INDIRECT COSTS

ADMINISTRATION	0
CONTINGENCIES	0
TOTAL O & M SITE 14	0
TOTAL SITE O & M COST	0

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 17:30:41

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 5--OFF-SITE INCINERAT
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
SITE 14	
Soil type	1
Depth of excavation (ft)	2
1. Steel sheeting or	
2. side slope?	0
Horizontal component	0
Length of excavation (ft)	170
Width of excavation (ft)	59
Depth of cover above contaminated materials (ft)	0
Depth of contaminated excav. w/o continuous sampling (ft)	0
Depth of contaminated excav. w/continuous sampling (ft)	2
Thickness of lifts (inches)	24
Number of drums	0
Pct. of contaminated zone	0
Base air monitoring required?	N
Pct. of backfill available onsite	100

RESULTS

Component	Total
BYPRODUCTS FOR TRANSPORT/DISPOSAL:	
DRUMS	0
CONTAMINATED SOIL (CY) (SWELL FACTOR=1.15)	854

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 17:30:41

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITE
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 5--OFF-SITE INCINERAT
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Protection level for:		COST FOR ALL EXCAVATIONS	
Uncontaminated materials	D		
Contaminated materials	D	CAPITAL COST	67,000
Temperature (degrees F)	70	O & M COSTS	0
Confidence level	M		

*** Excavation depth cannot exceed 25 feet. For excavations deeper than 25 feet, complex site-specific sheeting, bracing, dewatering, terracing and haul roads may be required. Excavation for depths deeper than 25 feet should be scoped and costed on a site-specific basis.

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 17:33:06

CORA USER-SUPPLIED COSTS COST MODULE (505)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 5--OFF-SITE INCINERAT
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
INCINERATION		CAPITAL COST	1,200,000
Capital cost	1153000	O & M COSTS	0
O & M cost	0		
Percentage of labor	0		
Percentage of contingency	20		
Average temp (degrees F)	70		
Protection level	D		

NOTES:

Off-site incineration (quote: Aptus, Aragonite, UT)

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 6

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB – FS JOB NO. _____

SUBJECT SITE 14 – ALT 6 SHEET 1 OF 8 SHEETS

ALTERNATIVE No. 6 – OFF-SITE DISPOSAL

ASSUMPTIONS

- EXCAVATE WITH FRONT-END LOADER
- 740 yd^3 (IN PLACE) x 1.15 = 850 BULK yd^3
- DEPTH = 2 FT TO 4 FT
- 1[illegible]0 ft x 60 ft
- BULK DENSITY = 1.25 TON/yd^3
- SANDY GRAVEL

RCRA LANDFILL – TECO, ROBSTOWN, TX (800 MILES)

VOLUME FROM CORA = 854 yd^3 x 1.25 = 1068 TONS

1068 TONS x \$125/TON = \$133,500 FOR INCINERATION

1068 TONS x \$80/TON = \$85,400 FOR TRANSPORTATION

TOTAL CAPITAL COST = \$610,000
O&M COST = \$ 0

NET PRESENT VALUE = \$610,000

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 17:37:45

CAPITAL COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITE 14
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT 6--EXCV & DISP (HAZ)

SOIL EXCAVATION	67,000
OFFSITE RCRA LANDFILL	159,000
TRANSPORTATION TO OFFSITE RCRA LANDFILL	190,000
SUBTOTAL	420,000

SITE COSTS

SITE PREPARATION	0
SITE ADMINISTRATION	3,600

GENERAL CONDITIONS

START-UP COSTS	0
CONSTRUCTION SUBTOTAL	420,000
BID CONTINGENCIES	84,000
SCOPE CONTINGENCIES	85,000
CONSTRUCTION TOTAL	590,000
PERMITTING AND LEGAL COSTS	10,000
SERVICES DURING CONSTRUCTION	12,000
TOTAL CAPITAL SITE 14	610,000
TOTAL SITE CAPITAL COST	610,000

CAPITAL COST DEVELOPMENT -- PAGE 2 DATE: 10/04/93
E NAME: HOLLOMAN 29 SITES REGION: 06 TIME: 17:37:46

NOTES

*** All costs are rounded to two significant figures.

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***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 17:37:47

OPERATION AND MAINTENANCE COST DEVELOPMENT

SITE NAME: HOLLOMAN 29 SITES REGION: 06

OPERABLE UNIT: SITE 14
ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INDIVIDUAL TECHNOLOGY COSTS

SCENARIO: ALT 6--EXCV & DISP (HAZ)

SOIL EXCAVATION	0
OFFSITE RCRA LANDFILL	0
TRANSPORTATION TO OFFSITE RCRA LANDFILL	0
SUBTOTAL	0

SITE COSTS

SITE PREPARATION	0

GENERAL CONDITIONS

INSURANCE AND PERMIT RENEWAL	0
SUBTOTAL	0

INDIRECT COSTS

ADMINISTRATION	0
CONTINGENCIES	0
TOTAL O & M SITE 14	0
TOTAL SITE O & M COST	0

NOTES

*** All costs are rounded to two significant figures.

*** The cost estimates shown are based on the data input to the program and cost algorithms developed for generic conditions. The final costs will depend on actual size, design and market conditions. As a result, the final project costs will vary from the estimates presented here.

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 17:33:46

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 6--EXCV & DISP (HAZ)
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
SITE 14	
Soil type	1
Depth of excavation (ft)	2
1. Steel sheeting or	
2. side slope?	0
Horizontal component	0
Length of excavation (ft)	170
Width of excavation (ft)	59
Depth of cover above contaminated materials (ft)	0
Depth of contaminated excav. w/o continuous sampling (ft)	0
Depth of contaminated excav. w/continuous sampling (ft)	2
Thickness of lifts (inches)	24
Number of drums	0
Pct. of contaminated zone	0
Base air monitoring required?	N
Pct. of backfill available onsite	100

RESULTS

Component	Total
BYPRODUCTS FOR TRANSPORT/DISPOSAL:	
DRUMS	0
CONTAMINATED SOIL (CY) (SWELL FACTOR=1.15)	854

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 17:33:47

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 6--EXCV & DISP (HAZ)
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Protection level for:		COST FOR ALL EXCAVATIONS	
Uncontaminated materials	D		
Contaminated materials	D	CAPITAL COST	67,000
Temperature (degrees F)	70	O & M COSTS	0
Confidence level	M		

*** Excavation depth cannot exceed 25 feet. For excavations deeper than 25 feet, complex site-specific sheeting, bracing, dewatering, terracing and haul roads may be required. Excavation for depths deeper than 25 feet should be scoped and costed on a site-specific basis.

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 17:35:45

CORA OFFSITE RCRA LANDFILL COST MODULE (401)

SITE NAME: HOLLOMAN 29 SITES
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 6--EXCV & DISP (HAZ)
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value	Unit Cost
RCRA AND NON-PCB SOLIDS:		
Bulk (Tons) *	1068	125.00
Mixed debris (CY) *	0	139.00
Drums (55-gallon)	0	66.50
Lab packs	0	110.00
Bulk waste requiring stabilization (Tons)**	0	225.00
Waste requiring stabilization (Drums)**	0	135.00
PCB/TOXIC SOLIDS:		
Bulk (Tons)*	0	237.00
Mixed debris (CY) *	0	222.00
Drums (55-gallon)	0	127.00
Tax per drum		8.95
Tax per cubic yard		27.00
Tax per ton		27.00
Level of confidence	M	
Miles to offsite facility	800	
Demurrage time/load (hrs)	2	
Capital or O&M landfill cost?	C	
Capital or O&M transportation cost?	C	

RESULTS

Component	Total
RCRA LANDFILL	
DISPOSAL COST	130,000
TAX	29,000
CAPITAL COST	159,000
O & M COSTS	0
TRANSPORTATION	
CAPITAL COST	190,000
O & M COSTS	0

* These materials will be charged at minimum rate of 2,000 lbs/cy. When converting tons to CY, CORA assumes a density of 90 lbs/cubic foot.

** Heavy/soft hammer wastes that have not been stabilized on site

APPENDIX D

DETAILED ANALYSIS CALCULATIONS

DESIGN CALCULATIONS--DETAILED ANALYSIS

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 1

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB FS JOB NO. _____

SUBJECT VOLUMES + AREAS - SITES 2+5 SHEET 1 OF 1 SHEETS

AREA OF CONTAMINATION = 9200 ft^2 AT MOUNDED AREA

DEPTH = 13 ft + 2 ft OF MOUND = 15 ft

VOLUME = 5100 yd^3 + 50 yd^3 (SB-02+5-24) = 5150 yd^3

FORMER BERMED AREA

80' x 300' = 24,000 ft^2

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 2

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB-ES JOB NO. _____

SUBJECT SITES 2 & 5 - FLOW RATE FOR SVE SYSTEM SHEET 1 OF 1 SHEETS

DESIGN FLOW RATES FOR SVE WELLS TO BE 15-25 CFM PER WELL FOR A TOTAL FLOW OF 60 TO 100 CFM. THIS FLOW RATE SHOULD BE SUFFICIENT TO YIELD A DIAMETER OF INFLUENCE OF ABOUT 75 FT. FURTHER, THIS FLOW RATE SHOULD FACILITATE VOLATILIZATION OF VOCs AND BIODEGRADATION OF HEAVIER PETROLEUM HYDROCARBONS. THIS RANGE OF FLOW RATES FALLS WITHIN THE OPTIMUM RANGE OF 0.5 TO 2 PORE VOLUMES PER DAY.

PORE VOLUME = 80' x 300' x 15' x 30% POROSITY = 108,000 ft^3

$$0.5 \frac{\text{PORE VOL}}{\text{DAY}} \times 108{,}000\ ft^3 \times \frac{1\ \text{DAY}}{24\ \text{HOURS}} \times \frac{1\ \text{HR}}{60\ \text{MIN}} = 37.5\ \text{CFM TOTAL}$$

$$2 \frac{\text{PORE VOL}}{\text{DAY}} \times 108{,}000\ ft^3 \times \frac{1\ \text{DAY}}{24\ \text{HRS}} \times \frac{1\ \text{HR}}{60\ \text{MIN}} = 150\ \text{CFM TOTAL}$$

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 3

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB - FS JOB NO. _____

SUBJECT SITES 2 & 5 - ESTIMATED REMEDIATION TIME SHEET 1 OF 1 SHEETS

SVE/BIODEGRADATION

HIGHEST KNOWN TPH CONCENTRATION (IN SATURATED SOIL) = 17,500 mg/kg

CLEANUP CRITERION = 1000 mg/kg TPH

16,500 mg/kg TPH MUST BE REMOVED.

FROM VARIOUS REFENCES,

10 mg/kg/day IS A REALISTIC BIODEGRADATION RATE FOR HEXANE

$$16{,}500 \text{ mg/kg} \cdot \frac{1 \text{ day}}{10 \text{ mg/kg}} = \underline{1650 \text{ DAYS}} = 4.5 \text{ YEARS}$$

ROUND TO 5 YEARS

THIS ESTIMATE OF CLEANUP TIME IS CONSERVATIVE, SINCE THE AVERAGE TPH LEVEL IS ABOUT 4000 mg/kg. HOWEVER, THE BIODEGRADATION RATE LISTED ABOVE DOES NOT INCLUDE A PERIOD FOR ACCLIMATION OF THE MICROORGANISMS TO FAVORABLE CONDITIONS FOR BIODEGRADATION.

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 4

SIGNATURE WW DULANEY / RJ MICHNA DATE 12/8/92 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB FS JOB NO. _____

SUBJECT REFERENCES FOR BIOSPARGING SYSTEM SHEET 1 OF 2 SHEETS

1) ESTIMATION OF BIODEGRADATION RATES

HINCHEE, R.E., AND S.K. ONG, "A RAPID IN SITU RESPIRATION TEST FOR MEASURING AEROBIC BIODEGRADATION RATES OF HYDROCARBONS IN SOIL," JOURNAL OF AIR AND WASTE MANAGEMENT ASSOCIATION, VOL. 42, NO. 10, OCTOBER 1992.

2) ESTIMATION OF APPROPRIATE FLOW RATES

a) MILLER, R.N., C.M. VOGEL, & R.E. HINCHEE, "A FIELD SCALE INVESTIGATION OF PETROLEUM HYDROCARBON BIODEGRADATION IN THE VADOSE ZONE ENHANCED BY SOIL VENTING AT TYNDALL AFB, FLORIDA," PRESENTED AT SEMINAR ON "BIOVENTING & VAPOR EXTRACTION: USES AND APPLICATIONS IN REMEDIAL OPERATIONS," SPONSORED BY AWMA & HWAC, APRIL 15, 1992.

b) DUPONT, R.R., "APPLICATION OF BIOREMEDIATION FUNDAMENTALS TO THE DESIGN AND EVALUATION OF IN SITU SOIL BIOVENTING SYSTEMS," PRESENTED AT THE 85TH ANNUAL AWMA MEETING & EXHIBITION, KANSAS CITY, MO, JUNE 21-26, 1992.

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 4

SIGNATURE NW DULANEY/RJ MICHANA DATE 12/8/92 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB FS JOB NO. _____

SUBJECT REFERENCES FOR BIOSPARGING DESIGN SHEET 2 OF 2 SHEETS

3) GENERAL INFO

a) HINCHEE, R.E. AND R.N. MILLER, "BIOVENTING FOR IN SITU REMEDIATION OF PETROLEUM HYDROCARBONS," PRESENTED AT SEMINAR ON "BIOVENTING + VAPOR EXTRACTION: USES AND APPLICATIONS IN REMEDIAL OPERATIONS," SPONSORED BY AWMA + HWAC, APRIL 15, 1992.

b) SAYLES, G.D., R.E. HINCHEE, R.C. BRENNER, C.M. VOGEL, + R.N. MILLER, "IN SITU BIOVENTING: TWO U.S. EPA AND AIR FORCE SPONSORED FIELD STUDIES," PRESENTED AT THE U.S. EPA/AWMA SYMPOSIUM ON IN SITU TREATMENT OF CONTAMINATED SOIL AND WATER, FEBRUARY 3-6, 1992.

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 5

SIGNATURE ROBERT MICHNA DATE 10-13-92 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB FS JOB NO. _____

SUBJECT AREAS, DISTANCES — SITE 8 SHEET 1 OF 1 SHEETS

FENCING

ALTERNATIVES 2 + 3 - 500 FT

ALTERNATIVE 4 - 800 FT

CAPPING AREA

ALTERNATIVE 3 — 13,050 ft^2

ALTERNATIVE 4 — 41,000 ft^2

KADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 6

SIGNATURE ROBERT MICHNA DATE 12/11/92 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB FS JOB NO. _____

SUBJECT AREAS AND DISTANCES - SITE 14 SHEET 1 OF 1 SHEETS

FENCING

(168' x 2) + (78' x 2) = 492' ROUND TO 500 FT

CAPPING

168' x 78' - (25' x 60')BLDG 66 = 11,600 ft²

ROUND TO

12,0100 ft²

10-88-30702

COST CALCULATIONS--DETAILED ANALYSIS

COST CALCULATIONS--DETAILED ANALYSIS

SITES 2&5

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 1

SIGNATURE ROBERT MICINA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB-FS JOB NO. _____

SUBJECT SITES 2+5 - ALT 1 SHEET 1 OF 1 SHEETS

DETAILED ANALYSIS COST

ALTERNATIVE NO. 1 - NO ACTION

CAPITAL COST = $0

O+M COST = $0

NET PRESENT VALUE = $0

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 2

SIGNATURE ROBERT MICHNA DATE 10-13-03 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB-FS JOB NO. _____

SUBJECT SITES 2+5 — ALT 3 SHEET 1 OF 7 SHEETS

DETAILED ANALYSIS COST

SVE ASSUMPTIONS

- 4 SVE WELLS
- 13 FT BGL DEPTH
- SCREENED FROM 8 TO 12 FT BGL
- WELL SPACING = 75 ft
- FLOW RATE = 15 TO 25 CFM/WELL => ~6.25 CFM/FT WELL SCREEN
- LEVEL C DRILLING; LEVEL D OPERATION

- 4 PASSIVE PROBES FOR SOIL GAS MONITORING

- EXCAVATE 50 yd^3 AT SB-02+5-24
- DISPOSAL OF WELL CUTTINGS AND EXCAVATED SOILS
  NU-MEX LANDFILL, SUNLAND PARK, NM (90 MILES)
  DISPOSAL COST = $25/TON

SOIL GAS MONITORING

MONITOR 4 PASSIVE PROBES 2X/YR FOR 5 YEARS

$100/SAMPLE COLLECTION X4 $100/SAMPLE ANALYSES (GC/FID) X4
$450/DAY LABOR/EXPENSE X2 $400/REPORT
$1000 TRAVEL

SUBTOTAL = $3100
+ 465 (15% CONTINGENCY)
$3565
X 2

$7200 ANNUAL O&M COST

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 2

SIGNATURE Robert Michna DATE 10-13-93 CHECKED _____ DATE _____

PROJECT Holloman AFB-FS JOB NO. _____

SUBJECT Sites 2 & 5 - Alts 3 & 4 - Volatiles SHEET 2 OF 7 SHEETS

5150 yd^3 soil x 1.25 tons/bulk yd^3 x 1.15 bulking factor

= 7403 tons x 229.5 mg/kg BTEX = 1.7 tons volatiles

(Note: Assume all volatiles are BTEX)

1.7 tons x 2000 lbs/ton = 3400 lbs volatiles

Use Ventsorb Canisters (Calgon) at 200 lbs carbon each

BTEX loading on carbon ≅ 30%

3400 lbs volatiles x $\frac{1 \text{ lb carbon}}{0.3 \text{ lb volatiles}}$ = 11,300 lbs carbon

⇒ 57 Ventsorb Canisters

Ventsorb unit cost = \$636 ÷ 200 lbs = \$3.18/lb

Regeneration/Freight = \$0.65/lb

Total carbon cost = \$3.83/lb

11,300 lbs x \$3.83/lb = \$43,280

O&M Costs

3-yrs treatment = \$14,430/yr

5-yrs treatment = \$8,660/yr

	B	T	E	X	Total BTEX
17-01	0	206	28	633	867
17-02	260	8600	2320	15900	27080
18-01	39	5420	378	21500	27337
18-02	194	6010	1350	21600	29154
19-01	0	3440	0	86000	89440
19-02	1060	87000	41900	332000	461960
19-03	498	49200	15400	126000	191098
20-01	0	2770	2280	134000	139050
20-02	323	74500	131000	242000	447823
21-01	3950	135000	78800	500000	717750
21-02	1620	81100	42300	208000	333020
21-03	146	8070	1860	279000	289076

avg. 229471.25

Costs: Sites 2&5 Alternative 3--Soil Vapor Extraction

CAPITAL COSTS		
Process Option		Capital Cost ($)
Groundwater Monitoring		14,000
Clay Cap		9,600
Soil Vapor Extraction		130,000
Soil Gas Monitoring		0
Granular Activated Carbon		0
Soil Excavation		2,500
Disposal of Wastes		1,300
Transportation of Wastes		2,000
Construction Subtotal		159,400
Bid Contingencies	15%	23,910
Scope Contingencies	20%	31,880
Construction Total		215,190
Engineering and Design	10%	21,519
Permitting and Legal	5%	10,760
Bonding and Insurance	3%	6,456
Construction Oversight	5%	10,760
Field and Laboratory Testing	3%	6,456
Total Capital Cost		271,139

OPERATION AND MAINTENANCE COSTS				
Process Option	Annual O&M Cost	Process Option Service Time (yrs)	Present Worth Factor	Present Worth Cost
Groundwater Monitoring	3,050	5	4.3294	13,205
Clay Cap	960	5	4.3294	4,156
Soil Vapor Extraction	34,000	5	4.3294	147,200
Soil Gas Monitoring	7,200	5	4.3294	31,172
Granular Activated Carbon	8,660	5	4.3294	37,493
Soil Excavation	0			0
Disposal of Wastes	0			0
Transportation of Wastes	0			0
Annual Operation and Maintenance Cost Subtotal	53,870	5	4.3294	233,225
Reserve Fund (1% of Capital Costs)	2,711	5	4.3294	11,739
5-Yr Site Reviews (2% of O&M Costs)	1,077	5	4.3294	4,664
Administration (5% of O&M Costs)	2,694	5	4.3294	11,661
Contingencies (5% of O&M Costs)	2,694	5	4.3294	11,661
Total Annual Operating and Maintenance Cost	63,046			272,950

NET PRESENT VALUE	
Capital Cost	271,139
Present Worth O&M Cost	272,950
Total Cost for Alternative	544,090

***** VERSION 3.0 DRAFT *****

DATE: 09/16/93
TIME: 21:19:28

CORA GROUNDWATER MONITORING COST MODULE (503)

SITE NAME: SITES 2&5 - DA
OPERABLE UNIT: SITES 2&5 - DA ESTIMATED START: MID FY 1994
SCENARIO: ALT 3 - SVE
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
Number of wells to install	2
Average well depth (ft)	20
Protection during setup of drill rig & installation of above-grade piping	D
Protection during drilling	C
Average temp (degrees F)	70
Confidence level	M
Number of wells to monitor	4
Monitoring frequency	1
Monitoring requirements:	
24 Plasma Metals	N
st/PCB	N
GC-BN	N
GC-Acid	N
HSLORG	N
VOA GC/MS	Y
Acid GC/MS	N
B/N GC/MS	N

RESULTS

Component	Total
CAPITAL COST	14,000
O & M COSTS	6,100

Biennial

Annual $ 3,050

***** VERSION 3.0 DRAFT *****

DATE: 10/06/93
TIME: 15:34:51

CORA SOIL VAPOR EXTRACTION COST MODULE (305)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITES 2&5 - DA ESTIMATED START: MID FY 1994
SCENARIO: ALT 3 - SVE
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
Soil: Mixed sandy, silty, clayey	
Site area (square ft)	24000
Well spacing (ft)	75
Average length of well screen per well (ft)	3
Well depth (ft)	18
Vapor flow per well per length of well screen	6
VOCs on site (lbs)	0.00
Protection level for well drilling & installation	D
Protection level for above grade construction	C
Average temp (degrees F)	70
Confidence level	L

RESULTS

Component	Total
CAPITAL COST	130,000
O & M COSTS	34,000
TOTAL VAPOR FLOW (CFM)	72
NUMBER OF WELLS	4
VOCs (LBS/DAY)	0.00
BYPRODUCTS FOR TRANSPORT/DISPOSAL:	
WELL CUTTINGS (CY)	3
(SWELL FACTOR = 1.25)	

***** VERSION 3.0 DRAFT *****

DATE: 10/06/93
TIME: 15:41:39

CORA OFFSITE SOLID WASTE LANDFILL COST MODULE (404)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITES 2&5 - DA ESTIMATED START: MID FY 1994
SCENARIO: ALT 3 - SVE
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Waste volume (CY)	53	SOLID WASTE LANDFILL	
Miles to landfill	90	CAPITAL COST	1,300
Landfill cost per CY	25.00	O & M COSTS	0
Confidence level	M		
Demurrage time/load (hrs)	2	TRANSPORTATION	
Capital or O&M landfill cost?	C	CAPITAL COST	2,000
		O & M COSTS	0
Capital or O&M transport cost?	C		

** Landfill costs are generally assessed in tons. CORA assumes a material density of 90 lb/cubic foot.

NOTES:

Disposal of Excavated Soils and Well Cuttings

COST CALCULATIONS--DETAILED ANALYSIS

SITE 8

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 1

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB - ES JOB NO. _____

SUBJECT SITE 8 - ALT 1 SHEET 1 OF 1 SHEETS

DETAILED ANALYSIS COST

ALTERNATIVE NO 1 - NO ACTION

CAPITAL = $0
O&M = $0
NET PV = $0

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 2

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB - ES JOB NO. _____

SUBJECT SITE 8 - ALT 4 SHEET 1 OF 5 SHEETS

DETAILED ANALYSIS COST

ALTERNATIVE NO. 4 - SOURCE CONTAINMENT - CAPPING

SITE PREPARATION

- FENCING (800 FT) FOR ACCESS RESTRICTIONS
- CLEARING/GRUBBING OF NON-WORK AREA (0.6 ACRES)

GENERAL SERVICES (INCLUDED IN START-UP COSTS)

- ADMIN TRAILER
- WORKER TRAILER
- H&S PROGRAM + EQUIPMENT
- PERSONNEL DECON AREA
- PARKING AREA

ASPHALT CAP

- 41,000 ft^2 (0.95 ACRES)
- 4" ASPHALT; 6" COMPACTED SOIL BASE

Costs: Site 8 Alternative 4--Source Containment

CAPITAL COSTS		
Process Option		Capital Cost ($)
Site Access Restrictions		40,000
Site Preparation		3,700
Asphalt Cap		93,000
Construction Subtotal		136,700
Bid Contingencies	15%	20,505
Scope Contingencies	20%	27,340
Construction Total		184,545
Engineering and Design	10%	18,455
Permitting and Legal	5%	9,227
Bonding and Insurance	3%	5,536
Construction Oversight	5%	9,227
Field and Laboratory Testing	3%	5,536
Total Capital Cost		232,527

OPERATION AND MAINTENANCE COSTS				
Process Option	Annual O&M Cost	Process Option Service Time (yrs)	Present Worth Factor	Present Worth Cost
Site Access Restrictions	0			0
Site Preparation	0			0
Asphalt Cap	5,330	30	15.3725	81,935
Annual Operation and Maintenance Cost Subtotal	5,330	30	15.3725	81,935
Reserve Fund (1% of Capital Costs)	2,325	30	15.3725	35,745
5-Yr Site Reviews (2% of O&M Costs)	107	30	15.3725	1,639
Administration (5% of O&M Costs)	267	30	15.3725	4,097
Contingencies (5% of O&M Costs)	267	30	15.3725	4,097
Total Annual Operating and Maintenance Cost	8,295			127,513

NET PRESENT VALUE	
Capital Cost	232,527
Present Worth O&M Cost	127,513
Total Cost for Alternative	360,040

***** VERSION 3.0 DRAFT *****

DATE: 09/17/93
TIME: 14:20:50

CORA SITE ACCESS RESTRICTIONS COST MODULE (504)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 8 ESTIMATED START: MID FY 1994
SCENARIO: ALT 6A-OFF-SITE DISP (NHZ
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
Site perimeter (ft)	800
Permanent fence required?	Y
Temporary fence required?	Y
Lighting required?	N
Security guard required?	N
Access points req. guard	0
Guards per access point	0
Number of shifts	0
Temporary guardhouses	0
Vehicles required	0
Confidence level	M

RESULTS

Component	Total
CAPITAL COST	40,000
O & M COSTS	0

***** VERSION 3.0 DRAFT *****

DATE: 09/17/93
TIME: 13:22:02

CORA SITE PREPARATION COST MODULE

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 8 ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS			RESULTS	
Parameter	Value	Prot. Level	Component	Total
Site clearing (acres)	0.6	D	SITE CLEARING	3,700
Tree removal (acres)	0.0		TREE REMOVAL	0
Dust control area (acres)	0.0		DUST CONTROL	0
Local util. connect.	N		POWER CONNECTION	0
Distance to power pt.(ft)	0		GAS CONNECTION	0
Gas conn. req'd	N		WATER CONNECTION	0
Distance to gas conn.(ft)	0		ACCESS ROAD	0
Water conn. req'd	N		TEMPORARY STORAGE	0
Distance to wtr (ft)	0		BLDG DEMOLITION	0
Water flow (GPM)	0		FLOW EQUAL.&INVENTORY	0
Access rd - ft req'd	0			
Acess road width (ft)	0		CAPITAL COSTS	3,700
Bldg. demolition (CY)	0		O&M (FLOW INV.)	0
Stored material (CY)	0			
Average temp. (deg. F)	70		BYPRODUCTS GENERATED	
Level of confidence	M		SOILS & ORGANICS (CY)	204

*** Permanent utility connections are not included in technology modules with the exception of onsite incineration. Because of the specific high demand for this process, allowances have been made within the cost algorithm.

***** VERSION 3.0 DRAFT *****

DATE: 10/07/93
TIME: 11:12:40

CORA ASPHALT CAP COST MODULE (102)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 8 ESTIMATED START: MID FY 1994
SCENARIO: ALT 4 - FULL CAP & FENCE
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Area of site (acres)	0.99	CAPITAL COST	93,000
Leveling layer (ft)	1.00	O & M COSTS	16,000/3
Protection level	D		
Average temp (degrees F)	70		≈ $5,300
Confidence level	M		

*** Costs for areas larger than 50 acres do not take into account potential variations for material availability.

Costs for this module are sensitive to the material costs for the soil barrier and top soil. Material costs used to develop the algorithm are $21.50/cy for the soil barrier (clay) and $14.00/cy for top soil. Should local costs vary, the estimate should be adjusted to reflect the local economy.

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 3

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB-ES JOB NO. _____

SUBJECT SITE 8 - ALT 5 SHEET 1 OF 6 SHEETS

DETAILED ANALYSIS COST

ALTERNATIVE NO. 5 — EXCAVATION AND INCINERATION

SITE PREPARATION

- TEMPORARY FENCING
- CLEARING + GRUBBING OF NON-WORK AREA (0.6 ACRES)

GENERAL SERVICES

- ADMIN. TRAILER
- WORKER TRAILER
- H&S PROGRAM + EQUIPMENT
- PERSONNEL DECON AREA
- PARKING AREA

EXCAVATION

- 1610 yd^3 (IN PLACE), APPROXIMATELY 207 ft x 105 ft
- SANDY GRAVEL
- 1.25 TONS/yd^3

SOIL VOLUME (FROM CORA) = 1852 yd^3 x 1.25 TON/yd^3 = 2315 TONS

INCINERATION COSTS = 2315 TONS x \$1000/TON = \$2,315,500
(APTUS, ARAGONITE, AT)

TRANSPORTATION (800 mi) = 2315 TONS x \$80/TON = \$185,200

Costs: Site 8 Alternative No. 5--Excavation and Incineration (Hazardous)

CAPITAL COSTS		
Process Option		Capital Cost ($)
Site Access Restrictions		22,000
Surface Water Controls		3,700
Excavation		100,000
Treatment: Off-Site Incinerator		2,315,000
Transportation: Off-Site Incinerator		185,200
Construction Subtotal		2,625,900
Bid Contingencies	15%	393,885
Scope Contingencies	20%	525,180
Construction Total		3,544,965
Engineering and Design	10%	354,497
Permitting and Legal	5%	177,248
Bonding and Insurance	3%	106,349
Construction Oversight	5%	177,248
Field and Laboratory Testing	3%	106,349
Total Capital Cost		4,466,656

OPERATION AND MAINTENANCE COSTS				
Process Option	Annual O&M Cost	Process Option Service Time (yrs)	Present Worth Factor	Present Worth Cost
Site Access Restrictions	0			0
Surface Water Controls	0			0
Excavation	0			0
Treatment: Off-Site Incinerator	0			0
Transportation: Off-Site Incinerator	0			0
Annual Operation and Maintenance Cost Subtotal	0			0
Total Annual Operating and Maintenance Cost	0			0

NET PRESENT VALUE	
Capital Cost	4,466,656
Present Worth O&M Cost	0
Total Cost for Alternative	4,466,656

***** VERSION 3.0 DRAFT *****

DATE: 09/17/93
TIME: 13:22:02

CORA SITE PREPARATION COST MODULE

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 8 ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS			RESULTS	
Parameter	Value	Prot. Level	Component	Total
Site clearing (acres)	0.6	D	SITE CLEARING	3,700
Tree removal (acres)	0.0		TREE REMOVAL	0
Dust control area (acres)	0.0		DUST CONTROL	0
Local util. connect.	N		POWER CONNECTION	0
Distance to power pt.(ft)	0		GAS CONNECTION	0
Gas conn. req'd	N		WATER CONNECTION	0
Distance to gas conn.(ft)	0		ACCESS ROAD	0
Water conn. req'd	N		TEMPORARY STORAGE	0
Distance to wtr (ft)	0		BLDG DEMOLITION	0
Water flow (GPM)	0		FLOW EQUAL.&INVENTORY	0
Access rd - ft req'd	0			
Acess road width (ft)	0		CAPITAL COSTS	3,700
Bldg. demolition (CY)	0		O&M (FLOW INV.)	0
S ed material (CY)	0			
Average temp. (deg. F)	70		BYPRODUCTS GENERATED	
Level of confidence	M		SOILS & ORGANICS (CY)	204

*** Permanent utility connections are not included in technology modules with the exception of onsite incineration. Because of the specific high demand for this process, allowances have been made within the cost algorithm.

***** VERSION 3.0 DRAFT *****

DATE: 09/17/93
TIME: 14:09:38

CORA SITE ACCESS RESTRICTIONS COST MODULE (504)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 8 ESTIMATED START: MID FY 1994
SCENARIO: ALT 5 - INCINERATION
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
Site perimeter (ft)	800
Permanent fence required?	N
Temporary fence required?	Y
Lighting required?	N
Security guard required?	N
Access points req. guard	0
Guards per access point	0
Number of shifts	0
Temporary guardhouses	0
Vehicles required	0
Confidence level	M

RESULTS

Component	Total
CAPITAL COST	22,000
O & M COSTS	0

***** VERSION 3.0 DRAFT *****

DATE: 10/07/93
TIME: 11:13:33

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 8 ESTIMATED START: MID FY 1994
SCENARIO: ALT 5 - INCINERATION
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
SITE 8	
Soil type	1
Depth of excavation (ft)	2
1. Steel sheeting or	
2. side slope?	0
Horizontal component	0
Length of excavation (ft)	207
Width of excavation (ft)	105
Depth of cover above contaminated materials (ft)	0
Depth of contaminated excav. w/o continuous sampling (ft)	0
Depth of contaminated excav. w/continuous sampling (ft)	2
Thickness of lifts (inches)	24
Number of drums	0
Pct. of contaminated zone	0
Base air monitoring required?	N
Pct. of backfill available onsite	100

RESULTS

Component	Total
BYPRODUCTS FOR TRANSPORT/DISPOSAL:	
DRUMS	0
CONTAMINATED SOIL (CY) (SWELL FACTOR=1.15)	1,852

***** VERSION 3.0 DRAFT *****

DATE: 10/07/93
TIME: 11:13:34

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 8 ESTIMATED START: MID FY 1994
SCENARIO: ALT 5 - INCINERATION
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Protection level for:		COST FOR ALL EXCAVATIONS	
Uncontaminated materials	D		
Contaminated materials	D	CAPITAL COST	100,000
Temperature (degrees F)	70	O & M COSTS	0
Confidence level	M		

*** Excavation depth cannot exceed 25 feet. For excavations deeper than 25 feet, complex site-specific sheeting, bracing, dewatering, terracing and haul roads may be required. Excavation for depths deeper than 25 feet should be scoped and costed on a site-specific basis.

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 4

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB-FS JOB NO. _____

SUBJECT SITE 8 - ALT 6 SHEET 1 OF 13 SHEETS

DETAILED ANALYSIS COST

ALTERNATIVE NO. 6 - EXCAVATION AND DISPOSAL

SITE PREPARATION
- FENCING
- CLEARING & GRUBBING OF NON-WORK AREA (0.6 ACRES)

GENERAL SERVICES
- ADMIN. TRAILER
- WORKER TRAILER
- H&S PROGRAM & EQUIPMENT
- PERSONNEL DECON AREA
- PARKING AREA

EXCAVATION

- 1610 yd^3 (IN PLACE); APPROXIMATELY 207 ft x 105 ft
- SANDY GRAVEL
- 1.25 TONS/yd^3

DISPOSAL

OPTION A: NONHAZARDOUS WASTE
- NU-MEX - (SUNLAND PARK, NM); (90 MILE); \$30/yd^3

OPTION B: HAZARDOUS WASTE
- TECO LANDFILL (ROBSTOWN, TX); (800 miles); \$125/TON

VOLUME FOR DISPOSAL = 1610 yd^3 x 1.15 = 1,852 yd^3

+ 204 yd^3 (SITE CLEARING) = 2056 yd^3 x 1.25 = 2570 TONS

Costs: Site 8 Alternative No. 6A--Excavation and Disposal (Nonhazardous)

CAPITAL COSTS		
Process Option		Capital Cost ($)
Site Access Restrictions		22,000
Surface Water Controls		3,700
Excavation		100,000
Disposal: Off-Site Nonhazardous Landfill		51,000
Transportation: Off-Site Nonhazardous Landfill		63,000
Construction Subtotal		239,700
Bid Contingencies	15%	35,955
Scope Contingencies	20%	47,940
Construction Total		323,595
Engineering and Design	10%	32,360
Permitting and Legal	5%	16,180
Bonding and Insurance	3%	9,708
Construction Oversight	5%	16,180
Field and Laboratory Testing	3%	9,708
Total Capital Cost		407,730

OPERATION AND MAINTENANCE COSTS				
Process Option	Annual O&M Cost	Process Option Service Time (yrs)	Present Worth Factor	Present Worth Cost
Site Access Restrictions	0			0
Surface Water Controls	0			0
Excavation	0			0
Disposal: Off-Site Nonhazardous Landfill	0			0
Transportation: Off-Site Nonhazardous Landfill	0			0
Annual Operation and Maintenance Cost Subtotal	0			0
Total Annual Operating and Maintenance Cost	0			0

NET PRESENT VALUE	
Capital Cost	407,730
Present Worth O&M Cost	0
Total Cost for Alternative	407,730

Costs: Site 8 Alternative No. 6B--Excavation and Disposal (Hazardous)

APITAL COSTS		
Process Option		Capital Cost ($)
Site Access Restrictions		22,000
Surface Water Controls		3,700
Excavation		100,000
Disposal: Off-Site RCRA Landfill		389,000
Transportation: Off-Site RCRA Landfill		440,000
Construction Subtotal		**954,700**
Bid Contingencies	15%	143,205
Scope Contingencies	20%	190,940
Construction Total		1,288,845
Engineering and Design	10%	128,885
Permitting and Legal	5%	64,442
Bonding and Insurance	3%	38,665
Construction Oversight	5%	64,442
Field and Laboratory Testing	3%	38,665
Total Capital Cost		**1,623,945**

OPERATION AND MAINTENANCE COSTS				
Process Option	Annual O&M Cost	Process Option Service Time (yrs)	Present Worth Factor	Present Worth Cost
.e Access Restrictions	0			0
Surface Water Controls	0			0
Excavation	0			0
Disposal: Off-Site RCRA Landfill	0			0
Transportation: Off-Site RCRA Landfill	0			0
Annual Operation and Maintenance Cost Subtotal	**0**			**0**
Total Annual Operating and Maintenance Cost	**0**			**0**

NET PRESENT VALUE	
Capital Cost	1,623,945
Present Worth O&M Cost	0
Total Cost for Alternative	1,623,945

***** VERSION 3.0 DRAFT *****

DATE: 09/17/93
TIME: 14:31:13

CORA SITE ACCESS RESTRICTIONS COST MODULE (504)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 8 ESTIMATED START: MID FY 1994
SCENARIO: ALT 6B-OFF-SITE DISP (~~HAZ~~ NHZ)
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Site perimeter (ft)	800	CAPITAL COST	22,000
Permanent fence required?	N	O & M COSTS	0
Temporary fence required?	Y		
Lighting required?	N		
Security guard required?	N		
Access points req. guard	0		
Guards per access point	0		
Number of shifts	0		
Temporary guardhouses	0		
Vehicles required	0		
Confidence level	M		

***** VERSION 3.0 DRAFT *****

DATE: 09/17/93
TIME: 13:22:02

CORA SITE PREPARATION COST MODULE

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 8 ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS			RESULTS	
Parameter	Value	Prot. Level	Component	Total
Site clearing (acres)	0.6	D	SITE CLEARING	3,700
Tree removal (acres)	0.0		TREE REMOVAL	0
Dust control area (acres)	0.0		DUST CONTROL	0
Local util. connect.	N		POWER CONNECTION	0
Distance to power pt.(ft)	0		GAS CONNECTION	0
Gas conn. req'd	N		WATER CONNECTION	0
Distance to gas conn.(ft)	0		ACCESS ROAD	0
Water conn. req'd	N		TEMPORARY STORAGE	0
Distance to wtr (ft)	0		BLDG DEMOLITION	0
Water flow (GPM)	0		FLOW EQUAL.&INVENTORY	0
Access rd - ft req'd	0			
Acess road width (ft)	0		CAPITAL COSTS	3,700
Bldg. demolition (CY)	0		O&M (FLOW INV.)	0
S[illegible]ed material (CY)	0			
Average temp. (deg. F)	70		BYPRODUCTS GENERATED	
Level of confidence	M		SOILS & ORGANICS (CY)	204

*** Permanent utility connections are not included in technology modules with the exception of onsite incineration. Because of the specific high demand for this process, allowances have been made within the cost algorithm.

***** VERSION 3.0 DRAFT *****

DATE: 10/07/93
TIME: 11:14:41

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 8 ESTIMATED START: MID FY 1994
SCENARIO: ALT 6A-OFF-SITE DISP (NHZ
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
SITE 8	
Soil type	1
Depth of excavation (ft)	2
1. Steel sheeting or	
2. side slope?	0
Horizontal component	0
Length of excavation (ft)	207
Width of excavation (ft)	105
Depth of cover above contaminated materials (ft)	0
Depth of contaminated excav. w/o continuous sampling (ft)	0
Depth of contaminated excav. w/continuous sampling (ft)	2
Thickness of lifts (inches)	24
Number of drums	0
Pct. of contaminated zone	0
Base air monitoring required?	N
Pct. of backfill available onsite	100

RESULTS

Component	Total
BYPRODUCTS FOR TRANSPORT/DISPOSAL:	
DRUMS	0
CONTAMINATED SOIL (CY) (SWELL FACTOR=1.15)	1,852

***** VERSION 3.0 DRAFT *****

DATE: 10/07/93
TIME: 11:14:42

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 8 ESTIMATED START: MID FY 1994
SCENARIO: ALT 6A-OFF-SITE DISP (NHZ
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Protection level for:		COST FOR ALL EXCAVATIONS	
Uncontaminated materials	D		
Contaminated materials	D	CAPITAL COST	100,000
Temperature (degrees F)	70	O & M COSTS	0
Confidence level	M		

*** Excavation depth cannot exceed 25 feet. For excavations deeper than 25 feet, complex site-specific sheeting, bracing, dewatering, terracing and haul roads may be required. Excavation for depths deeper than 25 feet should be scoped and costed on a site-specific basis.

***** VERSION 3.0 DRAFT *****

DATE: 10/12/93
TIME: 17:54:39

CORA OFFSITE SOLID WASTE LANDFILL COST MODULE (404)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 8 ESTIMATED START: MID FY 1994
SCENARIO: ALT 6A-OFF-SITE DISP (NHZ
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Waste volume (CY)	2056	SOLID WASTE LANDFILL	
Miles to landfill	90	CAPITAL COST	51,000
Landfill cost per CY	25.00	O & M COSTS	0
Confidence level	M		
Demurrage time/load (hrs)	2	TRANSPORTATION	
Capital or O&M landfill cost?	C	CAPITAL COST	63,000
		O & M COSTS	0
Capital or O&M transport cost?	C		

*** Landfill costs are generally assessed in tons. CORA assumes a material density of 90 lb/cubic foot.

***** VERSION 3.0 DRAFT *****

DATE: 09/17/93
TIME: 13:22:02

CORA SITE PREPARATION COST MODULE

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 8 ESTIMATED START: MID FY 1994
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS			RESULTS	
Parameter	Value	Prot. Level	Component	Total
Site clearing (acres)	0.6	D	SITE CLEARING	3,700
Tree removal (acres)	0.0		TREE REMOVAL	0
Dust control area (acres)	0.0		DUST CONTROL	0
Local util. connect.	N		POWER CONNECTION	0
Distance to power pt.(ft)	0		GAS CONNECTION	0
Gas conn. req'd	N		WATER CONNECTION	0
Distance to gas conn.(ft)	0		ACCESS ROAD	0
Water conn. req'd	N		TEMPORARY STORAGE	0
Distance to wtr (ft)	0		BLDG DEMOLITION	0
Water flow (GPM)	0		FLOW EQUAL.&INVENTORY	0
Access rd - ft req'd	0			
Acess road width (ft)	0		CAPITAL COSTS	3,700
Bldg. demolition (CY)	0		O&M (FLOW INV.)	0
[illegible]ed material (CY)	0			
Average temp. (deg. F)	70		BYPRODUCTS GENERATED	
Level of confidence	M		SOILS & ORGANICS (CY)	204

*** Permanent utility connections are not included in technology modules with the exception of onsite incineration. Because of the specific high demand for this process, allowances have been made within the cost algorithm.

***** VERSION 3.0 DRAFT *****

DATE: 09/17/93
TIME: 14:31:13

CORA SITE ACCESS RESTRICTIONS COST MODULE (504)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 8 ESTIMATED START: MID FY 1994
SCENARIO: ALT 6B-OFF-SITE DISP (HAZ
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
Site perimeter (ft)	800
Permanent fence required?	N
Temporary fence required?	Y
Lighting required?	N
Security guard required?	N
Access points req. guard	0
Guards per access point	0
Number of shifts	0
Temporary guardhouses	0
Vehicles required	0
Confidence level	M

RESULTS

Component	Total
CAPITAL COST	22,000
O & M COSTS	0

***** VERSION 3.0 DRAFT *****

DATE: 10/07/93
TIME: 11:19:42

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 8 ESTIMATED START: MID FY 1994
SCENARIO: ALT 6B-OFF-SITE DISP (HAZ
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
SITE 8	
Soil type	1
Depth of excavation (ft)	2
1. Steel sheeting or	
2. side slope?	0
Horizontal component	0
Length of excavation (ft)	207
Width of excavation (ft)	105
Depth of cover above contaminated materials (ft)	0
Depth of contaminated excav. w/o continuous sampling (ft)	0
Depth of contaminated excav. w/continuous sampling (ft)	2
Thickness of lifts (inches)	24
Number of drums	0
Pct. of contaminated zone	0
Base air monitoring required?	N
Pct. of backfill available onsite	100

RESULTS

Component	Total
BYPRODUCTS FOR TRANSPORT/DISPOSAL:	
DRUMS	0
CONTAMINATED SOIL (CY) (SWELL FACTOR=1.15)	1,852

***** VERSION 3.0 DRAFT *****

DATE: 10/07/93
TIME: 11:19:42

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 8 ESTIMATED START: MID FY 1994
SCENARIO: ALT 6B-OFF-SITE DISP (HAZ
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Protection level for:		COST FOR ALL EXCAVATIONS	
Uncontaminated materials	D		
Contaminated materials	D	CAPITAL COST	100,000
Temperature (degrees F)	70	O & M COSTS	0
Confidence level	M		

*** Excavation depth cannot exceed 25 feet. For excavations deeper than 25 feet, complex site-specific sheeting, bracing, dewatering, terracing and haul roads may be required. Excavation for depths deeper than 25 feet should be scoped and costed on a site-specific basis.

***** VERSION 3.0 DRAFT *****

DATE: 10/12/93
TIME: 17:55:09

CORA OFFSITE RCRA LANDFILL COST MODULE (401)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 8 ESTIMATED START: MID FY 1994
SCENARIO: ALT 6B-OFF-SITE DISP (HAZ
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value	Unit Cost
RCRA AND NON-PCB SOLIDS:		
Bulk (Tons) *	2570	125.00
Mixed debris (CY) *	0	139.00
Drums (55-gallon)	0	66.50
Lab packs	0	110.00
Bulk waste requiring stabilization (Tons)**	0	225.00
Waste requiring stabilization (Drums)**	0	135.00
PCB/TOXIC SOLIDS:		
Bulk (Tons)*	0	237.00
Mixed debris (CY) *	0	222.00
Drums (55-gallon)	0	127.00
Tax per drum		8.95
Tax per cubic yard		27.00
Tax per ton		27.00
Level of confidence	M	
Miles to offsite facility	800	
Demurrage time/load (hrs)	2	
Capital or O&M landfill cost?	C	
Capital or O&M transportation cost?	C	

RESULTS

Component	Total
RCRA LANDFILL	
DISPOSAL COST	320,000
TAX	69,000
CAPITAL COST	389,000
O & M COSTS	0
TRANSPORTATION	
CAPITAL COST	440,000
O & M COSTS	0

* These materials will be charged at minimum rate of 2,000 lbs/cy. When converting tons to CY, CORA assumes a density of 90 lbs/cubic foot.

** Heavy/soft hammer wastes that have not been stabilized on site

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 1

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB-FS JOB NO. _____

SUBJECT SITE 14- ALT 1 - DETAILED ANALYSIS SHEET 1 OF 1 SHEETS

ALTERNATIVE NO. 1 — NO ACTION

CAPITAL = $0
O&M = $0

NET PV = $0

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 2

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB-FS JOB NO. _____

SUBJECT SITE 14- ALT 3 - DETAILED ANALYSIS SHEET 1 OF 4 SHEETS

ALTERNATIVE No. 3 - SOURCE CONTAINMENT (CAPPING)

SITE PREPARATION
- TEMPORARY FENCING (500 ft)

GENERAL SERVICES INCLUDED IN START-UP COSTS

ASPHALT CAP AREA = 12,000 ft^2

Costs: Site 14 Alternative No. 3--Source Containment

CAPITAL COSTS		
Process Option		Capital Cost ($)
Site Access Restrictions		14,000
Asphalt Cap		67,000
Construction Subtotal		81,000
Bid Contingencies	15%	12,150
Scope Contingencies	20%	16,200
Construction Total		109,350
Engineering and Design	10%	10,935
Permitting and Legal	5%	5,468
Bonding and Insurance	3%	3,281
Construction Oversight	5%	5,468
Field and Laboratory Testing	3%	3,281
Total Capital Cost		137,781

OPERATION AND MAINTENANCE COSTS				
Process Option	Annual O&M Cost	Process Option Service Time (yrs)	Present Worth Factor	Present Worth Cost
Site Access Restrictions	0			0
Asphalt Cap	4300	30	15.3725	66,102
Annual Operation and Maintenance Cost Subtotal	4,300	30	15.3725	66,102
Reserve Fund (1% of Capital Costs)	1,378	30	15.3725	21,180
5-Yr Site Reviews (2% of O&M Costs)	86	30	15.3725	1,322
Administration (5% of O&M Costs)	215	30	15.3725	3,305
Contingencies (5% of O&M Costs)	215	30	15.3725	3,305
Total Annual Operating and Maintenance Cost	6,194			95,214

NET PRESENT VALUE	
Capital Cost	137,781
Present Worth O&M Cost	95,214
Total Cost for Alternative	232,995

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 18:15:55

CORA SITE ACCESS RESTRICTIONS COST MODULE (504)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 3--SOURCE CONTAINMENT
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
Site perimeter (ft)	500
Permanent fence required?	N
Temporary fence required?	Y
Lighting required?	N
Security guard required?	N
Access points req. guard	0
Guards per access point	0
Number of shifts	0
Temporary guardhouses	0
Vehicles required	0
Confidence level	H

RESULTS

Component	Total
CAPITAL COST	14,000
O & M COSTS	0

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 18:15:22

CORA ASPHALT CAP COST MODULE (102)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 3--SOURCE CONTAINMENT
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Area of site (acres)	0.28	CAPITAL COST	67,000
Leveling layer (ft)	1.00	O & M COSTS	13,000/3
Protection level	C		
Average temp (degrees F)	70		
Confidence level	M		≈ 4,300

*** Costs for areas larger than 50 acres do not take into account potential variations for material availability.

Costs for this module are sensitive to the material costs for the soil barrier and top soil. Material costs used to develop the algorithm are $21.50/cy for the soil barrier (clay) and $14.00/cy for top soil. Should local costs vary, the estimate should be adjusted to reflect the local economy.

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 3

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB-FS JOB NO. _____

SUBJECT SITE 14-ALT 5-DETAILED ANALYSIS SHEET 1 OF 6 SHEETS

ALTERNATIVE NO. 5 - EXCAVATION + INCINERATION

SITE PREPARATION

- TEMPORARY FENCING (500 ft)

GENERAL SERVICES INCLUDED IN START-UP COSTS

EXCAVATION

- 740 yd^3 IN PLACE X 1.15 = 850 yd^3 (bulk) X 1.25 = 1068 TONS
- DIMENSIONS = 170 ft X 59 ft
- SANDY GRAVEL
- DEPTH = 2 TO 4 ft

INCINERATION

VOLUME OF SOIL (FROM CORA) = 854 yd^3 X 1.25 = 1068 TONS

1,068 TONS X \$1000/TON = \$1,068,000 FOR INCINERATION
(APTUS, ARAGONITE, UT; 800 MILES)

1,068 TONS X \$80/TON = \$85,000 FOR TRANSPORTATION

Costs: Site 14 Alternative No. 5--Excavation and Incineration

CAPITAL COSTS		
Process Option		Capital Cost ($)
Site Access Restrictions		14,000
Surface Water Controls		17000
Excavation		73000
Treatment: Off-Site Incinerator		1,068,000
Transportation: Off-Site Incinerator		85,000
Construction Subtotal		**1,257,000**
Bid Contingencies	15%	188,550
Scope Contingencies	20%	251,400
Construction Total		1,696,950
Engineering and Design	10%	169,695
Permitting and Legal	5%	84,848
Bonding and Insurance	3%	50,909
Construction Oversight	5%	84,848
Field and Laboratory Testing	3%	50,909
Total Capital Cost		**2,138,157**

OPERATION AND MAINTENANCE COSTS				
Process Option	Annual O&M Cost	Process Option Service Time (yrs)	Present Worth Factor	Present Worth Cost
Site Access Restrictions	0			0
Surface Water Controls	0			0
Excavation	0			0
Treatment: Off-Site Incinerator	0			0
Transportation: Off-Site Incinerator	0			0
Annual Operation and Maintenance Cost Subtotal	**0**			**0**
Total Annual Operating and Maintenance Cost	**0**			**0**

NET PRESENT VALUE	
Capital Cost	2,138,157
Present Worth O&M Cost	0
Total Cost for Alternative	2,138,157

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 18:21:13

CORA SITE ACCESS RESTRICTIONS COST MODULE (504)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 5--EXCV. & INCINERATE
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
Site perimeter (ft)	500
Permanent fence required?	N
Temporary fence required?	Y
Lighting required?	N
Security guard required?	N
Access points req. guard	0
Guards per access point	0
Number of shifts	0
Temporary guardhouses	0
Vehicles required	0
Confidence level	H

RESULTS

Component	Total
CAPITAL COST	14,000
O & M COSTS	0

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 18:17:10

CORA SURFACE WATER DIVERSION/COLLECTION COST MODULE (105)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 5--EXCV. & INCINERATE
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
Site on raised ground	
Length of site (ft)	200
Width of site (ft)	75
25-yr, 24-hr rain (in.)	--
Protection level	C
Average temp (degrees F)	70
Confidence level	M

RESULTS

Component	Total
CAPITAL COST	17,000
O & M COSTS	200
BYPRODUCTS FOR TRANSPORT/DISPOSAL:	
EXCAVATED MATERIAL (CY) (SWELL FACTOR=1.25)	31

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 18:20:18

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 5--EXCV. & INCINERATE
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
SITE 14	
Soil type	1
Depth of excavation (ft)	2
1. Steel sheeting or	
2. side slope?	0
Horizontal component	0
Length of excavation (ft)	170
Width of excavation (ft)	59
Depth of cover above contaminated materials (ft)	0
Depth of contaminated excav. w/o continuous sampling (ft)	0
Depth of contaminated excav. w/continuous sampling (ft)	2
Thickness of lifts (inches)	24
Number of drums	0
Pct. of contaminated zone	0
Base air monitoring required?	N
Pct. of backfill available onsite	100

RESULTS

Component	Total
BYPRODUCTS FOR TRANSPORT/DISPOSAL:	
DRUMS	0
CONTAMINATED SOIL (CY) (SWELL FACTOR=1.15)	854

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 18:20:19

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 5--EXCV. & INCINERATE
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Protection level for:		COST FOR ALL EXCAVATIONS	
Uncontaminated materials	D		
Contaminated materials	C	CAPITAL COST	73,000
Temperature (degrees F)	70	O & M COSTS	0
Confidence level	M		

*** Excavation depth cannot exceed 25 feet. For excavations deeper than 25 feet, complex site-specific sheeting, bracing, dewatering, terracing and haul roads may be required. Excavation for depths deeper than 25 feet should be scoped and costed on a site-specific basis.

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. 4

SIGNATURE ROBERT MICHNA DATE 10-13-93 CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB-ES JOB NO. _____

SUBJECT SITE 14-ALT 6-DETAILED ANALYSIS SHEET 1 OF 7 SHEETS

ALTERNATIVE NO. 6 – EXCAVATION + DISPOSAL

SITE PREPARATION

- TEMPORARY FENCING (500 ft)

GENERAL SERVICES INCLUDED IN START-UP COSTS

EXCAVATION

- 740 yd^3, IN PLACE X 1.15 = 850 yd^3
- DIMENSIONS = 170 ft X 59 ft
- SANDY GRAVEL
- DEPTH = 2 TO 4 ft

SOIL VOLUME (FROM CRA) = 854 yd^3 X 1.25 TONS/yd^3 = 1,068 TONS

DISPOSAL (AS HAZARDOUS)

TECO LANDFILL, ROBSTOWN, TX 800 MILES

$125/TON X 1,068 TONS = $133,500

Costs: Site 14 Alternative No. 6--Excavation and Disposal

CAPITAL COSTS		
Process Option		Capital Cost ($)
Site Access Restrictions		14,000
Surface Water Controls		17,000
Excavation		73,000
Treatment: Off-Site RCRA Landfill		159,000
Transportation: Off-Site RCRA Landfill		190,000
Construction Subtotal		453,000
Bid Contingencies	15%	67,950
Scope Contingencies	20%	90,600
Construction Total		611,550
Engineering and Design	10%	61,155
Permitting and Legal	5%	30,578
Bonding and Insurance	3%	18,347
Construction Oversight	5%	30,578
Field and Laboratory Testing	3%	18,347
Total Capital Cost		770,553

OPERATION AND MAINTENANCE COSTS				
Process Option	Annual O&M Cost	Process Option Service Time (yrs)	Present Worth Factor	Present Worth Cost
Site Access Restrictions	0			0
Surface Water Controls	0			0
Excavation	0			0
Treatment: Off-Site RCRA Landfill	0			0
Transportation: Off-Site RCRA Landfill	0			0
Annual Operation and Maintenance Cost Subtotal	0			0
Total Annual Operating and Maintenance Cost	0			0

NET PRESENT VALUE	
Capital Cost	770,553
Present Worth O&M Cost	0
Total Cost for Alternative	770,553

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 18:23:46

CORA SITE ACCESS RESTRICTIONS COST MODULE (504)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 6--EXCV. & DISP. (HAZ
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
Site perimeter (ft)	500
Permanent fence required?	N
Temporary fence required?	Y
Lighting required?	N
Security guard required?	N
Access points req. guard	0
Guards per access point	0
Number of shifts	0
Temporary guardhouses	0
Vehicles required	0
Confidence level	H

RESULTS

Component	Total
CAPITAL COST	14,000
O & M COSTS	0

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 18:22:13

CORA SURFACE WATER DIVERSION/COLLECTION COST MODULE (105)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 6--EXCV. & DISP. (HAZ
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
Site on raised ground	
Length of site (ft)	200
Width of site (ft)	75
25-yr, 24-hr rain (in.)	--
Protection level	C
Average temp (degrees F)	70
Confidence level	M

RESULTS

Component	Total
CAPITAL COST	17,000
O & M COSTS	200
BYPRODUCTS FOR TRANSPORT/DISPOSAL:	
EXCAVATED MATERIAL (CY) (SWELL FACTOR=1.25)	31

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 18:22:40

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 6--EXCV. & DISP. (HAZ
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value
SITE 14	
Soil type	1
Depth of excavation (ft)	2
1. Steel sheeting or	
2. side slope?	0
Horizontal component	0
Length of excavation (ft)	170
Width of excavation (ft)	59
Depth of cover above contaminated materials (ft)	0
Depth of contaminated excav. w/o continuous sampling (ft)	0
Depth of contaminated excav. w/continuous sampling (ft)	2
Thickness of lifts (inches)	24
Number of drums	0
Pct. of contaminated zone	0
Base air monitoring required?	N
Pct. of backfill available onsite	100

RESULTS

Component	Total
BYPRODUCTS FOR TRANSPORT/DISPOSAL:	
DRUMS	0
CONTAMINATED SOIL (CY) (SWELL FACTOR=1.15)	854

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 18:22:41

CORA SOIL EXCAVATION COST MODULE (201)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 6--EXCV. & DISP. (HAZ
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS		RESULTS	
Parameter	Value	Component	Total
Protection level for:		COST FOR ALL EXCAVATIONS	
Uncontaminated materials	D		
Contaminated materials	C	CAPITAL COST	73,000
Temperature (degrees F)	70	O & M COSTS	0
Confidence level	M		

*** Excavation depth cannot exceed 25 feet. For excavations deeper than 25 feet, complex site-specific sheeting, bracing, dewatering, terracing and haul roads may be required. Excavation for depths deeper than 25 feet should be scoped and costed on a site-specific basis.

***** VERSION 3.0 DRAFT *****

DATE: 10/04/93
TIME: 18:23:30

CORA OFFSITE RCRA LANDFILL COST MODULE (401)

SITE NAME: HOLLOMAN 29 SITES - DA
OPERABLE UNIT: SITE 14 ESTIMATED START: MID FY 1994
SCENARIO: ALT 6--EXCV. & DISP. (HAZ
RUN BY: Craig Holloway PHONE NUMBER:

INPUTS

Parameter	Value	Unit Cost
RCRA AND NON-PCB SOLIDS:		
Bulk (Tons) *	1068	125.00
Mixed debris (CY) *	0	139.00
Drums (55-gallon)	0	66.50
Lab packs	0	110.00
Bulk waste requiring stabilization (Tons)**	0	225.00
Waste requiring stabilization (Drums)**	0	135.00
PCB/TOXIC SOLIDS:		
Bulk (Tons)*	0	237.00
Mixed debris (CY) *	0	222.00
Drums (55-gallon)	0	127.00
Tax per drum		8.95
Tax per cubic yard		27.00
Tax per ton		27.00
Level of confidence	M	
Miles to offsite facility	800	
Demurrage time/load (hrs)	2	
Capital or O&M landfill cost?	C	
Capital or O&M transportation cost?	C	

RESULTS

Component	Total
RCRA LANDFILL	
DISPOSAL COST	130,000
TAX	29,000
CAPITAL COST	159,000
O & M COSTS	0
TRANSPORTATION	
CAPITAL COST	190,000
O & M COSTS	0

* These materials will be charged at minimum rate of 2,000 lbs/cy. When converting tons to CY, CORA assumes a density of 90 lbs/cubic foot.

** Heavy/soft hammer wastes that have not been stabilized on site

APPENDIX E

CONTACT REPORTS/QUOTES

RADIAN CORPORATION

TELEPHONE CALL RECORD

☑ Incoming Call
☐ Outgoing Call

Project No.	
Project Name	HOLLOMAN AFB FS
Date	12-15-92
Time	11:00 AM
Person Calling	JIM MANNING
Activity	WESTINGHOUSE
Person Called	ROBERT MICHNA
Activity	RADIAN
General Subject	THERMAL DESORPTION COSTS

Distribution

TOPICS DISCUSSED AND ACTION TAKEN

- EARLIER MR. MANNING HAD INDICATED THAT TOTAL COSTS FOR THERMAL DESORPTION USING THE WESTINGHOUSE PROCESS (MODIFIED SHIRCO PROCESS) WOULD RANGE FROM $250 TO $350 PER TON. THIS COST INCLUDED EXCAVATION, MANAGEMENT, BACKFILL, ETC.
- MR. MANNING ESTIMATED THAT THE COSTS FOR THERMAL DESORPTION ALONE WOULD RANGE FROM ABOUT $100 PER TON TO $175 OR $200 PER TON. THE TREATMENT RATE FOR THE TECHNOLOGY IS ABOUT 10 TONS PER HOUR.

- 8-30-93: MR. MANNING CONFIRMED THAT THE ABOVE COSTS ARE CURRENT. RJM

Signature

RADIAN CORPORATION

TELEPHONE CALL RECORD

☐ Incoming Call
☒ Outgoing Call

Project No.	269-004-16-08
Project Name	HOLLOMAN AFB FS
Date	12-2-92
Time	3:00 pm
Person Calling	ROBERT MICHNA
Activity	
Person Called	JIM MANNING, [redacted]
Activity	(801) 265-2323 WESTINGHOUSE/APTUS; MURRAY, UT
General Subject	ACCEPTANCE OF CONTAMINATED SOILS FOR INCINERATION

Distribution

TOPICS DISCUSSED AND ACTION TAKEN

- I SENT (BY FAX) A SUMMARY OF THE MAXIMUM CONCENTRATIONS OF CONTAMINANTS IN THE CONTAMINATED SOILS. MR. MANNING SAID THAT ALL THE SOILS COULD BE INCINERATED AT THE APTUS FACILITY IN ARAGONITE, UT.

HE PROVIDED THE FOLLOWING COST INFORMATION:
INCINERATION: $0.85/lb ($1700/TON)
TRANSPORTATION: $0.03 TO $0.04/lb (ASSUMED 800 MILES)

OTHER TREATMENT COSTS (INCLUDING EXCAVATION, TREATMENT, BACKFILL):
SOIL WASHING: $150 TO $300/TON
THERMAL DESORPTION: $200 TO $400/TON

- SAMPLING REQUIREMENTS -- ONE PROFILE SAMPLE (IT CAN BE A COMPOSITE OF SEVERAL SITES) IS REQUIRED. IT COSTS ABOUT $500 GENERALLY, BUT AS HIGH AS $2000 IF WASTE IS NOT WELL KNOWN.
- ANALYSES INCLUDE: pH, Btu CONTENT, ASH CONTENT, MOISTURE FLASHPOINT, TOC, PCBs, VISCOSITY, MISCIBILITY WITH WATER, TCLP (PESTICIDES + HERBICIDES, BASE NEUTRALS, ACID EXTRACTABLES, TOTAL METALS, DIOXIN, AND PENTACHLOROPHENOL

Signature Robert J. Michna

RADIAN CORPORATION

TELEPHONE CALL RECORD

☐ Incoming Call
☒ Outgoing Call

Project No.	269-069-37-15
Project Name	HOLLOMAN AFB FS
Date	8-30-93
Time	4:00 pm
Person Calling	ROBERT MICHNA
Activity	
Person Called	JIM MANNING
Activity	(801) 265-2323 WESTINGHOUSE/APTUS; MURRAY, UT
General Subject	COSTS FOR INCINERATION

Distribution

TOPICS DISCUSSED AND ACTION TAKEN

- MR. MANNING INFORMED ME THAT COSTS FOR INCINERATION HAD FALLEN TO AS LOW AS $0.50/lb ($1000/TON).

Signature

RADIAN CORPORATION

TELEPHONE CALL RECORD

☐ Incoming Call
☒ Outgoing Call

Project No.	269-004-16-08
Project Name	HOLLOMAN AFB FS
Date	12-7-92
Time	12:45am
Person Calling	ROBERT MICHNA
Activity	
Person Called	JOE KING, NUMEX LANDFILL,
Activity	SUNLAND PARK, NM (505) 589-9440
General Subject	ACCEPTANCE OF CONTAMINATED SOILS AT INDUSTRIAL SW LANDFILL

Distribution

TOPICS DISCUSSED AND ACTION TAKEN

- MR. KING SAID NUMEX LANDFILL COULD ACCEPT CONTAMINATED SOILS IF THEY WERE NOT HAZARDOUS WASTES AND IF THEY FELL WITHIN THE FOLLOWING LIMITS:

TPH -- 50,000 ppm
BTEX -- 500 ppm
BENZENE -- 100 ppm
METALS -- BELOW TCLP LIMIT
PESTICIDES -- BELOW TCLP LIMIT

COSTS MAY RANGE FROM $9 TO $25/yd^3.

- TRANSPORTATION DIFFICULT FOR NUMEX TO SUPPLY.

- ACCEPTANCE — CLIENT MUST SUBMIT AN INITIAL SET OF COMPOSITE SAMPLES AND A WASTE PROFILE FORM. CONFIRMATION SAMPLING WOULD INVOLVE TAKING ONE RANDOM, COMPOSITE SAMPLE FROM EACH TRUCKLOAD.

Signature

RADIAN CORPORATION

TELEPHONE CALL RECORD

☐ Incoming Call
☒ Outgoing Call

Project No. 269-069-37-15	Distribution
Project Name HOLLOMAN AFB FS	
Date 8-19-93	Time 10:00 AM
Person Calling ROBERT MICHNA	Activity
Person Called JOE KING	Activity (915) 779-6401 NU-MEX LANDFILL, SUNLAND PARK, NM
General Subject	

TOPICS DISCUSSED AND ACTION TAKEN

- THE LANDFILL IS NOW USING BIOREMEDIATION FOR SOILS CONTAMINATED WITH CONTAMINANTS OTHER THAN LIGHTER FUELS. MR. KING SAID THAT PESTICIDE-CONTAMINATED SOILS WOULD NEED TO BE PUT THRUGH THIS PROCESS. THE LANDFILL COULD ACCEPT THE SOILS IF THEY ~~WERE~~ ARE NOT LAND-BANNED. COSTS WOULD BE $30/yd^3$ FOR DISPOSAL.

- DISPOSAL COSTS FOR TPH-CONTAMINATED SOILS RANGE FROM $10 TO $20/yd^3 ($9 TO $25/yd^3 ESTIMATED IN DEC 1992).

Signature

RADIAN CORPORATION

TELEPHONE CALL RECORD

☐ Incoming Call
☒ Outgoing Call

Project No.	269-004-16-08
Project Name	HOLLOMAN AFB FS
Date	12-3-92
Time	4:00 pm
Person Calling	ROBERT MICHNA
Activity	
Person Called	JIM JORDAN, CHEM. WASTE MGMT
Activity	RIO RANCHO, NM (505) 892-1200
General Subject	ACCEPTANCE OF CONTAMINATED SOILS AT RIO RANCHO LANDFILL

Distribution

TOPICS DISCUSSED AND ACTION TAKEN

- RIO RANCHO LANDFILL IS PERMITTED AS AN INDUSTRIAL SOLID WASTE LANDFILL. CHEM. WASTE MGMT. HAS A SIMILAR LANDFILL IN FARMINGTON. SAME CRITERIA.
- MR. JORDAN SAID THAT NON-HAZARDOUS, PETROLEUM-CONTAMINATED SOILS AND OTHER CONTAMINATED SOILS COULD BE ACCEPTED AS TYPE A WASTE IF THEY MET THE FOLLOWING CRITERIA:
- TPH -- 1000 ppm
- BTEX - 500 ppm
- BENZENE - TCLP (0.5 ppm mg/L)
- METALS - BELOW TCLP

DISPOSAL COST: $20/YD OR $30/DRUM

Signature

RADIAN CORPORATION

TELEPHONE CALL RECORD

☑ Incoming Call
☐ Outgoing Call

Project No.	
Project Name	HOLLOMAN AFB FS
Date	12-17-92
Time	4 PM
Person Calling	ROD STEELE, US ECOLOGY
Activity	(800) 999-7160
Person Called	ROBERT MICHNA
Activity	
General Subject	ACCEPTANCE OF CONTAMINATED SOIL AT TECO LANDFILL, ROBSTOWN, TX (RCRA HAZARDOUS WASTE)

Distribution

TOPICS DISCUSSED AND ACTION TAKEN

I HAD SENT MR. STEELE A SUMMARY OF MAXIMUM CONCENTRATIONS OF CONTAMINANTS IN THE SOIL. HE BELIEVED THAT MOST OF THE SOIL COULD PROBABLY BE ACCEPTED AT THE TECO LANDFILL. SPECIFIC COMMENTS FOLLOW—

SITE A(2+5) — ONLY BENZENE MAY CAUSE SOIL TO BE HAZARDOUS. THE SOIL COULD BE DECLARED A D018 WASTE OR TCLP ANALYSES COULD BE RUN ON A COMPOSITE SAMPLE.

SITE B(3) — BASED ON THE SUMMARY OF ANALYSES, THE SOIL IS NON-HAZARDOUS.

SITE C(8) — WOULD PROBABLY BE CLASSIFIED AS D008. THE SOIL MAY REQUIRE STABILIZATION FOR LEAD. AS LONG AS SOURCE OF CONTAMINATION IS "NORMAL APPLICATION OF PESTICIDES," TECO COULD PROBABLY ACCEPT SOIL.

SITE D(14) — AS LONG AS SOURCE IS DUE TO "NORMAL APPLICATION OF PESTICIDES," TECO COULD PROBABLY ACCEPT THE SOIL.

SITE E(20) — PCBs MAY BE A PROBLEM. SOIL MAY HAVE TO BE DISPOSED OF IN A TSCA-PERMITTED FACILITY. TECO IS NOT TSCA-PERMITTED. US ECOLOGY HAS A TSCA-PERMITTED FACILITY IN BEATTY, NEVADA

SITE F(30+33) — SOIL WILL PROBABLY REQUIRE STABILIZATION FOR LEAD PRIOR TO DISPOSAL IN THE TECO LANDFILL. STABILIZATION IS AVAILABLE AT TECO.

ANALYSES FOR KNOWN OR SUSPECTED CONTAMINANTS BY INDEPENDENT LAB IS REQUIRED FOR 1 COMPOSITE SAMPLE FROM EACH SITE. AFTER ACCEPTANCE, TECO RUNS A "MANDATORY AND SUPPLEMENTAL" ANALYSIS ON EACH LOAD. CLIENT USUALLY DOES NOT HAVE TO PAY THE MINIMAL COSTS FOR THIS CONFIRMATION SAMPLING.

Signature [illegible]

RADIAN CORPORATION

TELEPHONE CALL RECORD

☐ Incoming Call
☒ Outgoing Call

Project No. 269-004-16-08	Distribution
Project Name HOLLOMAN AFB FS	
Date 12-18-92	Time 9AM
Person Calling ROBERT MICHNA	Activity
Person Called BILL CAMPBELL	Activity TEXAS ECOLOGISTS (713) 821-5585

General Subject
COST ESTIMATES FOR DISPOSAL OF CONTAMINATED SOIL IN TECO LANDFILL (RCRA HAZARDOUS WASTE)

TOPICS DISCUSSED AND ACTION TAKEN

- ASSUMED BULK DENSITY OF SOIL = 1.25 tons/yd^3
- DISPOSAL COSTS MAY RANGE FROM $90 TO $115 PER TON FOR LARGE VOLUMES (e.g., 5000 TONS). COST MAY BE AS HIGH AS $150 PER TON FOR SMALLER VOLUMES.

- STABILIZATION COSTS, IF STABILIZATION IS REQUIRED, WOULD BE APPROXIMATELY $100 PER TON. TREATABILITY STUDIES COSTING $800 TO $1000 WOULD BE REQUIRED.

- COSTS FOR DISPOSAL OF SOIL IN THE US ECOLOGY TSCA-PERMITTED LANDFILL IN BEATTY, NEVADA WOULD BE ABOUT $100 PER TON TO $150 PER TON.

- MR. CAMPBELL RECOMMENDED LOADING THE SOIL INTO ROLL-OFFS AND SHIPPING THE ROLL-OFFS BY RAIL. TRANSPORTATION COSTS MAY RANGE FROM $60 TO $100 PER TON.

- SEPTEMBER 1993: A TECO REPRESENTATIVE CONFIRMED THESE PRICES.

Signature

RADIAN CORPORATION

TELEPHONE CALL RECORD

☐ Incoming Call
☒ Outgoing Call

Project No. 269-004-08-00	Distribution
Project Name HOLLOMAN AFB 28 SITES FS	
Date 2-1-93	Time 4:00pm
Person Calling ROBERT MICHNA	Activity
Person Called CHUCK POLINSKY	Activity CALGON (713) 690-2000

General Subject
COSTS FOR VAPOR-PHASE GAC

TOPICS DISCUSSED AND ACTION TAKEN

- CALGON VENTSORB CANISTERS HOLD 200 LBS CARBON APPROPRIATE FOR AIR FLOWS UP TO 100 cfm
- CANISTERS APPROPRIATE FOR BTEX COST $636 EACH.
- BTEX LOADING CAN RANGE FROM 10% TO 40% BY WT.
- BTEX LOADING OF 30 WT% CAN BE ACHIEVED UNDER FAVORABLE CONDITIONS

Signature

APPENDIX F

PDI ANALYTICAL RESULTS AND FIELD DATA

PDI ANALYTICAL RESULTS

Table F-1

Concentrations of Petroleum Hydrocarbons and Volatile Organics in Sites 2&5 Soil Samples

Location:	SB-02&5-17	SB-02&5-17	SB-02&5-18	SB-02&5-18	SB-02&5-18
Sample ID: Depth: [a]	SB-02&5-17-01 8.0 - 10.0 ft	SB-02&5-17-02 14.0 - 16.0 ft	SB-02&5-18-01 8.0 - 10.0 ft	SB-02&5-18-02 10.0 - 12.0 ft	SB-02&5-18-03 16.0 - 18.0 ft
EPA 418.1-TPH (mg/kg)	198	1140	491	2020	5050
SW8020-Volatile Aromatics (µg/kg)					
Benzene	ND	260	39	194	15700
Ethylbenzene	206	8600	5420	6010	101000
Toluene	28	2320	378	1350	43500
Total Xylenes	633	5900	21500	21600	244000
Location	SB-02&5-19	SB-02&5-19	SB-02&5-19	SB-02&5-19	
Sample ID Depth: [a]	SB-02&5-19-01 4.0 - 6.0 ft	SB-02&5-19-02 8.0 - 10.0 ft	SB-02&5-19-03 12.0 - 14.0 ft	SB-02&5-19-04 16.0 - 18.0 ft	
EPA 418.1-TPH (mg/kg)	5810	5600	3300	3790	
SW8020-Volatile Aromatics (µg/kg)					
Benzene	ND	1060	498	6040	
Ethylbenzene	3440	87000	49200	79200	
Toluene	ND	41900	15400	19800	
Total Xylenes	86000	332000	126000	208000	
Location:	SB-02&5-20	SB-02&5-20	SB-02&5-20		
Sample ID: Depth: [a]	SB-02&5-20-01 8.0 - 10.0 ft	SB-02&5-20-02 12.0 - 14.0 ft	SB-02&5-20-03 18.0 - 20.0 ft		
EPA 418.1-TPH (mg/kg)	2590	2420	1720		
SW8020-Volatile Aromatics (µg/kg)					
Benzene	ND	323	2150		
Ethylbenzene	27700	74500	30100		

Table F-1

(Continued)

Location:	SB-02&5-20	SB-02&5-20	SB-02&5-20		
Sample ID: Depth: [a]	SB-02&5-20-01 8.0 - 10.0 ft	SB-02&5-20-02 12.0 - 14.0 ft	SB-02&5-20-03 18.0 - 20.0 ft		
Toluene	2280	131000	9770		
Total Xylenes	134000	242000	110000		
Location:	SB-02&5-21	SB-02&5-21	SB-02&5-21	SB-02&5-21	
Sample ID: Depth: [a]	SB-02&5-21-01 6.0 - 8.0 ft	SB-02&5-21-02 10.0 - 12.0 ft	SB-02&5-21-03 14.0 - 16.0 ft	SB-02&5-21-04 16.0 - 18.0 ft	
EPA 418.1-TPH (mg/kg)	9930	5160	1520	8550	
SW8020-Volatile Aromatics (µg/kg)					
Benzene	3950	1620	146	5840	
Ethylbenzene	135000	81100	8070	68100	
Toluene	78800	42300	1860	9130	
Total Xylenes	500000	208000	279000	147000	
Location	SB-02&5-22	SB-02&5-22	SB-02&5-23	SB-02&5-23	
Sample ID Depth: [a]	SB-02&5-22-01 8.0 - 10.0 ft	SB-02&5-22-02 14.0 - 16.0 ft	SB-02&5-23-01 6.0 - 8.0 ft	SB-02&5-23-02 14.0 - 16.0 ft	
EPA 418.1-TPH (mg/kg)	ND	2340	ND	55.2	
SW8020-Volatile Aromatics (µg/kg)					
Benzene	ND	2450	ND	115	
Ethylbenzene	ND	58400	ND	5860	
Toluene	ND	10500	ND	ND	
Total Xylenes	98	88900	ND	8040	

Table F-1

(Continued)

Location:	SB-02&5-24	SB-02&5-24	SB-02&5-24	SB-02&5-25	SB-02&5-25
Sample ID: Depth: [a]	SB-02&5-24-01 0.0 - 2.0 ft	SB-02&5-24-02 6.0 - 8.0 ft	SB-02&5-24-03 10.0 - 12.0 ft	SB-02&5-25-01 4.0 - 6.0 ft	SB-02&5-25-02 14.0 - 16.0 ft
EPA 418.1-TPH (mg/kg)	1440	ND	305	ND	ND
SW8020-Volatile Aromatics (µg/kg)					
Benzene	ND	ND	851	ND	ND
Ethylbenzene	1420	ND	15200	ND	ND
Toluene	73	ND	7180	ND	ND
Total Xylenes	4350	ND	28100	ND	ND

[a]Depths for SB–2&5-17, -18, -19, -20, and -21 are measured from the top of the mounded area which is 4 ft above normal ground level.

ND = Not detected, below detection limit, or below reporting limit.

Table F-2

Fuel Identification, TOC, and Nutrient Results for Sites 2&5 Soil Samples

Location:	SB-02&5-18	SB-02&5-20	SB-02&5-21	SB-02&5-23
Sample ID: Depth:[a]	SB-02&5-18-02 10.0 - 12.0 ft	SB-02&5-20-02 12.0 - 14.0 ft	SB-02&5-21-03 14.0 - 16.0 ft	SB-02&5-23-02 14.0 - 16.0 ft
SW8015ME-Fuel ID (μg/kg)				
Diesel	NA	ND	1800X	ND
Jet Fuel	NA	ND	ND	ND
Kerosene	NA	2120I	1500I	143I
Total Organic Carbon (mg/kg)	NA	ND	ND	ND
Aerobic Bacteria (CFU/g)	2100	1100	300	NA
Nutrients (mg/kg)				
Ammonia	<1.0	<1.0	<1.0	NA
Nitrate	<1.0	<1.0	<1.0	NA
Phosphate	6.3	5.7	8.0	NA

[a] Depths for SB-02&5-18, -20, and -21 are measured from top of mound which is 4 ft above ground level.

NA = Not Analyzed.
ND = Not Detected or Detected Below Detection Limit.
I = Measured pattern does not meet standard profile.
X = Diesel is not present in sample. Measured pattern does not meet standard profile.

Table F-3

Concentrations of Analytes in Sites 2&5 Groundwater Samples

Location:	MW-02&5-02	MW-02&5-04	MW-02&5-05
Sample ID:	MW-02&5-02-01	MW-02&5-04-01	MW-02&5-05-01
Analyses			
Orthophosphate (mg/L)	0.051	0.024	0.234
Nitrate/Nitrite (mg/L)	ND	17.000	ND
Ammonia (mg/L)	0.082	0.241	0.215
TKN (mg/L)	0.999	0.136	0.800
Iron (mg/L)	2.520	18.900	5.780
pH	6.8	7.0	7.2
Dissolved Oxygen (mg/L)	3.3	4.7	2.2

ND = Not Detected.

Table F-4

Concentrations of Pesticides in Site 8 Soil Samples

Location:	SB-08-07	SB-08-08	SB-08-09	SB-08-10	SB-08-10	SB-08-11	SB-08-11	SB-08-12	SB-08-12
Sample ID: Depth:	SB-08-07-01 0.0 to 2.0 ft	SB-08-08-01 0.0 to 2.0 ft	SB-08-09-01 0.0 to 2.0 ft	SB-10-01-01 0.0 to 2.0 ft	SB-10-02-01 2.0 to 4.0 ft	SB-08-11-01 0.0 to 2.0 ft	SB-08-11-02 2.0 to 4.0 ft	SB-08-12-01 0.0 to 2.0 ft	SB-08-12-02 2.0 to 4.0 ft
Analyses									
SW8080-Pesticides (μg/kg)									
Aldrin	11.90B	5.47K	ND	ND	ND	ND	ND	2.08BP	ND
alpha-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta-BHC	ND	9.52K	ND	21.20K	ND	ND	ND	1.01P	ND
delta-BHC	ND	5.81	ND	ND	ND	ND	ND	ND	ND
gamma-BHC	2.44KB	ND	ND	2.74B	ND	6.51B	ND	ND	ND
Chlordane	ND	ND	ND	ND	ND	ND	ND	ND	ND
alpha-Chlordane	32.20B	18.10	1.25	106.00B	1.29B	11.10B	ND	21.10B	ND
gamma-Chlordane	57.30	67.80	2.30	157.00	1.64	46.60	238.00	30.00	ND
4,4'-DDD	56.40	9.35	3.38	116.00	1.51	21.00	ND	65.00P	ND
4,4'-DDE	52.10	8.10	8.96	88.40	1.40	23.30	ND	1850.00	12.00
4,4'-DDT	46.70	5.56	8.31	82.50	2.64	20.60	ND	2740.00	7.92
Dieldrin	ND	2.90KJ	ND	ND	ND	ND	ND	164.00K	ND
Endosulfan I	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	4.47K	5.61K	ND	10.10P	ND	4.31K	ND	ND	ND
Endosulfan Sulfate	ND	ND	ND	37.60B	ND	ND	ND	ND	ND
Endrin	7.67KB	7.78K	ND	10.70BK	ND	7.33KB	ND	15.70BK	ND
Endrin Aldehyde	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin Ketone	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor	4.14	3.29	ND	8.86P	ND	493.00	343.00	ND	ND
Heptachlor Epoxide	8.53B	3.90B	NR	6970.00 K	NR	5040.00 K	93600.00 K	10.50	ND
Isodrin	ND	6.29	ND	ND	ND	ND	ND	9.30	ND
Methoychlor	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mirex	ND	ND	ND	ND	ND	ND	ND	1.09P	ND

Table F-4

(Continued)

Location:	SB-08-07	SB-08-08	SB-08-09	SB-08-10	SB-08-10	SB-08-11	SB-08-11	SB-08-12	SB-08-12
Sample ID: Depth:	SB-08-07-01 0.0 to 2.0 ft	SB-08-08-01 0.0 to 2.0 ft	SB-08-09-01 0.0 to 2.0 ft	SB-10-01-01 0.0 to 2.0 ft	SB-10-02-01 2.0 to 4.0 ft	SB-08-11-01 0.0 to 2.0 ft	SB-08-11-02 2.0 to 4.0 ft	SB-08-12-01 0.0 to 2.0 ft	SB-08-12-02 2.0 to 4.0 ft
Analyses									
Toxaphene	ND	ND	ND	ND	ND	ND	ND	ND	ND
SW8080-TCLP Pesticides (μg/L)									
gamma-BHC	NA	NA	NA	0.13B	NA	NA	NA	NA	NA
Chlordane	NA	NA	NA	ND	NA	NA	NA	NA	NA
Endrin	NA	NA	NA	ND	NA	NA	NA	NA	NA
Heptachlor	NA	NA	NA	0.11	NA	NA	NA	NA	NA
Heptachlor Epoxide	NA	NA	NA	0.10	NA	NA	NA	NA	NA
Methoxychlor	NA	NA	NA	ND	NA	NA	NA	NA	NA
Toxaphene	NA	NA	NA	ND	NA	NA	NA	NA	NA
Location:	SB-08-13	SB-08-13	SB-08-13	SB-08-14	SB-08-14	SB-08-15	SB-08-15	SB-08-16	SB-08-17
Sample ID: Depth:	SB-08-13-01 0.0 to 2.0 ft	SB-08-13-02 2.0 to 4.0 ft	SB-08-13-03 4.0 to 6.0 ft	SB-08-14-01 2.0 to 4.0 ft	SB-08-14-02 4.0 to 6.0 ft	SB-08-15-01 0.0 to 2.0 ft	SB-08-15-02 2.0 to 4.0 ft	SB-08-16-01 0.0 to 2.0 ft	SB-08-17-01 0.0 to 2.0 ft
Analyses									
SW8080-Pesticides (μg/kg)									
Aldrin	9.64	ND	ND	ND	ND	2.54BP	ND	ND	ND
alpha-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta-BHC	ND	ND	ND	ND	ND	5.88K	1.51K	ND	ND
delta-BHC	8.48	ND	ND	ND	ND	ND	ND	ND	ND
gamma-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlordane	ND	ND	ND	ND	ND	ND	ND	ND	ND
alpha-Chlordane	72.40	ND	ND	ND	ND	1.47KB	ND	ND	ND
gamma-Chlordane	314.00	2.46	1.82	1.20	2.89	3.40	2.22	ND	ND
4,4'-DDD	492.00P	1.76P	4.93	ND	1.03	1.67	1.94	1.53	ND
4,4'-DDE	2500.00	15.60	12.10	2.89	5.86	6.10	4.02	10.20	106.00

Table F-4

(Continued)

Location:	SB-08-13	SB-08-13	SB-08-13	SB-08-14	SB-08-14	SB-08-15	SB-08-15	SB-08-16	SB-08-17
Sample ID: Depth:	SB-08-13-01 0.0 to 2.0 ft	SB-08-13-02 2.0 to 4.0 ft	SB-08-13-03 4.0 to 6.0 ft	SB-08-14-01 2.0 to 4.0 ft	SB-08-14-02 4.0 to 6.0 ft	SB-08-15-01 0.0 to 2.0 ft	SB-08-15-02 2.0 to 4.0 ft	SB-08-16-01 0.0 to 2.0 ft	SB-08-17-01 0.0 to 2.0 ft
Analyses									
4,4'-DDT	4210.00	23.40	18.40	3.69	6.02	3.48	3.98	8.06	29.60
Dieldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan I	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan Sulfate	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin	60.80K	1.12K	1.40K	ND	ND	ND	ND	ND	1.11KB
Endrin Aldehyde	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin Ketone	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor	7.75	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor Epoxide	18.40	1.16B	1.10B	ND	ND	2.42BP	ND	ND	ND
Isodrin	13.90	ND	ND	ND	ND	ND	ND	ND	ND
Methoychlor	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mirex	ND	ND	ND	ND	ND	ND	ND	17.90P	ND
Toxaphene	ND	ND	ND	ND	ND	ND	ND	ND	ND
SW8080-TCLP Pesticides (μg/L)									
gamma-BHC	0.09B	ND	NA	NA	NA	NA	NA	NA	ND
Chlordane	ND	ND	NA	NA	NA	NA	NA	NA	ND
Endrin	ND	ND	NA	NA	NA	NA	NA	NA	ND
Heptachlor	0.05K	ND	NA	NA	NA	NA	NA	NA	0.04K
Heptachlor Epoxide	1.22P	0.03	NA	NA	NA	NA	NA	NA	ND
Methoxychlor	ND	ND	NA	NA	NA	NA	NA	NA	ND
Toxaphene	ND	ND	NA	NA	NA	NA	NA	NA	ND

Table F-4

(Continued)

Location:	SB-08-17	SB-08-17	SB-08-18	SB-08-19	SB-08-19	SB-08-20	SB-08-20		
Sample ID: Depth:	SB-08-17-01 2.0 to 4.0 ft Field Dup	SB-08-17-02 2.0 to 4.0 ft	SB-08-18-01 0.0 to 2.0 ft	SB-08-19-01 0.0 to 2.0 ft	SB-08-19-02 2.0 to 4.0 ft	SB-08-20-01 0.0 to 2.0 ft	SB-08-20-02 2.0 to 4.0 ft		
Analyses									
SW8080-Pesticides (μg/kg)									
Aldrin	ND	ND	1.44BP	ND	ND	ND	ND		
alpha-BHC	ND	ND	ND	ND	ND	ND	ND		
beta-BHC	ND	ND	1.50K	ND	ND	ND	ND		
delta-BHC	ND	ND	ND	ND	ND	ND	ND		
gamma-BHC	ND	ND	ND	ND	ND	ND	ND		
Chlordane	ND	ND	ND	ND	ND	ND	ND		
alpha-Chlordane	ND	ND	9.15B	ND	ND	ND	ND		
gamma-Chlordane	ND	ND	12.40	2.83	ND	ND	ND		
4,4'-DDD	ND	ND	91.20	1.33	ND	ND	ND		
4,4'-DDE	105.0	8.90	696.00	1.20	ND	7.81	ND		
4,4'-DDT	0.27	4.41	707.00	3.43	ND	9.97	ND		
Dieldrin	ND	ND	148.00KE	ND	ND	ND	ND		
Endosulfan I	ND	ND	ND	ND	ND	ND	ND		
Endosulfan II	ND	ND	ND	ND	ND	ND	ND		
Endosulfan Sulfate	ND	ND	ND	ND	<DL	ND	<DL		
Endrin	ND	ND	10.40KB	ND	ND	ND	ND		
Endrin Aldehyde	ND	ND	ND	ND	ND	ND	ND		
Endrin Ketone	ND	ND	ND	ND	ND	ND	ND		
Heptachlor	ND	ND	ND	ND	ND	ND	ND		
Heptachlor Epoxide	ND	ND	ND	ND	ND	ND	ND		
Isodrin	ND	ND	2.70P	ND	ND	ND	ND		
Methoychlor	ND	ND	ND	ND	ND	ND	ND		

Table F-4

(Continued)

Location:	SB-08-17	SB-08-17	SB-08-18	SB-08-19	SB-08-19	SB-08-20	SB-08-20		
Sample ID: Depth:	SB-08-17-01 2.0 to 4.0 ft Field Dup	SB-08-17-02 2.0 to 4.0 ft	SB-08-18-01 0.0 to 2.0 ft	SB-08-19-01 0.0 to 2.0 ft	SB-08-19-02 2.0 to 4.0 ft	SB-08-20-01 0.0 to 2.0 ft	SB-08-20-02 2.0 to 4.0 ft		
Analyses									
Mirex	ND	ND	ND	ND	ND	ND	ND		
Toxaphene	ND	ND	ND	ND	ND	ND	ND		

B = Analyte detected in method blank.
E = Analyte concentration exceeded calibration range.
K = Confirmation unsuccessful. Analyte not detected on second column.
P = Analyte not confirmed. Ratio of results from primary and secondary GC columns greater than 3.
ND = Not detected, detected below detection limit, or detected below reporting limit.
NA = Not Analyzed.

Table F-5

Concentrations of Metals Analytes in Site 8 Soil Samples

Location:	SB-08-07	SB-08-10	SB-08-11	SB-08-12	
Sample ID: Depth:	SB-08-07-01 0.0 to 2.0 ft	SB-10-01-01 0.0 to 2.0 ft	SB-08-11-01 0.0 to 2.0 ft	SB-08-12-02 2.0 to 4.0 ft	
Analyses					
SW6010-Cadmium (mg/kg)	ND	3.710	ND	ND	
SW7421-Lead (mg/kg)	9.220	69.900	50.600	2.800	
SW7471-Mercury (mg/kg)	ND	0.297	0.068	ND	
SW6010-TCLP Metals (mg/L)					
Arsenic	NA	ND	NA	NA	
Barium	NA	0.148	NA	NA	
Cadmium	NA	ND	NA	NA	
Chromium	NA	0.028	NA	NA	
Lead	NA	ND	NA	NA	
Silver	NA	ND	NA	NA	
SW7470-TCLP Mercury (mg/L)	NA	ND	NA	NA	
SW7740-TCLP Selenium (mg/L)	NA	0.017	NA	NA	
Location:	SB-08-13	SB-08-13	SB-08-14	SB-08-17	SB-08-19
Sample ID: Depth:	SB-08-13-01 0.0 to 2.0 ft	SB-08-13-02 2.0 to 4.0 ft	SB-08-14-01 2.0 to 4.0 ft	SB-08-17-01 0.0 to 2.0 ft	SB-08-19-01 0.0 to 2.0 ft
Analyses					
SW6010-Cadmium (mg/kg)	NA	ND	ND	ND	ND
SW7421-Lead (mg/kg)	NA	9.110	7.250	7.440	0.726
SW7471-Mercury (mg/kg)	NA	ND	ND	ND	ND
SW6010-TCLP Metals (mg/L)					
Arsenic	ND	ND	NA	ND	NA
Barium	0.148	0.359	NA	0.388	NA
Cadmium	ND	ND	NA	ND	NA
Chromium	0.028	0.010	NA	0.023	NA
Analyses					
Lead	ND	ND	NA	ND	NA
Silver	ND	ND	NA	ND	NA
SW7470-TCLP Mercury (mg/L)	ND	ND	NA	ND	NA
SW7740-TCLP Selenium (mg/L)	0.029	ND	NA	ND	NA

ND = Not detected, detected below detection limit, or detected below reporting limit.

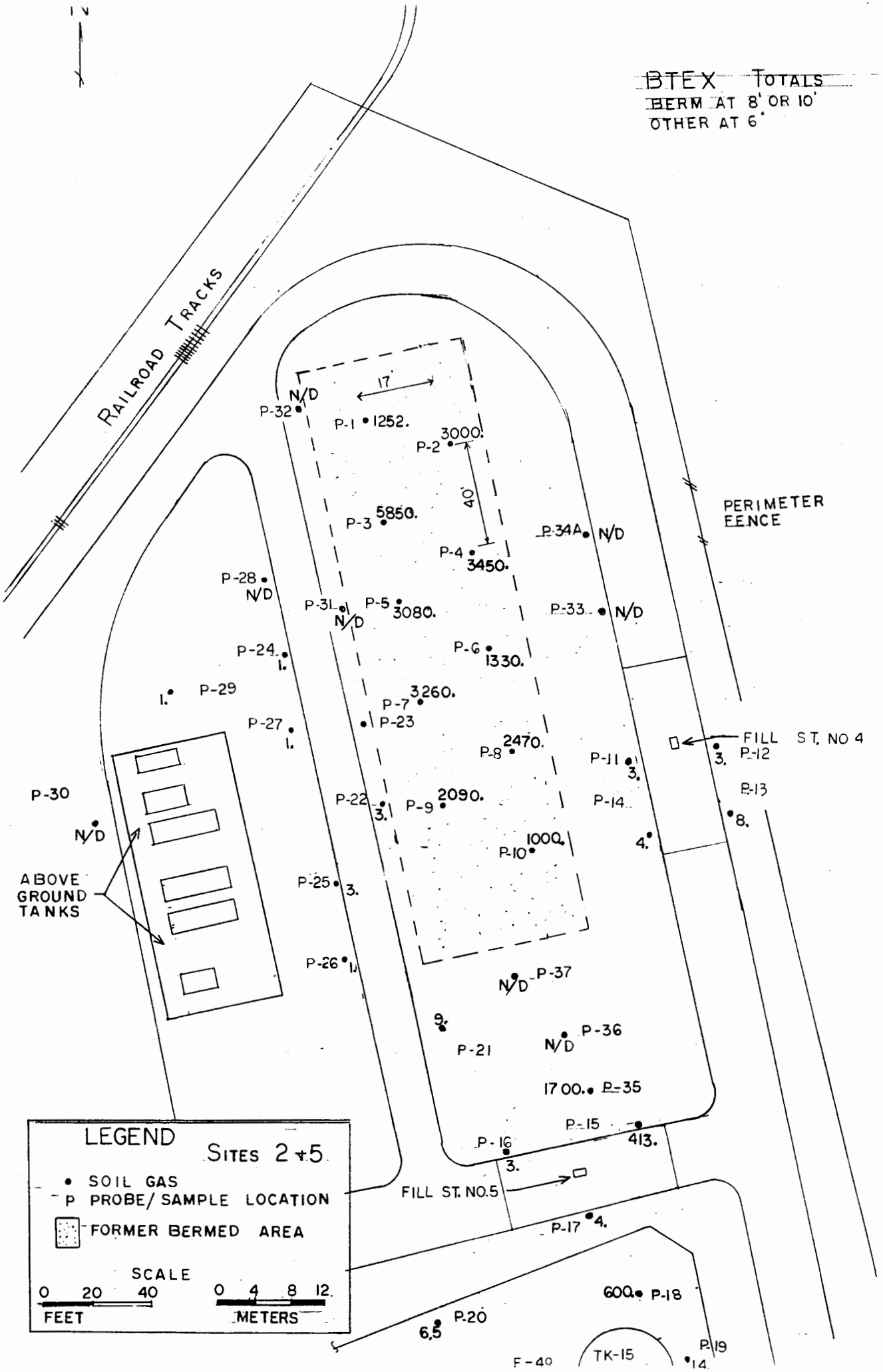
PDI SOIL GAS SURVEY RESULTS

BERM AREA

Location	Depth	Conc. ug/l	V1	V2 sec.	Comments
P-1-A	10'	1252.	29.	12.	
P-1-B	14'	1835.			
P-2-A	8'	571.	12.	5.	
P-2-A	"	3402.	13.	5.	Duplicate
P-2-A	"	2738.	15.	6.	Duplicate
P-2-B	12'	3333.	21.	12.	
P-3-A	10'	5849.	19.	10.	
P-3-B	14'	No Vapor	180.+	-	Unable to aquire SV Sample.
P-3-C	13/15'	23450.	-	-	Soil Sample
P-4-A	8'	3452.	34.	12.	
P-4-B	16'	5391.	23.	10.	
P-5-A	10'	3079.	18.	8.	
P-5-B	14'	94.	24.	12.	
P-6-A	8'	1327.	20.	9.	
P-6-B	12'	3072.	26.	12.	
P-7-A	10'	3260.	18.	10.	
P-7-B	14'	179.	16.	5.	
P-8-A	8'	2466.	15.	6.	
P-8-B	14/16'	47.	25.	12.	
P-9-A	10'	2088.	18.	8.	
P-9-B	14'	4432.	20.	8.	
P-10-A	8'	993.	16.	6.	
P-10-B	12'	349.	23.	11.	
P-10-C	16'	2364.	19.	5.	Duplicate
P-10-C	16'	3138.	18.	7.	Duplicate

OTHER AREAS

Location	Depth	Conc. ug/l	V1	V2 sec.	Comments
P-11	6'	19.	23.	10.	
P-14	6'	4.	34.	15.	
P-12	6'	3.	35.	16.	
P-13	6'	8.	23.	12.	
P-15	6'	413.	20.	8.	
P-16	6'	3.	12.	5.	
P-17	6'	4.	12.	4.	
P-18	6'	600.	21.	10.	
P-19	6'	14.	16.	5.	
P-20	6'	6.5	31.	12.	
P-21	6'	9.	36.	15.	
P-22	6'	3.	30.	12.	
P-23	6'	2.	22.	10.	
P-24	6'	1.	18.	7.	
P-25	6'	3.	21.	10.	
P-26	6'	1.	28.	12.	
P-27	6'	1.	15.	6.	
P-28	6'	N/D	21.	10.	
P-29	6'	1.	16.	5.	
P-30	6'	N/D	26.	12.	
P-31	6'	N/D	24.	11.	
P-32	6'	N/D	19.	9.	
P-33-A	6'	N/D	23.	11.	
P-33-B	12'	N/D	16.	6.	
P-34-A	6'	N/D	26.	12.	
P-34-B	12'	N/D	16.	5.	
P-35	6'	1698.	18.	8.	
P-36	6'	N/D	18.	8.	
P-36	6'	N/D	20.	9.	Duplicate
P-37	6'	N/D	23.	10.	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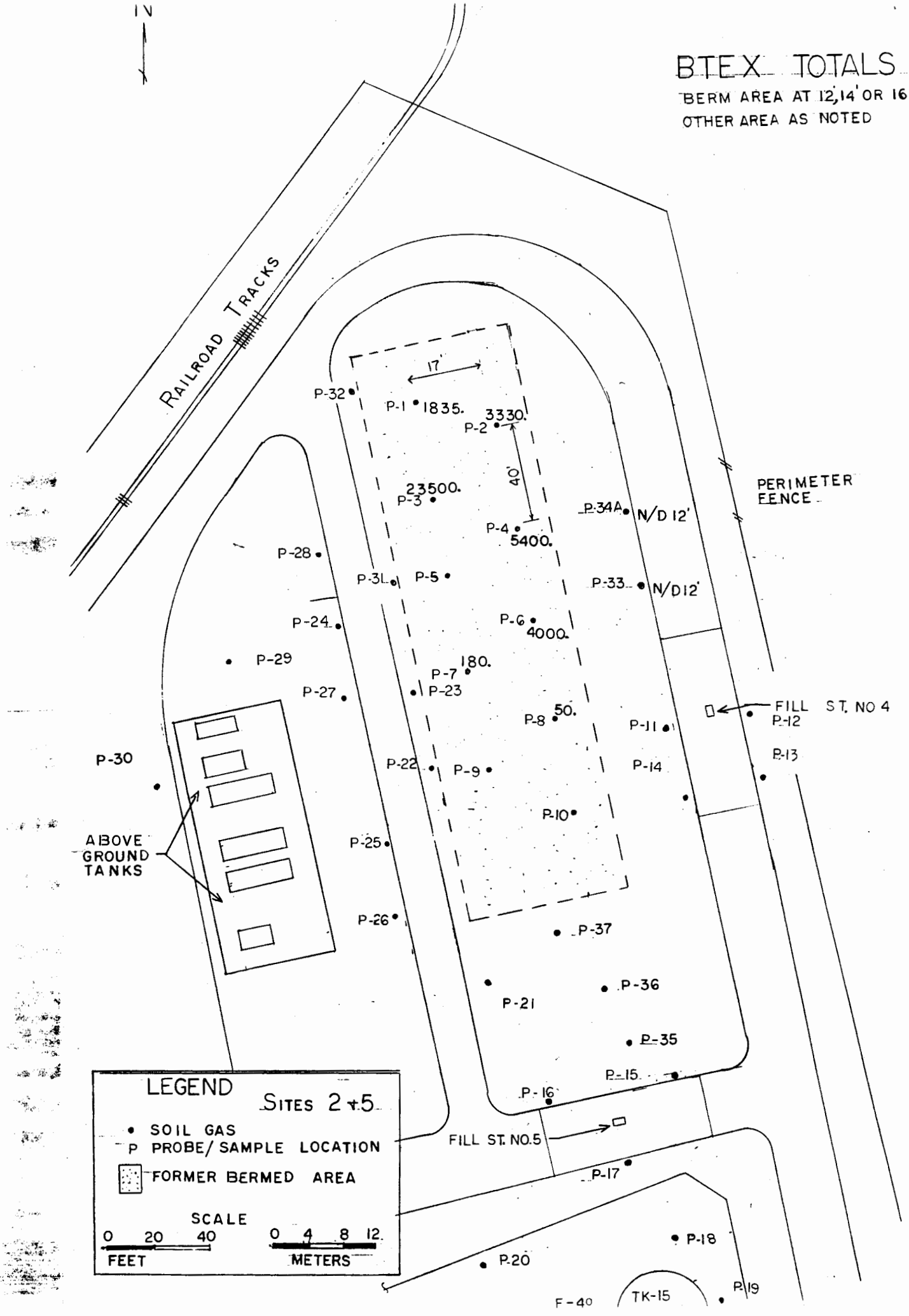
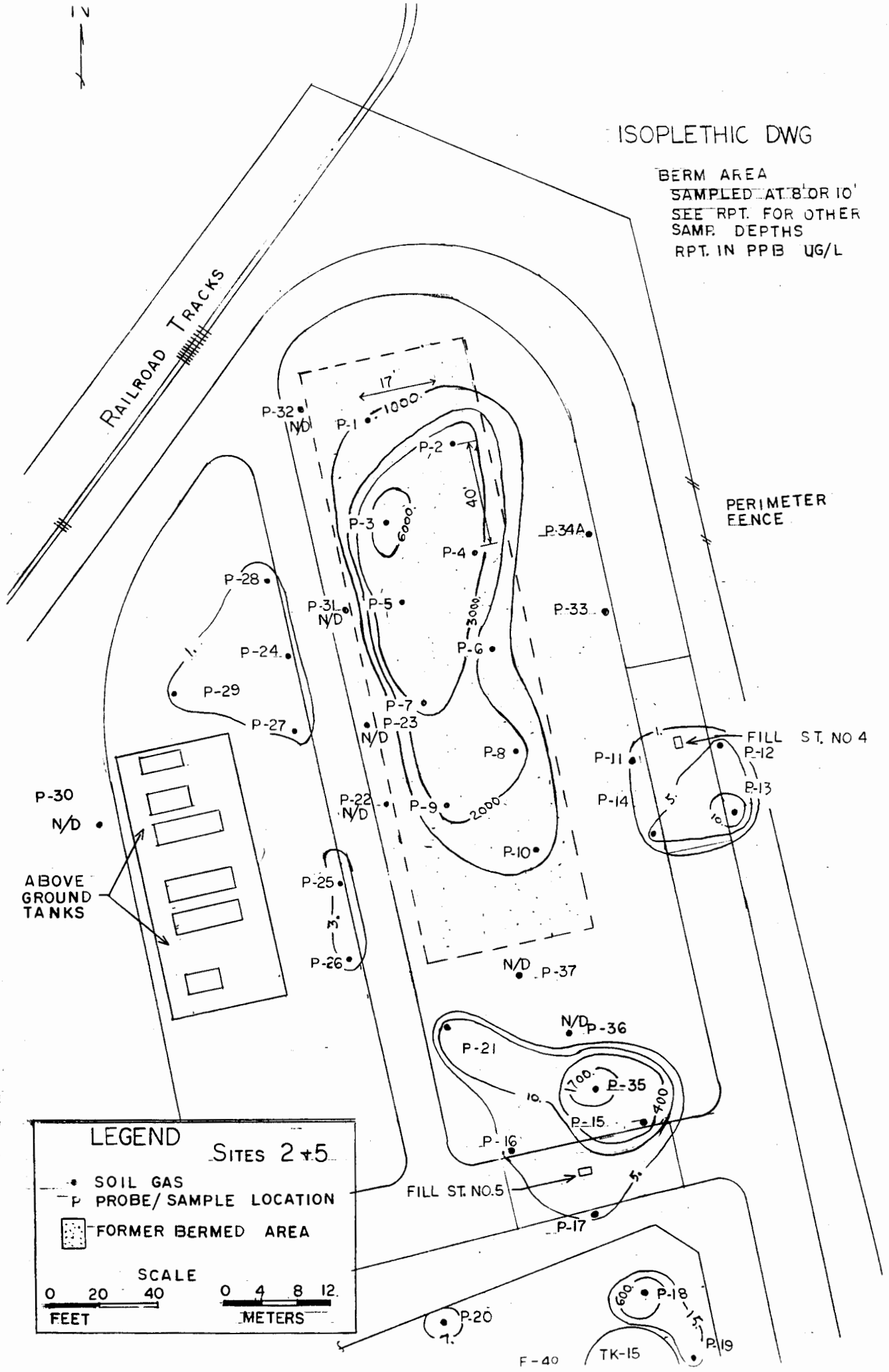
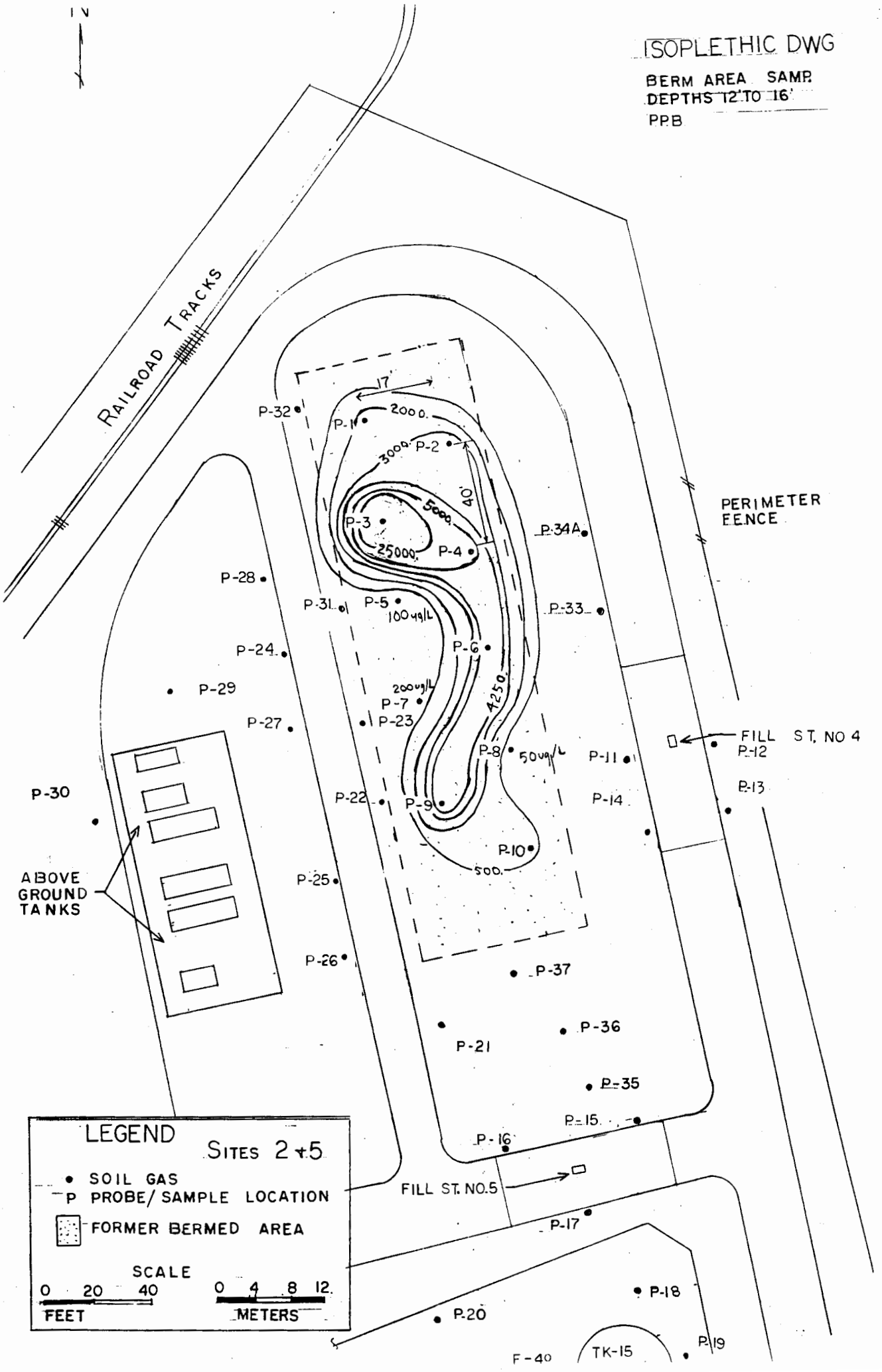
BTEX TOTALS
BERM AT 8' OR 10'
OTHER AT 6'
RAILROAD TRACKS
PERIMETER FENCE
17'
40'
P-32 N/D
P-1 1252.
P-2 3000.
P-3 5850.
P-4 3450.
P-34A N/D
P-28 N/D
P-31 N/D
P-5 3080.
P-33 N/D
P-24 1.
P-6 1330.
1. P-29
P-7 3260.
P-23
P-27 1.
P-8 2470.
P-11 3.
FILL ST. NO 4
3. P-12
P-13
8.
P-30
N/D
P-22 3.
P-9 2090.
P-14
4.
P-10 1000.
ABOVE GROUND TANKS
P-25 3.
P-26 1.
N/D P-37
9.
P-21
N/D P-36
1700. P-35
P-15 413.
P-16 3.
FILL ST. NO.5
P-17 4.
600. P-18
P-20 6.5
F-40
TK-15
P-19 14.
LEGEND
SITES 2 + 5
• SOIL GAS
P PROBE/SAMPLE LOCATION
FORMER BERMED AREA
SCALE
0 20 40
FEET
0 4 8 12.
METERS


BTEX TOTALS
BERM AREA AT 12,14' OR 16'
OTHER AREA AS NOTED
N
RAILROAD TRACKS
17'
40'
P-32
P-1
1835.
P-2
3330.
23500.
P-3
P-4
5400.
P-34A
N/D 12'
PERIMETER FENCE
P-28
P-31
P-5
P-33
N/D12'
P-24
P-6
4000.
P-29
P-7
180.
P-23
P-27
P-8
50.
P-11
FILL ST. NO 4
P-12
P-13
P-30
P-22
P-9
P-14
P-10
ABOVE GROUND TANKS
P-25
P-26
P-37
P-36
P-21
P-35
P-15
P-16
FILL ST. NO.5
P-17
P-18
P-20
P-19
TK-15
LEGEND
SITES 2+5
SOIL GAS
P PROBE/SAMPLE LOCATION
FORMER BERMED AREA
SCALE
0 20 40
FEET
0 4 8 12
METERS


N
ISOPLETHIC DWG
BERM AREA
SAMPLED AT 8' OR 10'
SEE RPT. FOR OTHER
SAMP. DEPTHS
RPT. IN PPB UG/L
RAILROAD TRACKS
PERIMETER FENCE
17'
40'
1000
6000
3000
2000
P-32 N/D
P-1
P-2
P-3
P-4
P-5
P-6
P-7
P-8
P-9
P-10
P-11
P-12
P-13
P-14
P-15
P-16
P-17
P-18
P-19
P-20
P-21
P-22 N/D
P-23 N/D
P-24
P-25
P-26
P-27
P-28
P-29
P-30 N/D
P-31 N/D
P-33
P-34A
P-35
P-36 N/D
P-37 N/D
FILL ST. NO 4
FILL ST. NO.5
ABOVE GROUND TANKS
TK-15
LEGEND
SITES 2 + 5
SOIL GAS
PROBE/SAMPLE LOCATION
FORMER BERMED AREA
SCALE
0 20 40
FEET
0 4 8 12
METERS


ISOPLETHIC DWG
BERM AREA SAMP.
DEPTHS 12' TO 16'
PPB
N
RAILROAD TRACKS
PERIMETER FENCE
17'
40'
2000.
3000.
5000.
25000.
4250.
500.
100 ug/L
200 ug/L
50 ug/L
P-1
P-2
P-3
P-4
P-5
P-6
P-7
P-8
P-9
P-10
P-11
P-12
P-13
P-14
P-15
P-16
P-17
P-18
P-19
P-20
P-21
P-22
P-23
P-24
P-25
P-26
P-27
P-28
P-29
P-30
P-31
P-32
P-33
P-34A
P-35
P-36
P-37
FILL ST. NO 4
FILL ST. NO.5
ABOVE GROUND TANKS
TK-15
F-40
LEGEND
SITES 2+5
SOIL GAS
P PROBE/SAMPLE LOCATION
FORMER BERMED AREA
SCALE
0 20 40
FEET
0 4 8 12
METERS

ANALYTICAL REPORT
Petro Site Assessment

Site: HOLLOMAN AFB # 2 & 5 Sites

Client : RADIAN CORP. Client site Rep. LAURA MALEY Date 4-28-93

SAMPLE		MW	ANALYTE	(PPM) ul/L	ug /L	mg/Kg
Location	P-2A	78.12	BENZENE	60.	192.	
Depth	8'	92.15	TOLUENE	22.	83.	
Type	SV	106.17	ETHYL BENZENE	29.	126.	
Weight	100ul	106.17	XYLENES (P,M,O)	39.	170.	
Rpt.#	4		BTEX	151.	571.	
Run #	005		METHANE			
Location	P-2A	78.12	BENZENE	395.	1265.	
Depth	8'	92.15	TOLUENE	145.	548.	
Type	SV	106.17	ETHYL BENZENE	152.	662.	
Weight	100ul	106.17	XYLENES (P,M,O)	213.	927.	
Rpt.#	5		BTEX	913.	3402.	
Run #	005		METHANE Duplicate			
Location	P-2A	78.12	BENZENE	322.	1031.	
Depth	8'	92.15	TOLUENE	119.	450.	
Type	SV	106.17	ETHYL BENZENE	119.	518.	
Weight	100ul	106.17	XYLENES (P,M,O)	169.	736.	
Rpt.#	6		BTEX	729.	2738.	
Run #	006		METHANE (NOTE: decon more 2' 7 re-sample			
Location	P-2B	78.12	BENZENE	354.	1134.	
Depth	12'	92.15	TOLUENE	136.	514.	
Type	SV	106.17	ETHYL BENZENE	158.	688.	
Weight	100ul	106.17	XYLENES (P,M,O)	229.	997	
Rpt.#	8		BTEX	878.	3333.	
Run #	007		METHANE			

MW = molecular weight , PPM = parts per million , ul/L = microliter per liter
ug/L = milligram per liter , mg/Kg = milligram per kilogram , g = gram
N/D = non-detect , SS = soil sample, WS= water sample, SV= soil vapor sample

PROBE TECHNICIAN: Franklyn A. Galvez Analyst: Roger R. Sense X_____

ANALYTICAL REPORT
Petro Site Assessment

Site: HOLLOMAN AFB # 2 & 5 Sites

Client : RADIAN CORP. Client site Rep. LAURA MALEY Date 4-28-93 pg. 2 of

AMPLE		MW	ANALYTE	(PPM) ul/L	ug /L	mg/Kg
ocation	P-11	78.12	BENZENE	1.	3.	
epth	6'	92.15	TOLUENE	2.	8.	
ype	SV	106.17	ETHYL BENZENE	1.	4.	
eight	100ul	106.17	XYLENES (P,M,O)	1.	4.	
C Rpt.#	009		BTEX	5.	19.	
C Run #	008		METHANE			
ocation	P-11	78.12	BENZENE	.4	1.	
epth	6'	92.15	TOLUENE	.5	2.	
ype	SV	106.17	ETHYL BENZENE	N/D	-	
eight	100ul	106.17	XYLENES (P,M,O)	N/D	-	
C Rpt.#	10		BTEX	1.0	3.	
C Run #	010		METHANE			
ocation	P--=14A	78.12	BENZENE	.3	1.	
epth	6'	92.15	TOLUENE	.6	2.	
ype	SV	106.17	ETHYL BENZENE	N/D	-	
eight	100ul	106.17	XYLENES (P,M,O)	.2	1.	
C Rpt.#	13		BTEX	1.5	4.	
C Run #	011		METHANE			
ocation	P-12A	78.12	BENZENE	.2		
epth	6'	92.15	TOLUENE	.5		
ype	SV	106.17	ETHYL BENZENE	N/D		
eight	100ul	106.17	XYLENES (P,M,O)	"		
C Rpt.#	16		BTEX	1.		
C Run #	013		METHANE			

MW = molecular weight , PPM = parts per million , ul/L = microliter per liter
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N/D = non-detect , SS = soil sample, WS= water sample, SV= soil vapor sample

PROBE TECHNICIAN: Franklyn A. Galvez Analyst: Roger R. Sense X_____

ANALYTICAL REPORT
Petro Site Assessment

Site: HOLLOMAN AFB # 2 & 5 Sites

Client : RADIAN CORP. Client site Rep. LAURA MALEY Date 4-28-93

LE		MW	ANALYTE	(PPM) ul/L	ug /L	mg/Kg
ocation	P-13A	78.12	BENZENE	.5	2.	
epth	6'	92.15	TOLUENE	1.5	6.	
ype	SV	106.17	ETHYL BENZENE	N/D	_	
eight	100ul	106.17	XYLENES (P,M,O)	"	_	
Rpt.#	17		BTEX	2.0	8.0	
Run #	013		METHANE			
ocation	P-15A	78.12	BENZENE	39.	125.	
epth	6'	92.15	TOLUENE	13.	49.	
ype	SV	106.17	ETHYL BENZENE	.	178.	
eight	100ul	106.17	XYLENES (P,M,O)	14.	61.	
Rpt.#	8		BTEX	108.	413.	
n #	021		METHANE			
ocation	P16	78.12	BENZENE	.1	<1	
epth	6'	92.15	TOLUENE	.2	<1	
ype	SV	106.17	ETHYL BENZENE	.3	>1	
eight	100ul	106.17	XYLENES (P,M,O)	.1	<1	
Rpt.#	11		BTEX	.7	3.	
Run #	023		METHANE			
ocation	P-17	78.12	BENZENE	.04	<1.	
pth	6'	92.15	TOLUENE	.6	2.	
pe	SV	106.17	ETHYL BENZENE	.24	1.	
ight	100ul	106.17	XYLENES (P,M,O)	N/D	-	
Rpt.#	13		BTEX	1.1	4.	
#	024		METHANE			

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/D = non-detect , SS = soil sample, WS= water sample, SV= soil vapor sample

ROBE TECH TAN: Franklyn A. Galvez Analyst: Roger R. Sense X_____

ANALYTICAL REPORT
Petro Site Assessment

Site: HOLLOMAN AFB # 2 & 5 Sites

Client : RADIAN CORP. Client site Rep. LAURA MALEY Date 4-28-93

MPLE		MW	ANALYTE	(PPM) ul/L	ug /L	mg/Kg
cation	P-21A	78.12	BENZENE	.9	3.	
pth	6'	92.15	TOLUENE	.9	3.	
pe	SV	106.17	ETHYL BENZENE	.4	2.	
ight	100ul	106.17	XYLENES (P,M,O)	.3	1.	
Rpt.#	15		BTEX	2.5	9.	
Run #	025		METHANE			
cation	P-22A	78.12	BENZENE	0.1	3.	
pth	6'	92.15	TOLUENE	N/D	-	
pe	SV	106.17	ETHYL BENZENE	"	-	
ight	100ul	106.17	XYLENES (P,M,O)	"	-	
Rpt.#	17		BTEX	0.1	3.	
Run #	026		METHANE			
cation	P-23	78.12	BENZENE	0.04	<1.	
pth	6'	92.15	TOLUENE	.6	2.	
pe	SV	106.17	ETHYL BENZENE	N/D	-	
ight	100ul	106.17	XYLENES (P,M,O)	"		
Rpt.#	19		BTEX	1.	2.	
Run #	029		METHANE			
cation	P-26A	78.12	BENZENE	N/D	<1	
pth	6'	92.15	TOLUENE	0.13		
pe	SV	106.17	ETHYL BENZENE	N/D		
ight	100ul	106.17	XYLENES (P,M,O)	"		
Rpt.#	21		BTEX	0.13	<1	
Run #	030		METHANE			

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/D = non-detect , SS = soil sample, WS= water sample, SV= soil vapor sample

ROBE TECHNICIAN: Franklyn A. Galvez Analyst: Roger R. Sense X_____

Petro Site Assessment

Site: HOLLOMAN AFB # 2 & 5 Sites

Client : RADIAN CORP. Client site Rep. LAURA MALEY Date 4-28-93 pg. 5 of 5

MPLE		MW	ANALYTE	(PPM) ul/L	ug /L	mg/Kg
ocation	P-25	78.12	BENZENE	0.06		
epth	6'	92.15	TOLUENE	.7		
ype	SV	106.17	ETHYL BENZENE	N/D		
eight	100ul	106.17	XYLENES (P,M,O)	"		
C Rpt.#	22		BTEX	0.8		
C Run #	031		METHANE			
ocation		78.12	BENZENE			
epth		92.15	TOLUENE			
ype		106.17	ETHYL BENZENE			
eight		106.17	XYLENES (P,M,O)			
C Rpt.#			BTEX			
C n #			METHANE			
ocation		78.12	BENZENE			
epth		92.15	TOLUENE			
ype		106.17	ETHYL BENZENE			
eight		106.17	XYLENES (P,M,O)			
C Rpt.#			BTEX			
C Run #			METHANE			
ocation		78.12	BENZENE			
epth		92.15	TOLUENE			
ype		106.17	ETHYL BENZENE			
eight		106.17	XYLENES (P,M,O)			
C Rpt.#			BTEX			
C n #			METHANE			

MW = molecular weight , PPM = parts per million , ul/L = microliter per liter
mg/L = milligram per liter , mg/Kg = milligram per kilogram , g = gram
N/D = non-detect , SS = soil sample, WS= water sample, SV= soil vapor sample

PROBE TECHNICIAN: Franklyn A. Galvez Analyst: Roger R. Sense X_____

Petro Site Assessment

Site : HOLLOMAN AFB # 2 & 5 SITES

Client : RADIAN CORP. Client site Rep. LAURA MALEY Date 4-26-93 pg. 1 of

SAMPLE		MW	ANALYTE	(PPM) ul/L	/L	mg/Kg
Location	P-1A	78.12	BENZENE	133.	425.	
Depth	10'	92.15	TOLUENE	38.	144.	
Type	SV	106.17	ETHYL BENZENE	65.	283.	
Weight	100ul	106.17	XYLENES (P,M,O)	92.	400.	
GC Rpt.#	8		BTEX	329.	1252.	
GC Run #	124		METHANE			
Location	P-1B	78.12	BENZENE	333.	1067.	
Depth	14'	92.15	TOLUENE	0.3-4	15.	
Type	SV	106.17	ETHYL BENZENE	85.	370.	
Weight	100ul	106.17	XYLENES (P,M,O)	88.	383.	
GC Rpt.#	12		BTEX	510.	1835.	
GC Run #	126		METHANE			
Location	P-19	78.12	BENZENE	0.8	3.	
Depth	6'	92.15	TOLUENE	1.3	5.	
Type	SV	106.17	ETHYL BENZENE	0.6	3.	
Weight	100ul	106.17	XYLENES (P,M,O)	0.7	3.	
GC Rpt.#	14		BTEX	3.5	14.	
GC Run #	128		METHANE			
Location	P-18	78.12	BENZENE	97.	311.	
Depth	6'	92.15	TOLUENE	N/D	-	
Type	SV	106.17	ETHYL BENZENE	67.	292.	
Weight	100	106.17	XYLENES (P,M,O)	N/D	-	
GC Rpt.#	16		BTEX	164.	600.	
GC Run #	129		METHANE			

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mg/L = milligram per liter , mg/Kg = milligram per kilogram , g = gram
N/D = non-detect , SS = soil sample, WS= water sample, SV= soil vapor sample

PROBE TECHNICIAN: Franklyn A. Galvez Analyst: Roger R. Sense X_____

Petro Site Assessment

Site : HOLLOMAN AFB # 2 & 5 SITES

Client : RADIAN CORP. Client site Rep. LAURA MALEY Date 4-26-93 pg. 2 of 3

SAMPLE		MW	ANALYTE	(PPM) ul/L	/L	mg/Kg
Location	P-20	78.12	BENZENE	0.2	1.	
Depth	6'	92.15	TOLUENE	0.7	3.	
Type	SV	106.17	ETHYL BENZENE	0.4	2.	
Weight	100ul	106.17	XYLENES (P,M,O)	N/D		
GC Rpt.#	18		BTEX	1.3	6.5	
GC Run #	130		METHANE			
Location	P-3A	78.12	BENZENE	517.	1655.	
Depth	10'	92.15	TOLUENE	497.	1878.	
Type	SV	106.17	ETHYL BENZENE	209.	910.	
Weight	100ul	106.17	XYLENES (P,M,O)	323.	1406.	
GC Rpt.#	20		BTEX	1545.	5849.	
GC Run #	132		METHANE			
Location	P-3B	78.12	BENZENE			
Depth	14'	92.15	TOLUENE			
Type	SV	106.17	ETHYL BENZENE			
Weight	100ul	106.17	XYLENES (P,M,O)			
GC Rpt.#	22		BTEX			
GC Run #	133		METHANE (NOTE: results questionable due to time)			
Location	P5A	78.12	BENZENE	231.	740.	
Depth	10'	92.15	TOLUENE	263.	994.	
Type	SV	106.17	ETHYL BENZENE	100.	435.	
Weight	100ul	106.17	XYLENES (P,M,O)	208.	905.	
GC Rpt.#	23		BTEX	803.	3079.	
GC Run #	143		METHANE			

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N/D = non-detect , SS = soil sample, WS= water sample, SV= soil vapor sample

PROBE TECHNICIAN: Franklyn A. Galvez Analyst: Roger R. Sense X_____

Petro Site Assessment

Site : HOLLOMAN AFB # 2 & 5 SITES

Client : RADIAN CORP. Client site Rep. LAURA MALEY Date 4-26-93 pg.3 of

SAMPLE		MW	ANALYTE	(PPM) ul/L	/L	mg/Kg
ocation	P-5B	78.12	BENZENE	17.	54.	
epth	14'	92.15	TOLUENE	9.	34.	
ype	SV	106.17	ETHYL BENZENE	.6	3.	
eight	100ul	106.17	XYLENES (P,M,O)	.8	3.	
C Rpt.#	25		BTEX	27.	94.	
C Run #	135		METHANE			
ocation	P-7A	78.12	BENZENE	209.	1332.	
epth	10	92.15	TOLUENE	156.	589.	
ype	SV	106.17	ETHYL BENZENE	103.	448.	
eight	100ul	106.17	XYLENES (P,M,O)	207.	901.	
C Rpt.#	27		BTEX	676.	3260.	
C Run #	137		METHANE			
ocation	P-7B	78.12	BENZENE	11.	35.	
epth	14'	92.15	TOLUENE	15.	57.	
ype	SV	106.17	ETHYL BENZENE	8.	35.	
eight	100ul	106.17	XYLENES (P,M,O)	12.	52.	
C Rpt.#	29		BTEX	45.	179.	
C Run #	139		METHANE			
ocation		78.12	BENZENE			
epth		92.15	TOLUENE			
ype		106.17	ETHYL BENZENE			
eight		106.17	XYLENES (P,M,O)			
C Rpt.#			BTEX			
C Run #			METHANE			

BRS

MW = molecular weight , PPM = parts per million , ul/L = microliter per lit
mg/L = milligram per liter , mg/Kg = milligram per kilogram , g = gram
N/D = non-detect , SS = soil sample, WS= water sample, SV= soil vapor sample

PROBE TECHNICIAN: Franklyn A. Galvez Analyst: Roger R. Sense X

Petro Site Assessment

Site HOLLOMAN AFB # 2 & 5 SITES

Client : RADIAN CORP. Client site Rep. LAURA MALEY Date 4-29-93 pg. 1 of

SAMPLE		MW	ANALYTE	(PPM) ul/L	/L	mg/Kg
Location	P-27	78.12	BENZENE	N/D		
Depth	6'	92.15	TOLUENE	0.2	<1.	
Type	SV	106.17	ETHYL BENZENE	N/D	_	
Weight	100ul	106.17	XYLENES (P,M,O)	N/D		
GC Rpt.#	7		BTEX	0.2	<1.	
GC Run #	037		METHANE			
Location	P-24	78.12	BENZENE	0.04	<1.	
Depth	6'	92.15	TOLUENE	N/D		
Type	SV	106.17	ETHYL BENZENE	"		
Weight	100ul	106.17	XYLENES (P,M,O)	"		
GC Rpt.#	8		BTEX	.04	<1.	
GC Run #	038		METHANE			
Location	P-28	78.12	BENZENE	N/D	-	
Depth	6'	92.15	TOLUENE	"	-	
Type	SV	106.17	ETHYL BENZENE	"	-	
Weight	100ul	106.17	XYLENES (P,M,O)	"	-	
GC Rpt.#	11		BTEX	"	-	
GC Run #	040		METHANE			
Location	P-29	78.12	BENZENE	0.03	<1.	
Depth	6'	92.15	TOLUENE	N/D	-	
Type	SV	106.17	ETHYL BENZENE	"	-	
Weight	100ul	106.17	XYLENES (P,M,O)	"	-	
GC Rpt.#	12		BTEX	0.03	<1.	
GC Run #	041		METHANE			

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mg/L = milligram per liter , mg/Kg = milligram per kilogram , g = gram
N/D = non-detect , SS = soil sample, WS= water sample, SV= soil vapor sample

PROBE TECHNICIAN: Franklyn A. Galvez Analyst: Roger R. Sense X_____

Petro Site Assessment

Site : HOLLOMAN AFB # 2 & 5 SITES

Client : RADIAN CORP. Client site Rep. LAURA MALEY Date 4-29-93 pg. 2 of 4

SAMPLE		MW	ANALYTE	(PPM) ul/L	/L	mg/Kg
Location	P30	78.12	BENZENE	N/D	1.	
Depth	6'	92.15	TOLUENE	"		
Type	SV	106.17	ETHYL BENZENE	"		
Weight	100ul	106.17	XYLENES (P,M,O)	"		
GC Rpt.#	14		BTEX	"		
GC Run #	043		METHANE			
Location	P-31	78.12	BENZENE	N/D	-	
Depth	6'	92.15	TOLUENE	"	-	
Type	SV	106.17	ETHYL BENZENE	"	-	
Weight	100ul	106.17	XYLENES (P,M,O)	"	-	
GC Rpt.#	16		BTEX	N/D	-	
GC Run #	043		METHANE			
Location	P-32	78.12	BENZENE	N/D		
Depth	6'	92.15	TOLUENE	"	-	
Type	SV	106.17	ETHYL BENZENE	"	-	
Weight		106.17	XYLENES (P,M,O)	"	-	
GC Rpt.#	17		BTEX	"	-	
GC Run #	044		METHANE			
ocation	P-33A	78.12	BENZENE	N/D	-	
epth	6'	92.15	TOLUENE	"	-	
ype	SV	106.17	ETHYL BENZENE	"	-	
eight	100ul	106.17	XYLENES (P,M,O)	"	-	
C Rpt.#	19		BTEX	"	-	
C Run #	045		METHANE			

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N/D = non-detect , SS = soil sample, WS= water sample, SV= soil vapor sample

PROBE TECHNICIAN: Franklyn A. Galvez Analyst: Roger R. Sense X_____

Petro Site Assessment

Site : HOLLOMAN AFB # 2 & 5 SITES

Client : RADIAN CORP. Client site Rep. LAURA MALEY Date 4-29-93 pg. 3 of

SAMPLE		MW	ANALYTE	(PPM) ul/L	/L	mg/Kg
Location	P-33B	78.12	BENZENE			
Depth	12'	92.15	TOLUENE			
Type	SV	106.17	ETHYL BENZENE			
Weight	100ul	106.17	XYLENES (P,M,O)			
GC Rpt.#	21		BTEX			
GC Run #	047		METHANE (Probable N/D review Data			
Location	P-34A	78.12	BENZENE			
Depth	6'	92.15	TOLUENE			
Type	SV	106.17	ETHYL BENZENE			
Weight	100ul	106.17	XYLENES (P,M,O)			
GC Rpt.#	28		BTEX			
GC Run #	058		METHANE (Probable N/D review data)			
Location	P-34B	78.12	BENZENE			
Depth	12	92.15	TOLUENE			
Type	SV	106.17	ETHYL BENZENE			
Weight	100ul	106.17	XYLENES (P,M,O)			
GC Rpt.#	2		BTEX			
GC Run #	054		METHANE (Probable N/d review data)			
Location	P-35	78.12	BENZENE	243.		
Depth	6'	92.15	TOLUENE	6.		
Type	SV	106.17	ETHYL BENZENE	143.		
Weight	100ul	106.17	XYLENES (P,M,O)	67.		
GC Rpt.#	30		BTEX	460.		
GC Run #	055		METHANE			

MW = molecular weight , PPM = parts per million , ul/L = microliter per liter
mg/L = milligram per liter , mg/Kg = milligram per kilogram , g = gram
N/D = non-detect , SS = soil sample, WS= water sample, SV= soil vapor sample

ROBE TECHNICIAN: Franklyn A. Galvez Analyst: Roger R. Sense X_____

Petro Site Assessment

Site : HOLLOMAN AFB # 2 & 5 SITES

Client : RADIAN CORP. Client site Rep. LAURA MALEY Date 4-29-93

SAMPLE		MW	ANALYTE	(PPM) ul/L	/L	mg/Kg
Location	P-36	78.12	BENZENE			
Depth	6'	92.15	TOLUENE			
Type	SV	106.17	ETHYL BENZENE			
Weight	100ul	106.17	XYLENES (P,M,O)			
GC Rpt.#	32		BTEX			
GC Run #	056		METHANE N/D S/T/D/R			
Location	P-36	78.12	BENZENE			
Depth	6'	92.15	TOLUENE			
Type	SV	106.17	ETHYL BENZENE			
Weight	100ul	106.17	XYLENES (P,M,O)			
GC Rpt.#	33		BTEX			
GC Run #	057		METHANE Duplicate			
Location	P-37	78.12	BENZENE			
Depth	6'	92.15	TOLUENE			
Type	SV	106.17	ETHYL BENZENE			
Weight	100ul	106.17	XYLENES (P,M,O)			
GC Rpt.#	34		BTEX	N/D		
GC Run #	058		METHANE S/T/D/R			
Location	P-38	78.12	BENZENE			
Depth		92.15	TOLUENE			
Type	WS	106.17	ETHYL BENZENE			
Weight	20ml	106.17	XYLENES (P,M,O)			
GC Rpt.#			BTEX			
GC Run #			METHANE (Unable to get W/S at 11.5'			

MW = molecular weight , PPM = parts per million , ul/L = microliter per liter
mg/L = milligram per liter , mg/Kg = milligram per kilogram , g = gram
N/D = non-detect , SS = soil sample, WS= water sample, SV= soil vapor sample

PROBE TECHNICIAN: Franklyn A. Galvez Analyst: Roger R. Sense X_____

ANALYTICAL REPORT
Petro Site Assessment

te: HOLLOMAN AFB # 2 & 5 Sites

ient : RADIAN CORP. Client site Rep. LAURA MALEY Date 4-27-93 pg. 1 of 4

ATE		MW	ANALYTE	(PPM) ul/L	ug /L	mg/Kg
ation	P-3C	78.12	BENZENE	111.		1960.
th	13/15	92.15	TOLUENE	162.		3370.
e	SS	106.17	ETHYL BENZENE	242.		5810.
ght	3.81	106.17	XYLENES (P,M,O)	513.		12310.
Rpt.#	8		BTEX	1028.		23450.
Run #	146		METHANE			
ation	P-94	78.12	BENZENE	221.	707.	
th	10'	92.15	TOLUENE	118.	446.	
e	SV	106.17	ETHYL BENZENE	78.	339.	
ght	100ul	106.17	XYLENES (P,M,O)	137.	596.	
Rpt.#	10		BTEX	555.	2088.	
n #	147		METHANE			
ation	P-9B	78.12	BENZENE	459.	1470.	
th	14'	92.15	TOLUENE	263.	994.	
e	SV	106.17	ETHYL BENZENE	169.	736.	
ght	100ul	106.17	XYLENES (P,M,O)	283.	1232.	
Rpt.#	12		BTEX	1174.	4432.	
Run #	148		METHANE			
ation	P-10A	78.12	BENZENE	107.	343.	
th	8'	92.15	TOLUENE	81.	306.	
e	SV	106.17	ETHYL BENZENE	32.	139.	
ght	100ul	106.17	XYLENES (P,M,O)	47.	205.	
Rpt.#	15		BTEX	266.	993.	
#	151		METHANE			

= molecular weight , PPM = parts per million , ul/L = microliter per liter
/L = milligram per liter , mg/Kg = milligram per kilogram , g = gram
D = non-detect , SS = soil sample, WS= water sample, SV= soil vapor sample

OBE TECHNICIAN: Franklyn A. Galvez Analyst: Roger R. Sense X_____

Petro Site Assessment

.te: HOLLOMAN AFB # 2 & 5 Sites

.ient : RADIAN CORP. Client site Rep. LAURA MALEY Date 4-27-93

IPLE		MW	ANALYTE	(PPM) ul/L	ug /L	mg/Kg
:ation	P-10B	78.12	BENZENE	58.	186.	
›th	12'	92.15	TOLUENE	26.	98.	
›e	SV	106.17	ETHYL BENZENE	7.	30.	
ght	100ul	106.17	XYLENES (P,M,O)	7.	30.	
Rpt.#	18		BTEX	99.	349.	
Run #	153		METHANE			
:ation	P-10B	78.12	BENZENE	55.	176.	
›th	12'	92.15	TOLUENE	44.	166.	
›e	SV	106.17	ETHYL BENZENE	15.	65.	
ght	100ul	106.17	XYLENES (P,M,O)	22.	96.	
Rpt.#	19		BTEX	139.	503.	
Run #	154		METHANE (Duplicate P-10B @ 12')			
:ation	P-10C	78.12	BENZENE	541.	1733.	
›th	16'	92.15	TOLUENE	64.	242.	
›e	SV	106.17	ETHYL BENZENE	42.	183.	
ght	100yl	106.17	XYLENES (P,M,O)	47.	206.	
Rpt.#	21		BTEX	697.	2364.	
Run #	155		METHANE			
:ation	P-10C	78.12	BENZENE	619.	1983.	
›th	16'	92.15	TOLUENE	113.	427.	
›e	SV	106.17	ETHYL BENZENE	80.	302.	
ght	100ul	106.17	XYLENES (P,M,O)	98.	426.	
Rpt.#	22		BTEX	914.	3138.	
Run #	156		METHANE (Duplicate)			

/ = molecular weight , PPM = parts per million , ul/L = microliter per lite
/L = milligram per liter , mg/Kg = milligram per kilogram , g = gram
D = non-detect , SS = soil sample, WS= water sample, SV= soil vapor sample

OBE TECHNICIAN: Franklyn A. Galvez Analyst: Roger R. Sense X_____

Petro Site Assessment
Sites

it site Rep. LAURA MALEY Date 4-27-93 pg.3 of 4

ANALYTE	(PPM) ul/L	ug /L	mg/Kg
ENE	240.	769.	
OLUENE	152.	574.	
THYL BENZENE	68.	296.	
YLENES (P,M,O)	190.	827.	
TEX	650.	2466.	
ETHANE			
ENZENE	3.	10.	
OLUENE	4.	15.	
THYL BENZENE	2.	9.	
YLENES (P,M,O)	3.	13.	
TEX	12.	47.	
ETHANE (NOTE: no sample at 16' to 14'			
ENZENE	1.	3.	
OLUENE	1.	4.	
THYL BENZENE	1.	4.	
YLENES (P,M,O)	1.	4.	
TEX	4.	19.	
ETHANE Duplicate			
ENZENE	84.	269.	
OLUENE	184.	695.	
THYL BENZENE	13.	57.	
YLENES (P,M,O)	69.	300.	
TEX	349.	1327.	
ETHANE			

arts per million , ul/L = microliter per liter
, mg/Kg = milligram per kilogram , g = gram
l sample, WS= water sample, SV= soil vapor sample

A. Galvez Analyst: Roger R. Sense X_____

Site: HOLLOMAN AFB # 2 & 5 Sites

Client : RADIAN CORP. Client site Rep. LAURA MALEY Date 4-27-93

MPLE		MW	ANALYTE	(PPM) ul/L	ug /L	mg/Kg
cation	P-6B	78.12	BENZENE	234.	749.	
pth	12'	92.15	TOLUENE	504.	1904.	
pe	SV	106.17	ETHYL BENZENE	113.	492.	
ight	100ul	106.17	XYLENES (P,M,O)	190.	897.	
Rpt.#	31		BTEX	1042.	3972.	
Run #	163		METHANE			
cation	P-4A	78.12	BENZENE	264.	846.	
pth	8'	92.15	TOLUENE	388.	1466.	
pe	SV	106.17	ETHYL BENZENE	92.	400.	
ight	100ul	106.17	XYLENES (P,M,O)	170.	740.	
Rpt.#	36		BTEX	1545.	5391.	
Run #	165		METHANE			
cation	P-2A	78.12	BENZENE			
pth		92.15	TOLUENE			
pe		106.17	ETHYL BENZENE			
ight		106.17	XYLENES (P,M,O)			
Rpt.#			BTEX			
Run #			METHANE			
cation		78.12	BENZENE			
pth		92.15	TOLUENE			
pe		106.17	ETHYL BENZENE			
ight		106.17	XYLENES (P,M,O)			
Rpt.#			BTEX			
Run #			METHANE			

W = molecular weight , PPM = parts per million , ul/L = microliter per lite
g/L = milligram per liter , mg/Kg = milligram per kilogram , g = gram
/D = non-detect , SS = soil sample, WS= water sample, SV= soil vapor sample

ROBE TECHNICIAN: Franklyn A. Galvez Analyst: Roger R. Sense X RRS

PDI SURVEY DATA

SURVEY DATA FOR SITES 2&5, 3, 4, 8, AND 30&33
HOLLOMAN AFB PRE-DESIGN INVESTIGATION

DATA FROM WESTERN LANDS SURVEYING MAY 26, 1993

DESCRIPTION	NORTH	EAST	ELEVATION
SB-02&5-17	673980.74	555347.91	4098.34
SB-02&5-18	673921.36	555365.45	4099.33
SB-02&5-19	673876.86	555379.81	4099.51
SB-02&5-20	673844.39	555386.88	4099.66
SB-02&5-21	673804.33	555398.85	4098.93
SB-02&5-22	673767.15	555417.90	4095.80
SB-02&5-23	674006.51	555341.19	4095.33
SB-02&5-24	673720.78	555455.89	4093.23
SB-02&5-25	673818.39	555453.55	4094.32
SB-03-02	673904.63	555559.82	4091.40
HA-04-01	689677.51	545681.23	4099.99
HA-04-02	689687.17	545654.25	4102.27
HA-04-03	689697.84	545642.74	4094.68
HA-04-04	689705.30	545616.24	4094.02
HA-04-05	689713.73	545518.97	4081.09
HA-04-06	689640.90	545582.41	4098.67
HA-04-07	689643.73	545577.42	4091.23
HA-04-08	689650.46	545563.51	4088.73
HA-04-09	689661.57	545568.59	4096.38
HA-04-10	689679.89	545505.59	4082.83
HA-04-11	689559.55	545535.07	4095.52
HA-04-12	689599.96	545515.85	4086.90
SB-08-07	672335.37	554707.91	4085.80
SB-08-08	672369.33	554725.38	4085.57
SB-08-09	672402.47	554793.84	4085.25
SB-08-10	672329.13	554745.71	4085.82
SB-08-11	672269.15	554673.73	4085.94
SB-08-12	672240.60	554756.05	4086.47
SB-08-13	672284.48	554787.48	4086.28
SB-08-14	672301.20	554782.59	4086.25
SB-08-15	672360.02	554816.96	4084.83
SB-08-16	672388.28	554855.49	4084.94
SB-08-17	672295.67	554841.20	4084.70
SB-08-18	672346.55	554875.26	4084.57
SB-08-19	672230.80	554844.83	4083.54
SB-08-20	672307.69	554951.89	4082.95
SB-30&33-11B	675882.10	552831.68	4101.63
SB-30&33-12	676056.81	552837.70	4101.13
SB-30&33-13	675898.46	552773.92	4102.05
SB-30&33-14	675938.47	552758.33	4102.27
SB-30&33-15	676057.34	552823.81	4101.01
SB-30&33-16	676078.65	552837.80	4101.56
SB-30&33-17	676061.38	552868.83	4101.13
SB-30&33-18	676070.40	552875.25	4101.22
SB-30&33-19	676084.13	552889.07	4101.43
SB-30&33-20	676058.89	552953.83	4101.04

DCN 92-269-004-16-09
RCN 269-004-16-08

CORRECTIVE MEASURES STUDY (CMS) PLAN

INVESTIGATION, STUDY, AND RECOMMENDATION FOR 29 WASTE SITES HOLLOMAN AIR FORCE BASE, NEW MEXICO

DRAFT FINAL

Prepared for:

49 SG/CEV
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Omaha, Nebraska

November 1992
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EXECUTIVE SUMMARY

Radian Corporation, under contract to the U.S. Army Corps of Engineers Omaha District, prepared this Corrective Measures Study (CMS) Plan for three sites at Holloman Air Force Base (AFB) to comply with Section IV.M.2 of the Base's Hazardous and Solid Waste Amendments Permit.

Holloman AFB is subject to the requirements of the Resource Conservation and Recovery Act (RCRA) corrective action program and the Installation Restoration Program (IRP). Both the IRP and the RCRA corrective action program are ultimately intended to ensure remediation of contaminated sites that pose an actual or potential threat to public health, welfare, or the environment. Both programs are implemented through similarly phased approaches to identify, investigate, and remediate these sites. To promote consistency throughout this project, the IRP format and terminology have been and will be used. However, all the requirements of the RCRA corrective action program were incorporated in each phase of the IRP. This CMS Plan is a requirement of the RCRA corrective action program, but not of the IRP. For this reason, the RCRA term "Corrective Measures Study Plan" is used. All other references in the CMS Plan are IRP terminology.

A Remedial Investigation (RI) was conducted on a total of 27 sites at Holloman AFB. The results of the RI are presented in the *Remedial Investigation Report* (Radian, 1992), which recommended three sites for the Feasibility Study (FS) phase. The IRP site ID and name, and RCRA solid waste management unit (SWMU) number are listed below for the three sites addressed in the CMS Plan.

- Site 2&5--POL Spill Sites No. 1 and No. 2 (AOC-T);
- Site 8--Refuse Collection Truck Washrack (SWMUs 4 and 82); and
- Site 14--Former Entomology Shop Area (SWMU 197).

The objectives of the CMS Plan are to describe the general approach to the investigation and potential remedies; define the overall objectives of the study; specify plans for evaluating remedies to ensure compliance with remedy standards; provide a schedule for conducting the FS; and propose a format for the FS.

The focus of this CMS Plan is the presentation of the remedial action objectives (RAOs). Cleanup criteria presented in the RAOs will provide the primary basis for evaluating alternatives developed in the FS and ensuring compliance with the RAOs. For the sites that pose a threat to human health (Sites 8 and 14), cleanup criteria were determined on the basis of the proposed RCRA Corrective Action Rules (40 CFR Part 264 Subpart S) guidance. Acceptable carcinogenic risk was established at 1E-6 for individual chemicals and 1E-4 for cumulative risk posed by multiple contaminants, and acceptable noncarcinogenic risk was set at a Hazard Index value of 1 for cumulative risk posed by multiple chemicals. The risk assessments conducted for the respective sites were used to "back-calculate" the cleanup criteria. For sites that require remediation due to petroleum product releases (Sites 2&5), cleanup criteria were based on standards of the New Mexico Environment Department established for Holloman AFB. The RAOs for all three sites are summarized in Table 1.

Table 1

Site-Specific Remedial Action Objectives

Objective	Exposure Route and Receptor	Criteria	Contaminant	Acceptable Level
SITE 2&5				
Soil/Waste:				
Prevent future contamination of groundwater	NA	NMED standard for HAFB	TPH	1000 mg/kg
			Benzene	25 mg/kg
SITE 8				
Soil/Waste:				
Prevent dermal contact with contaminated soil	Dermal contact with contaminated soil by on-Base workers	Acceptable health risk	4,4'-DDD	4.0 mg/kg
			4,4'-DDE	3.3 mg/kg
Prevent inhalation of contaminated soil	Inhalation of contaminated soil by on-Base workers	Acceptable health risk	4,4'-DDT	1.1 mg/kg
			Cadmium	0.29 mg/kg
			Chlordane	0.14 mg/kg
			Lead	12 mg/kg
			Mercury	0.016 mg/kg

Table 1

(Continued)

Objective	Exposure Route and Receptor	Criteria	Contaminant	Acceptable Level
SITE 14				
Soil:				
Prevent dermal contact with contaminated soil	Dermal contact with contaminated soil by current on-Base occupational adult	Acceptable health risk	4,4'-DDD	1.5 mg/kg
			4,4'-DDE	1.0 mg/kg
			4,4'-DDT	1.3 mg/kg
			Aldrin	0.01 mg/kg
			Chlordane	0.2 mg/kg
			Heptachlor	0.1 mg/kg
			Gamma BHC	0.7 mg/kg
			Cadmium	0.60 mg/kg

NMED = New Mexico Environment Department

HAFB = Holloman AFB

NA = Not Appropriate

1.0 INTRODUCTION

This Corrective Measures Study (CMS) Plan was prepared to comply with Section IV.M.2 of Holloman Air Force Base's (AFB) Hazardous and Solid Waste Amendments (HSWA) permit.

1.1 Background

1.1.1 Regulatory Background

Holloman AFB applied for a RCRA hazardous waste management permit to authorize the operation of an on-site storage facility for currently generated hazardous wastes. As a result, the Base is subject to the RCRA corrective action program. The Base's HSWA permit, administered by U.S. EPA Region VI, requires Holloman to conduct a RCRA Facilities Investigation (RFI) at solid waste management units (SWMUs) listed in the permit.

In addition, Holloman AFB is subject to the requirements of the U.S. Air Force (USAF) Installation Restoration Program (IRP). The IRP essentially follows the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedial action program. A comparison of the phases of the IRP and RCRA corrective action program is presented in Figure 1-1.

As part of the IRP, Holloman AFB performed a Remedial Investigation (RI) at 27 sites (two additional sites were addressed in a CERCLA Preliminary Assessment). Many of the sites included in the RI are also SWMUs on Holloman AFB's HSWA permit. Therefore, the investigation of the 27 sites was structured to meet all of the permit requirements for an RFI and the CERCLA requirements of an RI. To avoid confusion and promote consistency throughout the project, the reports associated with the investigation of

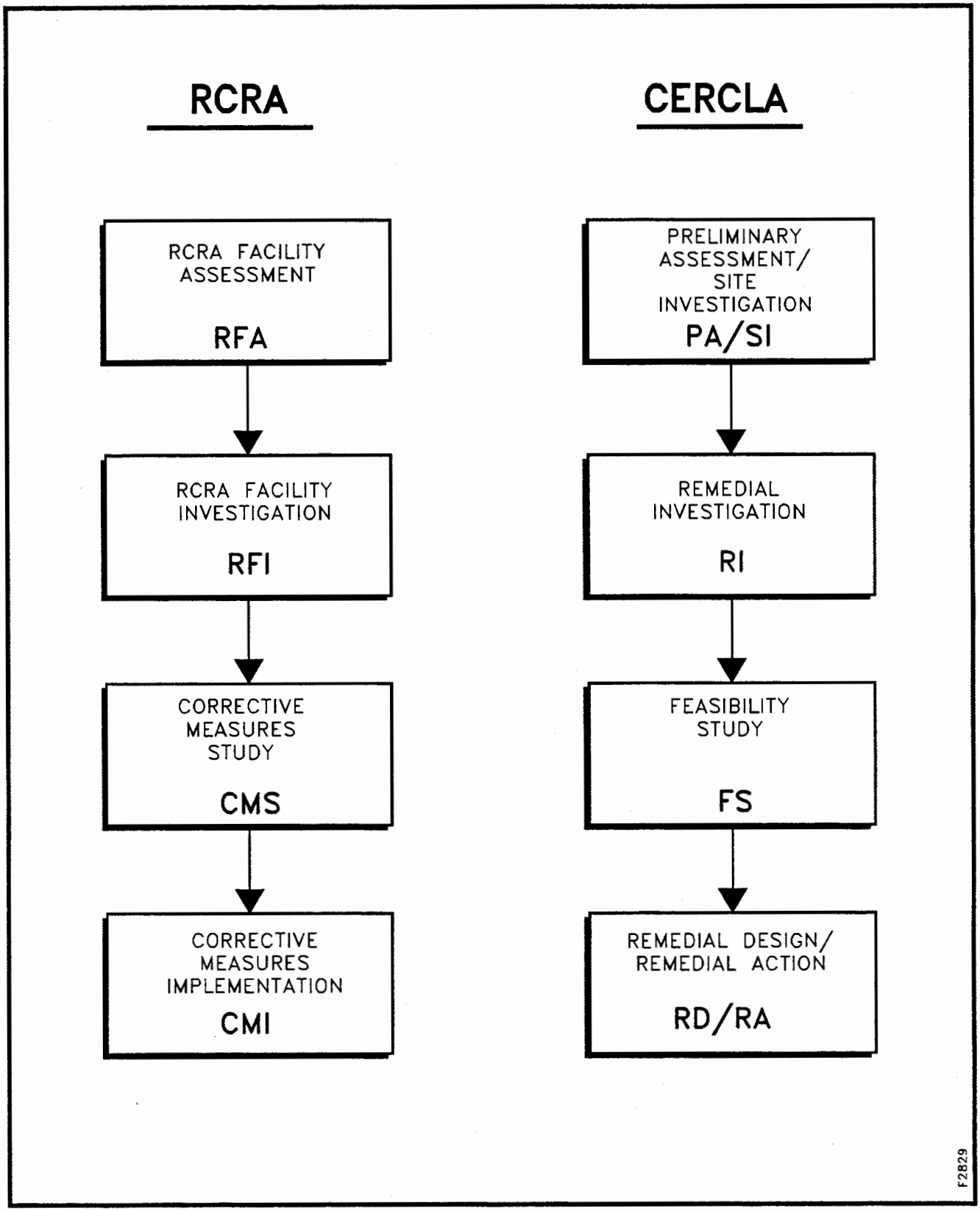

Figure 1-1. Comparison of RCRA Corrective Action and IRP Phases

the 27 sites were presented in CERCLA RI format and terminology, and the IRP site names and numbers were used. Sites 2 and 5 and Sites 30 and 33 are located adjacent to each other, respectively, and were combined as "Sites 2&5" and "Sites 30&33" for the RI. Due to this combination, the total number of sites addressed in the RI sums to 25.

Similar to the RI, the Feasibility Study (FS) phase of the IRP will be structured to meet all the requirements of a RCRA corrective action program CMS. This CMS Plan, for example, is a RCRA corrective action requirement, but will follow CERCLA FS terminology. Further discussion of the integration of the FS and CMS is provided in Section 2.0.

1.1.2 RI Report Recommendations

The results of the investigation of the 29 sites are presented in the *Remedial Investigation (RI) Report* (Radian, 1992). Data collected in the RI were also evaluated to determine site-specific risk to human health and the environment. The findings of the risk assessment are found in the *Risk Assessment Report for the Remedial Investigation (RI)* (Radian, 1992) and were used to determine which sites require remedial action. At a meeting in Dallas, TX, on 9 December 1991, the U.S. Environmental Protection Agency (U.S. EPA) Region VI and New Mexico Environment Department (NMED) agreed that the risk assessment could be used to determine which sites require remedial action and which sites require no action. The proceedings of the meeting are presented in Confirmation Notice No. 23, which is included in Appendix A.

The *RI Report* recommended that three sites be included in the FS. The IRP names and numbers and corresponding RCRA SWMU names and numbers of those three sites are listed on Table 1-1. Only those sites listed on Table 1-1 are addressed in this CMS Plan. Recommendations for the other sites included in the *RI Report* are discussed below:

Table 1-1

Cross Reference of IRP Sites and RCRA SWMUs

IRP #	IRP Name	SWMU #	SWMU Name
2&5	POL Spill Sites No. 1 and No. 2	AOC-T	POL Storage Tank Leaks
8	Refuse Collection Washrack	4	Building 131 O/WS
		82	Building 131 Washrack
14	Former Entomology Shop Area	197	Former Entomology Shop

- A CERCLA removal action/RCRA interim measures was recommended for one site.

- Further investigation was recommended for fives sites to determine the extent of contamination. (Further investigation will also be conducted at the sites included in the FS.)

- CERCLA site closeout/RCRA no further action was recommended for 15 sites. Proposed Plans and Decision Documents will be prepared for those sites.

- A conditional CERCLA site closeout/RCRA no further action was recommended for three sites. These sites will be remediated to remove buried waste prior to achieving the site closeout/no further action status. An engineering evaluation/cost analysis will be completed for these sites to determine the appropriate remedial alternative.

1.2 Objectives of the CMS Plan

As stated in Section IV.M.2 of Holloman AFB's HSWA permit, the objectives of the CMS Plan are to provide:

- A description of the general approach to the investigation and potential remedies;

- A definition of the overall objectives of the study;

- The specific plans for evaluating remedies to ensure compliance with remedy standards;

- The schedules for conducting the study; and

- The proposed format for the presentation of information.

1.3 Content of the CMS Plan

This CMS Plan briefly discusses the requirements for an FS and a CMS and how the proposed study and report integrates the two programs. The risk assessment process and the results of the risk assessments are discussed. The focus of the CMS Plan

is the development of the remedial action objectives. The objectives and specific cleanup criteria are presented for each site. The approach to the evaluation of technologies studied in the FS/CMS is addressed and the schedule for the FS is provided.

2.0 INTEGRATION OF IRP (CERCLA)/RCRA PROGRAM

Both the IRP and RCRA corrective action programs are ultimately intended to ensure the remediation of contaminated sites that pose an actual or potential threat to public health, welfare, or the environment. Both programs are implemented through phased approaches to identify, investigate, and remediate these sites. A detailed comparison of the two programs was presented in the *RI Report*. This CMS Plan will present specific comparisons for the FS and CMS phases and how the two programs will be integrated into one study.

2.1 Integration for FS/CMS

The purpose of an FS and a CMS is essentially the same: to identify and develop alternatives for remedial action/corrective measures, to evaluate the alternatives, and to justify and recommend specific alternatives based on accepted criteria. FS requirements are based on the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (Interim Final), EPA/540/G-89/004* (EPA, October 1988); CMS requirements are based on the *RCRA Corrective Action Plan (Interim Final), EPA/530-SW-88-028* (EPA, June 1988) and Holloman AFB's HSWA permit requirements for a CMS. Similar to the *RI Report*, the format will be consistent with the CERCLA FS program, and a reference table will be provided to cross-reference applicable RCRA corrective action CMS requirements with sections in the FS Report.

2.2 FS Report Format

Figure 2-1 presents the proposed outline for the FS Report. The identification of technologies will be developed for the types of contamination found at the three sites. Due to the similarity of the contamination at some sites, the development and screening of alternatives will group similar sites. The number of alternatives listed on the outline will vary, depending on how many are developed and screened.

Feasibility Study Report

Investigation, Study and Recommendation
for 29 Waste Sites
Holloman Air Force Base, NM

1.0 INTRODUCTION

- 1.1 Purpose and Organization of Report
- 1.2 Integration of Holloman AFB IRP and RCRA Corrective Action Program
  - 1.2.1 Background
  - 1.2.2 Incorporation of CMS Requirements in this Report

2.0 SITE-SPECIFIC INFORMATION

- 2.1 Sites 2&5
  - 2.1.1 Background Information
  - 2.1.2 Remedial Action Objectives
- 2.2 Site 8
  - 2.2.1 Background Information
  - 2.2.2 Remedial Action Objectives
- 2.3 Site 14
  - 2.3.1 Background Information
  - 2.3.2 Remedial Action Objectives

3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

- 3.1 General Response Actions
- 3.2 Identification and Screening of Technologies
- 3.3 Evaluation of Technologies and Selection of Representative Technologies

4.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

- 4.1 Development of Alternatives
  - 4.1.1 Development of Alternatives for Sites 2&5
  - 4.1.2 Development of Alternatives for Sites 8 and 14

Figure 2-1. Preliminary Outline for FS Report

4.2 Screening of Alternatives
4.2.1 Screening of Alternatives for Sites 2&5
4.2.2 Screening of Alternatives for Sites 8 and 14
4.3 Alternatives Recommended for Detailed Analysis
4.3.1 Alternatives Recommended for Sites 2&5
4.3.2 Alternatives Recommended for Sites 8 and 14

5.0 DETAILED ANALYSIS OF ALTERNATIVES

5.1 Introduction
5.1.1 Evaluation Criteria
5.1.2 Assumptions
5.2 Individual Analysis of Alternatives for Sites 2&5
5.2.1 Sites 2&5 Alternative 1
5.2.2 Sites 2&5 Alternative 2
5.3 Individual Analysis of Alternatives for Sites 8 and 14
5.3.1 Sites 8 and 14 Alternative 1
5.3.2 Sites 8 and 14 Alternative 2
5.4 Comparative Analysis of Alternatives for Sites 2&5
5.5 Comparative Analysis of Alternatives for Sites 8 and 14

6.0 RECOMMENDATIONS

Figure 2-1. (Continued)

3.0 REMEDIAL ACTION OBJECTIVES

Remedial action objectives (RAOs) specify the contaminants and media of interest, exposure pathways, and preliminary remediation goals that will permit a range of treatment and containment alternatives to be developed for each site. The basis for determining cleanup criteria for Holloman AFB was discussed during a meeting between the U.S. EPA Region VI, NMED, Holloman AFB, USACE, and Radian in Santa Fe, NM, on 28 July 1992. For sites that are contaminated from releases of petroleum spills (Sites 2&5), cleanup criteria established and agreed upon by both Holloman AFB and NMED were selected. For the other sites (Sites 8 and 14), which are related to other types of contamination (pesticides and metals), cleanup criteria were based on acceptable risk to human health. A more detailed discussion of the selection of cleanup criteria and development of remedial action objectives is presented in this section. Figure 3-1 illustrates the process used to select and develop cleanup criteria for the three sites recommended for the FS.

3.1 Overall Remedial Action Objectives

The overall remedial action objectives for Holloman AFB are presented in Table 3-1. These objectives were discussed at the July meeting in Santa Fe and fundamentally agreed upon by all parties. As discussed in the *Risk Assessment Report for the Remedial Investigation*, the groundwater at Holloman AFB is designated as unfit for human consumption based on the New Mexico Water Quality Control Commission regulations, because it exceeds New Mexico Human Health Standards for total dissolved solids and sulfate. For this reason, restoration of groundwater was not considered as an RAO. At this point, there are no data suggesting that groundwater releases to surface water through seeps and springs. Therefore, exposure to contaminated groundwater is not anticipated and was not evaluated in a risk assessment. Further discussion of this is provided on a site-specific basis.

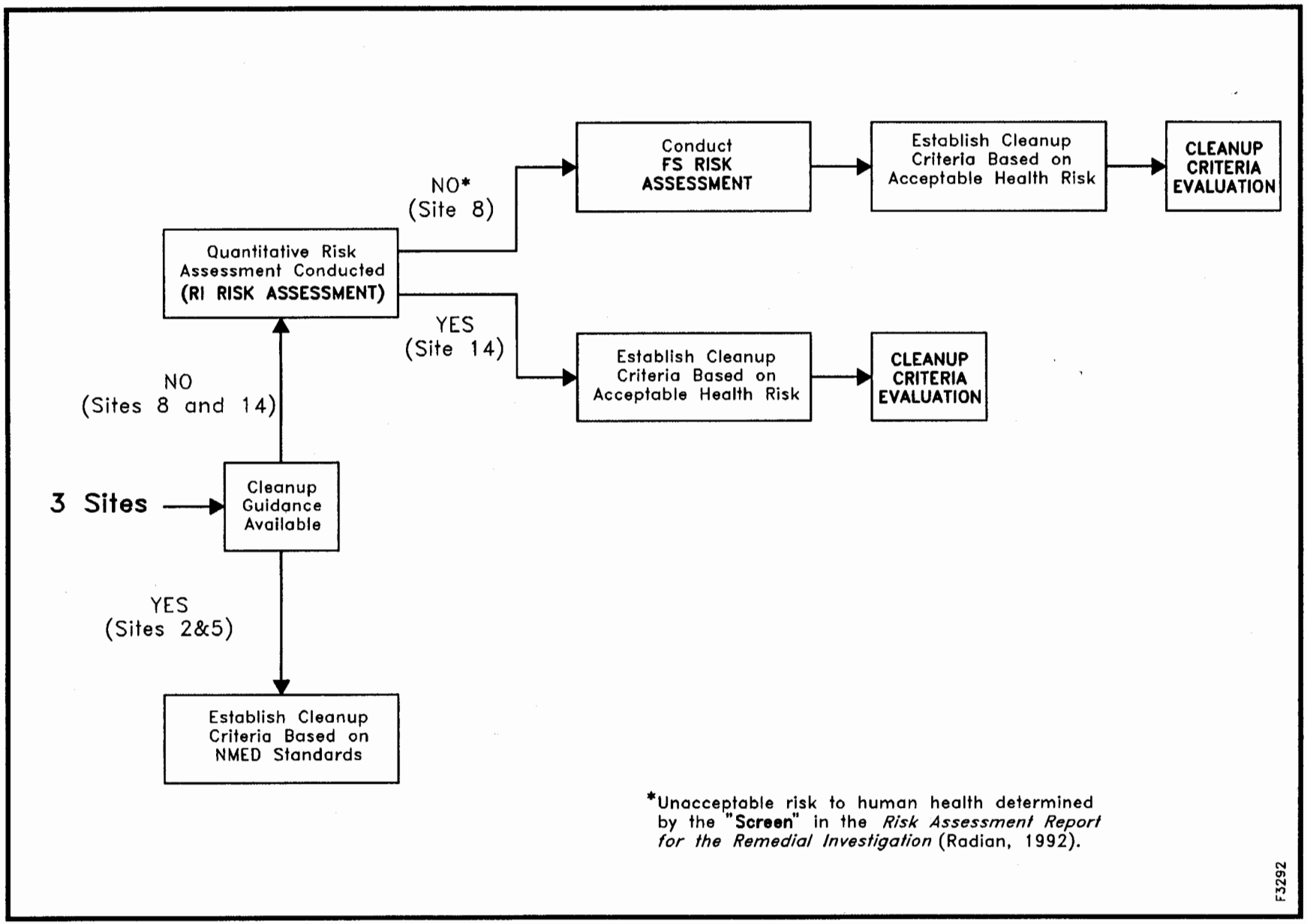

Figure 3-1. Process to Select and Develop Cleanup Criteria

Table 3-1

Potential Remedial Action Objectives

Goals	Criteria
Soil and Waste	
Prevent Contact with Contaminated Soil	Acceptable Health or Environmental Risk
Prevent Inhalation of Contaminated Soil	Acceptable Health or Environmental Risk
Prevent Future Contamination of Groundwater from Soil or Waste	Acceptable Health or Environmental Risk NMED Standards
Prevent Contamination of Surface Water From Soil or Waste	Acceptable Health or Environmental Risk

NMED = New Mexico Environment Department

3.2 NMED Standards

Standards were established for Holloman AFB for the remediation of sites contaminated with petroleum products and were agreed upon by both the Base and NMED. These standards were used at Sites 2&5, POL Spill Sites Nos. 1 and 2. In a letter from Steven J. Cary to Howard E. Moffit dated 22 July 1992 (Appendix A), the NMED recommended that soil exceeding concentrations of 1000 mg/kg total petroleum hydrocarbons (TPH) be remediated to that level. The NMED and EPA Region VI also recommended, during the RI Report meeting on 28 July 1992, that soil with benzene levels in excess of 25 mg/kg be remediated. Additionally, groundwater remediation, beyond removal of any floating hydrocarbon, is not required for sites contaminated with petroleum product (letter from Steven J. Cary to Howard E. Moffit dated 22 July 1992).

3.3 Risk Assessment Overview

Risk assessments were conducted to determine if adverse health effects may result from contaminants at a site, and the results were used to select sites for the FS. Furthermore, risk assessment data were used to calculate cleanup criteria for Sites 8 and 14. Four risk assessments were conducted during the RI/FS process. They include a screening assessment referred to as the "Screen"; a comprehensive risk assessment referred to as the "RI Risk Assessment"; an abbreviated risk assessment referred to as the "FS Risk Assessment"; and a risk assessment to verify cleanup criteria referred to as the "Cleanup Criteria Evaluation." Figure 3-1 provides a flow chart of how the four risk assessments relate to each other and the RI/FS process.

3.3.1 Risk Assessment Process

A complete description of the risk assessment process can be found in the *Risk Assessment Report for the Remedial Investigation*; however, an abbreviated discussion is presented here. Risk assessment is the process of determining if adverse health effects may

result from contaminants at a site. The process consists of four basic steps. The first step is the selection of chemicals of potential concern. This step involves gathering and analyzing the site data relevant to the human health evaluation and identifying the chemicals of potential concern at the site. In this step, the analytical methods and sample quantitation limits are evaluated. Chemicals may be deleted on the basis of data qualifiers and codes and blanks data. The remaining chemicals of potential concern are compared with background concentrations at the site, and further deletions are made if any chemicals are below background levels. The chemicals remaining on the list are considered the chemicals of potential concern at the site.

The second step of the risk assessment process is the toxicity assessment. The toxicity assessment is a discussion of the health effects associated with the chemicals of potential concern, the dose-response relationships, and the EPA toxicity values for each chemical (i.e., reference dose and slope factors).

The third step of the risk assessment process is the exposure assessment. The exposure assessment is the determination or estimation (qualitative or quantitative) of the magnitude, frequency, duration, and route of human exposure to the chemicals of potential concern that are present at or may have migrated from a site. In the exposure assessment, average and reasonable maximum estimates of exposure are developed. The average exposure estimate refers to the amount of exposure which is most likely to occur at the site under normal or expected conditions. The reasonable maximum exposure estimate refers to the worst-case exposure scenario. The reasonable maximum exposure estimate protects individuals who are at greater risk to exposure for a number of reasons (i.e., longer employment period, longer hours/day, greater dermal exposure due to type of clothing worn, higher inhalation rate due to level of work, etc.).

Current and future exposure scenarios are analyzed. Future exposure scenarios provide the decision-makers with an understanding of the potential future exposure that

could occur if land use were to change at the site. The exposure assessment results in pathway-specific intakes for current and future exposures to each chemical of concern.

The fourth step of the process is the risk characterization. The risk characterization uses information from the exposure assessment (intakes) and toxicity assessment (toxicity values) and chemical concentrations (averaged for each site), and derives a quantitative or qualitative statement of risk. Both carcinogenic and noncarcinogenic risks are quantified.

Carcinogenic risks are quantified using slope factors and chemical intake values, whereas noncarcinogenic risks are quantified using Hazard Quotients. A slope factor is the upper-bound probability that cancer will develop over a lifetime. A Hazard Quotient is the ratio of the chemical intake to a reference dose (the acceptable dose in mg/kg-day). The risk associated with each chemical for every pathway is summed to give a total risk for each chemical. The total risks for every chemical are summed to give the total risk for the site, or the Hazard Index (HI). This is done separately for carcinogenic and noncarcinogenic risks. Generally a total carcinogenic risk of 1E-6 for each chemical is considered acceptable. This is equivalent to a one-in-a-million excess cancer risk from exposure to that chemical at that site. In order for noncarcinogenic risk to be acceptable, the HI may not exceed 1.

As part of the risk assessment process, the ecological impacts must also be assessed. This complex process is described thoroughly in the *Risk Assessment Report for the Remedial Investigation*, Volume IV, Appendix K. No sites with adverse environmental effects are addressed in the CMS Plan.

3.3.2 Risk Assessment Report for the Remedial Investigation

The *Risk Assessment Report for the Remedial Investigation* discusses the procedures used to determine if adverse health or environmental effects result from

contaminants at a site. The *Risk Assessment Report for the Remedial Investigation* was conducted in two phases: 1) a screening assessment referred to as the "Screen," and 2) a comprehensive risk assessment referred to as the "RI Risk Assessment." These phases are discussed in detail in the *Risk Assessment Report for the Remedial Investigation* and are summarized below. Also described are the risk assessment methodologies applied specifically to the FS sites, the "FS Risk Assessment," and "cleanup criteria evaluation."

Screen

Because of the large number of sites that needed to be evaluated (25 sites), a screening method based on multimedia, multipathway models previously developed by McKone and Daniels (1991) was refined to rank and classify sites according to their level of contamination. This screen was used to initiate and expedite the risk assessment process by determining the "order of magnitude" risk present at each site prior to starting the RI Risk Assessment. Sites were ranked "clean," "borderline," or "dirty." The criteria used in determining the ranks are discussed in the *Risk Assessment Report for the Remedial Investigation*. Sites given a rank of clean or borderline were included in the RI Risk Assessment. The dirty sites included Sites 2&5, 3, 8, and 30&33. However, only Sites 2&5 and 8 were recommended for the FS. Sites 3 and 30&33 were recommended for a removal action/interim measures as discussed in the *RI Report*. The RI Risk Assessment was not conducted on any of those four sites.

RI Risk Assessment

Sites classified as clean or borderline in the Screen were evaluated in the RI Risk Assessment, which was accomplished as discussed in Section 3.3.1 and in more detail in the *Risk Assessment Report for the Remedial Investigation*. The RI Risk Assessment concluded that Site 14 poses unacceptable risk to human health and was, therefore, recommended for remedial action and the FS phase.

3.3.3 FS Risk Assessment

To determine which contaminants and media have unacceptable risk, it was necessary to proceed beyond the Screen in the FS and quantify the risk at Site 8. Therefore, the FS Risk Assessment was performed to quantify the worst-case exposure scenarios. The receptors expected to receive the highest exposure were identified, and a worst-case scenario was developed using the pathways and routes involving those receptors. Site 14 had already been quantitatively assessed in the RI Risk Assessment and was, therefore, not assessed in the FS Risk Assessment.

3.3.4 Cleanup Criteria Evaluation

Cleanup criteria were determined using methods described in the following subsection for pathways and receptors that have unacceptable human health risk. The cleanup criteria were then assessed to determine if they resulted in acceptable risk values. To accomplish this, risk values were recalculated using the cleanup criteria in the scenarios developed for the RI Risk Assessment or FS Risk Assessment, as appropriate. This process is referred to as the Cleanup Criteria Evaluation.

3.4 Calculation of Cleanup Criteria

As discussed previously, the RI Risk Assessment and the FS Risk Assessment used existing average concentrations for chemicals of concern to determine an associated risk for each site. The result of these two assessments is a tabulation of the chemicals of concern for each site with an associated risk. The results are presented and discussed for each site in Section 4.0.

Acceptable risk was based on the proposed RCRA Corrective Action Rules (40 CFR Part 264 Subpart S) guidance. Acceptable risk was established at 1E-6 for individual chemicals and 1E-4 for cumulative risk posed by multiple contaminants. The

basis for this rationale was presented to the U.S. EPA Region VI in a letter dated 14 August 1992 (included in Appendix A). The following paragraphs discuss how these acceptable risks were used to calculate the cleanup criteria for these sites.

The risk from an individual chemical at a site increases proportionally when the concentration of the chemical is increased. Due to this relationship, the following equation can be used to define the relationship:

$$Risk_x = K_x \bullet C_x,$$

where: $Risk_x$ = risk associated with chemical X;
K_x = a coefficient for chemical X which remains constant at each site; and
C_x = concentration of chemical X (μg/L).

The coefficient K_x can be determined by using the existing risks and average concentrations for each chemical.

After the coefficient (K_x) is determined for each chemical at each site, the acceptable concentrations of each chemical can be calculated using the following equation.

$$C_{x,avg} = (\text{Acceptable Risk})_x/K_x.$$

For carcinogenic risk, the acceptable risk for each chemical was set at 1E-6 and an average concentration for each chemical was calculated as follows:

$$\text{Carcinogenic risk: } C_{x,avg} = 1E\text{-}6/K_{x,carc}.$$

For noncarcinogenic risk, the acceptable risk for the sum of all chemicals was set at an HI of 1.0. For each chemical, the acceptable noncarcinogenic risk was set at some fraction of

1.0, such that the sum of the fractions would equal 1.0, and the average concentration for each chemical was calculated as:

$$\text{Noncarcinogenic risk: } C_{x,avg} = (1.0/N)/K_{x,noncarc},$$

where: N = the number of noncarcinogenic chemicals of concern.

If different average concentrations of a chemical of concern were calculated based on the chemical having carcinogenic and noncarcinogenic risks or a combination of these, the lowest concentration was used.

The acceptable average concentration was used to determine the "target" cleanup criteria. The concentrations used to determine risks are averages of all of the data collected for a site. It is possible to assume that the acceptable average concentration is the target cleanup criteria; however, this assumes that all of the data points that are less than the acceptable average concentration will be raised to the acceptable average. Because this is unlikely to occur during a remedial activity, the cleanup criteria were calculated assuming that any existing data points that are currently below the target cleanup criteria would remain below the cleanup criteria, whereas all data points above the target cleanup criteria would be lowered to the target cleanup criteria. The new average from these data would be equal to the acceptable average concentration. Appendix B presents the method that was used to establish the target cleanup criteria and provides an example calculation.

4.0 SITE-SPECIFIC DESCRIPTION, RISK DISCUSSION, AND RAOs

The following section provides a site description, a discussion of the risk assessment, and the remedial action objectives for each site.

4.1 Sites 2&5--POL Spill Sites No. 1 and No. 2

4.1.1 Site Description

POL Spill Sites No. 1 and No. 2 (Sites 2&5) are located in the vicinity of 14 former 25,000-gallon aboveground storage tanks in a former bermed area. Because of the proximity of these spill sites to each other, the investigations for Site 2 and Site 5 were combined and will be referred to as Sites 2&5. IRP Sites 2&5 are also an Area of Concern (AOC) listed on Table 1 of Holloman's HSWA Permit. The corresponding RCRA name and reference are POL Storage Tank Leaks, AOC-T (both IRP sites are considered one AOC). Figure 4-1 illustrates the site layout and features.

At Site 2, the former 25,000-gallon fuel tanks were periodically overtopped between the early 1960s and the late 1970s. Spills of JP-4 and Avgas occurred throughout the unlined bermed area; however, the amount of fuel spilled is not known. The tanks were removed in 1987, but the tank saddles were left in place and covered with soil.

At Site 5, approximately 30,000 gallons of JP-4 fuel was spilled in 1978, when a drain valve for the 4-in fuel line was accidentally left open. The fuel line was used for filling the former 25,000-gallon tanks with JP-4 from Tank 15. Interviews with POL personnel indicated that the 30,000-gallon spill accumulated primarily in the southeast corner of the former unlined bermed area, with fuel draining to a low point southeast of the berm through the berm drain valve. The personnel also indicated that approximately 95% of the fuel was recovered, with the remainder of the fuel seeping into the gravel base of the

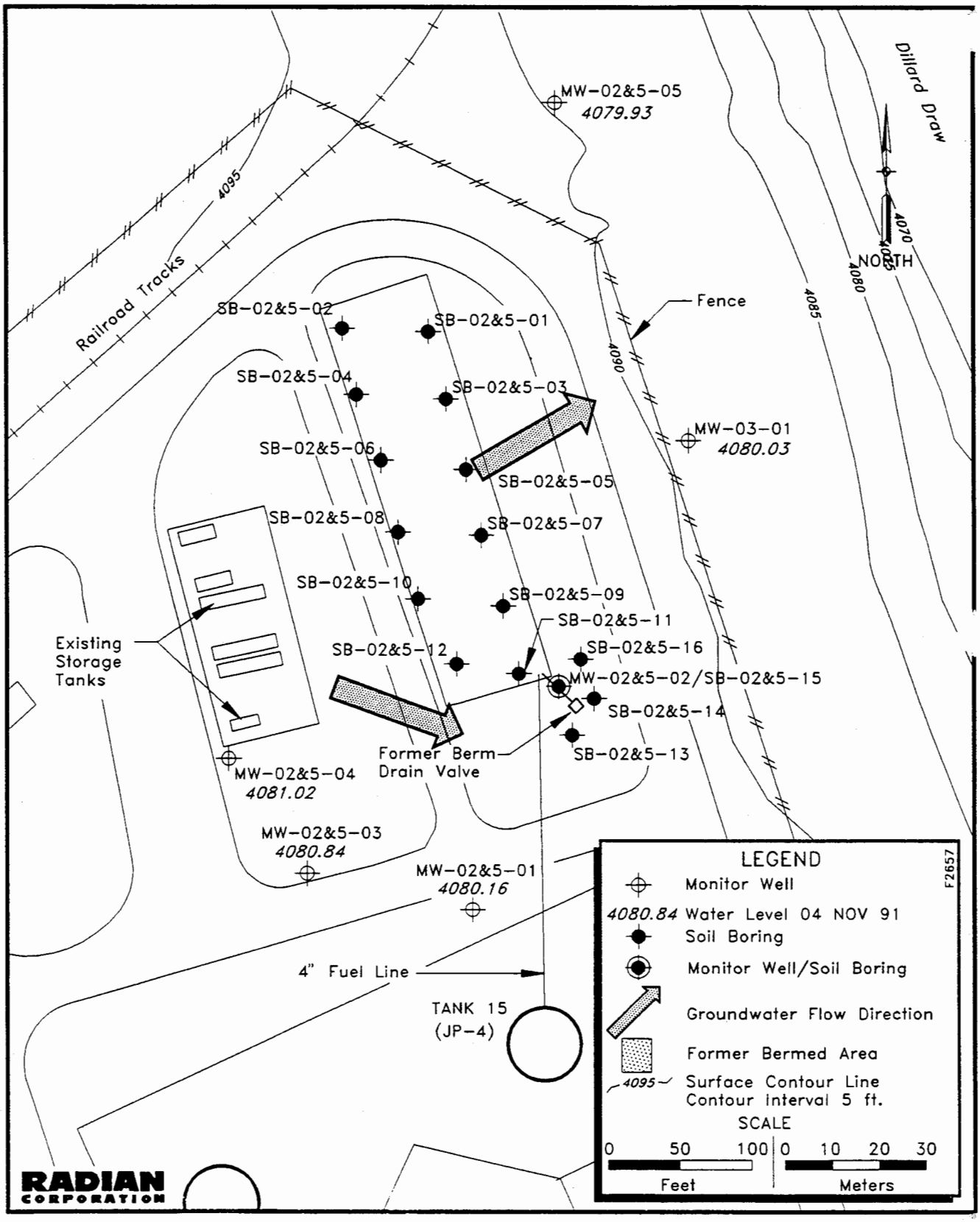

Figure 4-1. Illustration of Sites 2&5

POL storage area. An estimated 1500 gallons were not recovered and no remedial activity has been performed.

Analytical results indicate that the highest concentrations of petroleum hydrocarbons and benzene occur at depth in the southern portion of the former bermed area. Petroleum hydrocarbons and benzene were detected at much lower concentrations at the surface and in the northern portion of the former bermed area. Soil borings may have been drilled outside of the former bermed area, and may have missed the source of contamination. The source of contamination is believed to be located between the soil borings, as shown in Figure 4-1.

Five monitor wells were installed at Sites 2&5, and one monitor well was installed nearby at Site 3. Benzene was detected at concentrations greater than 2 mg/L in monitor wells downgradient of the suspected source.

4.1.2 Risk Assessment Results

The Screen conducted for Sites 2&5 indicated that the sites may pose unacceptable risk to human health and the environment and, therefore, require remedial action. The screen included a pathway that assumed that groundwater discharged to surface water in an adjacent arroyo called Dillard Draw. However, existing data are not sufficient to support this conclusion; it is unknown whether groundwater discharges to surface water through seeps and springs. As recommended in the *RI Report*, further investigation will be conducted in a predesign study for Sites 2&5. At that time, efforts will be made to determine whether groundwater discharges to surface water at Sites 2&5. If groundwater does discharge to surface water, that pathway will be evaluated in a risk assessment to determine the risk that the benzene contamination poses to human health and the environment. The soil at Sites 2&5 does not pose unacceptable risk.

4.1.3 RAOs, Sites 2&5

On the basis of the site description and the NMED recommendations for remediation of sites contaminated with petroleum products (Section 3.2), RAOs were established for Sites 2&5 and are presented in Table 4-1. Cleanup criteria for the soil are 1000 mg/kg for Total Petroleum Hydrocarbons (TPH) and 25 mg/kg for benzene.

4.2 Site 8--Refuse Collection Truck Washrack

4.2.1 Site Description

The Refuse Collection Truck Washrack (Site 8) is located southwest of the POL Storage Area and east of the Main Base Area. IRP Site 8 contains two SWMUs listed on Table 1 of Holloman AFB's HSWA Permit. Corresponding RCRA names and references are Building 131 O/WS, SWMU No. 4, and Building 131 Washrack, SWMU No. 82. It has been located in the same place since the beginning of Base operations. Figure 4-2 illustrates the features of the site.

At the washrack, refuse collection trucks and equipment are washed with soap and water, and the rinse water is discharged to the Base sewer system. Records indicate that pesticides were routinely sprayed inside the trucks during the 1970s for fly control. However, this is not a current practice, nor has it been since 1981. The current refuse collection foreman indicated that it was common for the sewer line from the washrack to clog, causing the sump and oil-water separator to overflow at the northwest end of the washrack. Other areas of concern include an engine oil drum storage basin, cracks in the concrete of the washrack, and general stains in the soil throughout the yard. The yard area was also used to wash trucks and should be considered a potential source of contamination. Subsequent to the field investigation in February 1992, the washrack was replaced with a new washrack in the same location.

Table 4-1

Remedial Action Objectives, Sites 2&5

Objective	Criteria	Contaminant	Acceptable Level
Soil/Waste:			
Prevent future contamination of groundwater	NMED standard for HAFB	TPH	1,000 mg/kg
		Benzene	25 mg/kg

HAFB = Holloman AFB

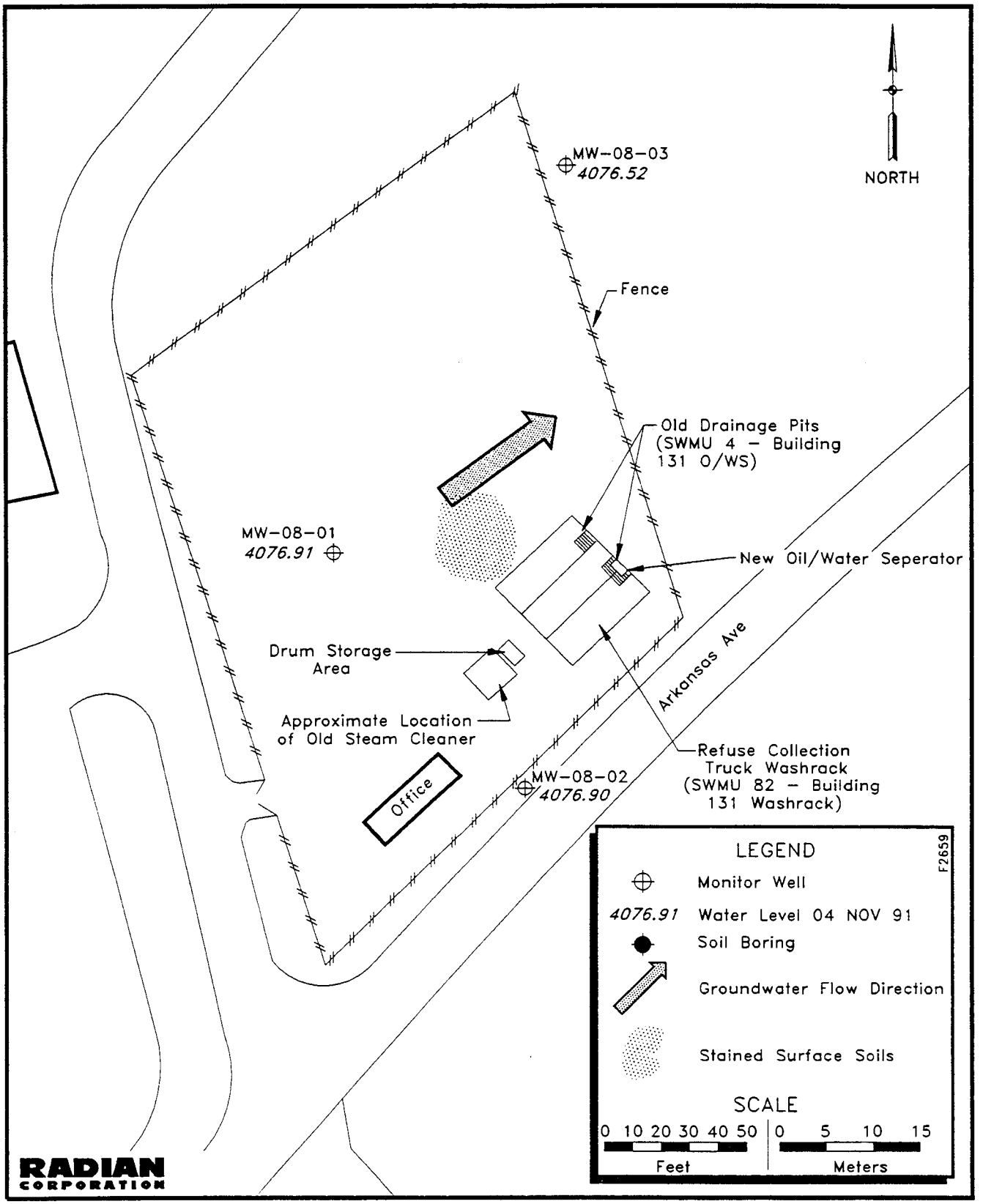

Figure 4-2. Illustration of Site 8

The results of the RI indicated that metals (above background concentrations) and organochlorine pesticides are present in the surface soil at this site. Organochlorine pesticides and volatile organic compounds (VOCs) were detected in the groundwater at the site. The highest concentrations detected were VOCs; however, VOCs were detected in the monitor well upgradient of the site. The VOCs in the groundwater are considered to be the result of another source of contamination. This other source has been identified as a new SWMU and will be investigated under a separate RFI, as recommended in the final *RI Report*.

4.2.2 Risk Assessment Results

The Screen conducted for Site 8 indicated that the site may pose unacceptable risk to human health and the environment and, therefore, requires remedial action. Site 8 was recommended for the FS and was not included in the RI Risk Assessment. However, Site 8 was addressed in the FS Risk Assessment described in Section 3. The results of the FS Risk Assessment for Site 8 are presented below.

Two exposure scenarios were evaluated for Site 8: 1) occupational exposure to surface (0 to 2 ft BGL) soil through incidental ingestion, dermal contact, and inhalation of fugitive dust in the ambient air; and 2) occupational exposure to VOCs from subsurface soil (greater than 2 ft BGL) and groundwater through inhalation. The two scenarios were calculated separately to determine unique carcinogenic and noncarcinogenic risk values for surface soil and subsurface conditions. By establishing two exposure scenarios, the surface soils, and subsurface soils and groundwater could be addressed separately in the FS (cleanup criteria for the two exposure scenarios could be calculated separately).

The selection of chemicals of concern for Site 8 is discussed in Appendix C. The average concentrations for each chemical are also presented in Appendix C.

Surface Soil

The exposure scenario identified for the site was occupational exposure to soil through incidental ingestion, dermal contact, and inhalation of fugitive dust in the ambient air. The exposure assumptions for these pathways are listed in Appendix D. For the inhalation scenario, the exposure concentrations are based on modeled on-site ambient air levels (refer to Appendix E for air modeling discussion and results). The model used measured groundwater and soil concentrations at the site. Only exposure to adults was estimated, because it was assumed that children would not be working at Site 8.

Appendix D contains the exposure model output for the site. Table 4-2 characterizes the estimated carcinogenic risk to workers. The total average and reasonable maximum carcinogenic risk is 1E-05 and 2E-05, respectively. The risk is the result of exposure to pesticides, VOCs and cadmium through dermal contact and inhalation. Individual chemicals exceed the acceptable carcinogenic risk of 1E-6.

An HI of greater than 1 indicates the potential for noncarcinogenic health effects. Table 4-3 characterizes the estimated noncarcinogenic risk to workers. The total HI for exposure while working is 20 for average exposure and 30 for reasonable maximum exposure. The risk resulted from exposure to pesticides, VOCs, and metals, through inhalation. These values suggest that adverse noncarcinogenic health effects are possible from occupational exposure to surface soils at this site.

Subsurface Soil and Groundwater

The carcinogenic risk from subsurface conditions was estimated to be 4E-8 and 8E-8 for average and reasonable maximum exposures, respectively. The noncarcinogenic risk was estimated to be 3E-5 and 4E-5 for average and reasonable maximum exposures, respectively. These values suggest that adverse health effects are not likely from

Table 4-2

Carcinogenic Risk for On-site Occupational Exposure
Site 8

Chemical	Ingestion of Soil	Dermal Contact with Soil	Inhalation of Ambient Air	Total	% Contribution
Average					
Aldrin	9E-8	9E-7	8E-8	1E-6	4.63
Benzene	3E-11	3E-10	8E-8	8E-8	0.328
Cadmium	0E+0	0E+0	2E-6	2E-6	8.1
Chlordane	8E-7	8E-6	7E-7	9E-6	40.5
4,4'-DDD	1E-7	1E-6	0E+0	1E-6	5.15
4,4'-DDE	2E-7	2E-6	0E+0	3E-6	11.1
4,4'-DDT	4E-7	4E-6	3E-7	4E-6	18.3
Heptachlor	4E-8	4E-7	3E-8	4E-7	1.83
Heptachlor epoxide	1E-7	9E-7	8E-8	1E-6	4.79
Methylene chloride	2E-9	2E-8	1E-6	1E-6	5.14
1,1-Dichloroethene	0E+0	0E+0	2E-8	2E-8	0.09
1,2-Dichloroethane	0E+0	0E+0	7E-10	7E-10	0.003
Chloroform	0E+0	0E+0	9E-11	9E-11	0.00036
Total by pathway	2E-6	2E-5	4E-6		
% Contribution by pathway	7.46	74.1	18.5		
Scenario Total				2E-5	
Reasonable Maximum					
Aldrin	1E-7	1E-6	1E-7	1E-6	4.42
Benzene	4E-11	4E-10	1E-7	1E-7	0.43
Cadmium	0E+0	0E+0	3E-6	3E-6	10.7
Chlordane	1E-6	1E-5	1E-6	1E-5	38.7
4,4'-DDD	1E-7	1E-6	0E+0	1E-6	4.77
4,4'-DDE	3E-7	3E-6	0E+0	3E-6	10.2
4,4'-DDT	4E-7	4E-6	5E-7	5E-6	17.5
Heptachlor	4E-8	4E-7	5E-8	5E-7	1.75
Heptachlor epoxide	1E-7	1E-6	1E-7	1E-6	4.57
Methylene chloride	2E-9	2E-8	2E-6	2E-6	6.77
1,1-Dichloroethene	0E+0	0E+0	4E-8	4E-8	0.12
1,2-Dichloroethane	0E+0	0E+0	1E-9	1E-9	0.004
Chloroform	0E+0	0E+0	1E-10	1E-10	0.0005
Total by pathway	2E-6	2E-5	7E-6		
% Contribution by pathway	6.92	68.6	24.4		
Scenario Total				3E-5	

Table 4-3

Noncarcinogenic Risk for Occupational Exposure
Site 8

Chemical	Ingestion of Soil	Dermal Contact with Soil	Inhalation of Ambient Air	Total	% Contribution
Average					
Aldrin	5E-4	5E-3	0E+0	6E-3	0.03
Cadmium	1E-3	2E-4	0E+0	1E-3	0.01
Chlordane	3E-2	3E-1	0E+0	3E-1	1.7
Chlorobenzene	1E-6	1E-5	4E-1	4E-1	2.18
Copper	9E-4	9E-4	0E+0	2E-3	0.01
4,4'-DDT	6E-3	6E-2	0E+0	7E-2	0.35
Endosulfan II	6E-5	6E-4	0E+0	6E-4	0.003
Ethyl benzene	3E-8	3E-7	2E-3	2E-3	0.01
Heptachlor	5E-5	4E-4	0E+0	5E-4	0.003
Heptachlor epoxide	2E-3	2E-2	0E+0	2E-2	0.13
Lead	3E-1	3E-1	0E+0	7E-1	3.51
Mercury	4E-3	3E-3	1E+1	1E+1	54.3
Methylene chloride	1E-5	1E-4	7	7	37.7
Toluene	4E-8	4E-7	3E-3	3E-3	0.01
Zinc	1E-3	1E-3	0E+0	3E-3	0.01
Xylenes	0E+0	0E+0	3E-5	3E-5	0.0001
Total by pathway	4E-1	7E-1	2E+1		
% Contribution by pathway	2	3.8	94.2		
Scenario Total				2E+1	
Reas. Max. Non-Cancer Hazard Index Summary					
Aldrin	5E-4	5E-3	0E+0	6E-3	0.0211
Cadmium	1E-3	2E-4	0E+0	1E-3	0.00468
Chlordane	3E-2	3E-1	0E+0	3E-1	1.21
Chlorobenzene	1E-6	1E-5	6E-1	6E-1	2.22
Copper	9E-4	9E-4	0E+0	2E-3	0.0066
4,4'-DDT	6E-3	6E-2	0E+0	7E-2	0.251
Endosulfan II	6E-5	6E-4	0E+0	6E-4	0.00245
Ethyl benzene	3E-8	3E-7	2E-3	2E-3	0.00868
Heptachlor	5E-5	4E-4	0E+0	5E-4	0.00189
Heptachlor epoxide	2E-3	2E-2	0E+0	2E-2	0.0942
Lead	3E-1	3E-1	0E+0	7E-1	2.5
Mercury	4E-3	3E-3	1E+1	1E+1	55.3
Methylene chloride	1E-5	1E-4	1E+1	1E+1	38.4
Toluene	4E-8	4E-7	4E-3	4E-3	0.0145
Zinc	1E-3	1E-3	0E+0	3E-3	1E-2
Xylenes	0E+0	0E+0	4E-5	4E-5	0.000145
Total by pathway	4E-1	7E-1	3E+1		
% Contribution by pathway	1.43	2.7	95.9		
Scenario Total				3E+1	

occupational exposure to subsurface conditions at the site. Supporting results for the exposure model output are found in Appendix D and for the air modeling in Appendix E.

Environmental Evaluation

Environmental receptors were not considered a major pathway for contamination at Site 8. Therefore, an ecological assessment was not conducted.

4.2.3 RAOs, Site 8

On the basis of the site description and the risk assessment discussed above, RAOs were established for Site 8 and are presented in Table 4-4. Cleanup criteria were determined for surface soils using methods discussed in Section 3. (Existing analytical data used to calculate the cleanup criteria for Site 8 are presented in Appendix F.)

4.2.4 Cleanup Criteria Evaluation

Cleanup criteria were evaluated using methods discussed in Section 3. The Cleanup Criteria Evaluation results are as follows: 7E-6 and 9E-6 for average and reasonable maximum carcinogenic risk, respectively, and 0.7 and 0.9 for average and reasonable maximum noncarcinogenic risk, respectively. All individual chemicals have acceptable carcinogenic risk values. These results indicate that occupational exposure to surface soils will be acceptable following remediation. Supporting data are provided in Appendix G.

Table 4-4

Remedial Action Objectives, Site 8

Objective	Exposure Route and Receptor	Criteria	Contaminant	Acceptable Level
Soil/Waste:				
Prevent dermal contact with contaminated soil	Dermal contact with contaminated soil by on-Base workers	Acceptable health risk	4,4'-DDD	4.0 mg/kg
			4,4'-DDE	3.3 mg/kg
Prevent inhalation of contaminated soil	Inhalation of contaminated soil by on-Base workers	Acceptable health risk	4,4'-DDT	1.1 mg/kg
			Cadmium	0.29 mg/kg
			Chlordane	0.14 mg/kg
			Lead	12 mg/kg
			Mercury	0.016 mg/kg

4.3 Site 14--Former Entomology Shop Area

4.3.1 Site Description

Site 14, the Former Entomology Shop Area, is located adjacent to existing Building 66. The corresponding RCRA name and reference are Former Entomology Shop, SWMU No. 229. Figure 4-3 is a map of the Former Entomology Shop Area. The site is located inside the civil engineering yard. It is bounded on the northwest by the civil engineering yard fence, on the southeast by Building 66, and by a smaller building on the northeast. The approximate location was determined in the field with the use of historical photos. Although the Former Entomology Office was located in Building 67, mixing and drum storage were conducted at the area located adjacent to Building 66. Pesticides commonly used at this site included DDT and chlordane. Diesel fuel was routinely used to solubilize the pesticides.

The investigation revealed that the predominant constituents in the soils at Site 14 were 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, aldrin, and chlordane. Due to the use of the area for storage, it is possible that the contamination is not homogeneous, and "hot spots" of contamination of certain chemicals may exist. Groundwater analytical results confirm that the pesticides have not migrated downward, because no organochlorine or organophosphorous pesticides were detected.

4.3.2 Risk Assessment Results

The Screen conducted for Site 14 indicated that the site may not pose unacceptable risk to human health and the environment. Therefore, Site 14 was more thoroughly evaluated in the RI Risk Assessment. The RI Risk Assessment indicated that contaminants at the site pose unacceptable risk to human health, and require remedial action. Site 14 was recommended to continue to the FS phase. The results of the RI Risk Assessment are presented in this subsection.

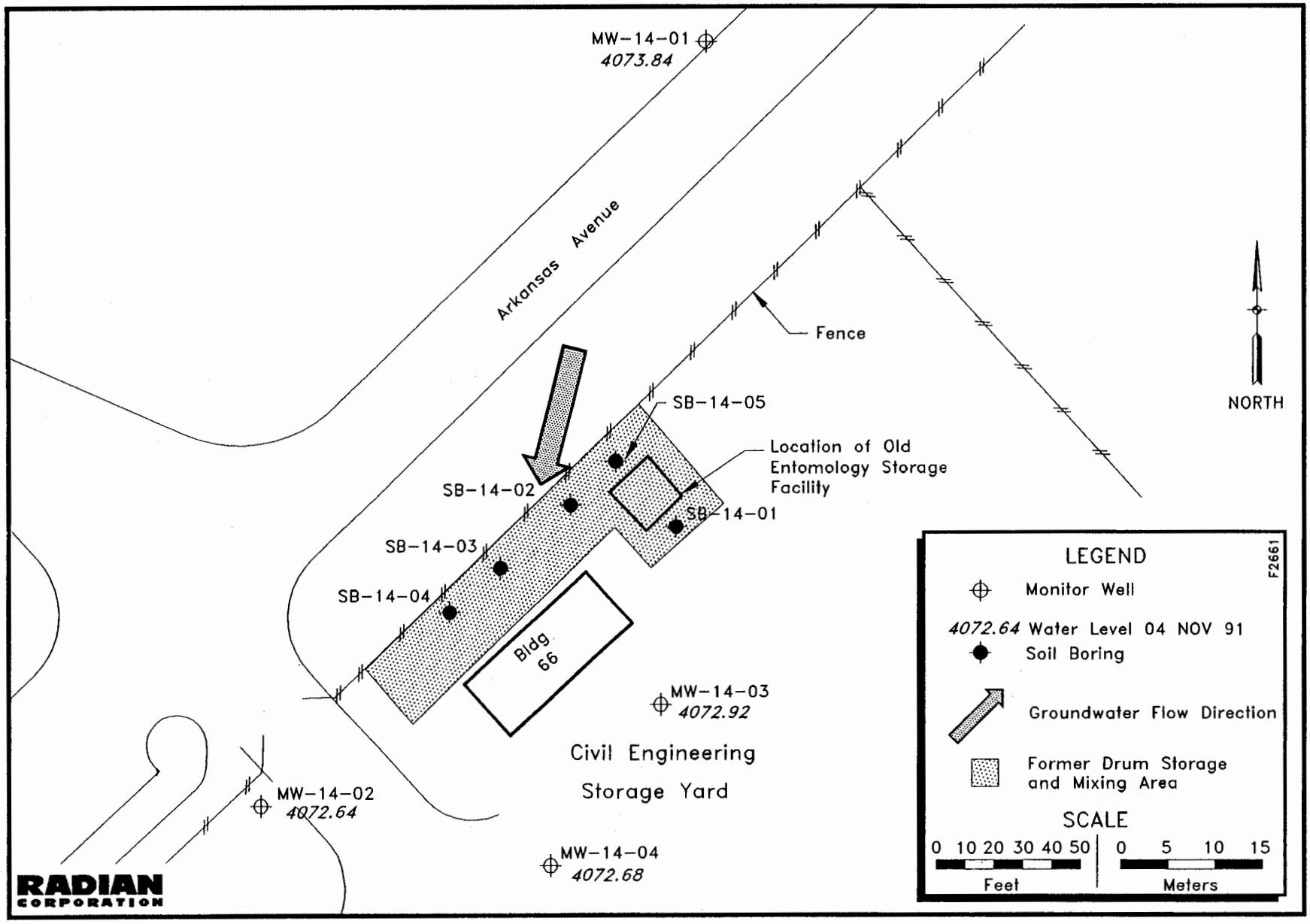

Figure 4-3. Illustration of Site 14

Three exposure scenarios were identified in the RI Risk Assessment for Site 14 (Radian, 1992). These were 1) on-Base residential exposure, 2) future off-Base residential exposure, and 3) on-Base occupational exposure. The selection of chemicals of concern for Site 14 is discussed in Appendix D; the average concentrations for each chemical are also presented. The RI Risk Assessment for Site 14 showed that unacceptable risks of carcinogenic and noncarcinogenic effects were possible for the on-site occupational scenario. For details on the RI Risk Assessment for Site 14, refer to the *Risk Assessment Report for the Remedial Investigation*. The pathways of concern involve occupational exposure to contaminated soil through inhalation of dust and volatiles, incidental ingestion, and dermal contact. Collectively, these pathways result in unacceptable carcinogenic and noncarcinogenic risk. The carcinogenic risk was determined to be 1E-04 and the noncarcinogenic risk was calculated to have an HI value of 3.0.

The environmental evaluation identified a borderline risk to black-tailed jackrabbits. The EQ for this site was 1.3 due to chlordane and 4,4'-DDT. The evaluation was based on uptake of pesticides by plants, followed by ingestion of plants by the rabbits. The site is not currently vegetated. Moreover, given that the site is heavily trafficked during the day and fenced in at night, rabbits have limited access to the site. Therefore, the borderline EQ value is unlikely to represent a realistic concern.

4.3.3 RAOs, Site 14

On the basis of the site description and the risk assessment discussion above, RAOs were established for Site 14 and are presented in Table 4-5. Cleanup criteria were determined using methods discussed in Section 3. (Existing analytical data used to calculate the cleanup criteria are provided in Appendix F.)

4.3.4 Cleanup Criteria Evaluation

Cleanup criteria were evaluated using methods discussed in Section 3. Surface soil was targeted for cleanup since the majority of the risk to workers is from the top 3 ft of soil at this site. Due to the nature and extent of contamination below 3 ft, deeper soil does not contribute significantly to the inhalation pathway. The Cleanup Criteria Evaluation results are as follows: 8E-6 for both average and reasonable maximum carcinogenic risk, and 0.7 and for both average and reasonable maximum noncarcinogenic risk. All individual chemicals have acceptable carcinogenic risk values (1E-6). These results indicate that occupational exposure to surface soils will be acceptable following remediation. Supporting data are provided in Appendix G.

Table 4-5

Remedial Action Objectives, Site 14

Objective	Exposure Route and Receptor	Criteria	Contaminant	Acceptable Level
Soil:				
Prevent dermal contact with contaminated soil	Dermal contact with contaminated soil by current on-Base occupational adult	Acceptable health risk	4,4'-DDD	1.5 mg/kg
			4,4'-DDE	1.0 mg/kg
			4,4'-DDT	1.3 mg/kg
			Aldrin	0.01 mg/kg
			Chlordane	0.2 mg/kg
Prevent dermal contact with contaminated soil	Dermal contact with contaminated soil by current on-Base occupational adult	Acceptable health risk	Heptachlor	0.1 mg/kg
			Gamma BHC	0.7 mg/kg

5.0 APPROACH TO EVALUATION OF TECHNOLOGIES

Potential remedial technologies for each medium and contaminant category will be identified for the general response actions. The technologies will be screened to eliminate those that may prove infeasible to implement, those that are unlikely to perform satisfactorily, and those that do not achieve the objectives within a reasonable period of time. The screening process will eliminate technologies which have significant limitations for a given set of waste and site-specific conditions.

The potential remedial technologies that are not screened out will then be evaluated based on their effectiveness, implementability, and cost to select a representative process option for each technology type. Representative technology process options for each medium will be assembled into remedial alternatives that represent a range of institutional action, containment, treatment, and disposal combinations for each site. Although specific process options will be selected for alternative development and evaluation, these options will represent the range of process options within each general technology type.

6.0 SCHEDULE

The Feasibility Study schedule is presented in Table 6-1.

Table 6-1

Proposed Schedule

Activity	Proposed Submittal Date
Submit draft final CMS Plan to U.S. EPA Region VI and NMED	11 November 1992
Receive comments on CMS Plan	7 December 1992
Submit final CMS Plan	21 December 1992
Receive approval on CMS Plan	11 January 1993
Submit draft final FS to U.S. EPA Region VI and NMED	15 February 1993
Receive comments from USEPA	15 March 1993
Submit final FS	12 April 1993

7.0 REFERENCES

1. Radian Corporation. Remedial Investigation (RI) Report: Investigation, Study and Recommedation for 29 Waste Sites. 1992.

2. Radian Corporation. Risk Assessment Report for the Remedial Investigation: Investigation, Study and Recommendation for 29 Waste Sites. 1992.

3. McKone, Thomas E. and Jeffrey I. Daniels. "Estimating Human Exposure Through Multiple Pathways from Air, Water and Soil." Reg. Toxicol. Pharmacol. 13:36-61, 1991.

4. U.S. Environmental Protection Agency. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (Interim Final). EPA/540/G-89/004. 1988.

5. U.S. Environmental Protection Agency. RCRA Corrective Action Plan (Interim Final). EPA/530-SW-88-028. 1988.

6. U.S. Environmental Protection Agency. Corrective Action for Solid Waste Management Units at Hazardous Waste Facilities (proposed rule). Federal Register, Vol. 55, No. 145, pp. 30798-30884, 27 July 1990.

APPENDIX A

CORRESPONDENCE

STATE OF NEW MEXICO
ENVIRONMENT DEPARTMENT

July 22, 1992

Mr. Howard E. Moffitt, Deputy Base Civil Engineer
49 CES/CEV
Holloman Air Force Base, NM 88330-5000

Dear Mr. Moffitt:

Under the auspices of the Defense-State Memorandum of Agreement concerning IRP sites at Holloman Air Force Base, I am responding to your letter of May 28 to Kathleen M. Sisneros concerning ground water remediation and soil cleanup standards for petroleum product releases at Holloman AFB.

Your understanding is correct that ground water remediation at these sites will not be required. As discussed verbally and mentioned in correspondence relating specifically to underground storage tank sites, any floating hydrocarbon must be removed from the ground water surface, and all "highly contaminated soil" must be removed or remediated. Dissolved phase hydrocarbon contamination of the ground water beneath the base need not be remediated.

The Underground Storage Tank Bureau does not believe it to be feasible at present to assign a numerical value to the regulatory definition of "highly contaminated soil" because of the many site-specific variables that can influence the determination.

As a method of settling this issue, we propose that Holloman AFB staff who will be in Santa Fe on July 28 to discuss the current Remedial Investigation report for IRP sites bring with them a kilogram or two of dry soil known to be representative of that beneath the hydrocarbon release sites. NMED staff will procure a small amount of gasoline and diesel fuel, 1000 ppm of both products can be added to the soil in our laboratory, and the resulting mixture can be evaluated by UST Bureau personnel to determine whether 1000 ppm is less than "highly contaminated". If so, NMED has no objection to its use as the appropriate soil cleanup level.

If you have any questions concerning any of this please contact David Morgan at 505-827-2754.

Sincerely,

Steven J. Cary, Chief
Ground Water Protection and Remediation Bureau

c: Edward Horst, NMED HRMB
Bob Sweeney, NMED USTB

Bruce King
Governor

Joseph M. Espinosa
Secretary

Steven J. Cary
Deputy Secretary

14 August 1992

Mr. Rich Mayer (GH-PS)
U.S.EPA Region VI
1445 Ross Avenue
Dallas, Texas 75202

Dear Rich:

At our meeting with Dave Morgan of the New Mexico Environment Department (NMED) and yourself, Radian presented the results of the RI/RFI for the 29 Sites at Holloman Air Force Base (AFB), New Mexico. During the presentation we discussed our findings that a total of eight sites (2&5, 3, 8, 9, 14, 30&33, 37, and 39) appeared to have concentrations of contaminants that might warrant remediation, and therefore a Feasibility Study (FS) would be needed. We discussed in general terms the remedial action objectives for these sites, and the methods to be used to establish the objectives.

As we discussed, Holloman AFB plans to develop health risk-based cleanup objectives for the six sites that pose a risk to human health (2&5, 3, 8, 9, 14, and 30&33). These cleanup objectives will be based on site-specific information such as exposure pathways, potential contact locations with contaminated media, and potentially exposed populations. A specific cleanup criterion will be determined separately for each contaminant in each medium in which it is found.

In order to determine health risk-based cleanup criteria, the level of acceptable risk must be specified. In the Preamble to the proposed Corrective Action Program, Subpart S of 40 CFR Part 264 (55 Fed. Reg. 30798-30873, July 27, 1990), EPA discusses the development of media cleanup standards. In general, EPA prefers an excess lifetime cancer risk of 1×10^{-6} as the point of departure for development of cleanup standards. However, our past experience indicates that EPA is willing to accept cleanup standards associated with risk levels as high as 1×10^{-4} under certain circumstances. As you know, many of the sites at Holloman contain more than one contaminant. EPA discusses this issue in the Preamble on page 30827: "The cumulative risk posed by multiple contaminants should not exceed a 1×10^{-4} cancer risk."

Subpart S has not yet been adopted formally by EPA. However we understand that the proposed rule is being implemented as policy by most EPA Regional offices until such time as the rule is adopted. Therefore Holloman proposes to determine cleanup standards in accordance with the proposed rule as follows:

- Media cleanup standards will be developed such that the cumulative risk posed by multiple contaminants will not exceed a 1×10^{-4} cancer risk; and

- The cleanup standard for a single chemical will result in an associated cancer risk in the range of 1×10^{-4} to 1×10^{-6}.

The cleanup standards for specific contaminants are critical to preparation of the FS because remedy selection and development of cost estimates requires information on the level of a contaminant that can be left in place. Therefore, it is important that we receive your concurrence with these proposed acceptable risks so that we can complete the FS. In order to prepare the Corrective Measures Study (CMS) Plan that is required by Section IV.M of our permit, we would like to receive concurrence on these proposed acceptable risks by 20 August 1992. Following this, we will submit the CMS Plan to the EPA Region VI and NMED by 8 September 1992 and would appreciate review comments by 22 September 1992.

Thank you in advance for your cooperation in expediting the review of the proposed acceptable risks and the CMS Plan schedule. If you have any questions, please call Rodger Wilkson or Warren Neff at 505/479-5878.

Howard E. Moffitt
Deputy Base Civil Engineer

cc: Ron Stirling/USACE, Omaha
Wally Hise, Radian
David Morgan / NMED

CONFIRMATION NOTICE NO. 23

TO:	U.S. Army Engineer District ATTN: CEMRO-ED-EA (Ron Stirling) 215 North 17th Street Omaha, Nebraska 68102-4978
CONTRACTOR:	Sirrine Environmental Consultants, Inc.
SUBCONTRACTOR:	Radian Corporation
CONTRACT NUMBER:	DACW45-89-D-0515
DELIVERY ORDER NUMBER:	5023. Radian DO #16
TITLE:	RI/FS at 29 Sites Holloman AFB, New Mexico
DATE OF THIS REPORT:	13 December 1991
SUBJECT:	**Investigation Report Format Meeting**
PARTICIPATING PERSONNEL:	See Attached List

On 9 December 1991, Radian personnel attended a meeting at the USAF Regional Environmental Office in Dallas, Texas to discuss the format and content of the remedial investigation report. Also in attendance were representatives from Holloman AFB, USACE, New Mexico Environment Department (NMED), and EPA Region VI. Following is a summary of the meeting.

I. Introduction

Mr. Roger Wilkson of HAFB provided a brief introduction and background to the project. He outlined the meeting objectives as: 1) to inform regulatory agencies of the present activities at IRP/SWMU sites and discuss discrepancies between the IRP investigation and Table 1 of Holloman's HSWA permit; and 2) to determine how to satisfy requirements of CERCLA and RCRA without duplication of effort and expense.

II. Summary of Field Program

Mr. Tom Holcomb of Radian provided a brief overview of the field program recently completed for the 29 waste sites, and then gave a detailed presentation of the work conducted at each site. Mr. Rich Mayer of EPA Region VI indicated that although the

IV. Determination of Remedial Action

The standard Feasibility Study/Corrective Measures Study approach to determine remedial action will be acceptable to both agencies. The final corrective action clean up levels will be determined through coordination by EPA Region VI and NMED.

V. Risk Assessment

Wallace Hise presented Radian's proposed approach to using a risk assessment for individual sites. In summary, a receptor and pathway identification will be completed for each of the 29 sites. This step will fulfill RCRA requirements under the RFI program. Then each site will be screened to determine the level of contamination. The following three scenarios are possible:

- For "grossly" contaminated sites (preliminary screen indicates a risk $\geq 10^{-4}$), remediation will be required and therefore no comprehensive risk assessment will be prepared;

- For "clean" sites (preliminary screen indicates a risk $\leq 10^{-6}$), a site-specific risk assessment will be prepared to justify a recommendation of no further action; and

- For "in between" sites (preliminary screen indicates a risk between 10^{-4} and 10^{-6}), a site-specific risk assessment will be prepared to accurately determine the risk, and facilitate selection of a remedial action or treatment alternative.

This approach will effectively combine CERCLA risk assessment techniques to satisfy RCRA requirements and meet objectives of the proposed Subpart S corrective action program. Both EPA and NMED agreed that this approach will be acceptable.

VI. Summary and Recommended Approach

The site investigation report will be presented in a CERCLA RI format with a narrative discussing applicable RCRA requirements and where they are located within the document. In general, neither the EPA nor RCRA Division of NMED are concerned with the report title or format.

Site-specific recommendations will be provided in the RI report, with reference to the stand-alone risk assessment for back-up documentation. The following three scenarios are anticipated for individual sites:

project plans (CDAP and SSHP) were verbally approved, an approval letter had not yet been prepared by EPA.

III. Report Format

Mr. Wallace Hise of Radian gave a brief summary of the intended format for the site investigation report.

Rich Mayer suggested that information for each site (figures, data summary tables, conclusions, and recommendations) be grouped together for ease of reading. Site-specific discussions may focus on only compounds detected as long as the result(s) and corresponding detection limit(s) are specified in data summary tables, and a complete copy of analytical data is provided in an appendix. Mr. David Morgan of NMED indicated that the RCRA Division currently has no specific reporting format requirements.

It was agreed that a draft final report will be submitted to EPA Region VI and NMED by 30 June 1992 for review and comment. By this date, investigation results for all sites on Table 1 of Holloman's permit should be submitted. This deliverable date will be reflected in a letter to be drafted by Rich Mayer approving the site investigation plans. Rich Mayer also requested that quarterly reports be prepared and submitted by HAFB to track the progress of SWMU investigations and document significant findings.

Action Items:

1. HAFB will coordinate submittal of results for all Table 1 sites, including those not covered under Radian's current investigation. [Note that several sites were previously investigated under other IRP work efforts or dealt with under the Base's Rapid Response Program.] This may include a narrative to clarify where information is presented for each individual site.

2. HAFB may choose to submit a permit modification to move several sites that have not been investigated from Table 1 to Table 2. Additionally, IRP Sites 37, 39, and 43 (SWMU nos. 165, 179, AOC L, and AOC G) listed on Table 2 are currently being investigated and can be moved to Table 1. These changes to the permit will facilitate scoping of future work activities and provide a comprehensive work effort for all Table 1 and Table 2 sites.

3. HAFB will prepare and submit progress reports for all activities associated with the HSWA permit.

- No further action;
- Additional investigation to fill in data gaps or provide support for remedial design; and
- Site remediation.

9 December 1991

Investigation, Study, and
Recommendation for 29 Waste Sites
Holloman Air Force Base, NM

Name	Organization	Phone No.
Richard Mayer	EPA Region VI	214-655-6775
Wally Hise	Radian Corp.	512-454-4797
Ron Stirling	USACE - Omaha	402-221-3761
Sandy Frye	USACE - Omaha	402-221-7642
Roger Wilkson	Holloman AFB	505-479-5878
David Morgan	NMED	505-827-2754
Sharon Moore	Holloman AFB	505-479-3931
Tom Holcomb	Radian Corp.	512-454-4797
Ron Jahns	AFCEE/ESD	214-767-4648

Table 1 From Holloman AFB Hazardous Waste Permit[a]

SWMU Name	SWMU No.	IRP Site No.	Status
Building 1 Waste Accumulation Area	42	9	√
Acid Trailer Disposal Site	102	4	√
Former Army Landfill	104	29	√
Golf Course Landfill	105	19	√
Main Base Landfill	106	1	X
Main Base Substation PCB Disposal Area	107	11	√
MOBSS Landfill Disposal Trench	108	23	√
Old Main Base Landfill	109	10	X
Sludge Disposal Trenches	113	20,30,33	√
TEL Disposal Site	114	3	√
West Area Landfill #1 PCB Disposal Area	115	22	√
West Area Landfill #2	116	21	√
Fire Department Training Area 1	170	31	X
Fire Department Training Area 2	171	31	X
Building 1191 Fuel Runoff Pits	178	36	√
Building 824 Waste Accumulation Area	212	28	√
Taxiway 4 Tank 28	130	46	X
Building 21 Entomology Leachfield	132	16	√
Building 1166 Test Track Drainfield	137	38	√
Building 1166 Oil/Water Separator Drainage Pit	138	--	*
Lake Holloman, which includes the earthen ditch carrying discharge from Lagoon G to Lake Holloman	139	-SL	**
Lake Stinky	140	-SL	**
Building 21 Pesticide Rinsewater Spill Area	AOC-A	16	√

(Continued)

SWMU Name	SWMU No.	IRP Site No.	Status
Building 882 Spills	AOC-D	26	√
Building 296 Fuel Tank Leaks	AOC-O	45	•
Building 301 Fuel Tank Leaks	AOC-P	44	X
POL Storage Tank Leaks	AOC-T	2 & 5	√
Pad 9 Drainage Pit	141	--	*
Former Entomology Shop	229	14	√
Building 131 O/WS	4	8	√
Building 131 Washrack	82	8	√
Building 702 O/WS	21	47	•
Radioactive Waste Disposal Area	111	42	√
Building 702 Waste Oil Tank	122	47	•
Building 703 Washrack Discharge Area	133	47	•
Buildings 920-924 Drainage Ditch	134	24	√
Coco Blockhouse Disposal Well	192	41	√

[a] = Reference HSWA Permit issued 22 August 1991 by EPA Region VI.

√ = Site is currently being investigated under the IRP Program.

X = Remedial Investigation has already been completed. Decision Documents to close the sites have been submitted.

* = No activities to date.

** = Already investigated with the Base Sewage Treatment Lagoons.

• = Sites are being investigated under the Base's Rapid Response Program.

Sites Investigated by Radian Corporation

IRP Site Name	IRP Site No.	SWMU No.	Permit Table No.[a]
POL Spill Site No. 1	2	AOC T	1
Tetraethyl Lead Disposal Area	3	114	1
Acid Trailer Burial Site	4	102	1
POL Spill Site No. 2	5	AOC T	1
Refuse Collection Truck Washrack	8	4, 82	--
Waste POL Drum Storage/Spill Area	9	42	1
Main Base Electrical Substation	11	107	1
Former Entomology Shop Area	14	197	1
Existing Entomology Shop Area	16	132 118* AOC A	1 2* 1
Golf Course Landfill	19	105	1
Wastewater Treatment Plant Grit Burial Site	20	113	1
West Area Landfill No. 2	21	115	1
West Area Landfill No. 1	22	116	1
MOBSS Landfill	23	108	1
Former Equipment Maintenance Area	24	134	1
Possible Missile Fuel Spill Site	26	AOC D	1
Former North Area Washrack Site	28	212	1
Former Army Landfill	29	104	1
Grease Trap Disposal Pits	30	113	1
Cooking Grease Disposal Trenches	33	113	1
Unconventional Fuels Area Spill Site	36	178 129	1 2
Early Missile Testing Site	37	AOC L	2
Sled Test Maintenance Area	38	137	1

(Continued)

IRP Site Name	IRP Site No.	SWMU No.	Permit Table No.[a]
Missile Fuel Spill Area	39	165	2
		167	--
		177	2
		179	2
		181	2
		185	--
Coco Blockhouse Borehole Disposal Site	41	192	1
Radioactive Waste Burial Pit	42	111	1
Atlas Electrical Substations	43	AOC G	2
Waste Disposal Pit	50	--	--
Primate Research Institute/-Borehole Disposal Pit	51	--	--

[a]Reference HSWA Permit issued 22 August 1991 by EPA Region VI.

*Groundwater monitoring wells installed around entire IRP site.

IRP - SWMU DISCREPANCIES

IRP ID	SWMU ID
2	AOC T
5	AOC T
20	113
30	113
33	113
39	167
--	165
--	177
--	179
--	181
--	185

RESOLUTION OF DISCREPANCIES

- IRP 2 & 5 (AOC T) - Combined
- IRP 20 (SWMU 113) - Separated
- IRP 30 & 33 (SWMU 113) - Combined
- IRP 39 (SWMU 167) - Added SWMUs 165, 177, 179, 181, and 185

APPENDIX B

RATIONALE FOR DETERMINING CLEANUP CRITERIA FROM ACCEPTABLE AVERAGE CONCENTRATIONS AND EXAMPLE CALCULATIONS

RATIONALE FOR DETERMINING CLEANUP CRITERIA FROM ACCEPTABLE AVERAGE CONCENTRATIONS

1. Arrange existing data points in ascending concentration. (C_1, C_2, C_3, ... $C_{Nx.}$ C_1 will be the lowest concentration).

2. Compare the acceptable average ($C_{x,avg}$) to the lowest existing concentration (C_1).

3. If $C_1 > C_{x,avg}$, then the cleanup criteria = $C_{x,avg}$. If $C_1 < C_{x,avg}$, continue.

4. Subtract the lowest concentration (C_1) from the acceptable total ($C_{x,total}$) and divide by the number of remaining data points (N_x-1).

$$VALUE = (C_{x,total} - C_1)/(N_x-1)$$

5. Compare VALUE to the second lowest existing concentration (C_2).

6. If $C_2 >$ VALUE, then the cleanup criteria = VALUE. If $C_2 <$ VALUE, continue.

7. Subtract the two lowest concentrations (C_1 and C_2) from the acceptable total ($C_{x,total}$) and divide by the number of remaining data points (N_x-2).

$$VALUE = (C_{x,total} - (C_1 + C_2))/(N_x-2)$$

8. Compare VALUE to the third lowest existing concentration (C_3).

9. If $C_3 >$ VALUE, then the cleanup criteria = VALUE. If $C_3 <$ VALUE, continue this process until the cleanup criteria is determined.

NOTE: If the highest existing concentration, C_N, is lower than $C_{x,avg}$, the existing concentrations are acceptable and no remediation is necessary. (The existing risk is already acceptable.)

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO.

SIGNATURE _____ DATE _____ CHECKED _____ DATE _____

PROJECT HOLLOMAN AFB FS JOB NO. _____

SUBJECT RAOS - CLEANUP CRITERIA SHEET _____ OF _____ SHEETS

SITE 8

CHLORDANE IN SOIL:

EXISTING CONDITIONS:

4 SAMPLES

950 ppb
4000 ppb
230 ppb
730 ppb

AVG CONC = 1478 ppb
RISK = 1.0×10^{-5}
ACCEPTABLE RISK = 1.0×10^{-6}

Calculate Coefficient

Risk = Coefficient × Concentration

$$COEFF = \frac{RISK}{CONC}$$

$$COEFF = \frac{1.0 \times 10^{-5}}{1478} = 6.77 \times 10^{-9}$$

Calculate Target Sum of Sample Concentrations

$$TARGET\ SUM = (AVG\ CONC)(4) = \frac{TARGET\ RISK \times \#\ OF\ SAMPLES}{COEFF}$$

$$TARGET\ SUM = \frac{1 \times 10^{-6} \times 4}{6.77 \times 10^{-9}} = 591\ ppb$$

Calculate Cleanup Level

$\frac{591}{4} = 148$ ppb < LOWEST EXISTING CONC.

∴ LOWER ALL VALUES TO 148 ppb

10-88-30702

APPENDIX C

CHEMICALS OF CONCERN

C.1 Selection of Chemicals of Potential Concern

A complete discussion of the methods used to select the chemicals of potential concern and a listing of the chemicals of concern at Holloman AFB can be found in the *Risk Assessment Report for the Remedial Investigation*, Volume II, Appendix A (Radian, 1992). Analytical summary tables for positive detections at each site are presented in Appendix B of that report. These tables include all positive detections for each analysis performed, detection concentrations, reporting limits, factors used to make adjustments for dilutions, and measurement units. Site ID numbers, location ID numbers, sampling depths, and field sample IDs are used to identify each set of sample results. Soil results are reported on a dry weight basis. Analytical summary tables for all sites are presented in Appendix B of the "Sampling and Quality Control Summary Report" (Radian, 1992). Chemicals eliminated from Site 14 are discussed in that report. In addition, the chemicals of concern for Site 14 are presented with the average concentration for each chemical in this Appendix.

Chemicals eliminated from Site 8 are listed here. Table C-1 lists the soil contaminants eliminated as chemicals of potential concern based on blanks data. Table C-2 lists the inorganic contaminants determined to be below upper tolerance levels in soil. Table C-3 lists the inorganic contaminants determined to be below statistical background in groundwater. Methylene chloride was detected in one soil boring at a concentration greater than 10 times the blank at both Site 8 and Site 14. However it was eliminated as a chemical of concern because methylene chloride is a common laboratory contaminant and it is not suspected to be a contaminant at these sites since it is not related to site activities. Soil samples will be collected after the remedial action has been completed. At that time, soil will again be analyzed for methylene chloride to verify that it was present as a laboratory contaminant only.

Table C-1

Soil Contaminants Eliminated as Chemicals of Concern Based on Blanks Data

Chemical	Analytical Result (μg/kg)	Frequency of Detection	Blank Result (μg/kg)	Blank Type[a]	Rationale for Elimination
Site 8					
Methylene chloride	51-410	6/12	140	ZB	Sample less than 10 times ZB

[a] ZB = Methanol Blank

[b] Analyzed by TCLP (μg/L).

Table C-2

Inorganic Contaminants Below Upper Tolerance Limits in Soil

Site 8
Arsenic
Beryllium
Chromium
Nickel

Table C-3

Inorganic Contaminants Below Statistical Background in Groundwater

Site 8
Chromium
Copper
Lead
Nickel
Zinc

Table C-4

Site 8--Soil Chemicals of Concern

Chemical	Average Concentration (mg/L)
4,4'-DDD	1.1
4,4'-DDE	1.7
4,4'-DDT	2.6
Aldrin	0.01
Benzene	.003
Cadmium	0.9
Chlordane	1.5
Chlorobenzene	0.02
Copper	29.5
delta-BHC	0.01
Endosulfan II	0.003
Endosulfan Sulfate	0.7
Ethyl benzene	2.6
Heptachlor	0.02
Heptachlor epoxide	25.0
Lead	111.8
Mercury	0.9
Methylene chloride	0.6
Toluene	0.006
Zinc	224.5

Table C-5

Site 14--Soil Chemicals of Concern

Chemical	Average Concentration (mg/L)
4,4'-DDD	3.9
4,4'-DDE	2.8
4,4'-DDT	117.3
Aldrin	0.5
Chlordane	10.1
Endosulfan II	0.01
gamma-BHC	0.5
Heptachlor	0.2
MCPP	116.0
Methylene chloride	0.4

APPENDIX D

FS RISK ASSESSMENT SUPPORTING DATA

FS Risk Assessment--Exposure Algorithms and Assumptions

Inhalation of ambient air (fugitive dust or volatiles)

Intake (mg/kg-day) = (CA x IR x ET x EF x ED)/BW x AT)

CA = Contaminant concentration in ambient air (mg/m^3)

IRA = Inhalation Rate of Ambient Air (m^3/hour)

ET = Exposure time (hours/day)

EF = Exposure frequency (days/year)

ED = Exposure duration (years)

BW = Body weight (kg)

AT = Averaging time - period over which exposure is averaged (days)

Parameter	Assumptions
CA	Site-specific
IRA	Adults: 2.1 m^3/hour - moderate activity level, EPA, 1989); 3.0 m^3/hour - high activity level, EPA, 1989).
	Child: 2.4 m^3/hour - average for ages 8-17, moderate activity level (EPA, 1989).
ET	2 hours/day - assumes workers spend 2 hours/day at the site; also 2 hours/day for participation in outdoor recreational activities.
EF	Worker: 250 days/year - assumes workers are at the site 5 days/week for 50 weeks/year (EPA, 1991).
	Child: 175 events/year - assumes children are involved in outdoor recreational activities 6 months/year, subtracting 2 weeks of vacation away from the site.
ED	Worker: 25 years - 90th percentile time spent working at the same location (EPA, 1991); 30 years - reasonable maximum.
	Child: 9 years - national median time--50th percentile--time at one residence (EPA, 1989); for military families this is comparable to three 3-year tours-of-duty.
BW	Adult: 70 kg (EPA, 1989).
	Child: 49 kg (BW averaged for ages 8-17; EPA, 1989).
AT	Carcinogenic effects: 25550 (70 years x 365 days/year)
	Noncarcinogenic effects: 9125 (ED x 365 days/year) 25 years; 3285 (9 years); 10950 (30 years).

FS Risk Assessment--Incidental Ingestion of Soil

Intake (mg/kg-day) = (CS x IR x CF x FI x EF x ED)/(BW x AT)

CS = Chemical concentration in soil (mg/kg)

IR = Ingestion Rate (mg soil/day)

CF = Conversion factor (kg/mg)

FI = Fraction ingested from contaminated source (unitless)

EF = Exposure frequency (days/year)

ED = Exposure duration (years)

BW = Body weight (kg)

AT = Averaging time - period over which exposure is averaged (days)

Parameter	Assumptions
CS	Site-specific
IR	Adult: 1000 mg/day - amount of soil ingested/day while participating in outdoor recreational activities, represents an upper-range ingestion rate for children (EPA, 1991).
CF	1E-06 kg/mg.
FI	1 - assumes 100% of the soil ingested is from the contaminated site. This represents a worst-case exposure scenario. This value should be used because it would be hard to justify using a smaller fraction.
EF	Worker: 250 days/year - assumes workers are at the site 5 days/week for 50 weeks/year (EPA, 1991); Child: 175 events/year - assumes children are involved in outdoor recreational activities 6 months/year, subtracting 2 weeks of vacation away from the site.
ED	Worker: 25 years - 90th percentile time spent working at the same location (EPA, 1991); 30 years - reasonable maximum; Child: 9 years - national median time--50th percentile--time at one residence (EPA, 1989); for military families this is comparable to three 3-year tours-of-duty.
BW	Adult: 70 kg (EPA, 1989); Child: 49 kg (BW averaged for ages 8-17: EPA, 1989).
AT	Carcinogenic effects: 25550 (70 years x 365 days/year) Noncarcinogenic effects: 9125 (ED x 365 days/year) 25 years; 3285 (9 years); 10950 (30 years).

FS Risk Assessment--Dermal Contact with Soil

Absorbed Dose (mg/kg-day) = (CS x CF x SA x AF x ABS x EF x ED)/(BW x AT)

CS = Chemical concentration in soil (mg/kg)

CF = Conversion factor (kg/mg)

SA = Skin surface area available for contact (cm^2/event)

AF = Soil to skin adherence factor (mg/cm^2)

ABS = Absorption factor (unitless)

EF = Exposure frequency (events/year)

ED = Exposure duration (years)

BW = Body weight (kg)

AT = Averaging time - period over which exposure is averaged (days)

Parameter	Assumptions
CS	Measured concentrations in surface soils or sediments at the site.
CF	1E-06 kg/mg
SA	Worker: 4300 cm^2/event - occupational, adult male (mean skin surface area for arms, hands, and head) (EPA, 1989); Child: 4620 cm^2/event - children involved in recreational activities, averaged for ages 8-17 (EPA, 1989).
AF	2.77 mg/cm^2 - Kaolin clay, for hands (EPA, 1989).
ABS	Chemical-specific. ABS for cadmium is 0.002 (CAPCOA, 1991). It is recommended that values of 1% for inorganic chemicals and 10% for organic chemicals be used as estimates of dermal absorption from a soil matrix (Clement, 1988).
EF	Worker: 250 events/year - 5 day work week for 50 weeks/year (EPA, 1991); Child: 175 events/year - assumes children are involved in outdoor recreational activities 6 months/year, subtracting 2 weeks of vacation away from the site.
ED	Worker: 25 years (95th percentile time spent working at the same location (EPA, 1991); Reasonable maximum value of 30 years was assumed; Child: 9 years - national median time--50th percentile--time at one residence (EPA, 1989); for military families this is comparable to three 3-year tours-of-duty.
BW	Adult: 70 kg (EPA, 1989); Child: 49 kg (BW averaged for ages 8-17; EPA, 1989).
AT	Carcinogenic Effects: 25550 (70 years x 365 days/year); Noncarcinogenic Effects: 3285 (ED x 365 days/year) 9 years; 9125 (ED x 365 days/year) 25 years; 10950 (30 years).

FS Risk Assessment--Dermal Contact with Water (wading and splashing)

Absorbed dose (mg/kg-day) = (CW x SA x PC x ET x EF x ED x CF)/(BW x AT)

CW = Chemical concentration in water (mg/liter)

SA = Skin surface area available for contact (cm^2)

PC = Chemical specific dermal permeability constant (cm/hr)

ET = Exposure time (hours/event)

EF = Exposure frequency (events/year)

ED = Exposure duration (years)

CF = Volumetric conversion factor for water (liter/cm^3)

BW = Body weight (kg)

AT = Averaging time - period over which exposure is averaged (days)

Parameter	Assumptions
CW	Measured concentrations in the water at the site.
SA	Child: Average = 4620 cm^2/event - children involved in recreational activities (wading), averaged for ages 8-17 (EPA, 1989). Reasonable maximum = 13328 cm^2/event - children swimming (EPA, 1989).
PC	Chemical-specific. Values for some organic compounds are available in EPA, 1991b, and in EPA dermal permeability database. Values for metals are not available.
ET	2 hour/event - assumes children play in water 2 hour/event.
EF	175 events/year - assumes children are involved in outdoor recreational activities 6 months/year, subtracting 2 weeks for vacation away from the site.
ED	9 years - national median time--50th percentile--time at one residence (EPA, 1989); for military families this is comparable to three 3-year tours-of-duty.
CF	0.001 liter/cm^3.
BW	49 kg (BW averaged for ages 8-17; EPA, 1989).
AT	Carcinogenic Effects: 25550 (70 years x 365 days/year); Noncarcinogenic Effects: 3285 (ED x 365 days/year).

Table D-1

FS Risk Assessment, Site 8

Non-Cancer Risk Estimates						
Working at Site 8						
Ingestion Of Soil: Soil - Site 8						
	Contaminant	Chronic RfD	Average Intake	Reas. Max. Intake	Average Haz. Index	Reas. Max. Haz. Index
	Aldrin	3E-5	1.51E-8	1.51E-8	5E-4	5E-4
	Cadmium	1E-3	1.02E-6	1.02E-6	1E-3	1E-3
	Chlordane	6E-5	1.73E-6	1.73E-6	3E-2	3E-2
	Chlorobenzene	2E-2	2.37E-8	2.37E-8	1E-6	1E-6
	Copper	4E-2	3.46E-5	3.46E-5	9E-4	9E-4
	4,4'-DDT	5E-4	3E-6	3E-6	6E-3	6E-3
	Endosulfan II	5E-5	2.94E-9	2.94E-9	6E-5	6E-5
	Ethyl benzene	1E-1	3.05E-9	3.05E-9	3E-8	3E-8
	Heptachlor	5E-4	2.26E-8	2.26E-8	5E-5	5E-5
	Heptachlor epoxide	1.3E-5	2.93E-8	2.93E-8	2E-3	2E-3
	Lead	4.3E-4	1.31E-4	1.31E-4	3E-1	3E-1
	Mercury	3E-4	1.06E-6	1.06E-6	4E-3	4E-3
	Methylene chloride	6E-2	6.93E-7	6.93E-7	1E-5	1E-5
	Toluene	2E-1	7.48E-9	7.48E-9	4E-8	4E-8
	Zinc	2E-1	2.64E-4	2.64E-4	1E-3	1E-3
Dermal Contact With Soil: Soil - Site 8						
	Contaminant	Chronic RfD	Average Intake	Reas. Max. Intake	Average Haz. Index	Reas. Max. Haz. Index
	Aldrin	3E-5	1.5E-7	1.5E-7	5E-3	5E-3
	Cadmium	1E-3	2.03E-7	2.03E-7	2E-4	2E-4
	Chlordane	6E-5	1.72E-5	1.72E-5	3E-1	3E-1
	Chlorobenzene	2E-2	2.35E-7	2.35E-7	1E-5	1E-5
	Copper	4E-2	3.44E-5	3.44E-5	9E-4	9E-4
	4,4'-DDT	5E-4	2.98E-5	2.98E-5	6E-2	6E-2
	Endosulfan II	5E-5	2.91E-8	2.91E-8	6E-4	6E-4
	Ethyl benzene	1E-1	3.03E-8	3.03E-8	3E-7	3E-7
	Heptachlor	5E-4	2.25E-7	2.25E-7	4E-4	4E-4
	Heptachlor epoxide	1.3E-5	2.91E-7	2.91E-7	2E-2	2E-2
	Lead	4.3E-4	1.3E-5	1.3E-5	3E-2	3E-2
	Mercury	3E-4	1.05E-6	1.05E-6	3E-3	3E-3
	Methylene chloride	6E-2	6.88E-6	6.88E-6	1E-4	1E-4
	Toluene	2E-1	7.42E-8	7.42E-8	4E-7	4E-7
	Zinc	2E-1	2.62E-4	2.62E-4	1E-3	1E-3

Table D-1

(Continued)

Inhalation Of Vapor: Ambient air - Site 8						
	Contaminant	Chronic RfD	Average Intake	Reas. Max. Intake	Average Haz. Index	Reas. Max. Haz. Index
	Chlorobenzene*	2E-2	8.12E-3	1.16E-2	4E-1	6E-1
	Ethyl benzene*	1	1.59E-3	2.27E-3	2E-3	2E-3
	Mercury*	3E-4	3.03E-3	4.33E-3	1E+1	1E+1
	Methylene chloride*	3	7.02	1E+1	2.	3.
	Toluene*	4E-1	5.32E-3	7.6E-3	1E-2	2E-2
	Xylenes	8.6E-2	2.27E-6	3.24E-6	3E-5	4E-5
Cancer Risk Estimates						
Working at Site 8						
Ingestion Of Soil: Soil - Site 8						
	Contaminant	SF	Evidence	Average CDI	Reas. Max. CDI	Average Risk	Reas. Max. Risk
	Aldrin	17	B2	5.41E-9	6.49E-9	9E-8	1E-7
	Benzene	2.9E-2	A	1.09E-9	1.31E-9	3E-11	4E-11
	Chlordane	1.3	B2	6.2E-7	7.44E-7	8E-7	1E-6
	4,4'-DDD	2.4E-1	B2	4.58E-7	5.5E-7	1E-7	1E-7
	4,4'-DDE	3.4E-1	B2	6.95E-7	8.34E-7	2E-7	3E-7
	4,4'-DDT	3.4E-1	B2	1.07E-6	1.29E-6	4E-7	4E-7
	Heptachlor	4.5	B2	8.08E-9	9.7E-9	4E-8	4E-8
	Heptachlor epoxide	9.1	B2	1.05E-8	1.26E-8	1E-7	1E-7
	Methylene chloride	7.5E-3	B2	2.47E-7	2.97E-7	2E-9	2E-9
Dermal Contact With Soil: Soil - Site 8							
	Contaminant	SF	Evidence	Average CDI	Reas. Max. CDI	Average Risk	Reas. Max. Risk
	Aldrin	17	B2	5.37E-8	6.44E-8	9E-7	1E-6
	Benzene	2.9E-2	A	1.08E-8	1.3E-8	3E-10	4E-10
	Chlordane	1.3	B2	6.15E-6	7.38E-6	8E-6	1E-5
	4,4'-DDD	2.4E-1	B2	4.55E-6	5.45E-6	1E-6	1E-6
	4,4'-DDE	3.4E-1	B2	6.89E-6	8.27E-6	2E-6	3E-6
	4,4'-DDT	3.4E-1	B2	1.06E-5	1.28E-5	4E-6	4E-6
	Heptachlor	4.5	B2	8.03E-8	9.63E-8	4E-7	4E-7
	Heptachlor epoxide	9.1	B2	1.04E-7	1.25E-7	9E-7	1E-6
	Methylene chloride	7.5E-3	B2	2.46E-6	2.95E-6	2E-8	2E-8
Inhalation Of Vapor: Ambient air - Site 8							
	Contaminant	SF	Evidence	Average CDI	Reas. Max. CDI	Average Risk	Reas. Max. Risk
	Aldrin*	4.9E-6	B2	1.55E-5	2.66E-5	8E-11	1E-10
	Benzene*	8.3E-9	A	9.17E-3	1.57E-2	8E-11	1E-10
	Cadmium*	1.8E-6	B1	1.05E-3	1.8E-3	2E-9	3E-9
	Chlordane*	3.7E-7	B2	1.78E-3	3.05E-3	7E-10	1E-9

Table D-1

(Continued)

	delta-BHC	1.8	D	4.71E-6	8.07E-6	8E-6	1E-5
	4,4'-DDT*	9.7E-5	B2	3.08E-3	5.28E-3	3E-7	5E-7
	Heptachlor*	1.3E-6	B2	2.32E-5	3.97E-5	3E-11	5E-11
	Heptachlor epoxide*	2.6E-3	B2	3E-5	5.15E-5	8E-8	1E-7
	Methylene chloride*	4.7E-10	B2	2.51	4.3	1E-9	2E-9
	1,1-Dichloroethene*	5E-8	C	4.15E-4	7.12E-4	2E-11	4E-11
	1,2-Dichloroethane*	2.6E-8	B2	2.66E-5	4.56E-5	7E-13	1E-12
	Chloroform*	2.3E-8	B2	3.74E-6	6.41E-6	9E-14	1E-13

APPENDIX E

AIR MODELING DISCUSSION AND SUPPORTING DATA

AIR MODELING DISCUSSION

SITE 8

1.0 EMISSION ESTIMATION

Emission rates of chemical compounds due to volatilization and wind entrainment of contaminated dust from Site 8 were estimated using predictive equations recommended by the U.S. EPA.

Emission rates of detected chemicals from Site 8 were calculated using emission rate equations applicable to various emission mechanisms. The various types of mechanisms considered included:

- Volatilization of organic compounds from surface contamination of soils, (contamination between 0 and 2 feet of soil);

- Volatilization of organic compounds from contaminated groundwater, (contamination between 8 and 10 feet);

- Volatilization of organic compounds from wastes buried wastes below the soil surface, (contamination below 2 feet);

- Wind entrainment of contaminated surface soil; (surface contamination: 0-2 feet); and

- Emissions of contaminated dust due to vehicular traffic.

Each of the emission mechanisms and the equations used to calculate emission rates are discussed below.

1.1 Volatilization from Surface Contamination

For the estimation of emission rates due to volatilization from open landfills (i.e., open dump), Shen (1981), suggests using Arnold's equation (Arnold, 1944) with Ziegler's modification (Ziegler, 1979). This equation was determined to be the most applicable equation to estimate emission of volatile compounds detected at the surface (0-2 feet) of the sites in this study. The equation presented below was used for calculation of emission of surface detected volatiles at sites 8.

$$E_i = \frac{2\ C_e\ w}{A} \sqrt{\frac{D\ L_v}{\Pi\ F_v}} \left(\frac{W_i}{W}\right)^{P_i}$$

where:

E_i = emission rate (g/m2-sec);

C_e = equilibrium vapor pressure (fraction);

L_v = length of open dump (cms);

D = diffusion coefficient (cm^2/sec);

v = wind speed (cms/sec);

F_v = correction factor

= C_e (-0.848) + 1.0635;

W_i/W = weight % of component i in bulk waste (g/g);

w = width of open dump (54.54 cms);

A = area of open dump (2974.42 m^2); and

P_i = gas density of component i.

The annual average wind speed (v) for the Holloman AFB area of 2.57 meters per second was used in the equation. The weight fraction (W_i/W) of each volatile compound used in the above equation was the average concentration measured

at the site. Contaminants detected between 0 and 2 ft below the soil surface were considered as surface contaminants.

1.2 Volatilization from Buried Waste/Contaminated Groundwater

The Shen equation (Shen, 1981) was used to estimate emissions from buried wastes, defined as soil contamination below a depth of 2 ft. Shen presents the following equation, which is derived from Fick's Law for steady-state diffusion:

$$E_i = D_i \, C_s \, A \, P_t^{\frac{4}{3}} \, \frac{W_i}{L}$$

where:

E_i = emission rate (g/m2);

D_i = diffusion coefficient (cm^2/sec);

C_s = saturation vapor concentration of component i (g/cm^3);

A = area of open dump (cm^2);

P_t = soil porosity (dimensionless);

W_i = weight % of component i in bulk waste (g/g); and

L = effective depth of soil cover (cms).

Soil porosity was based on field tests at Site 8 and was 0.41. This value was assumed to be constant over the entire depth of contamination.

A minimum depth of cover (L) of 2 ft (0.6 m) was assumed for all buried wastes, since contamination detected between 0 and 2 ft were considered as surface contamination. Groundwater contamination detected between 8 and 10 feet was assumed to be buried waste with a depth of cover of 8 feet.

1.3 Wind Blown Dust

Non-volatile organics and metals can enter the atmosphere due to wind entrainment of contaminated surface soil at Site 8. The wind-blown dust equation (Bohn, et al, 1978), presented below, was used to calculate the total dust emissions.

$$E = 3400 \frac{\frac{e}{50} \times \frac{s}{15} \times \frac{f}{25}}{\left(\frac{P-E}{50}\right)^2} \times (1-VC)$$

where:

E = emission rate (lb / acre-yr);

e = surface erodibiltility (235);

s = silt content (37.55 %);

f = percentage of time wind exceeds 12 mph (12%);

P-E = Thornwaite's Precipitation-Evaporation Index (19 for Holloman AFB area); and

VC = Vegetative cover (none for Site 8).

The emission rate of each non-volatile chemical was then calculated by multiplying the dust emission rate by the average measured concentration of the chemical in the surface soil (0-2 ft).

The surface erodibility was determined for each site and was defined as the percentage of soil particles not passing a No. 10 sieve. The silt content was based on the percentage of soil particles passing a No. 200 sieve. The was is no vegetative cover at site 8.

1.4 Emissions From Vehicular Traffic

The Refuse Collection Truck Washrack is located at Site 8. The quantity of dust emissions from a given area of unpaved road varies linearly with the volume of traffic. The following equation from section 11.2.1.2 of AP-42 was used to estimate dust emissions from trucks:

$$E = 5.9 \times \left(\frac{s}{12}\right) \times \left(\frac{S}{30}\right) \times \left(\frac{W}{3}\right)^{0.7} \times \left(\frac{w}{4}\right)^{0.5} \times \left(\frac{365 - P}{365}\right) \times VMT$$

E = emission rate (lbs/year);

k = particle size multiplier (1.0);

s = silt content (37.55 % for Site 8);

S = mean vehicle weight (5 mph);

W = mean vehicle weight (15 tons);

w = mean number of wheels (10);

p = number of days with at least 0.01 inches of precipitation per year (80 days); and

VMT = vehicle miles travelled per year = 711.36 (6 trucks per hour, 8 hours per day, 5 days per week, 300 feet per truck).

The emission rate of non-volatile chemicals detected at Site 8, due to truck movement, was calculated by multiplying the dust emission rate by the average measured surface concentration of the chemicals.

2.0 EMISSION SOURCE CHARACTERIZATION AND DISPERSION

Site 8 was modeled as an area source to predict the impact on onsite occupational receptors. The total contaminated area for Site 8 was estimated to be 2975 m^2. The ISCLT model does not compute a concentration for any receptor physically located on the area source being modeled. Therefore, concentrations at these receptors were calculated by dividing the mass emission rate by the air flow through the cross section of the source. The air flow was the product of the length (of the area source), height, and the average wind speed. A height of 6 feet, representative of an average worker was assumed. The average wind speed for the Holloman AFB area (2.57 meters per second) was used. Site 8 has a length of 54.54 meters. The on-site unit concentration was calculated to be 3898.65 $\mu g/m^3$. This concentration was based on a unit emission rate of 1 gram/sec. The concentration for each pollutant was obtained by multiplying the unit emission concentration with the emission rate for that pollutant.

SUPPORTING DATA

SITE 8

SITE 08 Emissions and On-Site Concentrations

Chemicals	Emissions (gms /sec) Surface	Subsurface	Groundwate	Trucks	Concentration (ug/m3) Surface	Trucks	Total Surface	Subsurface	Groundwater	Total
1,2-Dichloroethane			3.32053E-08	0.000E+00			0.000E+00	0.00000E+00	1.29456E-04	1.295E-04
1,2-Dichloroethene		5.18258E-07		0.000E+00	0.00000E+00		0.00000E+00	2.02051E-03	0.00000E+00	2.021E-03
4,4'-DDD	1.092E+03	1.53512E-06		1.047E-07	5.98490E-03	4.08278E-04	6.39318E-03	0.00000E+00	0.00000E+00	6.393E-03
4,4'-DDE	1.657E+03	2.32869E-06		1.589E-07	9.07874E-03	6.19333E-04	9.69808E-03	0.00000E+00	0.00000E+00	9.698E-03
4,4'-DDT	2.557E+03	3.59390E-06		2.452E-07	1.40114E-02	9.55826E-04	1.49672E-02	0.00000E+00	0.00000E+00	1.497E-02
Aldrin	1.290E+01	1.81347E-08		1.237E-09	7.07007E-05	4.82306E-06	7.55238E-05	0.00000E+00	0.00000E+00	7.552E-05
Benzene		2.92601E-06	8.51329E-06	0.000E+00	1.14075E-02	0.00000E+00	1.14075E-02	0.00000E+00	3.31903E-02	4.460E-02
Bromodichloromethane			1.44031E-09	0.000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	5.61527E-06	5.615E-06
Cadmium	8.725E+02	1.22655E-06		8.367E-08	4.78189E-03	3.26211E-04	5.10810E-03	0.00000E+00	0.00000E+00	5.108E-03
Chlordane	1.478E+03	2.07705E-06		1.417E-07	8.09770E-03	5.52408E-04	8.65011E-03	0.00000E+00	0.00000E+00	8.650E-03
Chlorobenzene		3.60100E-06	2.90599E-09	0.000E+00	1.40390E-02	0.00000E+00	1.40390E-02	1.13295E-05	0.00000E+00	1.405E-02
Chloroform			4.66517E-09	0.000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	1.81879E-05	1.819E-05
Copper	2.950E+04	4.14708E-05		2.829E-06	1.61680E-01	1.10295E-02	1.72709E-01	0.00000E+00	0.00000E+00	1.727E-01
Dichloroprop			1.04030E-08	0.000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	4.05575E-05	4.056E-05
Endosulfan II	2.500E+00	3.51447E-09		2.398E-10	1.37017E-05	9.34701E-07	1.46364E-05	0.00000E+00	0.00000E+00	1.464E-05
Endosulfan sulfate	6.800E-01	9.55936E-10		6.521E-11	3.72686E-06	2.54239E-07	3.98110E-06	0.00000E+00	0.00000E+00	3.981E-06
Ethyl benzene		3.79123E-07	3.27975E-07	0.000E+00	1.47807E-03	0.00000E+00	1.47807E-03	0.00000E+00	1.27866E-03	2.757E-03
Heptachlor	1.928E+01	2.70966E-08		1.848E-09	1.05640E-04	7.20655E-06	1.12847E-04	0.00000E+00	0.00000E+00	1.128E-04
Heptachlor epoxide	2.495E+01	3.50744E-08		2.393E-09	1.36743E-04	9.32832E-06	1.46071E-04	0.00000E+00	0.00000E+00	1.461E-04
Lead	1.118E+05	1.57132E-04		1.07192E-05	6.12603E-01	4.17905E-02	6.54393E-01	0.00000E+00	0.00000E+00	6.544E-01
Mercury	9.000E+02	1.26521E-06		8.631E-08	4.93261E-03	3.36492E-04	5.26910E-03	0.00000E+00	0.00000E+00	5.269E-03
Methylene chloride		3.12232E-03	6.35409E-06	4.40636E-08	0.000E+00	1.21728E+01	0.00000E+00	1.21728E+01	2.47724E-02	1.71788E-04	1.220E+01
Naphthalene			9.96647E-10	0.000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	3.88558E-06	3.886E-06
Toluene		2.35178E-06	1.39974E-08	4.27700E-09	0.000E+00	9.16877E-03	0.00000E+00	9.16877E-03	5.45711E-05	1.66745E-05	9.240E-03
Xylenes				3.53475E-09	0.000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	1.37808E-05	1.378E-05
Zinc	2.245E+05	3.15600E-04			2.153E-05	1.23041E+00	8.39362E-02	1.31435E+00	0.00000E+00	0.00000E+00	1.314E+00
delta-BHC	1.370E+01	1.92593E-08			1.314E-09	7.50853E-05	5.12216E-06	8.02075E-05	0.00000E+00	0.00000E+00	8.021E-05
gamma-BHC										

Unit Conc. = 3.899E+03 ug/m3

APPENDIX F

ANALYTICAL DATA FOR SITES 2&5, 8, AND 14

ANALYTICAL DATA FOR SOILS

Sample id	Site id	Type	Top depth	Bottom depth	Analyte	Result_Type	Result_Flag	Result	Unit_Of_Measure
91JULH002&5-001	02&5	N	5	7	Benzene	N		3.7	ug/kg
91JULH002&5-002	02&5	N	10	12	Benzene	N	<	120	ug/kg
91JULH002&5-003	02&5	N	0	2	Benzene	N	<	120	ug/kg
91JULH002&5-004	02&5	N	2.5	4.5	Benzene	N	<	130	ug/kg
91JULH002&5-005	02&5	N	0	2	Benzene	N	<	130	ug/kg
91JULH002&5-006	02&5	N	10	12	Benzene	N	<	120	ug/kg
91JULH002&5-007	02&5	N	0	2	Benzene	N		5.8	ug/kg
91JULH002&5-008	02&5	N	2.5	4.5	Benzene	N		2.2	ug/kg
91JULH002&5-009	02&5	N	2	4	Benzene	N	<	130	ug/kg
91JULH002&5-010	02&5	N	8	10	Benzene	N	<	130	ug/kg
91JULH002&5-011	02&5	N	10	12	Benzene	N	<	110	ug/kg
91JULH002&5-012	02&5	N	15	17	Benzene	N		1800	ug/kg
91JULH002&5-013	02&5	N	2.5	4.5	Benzene	N	<	140	ug/kg
91JULH002&5-014	02&5	N	7.5	9.5	Benzene	N	<	110	ug/kg
91JULH002&5-015	02&5	N	10	12	Benzene	N	<	130	ug/kg
91JULH002&5-016	02&5	N	15	17	Benzene	N	<	130	ug/kg
91JULH002&5-017	02&5	N	5	7	Benzene	N	<	120	ug/kg
91JULH002&5-018	02&5	N	15	17	Benzene	N		12000	ug/kg
91JULH002&5-019	02&5	N	5	7	Benzene	N	<	120	ug/kg
91JULH002&5-020	02&5	N	15	17	Benzene	N		4500	ug/kg
91JULH002&5-021	02&5	N	2.5	4.5	Benzene	N	<	120	ug/kg
91JULH002&5-022	02&5	N	10	12	Benzene	N	<	140	ug/kg
91JULH002&5-023	02&5	N	10	12	Benzene	N	<	110	ug/kg
91JULH002&5-024	02&5	N	15	17	Benzene	N		48000	ug/kg
91JULH002&5-025	02&5	N	0	2	Benzene	N		46	ug/kg
91JULH002&5-026	02&5	N	10	12	Benzene	N		64	ug/kg
91JULH002&5-027	02&5	N	5	7	Benzene	N	<	120	ug/kg
91JULH002&5-028	02&5	N	10	12	Benzene	N	<	130	ug/kg
91JULH002&5-029	02&5	N	0	2	Benzene	N	<	120	ug/kg
91JULH002&5-030	02&5	N	5	7	Benzene	N	<	120	ug/kg
91JULH002&5-031	02&5	N	2.5	4.5	Benzene	N	<	120	ug/kg
91JULH002&5-032	02&5	N	7.5	9.5	Benzene	N	<	130	ug/kg
91JULH002&5-033	02&5	FD	5	7	Benzene	FD	<	120	ug/kg
91JULH002&5-034	02&5	FD	15	17	Benzene	FD		43000	ug/kg
91JULH002&5-001	02&5	N	5	7	Ethyl benzene	N	<	130	ug/kg
91JULH002&5-002	02&5	N	10	12	Ethyl benzene	N	<	120	ug/kg
91JULH002&5-003	02&5	N	0	2	Ethyl benzene	N	<	120	ug/kg
91JULH002&5-004	02&5	N	2.5	4.5	Ethyl benzene	N		2.9	ug/kg

Sample id	Site id	Type	Top depth	Bottom depth	Analyte	Result_Type	Result_Flag	Result	Unit_Of_Measure
91JULH002&5-005	02&5	N	0	2	Ethyl benzene	N		12	ug/kg
91JULH002&5-006	02&5	N	10	12	Ethyl benzene	N		2.4	ug/kg
91JULH002&5-007	02&5	N	0	2	Ethyl benzene	N		1200	ug/kg
91JULH002&5-008	02&5	N	2.5	4.5	Ethyl benzene	N		100	ug/kg
91JULH002&5-009	02&5	N	2	4	Ethyl benzene	N	<	130	ug/kg
91JULH002&5-010	02&5	N	8	10	Ethyl benzene	N	<	130	ug/kg
91JULH002&5-011	02&5	N	10	12	Ethyl benzene	N	<	110	ug/kg
91JULH002&5-012	02&5	N	15	17	Ethyl benzene	N		29000	ug/kg
91JULH002&5-013	02&5	N	2.5	4.5	Ethyl benzene	N		20	ug/kg
91JULH002&5-014	02&5	N	7.5	9.5	Ethyl benzene	N	<	110	ug/kg
91JULH002&5-015	02&5	N	10	12	Ethyl benzene	N	<	130	ug/kg
91JULH002&5-016	02&5	N	15	17	Ethyl benzene	N	<	130	ug/kg
91JULH002&5-017	02&5	N	5	7	Ethyl benzene	N		13	ug/kg
91JULH002&5-018	02&5	N	15	17	Ethyl benzene	N		62000	ug/kg
91JULH002&5-019	02&5	N	5	7	Ethyl benzene	N	<	120	ug/kg
91JULH002&5-020	02&5	N	15	17	Ethyl benzene	N		35000	ug/kg
91JULH002&5-021	02&5	N	2.5	4.5	Ethyl benzene	N		18	ug/kg
91JULH002&5-022	02&5	N	10	12	Ethyl benzene	N	<	140	ug/kg
91JULH002&5-023	02&5	N	10	12	Ethyl benzene	N		23	ug/kg
91JULH002&5-024	02&5	N	15	17	Ethyl benzene	N		180000	ug/kg
91JULH002&5-025	02&5	N	0	2	Ethyl benzene	N		240	ug/kg
91JULH002&5-026	02&5	N	10	12	Ethyl benzene	N		4600	ug/kg
91JULH002&5-027	02&5	N	5	7	Ethyl benzene	N		62	ug/kg
91JULH002&5-028	02&5	N	10	12	Ethyl benzene	N		130	ug/kg
91JULH002&5-029	02&5	N	0	2	Ethyl benzene	N	<	120	ug/kg
91JULH002&5-030	02&5	N	5	7	Ethyl benzene	N		180	ug/kg
91JULH002&5-031	02&5	N	2.5	4.5	Ethyl benzene	N	<	120	ug/kg
91JULH002&5-032	02&5	N	7.5	9.5	Ethyl benzene	N	<	130	ug/kg
91JULH002&5-033	02&5	FD	5	7	Ethyl benzene	FD		45	ug/kg
91JULH002&5-034	02&5	FD	15	17	Ethyl benzene	FD		210000	ug/kg
91JULH002&5-001	02&5	N	5	7	Methyl ethyl ketone	N	<	2700	ug/kg
91JULH002&5-002	02&5	N	10	12	Methyl ethyl ketone	N	<	2500	ug/kg
91JULH002&5-003	02&5	N	0	2	Methyl ethyl ketone	N	<	2400	ug/kg
91JULH002&5-004	02&5	N	2.5	4.5	Methyl ethyl ketone	N	<	2600	ug/kg
91JULH002&5-005	02&5	N	0	2	Methyl ethyl ketone	N	<	2500	ug/kg
91JULH002&5-006	02&5	N	10	12	Methyl ethyl ketone	N	<	2500	ug/kg
91JULH002&5-007	02&5	N	0	2	Methyl ethyl ketone	N	<	2400	ug/kg
91JULH002&5-008	02&5	N	2.5	4.5	Methyl ethyl ketone	N	<	2500	ug/kg

Sample id	Site id	Type	Top depth	Bottom depth	Analyte	Result_Type	Result_Flag	Result	Unit_Of_Measure
91JULH002&5-009	02&5	N	2	4	Methyl ethyl ketone	N	<	2700	ug/kg
91JULH002&5-010	02&5	N	8	10	Methyl ethyl ketone	N	<	2500	ug/kg
91JULH002&5-011	02&5	N	10	12	Methyl ethyl ketone	N	<	2300	ug/kg
91JULH002&5-012	02&5	N	15	17	Methyl ethyl ketone	N	<	13000	ug/kg
91JULH002&5-013	02&5	N	2.5	4.5	Methyl ethyl ketone	N	<	2700	ug/kg
91JULH002&5-014	02&5	N	7.5	9.5	Methyl ethyl ketone	N	<	2300	ug/kg
91JULH002&5-015	02&5	N	10	12	Methyl ethyl ketone	N	<	2600	ug/kg
91JULH002&5-016	02&5	N	15	17	Methyl ethyl ketone	N	<	2500	ug/kg
91JULH002&5-017	02&5	N	5	7	Methyl ethyl ketone	N	<	2400	ug/kg
91JULH002&5-018	02&5	N	15	17	Methyl ethyl ketone	N	<	14000	ug/kg
91JULH002&5-019	02&5	N	5	7	Methyl ethyl ketone	N	<	2400	ug/kg
91JULH002&5-020	02&5	N	15	17	Methyl ethyl ketone	N	<	13000	ug/kg
91JULH002&5-021	02&5	N	2.5	4.5	Methyl ethyl ketone	N	<	2500	ug/kg
91JULH002&5-022	02&5	N	10	12	Methyl ethyl ketone	N	<	2800	ug/kg
91JULH002&5-023	02&5	N	10	12	Methyl ethyl ketone	N		1800	ug/kg
91JULH002&5-026	02&5	N	10	12	Methyl ethyl ketone	N		20000	ug/kg
91JULH002&5-027	02&5	N	5	7	Methyl ethyl ketone	N		4200	ug/kg
91JULH002&5-028	02&5	N	10	12	Methyl ethyl ketone	N		6000	ug/kg
91JULH002&5-029	02&5	N	0	2	Methyl ethyl ketone	N	<	2400	ug/kg
91JULH002&5-030	02&5	N	5	7	Methyl ethyl ketone	N		5800	ug/kg
91JULH002&5-031	02&5	N	2.5	4.5	Methyl ethyl ketone	N	<	2400	ug/kg
91JULH002&5-032	02&5	N	7.5	9.5	Methyl ethyl ketone	N	<	2600	ug/kg
91JULH002&5-033	02&5	FD	5	7	Methyl ethyl ketone	FD	<	2300	ug/kg
91JULH002&5-034									
91JULH002&5-001	02&5	N	5	7	Toluene	N		7.3	ug/kg
91JULH002&5-002	02&5	N	10	12	Toluene	N		17	ug/kg
91JULH002&5-003	02&5	N	0	2	Toluene	N		11	ug/kg
91JULH002&5-004	02&5	N	2.5	4.5	Toluene	N		8.2	ug/kg
91JULH002&5-005	02&5	N	0	2	Toluene	N		8.8	ug/kg
91JULH002&5-006	02&5	N	10	12	Toluene	N		11	ug/kg
91JULH002&5-007	02&5	N	0	2	Toluene	N		14	ug/kg
91JULH002&5-008	02&5	N	2.5	4.5	Toluene	N		21	ug/kg
91JULH002&5-009	02&5	N	2	4	Toluene	N	<	130	ug/kg
91JULH002&5-010	02&5	N	8	10	Toluene	N	<	130	ug/kg
91JULH002&5-011	02&5	N	10	12	Toluene	N	<	110	ug/kg
91JULH002&5-012	02&5	N	15	17	Toluene	N		11000	ug/kg
91JULH002&5-013	02&5	N	2.5	4.5	Toluene	N		13	ug/kg
91JULH002&5-014	02&5	N	7.5	9.5	Toluene	N	<	110	ug/kg

Sample id	Site id	Type	Top depth	Bottom depth	Analyte	Result_Type	Result_Flag	Result	Unit_Of_Measure
91JULH002&5-015	02&5	N	10	12	Toluene	N	<	130	ug/kg
91JULH002&5-016	02&5	N	15	17	Toluene	N	<	130	ug/kg
91JULH002&5-017	02&5	N	5	7	Toluene	N	<	120	ug/kg
91JULH002&5-018	02&5	N	15	17	Toluene	N		16000	ug/kg
91JULH002&5-019	02&5	N	5	7	Toluene	N	<	120	ug/kg
91JULH002&5-020	02&5	N	15	17	Toluene	N		19000	ug/kg
91JULH002&5-021	02&5	N	2.5	4.5	Toluene	N	<	120	ug/kg
91JULH002&5-022	02&5	N	10	12	Toluene	N	<	140	ug/kg
91JULH002&5-023	02&5	N	10	12	Toluene	N	<	110	ug/kg
91JULH002&5-024	02&5	N	15	17	Toluene	N		210000	ug/kg
91JULH002&5-025	02&5	N	0	2	Toluene	N		240	ug/kg
91JULH002&5-026	02&5	N	10	12	Toluene	N		170	ug/kg
91JULH002&5-027	02&5	N	5	7	Toluene	N		14	ug/kg
91JULH002&5-028	02&5	N	10	12	Toluene	N		28	ug/kg
91JULH002&5-029	02&5	N	0	2	Toluene	N	<	120	ug/kg
91JULH002&5-030	02&5	N	5	7	Toluene	N		73	ug/kg
91JULH002&5-031	02&5	N	2.5	4.5	Toluene	N	<	120	ug/kg
91JULH002&5-032	02&5	N	7.5	9.5	Toluene	N	<	130	ug/kg
91JULH002&5-033	02&5	FD	5	7	Toluene	FD		19	ug/kg
91JULH002&5-034	02&5	FD	15	17	Toluene	FD		230000	ug/kg
91JULH002&5-001	02&5	N	5	7	Xylenes	N	<	130	ug/kg
91JULH002&5-002	02&5	N	10	12	Xylenes	N	<	120	ug/kg
91JULH002&5-003	02&5	N	0	2	Xylenes	N		23	ug/kg
91JULH002&5-004	02&5	N	2.5	4.5	Xylenes	N	<	130	ug/kg
91JULH002&5-005	02&5	N	0	2	Xylenes	N		19	ug/kg
91JULH002&5-006	02&5	N	10	12	Xylenes	N		3.2	ug/kg
91JULH002&5-007	02&5	N	0	2	Xylenes	N		620	ug/kg
91JULH002&5-008	02&5	N	2.5	4.5	Xylenes	N		160	ug/kg
91JULH002&5-009	02&5	N	2	4	Xylenes	N	<	130	ug/kg
91JULH002&5-010	02&5	N	8	10	Xylenes	N	<	130	ug/kg
91JULH002&5-011	02&5	N	10	12	Xylenes	N	<	110	ug/kg
91JULH002&5-012	02&5	N	15	17	Xylenes	N		65000	ug/kg
91JULH002&5-013	02&5	N	2.5	4.5	Xylenes	N		120	ug/kg
91JULH002&5-014	02&5	N	7.5	9.5	Xylenes	N	<	110	ug/kg
91JULH002&5-015	02&5	N	10	12	Xylenes	N	<	130	ug/kg
91JULH002&5-016	02&5	N	15	17	Xylenes	N	<	130	ug/kg
91JULH002&5-017	02&5	N	5	7	Xylenes	N		41	ug/kg
91JULH002&5-018	02&5	N	15	17	Xylenes	N		150000	ug/kg

Sample id	Site id	Type	Top depth	Bottom depth	Analyte	Result_Type	Result_Flag	Result	Unit_Of_Measure
91JULH002&5-019	02&5	N	5	7	Xylenes	N	<	120	ug/kg
91JULH002&5-020	02&5	N	15	17	Xylenes	N		77000	ug/kg
91JULH002&5-021	02&5	N	2.5	4.5	Xylenes	N		52	ug/kg
91JULH002&5-022	02&5	N	10	12	Xylenes	N		22	ug/kg
91JULH002&5-023	02&5	N	10	12	Xylenes	N		130	ug/kg
91JULH002&5-024	02&5	N	15	17	Xylenes	N		450000	ug/kg
91JULH002&5-025	02&5	N	0	2	Xylenes	N		630	ug/kg
91JULH002&5-026	02&5	N	10	12	Xylenes	N		3300	ug/kg
91JULH002&5-027	02&5	N	5	7	Xylenes	N		350	ug/kg
91JULH002&5-028	02&5	N	10	12	Xylenes	N		780	ug/kg
91JULH002&5-029	02&5	N	0	2	Xylenes	N	<	120	ug/kg
91JULH002&5-030	02&5	N	5	7	Xylenes	N		990	ug/kg
91JULH002&5-031	02&5	N	2.5	4.5	Xylenes	N	<	120	ug/kg
91JULH002&5-032	02&5	N	7.5	9.5	Xylenes	N	<	130	ug/kg
91JULH002&5-033	02&5	FD	5	7	Xylenes	FD		110	ug/kg
91JULH002&5-034	02&5	FD	15	17	Xylenes	FD		520000	ug/kg
91JULH003-002	03	N	6	9	Ethyl benzene	N		64	ug/kg
91JULH003-001	03	N	0	6	Ethyl benzene	N		1600	ug/kg
91JULH003-006	03	N	0	2	Lead	N		3.2	mg/kg
91JULH003-008	03	N	0	2	Lead	N		3.9	mg/kg
91JULH003-007	03	N	0	2	Lead	N		2.4	mg/kg
91JULH003-016	03	N	0	1.7	Lead	N		1.7	mg/kg
91JULH003-017	03	N	0	2	Lead	N		3.3	mg/kg
91JULH003-002	03	N	6	9	Lead	N		48	mg/kg
91JULH003-009	03	N	0	2	Lead	N		2.9	mg/kg
91JULH003-019	03	FD	0	2	Lead	FD		4.5	mg/kg
91JULH003-010	03	N	0	2	Lead	N		2.3	mg/kg
91JULH003-003	03	N	0	2	Lead	N		4.3	mg/kg
91JULH003-011	03	N	0	2	Lead	N		38	mg/kg
91JULH003-005	03	N	0	2	Lead	N		5.2	mg/kg
91JULH003-012	03	N	0	2	Lead	N		7.8	mg/kg
91JULH003-001	03	N	0	6	Lead	N		50	mg/kg
91JULH003-015	03	N	0	1.5	Lead	N		5.4	mg/kg
91JULH003-018	03	N	0	2	Lead	N		2.4	mg/kg
91JULH003-014	03	N	0	2	Lead	N		2.8	mg/kg
91JULH003-004	03	N	0	2	Lead	N		4.8	mg/kg
91JULH003-013	03	N	0	1.5	Lead	N		5.5	mg/kg
91JULH003-001	03	N	0	6	Methylene chloride	N		180	ug/kg

Sample id	Site id	Type	Top depth	Bottom depth	Analyte	Result_Type	Result_Flag	Result	Unit_Of_Measure
91JULH003-002	03	N	6	9	Methylene chloride	N		170	ug/kg
91JULH003-001	03	N	0	6	Toluene	N		100	ug/kg
91JULH003-002	03	N	6	9	Toluene	N		7	ug/kg
91JULH003-001	03	N	0	6	Xylenes	N		3300	ug/kg
91JULH003-002	03	N	6	9	Xylenes	N		260	ug/kg
91JULH002&5-002	02&5	N	10	12	Methylene chloride	N		430	ug/kg
91JULH002&5-006	02&5	N	10	12	Methylene chloride	N		550	ug/kg
91JULH002&5-008	02&5	N	2.5	4.5	Methylene chloride	N	<	120	ug/kg
91JULH002&5-012	02&5	N	15	17	Methylene chloride	N		720	ug/kg
91JULH002&5-016	02&5	N	15	17	Methylene chloride	N	<	130	ug/kg
91JULH002&5-018	02&5	N	15	17	Methylene chloride	N		820	ug/kg
91JULH002&5-019	02&5	N	5	7	Methylene chloride	N		300	ug/kg
91JULH002&5-020	02&5	N	15	17	Methylene chloride	N	<	670	ug/kg
91JULH002&5-021	02&5	N	2.5	4.5	Methylene chloride	N		170	ug/kg
91JULH002&5-022	02&5	N	10	12	Methylene chloride	N		170	ug/kg
91JULH002&5-023	02&5	N	10	12	Methylene chloride	N		260	ug/kg
91JULH002&5-024	02&5	N	15	17	Methylene chloride	N		4000	ug/kg
91JULH002&5-025	02&5	N	0	2	Methylene chloride	N		220	ug/kg
91JULH002&5-027	02&5	N	5	7	Methylene chloride	N		400	ug/kg
91JULH002&5-028	02&5	N	10	12	Methylene chloride	N		790	ug/kg
91JULH002&5-029	02&5	N	0	2	Methylene chloride	N		62	ug/kg
91JULH002&5-030	02&5	N	5	7	Methylene chloride	N		980	ug/kg
91JULH002&5-031	02&5	N	2.5	4.5	Methylene chloride	N		190	ug/kg
91JULH002&5-032	02&5	N	7.5	9.5	Methylene chloride	N		110	ug/kg
91JULH002&5-033	02&5	FD	5	7	Methylene chloride	FD		140	ug/kg
91JULH002&5-034	02&5	FD	15	17	Methylene chloride	FD		2200	ug/kg

Sample id	Site id	Type	Top depth	Bottom depth	Analyte	Result_Type	Result_Flag	Result	Unit_Of_Measure
91JULH008-006	08	N	10	12	1,1-Dichloroethene	N		23	ug/kg
91JULH008-001	08	N	0	2	4,4'-DDD	N		110	ug/kg
91JULH008-002	08	N	6	8	4,4'-DDD	N	<	0.60	ug/kg
91JULH008-003	08	N	0	2	4,4'-DDD	N		4000	ug/kg
91JULH008-004	08	N	5	7	4,4'-DDD	N		1.0	ug/kg
91JULH008-005	08	N	0	2	4,4'-DDD	N		28	ug/kg
91JULH008-006	08	N	10	12	4,4'-DDD	N	<	0.79	ug/kg
91JULH008-007	08	N	0	2	4,4'-DDD	N		230	ug/kg
91JULH008-008	08	N	2	4	4,4'-DDD	N	<	0.61	ug/kg
91JULH008-009	08	N	2	4	4,4'-DDD	N		0.11	ug/kg
91JULH008-010	08	N	6	8	4,4'-DDD	N	<	0.68	ug/kg
91JULH008-011	08	N	2.5	4.5	4,4'-DDD	N		3.2	ug/kg
91JULH008-012	08	N	7.5	9.5	4,4'-DDD	N		4.0	ug/kg
91JULH008-001	08	N	0	2	4,4'-DDE	N		410	ug/kg
91JULH008-002	08	N	6	8	4,4'-DDE	N	<	0.60	ug/kg
91JULH008-003	08	N	0	2	4,4'-DDE	N		5600	ug/kg
91JULH008-004	08	N	5	7	4,4'-DDE	N		10.0	ug/kg
91JULH008-005	08	N	0	2	4,4'-DDE	N		86	ug/kg
91JULH008-006	08	N	10	12	4,4'-DDE	N	<	0.79	ug/kg
91JULH008-007	08	N	0	2	4,4'-DDE	N		530	ug/kg
91JULH008-008	08	N	2	4	4,4'-DDE	N		3.3	ug/kg
91JULH008-009	08	N	2	4	4,4'-DDE	N		1.0	ug/kg
91JULH008-010	08	N	6	8	4,4'-DDE	N	<	0.68	ug/kg
91JULH008-011	08	N	2.5	4.5	4,4'-DDE	N		0.055	ug/kg
91JULH008-012	08	N	7.5	9.5	4,4'-DDE	N		0.76	ug/kg
91JULH008-001	08	N	0	2	4,4'-DDT	N		400	ug/kg
91JULH008-002	08	N	6	8	4,4'-DDT	N	<	1.2	ug/kg
91JULH008-003	08	N	0	2	4,4'-DDT	N		9300	ug/kg
91JULH008-004	08	N	5	7	4,4'-DDT	N		12	ug/kg
91JULH008-005	08	N	0	2	4,4'-DDT	N		26	ug/kg
91JULH008-006	08	N	10	12	4,4'-DDT	N	<	1.6	ug/kg
91JULH008-007	08	N	0	2	4,4'-DDT	N		500	ug/kg
91JULH008-008	08	N	2	4	4,4'-DDT	N		1.0	ug/kg
91JULH008-009	08	N	2	4	4,4'-DDT	N		0.34	ug/kg
91JULH008-010	08	N	6	8	4,4'-DDT	N	<	1.4	ug/kg
91JULH008-011	08	N	2.5	4.5	4,4'-DDT	N		1.3	ug/kg
91JULH008-012	08	N	7.5	9.5	4,4'-DDT	N		2.0	ug/kg
91JULH008-001	08	N	0	2	Aldrin	N	<	5.6	ug/kg

Sample id	Site id	Type	Top depth	Bottom depth	Analyte	Result_Type	Result_Flag	Result	Unit_Of_Measure
91JULH008-002	08	N	6	8	Aldrin	N		0.49	ug/kg
91JULH008-003	08	N	0	2	Aldrin	N		41	ug/kg
91JULH008-004	08	N	5	7	Aldrin	N		0.49	ug/kg
91JULH008-005	08	N	0	2	Aldrin	N	<	5.6	ug/kg
91JULH008-006	08	N	10	12	Aldrin	N		0.45	ug/kg
91JULH008-007	08	N	0	2	Aldrin	N		5.0	ug/kg
91JULH008-008	08	N	2	4	Aldrin	N	<	0.61	ug/kg
91JULH008-009	08	N	2	4	Aldrin	N	<	0.61	ug/kg
91JULH008-010	08	N	6	8	Aldrin	N	<	0.68	ug/kg
91JULH008-011	08	N	2.5	4.5	Aldrin	N	<	0.61	ug/kg
91JULH008-012	08	N	7.5	9.5	Aldrin	N		1.7	ug/kg
91JULH008-007	08	N	0	2	Benzene	N		2.6	ug/kg
91JULH008-001	08	N	0	2	Cadmium	N		0.92	mg/kg
91JULH008-002	08	N	6	8	Cadmium	N	<	1.1	mg/kg
91JULH008-003	08	N	0	2	Cadmium	N		1.8	mg/kg
91JULH008-004	08	N	5	7	Cadmium	N	<	0.37	mg/kg
91JULH008-005	08	N	0	2	Cadmium	N	<	0.78	mg/kg
91JULH008-006	08	N	10	12	Cadmium	N	<	1.0	mg/kg
91JULH008-007	08	N	0	2	Cadmium	N	<	0.77	mg/kg
91JULH008-008	08	N	2	4	Cadmium	N	<	0.95	mg/kg
91JULH008-009	08	N	2	4	Cadmium	N	<	0.80	mg/kg
91JULH008-010	08	N	6	8	Cadmium	N	<	1.0	mg/kg
91JULH008-011	08	N	2.5	4.5	Cadmium	N		0.92	mg/kg
91JULH008-012	08	N	7.5	9.5	Cadmium	N	<	1.0	mg/kg
91JULH008-001	08	N	0	2	Chlordane	N		950	ug/kg
91JULH008-002	08	N	6	8	Chlordane	N	<	3.0	ug/kg
91JULH008-003	08	N	0	2	Chlordane	N		4000	ug/kg
91JULH008-004	08	N	5	7	Chlordane	N		20	ug/kg
91JULH008-005	08	N	0	2	Chlordane	N		230	ug/kg
91JULH008-006	08	N	10	12	Chlordane	N	<	3.9	ug/kg
91JULH008-007	08	N	0	2	Chlordane	N		730	ug/kg
91JULH008-008	08	N	2	4	Chlordane	N	<	3.1	ug/kg
91JULH008-009	08	N	2	4	Chlordane	N	<	3.0	ug/kg
91JULH008-010	08	N	6	8	Chlordane	N	<	3.4	ug/kg
91JULH008-011	08	N	2.5	4.5	Chlordane	N		17	ug/kg
91JULH008-012	08	N	7.5	9.5	Chlordane	N		32	ug/kg
91JULH008-001	08	N	0	2	Chlorobenzene	N		40	ug/kg
91JULH008-002	08	N	6	8	Chlorobenzene	N		2.8	ug/kg

Sample id	Site id	Type	Top depth	Bottom depth	Analyte	Result_Type	Result_Flag	Result	Unit_Of_Measure
91JULH008-003	08	N	0	2	Chlorobenzene	N		15	ug/kg
91JULH008-005	08	N	0	2	Chlorobenzene	N		5.6	ug/kg
91JULH008-001	08	N	0	2	Copper	N		51	mg/kg
91JULH008-002	08	N	6	8	Copper	N	<	4.5	mg/kg
91JULH008-003	08	N	0	2	Copper	N		37	mg/kg
91JULH008-004	08	N	5	7	Copper	N		5.8	mg/kg
91JULH008-005	08	N	0	2	Copper	N		10	mg/kg
91JULH008-006	08	N	10	12	Copper	N	<	4.0	mg/kg
91JULH008-007	08	N	0	2	Copper	N		20	mg/kg
91JULH008-008	08	N	2	4	Copper	N		7.0	mg/kg
91JULH008-009	08	N	2	4	Copper	N		3.2	mg/kg
91JULH008-010	08	N	6	8	Copper	N	<	4.2	mg/kg
91JULH008-011	08	N	2.5	4.5	Copper	N		5.2	mg/kg
91JULH008-012	08	N	7.5	9.5	Copper	N		4.2	mg/kg
91JULH008-001	08	N	0	2	delta-BHC	N		16	ug/kg
91JULH008-002	08	N	6	8	delta-BHC	N		1.6	ug/kg
91JULH008-003	08	N	0	2	delta-BHC	N		21	ug/kg
91JULH008-004	08	N	5	7	delta-BHC	N		1.6	ug/kg
91JULH008-005	08	N	0	2	delta-BHC	N		15	ug/kg
91JULH008-006	08	N	10	12	delta-BHC	N		2.1	ug/kg
91JULH008-007	08	N	0	2	delta-BHC	N	<	5.5	ug/kg
91JULH008-008	08	N	2	4	delta-BHC	N		1.8	ug/kg
91JULH008-009	08	N	2	4	delta-BHC	N	<	0.61	ug/kg
91JULH008-010	08	N	6	8	delta-BHC	N	<	0.68	ug/kg
91JULH008-011	08	N	2.5	4.5	delta-BHC	N		1.8	ug/kg
91JULH008-012	08	N	7.5	9.5	delta-BHC	N		1.7	ug/kg
91JULH008-001	08	N	0	2	Endosulfan II	N		2.5	ug/kg
91JULH008-002	08	N	6	8	Endosulfan II	N	<	1.8	ug/kg
91JULH008-004	08	N	5	7	Endosulfan II	N	<	1.7	ug/kg
91JULH008-006	08	N	10	12	Endosulfan II	N	<	2.4	ug/kg
91JULH008-008	08	N	2	4	Endosulfan II	N	<	1.8	ug/kg
91JULH008-009	08	N	2	4	Endosulfan II	N	<	1.8	ug/kg
91JULH008-010	08	N	6	8	Endosulfan II	N	<	2.1	ug/kg
91JULH008-011	08	N	2.5	4.5	Endosulfan II	N	<	1.8	ug/kg
91JULH008-012	08	N	7.5	9.5	Endosulfan II	N	<	1.9	ug/kg
91JULH008-002	08	N	6	8	Endosulfan Sulfate	N		1.1	ug/kg
91JULH008-004	08	N	5	7	Endosulfan Sulfate	N		0.27	ug/kg
91JULH008-006	08	N	10	12	Endosulfan Sulfate	N		0.64	ug/kg

Sample id	Site id	Type	Top depth	Bottom depth	Analyte	Result_Type	Result_Flag	Result	Unit_Of_Measure
91JULH008-007	08	N	0	2	Endosulfan Sulfate	N		0.68	ug/kg
91JULH008-011	08	N	2.5	4.5	Endosulfan Sulfate	N		2.3	ug/kg
91JULH008-007	08	N	0	2	Ethyl benzene	N		2.6	ug/kg
91JULH008-002	08	N	6	8	gamma-BHC	N		0.61	ug/kg
91JULH008-004	08	N	5	7	gamma-BHC	N	<	0.58	ug/kg
91JULH008-008	08	N	2	4	gamma-BHC	N	<	0.61	ug/kg
91JULH008-009	08	N	2	4	gamma-BHC	N	<	0.61	ug/kg
91JULH008-011	08	N	2.5	4.5	gamma-BHC	N	<	0.61	ug/kg
91JULH008-001	08	N	0	2	Heptachlor	N		6.3	ug/kg
91JULH008-002	08	N	6	8	Heptachlor	N		0.31	ug/kg
91JULH008-003	08	N	0	2	Heptachlor	N		56	ug/kg
91JULH008-004	08	N	5	7	Heptachlor	N		0.90	ug/kg
91JULH008-005	08	N	0	2	Heptachlor	N	<	5.6	ug/kg
91JULH008-006	08	N	10	12	Heptachlor	N		0.87	ug/kg
91JULH008-007	08	N	0	2	Heptachlor	N		12	ug/kg
91JULH008-008	08	N	2	4	Heptachlor	N		0.30	ug/kg
91JULH008-009	08	N	2	4	Heptachlor	N		0.39	ug/kg
91JULH008-010	08	N	6	8	Heptachlor	N	<	0.68	ug/kg
91JULH008-011	08	N	2.5	4.5	Heptachlor	N	<	0.61	ug/kg
91JULH008-012	08	N	7.5	9.5	Heptachlor	N	<	0.63	ug/kg
91JULH008-001	08	N	0	2	Heptachlor epoxide	N		11	ug/kg
91JULH008-002	08	N	6	8	Heptachlor epoxide	N		0.3	ug/kg
91JULH008-003	08	N	0	2	Heptachlor epoxide	N		74	ug/kg
91JULH008-004	08	N	5	7	Heptachlor epoxide	N		4.4	ug/kg
91JULH008-005	08	N	0	2	Heptachlor epoxide	N	<	5.6	ug/kg
91JULH008-006	08	N	10	12	Heptachlor epoxide	N	<	0.79	ug/kg
91JULH008-007	08	N	0	2	Heptachlor epoxide	N		12	ug/kg
91JULH008-008	08	N	2	4	Heptachlor epoxide	N	<	.61	ug/kg
91JULH008-009	08	N	2	4	Heptachlor epoxide	N	<	.61	ug/kg
91JULH008-010	08	N	6	8	Heptachlor epoxide	N	<	.68	ug/kg
91JULH008-011	08	N	2.5	4.5	Heptachlor epoxide	N	<	.61	ug/kg
91JULH008-012	08	N	7.5	9.5	Heptachlor epoxide	N	<	.63	ug/kg
91JULH008-001	08	N	0	2	Lead	N		50	mg/kg
91JULH008-002	08	N	6	8	Lead	N		1.1	mg/kg
91JULH008-003	08	N	0	2	Lead	N		370	mg/kg
91JULH008-004	08	N	5	7	Lead	N		2.3	mg/kg
91JULH008-005	08	N	0	2	Lead	N		19	mg/kg
91JULH008-006	08	N	10	12	Lead	N		0.30	mg/kg

Sample id	Site id	Type	Top depth	Bottom depth	Analyte	Result_Type	Result_Flag	Result	Unit_Of_Measure
91JULH008-007	08	N	0	2	Lead	N		8.1	mg/kg
91JULH008-008	08	N	2	4	Lead	N		18	mg/kg
91JULH008-009	08	N	2	4	Lead	N		2.0	mg/kg
91JULH008-010	08	N	6	8	Lead	N		0.75	mg/kg
91JULH008-011	08	N	2.5	4.5	Lead	N		1.0	mg/kg
91JULH008-012	08	N	7.5	9.5	Lead	N		1.3	mg/kg
91JULH008-001	08	N	0	2	Mercury	N		0.49	mg/kg
91JULH008-002	08	N	6	8	Mercury	N	<	0.060	mg/kg
91JULH008-003	08	N	0	2	Mercury	N		2.2	mg/kg
91JULH008-004	08	N	5	7	Mercury	N	<	0.053	mg/kg
91JULH008-005	08	N	0	2	Mercury	N		0.11	mg/kg
91JULH008-006	08	N	10	12	Mercury	N	<	0.064	mg/kg
91JULH008-007	08	N	0	2	Mercury	N		0.80	mg/kg
91JULH008-008	08	N	2	4	Mercury	N	<	0.053	mg/kg
91JULH008-009	08	N	2	4	Mercury	N	<	0.053	mg/kg
91JULH008-010	08	N	6	8	Mercury	N	<	0.060	mg/kg
91JULH008-011	08	N	2.5	4.5	Mercury	N	<	0.056	mg/kg
91JULH008-012	08	N	7.5	9.5	Mercury	N	<	0.060	mg/kg
91JULH008-007	08	N	0	2	Methylene chloride	N		590	ug/kg
91JULH008-008	08	N	2	4	Methylene chloride	N		320	ug/kg
91JULH008-009	08	N	2	4	Methylene chloride	N	<	120	ug/kg
91JULH008-010	08	N	6	8	Methylene chloride	N	<	130	ug/kg
91JULH008-011	08	N	2.5	4.5	Methylene chloride	N		170	ug/kg
91JULH008-012	08	N	7.5	9.5	Methylene chloride	N		570	ug/kg
91JULH008-001	08	N	0	2	Toluene	N		5.7	ug/kg
91JULH008-003	08	N	0	2	Toluene	N		7.4	ug/kg
91JULH008-004	08	N	5	7	Toluene	N		5.5	ug/kg
91JULH008-005	08	N	0	2	Toluene	N		6.0	ug/kg
91JULH008-006	08	N	10	12	Toluene	N		7.1	ug/kg
91JULH008-001	08	N	0	2	Zinc	N		180	mg/kg
91JULH008-002	08	N	6	8	Zinc	N		12	mg/kg
91JULH008-003	08	N	0	2	Zinc	N		620	mg/kg
91JULH008-004	08	N	5	7	Zinc	N		21	mg/kg
91JULH008-005	08	N	0	2	Zinc	N		48	mg/kg
91JULH008-006	08	N	10	12	Zinc	N		6.3	mg/kg
91JULH008-007	08	N	0	2	Zinc	N		50	mg/kg
91JULH008-008	08	N	2	4	Zinc	N		30	mg/kg
91JULH008-009	08	N	2	4	Zinc	N		23	mg/kg

Sample id	Site id	Type	Top depth	Bottom depth	Analyte	Result_Type	Result_Flag	Result	Unit_Of_Measure
91JULH008-010	08	N	6	8	Zinc	N		9.6	mg/kg
91JULH008-011	08	N	2.5	4.5	Zinc	N		16	mg/kg
91JULH008-012	08	N	7.5	9.5	Zinc	N		11	mg/kg

Sample id	Site id	Type	Top depth	Bottom depth	Analyte	Result_Type	Result_Flag	Result	Unit_Of_Measure
91JULH014-001	14	N	0	2.5	4,4'-DDD	N		180	ug/kg
91JULH014-003	14	N	0	2	4,4'-DDD	N		3100	ug/kg
91JULH014-005	14	N	0	2	4,4'-DDD	N		10000	ug/kg
91JULH014-007	14	N	0	2	4,4'-DDD	N		3200	ug/kg
91JULH014-009	14	N	0	2	4,4'-DDD	N		35	ug/kg
91JULH014-011	14	FD	0	2	4,4'-DDD	FD		6700	ug/kg
91JULH014-001	14	N	0	2.5	4,4'-DDE	N		160	ug/kg
91JULH014-003	14	N	0	2	4,4'-DDE	N		3900	ug/kg
91JULH014-005	14	N	0	2	4,4'-DDE	N		6100	ug/kg
91JULH014-007	14	N	0	2	4,4'-DDE	N		2200	ug/kg
91JULH014-009	14	N	0	2	4,4'-DDE	N		30	ug/kg
91JULH014-011	14	FD	0	2	4,4'-DDE	FD		4300	ug/kg
91JULH014-001	14	N	0	2.5	4,4'-DDT	N		320	ug/kg
91JULH014-003	14	N	0	2	4,4'-DDT	N		6500	ug/kg
91JULH014-005	14	N	0	2	4,4'-DDT	N		36000	ug/kg
91JULH014-007	14	N	0	2	4,4'-DDT	N		4400	ug/kg
91JULH014-009	14	N	0	2	4,4'-DDT	N		130	ug/kg
91JULH014-011	14	FD	0	2	4,4'-DDT	FD		23000	ug/kg
91JULH014-001	14	N	0	2.5	Aldrin	N		26	ug/kg
91JULH014-003	14	N	0	2	Aldrin	N		640	ug/kg
91JULH014-005	14	N	0	2	Aldrin	N		160	ug/kg
91JULH014-007	14	N	0	2	Aldrin	N		1700	ug/kg
91JULH014-009	14	N	0	2	Aldrin	N	<	5.6	ug/kg
91JULH014-011	14	FD	0	2	Aldrin	FD		180	ug/kg
91JULH014-001	14	N	0	2.5	Chlordane	N		1100	ug/kg
91JULH014-003	14	N	0	2	Chlordane	N		17000	ug/kg
91JULH014-005	14	N	0	2	Chlordane	N		4500	ug/kg
91JULH014-007	14	N	0	2	Chlordane	N		34000	ug/kg
91JULH014-009	14	N	0	2	Chlordane	N	<	28	ug/kg
91JULH014-011	14	FD	0	2	Chlordane	FD		4000	ug/kg
91JULH014-001	14	N	0	2.5	Endosulfan II	N		8.3	ug/kg
91JULH014-005	14	N	0	2	Endosulfan II	N	<	16	ug/kg
91JULH014-007	14	N	0	2	Endosulfan II	N	<	17	ug/kg
91JULH014-009	14	N	0	2	Endosulfan II	N	<	17	ug/kg
91JULH014-011	14	FD	0	2	Endosulfan II	FD	<	16	ug/kg
91JULH014-001	14	N	0	2.5	gamma-BHC	N		5.7	ug/kg
91JULH014-003	14	N	0	2	gamma-BHC	N		2800	ug/kg
91JULH014-005	14	N	0	2	gamma-BHC	N		5.0	ug/kg

Sample id	Site id	Type	Top depth	Bottom depth	Analyte	Result_Type	Result_Flag	Result	Unit_Of_Measure
91JULH014-007	14	N	0	2	gamma-BHC	N		10	ug/kg
91JULH014-009	14	N	0	2	gamma-BHC	N	<	5.6	ug/kg
91JULH014-011	14	FD	0	2	gamma-BHC	FD		7.0	ug/kg
91JULH014-001	14	N	0	2.5	Heptachlor	N	<	5.6	ug/kg
91JULH014-003	14	N	0	2	Heptachlor	N		150	ug/kg
91JULH014-005	14	N	0	2	Heptachlor	N		20	ug/kg
91JULH014-007	14	N	0	2	Heptachlor	N		770	ug/kg
91JULH014-009	14	N	0	2	Heptachlor	N	<	5.6	ug/kg
91JULH014-011	14	FD	0	2	Heptachlor	FD		43	ug/kg
91JULH014-007	14	N	0	2	MCPP	N		43000	ug/kg
91JULH014-001	14	N	0	2.5	Methylene chloride	N		680	ug/kg
91JULH014-003	14	N	0	2	Methylene chloride	N		230	ug/kg
91JULH014-005	14	N	0	2	Methylene chloride	N		130	ug/kg
91JULH014-007	14	N	0	2	Methylene chloride	N		570	ug/kg
91JULH014-009	14	N	0	2	Methylene chloride	N		130	ug/kg
91JULH014-011	14	FD	0	2	Methylene chloride	FD		700	ug/kg

Sample id	Top depth	Bottom depth	Analyte	Result_Flag	Result
91JULH039-007	0	2	Nickel		6.5
91JULH039-009	0	2	Nickel		21
91JULH039-005	0	2	Nickel		31
91JULH039-008	0	2	Nickel		23
91JULH039-006	0	2	Nickel		58
91JULH039-005	0	2	Silver	<	2.4
91JULH039-008	0	2	Silver	<	1.8
91JULH039-009	0	2	Silver		12
91JULH039-006	0	2	Silver	<	2.4
91JULH039-007	0	2	Silver	<	2.3
91JULH039-006	0	2	Tetrachloroethene		28
91JULH039-008	0	2	Toluene		8.0
91JULH039-005	0	2	Toluene		8.9
91JULH039-009	0	2	Toluene		9.1
91JULH039-007	0	2	Toluene		9.1
91JULH039-006	0	2	Toluene		9.3
91JULH039-006	0	2	Xylenes		13
91JULH039-005	0	2	Xylenes		38
91JULH039-005	0	2	Zinc		540
91JULH039-007	0	2	Zinc		30
91JULH039-008	0	2	Zinc		250
91JULH039-009	0	2	Zinc		180
91JULH039-006	0	2	Zinc		130

APPENDIX G

CLEANUP CRITERIA EVALUATION SUPPORTING DATA

Table G-1

Cleanup Criteria Evaluation--Carcinogenic and Noncarcinogenic Risks, Occupational Exposure to Subsurface VOCs at Site 8

Chemicals Contributing to Carcinogenic Risk	Carcinogenic Risk	
	Average	Reasonable Maximum
Chloroform	9E-11	1E-10
Methylene chloride	0.0	0.0
1,1-Dichloroethene	2E-8	4E-8
1,2-Dichloroethane	7E-10	1E-09
Chemicals Contributing to Noncarcinogenic Risk	**Noncarcinogenic Risk**	
	Average	Reasonable Maximum
Chlorobenzene	0.0	0.0
Methylene chloride	0.0	0.0
Toluene	0.0	0.0
Xylenes	3E-05	4E-05

Table G-2

Cleanup Criteria Evaluation--Toxicity Values and Output Results, Occupational Exposure to Subsurface VOCs at Site 8

Carcinogenic Risk							
Working at Site 8							
Ingestion Of Soil: Soil - Site 8							
	Contaminant	SF	Evidence	Average CDI	Reas. Max. CDI	Average Risk	Reas. Max. Risk
	Methylene chloride	7.5E-3	B2	1.04E-2	1.25E-2	8E-5	9E-5
	1,1-Dichloroethene	6E-1	C	9.64E-9	1.16E-8	6E-9	7E-9
Dermal Contact With Soil: Soil - Site 8							
	Contaminant	SF	Evidence	Average CDI	Reas. Max. CDI	Average Risk	Reas. Max. Risk
	Methylene chloride	7.5E-3	B2	1.04E-1	1.24E-1	8E-4	9E-4
	1,1-Dichloroethene	6E-1	C	9.57E-8	1.15E-7	6E-8	7E-8
Inhalation Of Vapor: Ambient Air - Site 8							
	Contaminant*	SFC	Evidence	Average EAC	Reas. Max. EAC	Average Risk	Reas. Max. Risk
	1,1-Dichloroethene*	5E-5	C	4.15E-4	7.12E-4	2E-8	4E-8
	1,2-Dichloroethane*	2.6E-5	B2	2.65E-5	4.55E-5	7E-10	1E-9
	Chloroform*	2.3E-5	B2	3.74E-6	6.41E-6	9E-11	1E-10
Noncarcinogenic Risk							
Working at Site 8							
Ingestion Of Soil: Soil - Site 8							
	Contaminant	Chronic RfD	Average Intake	Reas. Max. Intake	Average Haz. Index	Reas. Max. Haz. Index	
	Chlorobenzene	2E-2	3.29E-9	3.29E-9	2E-7	2E-7	
	Methylene chloride	6E-2	2.92E-2	2.92E-2	5E-1	5E-1	
	Toluene	2E-1	7.4E-9	7.4E-9	4E-8	4E-8	
	1,1-Dichloroethene	9E-3	2.7E-8	2.7E-8	3E-6	3E-6	
Dermal Contact With Soil: Soil - Site 8							
	Contaminant	Chronic RfD	Average Intake	Reas. Max. Intake	Average Haz. Index	Reas. Max. Haz. Index	
	Chlorobenzene	2E-2	3.26E-8	3.26E-8	2E-6	2E-6	
	Methylene chloride	6E-2	2.9E-1	2.9E-1	5.	5.	
	Toluene	2E-1	7.34E-8	7.34E-8	4E-7	4E-7	
	1,1-Dichloroethene	9E-3	2.68E-7	2.68E-7	3E-5	3E-5	
Inhalation Of Vapor: Ambient Air - Site 8							
	Contaminant	Chronic RfD	Average Intake	Reas. Max. Intake	Average Haz. Index	Reas. Max. Haz. Index	
	Contaminant*	Chronic RfC	Average EAC	Reas. Max. EAC	Average Haz. Index	Reas. Max. Haz. Index	
	Xylenes*	3E-1	7.93E-6	1.13E-5	3E-5	4E-5	

Table G-3

Cleanup Criteria Evaluation--Carcinogenic Risk from Surface Soils, and VOCs Occupational Exposure at Site 8

Chemical	Ingestion of Soil	Dermal Contact with Soil	Inhalation of Ambient Air	Total	% Contribution
Average					
Aldrin	9E-8	9E-7	8E-8	1E-6	15
Benzene	3E-11	3E-10	8E-8	4E-8	1.06
Cadmium (food)	0E+0	0E+0	6E-7	6E-7	8.76
Chlordane	8E-8	8E-7	7E-8	9E-7	13.2
4,4'-DDD	1E-7	1E-6	0E+0	1E-6	16.6
4,4'-DDE	8E-8	8E-7	0E+0	9E-7	11.9
4,4'-DDT	7E-8	7E-7	6E-8	9E-7	11.8
Heptachlor	4E-8	4E-7	3E-8	4E-7	5.92
Heptachlor epoxide	1E-7	9E-7	8E-8	1E-6	15.5
1,1-Dichloroethene	0E+0	0E+0	2E-8	2E-8	0.29
1,2-Dichloroethane	0E+0	0E+0	7E-10	7E-10	0.01
Chloroform	0E+0	0E+0	9E-11	9E-11	0.001
Total by pathway	6E-7	6E-6	1E-6		
% Contribution by pathway	7.83	77.7	14.4		
Scenario Total				7E-6	
Reasonable Maximum					
Aldrin	1E-7	1E-6	1E-7	1E-6	14.5
Benzene	4E-11	4E-10	1E-7	1E-7	1.42
Cadmium (food)	0E+0	0E+0	1E-6	1E-6	11.8
Chlordane	1E-7	1E-6	1E-7	1E-6	12.8
4,4'-DDD	1E-7	1E-6	0E+0	1E-6	15.6
4,4'-DDE	9E-8	9E-7	0E+0	1E-6	11.2
4,4'-DDT	9E-8	9E-7	1E-7	1E-6	11.5
Heptachlor	4E-8	4E-7	5E-8	5E-7	5.75
Heptachlor epoxide	1E-7	1E-6	1E-7	1E-6	15.0
1,1-Dichloroethene	0E+0	0E+0	4E-8	4E-8	0.39
1,2-Dichloroethane	0E+0	0E+0	1E-9	1E-9	0.01
Chloroform	0E+0	0E+0	1E-10	1E-10	0.002
Total by pathway	7E-7	7E-6	2E-6		
% Contribution by pathway	7.37	73.2	19.4		
Scenario Total				9E-6	

Table G-4

Cleanup Criteria Evaluation--Noncarcinogenic Risk from Surface Soils, and VOCs Occupational Exposure at Site 8

Chemical	Ingestion of Soil	Dermal Contact with Soil	Inhalation of Ambient Air	Total	% Contribution
Average					
Aldrin	5E-4	5E-3	0E+0	6E-3	0.82
Cadmium (food)	3E-4	7E-5	0E+0	4E-4	0.06
Chlordane	3E-3	3E-2	0E+0	3E-2	4.71
Chlorobenzene	1E-6	1E-5	4E-1	4E-1	60.4
Copper	9E-4	9E-4	0E+0	2E-3	0.26
4,4'-DDT	1E-3	1E-2	0E+0	1E-2	1.95
Endosulfan II	6E-5	6E-4	0E+0	6E-4	0.10
Ethyl benzene	3E-8	3E-7	2E-3	2E-3	0.24
Heptachlor	5E-5	4E-4	0E+0	5E-4	0.07
Heptachlor epoxide	2E-3	2E-2	0E+0	2E-2	3.67
Mercury	6E-5	6E-5	2E-1	2E-1	26.9
Toluene	4E-8	4E-7	3E-3	3E-3	0.40
Zinc	1E-3	1E-3	0E+0	3E-3	0.39
Xylenes	0E+0	0E+0	3E-5	3E-5	0.004
Total by pathway	1E-2	7E-2	6E-1		
% Contribution by pathway	1.42	10.6	87.9		
Scenario Total				7E-1	
Reasonable Maximum					
Aldrin	5E-4	5E-3	0E+0	6E-3	0.60
Cadmium (food)	3E-4	7E-5	0E+0	4E-4	0.04
Chlordane	3E-3	3E-2	0E+0	3E-2	3.42
Chlorobenzene	1E-6	1E-5	6E-1	6E-1	62.7
Copper	9E-4	9E-4	0E+0	2E-3	0.19
4,4'-DDT	1E-3	1E-2	0E+0	1E-2	1.42
Endosulfan II	6E-5	6E-4	0E+0	6E-4	0.07
Ethyl benzene	3E-8	3E-7	2E-3	2E-3	0.24
Heptachlor	5E-5	4E-4	0E+0	5E-4	0.05
Heptachlor epoxide	2E-3	2E-2	0E+0	2E-2	2.66
Mercury	6E-5	6E-5	3E-1	3E-1	27.9
Toluene	4E-8	4E-7	4E-3	4E-3	0.41
Zinc	1E-3	1E-3	0E+0	3E-3	0.28
Xylenes	0E+0	0E+0	4E-5	4E-5	0.004
Total by pathway	1E-2	7E-2	8E-1		
% Contribution by pathway	1.03	7.72	91.2		
Scenario Total				9E-1	

Table G-5

Cleanup Criteria Evaluation--Toxicity Values and Output Results for Site 8

Carcinogenic Risk Estimates							
Working at Site 8							
Ingestion Of Soil: Soil - Site 8							
	Contaminant	SF	Evidence	Average CDI	Reas. Max. CDI	Average risk	Reas. Max. Risk
	Aldrin	17	B2	5.41E-9	6.49E-9	9E-8	1E-7
	Benzene	2.9E-2	A	1.09E-9	1.31E-9	3E-11	4E-11
	Chlordane	1.3	B2	6.21E-8	7.45E-8	8E-8	1E-7
	4,4'-DDD	2.4E-1	B2	4.57E-7	5.49E-7	1E-7	1E-7
	4,4'-DDE	3.4E-1	B2	2.31E-7	2.78E-7	8E-8	9E-8
	4,4'-DDT	3.4E-1	B2	2.14E-7	2.57E-7	7E-8	9E-8
	Heptachlor	4.5	B2	8.08E-9	9.7E-9	4E-8	4E-8
	Heptachlor epoxide	9.1	B2	1.05E-8	1.26E-8	1E-7	1E-7
Dermal Contact With Soil: Soil - Site 8							
	Contaminant	SF	Evidence	Average CDI	Reas. Max. CDI	Average risk	Reas. Max. Risk
	Aldrin	17	B2	5.37E-8	6.44E-8	9E-7	1E-6
	Benzene	2.9E-2	A	1.08E-8	1.3E-8	3E-10	4E-10
	Chlordane	1.3	B2	6.16E-7	7.39E-7	8E-7	1E-6
	4,4'-DDD	2.4E-1	B2	4.54E-6	5.44E-6	1E-6	1E-6
	4,4'-DDE	3.4E-1	B2	2.3E-6	2.76E-6	8E-7	9E-7
	4,4'-DDT	3.4E-1	B2	2.12E-6	2.55E-6	7E-7	9E-7
	Heptachlor	4.5	B2	8.03E-8	9.63E-8	4E-7	4E-7
	Heptachlor epoxide	9.1	B2	1.04E-7	1.25E-7	9E-7	1E-6
Inhalation Of Vapor: Ambient air - Site 8							
	Contaminant	SF	Evidence	Average CDI	Reas. Max. CDI	Average risk	Reas. Max. Risk
	Aldrin*	4.9E-3	B2	1.55E-5	2.66E-5	8E-8	1E-7
	Benzene*	8.3E-6	A	9.17E-3	1.57E-2	8E-8	1E-7
	Cadmium (food)*	1.8E-3	B1	3.52E-4	6.03E-4	6E-7	1E-6
	Chlordane*	3.7E-4	B2	1.85E-4	3.17E-4	7E-8	1E-7
	4,4'-DDT*	9.7E-5	B2	6.17E-4	1.06E-3	6E-8	1E-7
	Heptachlor*	1.3E-3	B2	2.32E-5	3.97E-5	3E-8	5E-8
	Heptachlor epoxide*	2.6E-3	B2	3E-5	5.15E-5	8E-8	1E-7
	1,1-Dichloroethene*	5E-5	C	4.15E-4	7.12E-4	2E-8	4E-8
	1,2-Dichloroethane*	2.6E-5	B2	2.66E-5	4.56E-5	7E-10	1E-9
	Chloroform*	2.3E-5	B2	3.74E-6	6.41E-6	9E-11	1E-10

Table G-5

(Continued)

Post Remedial Non-Carcinogenic Risk Estimates

Working at Site 8

Ingestion Of Soil: Soil - Site 8

	Contaminant	Chronic Rfd	Average Intake	Reas. Max. Intake	Average Haz. Index	Reas. Max. Haz. Index
	Aldrin	3E-5	1.51E-8	1.51E-8	5E-4	5E-4
	Cadmium (food)	1E-3	3.41E-7	3.41E-7	3E-4	3E-4
	Chlordane	6E-5	1.74E-7	1.74E-7	3E-3	3E-3
	Chlorobenzene	2E-2	2.37E-8	2.37E-8	1E-6	1E-6
	Copper	4E-2	3.46E-5	3.46E-5	9E-4	9E-4
	4,4'-DDT	5E-4	5.99E-7	5.99E-7	1E-3	1E-3
	Endosulfan II	5E-5	2.94E-9	2.94E-9	6E-5	6E-5
	Ethyl benzene	1E-1	3.05E-9	3.05E-9	3E-8	3E-8
	Heptachlor	5E-4	2.26E-8	2.26E-8	5E-5	5E-5
	Heptachlor epoxide	1.3E-5	2.93E-8	2.93E-8	2E-3	2E-3
	Mercury	3E-4	1.88E-8	1.88E-8	6E-5	6E-5
	Toluene	2E-1	7.48E-9	7.48E-9	4E-8	4E-8
	Zinc	2E-1	2.64E-4	2.64E-4	1E-3	1E-3

Dermal Contact With Soil: Soil - Site 8

	Contaminant	SF	Evidence	Average CDI	Reas. Max. CDI	Average risk	Reas. Max. Risk
	Aldrin	3E-5	1.5E-7	1.5E-7	5E-3	5E-3	
	Cadmium (food)	1E-3	6.76E-8	6.76E-8	7E-5	7E-5	
	Chlordane	6E-5	1.72E-6	1.72E-6	3E-2	3E-2	
	Chlorobenzene	2E-2	2.35E-7	2.35E-7	1E-5	1E-5	
	Copper	4E-2	3.44E-5	3.44E-5	9E-4	9E-4	
	4,4'-DDT	5E-4	5.94E-6	5.94E-6	1E-2	1E-2	
	Endosulfan II	5E-5	2.91E-8	2.91E-8	6E-4	6E-4	
	Ethyl benzene	1E-1	3.03E-8	3.03E-8	3E-7	3E-7	
	Heptachlor	5E-4	2.25E-7	2.25E-7	4E-4	4E-4	
	Heptachlor epoxide	1.3E-5	2.91E-7	2.91E-7	2E-2	2E-2	
	Mercury	3E-4	1.86E-8	1.86E-8	6E-5	6E-5	
	Toluene	2E-1	7.42E-8	7.42E-8	4E-7	4E-7	
	Zinc	2E-1	2.62E-4	2.62E-4	1E-3	1E-3	

Inhalation Of Vapor: Ambient air - Site 8

	Contaminant	SF	Evidence	Average CDI	Reas. Max. CDI	Average risk	Reas. Max. Risk
	Chlorobenzene*	2E-2	8.12E-3	1.16E-2	4E-1	6E-1	
	Ethyl benzene*	1	1.59E-3	2.27E-3	2E-3	2E-3	
	Mercury*	3E-4	5.41E-5	7.73E-5	2E-1	3E-1	
	Toluene*	2	5.32E-3	7.6E-3	3E-3	4E-3	
	Xylenes	3E-1	7.94E-6	1.13E-5	3E-5	4E-5	

Table G-6

Cleanup Criteria Evaluation--Carcinogenic Risk, Occupational Exposure for Site 14

Chemical	Inhalation of Volatiles in Ambient Air	Ingestion of Soil	Dermal Contact with Soil	Total	% Contribution
Average					
4,4'-DDD	0.0	0.1	1E-6	1E-6	14.1
4,4'-DDE	0.0	1E-7	1E-6	1E-6	14.3
4,4'-DDT	1E-8	1E-7	1E-6	1E-6	18.1
Aldrin	6E-9	8E-8	8E-7	9E-7	11.4
Chlordane	8E-9	9E-8	9E-7	1E-6	13.4
Heptachlor	8E-9	1E-7	1E-6	1E-6	14.6
Methylene chloride	1E-7	1E-9	1E-8	1E-7	1.81
gamma-BHC	0.0	9E-8	8E-7	9E-7	12.3
Total by pathway	2E-7	7E-7	7E-6		
% Contribution by pathway	2.05	8.97	89		
Scenario Total				8E-6	
Reasonable Maximum					
4,4'-DDD	0.0	1E-7	1E-6	1E-6	14
4,4'-DDE	0.0	1E-7	1E-6	1E-6	14.2
4,4'-DDT	1E-8	1E-7	1E-6	1E-6	18
Aldrin	9E-9	8E-8	8E-7	9E-7	11.4
Chlordane	1E-8	9E-8	9E-7	1E-6	13.3
Heptachlor	1E-8	1E-7	1E-6	1E-6	14.5
Methylene chloride	2E-7	1E-9	1E-8	2E-7	2.49
gamma-BHC	0.0	9E-8	8E-7	9E-7	12.2
Total by pathway	2E-7	7E-7	7E-6		
% Contribution by pathway	2.9	8.89	88.2		
Scenario Total				8E-6	

Table G-7

Cleanup Criteria Evaluation--Noncarcinogenic Risk, Occupational Exposure for Site 14

Chemical	Inhalation of Volatiles in Ambient Air	Ingestion of Soil	Dermal Contact with Soil	Total	% Contribution
Average					
4,4'-DDT	0.0	0.002	0.02	0.02	1.64
Aldrin	0.0	0.0004	0.004	0.005	0.3
Chlordane	0.0	0.003	0.003	0.04	2.66
Endosulfan II	0.0	0.0002	0.002	0.002	0.2
Heptachlor	0.0	0.0001	0.001	0.001	0.1
MCPP	0.0	0.05	0.5	0.6	40.6
Methylene chloride	0.7	8E-6	8E-5	0.7	54
gamma-BHC	0.0	0.0006	0.006	0.007	0.5
Total by pathway	0.7	0.06	0.6		
% Contribution by pathway	54.0	4.21	41.8		
Scenario Total				0.7*	
Reasonable Maximum					
4,4'-DDT	0.0	0.002	0.02	0.02	1.33
Aldrin	0.0	0.0004	0.004	0.005	0.3
Chlordane	0.0	0.003	0.03	0.04	2.16
Endosulfan II	0.0	0.0002	0.002	0.002	0.1
Heptachlor	0.0	0.0001	0.001	0.001	0.08
MCPP	0.0	0.05	0.5	0.6	33.0
Methylene chloride	1.0	8E-6	8E-5	1.0	62.7
gamma-BHC	0.0	0.0006	0.006	0.007	0.4
Total by pathway	1.0	0.06	0.6		
% Contribution by pathway	62.6	3.42	33.9		
Scenario Total				0.7*	

* Methylene Chloride was considered a laboratory contaminant, therefore the risk from methylene chloride has been subtracted from the total risk

Table G-8

Cleanup Criteria Evaluation--Toxicity Values and Output Results for Site 14

Carcinogenic Risk Eastimates							
Working at Site 14							
Inhalation Of Vapor: Particulate - Occ							
	Contaminant*	SFC	Evidence	Average EAC	Reas. Max. EAC	Average Risk	Reas. Max. Risk
Inhalation Of Vapor: Ambient air - Occ							
	Contaminant*	SFC	Evidence	Average EAC	Reas. Max. EAC	Average Risk	Reas. Max. Risk
	4,4'-DDT*	9.7E-5	B2	1.03E-4	1.48E-4	1E-8	1E-8
	Aldrin*	4.9E-3	B2	1.23E-6	1.76E-6	6E-9	9E-9
	Chlordane*	3.7E-4	B2	2.07E-5	2.95E-5	8E-9	1E-8
	Heptachlor*	1.3E-3	B2	6.12E-6	8.74E-6	8E-9	1E-8
	Methylene chloride*	4.7E-7	B2	2.62E-1	3.74E-1	1E-7	2E-7
Ingestion Of Soil: Soil							
	Contaminant	SF	Evidence	Average CDI	Reas. Max. CDI	Average Risk	Reas. Max. Risk
	4,4'-DDD	2.4E-1	B2	4.07E-7	4.07E-7	1E-7	1E-7
	4,4'-DDE	3.4E-1	B2	2.91E-7	2.91E-7	1E-7	1E-7
	4,4'-DDT	3.4E-1	B2	3.65E-7	3.65E-7	1E-7	1E-7
	Aldrin	17	B2	4.61E-9	4.61E-9	8E-8	8E-8
	Chlordane	1.3	B2	7.09E-8	7.09E-8	9E-8	9E-8
	Heptachlor	4.5	B2	2.22E-8	2.22E-8	1E-7	1E-7
	Methylene chloride	7.5E-3	B2	1.71E-7	1.71E-7	1E-9	1E-9
	gamma-BHC	1.3	B2/C	6.54E-8	6.54E-8	9E-8	9E-8
Dermal Contact WithSoil: Soil							
	Contaminant	SF	Evidence	Average CDI	Reas. Max. CDI	Average Risk	Reas. Max. Risk
	4,4'-DDD	2.4E-1	B2	4.04E-6	4.04E-6	1E-6	1E-6
	4,4'-DDE	3.4E-1	B2	2.89E-6	2.89E-6	1E-6	1E-6
	4,4'-DDT	3.4E-1	B2	3.62E-6	3.62E-6	1E-6	1E-6
	Aldrin	17	B2	4.58E-8	4.58E-8	8E-7	8E-7
	Chlordane	1.3	B2	7.03E-7	7.03E-7	9E-7	9E-7
	Heptachlor	4.5	B2	2.21E-7	2.21E-7	1E-6	1E-6
	Methylene chloride	7.5E-3	B2	1.69E-6	1.69E-6	1E-8	1E-8
	gamma-BHC	1.3	B2/C	6.49E-7	6.49E-7	8E-7	8E-7
Noncarcinogenic Risk Estimates							
Working at Site 14							
InhalationOfVapor: Particulate - Occ							
	Contaminant*	Chronic RfC	Average EAC	Reas. Max. EAC	Average Haz. Index	Reas. Max. Haz. Index	
Inhalation Of Vapor: Ambient Air - Occ							

Table G-8

(Continued)

	Contaminant*	Chronic RfC	Average EAC	Reas. Max. EAC	Average Haz. Index	Reas. Max. Haz. Index
	Methylene chloride*	1	7.34E-1	1.05	7E-1	1.
Ingestion Of Soil: Soil						
	Contaminant	Chronic RfD	Average Intake	Reas. Max. Intake	Average Haz. Index	Reas. Max. Haz. Index
	4,4'-DDT	5E-4	1.02E-6	1.02E-6	2E-3	2E-3
	Aldrin	3E-5	1.29E-8	1.29E-8	4E-4	4E-4
	Chlordane	6E-5	1.98E-7	1.98E-7	3E-3	3E-3
	Endosulfan II	5E-5	9.75E-9	9.75E-9	2E-4	2E-4
	Heptachlor	5E-4	6.22E-8	6.22E-8	1E-4	1E-4
	MCPP	1E-3	5.05E-5	5.05E-5	5E-2	5E-2
	Methylene chloride	6E-2	4.78E-7	4.78E-7	8E-6	8E-6
	gamma-BHC	3E-4	1.83E-7	1.83E-7	6E-4	6E-4
Dermal Contact With Soil: Soil						
	Contaminant	Chronic RfD	Average Intake	Reas. Max. Intake	Average Haz. Index	Reas. Max. Haz. Index
	4,4'-DDT	5E-4	1.01E-5	1.01E-5	2E-2	2E-2
	Aldrin	3E-5	1.28E-7	1.28E-7	4E-3	4E-3
	Chlordane	6E-5	1.97E-6	1.97E-6	3E-2	3E-2
	Endosulfan II	5E-5	9.67E-8	9.67E-8	2E-3	2E-3
	Heptachlor	5E-4	6.18E-7	6.18E-7	1E-3	1E-3
	MCPP	1E-3	5.01E-4	5.01E-4	5E-1	5E-1
	Methylene chloride	6E-2	4.74E-6	4.74E-6	8E-5	8E-5
	gamma-BHC	3E-4	1.82E-6	1.82E-6	6E-3	6E-3