DEPARTMENT OF THE AIR FORCE
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30 Jun 99

MEMORANDUM FOR MR. JAMES BEARZI, CHIEF
HAZARDOUS & RADIOACTIVE MATERIALS BUREAU
NEW MEXICO ENVIRONMENT DEPARTMENT
PO BOX 26110
SANTA FE NM 87502

FROM: 377 ABW/EMR
2050 Wyoming Blvd SE, Rm 124
Kirtland AFB NM 87117-5270

SUBJECT: RCRA Corrective Action Document Submittal

1. We are forwarding a copy of our final CMS Work Plan for SWMUs 6-1, Landfill No. 1 (LF-01); 6-4, Landfill No. 4, 5, and 6 (LF-08); and SWMU 6-22, Lake Christian (OT-46); and a copy of the Sludge/Surface Soil Sampling and Analysis Plan for the Sewage Lagoons (WP-26). Included with each plan is a copy in Word Perfect 5.2 on 3 ½" disc. Copies of these plans areis report are also being submitted to Mr. David Cobrain of your staff and Ms. Julie Jacobs of the Groundwater Protection Bureau.

2 Please call Mr. Jerry Sillerud at (505) 846-9004, Mr. Mark Holmes at (505) 846-9005, or me at (505) 846-0053, if you have any questions regarding this report.

CHRISTOPHER B. DEWITT, R.P.G.
Chief, Restoration Branch
Environmental Management Division

Attachment:
CMS Work Plan

cc:
NMED-HRMB (Mr. Cobrain)
NMED-GWPB (Ms. Jacobs)
EPA Region 6 (Ms. Morlock)
HQ AFMC/CEVR (Mr. Wray) w/o attachment
USACE Omaha (Mr. Rowe) w/o attachment
FWE (Mr. Foley) w/o attachment

KAFB2045

TVI

KIRTLAND AIR FORCE BASE
ALBUQUERQUE, NEW MEXICO

SLUDGE/SURFACE SOIL SAMPLING AND ANALYSIS PLAN FOR SEWAGE LAGOONS WP-26

Final – June 1999

377 ABW/EMR
2050 Wyoming Blvd. SE
Kirtland AFB, New Mexico 87117-5720

COMMENT/RESOLUTION FORM

DOCUMENT TITLE: Draft Sludge/Surface Soil Sampling and Analysis Plan for Sewage Lagoons (WP-26), April 99

ITEM NO.	PAGE NO.	REVIEWER'S COMMENT	COMMENT RESOLUTION: INCORPORATED-YES OR REASON WHY NOT INCORPORATED.
		REVIEWER: ***Mr. M. Holmes***	
General Comments			
1		The media to be sampled should be revised in the text and project title to "Sludge/Surface Soil." The sampling is primarily to address the sludge that remains above the surface soil; the subjacent surface soil will also be sampled in conjunction with the sludge.	Yes. Change made throughout the document.
2		The sampling should include a background sample from outside of the lagoon area.	Yes, A background location was added to Figure 1-1 and added to text.
Specific Comments			
1	2	Figure 1-1: Fill in the outline of the sewage lagoons for easier identification.	Yes.
2	5	Para 2, Sent 4: Change "Gray water" to "Liquid effluent" and "effluent line" to "gravity-fed pipeline"	Yes.
3	6	Pg 6, Phase II, Stage 2 RFI Section: Analytes were detected that exceeded the action levels and should be discussed: cadmium in the dry sludge (soil standards) and chromium (dissolved and total recoverable) in the groundwater.	Yes, discussion added.
4	6	LTM Section: Analytical results for the wells sampled during the LTM should be stated.	Yes, text added.
5	6	LTM Section, Sent 2: Change "the wells" to " all four wells".	Yes.

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ITEM NO.	PAGE NO.	REVIEWER'S COMMENT	COMMENT RESOLUTION: INCORPORATED-YES OR REASON WHY NOT INCORPORATED.
6	7	Line 1: Delete " and three of the four wells were abandoned during FY98." None of the wells have been abandoned to date.	Yes.
7	7	Para 2: This paragraph should be separated from the LTM as a separate summary of the investigations. Include the Stage 2 detections in the summary.	Yes, paragraph was determined to be redundant and was deleted.
8	7	Section 2.1.3: Delete the last sentence. Add a brief discussion of the two current post-closure activities that are proactive projects to determine if the lagoons are the source for contamination discovered at this site and to continue monitoring the groundwater: Project 1) Two deep soil borings, one in each lagoon, sampled from the surface to the regional aquifer and installations of a perched and regional monitor well that will be sampled as part of the LTM, and Project 2) This project.	Yes, discussion added.
9	8	Section 2.2: How many sludge/surface soil samples will be collected? The text in Section 2.2.2 states 10 sample locations, Figure 2-1 indicates 8 sample points, and Table 2-1 lists 9 field samples.	Yes, corrections made.
10	8	Section 2.2.2: Bullet 4: Explain "homogenized".	Yes, Homogenization Procedure was added.
11	10	Bullet at top of page: Nitrates should be added to the list of analytes if they will be a consideration for closure-in-place, disposal or risk assessment.	Yes, change made.
12	A-5	Section 4: Are all of the PQL's less than the respective standards?	Yes, with the exception of 7 semivolatile compounds. RBCs have been added to tables in QAPP.
13	A-18	Field Duplicate Samples Section: The text of the paragraph does not appear to be related to the title of the section.	The header was deleted.

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DOCUMENT TITLE: Draft Sludge/Surface Soil Sampling and Analysis Plan for Sewage Lagoons (WP-26), April 99

ITEM NO.	PAGE NO.	REVIEWER'S COMMENT	COMMENT RESOLUTION: INCORPORATED-YES OR REASON WHY NOT INCORPORATED.
		REVIEWER: ***Ms. Kim Mulhern***	
General Comments			
1		The SAP is well-organized and well-written	Thank you.
Specific Comments			
1	2.1/4	Is the appropriate size of the pipe "15-inch"? Is that the diameter? Please clarify.	Yes, text corrected.
2	2.1/5	The last paragraph leaves the impression that the Golf Course Main Pond is also being investigated. Please revise/rewrite to clarify that only the lagoons are being investigated.	Yes, text revised.
3	2.11/5	If the lagoons are not on the RCRA permit, how are they regulated? What are/would be the ARARs?	The Sewage Lagoons are included in the Environmental Restoration Program at Kirtland AFB. Restoration activities are conducted under the regulatory authority of EPA Region 6, which is administered by the New Mexico Environment Department Hazardous and Radioactive Materials Bureau.
4	2.1.2/7	Other reports mention that Mn and Se are naturally-elevated at KAFB. Suggest addition of sentence regarding naturally-occurring levels of these 2 metals.	Yes, text added.

COMMENT/RESOLUTION FORM

DOCUMENT TITLE: Draft Sludge/Surface Soil Sampling and Analysis Plan for Sewage Lagoons (WP-26), April 99

ITEM NO.	PAGE NO.	REVIEWER'S COMMENT	COMMENT RESOLUTION: INCORPORATED-YES OR REASON WHY NOT INCORPORATED.
5	2.2.2/8	Although surface soil samples are normally collected from 0 to 0.5 feet, it may be more appropriate to collect samples for VOCs from 0.5 to 1.0 feet. There is an improved chance of detected VOCs which will be less likely to have evaporated/volatilized from deeper sludge. Also, because one of the objectives of this investigation is to "provide information for assessing additional characterization requirements", it is important to collecte VOCs from a depth at which they are more likely to still be present. The chlorinated solvents would possibly have migrated to deeper soils below the sludge. Correct spelling of "homoginized" to "homogenized".	No. Previous samples collected within the Sewage Lagoons in the 1–2 foot interval had no VOC hits above action levels. The focus of this investigation is the sludge and immediate subjacent soils. Yes.
6	2.2.2/10	Are the jars for TCLP analyses being collected at the same time and held for analyses, if necessary? Is there any IDW being generated?	Yes, an additional sample container will be collected at the same time for TCLP metals analysis, and held at the lab. Yes, Section 5 discusses IDW.
7	4/11	How does the lack of survey coordinates affect the ERPIMS database? Although not highly accurate, perhaps "approximate sample locations" could be identified using a handheld GPS unit. They can be accurate to within 20 to 25 feet.	Yes, procedure for locating sample is described with more detail in the text.
8	5.2/13	Since all soil cuttings are going back in the hole and decon water is being permitted to evaporate, this section appears to be unnecessary/confusing. What will IDW consist of other than PPE? Please clarify.	Yes, although hazardous IDW is not anticipated. The section will remain as a contingency with modifications to the text.
9	A-17	Should TCLP Methods also be included, or is this even necessary since cuttings are being returned to the hole.	Yes, have been included.

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ITEM NO.	PAGE NO.	REVIEWER'S COMMENT	COMMENT RESOLUTION: INCORPORATED-YES OR REASON WHY NOT INCORPORATED.
		REVIEWER: ***Ms. Mary Johansen***	
1		Section 2.2.2. there have been a number of investigations at this site. We seem to be having difficulty locating the contamination - generally due to the groundwater fluctuations. However, surveying the sampling locations will allow us to return to that exact spot if we locate a potential source. Will measuring the locations from existing points be sufficient to relocate the sampling locations?	Yes, procedure for locating sample points is described with more detail in the text.
2		Section 2.2.2 Add the rationale for the sampling depth. Was the 0-6 inches selected because that is the depth of the sludge? Was it selected for Risk Assessment purposes? If so reference the state's or EPA's guidance.	No. The primary objective of the sampling event is to determine if contamination is present in the dry sludge/sand immediate subjacent soils. No risk assessment is anticipated, however DQOs will be sufficient to support a risk assessment if necessary.
3		Section 5.3 Decon fluids, we are looking for volatiles and Chromium. State concurrence for a release of VOCs from the decon fluid to the air would be appropriate.	No. No VOCs are anticipated in the 0"–6" interval.
4		References: Tyndall AFB?	Text has been corrected.
5		Appendix A. Section 4. Data Quality Objectives. Please clarify the objectives of this work effort. We have already done on a Risk Assessment at this site. The State did not concur. Why are we doing another risk assessment?	No. A risk assessment is not planned for this site, however, the DQOs will satisfy a Risk Assessment if required in the near future.

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DOCUMENT TITLE: Draft Sludge/Surface Soil Sampling and Analysis Plan for Sewage Lagoons (WP-26), April 99

ITEM NO.	PAGE NO.	REVIEWER'S COMMENT	COMMENT RESOLUTION: INCORPORATED-YES OR REASON WHY NOT INCORPORATED.
6		Table 4 or in the WP add the regulatory criteria. We need to know what we are screening the data against in order to be sure the detection limits are low enough. Expand the DQO to include regulatory screening criteria. Table 4-4, for metals, are we using background?	Regulatory screening criteria have been added to Tables 4-1 through 4-4 in QAPP; and to Section 4.1. Region 6 RBCs are the screening criteria for all parameters.
7		Table 4-8. 40 CFR 261. The TCLP data will be used for disposal only if the results from normal sampling show contaminants above 20 x the TCLP criteria. Columns 3 and 4 of this table will not be used for any screening criteria. Delete these columns.	Columns have been deleted.

KIRTLAND AIR FORCE BASE
ALBUQUERQUE, NEW MEXICO

SLUDGE/SURFACE SOIL SAMPLING AND ANALYSIS PLAN FOR SEWAGE LAGOONS WP-26

JUNE 1999

Prepared For

U.S. CORPS OF ENGINEERS
OMAHA DISTRICT
OMAHA, NEBRASKA

TERC CONTRACT NO. DACW45-94-D-0003
DELIVERY ORDER 23, WORK AUTHORIZATION DIRECTIVE 1

Prepared By

FOSTER WHEELER ENVIRONMENTAL CORPORATION
6605 UPTOWN BOULEVARD N.E. #220
ALBUQUERQUE, NEW MEXICO 87110

NOTICE

This Plan has been prepared for the U.S. Army Corps of Engineers by Foster Wheeler Environmental Corporation for the purpose of aiding in the implementation of a final remedial action plan under the Air Force Installation Restoration Program (IRP). As the report relates to actual or possible releases of potentially hazardous substances, its release prior to an Air Force final decision on remedial action may be in the public's interest. The limited objectives of this report and the ongoing nature of the IRP, along with the evolving knowledge of site conditions and chemical effects on the environment and health, must be considered when evaluating this report, as subsequent facts may become known that may make this report premature or inaccurate.

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Nongovernment agencies may purchase copies of this document from National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, Virginia 22161.

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1. AGENCY USE ONLY	2. REPORT DATE June 1999	3. REPORT TYPE AND DATES COVERED Sludge/Surface Soil Sampling and Analysis Plan for Sewage Lagoons WP-26

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6. AUTHOR Mr. Eric Tow	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Foster Wheeler Environmental Corporation 6605 Uptown Boulevard N.E. Suite 220 Albuquerque, New Mexico 87110	8 PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) USACE Omaha District 215 North 17th Street Omaha, Nebraska 68102-4978 Project Manager: Mr. Steven M. Rowe	10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT	12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

This Sampling and Analysis Plan presents the site-specific strategies to complete the field and laboratory activities for characterizing sludge/surface soils at WP-26, Sewage Lagoons, at Kirtland Air Force Base. The objectives of the investigation are to determine if chemical contamination is present in site sludge and subjacent surface soils, provide information for assessing additional characterization requirements and support sludge/surface soil disposal options, and provide information for additional postclosure activities.

14. SUBJECT TERMS Sludge/Surface Soil Sampling and Analysis Plan for Sewage Lagoons WP-26	15. NUMBER OF PAGES Approx. 50
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	ICM CR

NSN 7540-01-280-5500

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Prescribed by ANSI Std 239-18 298-102

CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

JAMES S. LEATHERWOOD, GS-14
Director
Environmental Management Division

This document has been approved for public release.

ROBERT S. MULLIGAN
Environmental Public Affairs Specialist

CERTIFICATION

This document has been approved for public release.

ROBERT S. MILLIGAN
Environmental Public Affairs Officer

PREFACE

This Sampling and Analysis Plan (SAP) is an addendum to the Kirtland Air Force Base (AFB) Base-Wide Plans for the Installation Restoration Program (IRP). The SAP outlines the strategies to conduct the field investigation for characterizing sludge and subjacent surface soils at WP-26, Sewage Lagoons, Kirtland AFB, New Mexico, under the IRP.

The objectives of this investigation are to: (1) determine if chemical contamination is present in site sludge/surface soils, (2) provide information for assessing additional characterization requirements, (3) provide information to support onsite or offsite sludge/surface soil disposal options, and (4) provide information for additional postclosure activities.

This work will be performed under the authority of the U.S. Army Corps of Engineers (USACE), Total Environmental Restoration Contract No. DACW45-94-D-0003, Subcontract No. DENS-94-1159-JM(MOA). All work will be conducted between April 1999 and September 1999. Mr. Steven M. Rowe (USACE) is the Project Manager for this program.

The Remedial Program Manager is Mr. Chris DeWitt of Kirtland AFB, Environmental Management Division. Mr. William J. Foley of Foster Wheeler Environmental Corporation (Foster Wheeler) is the Delivery Order Manager, and Mr. Eric D. Tow of Foster Wheeler is the Task Manager. This SAP was prepared by Mr. Tow and reviewed by Mr. Foley.

Eric D. Tow
Foster Wheeler
Task Manager

William J. Foley
Foster Wheeler
Delivery Order Manager

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ACRONYMS

AFB	Air Force Base
bgs	below ground surface
BWP	Base-Wide Plans
DCQAP	Data Collection Quality Assurance Plan
DMP	Data Management Plan
EPA	United States Environmental Protection agency
ERPIMS	Environmental Resources Program Information Management System
FSP	Field Sampling Plan
ft	feet/foot
IDW	investigation derived waste
IDWMP	IDW Management Plan
IRP	Installation Restoration Program
LTM	long-term monitoring
MAP	Management Action Plan
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
NFA	no further action
NMED	New Mexico Environment Department
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
SAP	Sampling and Analysis Plan
SNL	Sandia National Laboratories
SOP	standard operating procedure
SSHP	Site Safety and Health Plan
SVOC	semivolatile organic compound
TCA	trichloroethane
TCLP	Toxicity Characteristic Leaching Procedure

ACRONYMS (Concluded)

USACE	U.S. Army Corps of Engineers
USAF	United States Air Force
VOC	volatile organic compound

1. INTRODUCTION

This Sampling and Analysis Plan (SAP) outlines the site-specific strategies to complete the field and laboratory activities for characterizing sludge/surface soils at WP-26, Sewage Lagoons, at Kirtland Air Force Base (AFB). This SAP, which is an addendum to the Kirtland AFB Base-Wide Plans (BWP) for the Installation Restoration Program (IRP) (USAF, 1996), implements the Resource Conservation and Recovery Act (RCRA) Solid Waste Management Unit Assessment Report requirements and describes the site-specific sampling to be conducted at the Sewage Lagoons under the IRP. The Kirtland AFB Environmental Restoration Program is conducted under the regulatory authority of the New Mexico Environmental Department (NMED) and the United States Environmental Protection Agency (EPA) Region 6.

The objectives of this investigation are to: (1) determine if chemical contamination is present in site sludge and subjacent surface soils, (2) provide information for assessing additional characterization requirements, (3) provide information to support onsite or offsite sludge/surface soil disposal options, and (4) provide information for additional postclosure activities. Figure 1-1 depicts Kirtland AFB and the Sewage Lagoons where sampling will be conducted. A detailed site description and descriptions of planned sampling activities are presented in Section 2 of this SAP.

1.1 Background

Kirtland AFB is implementing this SAP as part of postclosure activities under the IRP. Environmental restoration activities have been conducted at IRP sites since 1981. In 1981, a Phase I Records Search was performed as part of the base RCRA Facility Assessment (RFA) (USAF, 1981). Additional RFA activities occurred in 1985 (Phase II—Confirmation/Quantification Stage 1 [USAF, 1985]); 1988 (Preliminary Review/Visual Site Inspection [USAF, 1988]); and 1990 (Stage 2 Interim Technical Information Report [USAF, 1990]). Additional details regarding the IRP, the Kirtland AFB RCRA Part B permit, and environmental compliance activities are documented in the Kirtland AFB Management Action Plan (MAP) (USAF, 1997) and the Kirtland AFB BWP (USAF, 1996).

1.2 Relationship With Base-Wide Planning Initiative

In May 1996, Kirtland AFB issued the Final BWP for the IRP. The BWP are structured to satisfy the EPA permit requirements and include:

- Volume I—Project Management Plan
- Volume II—Data Collection Quality Assurance Plan (DCQAP)
  - Part I—Field Sampling Plan (FSP)
  - Part II—Quality Assurance Project Plan (QAPP)
- Volume III—Data Management Plan (DMP)
- Volume IV—Site Safety and Health Plan (SSHP)
- Volume V—Investigation Derived Waste Management Plan (IDWMP)
- Volume VI—Community Relations Plan

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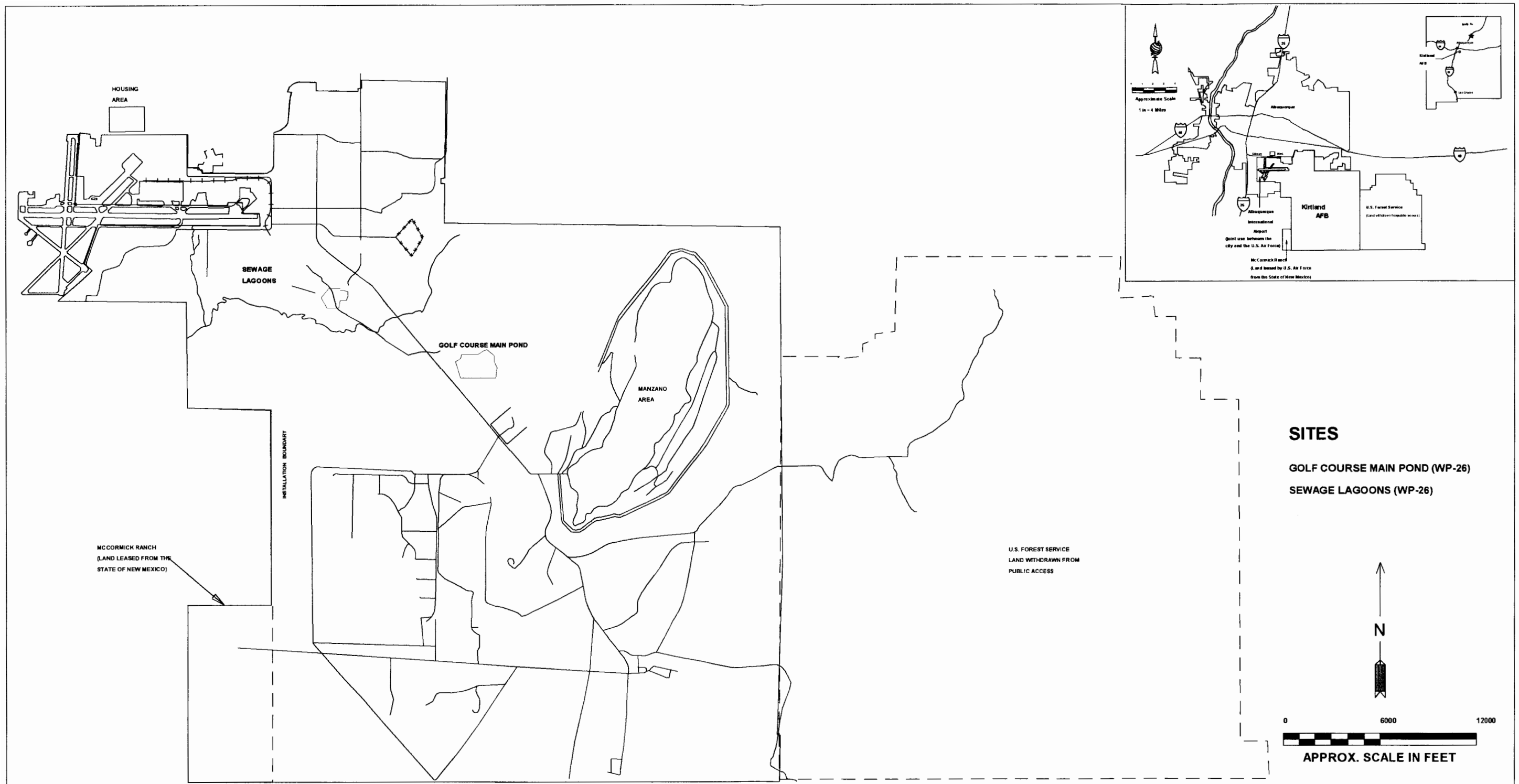

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SITE LOCATION MAP

KIRTLAND AIR FORCE BASE

Sewage Lagoons (WP-26) Soil Sampling Points

FIGURE 1-1

These plans provide general guidance for performing site characterization activities. They address requirements, guidelines, and standard operating procedures (SOPs) for discrete work elements that may occur at the base. Where specific information is not provided in the plans for a particular activity, addenda are issued and/or the BWP are revised.

This SAP represents a site-specific addendum to the Base-Wide FSP, and, in general, refers the reader to specific sections or SOPs within the Base-Wide FSP. Although this site-specific SAP is intended to be used in tandem with the BWP, the material contained within this plan supersedes information presented within the BWP. Thus, if an SOP has been amended for site-specific reasons, the information contained within this SAP will be adhered to when activities are implemented in the field. Amendments to SOPs and other basewide requirements are clearly defined within this SAP.

1.3 Overview of Sampling and Analysis Plan

This SAP is structured to address all major issues that relate to conducting proposed sampling activities at the Sewage Lagoons sites. The majority of the sections within the plan are site-specific addenda to the Base-Wide FSP. For ease of understanding, cross-referencing is used throughout the document to direct the reader to the appropriate section that addresses related requirements to a particular activity or aspect of work.

The SAP is organized into the following sections:

- Section 1 presents an overview of the work plan, background information on previous work, and the goal of sampling activities.
- Section 2 represents the project-specific FSP and includes the site history, description, and regulatory background. The general approach to implementing field investigation activities is discussed.
- Section 3 addresses project-specific quality assurance (QA) and quality control (QC) procedures and requirements for the sampling activities. The combined information presented in Sections 2 and 3, and the referenced material in the BWP, satisfy requirements for a DCQAP, as defined by EPA.
- Section 4 is the project-specific DMP. This section identifies the various data types that will be generated from planned activities and the means by which the data will be controlled from generation through ultimate use.
- Section 5 represents the project-specific IDWMP. The general guidelines and requirements included in the BWP are referenced; media- and site-specific issues are presented with emphasis placed upon waste minimization, segregation, timely characterization, and accurate documentation.
- Section 6 outlines health and safety issues relevant to this plan.

2. SITE HISTORY DESCRIPTION AND FIELD SAMPLING PLAN

2.1 Site History and Description

The Sewage Lagoons, consisting of two lagoons, are located in the northwestern region of the base and are connected to the Golf Course Main Pond by a 15-inch-diameter, gravity-fed pipe. Positioned in Hydrogeologic Region 1, this site is unaffected by the complex fault system of the Kirtland AFB area. Characterized by the simple geology of Region 1, this area consists primarily of a thick sequence of the

Phase II, Stage 2A RFI (1993)

In 1993, a Phase II, Stage 2A RFI was conducted at the Sewage Lagoons (USAF, 1993b). Four groundwater monitoring wells were each sampled four times; no metals were detected above RCRA risk-based or other action levels or upper tolerance limit values. Nitrate plus nitrite was detected above the action level in one sample; however, subsequent sampling revealed no further detections. All volatile organic compound (VOC) detections were below action levels. One semivolatile organic compound (SVOC) (bis [2-ethylhexyl]phthalate) was detected above action levels, but was considered the result of laboratory contamination.

According to risk assessment results (GCL, 1991), the only excessive concentrations of hazardous substances were in the dry sludge; however, no concentrations were above regulatory levels. Nitrate was the only constituent in the groundwater and sludge considered harmful. The chromium concentration detected in the groundwater sample from one well was believed to be the result of contamination from the drilling process. Although TCA was initially believed to be present in high concentrations, subsequent additional sampling by Sandia National Laboratories (SNL) and Kirtland AFB has not confirmed TCA contamination in the Sewage Lagoons. (It should noted that the lagoon water in which TCA was originally found had evaporated before 1991.)

Long-Term Monitoring Program (1996–1998)

Monitoring of two Sewage Lagoons wells was initiated in late 1996. The wells were analyzed for VOCs and nitrate as nitrogen only. Given the limited or nonexistent saturated screen interval in all four wells, Kirtland AFB discontinued monitoring after the fourth LTM event in March of 1997. No analytes were detected above New Mexico Solid Waste Management Regulations standards during the two sampling events. A new monitoring well (KAFB-0506) was installed during Fiscal Year 1998 in a perched aquifer and sampled as part of the LTM Program during the December 1998 sampling event. Concentrations of the following analytes were detected above their respective New Mexico Solid Waste Management Regulations standards at well KAFB-0506: trichloroethene at 7.3 micrograms per liter (µg/L) exceeded the standard of 5 µg/L, manganese at 103 µg/L exceeded the standard of 50 µg/L, and selenium at 20.9 µg/L exceeded the standard of 10 µg/L. Manganese and selenium both occur at naturally elevated concentrations in groundwater in the vicinity of Kirtland AFB (IT Corporation, 1996).

2.1.3 Remedial Action Summary

No remedial actions have occurred to date at this site. The 1991 risk assessment presented a closure plan recommending no further action (NFA) for the Sewage Lagoons and Golf Course Main Pond (GCL, 1991). Based on chromium levels detected in the groundwater, NMED denied closure and required postclosure monitoring of sludge and groundwater. Kirtland AFB has complied with Postclosure Plan requirements and is currently awaiting NMED's determination regarding closure requirements before submitting a new closure request. The previously installed monitoring wells can no longer be sampled due to a drop in the groundwater elevation below the screened interval.

Two current postclosure activities have been initiated as proactive projects to determine if the Sewage Lagoons are the source for contamination discovered at this site and whether to continue monitoring the groundwater. The first project consisted of advancing two deep soil borings, one in each lagoon, sampling from the surface to the regional aquifer, and installing a perched and regional well that will be sampled as

part of the LTM Program. The second project is the sampling, analyses, and reporting associated with this SAP.

2.2 Overview of Field Sampling Plan Addendum

This section represents the site-specific addendum to the Kirtland AFB Base-Wide FSP to implement sampling and analysis activities at the Sewage Lagoons. The general approach to the field investigation, sample collection activities, and other investigation activities planned for the Sewage Lagoons are specified and presented herein. This site-specific addendum is intended to serve as the guide for organizing and conducting the field investigation and collecting the required data at the site. The sampling and analysis requirements will drive the investigative activities under this FSP.

2.2.1 Sludge/Surface Soil Investigation Report Objectives

The objectives of this investigation are to: (1) determine if chemical contamination is present in site sludge and subjacent surface soils at concentrations that exceed EPA Region 6 Human Health Media-Specific Screening Levels (EPA, 1999) for residential soil, (2) provide information for assessing additional characterization requirements, (3) provide information to support onsite or offsite sludge/surface soil disposal options, and (4) provide information for additional postclosure activities.

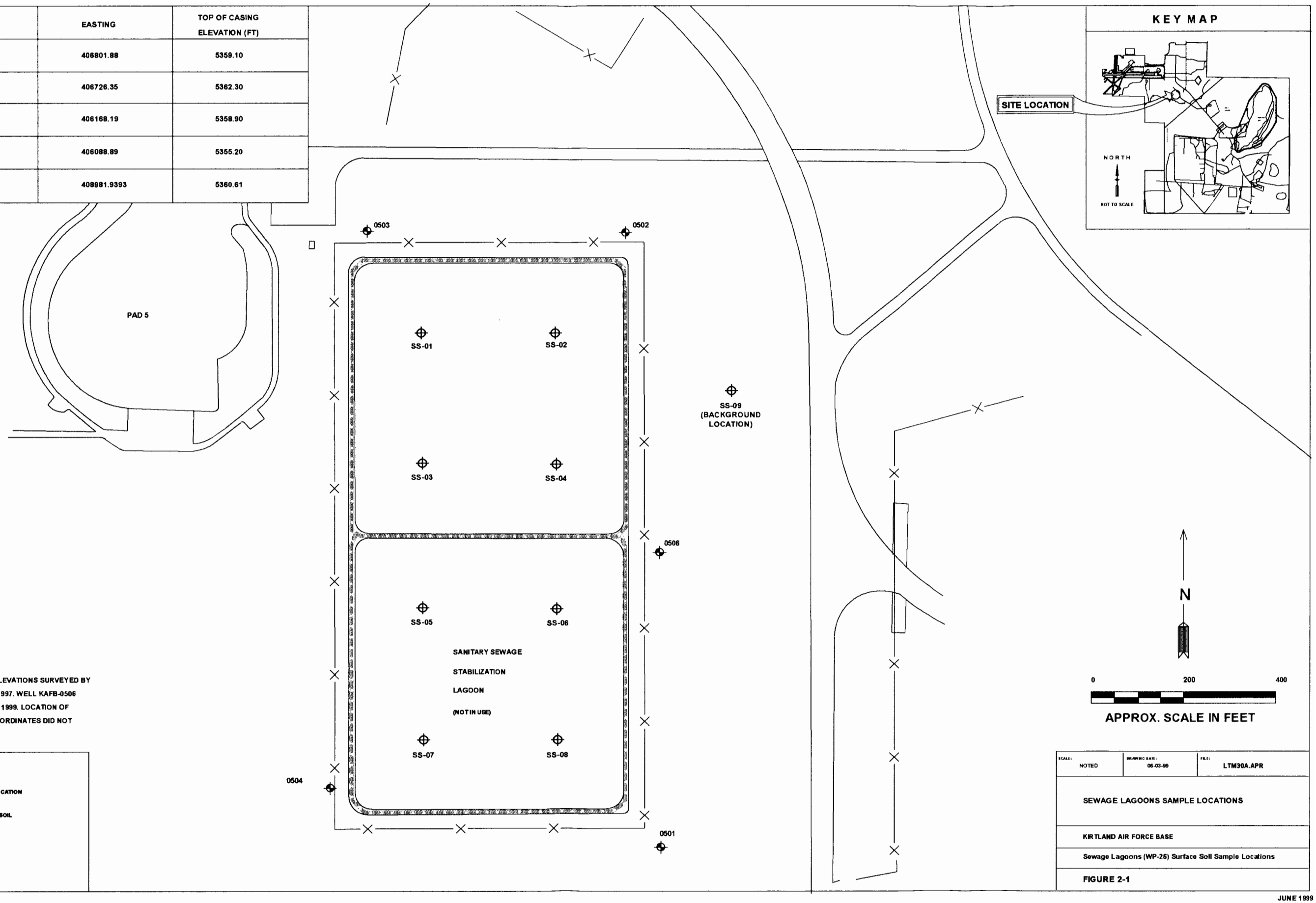
2.2.2 General Approach to Sampling

The following requirements will be applied to the sludge/surface soil sampling investigation at the Sewage Lagoons. Figure 2-1 presents the sampling locations.

- Borehole locations and site boundaries will not be surveyed. Distances will be measured from previously surveyed site features to sample locations. The measurements will be input to the site drawing files and a geo-referenced location will be established in the Environmental Resources Program Information Management System (ERPIMS) database.
- Sample collection will be completed to a depth of 6 inches below grade at nine sample locations by using a 3-inch-diameter stainless steel hand auger. Eight locations are located within the Sewage Lagoons; one sample location will be located outside of the Sewage Lagoons and will serve as a background location.
- Samples designated for volatile organic analyses will be collected using the EnCore™ Sampler device to minimize loss of VOCs. A 4-ounce glass container sample will also be collected in case of high-level volatile organics and for moisture determination. Soil samples for SVOCs, metals, nitrate, and Toxicity Characteristic Leaching Procedure (TCLP) metals analysis will be collected in 8-ounce glass containers. EnCore™ Samplers and sample containers will be immediately placed on ice after collection.
- Samples for all analyses except VOCs will be homogenized prior to placement into containers. Homogenization of soil samples will be conducted as follows:

  Rocks, twigs, leaves and other debris will first be removed, as they are not considered part of the sample. Sludge/soil will be removed from the sampling device and placed in a stainless steel pan, then thoroughly mixed using a stainless steel spoon. The sludge/soil in the pan will be scraped from the sides, corners, and bottom of the pan, rolled into the middle of the pan, and initially mixed. The

LOCATION	NORTHING	EASTING	TOP OF CASING ELEVATION (FT)
WELL 0501	1468366.34	406801.88	5359.10
WELL 0502	1469685.17	406726.35	5362.30
WELL 0503	1469688.31	406168.19	5358.90
WELL 0504	1468493.37	406088.89	5355.20
WELL 0506	1467242.0152	408981.9393	5360.61



NOTES:

1. MONITORING WELL LOCATIONS AND ELEVATIONS SURVEYED BY HALL ENGINEERING CO., INC., JANUARY 1997. WELL KAFB-0506 SURVEYED BY SURV-TEK, INC., JANUARY 1999. LOCATION OF 0506 IS APPROXIMATE SINCE SURVEY COORDINATES DID NOT PLOT CORRECTLY.

LEGEND

MONITORING WELL LOCATION

PROPOSED SURFACE SOIL SAMPLE LOCATION

FENCE

ROAD

SCALE:	DRAWING DATE:	FILE:
NOTED	06-03-99	LTM30A.APR

SEWAGE LAGOONS SAMPLE LOCATIONS

KIRTLAND AIR FORCE BASE

Sewage Lagoons (WP-26) Surface Soil Sample Locations

FIGURE 2-1

samples will then be quartered and moved to the four corners of the pan. Each quarter of the pan will be mixed individually, then rolled to the center of the container, and the entire sample mixed again.

- Unless otherwise noted, soil samples will be analyzed for the following:
  - Target Analyte List Metals (EPA Methods 6010B, 7471A)
  - VOCs (EPA Method 5035/8260B)
  - SVOCs (EPA Method 8270C)
  - Nitrate as nitrogen—(EPA Method 300.0)
  - TCLP (EPA Methods 1311/6010B/7470A) (samples where initial analytical results for metals exceed RCRA standards when the 20 times rule is applied)

All investigation derived waste (IDW) will be managed in accordance with the Base-Wide IDWMP and provisions set forth in Section 5 of this plan.

2.2.3 Field Investigation Activities

The specific SOPs to be followed during field activities are presented in the BWP; Volume II, DCQAP, Part I, FSP (USAF, 1996).

In addition, sampling equipment will be decontaminated in accordance with SOP A2.1, Equipment Decontamination, with the following amendments:

- A detergent solution consisting Liquinox™ (or equivalent, nonphosphate, laboratory-grade detergent) mixed in potable water will be used when a detergent is required by SOP A2.1c.
- Decontamination of sampling equipment will be kept to a minimum in the field and, whenever possible, dedicated sampling equipment will be used. Mobile or temporary decontamination stations will be constructed, as appropriate, to adequately capture and contain decontamination fluids. Decontamination fluids will be disposed as required by the IDWMP.

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2.2.4 Summary of Chemical Data Collection Activities

Table 2-1 specifies the analytical parameters for the samples to be collected during the investigative activities at the Sewage Lagoons.

Table 2-1. Sludge/Surface Soil Sample Analytical Parameters—Sewage Lagoons

Parameter	Field Samples	Duplicates/ CMQAL Splits (each)	Equipment Blanks	Total Samples
SVOCs	9	1	1	11
TAL Metals	9	1	1	11
Nitrate as N	9	1	1	11
VOCs	9	1	1	11
TCLP Metals*	TBD	0	0	TBD

FOOTNOTES

*	TCLP analyses will be performed only on samples in which metals results exceed RCRA standards when the 20 times rule is applied.
CMQAL	Chemical Materials Quality Assurance Laboratory-Waterways Experimentation Station
N	nitrogen
SVOC	semivolatile organic compound
TAL	Target Analyte List
TBD	to be determined
VOC	volatile organic compound

3. QUALITY ASSURANCE/QUALITY CONTROL

The Base-Wide QAPP focuses on QA issues and procedures for all investigation activities. Also included are descriptions of, or references to, all data quality objectives and procedures specific to the performance of this field investigation. Appendix A presents the site-specific QAPP for the Sewage Lagoons sludge/surface soil sampling investigation. Sections 2, 4, 5, 8, 9, and 10 of the Base-Wide QAPP were affected, and as a result, the specific content found in Appendix A supersedes the Base-Wide QAPP but does not replace other information found within these sections.

4. DATA MANAGEMENT

This section describes the policies, objectives, concepts, systems, and procedures to be used for the management of all data generated or gathered during these activities. Sources of data will include:

- Field measurement data
- Analytical data
- Existing and/or historic project data

Established ERPIMS formats and guidelines will be followed for the formatting, submittal, and validation of all analytical data generated from this project. For this project, Section 4, Data Management System, of

the Base-Wide DMP has been amended, modified, or further clarified. Guidance in this section supersedes the Base-Wide DMP but does not replace other information found within the sections. The remaining sections of the Base-Wide DMP required no modification; therefore, they are not discussed herein.

Data will be generated from two sources during this field investigation. The ERPIMS data formats will be strictly followed for all analytical data generated from this project. The two sources are (1) analytical data from sludge/surface soils and (2) field measurements with sample locations.

Other types of data, including location definition, site location, lithologic parameters, and other environmental sampling information, will also be incorporated into the ERPIMS system. Data generated by each source will be recorded and tracked in either spreadsheets or a project-specific database. The project-specific database will also track analytical samples sent to the laboratory to ensure timely submittal of results.

The aggregate ERPIMS chemical data will be submitted, along with a database file containing all samples and any data validation qualifier codes, when the first draft of the project report is delivered.

5. INVESTIGATION DERIVED WASTE MANAGEMENT

5.1 Introduction

During investigation activities, a variety of waste types will be generated. These wastes will be managed in accordance with regulatory requirements and the Base-Wide IDWMP (USAF, 1996). This section provides site-specific guidance for applying procedures and requirements contained within the Base-Wide IDWMP for containerizing, handling, storing, characterizing, and disposing of IDW generated during field sampling activities. The Base-Wide IDWMP will be used in conjunction with information provided herein for all IDW issues. If either the Base-Wide IDWMP or this site-specific addendum does not provide enough guidance for a particular IDW management issue, a representative from the field investigation team is to contact the Restoration Project Manager for guidance.

5.2 Characterization of Hazardous Investigation Derived Waste

The IDW generated will be composed largely of personnel protective equipment (nitrile gloves) and/or water. Other types of wastes may be generated on a limited basis. The IDW is not expected to be listed waste or to exhibit characteristics of a RCRA hazardous waste. On the basis of field observations and site characterization data, limited analysis for ignitability, corrosivity, or reactivity characteristics may be performed to ensure proper handling, storage, and disposal of the wastes. According to EPA, the determination of whether IDW is hazardous or not should be assessed using best professional judgment, along with readily available information about the site (manifests, storage records, results of previous investigations, and chemical analytical data). The EPA has specifically stated that it may be assumed IDW does not contain listed wastes under RCRA unless available information about the site suggests otherwise (53 Federal Register 51444, December 21, 1988).

5.3 Management and Characterization of Investigation Derived Waste

The Base-Wide IDWMP discusses the procedures to be followed for management and characterization of IDW. The following are general procedures to be followed when handling soil from investigation activities:

- Unused sample materials. Small amounts of unused sample materials will be returned to the sample location.
- Gross decontamination residues. Gross decontamination soil residues are not anticipated to be generated during the sampling activities. However, in the event soil residues are generated, they will be removed from vehicles during gross decontamination and left onsite. If residues are attributable to downhole activities, they will be returned to the hole.
- Decontamination fluids. It is anticipated that minimal fluid will be generated onsite, and an evaporation pad constructed using polyethylene sheeting will be used to evaporate any IDW fluid. The sheeting will be disposed of in the Kirtland AFB Landfill.

5.4 Waste Disposal

In the unlikely event hazardous IDW is generated during sampling activities, containers of hazardous IDW will be properly labeled and removed from the base within 90 days of generation. Drums will either be transported directly from the project staging area by a licensed hauler to a permitted offsite disposal facility or moved to the permitted storage facility at Kirtland AFB until offsite transport and disposal are arranged. In no case will the 90-day holding time be exceeded.

Offsite disposal facilities will be selected on the basis of the waste characterization and in accordance with the land disposal restrictions (Title 40 of the Code of Federal Regulations Part 268). Section 5 of the Base-Wide IDWMP provides guidance requirements for the disposal of hazardous waste. Hazardous waste disposal is not included in the current scope of work.

5.5 Spill Response

In the event of a release of hazardous material into the environment, Foster Wheeler will initiate action to contain or control the release. The area will be evacuated if the spill is significant or represents an immediate health threat, in accordance with the BWP.

6. HEALTH AND SAFETY

For this project, Section 4, SSHP, of the Base-Wide SSHP has been modified and produced as an addendum to the Base-Wide SSHP, as presented in Appendix B of this document. Guidance in this text supersedes the Base-Wide SSHP but does not replace other information found within the sections. The addendum addresses site-specific information, including hazard assessment, job safety analysis, and personal protective equipment.

REFERENCES

EPA, 1999. *Region 6 Human Health Media-Specific Screening Levels.*

GCL, 1991. *Unit Closure Plan for Sewage Lagoons.* Kirtland AFB, New Mexico.

IT Corporation, 1998 (March). *Background Concentrations of Constitutents of Concern to the Sandia National Laboratories/New Mexico Environmental Restoration Program.* Albuquerque, New Mexico.

USAF, 1997 (December). *Management Action Plan.* Kirtland Air Force Base, New Mexico.

USAF, 1996 (March). *Final Base-Wide Plans for the Installation Restoration Program.* Kirtland Air Force Base, New Mexico.

USAF, 1993a. *IRP Stage 2 RFI Report.* Kirtland AFB, New Mexico.

USAF, 1993b. *IRP Stage 2A RFI Report.* Kirtland AFB, New Mexico.

USAF, 1990. *Stage 2 Interim Technical Information Report.* Kirtland AFB, New Mexico.

USAF, 1988. *Preliminary Review/Visual Site Inspection.* Kirtland AFB, New Mexico.

USAF, 1985. *Installation Restoration Program Phase II, Confirmation/Quantification Stage 1, Final Report for Kirtland AFB, Albuquerque, New Mexico.*

USAF, 1981. *Installation Restoration Program, Phase I, Kirtland AFB.* Kirtland AFB, New Mexico.

Appendix A

Quality Assurance Project Plan

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ACRONYMS

AFB	Air Force Base
DQO	data quality objective
EPA	United States Environmental Protection Agency
FSP	Field Sampling Plan
PARCC	precision, accuracy, representativeness, comparability, and completeness
QAPP	Quality Assurance Project Plan
QC	quality control
SAP	Sampling and Analysis Plan
SOP	standard operating procedure

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1. INTRODUCTION

This site-specific Quality Assurance Project Plan (QAPP) has been prepared to support environmental restoration activities, specifically surface soil sampling at the Sewage Lagoons at Kirtland Air Force Base (AFB) southeast of Albuquerque, New Mexico. Environmental restoration activities involve investigative activities, the monitoring of natural systems, and other associated work efforts.

The purpose of this site-specific QAPP is to amend, modify, or clarify, where necessary, the policies, objectives, concepts, systems, and procedures outlined in the Base-Wide QAPP (USAF, 1996) to effectively address the unique nature and scope of the investigative activities at the Sewage Lagoons. Sections 2, 4, 5, 8, 9, and 10 of the Base-Wide QAPP were affected, and as a result, the specific content found herein supersedes the Base-Wide QAPP but does not replace other information found within those sections. The remaining sections of the Base-Wide QAPP required no modification and therefore are not discussed here.

2. PROJECT DESCRIPTION

A specific description of the Sewage Lagoons, along with the scope and objectives of site investigative activities, is provided in the site-specific Field Sampling Plan (FSP), Section 2 of the Sampling and Analysis Plan (SAP).

4. QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT OF DATA

4.1 Data Quality Objectives

The data quality objective (DQO) development process is described in the Base-Wide QAPP (USAF, 1996). The fundamental goals of this project's DQOs are to acquire data of sufficient quality and quantity to accomplish the following goals:

- Identify source areas having the potential to release hazardous constituents to the environment
- Define the existence, nature, and extent of releases of hazardous substances to the environment
- Collect data that may be used in the future to support a screening level health risk and environmental assessment or baseline risk assessment and address all significant exposure pathways.

Based on the end use of the data, the following analytical levels are needed:

Analytical Data:

Definitive Level Offsite analytical chemistry sample results

A definitive level of data will be required to determine if chemical contamination is present in the sludge and surface soils at concentrations that exceed the EPA Region 6 Human Health Media-Specific Screening Levels (EPA, 1999) for residential soil. Tables 4-1 through 4-4 provide the project quantification limits required to meet the objectives of the program. Table 4-5 measures accuracy for organic parameters and Tables 4-6 through 4-7 provide the objectives for precision and accuracy for the organic and inorganic parameters, respectively. Table 4-8 provides the Resource Conservation and Recovery Act (RCRA) toxicity characteristics, contaminants, and associated regulatory levels given for

comparison to analytical results. The United States Environmental Protection Agency (EPA) SW-846, Test Methods for Evaluating Solid Waste, Third Edition (EPA, 1986) and latest revisions and update (EPA, 1994a; 1998 and EPA Manual 600/4-79-020, Methods for Chemical Analysis of Water and Wastes (EPA, 1979) will be used for the analyses required in Table 8-1 of this QAPP.

Table 4-1. Project Quantification Limits (PQL) for Volatile Organics EPA Method 5035/8260B

Analyte[1]	Low Soil (mg/kg)	EPA Region 6 RBCs
Chloromethane	.010	1.2
Bromomethane	.010	3.8
Vinyl Chloride	.010	.021
Chloroethane	.010	NA
Acetone	.020	1,400
Carbon Disulfide	.005	350
1,1-Dichloroethene	.005	630
1,1-Dichloroethane	.005	570
1,2-Dichloroethene (Total)	.005	42
Methylene Chloride	.005	8.5
Chloroform	.005	.24
1,2-Dichloroethane	.005	.34
Carbon Tetrachloride	.005	.23
Bromodichloromethane	.005	.98
1,2-Dichloropropane	.005	.35
cis-1,3-Dichloropropene	.005	.081
Trichloroethene	.005	2.7
Dibromochloromethane	.005	5.3
1,1,2-Trichloroethane	.005	.82
1,1,2,2-Tetrachloroethane	.005	3.6
Benzene	.005	.62
Toluene	.005	520
Trans-1,3-Dichloropropene	.005	.081
Bromoform	.005	56
4-Methyl-2-pentanone	.020	750
2-Hexanone	.020	NA
Tetrachloroethene	.005	4.7
Chlorobenzene	.005	54
Ethylbenzene	.005	230
Styrene	.005	1,700
Xylenes (Total)	.005	210

FOOTNOTES

[1] In accordance with EPA SW-846, 3rd Edition and Final Update (EPA, 1998). PQLs are for Laucks Testing Laboratories, Seattle, Washington.

mg/kg milligrams per kilogram

NA not available

RBCs EPA Region 6 Risk Based Concentrations for residential soil

Table 4-2. Project Quantification Limits for Semivolatile Organics—EPA Method 8270C

Analyte[1]	Low Soil (m/kg)	EPA Region 6 RBCs
Acenaphthene	.330	2,600
Acenaphthylene	.330	NA
Anthracene	.330	14,000
Benzo(a)anthracene	.330	.56
Benzo(b)fluoranthene	.330	.56
Benzo(k)fluoranthene	.330	5.6
Benzo(g,h,i)perylene	.330	NA
Benzo(a)pyrene	.330	.056
Bis (2-Chloroethyl)ether	.330	.18
Bis (2-Chloroethoxy)methane	.330	NA
4-Bromophenyl phenyl ether	.330	NA
Butyl benzyl phthalate	.330	240
Carbazole	.330	22
4-Chloroaniline	.330	220
2,2-oxybis(1-Chloropropane)	.330	NA
4-Chloro-3-methylphenol	.330	NA
2-Chloronaphthalene	.330	3,000
2-Chlorophenol	.330	59
4-Chlorophenyl phenyl ether	.330	NA
Chrysene	.330	56
Dibenz(a,h)anthracene	.330	.056
Dibenzofuran	.330	210
Di-n-butyl phthalate	.330	NA
1,2-Dichlorobenzene	.330	370
1,3-Dichlorobenzene	.330	41
1,4-Dichlorobenzene	.330	3
3,3'-Dichlorobenzidine	1.6	.99
2,4-Dichlorophenol	.330	160
Diethyl phthalate	.330	44,000
2,4-Dimethylphenol	.330	1,100
Dimethyl phthalate	.330	100,000
4,6-Dinitro-2-methylphenol	1.6	NA
2,4-Dinitrophenol	1.6	110
2,4-Dinitrotoluene	.330	110
2,6-Dinitrotoluene	.330	55

Table 4-2. Project Quantification Limits for Semivolatile Organics—EPA Method 8270C (Concluded)

Analyte[1]	Low Soil (mg/kg)	EPA Region 6 RBCs
Di-n-octyl phthalate	.330	1,100
Bis(2-Ethylhexyl)^phthalate	.330	32
Fluoranthene	.330	2,000
Fluorene	.330	1,800
Hexachlorobenzene	.330	.28
Hexachlorobutadiene	1.6	11
Hexachloroethane	.330	55
Ideno(1,2,3-cd)pyrene	.330	.56
Isophorone	.330	4,700
2-Methylnaphthalene	.330	NA
2-Methylphenol	.330	2,700
4-Methylphenol	.330	270
Naphthalene	.330	55
2-Nitroaniline	1.6	3.3
3-Nitroaniline	1.6	NA
4-Nitroaniline	1.6	NA
Nitrobenzene	.330	16
2-Nitrophenol	.330	NA
4-Nitrophenol	1.6	3,400
N-Nitrosodiphenylamine	.330	91
N-Nitroso-di-n-propylamine	.330	.063
Pentachlorophenol	.670	2.5
Phenanthrene	.330	NA
Phenol	.330	33,000
Pyrene	.330	1,500
1,2,4-Trichlorobenzene	.330	480
2,4,5-Trichlorophenol	.330	5,500
2,4,6-Trichlorophenol	.330	40
Bis(2-Chloroethyl)ether	.330	.18
4-Methylphenol	.330	270
Dimethylphthalate	.330	100,000
Carbazole	.330	22

FOOTNOTES

[1] In accordance with EPA SW-846, 3rd Edition revisions (EPA, 1994a). PQLs are from Laucks Testing Laboratories, Seattle, Washington.

mg/kg milligrams per kilogram

RBCs risk-based concentrations

Table 4-3. Project Quantification Limits for Nitrate as Nitrogen by Ion Chromatography and Mercury by Cold Vapor Atomic Absorption—EPA Methods 300.0 and 7471A

Analyte[1]	Low Soil (mg/kg)	EPA Region 6 RBCs
Nitrate	5.0	NA
Mercury	0.2	22

FOOTNOTES

[1] In accordance with EPA SW-846, 3rd Edition revisions (EPA, 1994a). PQLs are from Laucks Testing Laboratories, Seattle, Washington.

mg/kg milligrams per kilogram

RBCs EPA Region 6 Risk Based Concentrations for residential soil

Table 4-4. Project Quantification Limits for Metals by Inductively Coupled Plasma (ICP)—EPA Method 6010B

Analyte[1]	Low Soil (mg/kg)	EPA Region 6 RBCs
Aluminum	20	75,000
Antimony	6	30
Arsenic	5	21
Barium	20	5,200
Beryllium	0.5	150
Cadmium	0.5	37
Calcium	500	NA
Chromium	1	210
Cobalt	5	3,300
Copper	2.5	2,800
Iron	10	22,000
Lead	5	400
Magnesium	500	NA
Manganese	1.5	3,100
Nickel	4	1,500
Potassium	500	NA
Selenium	20	370
Silver	1	370
Sodium	500	NA
Thallium	25	NA
Vanadium	5	520
Zinc	2	22,000

FOOTNOTES

[1] In accordance with EPA SW-846, 3rd Edition revisions (EPA, 1994a). PQLs are from Laucks Testing Laboratories, Seattle, Washington.

mg/kg milligrams per kilogram

RBCs EPA Region 6 Risk Based Concentrations for residential soil

Table 4-5. Data Quality Objectives for Organic Parameters (Surrogate Spike Recoveries)

Parameter	Surrogate Compound	*Accuracy as % Recovery* Soil/Sediment
Volatile Organics	1,2-Dichloroethane-d4	60-140
	Toluene-d8	60-140
	4-Bromofluorobenzene	60-140
Semivolatile Organics	2-Fluorobiphenyl	32-99
	Nitrobenzene-d5	24-102
	Terphenyl-d14	31-109
	2-Fluorophenol	25-108
	Phenol-d5	24-112
	2,4,6-Tribromophenol	19-122

FOOTNOTE

The percent (%) recoveries are specific to Laucks Testing Laboratories, Seattle, Washington.

Table 4-6. Data Quality Objectives for Accuracy (Laboratory Control Samples and Matrix Spike Recoveries) and Precision (Relative Percent Difference) for Organic Parameters

Parameter	Soil	
	Percent Recovery	Relative Percent Difference
Volatile Organics		
Benzene	63-141	30
Chlorobenzene	61-143	30
1,1-Dichloroethene	30-160	30
Toluene	62-148	30
Trichloroethene	65-146	30
Semivolatile Organics		
1,4-Dichlorobenzene	34-107	30
Pyrene	25-141	30
1,2,4-Trichlorobenzene	40-121	30
2-Chlorophenol	40-106	30
Phenol	41-109	30
N-Nitroso-di-n-propylamine	48-118	30
4-Chloro-3-methylphenol	55-120	30
Acenaphthene	41-122	30
4-Nitrophenol	23-143	30
2,4-Dinitrotoluene	32-127	30
Pentachlorophenol	20-159	30

FOOTNOTE

The percent recoveries and relative percent differences are specific to Laucks Testing Laboratories, Seattle, Washington.

Table 4-7. Data Quality Objectives for Metals and Nitrate as Nitrogen (Laboratory Control Samples and Matrix Spike/Matrix Spike Duplicate Samples)

Analyte	Soil	
	Accuracy Percent Recovery	Precision RPD
Aluminum	80-120	20
Antimony	80-120	20
Arsenic	80-120	20
Barium	80-120	20
Beryllium	80-120	20
Cadmium	80-120	20
Calcium	80-120	20
Chromium	80-120	20
Cobalt	80-120	20
Copper	80-120	20
Iron	80-120	20
Lead	80-120	20
Magnesium	80-120	20
Manganese	80-120	20
Mercury	80-120	20
Nickel	80-120	20
Potassium	80-120	20
Selenium	80-120	20
Silver	80-120	20
Sodium	80-120	20
Thallium	80-120	20
Vanadium	80-120	20
Zinc	80-120	20
Nitrate as N	80-120	20

FOOTNOTES

The percent recoveries and RPD are specific to Laucks Testing Laboratories, Seattle, Washington.

RPD relative percent difference

Table 4-8. Toxicity Characteristic Contaminants and Regulatory Levels

EPA Hazardous Waste Number	Contaminant	Regulatory Level (mg/L) †
D004	Arsenic	5.0
D005	Barium	100
D018	Benzene	0.5
D006	Cadmium	1.0
D019	Carbon tetrachloride	0.5
D020	Chlordane	0.03
D021	Chlorobenzene	100.0
D022	Chloroform	6.0
D007	Chromium	5.0
D023	o-Cresol	200.0[a]
D024	m-Cresol	200.0[a]
D025	p-Cresol	200.0[a]
D026	Cresol	200.0[a]
D016	2,4-D	10.0
D027	1,4-Dichlorobenzene	7.5
D028	1,2-Dichloroethane	0.5
D029	1,1-Dichloroethylene	0.7
D030	2,4-Dinitrotoluene	0.13[b]
D012	Endrin	0.02
D031	Heptachlor (and its hydroxide)	0.008
D032	Hexachlorobenzene	0.13[b]
D033	Hexachloro-1,3-butadiene	0.5
D034	Hexachloroethane	3.0
D008	Lead	5.0
D013	Lindane	0.4
D009	Mercury	0.2
D014	Methoxychlor	10.0
D035	Methyl ethyl ketone	200.0
D036	Nitrobenzene	2.0
D037	Pentachlorophenol	100.0
D038	Pyridine	5.0[b]
D010	Selenium	1.0
D011	Silver	5.0
D039	Tetrachloroethylene	0.7
D015	Toxophene	0.5
D040	Trichloroethylene	0.5
D041	2,4,5-Trichlorophenol	400.0
D042	2,4,6-Trichlorophenol	2.0
D017	2,4,5-TP (Silvex)	1.0
D043	Vinyl chloride	0.2

Table 4-8. Toxicity Characteristic Contaminants and Regulatory Levels (Concluded)

FOOTNOTES

† The regulatory level equals the chronic toxicity reference level times a dilution/attenuation factor (DAF) of 100, unless otherwise noted.

[a] o-, m-, and p-cresol concentrations cannot be differentiated, the total cresol (D026) concentration is used. Note that D026 was added to the final rule for this purpose, but is not a new constituent.

[b] The quantitation limit (i.e., five times the detection limit) is greater than the calculated regulatory level; thus, the quantitation limit becomes the regulatory level.

mg/L milligrams per liter

Source: 55 FR 11804 and 11815-11816.

A definitive hardcopy data package deliverable will be provided for all analytical data for this project. This level of documentation will further enhance the quality of data for all methods used. The data package will include the following information:

- Case narrative—associated analytical problems or deviations
- Sample results
- Method blank summary
- Laboratory control sample summary
- Matrix spike/spike duplicate summary
- Initial and continuing calibration information
- Gas chromatography mass spectrometer tuning data
- Surrogate percent recovery data
- Internal standard area summary
- Chain-of-custody record
- Instrument output data

5. FIELD INVESTIGATION PROCEDURES

The standard operating procedures (SOPs) that will be used for this project are presented in the Base-Wide Data Collection Quality Assurance Plan (USAF, 1996) and the site-specific addenda to the FSP (Section 2). Tables 5-1 and 5-2 of the Base-Wide QAPP provide details of sample containers and preservatives.

8. ANALYTICAL PROCEDURES

Table 6-1 lists all laboratory sample preparation and analytical methods to be used for the project. The field analytical methods are included in the SOPs of the Base-Wide FSP. Refer to Section 8 of the Base-Wide QAPP for additional information on analytical methods.

Table 8-1. Sample Preparation and Analytical Methods for the Kirtland AFB, Sewage Lagoons

Parameter	Soil
VOCs	SW5035/8260B
SVOCs	SW3550/8270C
Metals	SW3050/6010B
Nitrate as nitrogen	EPA 300.0
Mercury	SW 7471A
TCLP Metals	SW 1311/6010B/7470A

SVOC—semivolatile organic compounds
TCLP—Toxicity characteristic leaching procedures
VOC—volatile organic compounds

9. INTERNAL QUALITY CONTROL CHECKS

One field duplicate, one equipment rinse blank, and one Chemical Materials Quality Assurance Laboratory sample will be collected for this project. A complete listing of samples and field quality control (QC) samples by site is given in the site-specific FSP, Section 2 of the SAP. The frequency of field and laboratory QC samples is specified in Section 9.1 of the Base-Wide QAPP (USAF, 1996).

10. DATA VALIDATION, REDUCTION, AND REPORTING

For this project, 100 percent of the analytical data will be validated for precision, accuracy, representativeness, comparability, and completeness (PARCC). The PARCC review will be achieved by evaluating the following criteria:

- Deliverables for completeness
- Extraction and analysis holding times
- Blanks (method and equipment)
- System monitoring compounds (surrogates and internal standards)
- Laboratory duplicate samples
- Laboratory control sample recoveries
- Matrix spike and matrix spike duplicate recoveries

Analytical data for the surface soil investigation at the Sewage Lagoons will be provided by the laboratory in hardcopy data package and on electronic data file in Environmental Resources Program Information Management System compatible format. The hardcopy data package will be in accordance with the definitive data deliverable in the Kirtland AFB Base-Wide Plans (USAF, 1996).

Validation will be performed in accordance with EPA Contract Laboratory Program National Functional Guidelines for Inorganic and Organic Data Review (EPA, 1994a;b).

REFERENCES

EPA, 1979. *Methods for Chemical Analysis of Water and Wastes.* EPA Manual 600/4-79-020.

EPA, 1986. *SW-846, Test Methods for Evaluating Solid Waste, Third Edition.*

EPA, 1994a. *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review.*

EPA, 1994b. *Contract Laboratory Program National Functional Guidelines for Organic Data Review.*

EPA, 1998. *SW-846, Test Methods for Evaluating Solid Waste, Third Edition and Final Update 1.*

EPA, 1999. *Region 6 Human Health Media-Specific Screening Levels.*

USAF, 1995 (March). *Final Base-Wide Plans for the Installation Restoration Program.* Kirtland Air Force Base, New Mexico.

Appendix B

Appendix B

Site-Specific Safety and Health Plan

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ACRONYMS

AFB	Air Force Base
°F	degrees Fahrenheit
HST	Health and Safety Technician
MSDS	Material Safety Data Sheet
PHSM	Project Health and Safety Manager
SAP	Sampling and Analysis Plan
SHSO	Site Health and Safety Officer
SSHP	Site Safety and Health Plan

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1. INTRODUCTION

This Site Safety and Health Plan (SSHP) provides site-specific guidance for sludge/surface soil sampling at the Sewage Lagoons, Kirtland Air Force Base (AFB), southeast of Albuquerque, New Mexico. This SSHP will serve as an addendum to the Base-Wide SSHP (USAF, 1996) and will provide a Hazard Assessment and Job Safety Analysis, as well as required personal protective equipment information for the anticipated field activities. The Base-Wide SSHP shall be referenced for all other safety and health issues. This SSHP, the Base-Wide SSHP, and the Foster Wheeler Environmental Health and Safety Program Manual shall be onsite at all times during field activities.

2. SITE HISTORY AND DESCRIPTION

Section 2 of the Sampling and Analysis Plan (SAP) contains the scope of work and description of the Sewage Lagoons.

3. HEALTH AND SAFETY PERSONNEL

Section 2 of the Base-Wide SSHP, Health and Safety Personnel Responsibilities, presents a discussion of health and safety personnel. The Health and Safety Technician (HST) and competent person for project activities will be designated by the subcontractor and approved by the Project Health and Safety Manager (PHSM) and Site Health and Safety Officer (SHSO) prior to field mobilization.

4. HAZARD ASSESSMENT

The potential hazards associated with the site activities during field investigations at the Sewage Lagoons are chemical and physical in nature. The potential for encountering these hazards will depend on the type of work to be performed and the location of the work activity. The remainder of this section provides information on these hazards.

4.1 Chemical Hazards

Based on the low concentrations that are expected and the anticipated work activities, the likelihood of exposure to hazardous chemicals is considered low. The Material Safety Data Sheets (MSDSs) for contaminants of concern in dry surface sludges and surface soils are presented in Attachment 1 of Appendix B. The MSDSs provide information regarding chemical, physical, and toxicological properties of the contaminants that may exist at the Sewage Lagoons.

4.2 Physical Hazards

Potential physical hazards at the site include:

- Trips, slips, and falls
- Heat stress

- Inclement weather
- Objects requiring manual lifting
- Hand tools

Requirements for minimizing potential exposures to these physical hazards are detailed in Section 6 of this SSHP.

4.3 Job Hazard Analysis

The activities anticipated during the field investigation include hand augering and sample collection and equipment decontamination. The Job Hazard Analysis for these activities is outlined in Table 4-5 of the Base-Wide SSHP (USAF, 1996). Additional tasks, hazards, and controls specific to this project are detailed in Table 4-1.

Table 4-1. Project-Specific Task Hazard Analysis

Task	Hazard	Control
Hand auger sampling	Back injuries, muscle pulls, exposure to contaminants	Personal protective equipment Proper lifting and augering techniques
Equipment decontamination	Splashing of liquid	Personal protective equipment

5. PERSONAL PROTECTIVE EQUIPMENT

The levels of protection required for anticipated activities are outlined below.

Activity	LOP
Hand auger sampling	D
Equipment decontamination	D

LOP – level of protection

The ensemble required for Level D protection is outlined in Section 6.2 of the Base-Wide SSHP (USAF, 1996). Modified Level D protection will include nitrile surgical gloves and may include splash protection along with the required Level D ensemble. Personal decontamination procedures are outlined in Section 9 of the Base-Wide SSHP (USAF, 1996).

6. SAFETY CONSIDERATIONS FOR SITE OPERATIONS

Because of the nature of work to be conducted, physical hazards potentially pose the greatest health and safety concern during this project. The following sections provide a supplement to the Base-Wide SSHP.

6.1 Slips, Trips, and Falls

Field personnel will become familiar with the specific hazards associated with each structure and work area. Hazards causing slips, trips, and falls may be a result of debris, uneven terrain, sampling at elevated locations, or poor lighting. Field personnel will remain alert to the surrounding conditions. Upon arrival at a site, personnel will inspect the area for hazards. These hazards will either be removed from the immediate area or marked to prevent injury.

6.2 Heat Stress

Site employees must learn to recognize and treat various forms of heat stress through preventive heat stress management. The potential for heat stress is minimal. However, the following procedures should be observed, as applicable:

- Have workers drink 16 ounces of water before beginning work. Provide disposable, 4-ounce cups and water that is maintained at 50 to 60 degrees Fahrenheit (°F). Urge workers to drink one or two of these cups of water every 20 minutes, for a total of 1 to 2 gallons per day. Provide a cool, preferably air-conditioned, area for rest breaks.
- Discourage the use of alcohol during nonworking hours and discourage the intake of coffee during working hours. Monitor for signs of heat stress.
- Acclimate workers to site work conditions by slowly increasing work loads (i.e., do not begin site work activities with extremely demanding activities).
- Provide cooling devices to aid natural body ventilation; however, these devices add weight, and their use should be balanced against worker efficiency. An example of a cooling aid is long cotton underwear, which acts as a wick to help absorb moisture and protect the skin from direct contact with heat-absorbing protective clothing.
- Ensure that adequate shelter is available to protect personnel against heat, which can decrease physical efficiency and increase the probability of heat stress. If possible, set up a rest area in the shade.

One or more of the following physiologic monitoring methods will be used for work conducted in protective clothing:

- Measure heart rate by monitoring the radial pulse for 30 seconds as early as possible in the resting period. The heart rate at the beginning of the rest period should not exceed 110 beats per minute. If the heart rate is higher, the next work period is shortened 33 percent, and the length of the rest period stays the same. If the pulse rate still exceeds 110 beats per minute at the beginning of the next rest period, the following work cycle is further shortened by 33 percent. The procedure is continued until the rate is maintained below 110 beats per minute.
- Body temperature is measured orally with a clinical thermometer as early as possible in the resting period. Oral temperature at the beginning of the rest period should not exceed 99 °F. If it does,

the next work period is shortened by 33 percent, and the length of the rest period stays the same. However, if the oral temperature exceeds 99.6° F at the beginning of the next period, the following work cycle is further shortened by 33 percent. Oral temperature is measured again at the end of the rest period to ensure that it has dropped below 99° F. Anyone with an oral temperature exceeding 100.6° F will not wear impermeable clothing.

6.3 Inclement Weather

Natural phenomena, including excessive heat or cold, rain, snow, ice, and lightning, can affect work activities and increase risk. At the daily morning health and safety meetings, the Health and Safety Technician (HST) will discuss potential weather issues that could affect workers. Additionally, extremes in temperature and moisture could affect the function of monitoring instrumentation and personal protective equipment. It is the responsibility of the HST to recognize weather conditions and adjust site activities accordingly.

6.4 Manual Lifting

Personnel performing material handling will abide by the following guidelines:

- **DO** design manual lifting and lowering out of the task and workplace. If manual lifting must be done by a worker, perform it between knuckle and shoulder height.
- **DO** maintain good physical condition. If you are not used to lifting and vigorous exercise, do not attempt to do difficult lifting or lowering tasks.
- **DO** think before acting. Place material conveniently within reach. Have handling aids available. Make sure sufficient space is cleared.
- **DO** get the load close to the body. Test the weight before trying to move it. If it is too bulky or heavy, get a mechanical lifting aid or somebody else to help, or both. Place the feet close to the load. Stand in a stable position with the feet pointing in the direction of movement. Lift mostly by straightening the legs.
- **DO NOT** twist the back or bend sideways.
- **DO NOT** lift or lower awkwardly.
- **DO NOT** hesitate to get mechanical help or help from another person.
- **DO NOT** continue heaving when the load is too heavy.

6.5 Hand Tools

Hand tools used will be in accordance with the following practices:

- Tools will be maintained in good condition and be inspected prior to use.
- Tools will be used for their intended purpose.
- Unsafe tools will be removed from service.

7. MONITORING

Monitoring will be performed during sample collection activities. The likelihood of encountering hazardous concentrations of chemicals in the 0- to 6-inch interval below ground surface is highly unlikely. The Sewage Lagoons dried shortly after last receiving effluent in 1987 and have been exposed to the high desert climate for the past 12 years.

8. EMERGENCY RESPONSE PLAN

The Emergency Response Plan of the Base-Wide SSHP will be followed during this investigation (USAF, 1996). Additional information is provided below.

8.1 Emergency Contacts

Emergency contact numbers will be conspicuously posted onsite to allow for easy access to all personnel. Additional emergency telephone numbers include:

Roger Margotto, PHSM/SHSO	(619) 234-8696, Ext. 203	Pager (714) 810-3742
William Foley, Delivery Order Manager	(505) 878-8924	
Eric Tow, Task Manager/SHSO	(505) 878-8907	
Mark Holmes, Kirtland AFB	(505) 846-9005	
Kirtland AFB Security	(505) 846-7926	

8.2 Emergency Route to Hospital

The routes to the Lovelace hospital and Kirtland AFB Emergency Room are shown in Figure 8-1.

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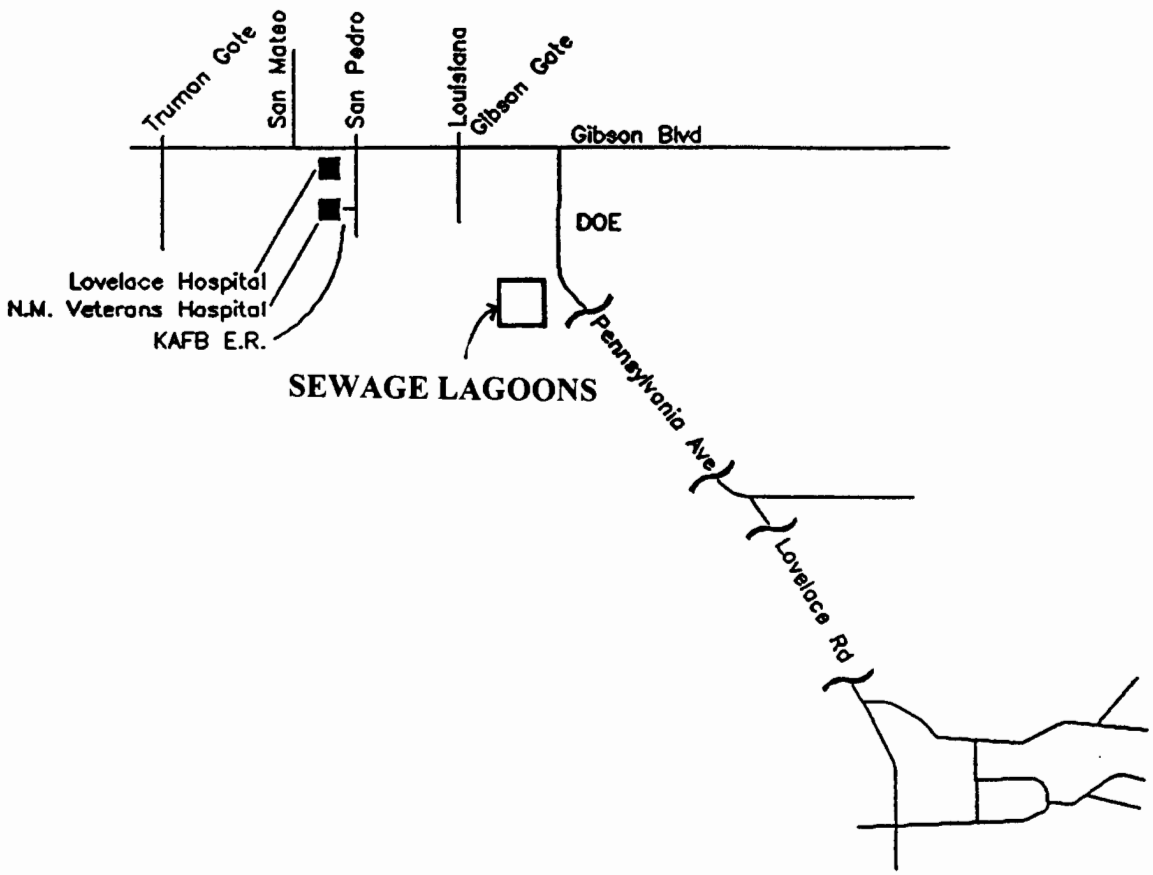
Figure 8-1 Hospital Route



Directions: The Sewage Lagoons are located several hundered yards south of Pennsylvania Avenue, which intersects Gibson Avenue at the Base BX east of the Gibson Gate. From the site, take Pennsylvania Avenue north to Gibson Avenue. Turn right on Gibson Avenue, exit through Gibson Gate, and follow west the hospital facilities shown on the map.

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9. APPROVALS

By their signature, the undersigned certify that this SSHP is approved and will be used for the sampling activities at the Sewage Lagoons, Kirtland AFB.

William Foley
Delivery Order Manager

Date 6/4/99

Eric Tow
Site Health and Safety Officer

Date 6/4/99

Roger N Margotto, CIH
Project Health and Safety Manager
Roger Margotto, CIH

Date 6/4/99

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REFERENCES

USAF, 1996. *Final Base-Wide Plans for the Installation Restoration Program.* Kirtland Air Force Base, New Mexico

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Attachment 1

Material Safety Data Sheets for Contaminants of Concern

Genium Publishing Corp.
One Genium Plaza
Schenectady, NY 12304-4690
(518) 377-8854

Chromium (III) Oxide **MSDS No. 182**

Date of Preparation: 4/86 Revision: A, 6/94

Section 1 - Chemical Product and Company Identification 44

Product/Chemical Name: Chromium (III) Oxide
Chemical Formula: Cr_2O_3
CAS No.: 1308-38-9
Synonyms: chrome green, chrome oxide, chromic oxide, chromium sesquioxide, chromium (3^+) trioxide, dichromium trioxide, green cinnabar, oxide of chromium
Derivation: Prepared by reaction of sodium dichromate or chromate with sulfur or by heating chromic hydroxide or dry ammonium dichromate.
General Use: Used in abrasives, electrical semiconductors, alloys; for printing fabrics and bank notes; as a component of refractory bricks and green asphalt roofing, sensitizer in photochemical processing, a colorant for latex paints, cement, paper, and rubber, and as a catalyst in preparation of methanol, butadiene, and high density polyethylene.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Chromium (III) Oxide, > 95.5 % wt.
Trace Impurities: moisture 0.3%, iron 0.05%, sulfur 0.2%, inert material 0.75%, other water soluble material 0.2%.

OSHA PEL
Chromium (III) compounds, as Cr
8-hr TWA: 0.5 mg/m^3

NIOSH REL
Chromium (II) & (III) compounds, as Cr
10-hr TWA: 0.5 mg/m^3

DFG (Germany) MAK
None established

ACGIH TLV
Chromium (III) compounds, as Cr
8-hr TWA: 0.5 mg/m^3

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Chromium (III) oxide exists as small green crystals or powder. It has very low toxicity due to poor membrane (skin and mucous membrane) permeability. Chromium (III) oxide is not combustible itself, but as an oxidizer it is capable of igniting combustible materials and increasing the intensity of a fire.

Wilson Risk Scale
R 1
I 3
S 1
K 0

HMIS
H 1
F 0
R 0

PPE*
*Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, skin and eye contact.
Target Organs: Skin, eyes, respiratory tract.
Acute Effects
Inhalation: May cause minor irritation of the respiratory tract.
Eye: May cause minor irritation.
Skin: May cause minor irritation.
Ingestion: When taken orally, trivalent chromium compounds do not produce any local or systemic effects because of poor absorption.
Carcinogenicity: NTP and OSHA do not list chromium (III) oxide as a carcinogen. IARC has evaluated chromium (III) oxide and designated it as Class 3, unclassifiable as to human carcinogenicity. In general, hexavalent (VI) chromium compounds have been found to be carcinogenic, but trivalent (III) compounds have not.
Medical Conditions Aggravated by Long-Term Exposure: Possibly, dermatitis.
Chronic Effects: Dermatitis is possible in sensitive individuals. In a case study of 85 chrome factory workers exposed to 4.5 to 9.2 mg/m^3 of chromium (III) compounds, 18.8% developed chronic bronchitis after 5 yr and 5.9% developed pneumoconiosis after 9 yr.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.
Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water for at least 15 minutes. If pain or irritation persists, consult an ophthalmologist.
Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water followed by a soap and water wash.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water to dilute.
After first aid, get appropriate in-plant, paramedic, or community medical support.

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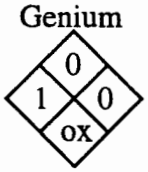
Note to Physicians: Urinary excretion is generally < 10 µg/day in absence of excess exposure. Treat weeping dermatitis with 1% aluminum acetate wet dressings.

Section 5 - Fire-Fighting Measures

Genium



Flash Point: Noncombustible
Autoignition Temperature: Noncombustible
LEL: None reported.
UEL: None reported.
Extinguishing Media: Use agents suitable for surrounding fire.
Unusual Fire or Explosion Hazards: Although chromium (III) oxide is noncombustible, it is an oxidizer capable of igniting combustible materials and increasing the intensity of a fire.
Hazardous Combustion Products: None
Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways.
Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel, isolate, and ventilate area, deny entry, and stay upwind. Cleanup personnel should protect against inhalation and skin/eye contact. Immediate clean-up is necessary to prevent dust dispersion.
Small Spills: Damp mop or vacuum (with appropriate filter). *Do not* sweep!
Large Spills
Containment: Flush spills with water to containment area for reclamation or disposal. *Do not* release into sewers or waterways.
Cleanup: Damp mop any residue.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Prevent dust dispersion.
Storage Requirements: Store in a cool, dry, well-ventilated area away from incompatibles (Sec. 10). *Do not* store on wooden floors or shelves (oxidizer - capable of igniting combustible materials).

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Enclose all processes where possible to prevent dust dispersion into work area.
Ventilation: Provide general or local exhaust ventilation systems to maintain airborne levels below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Administrative Controls: Consider preplacement and periodic (annual) medical exams of exposed workers with emphasis on the respiratory system (including a 14" x 17" chest roentgenogram and FVC/FEV).
Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For ≤ 2.5 mg/m^3, use any dust and mist respirator. For ≤ 5 mg/m^3, use any dust and mist respirator except single-use and quarter mask respirators; any supplied-air respirator (SAR); or any SCBA. For ≤ 12.5 mg/m^3, use any powered, air-purifying respirator with a dust and mist filter or any SAR operated in continuous-flow mode. For ≤ 25 mg/m^3, use any air-purifying, full facepiece respirator with a high-efficiency particulate filter; any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter; or any SAR or SCBA with a full facepiece. For ≤ 250 mg/m^3, use any SAR with a full facepiece and operated in pressure demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.
Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.
Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.
Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove chromium (III) oxide from your shoes and clean personal protective equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using chromium (III) oxide, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

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Section 9 - Physical and Chemical Properties

Physical State: Solid
Appearance and Odor: Light to dark green, fine, hexagonal crystals or powder which turn brown upon heating. The crystals will scratch quartz, topaz, or zircon.
Formula Weight: 152.02
Specific Gravity (H_2O=1, at 4 °C): 5.21
Water Solubility: Nearly insoluble
Other Solubilities: Practically insoluble in alcohol and acetone. Slightly soluble in acids and alkalis.
Boiling Point: 7232 °F (4000 °C)
Melting Point: 4415 °F (2435 °C)
Refractive Index: 2.551

Section 10 - Stability and Reactivity

Stability: Chromium (III) oxide is stable at room temperature in closed containers under normal storage and handling conditions.
Polymerization: Hazardous polymerization does not occur.
Chemical Incompatibilities: Chromium (III) oxide is reduced to the 2+ oxidation state by hypophosphites, electrolysis, or reducing metals such as zinc, magnesium, and aluminum in acid solution. It is incompatible with lithium + heat 1769 °F (965 °C), oxygen difluoride, glycerol (explodes), chlorine trifluoride, and rubidium acetylide.
Conditions to Avoid: Exposure to incompatibles and dispersion of dusts into air.
Hazardous Decomposition Products: None reported.

Section 11- Toxicological Information

Toxicity Data:*

Carcinogenicity:
Rat, intraperitoneal: 90 mg/kg caused respiratory and kidney tumors.
Mutagenicity:
Hamster, lung cell: 34 mg/L caused sister chromatid exchange.

* See NIOSH, *RTECS* (GB6475000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: There is little tendency for bioaccumulation along the food chain. The BCF (chromium III compounds) for saltwater organisms = 86 to 153.
Environmental Degradation: In water, chromium (III) oxide is expected to eventually precipitate to sediments. The estimated residence time of *chromium* in lake water is 4.6 to 18 yr. In air, chromium (III) oxide is primarily removed by fallout and precipitation. Soils with a high chromium (all compounds included) content (> 0.2%) are expected to be infertile. The half-life of chromium in soils may be several years.

Section 13 - Disposal Considerations

Disposal: Chromium (III) oxide is a poor candidate for incineration. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101): Not listed

Section 15 - Regulatory Information

EPA Regulations:
RCRA Hazardous Waste Classification (40 CFR 261.21): D001, Characteristic of Ignitability (oxidizer).
Listed as (chromium compounds) a CERCLA Hazardous Substance (40 CFR 302.4) CWA, Sec. 311 (b)(4)
CERCLA *Statutory* Reportable Quantity (RQ), 1 lb (0.454 kg)
Listed as (chromium compounds) a SARA Toxic Chemical (40 CFR 372.65)
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed
OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A)

Section 16 - Other Information

References: 73, 103, 124, 132, 136, 148, 149, 167, 176, 187, 189, 192

Prepared By.....M Gannon, BA
Industrial Hygiene Review.....DJ Wilson, CIH
Medical Review.....T Thoburn, MD, MPH

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Section 1. Material Identification

Chromic Acid (CrO_3) Description: Produced by roasting chromite ore with alkali or lime, leaching with calcium oxide, crystallizing the chromate or dichromate, and then treating it with an excess of sulfuric acid. Used in ceramic glazes, colored glass, dyes, batteries, explosives, water treatment, wood treatment and preservatives, refractories, copper stripping, aluminum anodizing, photomechanical processing, chromium metal plating, purifying oil and acetylene, hardening microscopic preparations, and manufacturing chromated copper arsenate; and as a corrosion inhibitor, a catalyst, an oxidizing agent in organic chemistry, and an etchant for plastics.

R	1
I	4
S	3*
K	0

* Percutaneous (broken skin)

NFPA: 0 / 3 / 1 / ox

HMIS
H 3
F 0
R 1
PPG†
† Sec. 8

Other Designations: CAS No. 1333-82-0; chromic acid; chromic acid, solid (DOT); chromium anhydride; chromium (VI) oxide; chromium trioxide; chromium (6+) trioxide; monochromium trioxide; puratronic chromium trioxide. Chromic acid is the commonly used name, although true chromic acid (CrH_2O_4, CAS No. 7738-94-5) cannot be isolated from solution. Chromic acid and chromates (as CrO_3, CAS No. 7440-47-3).

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

Caution: A powerful oxidizer, chromic acid may explode on contact with reducing agents and cause ignition on contact with organic materials. This poison and human carcinogen is corrosive to skin and irritating to mucous membranes. Eye contact may cause permanent blindness.

Section 2. Ingredients and Occupational Exposure Limits

Chromic acid, 99% CrO_3

1990 OSHA PEL
Ceiling: 0.1 mg(CrO_3)/m^3

1987 IDLH Level
30 mg/m^3

1990-91 ACGIH TLVs
TWA: 0.05 mg(Cr)/m^3
Ceiling: 0.1 mg/m^3

1990 NIOSH REL
TWA: 0.025 mg(Cr(VI))/m^3
Ceiling: 0.05 mg/m^3/15 min (Cr(VI))

1985-86 Toxicity Data*
Rat, oral, LD_{50}: 80 mg/kg
Mouse, oral, LD_{50}: 127 mg/kg
Human, inhalation, TC_{Lo}: exposed continuously to 110 µg over 3 years. Toxic effects include tumorigenic (carcinogenic by *RTECS* criteria); sense organs and special senses (olfaction tumors); lungs, thorax, or respiration (tumors).
Dog, subcutaneous, LD_{Lo}: 330 mg/kg

* See NIOSH, *RTECS* (GB6650000), for additional mutative, reproductive, toxicity and tumorigenic data.

Section 3. Physical Data*

Boiling Point: Decomposes at 482 °F (250 °C) to $Cr_2O_3 + O_2$
Melting Point: 385 °F (196 °C)
Molecular Weight: 99.98

Specific Gravity: 2.7
Water Solubility: Soluble
Heat of Fusion: 37.7 cal/g

Appearance and Odor: Dark, purplish-red, prismatic, deliquescent (absorbs all moisture from air) crystals, or a granular powder with no detectable odor.

* These physical data apply only to chromic acid (CAS No. 1333-82-0).

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: Chromic acid is noncombustible, but accelerates burning of combustibles (wood, paper, oil). For small fires, *use only water,* not dry chemical, carbon dioxide (CO_2), or halon.

Unusual Fire or Explosion Hazards: A powerful oxidizer, chromic acid ignites on contact with acetic acid and alcohol. It may react rapidly enough with organic materials to cause ignition. Containers may explode if involved in fire.

Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Cool fire-exposed containers with flooding amounts of water since the decomposing material may form a hot, viscous foam that can cause containers to rupture and explode. *Use caution!* For large fires, flood area from a safe distance, and cool containers from the side with a water spray until after fire is well out. If possible without risk, move containers. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holder. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Chromic acid is generally stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: This material is incompatible with acetic acid, acetic anhydride, acetone, alcohols, alkali metals, ammonia, arsenic, anthracene, benzene, bromine penta fluorine, butyric acid, camphor, chromous sulfide, diethyl ether, glycerol, hydrogen sulfide, methyl alcohol, naphthalene, peroxyformic acid, phosphorus, potassium hexacyanoferrate, pyridine, selenium, sodium, and turpentine. Chromic acid ignites ethyl alcohol and many hydrocarbons.

Conditions to Avoid: Avoid excess heat and contact with combustible or organic materials.

Hazardous Products of Decomposition: Thermal oxidative decomposition of chromic acid can produce carbon dioxide, smoke, and irritating toxic fumes.

Section 6. Health Hazard Data

Carcinogenicity: The IARC and NTP list chromic acid and other forms of hexavalent (VI) chromium as human carcinogens.

Summary of Risks: Chromic acid is a poison and a powerful irritant to skin, eyes, and respiratory tract. Skin or lung sensitization (allergic reactions) may occur. Exposure can cause dermatitis (skin rash), asthma, pulmonary edema (fluid in lungs), kidney damage, a "chrome hole," or a perforation of the nasal septum (tissue between nostrils).

Medical Conditions Aggravated by Long-Term Exposure: Any chronic lung or skin condition.

Target Organs: Skin, respiratory tract (including nose, throat, airways, and lungs), and kidney.

Primary Entry Routes: Eyes, skin contact, inhalation, and ingestion.

Acute Effects: Inhalation may cause irritation or burning of nose, throat, and air passages, cough, wheezing, and shortness of breath. Higher exposures may cause pulmonary edema (fluid in lungs). Skin exposure may cause dermatitis (skin rash), irritation, burning, itching, redness, and ulceration (skin destruction) which may penetrate. Eye contact can cause irritation, burning, lacrimation (watering), loss of sight and permanent blindness if not removed quickly.

Chronic Effects: Chronic inhalation of excessive levels may cause epistaxis (nosebleed), "chrome holes," nasal congestion, tooth enamel erosion, chest pain, asthma (via allergic sensitization), bronchitis, or respiratory tract cancer. Chronic eye exposure may cause conjunctivitis. Skin contact

Continue on next page

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Section 6. Health Hazard Data, *continued*

can cause irritant or allergic contact dermatitis, or skin ulceration. Chronic systemic absorption could cause liver or kidney damage.

FIRST AID

Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Do not let victim rub eyes or keep them tightly shut. Consult a physician immediately.

Skin: Rinse with flooding amounts of water for at least 15 min, and wash with a gentle soap. Promptly remove contaminated clothing. For redness, blistering, or persistent irritation, consult a physician.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious* person drink 1 to 2 glasses of water. *Do not induce vomiting* since this worsens the victim's condition. *Do not* neutralize this acid.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: After decontamination and neutralization, treatment of acid burns is similar to that of thermal burns, although bullae and loose necrotic tissue should be debrided. Update tetanus status. *For severe acid burns,* fluid resuscitation is critical to prevent mortality from hypovolemia and renal failure. Monitor serial vital signs, urine output, electrolytes, blood count, and urinalysis as clinically indicated. Neurovascular compromise distal to a circumferential extremity burn may require escharotomy or fasciotomy. *For inhalation exposures to acids,* a CXR, EKG, ABGs, PFTs, SMA, and CBC may aid in treatment. Evaluate and treat as indicated for reactive airways, upper airway obstruction and noncardiogenic pulmonary edema (possibly delayed onset). Although literature documentation is inadequate, a burst of steroids may help prevent development of sequelae such as reactive airways dysfunction syndrome or bronchilitis obliterans. For ocular exposures to acids, ensure adequate decontamination. Determination of pH may be helpful. A Morgan Lens® and topical anesthesia may aid in irrigation. Perform fluorescein staining and slit lamp evaluation and consult an opthamalogist. Antibiotic ointments, mydriatic/cycloplegics, topical corticosteroids (after epithelial recovery), patching, and possibly anterior chamber paracentesis may be indicated depending on clinical presentation. Acutely and in follow-up, evaluate as indicated for intraocular pressure, lacrimal and lid function, corneal integrity and infection. Urinary chromium is of questionable value.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel and evacuate all unnecessary personnel. Cleanup personnel should protect against dust inhalation and eye contact. Do not handle broken packages unless wearing appropriate personal protective equipment. Keep combustibles (wood, paper, etc.) away from spilled material. Whenever possible, use wet cleanup methods; if not, use vacuum cleanup. Remove spills immediately to prevent dust dispersion. For a water spill, neutralize with agricultural lime, crushed limestone, or sodium bicarbonate. For a land spill, dig a pit, pond, or lagoon to contain material. If time permits, seal these with an impermeable, flexible membrane liner. Dike surface flow with soil, sand or foamed concrete. Follow applicable OSHA regulations (29 CFR 1910.120).

Environmental Transport: If allowed contact with soil, chromic acid, solid, lowers pH and may leach into water sources, causing an effect similar to acid rain's on water sources. This material's carcinogenicity makes it hazardous to the environment in its hexavalent state.

Environmental Degradation: The recommended disposal means are reduction, precipitation, or ion exchange. Landfill disposal is not recommended since it raises soil acidity.

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.22): Corrosive waste

RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 10 lb (4.54 kg) [*per Clean Water Act, Sec. 311(b)(4)]†

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Tables Z-1-A and Z-2)

† Chromic acid (CAS No. 7738-94-5) is listed.

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For 0.5 mg/m^3 concentrations (if not fumes), use any dust and mist respirator except single-use and quarter-mask respirators. For 1.25 mg/m^3 concentrations, use any powered air-purifying respirator with a high-efficiency particulate filter. For 2.5 mg/m^3 concentrations, use any air-purifying full facepiece respirator with a high-efficiency particulate filter. For 30 mg/m^3 concentrations, use any supplied air respirator with a full facepiece and operated in a pressure-demand or other positive-pressure mode. All concentrations may require eye protection. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.

Ventilation: Provide general and local ventilation systems to maintain airborne concentrations below occupational exposure levels. Local exhaust ventilation is preferred since it prevents contaminant dispersion into work area by controlling it at its source.[103]

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Contact lenses may minimize or worsen eye injuries. In some cases, soft lenses can actually protect eyes, not worsen corneal damage, due to strong chemicals. In other cases, chemical entrapment is presumed a possible hazard. Since contact lens use in industry is controversial, establish your own policy. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in glass bottles, cans, or drums. Protect against physical damage. Separate from combustible, organic, or other easily oxidizable materials. Protect from excess moisture which could cause containers to rust. Do not store on wooden floors. Store away from foodstuffs and flammable liquids and solids.

Engineering Controls: Avoid dust inhalation and skin or eye contact. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good housekeeping procedures.

Other Precautions: Institute preplacement and periodic medical exams of exposed workers with attention to the skin and respiratory tract. Consider preplacement and periodic chest radiographs.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Chromic acid, solid
DOT Hazard Class: Oxidizer
ID No.: NA1463
DOT Label: Oxidizer
DOT Packaging Exceptions: 173.153
DOT Packaging Requirements: 173.164

IMO Shipping Name: Chromium trioxide, anhydrous
IMO Hazard Class: 5.1
ID No.: UN1463
IMO Label: Oxidizer, Corrosive
IMDG Packaging Group: II

***MSDS Collection* References:** 26, 38, 73, 85, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138, 139, 140, 143, 142, 145, 148, 159

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

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Section 1. Material Identification

Arsenic Description: Obtained from flue dust of copper and lead smelters as white arsenic (arsenic trioxide). Reduction with charcoal and sublimation in an N_2 current yields pure arsenic. Metallic arsenic is used for hardening copper, lead, and alloys; as a doping agent in germanium and silicon solid-state products, special solders, and medicine; and to make gallium arsenide for dipoles and other electronic devices. Arsenic compounds are used in manufacturing certain types of glass; in textile printing, tanning, taxidermy, pharmaceuticals, insecticides and fungicides, pigment production, and antifouling paints; and to control sludge formation in lubricating oils. Arsenic trioxide is the source for 97% of all arsenic products.

Other Designations: CAS No. 7440-38-2; arsen; arsenic black; As; gray arsenic; metallic arsenic.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.

R 1
I 4
S 2
K 0

Genium

HMIS
H 3
F 2
R 2
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Arsenic and soluble compounds, as As

OSHA PEL
8-hr TWA: 0.5 mg/m³,* 0.01 mg/m³†

NIOSH REL, 1987
Ceiling: 0.002 mg/m³

ACGIH TLV, 1989-90
TLV-TWA: 0.2 mg/m³

Toxicity Data‡
Man, oral, TD_{Lo}: 76 mg/kg administered intermittently over a 12-year period affects the liver (tumors) and blood (hemorrhage)
Man, oral: 7857 mg/kg administered over 55 years produces gastrointestinal (in the structure or function of the esophagus), blood (hemorrhage), and skin and appendage (dermatitis) changes
Rat, oral, TC_{Lo}: 605 µg/kg administered to a 35-week pregnant rat affects fertility (pre- and post-implantation mortality)

* Organic compounds.
† Inorganic compounds.
‡ See NIOSH, *RTECS* (CG0525000), for additional mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data*

Boiling Point: sublimes at 1134 °F/612 °C
Melting Point: 1497 °F/814 °C
Vapor Pressure: 1 mm at 702 °F/372 °C (sublimes)
Atomic Weight: 74.92
Density: 5.724 at 57 °F/14 °C
Water Solubility: Insoluble†

Appearance and Odor: A brittle, crystalline, silvery to black metalloid. Odorless.

* This data pertains to arsenic only.
† Arsenic is soluble in nitric acid (HNQ).

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: Use dry chemical, CO_2, water spray, or foam to fight fires.
Unusual Fire or Explosion Hazards: Flammable and slightly explosive in the form of dust when exposed to heat or flame.
Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Arsenic is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Arsenic can react vigorously on contact with powerful oxidizers such as bromates, peroxides, chlorates, iodates, lithium, silver nitrate, potassium nitrate, potassium permanganate, and chromium (VI) oxide. This material is also incompatible with halogens, bromine azide, palladium, dirubidium acetylide, zinc, and platinum.
Hazardous Products of Decomposition: Thermal oxidative decomposition of arsenic and its compounds produces irritating or poisonous gases.

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Section 6. Health Hazard Data

Carcinogenicity: The IARC, NTP, and OSHA list arsenic as a human carcinogen (Group 1). This evaluation applies to arsenic and arsenic compounds as a whole, and not necessarily to all individual chemicals within the group. Studies report that both the trivalent and pentavalent compounds are strongly implicated as causes of skin, lung, and lymphatic cancers. Experimental studies have shown that arsenic has tumorigenic and teratogenic effects in laboratory animals.
Summary of Risks: Arsenic compounds are irritants of the skin, mucous membranes, and eyes. The moist mucous membranes are most sensitive to irritation. Prolonged contact results in local hyperemia (blood congestion) and later vesicular or pustular eruption. Epidermal carcinoma is a reported risk of exposure. Peripheral neuropathy (degenerative state of the nervous system) is common after acute or chronic arsenic poisoning. Symptoms include decreased sensation to touch, pinprick, and temperature; loss of vibration sense; and profound muscle weakness and wasting. Other complications of acute and chronic arsenic poisoning are encephalopathy (alterations of brain structure) and toxic delirium.
Medical Conditions Aggravated by Long-Term Exposure: Damage to the liver, nervous, and hematopoietic (responsible for the formation of blood or blood cells in the body) system may be permanent. Pulmonary and lymphatic cancer may also occur.
Target Organs: Liver, kidneys, skin, lungs, lymphatic system.
Primary Entry Routes: Inhalation, ingestion of dust and fumes, via skin absorption.
Acute Effects: Acute industrial intoxication is more likely to arise from inhalation of arsine. However, with corrosive arsenical vapors, conjunctivitis, eyelid edema, and even corneal erosion may result. Inhalation may result in nasal irritation with perforation of the septum, cough, chest pain, hoarseness, pharyngitis, and inflammation of the mouth. If ingested, metallic or garlic taste, intense thirst, nausea, vomiting, abdominal pain, diarrhea, and cardiovascular arrhythmias (heartbeat irregularities) may occur. Symptoms generally occur within 30 minutes, but may be delayed for several hours if ingested with food. Acute poisoning may result in acute hemolysis (breakdown of red blood cells).
Chronic Effects: Chronic symptoms include weight loss, hair loss, nausea, and diarrhea alternating with constipation, palmar and plantar hyperkeratoses (thickening of the corneous layer of skin on palms and soles of feet), and skin eruptions, and peripheral neuritis (inflammation of the nerves). Leukemia, bone marrow depression, or aplastic anemia (dysfunctioning of blood-forming organs) may occur after chronic exposure.
FIRST AID
Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
Skin: *Quickly* remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have a *conscious* person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: If emesis is unsuccessful after two doses of Ipecac, consider gastric lavage. Monitor urine arsenic level. Alkalinization of urine may help prevent disposition of red cell breakdown products in renal tubular cells. If acute exposure is significant, maintain high urine output and monitor volume status, preferably with central venous pressure line. Abdominal X-rays should be done routinely for all ingestions. Chelation therapy with BAL, followed by n-penicillamine is recommended, but specific dosing guidelines are not clearly established.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of spill, evacuate all unnecessary personnel, remove all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against dust inhalation and contact with skin and eyes. Use nonsparking tools. With a clean shovel, scoop material into a clean, dry container and cover. Absorb liquid material with sand or noncombustible inert material and place in disposal containers. Do not release to sewers, drains, or waterways. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations*
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance† (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [† per Clean Water Act, Sec. 307(a); per Clean Air Act, Sec. 112]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations‡
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

* Designations for arsenic only.
‡ Listed as arsenic organic compounds (as As).

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.
Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PELs, ACGIH TLVs, and NIOSH REL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed, properly labeled, containers in a cool, well-ventilated area away from all incompatible materials (Sec. 5) and heat and ignition sources. Protect containers from physical damage.
Engineering Controls: Avoid inhalation or ingestion of dust and fumes, and skin or eye contact. Practice good personal hygiene and housekeeping procedures. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program with training, maintenance, inspection, and evaluation. All engineering systems should be of maximum explosion-proof design and electrically grounded and bonded. Provide preplacement and annual physical examination with emphasis on the skin, respiratory system, and blood.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Arsenic, solid
DOT Hazard Class: Poison B
ID No.: UN1558
DOT Label: Poison
DOT Packaging Requirements: 173.366
DOT Packaging Exceptions: 173.364

IMO Shipping Name: Arsenic, metallic
IMO Hazard Class: 6.1
IMO Label: Poison
IMDG Packaging Group: II
ID No.: UN1558

***MSDS Collection* References:** 7, 26, 38, 53, 73, 85, 87, 88, 89, 100, 103, 109, 123, 124, 126, 127, 130, 136, 138
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD

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Benzo(a)pyrene **MSDS No. 164**

Date of Preparation: 2/94

Section 1 - Chemical Product and Company Identification 43

Product/Chemical Name: Benzo(a)pyrene
Chemical Formula: $C_{20}H_{12}$; a polynuclear aromatic hydrocarbon
CAS No.: 50-32-8
Synonyms: BaP; 3,4-benz(a)pyrene; BP; 3,4-benzopyrene; 3,4-benzpyrene. Formerly called 1,2-benzpyrene.
Derivation: Synthesized from pyrene and succinic anhydride.
General Use: Benzo(a)pyrene is no longer used or produced commercially in the US. In its pure form, benzo(a)pyrene may be used as a research laboratory reagent. It also occurs in combustion products of coal, oil, petroleum, wood and other biological matter; in motor vehicle and other gasoline and diesel engine exhaust; in charcoal-broiled foods; in cigarette smoke and general soot and smoke of industrial, municipal, and domestic origin. It occurs naturally in crude oils, shale oils, coal tars, gases and fly ash from active volcanoes and forest fires. **Vendors:** Consult the latest *Chemical Week Buyers' Guide.* [73]

Section 2 - Composition / Information on Ingredients

Benzo(a)pyrene, ca 100 %wt; except in laboratories, benzo(a)pyrene is usually mixed with other coal tar pitch chemicals. Consider exposure limits for coal tar pitch volatiles as a guideline. However, because benzo(a)pyrene is considered a probable carcinogen to humans, it is recommended that exposures to carcinogens be limited to the lowest feasible concentration.

OSHA PELs
Coal tar pitch volatiles
8-hr TWA: 0.2 mg/m^3

ACGIH TLVs
A2: Suspected Human Carcinogen

NIOSH REL
10-hr TWA: 0.1 mg/m^3
Carcinogen; coal tar pitch volatile, cyclohexane extractable fraction.

DFG (Germany) MAK
None established

IDLH Level
700 mg/m^3
Coal tar pitch volatiles (benzene soluble fraction)

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Benzo(a)pyrene is a pale yellow, crystalline solid or powder that is irritating to the skin, eyes, and respiratory tract. It is a carcinogen and mutagen. Handle with extreme caution!

Wilson Risk Scale
R 1
I 4
S 4
K 1

HMIS
H 2*
F 1
R 0
* Chronic Effects
PPE†
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion. **Target Organs:** Respiratory system, bladder, kidneys, skin.
Acute Effects: **Inhalation:** Respiratory tract irritation. **Eye:** Irritation and/or burns on contact. **Skin:** Irritation with burning sensation, rash, and redness; dermatitis on prolonged exposure. Sunlight enhances effects (photosensitization). **Ingestion:** None reported.
Carcinogenicity: IARC, NTP, NIOSH, ACGIH, EPA, and MAK list benzo(a)pyrene as: an IARC 2A (probably carcinogenic to humans: limited human evidence, sufficient evidence in experimental animals), an NTP-2 (reasonably anticipated to be a carcinogen: limited evidence from studies in humans or sufficient evidence from studies in experimental animals), a NIOSH-X (carcinogen defined with no further categorization); an ACGIH TLV-A2 (suspected human carcinogen: carcinogenic in experimental animals, but available epidemiological studies are conflicting or insufficient to confirm an increased risk of cancer in exposed humans); an EPA-B2 (sufficient evidence from animal studies, inadequate evidence or no data from epidemiological studies); and an MAK-A1 (capable of inducing malignant tumors as shown by experience with humans) carcinogen, respectively.
Medical Conditions Aggravated by Long-Term Exposure: Respiratory system, bladder, kidney, and skin disorders.
Chronic Effects: Inhalation: Cough and bronchitis. **Eye:** Photosensitivity and irritation. **Skin:** Skin changes such as thickening, darkening, pimples, loss of color, reddish areas, thinning of the skin, and warts. Sunlight enhances effects (photosensitization). **Other:** Gastrointestinal (GI) effects include leukoplakia (a pre-cancerous condition characterized by thickened white patches of epithelium on mucous membranes, especially of the mouth). Cancer of the lung, skin, kidneys, bladder, or GI tract is also possible. Smoking in combination with exposure to benzo(a)pyrene increases the chances of developing lung cancer. Persons with a high degree of inducibility of the enzyme aryl hydrocarbon hydroxylase may be a high risk population.
Comments: Pregnant women may be especially susceptible to exposure effects of benzo(a)pyrene; exposure may damage the fetus. In general, polyaromatic hydrocarbons such as benzo(a)pyrene tend to localize primarily in body fat and fatty tissues (for ex. breasts) and are excreted in breast milk. Benzo(a)pyrene may also affect the male reproductive system (testes and sperm).

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

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Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of tepid water for at least 15 min. Consult an ophthalmologist if irritation or pain persist.

Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water (less than 15 min). Wash exposed area with soap and water. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water to dilute. Inducing vomiting is not necessary since benzo(a)pyrene has a low acute toxicity and therefore, is generally an unnecessary procedure. Consider activated charcoal/cathartic.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Monitor CBC and arterial blood gases, conduct liver, renal, and pulmonary function tests (if respiratory tract irritation is present), and urinalysis. Biological monitoring techniques testing for metabolites in blood or urine, or DNA adducts in blood or tissues are useful for epidemiological studies that determine if exposure has occurred. Because neither normal nor toxic levels have been established, those techniques may not be useful for evaluating individual patients.

Special Precautions/Procedures: Emergency personnel should protect against exposure.

Section 5 - Fire-Fighting Measures

Genium

Flash Point: None reported. Benzo(a)pyrene may burn, but does *not* readily ignite.

Autoignition Temperature: None reported.

LEL: None reported.

UEL: None reported.

Extinguishing Media: For small fires, use dry chemical, sand, water spray, or foam. For large fires, use water spray, fog, or foam.

Unusual Fire or Explosion Hazards: None reported.

Hazardous Combustion Products: Carbon monoxide and carbon dioxide.

Fire-Fighting Instructions: Isolate hazard and deny entry. If feasible and without undue risk, move containers from fire hazard area. Otherwise, cool fire-exposed containers with water spray until well after fire is extinguished. Do not release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode and full protective clothing.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel of large spills, remove heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against dust inhalation and skin or eye contact. Clean up spills promptly.

Small Spills: Carefully scoop up spilled material and place into appropriate containers for disposal. For liquid spills, take up with a noncombustible, inert absorbent and place into appropriate containers for disposal.

Large Spills

Containment: For large spills, dike far ahead of liquid spill or contain dry spill for later disposal. Do not release into sewers or waterways.

Cleanup: *Do not* dry sweep! Use a vacuum with a HEPA filter or a wet method to reduce dust. After cleanup is complete, thoroughly decontaminate all surfaces. *Do not* reuse contaminated cleaning materials.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Handle with extreme caution and take all necessary measures to avoid exposure to benzo(a)pyrene because it is a carcinogen and mutagen. Follow good personal hygiene procedures and thoroughly wash hands with soap and water after handling. Use safety pipettes for all pipetting.

Storage Requirements: Store in tightly closed and properly labeled containers in a cool, well-ventilated area.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Use a Class I, Type B, biological safety hood when working with benzo(a)pyrene in a laboratory. Decrease the rate of air extraction, so that benzo(a)pyrene can be handled without powder being blown around the hood. Keep glove boxes under negative pressure. Use vertical laminar-flow, 100% exhaust, biological safety cabinets for containment of in vitro procedures. The exhaust air flow should be sufficient to provide an inward air flow at the face opening of the cabinet. Ensure contaminated air sheaths that are under positive pressure are leak-tight. Never use horizontal laminar-flow hoods or safety cabinets where filtered air is blown across the working area towards the operator. Test cabinets before work begins to ensure they are functioning properly.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations as low as possible. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103]

Administrative Controls: Consider preplacement and periodic medical examinations with emphasis on the oral cavity, bladder, kidneys, skin, and respiratory tract. Conduct urinalysis including specific gravity, albumin, glucose, and microscopic examination of centrifuged sediment for red blood cells. Also, include 14" x 17" chest roentgenogram, FVC + FEV_1, and CBC to detect any leukemia or aplastic anemia. It is recommended that this exam be repeated on an annual basis and semi-

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annual basis for employees 45 yr of age or older or with 10 or more years of exposure to coal tar pitch volatiles. Train workers about the hazards of benzo(a)pyrene and the necessary protective measures to prevent exposure. Periodically inspect lab atmospheres, surfaces such as walls, floors, and benches, and interior of fume hoods and air ducts for contamination. Post appropriate signs and labels on doors leading into areas where benzo(a)pyrene is used.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. The following respirator recommendations are for coal tar pitch volatiles. For any unknown concentration, wear any SCBA with a full facepiece and operated in a pressure-demand or other positive pressure mode, or any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary SCBA operated in pressure-demand or other positive pressure mode. For escape, wear any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapor canister having a high-efficiency particulate filter, or any appropriate escape-type SCBA. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. In animal laboratories, wear protective suits (disposable, one-piece and close-fitting at ankles and wrists), gloves, hair covering, and overshoes. In chemical laboratories, wear gloves and gowns. Wear protective eyeglasses or chemical safety, gas-proof goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy.

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Shower and change clothes after exposure or at the end of the workshift. Separate contaminated work clothes from street clothes. Launder before reuse. Remove benzo(a)pyrene from your shoes and clean personal protective equipment. Use procedures to ensure laundry personnel are not exposed.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid

Appearance and Odor: Pale yellow monoclinic needles with a faint, aromatic odor.

Vapor Pressure: >1 mm Hg at 68 °F (20 °C)

Formula Weight: 252.30

Specific Gravity (H_2O=1, at 4 °C): 1.351

Water Solubility: Insoluble; 0.0038 mg (+/- 0.00031 mg) in 1 L at 77 °F (25 °C)

Other Solubilities: Ether, benzene, toluene, xylene, concentrated hydrosulfuric acid; sparingly soluble in alcohol, methanol.

Boiling Point: >680 °F (>360 °C); 540 °F (310 °C) at 10 mm Hg

Melting Point: 354 °F (179 °C)

Octanol/Water Partition Coefficient: log Kow= 6.04

Section 10 - Stability and Reactivity

Stability: Benzo(a)pyrene is stable at room temperature in closed containers under normal storage and handling conditions. It undergoes photo-oxidation when exposed to sunlight or light in organic solvents and is also oxidized by chromic acid and ozone.

Polymerization: Hazardous polymerization cannot occur.

Chemical Incompatibilities: Strong oxidizers (chlorine, bromine, fluorine) and oxidizing chemicals (chlorates, perchlorates, permanganates, and nitrates).

Conditions to Avoid: Avoid heat and ignition sources and incompatibles.

Hazardous Decomposition Products: Thermal oxidative decomposition of benzo(a)pyrene can produce carbon monoxide and carbon dioxide.

Section 11- Toxicological Information

Toxicity Data:*

Tumorigenic Effects:

Rat, oral: 15 mg/kg produced gastrointestinal and musculoskeletal tumors.

Mouse, inhalation: 200 ng/m^3/6 hr administered intermittently over 13 weeks produced tumors of the lungs.

Rabbit, skin: 17 mg/kg administered intermittently over 57 weeks produced tumors of the skin and appendages.

Teratogenicity:

Rat, oral: 2 g/kg administered 28 days prior to mating and 1-22 days of pregnancy produced a stillbirth.

Rat, oral: 40 mg/kg on the 14th day of pregnancy caused changes in the extra embryonic structures.

Mouse, oral: 75 mg/kg administered to the female during the 12-14 day of pregnancy produced biochemical and metabolic effects on the newborn.

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Skin Effects:
Mouse: 14 µg caused mild irritation.

Mutagenicity:
Human, liver cell: 100 nmol/L caused DNA damage.
Human, lung cell: 1 µmol/L caused DNA damage.
Human, HeLa cell: 1500 nmol/L caused DNA inhibition.

* See NIOSH, *RTECS* (DJ3675000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Oysters, BCF (bioconcentration factor): 3000; rainbow trout, BCF: 920; *Daphnia pulex*, BCF: 13,000.
Environmental Transport: Some marine organisms such as phytoplankton, certain zooplankton, scallops (*Placopecten sp*), snails (*Litternia littorea*), and mussels (*Mytilus edulis*) lack a metabolic detoxification enzyme system to metabolize benzo(a)pyrene and therefore, tend to accumulate benzo(a)pyrene. Humic acid in solution may decrease bioconcentration.
Environmental Degradation: If released to water, benzo(a)pyrene adsorbs very strongly to particulate matter and sediments, bioconcentrates in aquatic organisms which cannot metabolize it, but does not hydrolyze. Direct photolysis at the water surface, evaporation, or biodegradation may be important, but adsorption may significantly retard these processes. Adsorption to particulates may also retard direct photolysis when benzo(a)pyrene is released to air. Benzo(a)pyrene may be removed from air by reaction with nitrogen dioxide (half-life, 7 days) or ozone (half-life, 37 min), or photochemically produced hydroxyl radicals (estimated half-life, 21.49 hr).
Soil Absorption/Mobility: It will adsorb very strongly to the soil. Although it is not expected to appreciably leach to the groundwater, groundwater samples indicate that it can be transported there. It is not expected to significantly evaporate or hydrolyze from soils and surfaces. However, it may be subject to appreciable biodegradation in soils.

Section 13 - Disposal Considerations

Disposal: Small quantities: 10 mL of a solution containing 0.3 mol/L of potassium permanganate and 3 mol/L of sulfuric acid will degrade 5 mg of benzo(a)pyrene. Also, can treat with sodium dichromate in strong sulfuric acid (1-2 days). Benzo(a)pyrene is also a good candidate for fluidized bed incineration at a temperature range of 842 to 1796 °F (450 to 980 °C) or rotary kiln incineration at 820 to 1600°C. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Environmentally hazardous substances, solid, n.o.s.*
Shipping Symbols: —
Hazard Class: 9
ID No.: UN3077
Packing Group: III
Label: Class 9
Special Provisions (172.102): 8, B54

Packaging Authorizations
a) Exceptions: 173.155
b) Non-bulk Packaging: 173.213
c) Bulk Packaging: 173.240

Quantity Limitations
a) Passenger, Aircraft, or Railcar: None
b) Cargo Aircraft Only: None

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: —

* If it is in a quantity, in one package, which equals or exceeds the reportable quantity (RQ) of 1 lb (0.454 kg)

Section 15 - Regulatory Information

EPA Regulations:
Listed as a RCRA Hazardous Waste (40 CFR 261.33)
RCRA Hazardous Waste Number: U022
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) per RCRA and CWA, Sec. 307(a)
CERCLA Reportable Quantity (RQ), 1 lb (0.454 kg)
SARA 311/312 Codes: 1,2
SARA Toxic Chemical (40 CFR 372.65): Not listed
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed
OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)
Listed as an OSHA Specifically Regulated Substance, Coal Tar Pitch Volatiles, (29CFR 1910.1002)

Section 16 - Other Information

References: 73, 103, 124, 127, 132, 133, 136, 139, 148, 164, 169, 174, 175, 184, 187, 189, 190
Prepared By .. MJ Wurth, BS **Industrial Hygiene Review** .... PA Roy, MPH **Medical Review** .... T Thoburn, MD, MPH
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Cadmium Sulfate

MSDS No. 199

Date of Preparation: 1/87 Revision: A, 4/95

Section 1 - Chemical Product and Company Identification 46

Product/Chemical Name: Cadmium Sulfate
Chemical Formula: $CdSO_4$; $3CdSO_4 \cdot 8H_2O$; $CdSO_4 \cdot 4H_2O$
CAS Number: 10124-36-4
Synonyms: cadmium monosulfate, cadmium sulfate (1:1), cadmium sulphate; sulfuric acid, cadmium salt (1:1); sulfuric acid, cadmium (2^+) salt
Derivation: By the action of dilute sulfuric acid on cadmium, cadmium carbonate, or cadmium oxide; also produced as an intermediate in recovery of cadmium from zinc ore. Anhydrous cadmium sulfate is prepared by the oxidation of the sulfide or sulfite at elevated temperatures.
General Use: In pigments, electroplating, fluorescent screens, the manufacture of standard cadmium elements, determining hydrogen sulfide, detecting fumaric acid, vacuum tubes; as an accelerator in cement formation; a chemical intermediate for cadmium salts of long chain fatty acids, a fungicide, as a catalyst in marsh test for arsenic, an electrolyte in Weston standard cell; and to absorb hydrochloric acid from waste gases from chemical plants.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* [73]

Section 2 - Composition / Information on Ingredients

Cadmium Sulfate, ca 99 % wt minimum (reagent grade). Commercial grade reportedly contains approximately 49.5% cadmium. Trace Impurities (anhydrous): insoluble matter: 0.005%; sulfate: 0.15%; chloride: 0.001%; nitrate and nitrite: 0.003%; copper: 0.002%; iron: 0.001%; lead: 0.003%; zinc: 0.10%; and arsenic: 2 ppm.

OSHA PELs*
8-hr TWA: 0.005 mg (Cd)/m^3
Carcinogen (See 29 CFR 1910.1027)

ACGIH TLVs*
TWA: 0.01 mg (Cd)/m^3, inhalable dust/particle
TWA: 0.002 mg (Cd)/m^3, respirable fraction of dust

NIOSH REL*
Carcinogen; lowest feasible concentration
Limit of Quantitation: 0.1 mg (Cd)/m^3

IDLH Level
Carcinogen; 9 mg (Cd)/m^3

DFG (Germany) MAK*
None established

* These exposure limits apply to cadmium and compounds, as Cd.

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Cadmium sulfate exists as colorless to white crystals or powder; odorless. It is a skin, eye, and respiratory tract irritant. Exposure may cause kidney damage. Cadmium and compounds are classified as carcinogens.

Wilson Risk Scale
R 1
I 4
S 2
K 1

HMIS
H 2*
F 0
R 0
* Chronic effects
PPE†
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation and ingestion.
Target Organs: Kidneys, respiratory and gastrointestinal tracts.
Acute Effects
Inhalation: Metallic taste in the mouth, nausea, vomiting, chills, weakness, leg pains, diarrhea, throat dryness, cough, headache, shortness of breath, chest pains, kidney damage, extreme restlessness and irritability, pneumonitis, bronchitis, and in severe cases, pulmonary edema (possibly resulting in death). Note: Symptoms may not begin for up to 12 hr following exposure.
Eye: Irritation.
Skin: Irritation.
Ingestion: Severe nausea, salivation, choking, vomiting, diarrhea, abdominal pain, headache, muscular cramps, vertigo (dizziness), and perhaps convulsions (rarely). Exhaustion, collapse, shock and death may occur within 24 hr if large doses are ingested.
Carcinogenicity: IARC, NTP, and OSHA list cadmium and compounds (as Cd) as IARC-1 (carcinogenic to humans: sufficient evidence of carcinogenicity), NTP-2 (reasonably anticipated to be a carcinogen: limited evidence from studies in humans or sufficient evidence from studies in experimental animals), and OSHA-X (carcinogen defined with no further categorization), respectively. The EPA, DFG, ACGIH, and NIOSH list cadmium and compounds (as Cd) as EPA-B1 (limited evidence of carcinogenicity from epidemiologic studies), MAK-A2 (unmistakably carcinogenic in animal experimentation only), TLV-A2 (suspected human carcinogen), and NIOSH-X (carcinogen defined with no further categorization), respectively.
Medical Conditions Aggravated by Long-Term Exposure: Kidney, skin and lung disease.

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Chronic Effects: Chronic bronchitis and rhinitis, gastrointestinal symptoms, impairment or loss of sense of smell, pulmonary fibrosis, emphysema, kidney dysfunction, proteinuria, kidney stones, kidney damage, yellow discoloration of the teeth, and changes in bone. The data concerning anemia is conflicting in human and animal studies. Anemia primarily results from impaired absorption of iron from the diet following gastrointestinal exposure to cadmium. Liver effects have occasionally been found in animal studies, but they have rarely been observed in humans. Immunosuppression has been observed in animal studies and there is limited evidence in humans. The data concerning prostate cancer and exposure to cadmium is conflicting. Early studies suggested elevations in prostate cancer among men occupationally exposed to cadmium, but subsequent investigations found elevations in prostate cancer that were not statistically significant.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air, monitor for respiratory distress, and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of tepid water for at least 15 min. Consult a physician or ophthalmologist if pain or irritation develop or persist.

Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Cadmium-induced renal disease may appear in workers months or years following removal from exposure; signs of renal pathology may progress slowly. Proteinuria is commonly characterized by excretion of low molecular weight proteins (15,000 to 40,000 MW) accompanied by loss of electrolytes, calcium, uric acids, and phosphate. Compounds commonly excreted include: beta-2-microglobulin (β2-M), ribonuclease, lysozyme, immunoglobulin light chains, and retinol-binding protein. Elevated urinary excretion of these proteins is symptomatic of proximal tubular damage. Chelation therapy may be of benefit immediately following an acute ingestion exposure, but is not recommended for cases of chronic poisoning. Activated charcoal has no proven benefit in cadmium poisoning. For pulmonary edema, maintain ventilation and oxygenation with close arterial blood gas monitoring. Early use of PEEP and mechanical ventilation may be needed to maintain pO_2 greater than 50 mm Hg with FIO_2 less than 60%.

Special Precautions/Procedures: Emergency personnel should protect against contamination when rescuing exposure victims.

Section 5 - Fire-Fighting Measures

Genium

Flash Point: None reported.*

Autoignition Temperature: None reported.

LEL: None reported.

UEL: None reported.

Extinguishing Media: Use extinguishing media appropriate to the surrounding fire.

Unusual Fire or Explosion Hazards: Cadmium sulfate is a moderate fire hazard in the form of dust.

Hazardous Combustion Products: Oxides of sulfur and cadmium.

Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing will provide limited protection.

* Cadmium sulfate is a moderate fire hazard in the form of dust.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel of large spills, evacuate unnecessary personnel, provide adequate ventilation, and remove heat and ignition sources.

Small Spills: Carefully take up spilled material in a manner that minimizes dust generation; use a vacuum with a HEPA filter. For liquid spills, take up with an inert, absorbent material such as sand or vermiculite and place in appropriate containers for disposal.

Large Spills

Containment: For large spills, dike far ahead of liquid spill for later disposal. Do not release into sewers or waterways.

Cleanup: Avoid dust generation; *do not* sweep!

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid dust inhalation, skin/eye contact, and ingestion. Use only with adequate ventilation. Wear appropriate personal protective equipment (Sec. 8). Practice good personal hygiene and housekeeping measures. Thoroughly wash hands and face before eating, drinking or smoking.

Storage Requirements: Store in a cool, dry, well-ventilated area away from heat and ignition sources and incompatibles.

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Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Enclose all processes to prevent dust dispersion into the work area.
Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Administrative Controls: Consider preplacement and periodic medical exams with emphasis on the respiratory system and kidneys. Obtain pulmonary function tests (FVC and FEV 1 sec), a 14 x 17 in roentgenogram, and urinalysis including specific gravity, protein, glucose, and a microscopic examination of the centrifuged sediment. Refer to 29 CFR 1910.1027 for specific medical surveillance requirements. The ACGIH Biological Exposure Index for cadmium and inorganic compounds is 5 µg/g creatinine for cadmium in urine and 5 µg/L for cadmium in blood. The amount of cadmium in the blood shows only recent exposure while cadmium in the urine shows both recent and past exposure. Urinary metallothionein may be a better indicator of body burden.
Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. The following respirator recommendations are for cadmium dust, as Cd. For concentrations above the NIOSH REL, where there is no REL, or at any detectable concentration, wear any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.
Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.
Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.
Contaminated Equipment: Shower and completely change clothes at the end of the work shift. Separate contaminated work clothes from street clothes. Launder before reuse. Remove cadmium sulfate from your shoes and clean personal protective equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid
Appearance and Odor: Colorless to white; odorless.
Formula Weight: 208.47
Density (H_2O=1, at 4 °C): 4.691 g/cm^3 at 68 °F (20 °C)
Water Solubility: 75.5 g/100 mL at 32 °F (0 °C); 60.8 g/100 mL at 212 °F (100 °C)
Other Solubilities: Insoluble in alcohol, acids, acetone, and ammonia.
Melting Point: 1832 °F (1000 °C)
Refractive Index: 1.565
pH (of a 5% solution at 77 °F/25 °C): 3.5-5.0; octahydrate

Section 10 - Stability and Reactivity

Stability: Cadmium sulfate is stable at room temperature in closed containers under normal storage and handling conditions.
Polymerization: Hazardous polymerization does not occur.
Chemical Incompatibilities: Oxidizing agents, metals, hydrogen azide, zinc, selenium, and tellurium.
Conditions to Avoid: Avoid heat and ignition sources and incompatibles.
Hazardous Decomposition Products: Thermal oxidative decomposition of cadmium sulfate can produce oxides of sulfur and cadmium.

Section 11 - Toxicological Information

Toxicity Data:*

Acute Oral Effects:
Rat, oral, LD_{50}: 280 mg/kg
Mouse, oral, LD_{50}: 88 mg/kg

Genetic Effects:
Human lymphocyte: 500 µmol/L caused DNA damage.
Rat, liver cell: 30 µmol/L caused DNA damage.
Mouse, lymphocyte: 150 µg/L caused mutations.

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Reproductive Effects:

Mouse, intraperitoneal: 2570 µg/kg administered to a female on the 9th day of pregnancy caused specific developmental abnormalities of the musculoskeletal system.

Rat, oral, TD_{Lo}: 35230 mg/kg (1-19 days of pregnancy); toxic effects include effects on fertility (pre-implantation; post-implantation mortality), effects on embryo or fetus (maternal fetal exchange), specific developmental abnormalities (cardiovascular system), and effects on newborn (weaning or lactation index; growth statistics).

* See NIOSH, *RTECS* (EV2700000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: *Cloeon dipterum* (mayfly), LC_{50}: 6990 µg/L/72 hr at 77 °F (25 °C); *Acanthocyclops viridis* (copepod), LC_{50}: 0.5 µg/L/72 hr; *Daphnia magna* (cladoceran), 3-5 days old, LC_{50}: 12 µg/L/72 hr at 77 °F (25 °C)

Aquatic Toxicity: Striped bass, LC_{50}: 0.003 mg/L/24 hr, static test environment; *Tetrahymena pyriformis* (protozoa), LC_{50}: 1.67 mg/L/96 hr, static distilled test environment; minnows, lethal: 1042 mg/L.

Environmental Fate: Cadmium sulfate tends to precipitate in natural waters with manganese oxide, iron oxide, and hydrates. Cadmium is relatively mobile in the aquatic environment and may be transported in solution as either hydrated cations or as organic or inorganic complexes. Photolysis is not an important removal mechanism in the aquatic environment.

Environmental Transport: *Corbicula fluminea* (Asiatic clam) exposed to cadmium sulfate for 28 days exhibited a bioconcentration factor of 1752-3770. *Daphnia magna* (cladoceran) exposed to cadmium sulfate for 7 days exhibited a bioconcentration factor of 484.

Soil Absorption/Mobility: Adsorption to soil is strongly pH-dependent, increasing as conditions become more alkaline. When the pH is below 6-7, cadmium is desorbed from these materials.

Section 13 - Disposal Considerations

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Container Cleaning and Disposal: Handle empty containers carefully as residues may still remain. Triple rinse containers and dispose of wastewater accordingly.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Cadmium compounds
Shipping Symbols: —
Hazard Class: 6.1
ID No.: UN2570
Packing Group: III
Label: Keep away from food
Special Provisions (172.102): —

Packaging Authorizations
a) **Exceptions:** 173.153
b) **Non-bulk Packaging:** 173.213
c) **Bulk Packaging:** 173.240

Quantity Limitations
a) **Passenger, Aircraft, or Railcar:** 100 kg
b) **Cargo Aircraft Only:** 200 kg

Vessel Stowage Requirements
a) **Vessel Stowage:** A
b) **Other:** —

Section 15 - Regulatory Information

EPA Regulations:

Classified as a RCRA Hazardous Waste (40 CFR 261.24): Hazardous Waste Number D006, Toxicity Characteristic, Regulatory Level: 1.0 mg/L

Listed as a CERCLA Hazardous Substance (40 CFR 302.4), as cadmium and compounds, per CWA, Sec. 307(a)

CERCLA Reportable Quantity Statutory (RQ), 1 lb (0.454 kg)

Listed as a SARA Toxic Chemical, as cadmium compounds, (40 CFR 372.65)

SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)

Listed as an OSHA Specifically Regulated Substance, as cadmium, (29 CFR 1910.1027)

Section 16 - Other Information

References: 73, 103, 136, 167, 176, 189, 190, 197, 201, 202, 204, 206

Prepared By ..... MJ Wurth, BS
Industrial Hygiene Review ..... PA Roy, MPH, CIH
Medical Review ..... T Thoburn, MD, MPH

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Material Safety Data Sheets Collection:

Sheet No. 59
Beryllium Metal/Powder

Issued: 4/80 Revision: A, 11/89

Section 1. Material Identification 30

Beryllium Metal/Powder Description: A naturally occurring ore found in chrysoberyl (Be_2SiO_4) or produced industrially from beryl ($3BeO.Al_2O_3.6SiO_2$). The ore is converted to the oxide or hydroxide, then to the fluoride or chloride. The halide may be reduced in a furnace by magnesium metal or by electrolysis. An alternative purification process is a liquid-liquid extraction with an organophosphate chelating agent. Used in aerospace structures, radio tube parts, inertial guidance systems, computer parts, Be-Cu alloys, gyroscopes; used as an additive in solid propellant rocket fuels, as a neutron source when bombarded with alpha particles, and as a neutron moderator and reflector in nuclear reactors.
Other Designations: Glucinium; Be; CAS No. 7440-41-7.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

R	1
I	4
S	2
K	1

Genium

HMIS
H 4
F 1
R 0
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Beryllium and compounds, ca 100%

OSHA PELs
8-hr TWA: 0.002 ppm
30-min STEL: 0.005 ppm
Ceiling level: 0.025 ppm

ACGIH TLV, 1989-90*
TLV-TWA: 0.002 mg/m³

NIOSH REL, 1987*
Not to exceed 0.5 µg/m³

Toxicity Data†
Human, inhalation, TC_{Lo}: 300 mg/m³, pulmonary effects
Rabbit, intravenous, TD_{Lo}: 20 mg/kg, neoplastic effects

* These values are for beryllium and its compounds.
† See NIOSH, *RTECS* (DS1750000), for additional data with references to mutagenic and tumorigenic effects.

Section 3. Physical Data

Boiling Point: 5378 °F (2970 °C)
Melting Point: 2332 °F (1278 °C)
Vapor Pressure: 7.6 mm Hg at 3470 °F (1910 °C)
Atomic Weight: 9.01 g/mol

Specific Gravity (H_2O = 1 at 39 °F (4 °C)): 1.848 at 68 °F (20 °C)
Water Solubility, hot water: Slight
cold water: Insoluble

Appearance and Odor: A grayish-white metal with a hexagonal and aniostropic crystal structure (i.e., their index of refraction varies with incident light direction), and a powdered metal, no odor.

Section 4. Fire and Explosion Data

Flash Point: None reported **Autoignition Temperature:** Powder, ca 1200 °F (649 °C) **LEL:** None reported **UEL:** None reported
Extinguishing Media: *Never* use water or CO_2. Instead, smother the fire with an approved dry-powder extinguisher. Sand, graphite powder, and sodium chloride are also recommended.
Unusual Fire or Explosion Hazards: Beryllium can be a moderate fire hazard if exposed to flame. The hazards increase as particulate size decreases. A beryllium dust cloud can be explosive (areas where dusting may occur require Class 2, Group E electrical services, 29 CFR 1910.309). This material's combustion products are *highly toxic.*
Special Fire-fighting Procedures: Fire fighters should use full protective clothing, eye protection, and a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. After exposure to a beryllium fire, they should clean equipment and bathe carefully.

Section 5. Reactivity Data

Stability/Polymerization: Beryllium is stable at room temperature in closed containers.* Hazardous polymerization cannot occur.
Chemical Incompatibilities: Acid and alkali soluble, it reacts with strong bases to evolve hydrogen.† Warm beryllium reacts incandescently with phosphorus, fluorine, or chlorine. Molten lithium metal at 356 °F (180 °C) severely attacks beryllium metal.
Conditions to Avoid: When heated in air or in mixed CO_2 and nitrogen, beryllium is ignitable. Mixtures of the powdered metal with CCl_4 or trichloroethylene flash on heavy impact.
Hazardous Products of Decomposition: Thermal oxidative decomposition of beryllium emits very toxic oxide of beryllium fumes.

* When moist, beryllium forms thin, acid-resistant oxide films on solid surfaces.
† A simple asphyxiant gas, hydrogen is extremely flammable.

Section 6. Health Hazard Data

Carcinogenicity: The NTP, IARC, and ACGIH list beryllium as a carcinogen. Animal studies also indicate that beryllium produces lung and bone tumors.
Summary of Risks: Beryllium is highly toxic by inhalation of fume or dust and exposure to this element and its salts may cause death. Inhaled beryllium is partially deposited in the lungs, the blood system, and finally the bones, thus affecting all organ systems. Since the human body does not quickly eliminate beryllium, trace amounts in urine are detectable as long as 10 years after exposure. Prolonged or repeated skin contact can cause skin irritation or dermatitis. Eye contact can produce conjuctivitis and eye ulcers. If introduced through the skin via cuts or punctures, nonhealing ulcers may develop.

Continue on next page

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Section 6. Health Hazard Data, continued

Medical Conditions Aggravated by Long-Term Exposure: Increased risk of lung, liver, gall bladder, and bile duct cancers. **Target Organs:** Lungs, mucous membranes, eyes, skin. **Primary Entry:** Inhalation. **Acute Effects:** Symptoms may occur up to 72 hr after a massive exposure. Acute inhalation can produce pneumonitis with inflammation of the upper and lower respiratory tracts, nasal congestion, nonproductive coughing, and pulmonary edema. High dose exposures may cause acute respiratory distress, brain hemorrhaging, liver inflammation, and spleen hemorrhaging. **Chronic Effects:** Symptoms may be delayed up to 15 years. Chronic exposures result from long-term exposure to small (microgram) quantities and can produce berylliosis. Berylliosis is a progressive granuloma formation in the lungs which eventually causes increasing shortness of breath and, in some cases, death. Since it also circulates among other organs, beryllium causes eventual heart enlargement and failure, liver and spleen enlargement, kidney stones, various malignant tumors, and damaging cell death in any organ in which it accumulates.

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min. **Skin:** After rinsing affected area with flooding amounts of water, wash it with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear. Present studies indicate that beryllium is so poorly absorbed through the intestinal tract, that ingestion is not an important hazard (*Industrial Toxicology*, 3rd Edition, Hamilton).

After first aid, get appropriate in-plant, paramedic, or community medical attention and support. Watch for signs of respiratory deterioration, and use oxygen as needed.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: If powdered metal is spilled, notify safety personnel. Evacuate area except for cleanup personnel with protective equipment against contact or inhalation hazards. Provide ventilation and remove heat and ignition sources. To prevent dusting conditions, vacuum or wet mop powder spills. Collect particulate scrap, absorb on paper, and transfer to a sealed recovery or disposal container. **Disposal:** Dissolve beryllium in a small amount of 6M-HCl, filter it, and add a slight excess of 6M-NH_4OH to the filtrate using litmus as an indicator (blue at pH 8.3). Heat and coagulate the precipitate. After 12 hr, filter and dry it. Handle beryllium waste unsuitable for recycling in accordance with Federal, state, and local regulations. Dispose of scrap or waste material by arranging its return to the supplier in a mutually acceptable form. Contact your supplier or a licensed contractor for detailed recommendations.

OSHA Designations

Listed as Air Contaminant (29 CFR 1910.1000, Table Z-2)

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 100 lb (45.4 kg) [* per RCRA, Sec. 3001; per Clean Water Act, Sec. 307(a), 112]

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

SARA Toxic Chemical (40 CFR 372.65): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Wear a NIOSH-approved respirator for emergency and nonroutine use in concentrations above the 8-hr, 2-µg/m³ TWA. For any time period, a half-mask, air-purifying respirator with a high-efficiency filter is suitable for concentrations as high as 25-µg Be/m³ (see NIOSH, *A Recommended Standard for Occupational Exposure to Beryllium*, Sec. 4). A powered, air-purifying respirator equipped with a "fume filter" is suitable for concentrations up to 40 µg Be/m³. A full facepiece, air-purifying respirator with a high-efficiency filter is suitable for concentrations up to 100 µg Be/m³. A powered, air-purifying respirator equipped with a high-efficiency filter, operating in the positive-pressure mode, is suitable for concentrations up to 1000 µg Be/m³. An SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode is suitable for concentrations above 1000 µg Be/m³. Follow OSHA respirator regulations (29 CFR 1910.134). **Warning:** Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. When exposure levels exceed the TLV, change into clean protective clothing and shower at the end of your shift. **Ventilation:** Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL standards (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103). **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Clearly label and store beryllium away from incompatible materials (Sec. 5) in a clean, dry, low fire-hazard area. Protect containers from physical damage. **Engineering Controls:** Provide adequate ventilation in areas where beryllium can become airborne. Monitor these areas with personal samplers to limit and control exposure levels. Teach workers about beryllium's potential hazards. Practice good housekeeping to prevent accumulation of beryllium-containing deposits. Give preplacement and annual medical exams (chest x-rays, baseline pulmonary function tests [FVC_1 (functional vital capacity) and FEV_1 (the amount of air exhaled in the first second after maximum inhalation)] and body weight measurements to workers possibly exposed to concentrations above the TLV. Prevent exposing those with pulmonary disease, chronic skin, liver, heart, or kidney conditions; abnormal chest x-ray or blood count; or vital capacity depression greater than 10%. Ensure all engineering systems (production, transportation) are of maximum explosion-proof design. To prevent static sparks, electrically ground and bond all containers and pipelines used in shipping, transferring, reacting, producing, and sampling operations.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Beryllium compound, n.o.s.
DOT Hazard Class: Poison B
DOT ID No.: UN1567

IMO Shipping Name: Beryllium, metal powder
IMO Hazard Class: 6.1
IMO Label: Poison, flammable solid

***MSDS Collection* References:** 1-12, 18-20, 24-26, 81, 84, 85, 88-91, 100, 116, 117

Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** Warren Silverman, MD

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Material Safety Data Sheets Collection:

Sheet No. 312

Trichloroethylene

Issued: 7/79 Revision: F, 9/92

Section 1. Material Identification

Trichloroethylene (C_2HCl_3) Description: Derived by treating tetrachloroethane with lime or other alkali in the presence of water, or by thermal decomposition of tetrachloroethane followed by steam distillation. Stabilizers such as epichlorohydrin, isobutanol, carbon tetrachloride, chloroform, benzene, or pentanol-2-triethanolamine are then added. Used as a degreasing solvent in electronics and dry cleaning, a chemical intermediate, a refrigerant and heat-exchange liquid, and a diluent in paint and adhesives; in oil, fat, and wax extraction and in aerospace operations (flushing liquid oxygen). Formerly used as a fumigant (food) and anesthetic (replaced due to its hazardous decomposition in closed-circuit apparatus).
Other Designations: CAS No. 79-01-6; acetylene trichloride; Algylen; Anamenth; Benzinol; Cecolene; Chlorylen; Dow-Tri; ethylene trichloride; Germalgene; Narcogen; Triasol; trichloroethene; TCE; 1,1,3-trichloroethylene.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

R 1
I 2
S 2*
K 3
* Skin absorption

NFPA
2 / 2 / 0 / -

HMIS
H 2†
F 2
R 0
PPE‡
† Chronic Effects
‡ Sec. 8

Cautions: TCE is irritating and toxic to the central nervous system (CNS). Inhalation of high concentrations have lead to death due to ventricular fibrillation. Chronic exposure may lead to heart, liver, and kidney damage. The liquid is absorbed through the skin. Although it has a relatively low flash point, TCE burns with difficulty.

Section 2. Ingredients and Occupational Exposure Limits

Trichloroethylene, < 100% [contains stabilizers (Sec. 1)].

1991 OSHA PELs
8-hr TWA: 50 ppm (270 mg/m^3)
15-min STEL: 200 ppm (1080 mg/m^3)

1990 IDLH Level
1000 ppm

1990 NIOSH REL
10-hr TWA: 25 ppm (~135 mg/m^3)

1992-93 ACGIH TLVs
TWA: 50 ppm (269 mg/m^3)
STEL: 200 ppm (1070 mg/m^3)

1990 DFG (Germany) MAK
Ceiling: 50 ppm (270 mg/m^3)
Category II: Substances with systemic effects
Half-life: 2 hr to shift length
Peak Exposure Limit: 250 ppm, 30 min average value; 2 peaks/shift

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 160 ppm/83 min caused hallucinations and distorted perceptions.
Human, lymphocyte: 5 mL/L caused DNA inhibition.
Rabbit, skin: 500 mg/24 hr caused severe irritation.
Rabbit, eye: 20 mg/24 hr caused moderate irritation.
Mouse, oral, TD_{Lo}: 455 mg/kg administered intermittently for 78 weeks produced liver tumors.

* See NIOSH, *RTECS* (KX4550000), for additional irritation, mutation, reproductive, tumorigenic and toxicity data.

Section 3. Physical Data

Boiling Point: 189 °F (87 °C)
Freezing Point: -121 °F (-85 °C)
Viscosity: 0.0055 Poise at 77 °F (25 °C)
Molecular Weight: 131.38
Density: 1.4649 at 20/4 °C
Refraction Index: 1.477 at 68 °F (20 °C/D)
Odor Threshold: 82 to 108 ppm (*not an effective warning*)

Vapor Pressure: 58 mm Hg at 68 °F (20 °C); 100 mm Hg at 32 °F (0 °C)
Saturated Vapor Density (Air = 0.075 lbs/ft^3; 1.2 kg/m^3): 0.0956 lbs/ft^3; 1.53 kg/m^3
Water Solubility: Very slightly soluble; 0.1% at 77 °F (25 °C)
Other Solubilities: Highly soluble in organic solvents (alcohol, acetone, ether, carbon tetrachloride, & chloroform) and lipids.
Surface Tension: 29.3 dyne/cm

Appearance and Odor: Clear, colorless (sometimes dyed blue), mobile liquid with a sweet chloroform odor.

Section 4. Fire and Explosion Data

Flash Point: 90 °F (32 °C) CC	Autoignition Temperature: 788 °F (420 °C)	LEL: 8% (25 °C); 12.5% (100 °C)	UEL: 10% (25 °C); 90% (100 °C)

Extinguishing Media: A Class 1C Flammable Liquid. Although it has a flash point of 90 °F, TCE burns with difficulty. For small fires, use dry chemical, carbon dioxide, water spray, or regular foam. For large fires, use water spray, fog, or regular foam. **Unusual Fire or Explosion Hazards:** Vapor/air mixtures may explode when ignited. Container may explode in heat of fire. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing provides only limited protection against TCE. Apply cooling water to sides of container until well after fire is out. Stay away from ends of tanks. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: TCE slowly decomposes in the presence of light and moisture to form corrosive hydrochloric acid. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Include alkalis (sodium hydroxide), chemically active metals (aluminum, beryllium, lithium, magnesium, sodium, potassium, and titanium), epoxides, and oxidants (nitrogen tetraoxide, perchloric acid). Contact with 1-chloro-2,3-epoxy propane or the mono and di 2,3-epoxypropyl ethers of 1,4-butanediol + 2,2-bis-4(2',3'-epoxypropoxy)-phenylpropane can, in the presence of catalytic quantities of halide ions, cause dehydrochlorination of TCE to explosive dichloroacetylene. **Conditions to Avoid:** Exposure to light, moisture, ignition sources, and incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of TCE (above 300 °C) or exposure to ultraviolet light can produce carbon dioxide (CO_2) and toxic dichloro acetylene (explosive), chlorine, hydrogen chloride, and phosgene gas.

Section 6. Health Hazard Data

Carcinogenicity: The following agencies have rated TCE's carcinogenicity: IARC (Class 3, limited animal evidence & insufficient human data), Germany MAK (Class B, justifiably suspected of having carcinogenic potential), & NIOSH (Class X, carcinogen defined with no further categorization). **Summary of Risks**: TCE vapor is irritating to the eyes, nose, and respiratory tract and inhalation of high concentrations can lead to severe CNS effects such as unconsciousness, ventricular arrythmias, and death due to cardiac arrest. Mild liver dysfunction was also seen at levels high enough to produce CNS effects. Contact with the liquid is irritating to the skin and can lead to dermatitis by defatting the skin. Chronic toxicity is observed in the victims increasing intolerance to alcohol characterized by 'degreasers flush', a transient redness of the face, trunk, and arms. The euphoric effect of TCE has led to craving, and habitual sniffing of its vapors.

Continue on next page

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Section 6. Health Hazard Data, *Continued*

TCE crosses the placental barrier and thus exposes the fetus (any effects are yet unknown). There are increased reports of menstrual disorders in women workers and decreased libido in males at exposures high enough to cause CNS effects. TCE is eliminated unchanged in expired air and as metabolites (trichloroacetic acid & trichloroethanol) in blood and urine. **Medical Conditions Aggravated by Long-Term Exposure:** Disorders of the nervous system, skin, heart, liver, and kidney. **Target Organs:** Respiratory, central & peripheral nervous, and cardiovascular (heart) systems, liver, kidney, and skin. **Primary Entry Routes:** Inhalation, skin and eye contact, and ingestion (rarely). **Acute Effects:** Vapor inhalation can cause eye, nose, and throat irritation, nausea, blurred vision, overexcitement, headache, drunkenness, memory loss, irregular heartbeat (resulting in sudden death), unconsciousness, and death due to cardiac failure. Skin contact with the liquid can cause dryness and cracking and prolonged exposure (generally if the victim is unconscious) can cause blistering. Eye contact can cause irritation and watering, with corneal epithelium injury in some cases. Ingestion of the liquid can cause lip, mouth, and gastrointestinal irritation, irregular heartbeat, nausea and vomiting, diarrhea (possibly blood-stained), drowsiness, and risk of pulmonary edema (fluid in lungs). **Chronic Effects:** Effects may persist for several weeks or months after repeated exposure. Symptoms include giddiness, irritability, headache, digestive disturbances, mental confusion, intolerance to alcohol (degreasers flush), altered color perception, loss or impairment of sense of smell, double vision, and peripheral nervous system function impairment including persistent neuritis, temporary loss of sense of touch, and paralysis of the fingers from direct contact with TCE liquid.

FIRST AID Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. Do not give milk, as its fat content (TCE is lipid soluble) may inhance gastrointestinal absorption of TCE. **Note to Physicians:** TCE elimination seems to be triphasic with half lives at 20 min, 3 hr, and 30 hr. Some success is seen in treating patients with propranolol, atropine, and disulfiram. Monitor urine and blood (lethal level = 3 to 110 µg/mL) metabolites. BEI = 100 mg/g creatinine (trichloroacetic acid) in urine, *sample at end of workweek.* BEI = 4 mg/L (trichloroethanol) in blood, *sample at end of shift at end of the workweek.* These tests are not 100% accurate indicators of exposure; monitor TCE in expired air as a confirmatory test.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Immediately notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off all ignition sources. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable container for later disposal. For large spills, flush to containment area where density stratification will form a bottom TCE layer which can be pumped and containerized. Report any release in excess of 1000 lbs. Follow applicable OSHA regulations (29 CFR 1910.120). **Ecotoxicity Values:** Bluegill sunfish, LC_{50} = 44,700 µg/L/96 hr; fathead minnow (*Pimephales promelas*), LC_{50} = 40.7 mg/L/96 hr. **Environmental Degradation:** In air, TCE is photooxidized with a half-life of 5 days and reported to form phosgene, dichloroacetyl chloride, and formyl chloride. In water it evaporates rapidly in minutes to hours. TCE rapidly evaporates and may leach since it does not absorb to sediment. **Soil Absorption/Mobility:** TCE has a Log K_{oc} of 2, indicating high soil mobility. **Disposal:** Waste TCE can be poured on dry sand and allowed to vaporize in isolated location, purified by distillation, or returned to supplier. A potential candidate for rotary kiln incineration at 1508 to 2912 °F (820 to 1600 °C) with an acid scrubber to remove halo acids. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
Listed as a RCRA Hazardous Waste (40 CFR 261.33 & 261.31): No. U228 & F002 (*spent solvent*)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 100 lb (45.4 kg) [* per RCRA, Sec. 3001, CWA Sec. 311 (b)(4), & CWA Sec. 307 (a)]

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear chemical safety goggles (cup-type or rubber framed, equipped with impact-resistant glass), per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. At any detectable concentration, wear a SCBA with a full facepiece operated in pressure demand or other positive pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets made from Viton or Neoprene to prevent skin contact. *Do not* use natural rubber or polyvinyl chloride (PVC). **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in steel drums, in a cool, dry, well-ventilated area away from sunlight, heat, ignition sources, and incompatibles (Sec. 5). Store large quantities in galvanized iron, black iron, or steel containers; small amounts in dark (amber) colored glass bottles. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Design processes so that the operator is not directly exposed to the solvent or its vapor. Do not use open electric heaters, high-temperature processes, arc-welding or open flames in TCE atmospheres. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers with emphasis on skin, respiratory, cardiac, central and peripheral nervous systems, and liver and kidney function. Employ air and biological monitoring (BEIs). Instruct employees on safe handling of TCE.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Trichloroethylene
DOT Hazard Class: 6.1
ID No.: UN1710
DOT Packing Group: III
DOT Label: Keep Away From Food
DOT Special Provisions (172.102): N36, T1

Packaging Authorizations
a) Exceptions: 173.153
b) Non-bulk Packaging: 173.203
c) Bulk Packaging: 173.241

Quantity Limitations
a) Passenger Aircraft or Railcar: 60L
b) Cargo Aircraft Only: 220L

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: 40

***MSDS Collection* References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 149, 153, 159, 163, 164, 167, 168, 171, 174, 175, 176, 180.
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** D Wilson, CIH; **Medical Review:** AC Darlington, MD

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Focused Corrective Measures Study Work Plan for SWMU 6-1, Landfill 1 (LF-01); SWMU 6-4, Landfills 4, 5, and 6 (LF-08); and SWMU 6-22, Lake Christian (OT-46)

June 1999

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KIRTLAND AIR FORCE BASE
ALBUQUERQUE, NEW MEXICO

FOCUSED CORRECTIVE MEASURES STUDY WORK PLAN FOR SWMU 6-1, LANDFILL 1 (LF-01); SWMU 6-4, LANDFILLS 4, 5, and 6 (LF-08); AND SWMU 6-22, LAKE CHRISTIAN (OT-46)

JUNE 1999

Prepared For
U.S. ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
OMAHA, NEBRASKA

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This document consists of the Focused Corrective Measures Study (CMS) Work Plan for Landfill 1 (LF-01); Landfills 4, 5, and 6 (LF-08); and Lake Christian (OT-46) on Kirtland Air Force Base. The report outlines and briefly discusses the anticipated corrective measures required to achieve closure of the three sites. The Work Plan also includes an annotated outline for the Draft CMS Report, the proposed management approach for the three sites, and project schedules that specify all significant steps in the site closure processes. It is anticipated that the LF-01 and LF-08 CMSs will focus on landfill cover systems and erosion control. The OT-46 CMS will focus on draining Lake Christian and backfilling to achieve closure.

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ROBERT S. MILLIGAN
Environmental Public Affairs Specialist

This document has been approved for public release.

PREFACE

This document consists of the Focused Corrective Measures Study (CMS) Work Plan for Solid Waste Management Unit (SWMU) 6-1, Landfill 1 (LF-01); SWMU 6-4, Landfills 4, 5, and 6 (LF-08); and SWMU 6-22, Lake Christian (OT-46) on Kirtland Air Force Base (AFB). It outlines and briefly discusses the corrective action measures that shall be identified, evaluated, and recommended as corrective measures to achieve closure of the three sites. The Work Plan also includes an annotated outline for the Draft CMS Report, the proposed management approach for the three sites, and project schedules that specify all significant steps in the site closure processes. It is anticipated that the LF-01 and LF-08 CMSs will focus on landfill cover systems and erosion control. The OT-46 CMS will focus on draining Lake Christian and backfilling to achieve closure.

This work was performed under the authority of the U.S. Army Corps of Engineers (USACE), Total Environmental Restoration Contract No. DACW45-94-D-0003, Subcontract No. DENS-94-1159-JM (MOA). All work was conducted between May 1998 and June 1999. Mr. Steven M. Rowe (USACE) is the Project Manager for this program.

The Remedial Program Manager is Mr. Chris DeWitt of Kirtland AFB, Environmental Management Division. Mr. William J. Foley of Foster Wheeler Environmental Corporation (Foster Wheeler) is the Delivery Order Manager. The Task Manager is Mr. Derek Johnson of Foster Wheeler, who prepared this Work Plan with assistance from a multidisciplinary team comprised of representatives from geomorphology, hydraulic engineering, civil engineering, regulatory compliance and quality control, and technical editing.

Derek Johnson, P.E.
Foster Wheeler
Task Manager

William J. Foley, P.E.
Foster Wheeler
Delivery Order Manager

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ACRONYMS

AFB	Air Force Base
C&D	construction and demolition
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm/s	centimeters per second
CMD	corrective measures design
CMS	Corrective Measures Study
DQO	data quality objective
EPA	United States Environmental Protection Agency
Foster Wheeler	Foster Wheeler Environmental Corporation
ft	feet
H:V	horizontal to vertical
ICM	Interim Corrective Measure
IRP	Installation Restoration Program
LF	Landfill
LTM	long-term monitoring
NMED	New Mexico Environment Department
NMSWMR	New Mexico Solid Waste Management Regulations
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SWMU	Solid Waste Management Unit
USACE	U.S. Army Corps of Engineers

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Section 1

1. INTRODUCTION

1.1 Project Overview and Purpose

This Focused Corrective Measures Study (CMS) Work Plan discusses both the scope and substance of the proposed Focused CMSs for Solid Waste Management Unit (SWMU) 6-1, Landfill 1 (LF-01); SWMU 6-4, Landfills 4, 5, and 6 (LF-08); and SWMU 6-22, Lake Christian (OT-46) on Kirtland Air Force Base (AFB). It outlines the corrective measures that will be identified, evaluated, and recommended to achieve closure of the three sites. Sections 2.3, 3.3, and 4.3 provide a more detailed description of the technologies being considered. The annotated outline for the CMSs is provided as Appendix A.

This Focused CMS Work Plan outlines the scope of work authorized under U.S. Army Corps of Engineers (USACE) Contract No. DACW45-94 D-0003, Delivery Order 19, Work Authorization Directives 3, 5, and 11. This Work Plan complies with the requirements outlined in the Resource Conservation and Recovery Act (RCRA) Corrective Action Plan (EPA, 1994) and Presumptive Remedies: Policy and Procedures (EPA, 1993). Specifically, the RCRA Corrective Action Plan allows certain flexibility in the complexity of studies needed to develop sound, environmentally protective remedies. Highly focused CMSs are appropriate in the following situations: high quality remedies, facilities with straightforward remedial solutions, and phased remedies. Based on these criteria, all three sites discussed in this Work Plan are appropriate for focused CMSs.

A focused CMS is applicable to LF-01 and LF-08 based on the straightforward remedial solution available: containment/source control. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) further describes a straightforward remedial solution as a presumptive remedy. Presumptive remedies for municipal/military landfills relate primarily to containment (landfill cover system) of the landfill mass and collection and/or treatment of landfill gas. Leachate control, affected groundwater control at the landfill perimeter, and/or upgradient control of groundwater causing saturation of the landfill mass may also be implemented as part of a presumptive remedy. The presumptive remedy is not intended to address exposure pathways outside of the source area (landfill) or include long-term groundwater response action. Typical objectives for landfill containment are:

- Preventing direct human/ecological contact with landfill contents
- Minimizing infiltration and resulting contaminant leaching to groundwater
- Controlling surface water runoff and erosion
- Collecting and treating contaminated groundwater and leachate to contain the contaminant plume and prevent further migration from the source area
- Controlling and treating landfill gas (EPA, 1993)

The LF-01 and LF-08 CMSs will focus on determinating appropriate landfill cover systems and erosion control through (1) proper grading of the landfill cover to facilitate surface water drainage; (2) minimization of leachate generation; (3) adequate surface water control measures (i.e., interceptor ditches and down drains); and (4) the potential utilization of either prescribed systems (RCRA Subtitles C and D) or alternative systems (i.e., geosynthetic clay liner, capillary barrier, anisotropic barrier, and evapotranspiration).

OT-46 is also an appropriate site for a focused CMS based on the straightforward remedial solution available: containment/source control. The OT-46 CMS focuses on draining Lake Christian and

backfilling to achieve closure through the use of either construction and demolition (C&D) debris or native soil.

The major elements of this scope of work included reviewing existing information and identifying, evaluating, and recommending corrective measures for each of the three sites.

Section 2

2. FOCUSED CORRECTIVE MEASURES STUDY—LF-01

2.1 Site-Specific Description of Overall Purpose of CMS

LF-01 is a high relative risk site located on the west side of Kirtland AFB and approximately 100 feet (ft) from the southern edge of Albuquerque International Airport (See Figure 2-1) (USAF, 1997b). The CMS will include a summary of risk assessment results available for the site based on the most recently collected data. This risk assessment will include discussion of both baseline human health risk assessment results and screening level ecological risk assessment results where appropriate. At LF-01, available information indicates that an inadequate cover is currently placed on the site. As a result of current cover conditions, ponding occurs, areas of fill are not covered, limited cover material is in place at several locations, limited vegetation is present, and results of erosion are visible. To minimize potential future impacts and address current site concerns, a focused CMS for LF-01 should be completed. This focused CMS will target site closure by addressing current conditions via a landfill cover system resulting in source control. The focused CMS for LF-01 will primarily evaluate six plausible cover systems to achieve proper closure and erosion control for the landfill site. The CMS will assess both prescribed cover systems (RCRA Subtitles C and D) and alternative cover systems (geosynthetic clay liner, capillary barrier, anisotropic barrier, and evapotranspiration). In addition, regardless of which cover system is recommended in this CMS, the erosion control design will minimize leachate generation, provide proper grading of the landfill cover to facilitate surface water drainage, and provide adequate surface water control measures (i.e., interceptor ditches and down drains).

2.2 Potentially Applicable Regulatory Requirements

This section identifies potentially applicable regulatory requirements to be complied with during the planned actions at LF-01. The activities are being completed under the Installation Restoration Program (IRP), which provides certain flexibility regarding permitting and waste management. Although specific permits will not be obtained for the response actions as planned, per CERCLA regulations, Kirtland AFB will ensure permit equivalency.

Table 2-1 presents potentially applicable regulatory requirements for LF-01 based on the anticipated corrective actions to be implemented at this site.

2.3 Specific Corrective Measure Technologies and/or Alternatives

The appropriate corrective measures to be evaluated for the landfill cover system shall include:

No Action—This alternative is the baseline against which other alternatives are compared and consists of allowing the existing conditions to continue at LF-01. The poor vegetative cover, as it presently exists, would continue to grow, and the existing steep side slopes would continue to erode, possibly uncovering solid waste and/or hazardous waste. Currently exposed debris would remain. It is unlikely this alternative will be acceptable to the New Mexico Environment Department (NMED) as a closure action.

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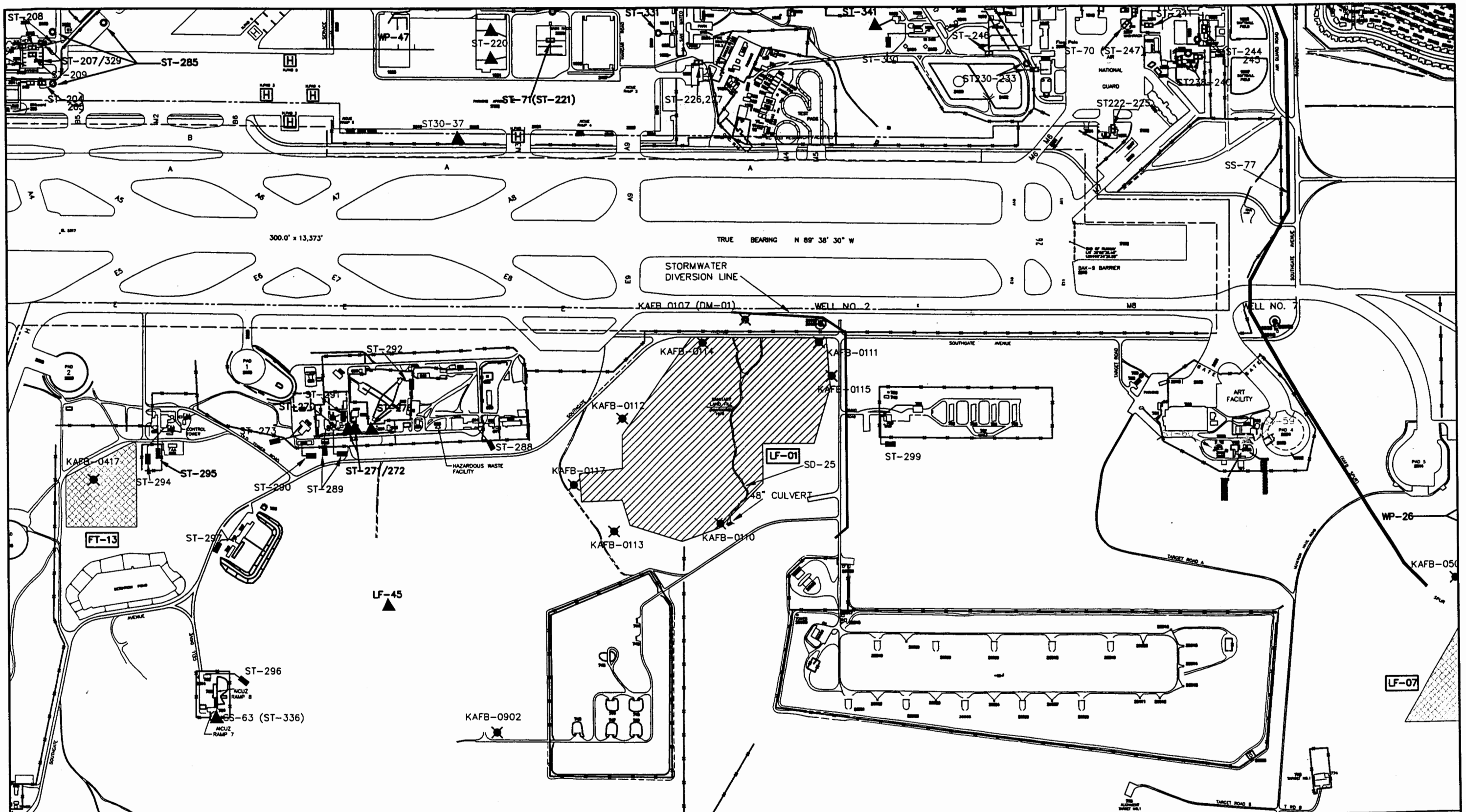

LEGEND

MONITORING WELL LOCATIONS

ROAD

LF-01

N

400 0 400 800 1200

Scale in Feet

KIRTLAND AIR FORCE BASE
LF-01 FOCUSED CORRECTIVE MEASURES STUDY

Site Location Map

Date: 9/18/98

File Name:

Figure 2-1

Table 2-1. Summary of Potentially Applicable Environmental Regulations at LF-01

Requirement	Citation	Description
CHEMICAL-RELATED REGULATORY REQUIREMENTS		
New Mexico Standards for Groundwater	20 NMAC 6 Part 2, Subpart III, Section 3104	Unless otherwise provided by this Part, no person shall cause or allow effluent, leachate, or water/liquid to discharge so that it may move directly or indirectly into groundwater unless they are discharging pursuant to a discharge plan approved by the NMED secretary.
New Mexico Standards for Groundwater	20 NMAC 6 Part 2, Subpart III, Section 3101	The following standards apply to discharges of water to the ground (chemical-specific standards to be included in Work Plan): A. Human Health Standards—Groundwater: Nonaqueous phase liquid shall not be present floating atop of or immersed within groundwater, as can be reasonably measured. B. Other Standards for Domestic Water Supply C. Standards for Irrigation Use: Groundwater shall meet the standards of Subsections A, B, and C unless otherwise provided.
New Mexico Surface Water Standards	20 NMAC 6 Part 2, Subpart II, Section 2101	Discharges to surface waters cannot exceed constituent parameters listed under this regulation.
National Ambient Air Quality Standards	40 CFR 50	Sources cannot cause or contribute to an exceedance of a national ambient air quality standard.
New Mexico and Bernallilo County Ambient Air Quality Standards	20 NMAC 2 Part 3, Section 109 20 NMAC 11.01.II.2	Sources cannot cause or contribute to an exceedance of national, New Mexico, or Bernallilo County ambient air quality standards for total suspended solids, particulate matter, carbon monoxide, and nitrogen dioxide.

Table 2-1. Summary of Potentially Applicable Environmental Regulations at LF-01 (Continued)

Requirement	Citation	Description
ACTION-RELATED REGULATORY REQUIREMENTS		
Air Emissions		
Air Emissions from Diesel-powered Vehicles Associated with Excavation and Backfill Operations	20 NMAC 2 Part 61, Section 110 20 NMAC 11 Part 103, Section II.1.4	A. No person shall permit, cause, suffer, or allow the emission into the open air of any smoke having an opacity greater than 30% for any period greater than 10 seconds from any diesel-powered vehicle operating below 8,000 ft (mean sea level). B. No owner shall cause to be emitted from any diesel-powered nonhighway motor vehicle continuous visible air contaminant emission while the vehicle is in operation for a period greater than 10 consecutive seconds, which is a shade or density of more than 40% opacity.
Surface Disturbance	20 NMAC 11 Part 20, Subpart II, Section 3	SOIL: Except for an area zoned for agriculture that grows a crop, no responsible party shall engage in an activity disturbing ¾ acre (32,670 square ft) or more of surface area, if the activity may result in transported material or particulate matter becoming airborne, without having a valid Surface Disturbance/Demolition permit issued by NMED. If the applicant and NMED agree, the permit application and any resulting programmatic permit may include multiple locations, if the surface disturbance activities are similar.
Surface Disturbance/ Demolition Permitting Procedures	20 NMAC 11 Part 20, Subpart II, Section 9	APPLICATIONS: An application for a permit shall be made on forms provided by NMED and shall include a particulate matter control plan. Within 10 days of receiving the completed permit application, NMED shall grant or deny the permit. The NMED may reject and return an incomplete or illegible application.
Design/ Installation of Caps/Covers	Final Covers on Hazardous Waste Landfills and Surface Impoundments (EPA/530/SW-89/047)	Caps and covers must be designed and installed to prevent wind dispersal of hazardous wastes. They should be designed, constructed, and installed as specified in this EPA report.

Table 2-1. Summary of Potentially Applicable Environmental Regulations at LF-01 (Continued)

Requirement	Citation	Description
Waste Characterization		
Determination of Hazardous Waste	40 CFR 262.11 40 CFR Part 261 20 NMAC 4 Part 1, Subpart II	Any wastes generated during corrective action activities must be characterized and evaluated according to the following method to determine whether the waste is hazardous: • Determine whether the waste is excluded from regulation under 40 CFR 261.4 • Determine whether the waste is listed under 40 CFR Part 261 • Determine whether the waste is identified in 40 CFR Part 261 by testing the waste according to specified test methods or by applying knowledge of the hazardous characteristics of the waste in light of the materials or the process used.
Waste Management		
Hazardous Waste Generator Standards	40 CFR Part 262 20 NMAC 4 Part 1, Subpart III—Generator Standards 20 NMAC 4 Part 1, Subpart VIII—Land Disposal Restriction Standards	Hazardous wastes generated during corrective action activities must be managed and disposed of per RCRA requirements pertaining to storage (i.e., container requirements) and disposal at approved, offsite permitted hazardous treatment, storage, and disposal facilities.
Treatment, Storage, or Disposal of RCRA Hazardous Waste	40 CFR 264.310(a)(4), (5), (b)(1) and (5) 40 CFR 264.117 through 264.120 20 NMAC 4 Part 1, Subpart V 40 CFR Part 264.95 40 CFR Part 264.16 (a)(1) 20 NMAC 4 Part 1, Subpart V	Closure and cover requirements for landfills Post-closure requirements Groundwater protection standard point of compliance Personnel training

Table 2-1. Summary of Potentially Applicable Environmental Regulations at LF-01 (Concluded)

Requirement	Citation	Description
Waste Management (Continued)		
Treatment and Disposal of Hazardous Debris	40 CFR 268.45 20 NMAC 4 Part 1, Subpart VIII	Hazardous debris generated during corrective action activities must be treated using specific technologies to extract, destroy, or immobilize hazardous constituents on or in the debris if placement occurs. In certain cases, the debris may no longer be subject to RCRA Subtitle C regulation after treatment.
Solid Waste		
Solid Waste Landfill Closure Requirements	20 NMAC 9 Part 1, Subpart V, Section 501 20 NMAC 9 Part 1, Subpart V, Section 502 RCRA Nonhazardous Solid Waste Landfills: 40 CFR 258.60 and 40 CFR 258.61 RCRA Hazardous Waste Landfills: 40 CFR 264.310	Owners and operators shall install a final cover system that consists of the following: • An erosion layer consisting of a minimum of 6 inches of earthen material that is capable of sustaining native plant growth • Cover system meeting the closure and post-closure requirements for landfills • Side slopes that shall not exceed a 25% grade (4H:IV) for 20 NMAC and 3H:1V for RCRA, such that the final cover of the top portion of a landfill shall have a gradient of 2% to 5% and that the slope shall be sufficient to prevent the ponding of water and erosion of the cover material.
Health and Safety Requirements		
Health and Safety Requirements	29 CFR 1910.120	Hazardous waste site supervisors, workers, and visitors are required to comply with the training and medical surveillance requirements detailed in this citation.
Storm Water Management		
Discharge of Storm Water to On-post Surface Water	40 CFR Parts 122–125	Storm water runoff, snow melt runoff, and surface water runoff and drainage associated with industrial activity (as defined in 40 CFR Part 122) or such activities that disturb 5 acres or more and that discharge to surface waters must be conducted in compliance with the storm water management regulations (Note: New Mexico is a nondelegated state with regard to NPDES permits).

%	percent
CFR	Code of Federal Regulations
EPA	United States Environmental Protection Agency
ft	feet
H:V	horizontal to vertical
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NPDES	National Pollution Discharge Elimination System
RCRA	Resource Conservation and Recovery Act

Construct a Cover System—This alternative requires that the entire cover area of LF-01 be regraded to be between a 2 and 5 percent slope and the steep side slopes flattened to be a 33 percent slope, 3 horizontal to 1 vertical (3H:1V) or flatter. Following grading/subsurface preparation, a cover system would be installed. The potential cover systems are described below.

- **Soil Cover—RCRA Subtitle D**. This cover consists of 18 inches of soil compacted to achieve a hydraulic conductivity of 1×10^{-5} centimeters per second (cm/s) or less covered with 6 inches of topsoil.
- **Compacted Clay Cover—RCRA Subtitle C.** The compacted clay cover consists of 24 inches of clay compacted to achieve a hydraulic conductivity of 1×10^{-7} cm/s or less, a geomembrane, a 12-inch sand drainage layer, and 24 inches of topsoil.
- **Geosynthetic Clay Liner Cover.** This cover consists of a geosynthetic clay liner, a geomembrane, a 12-inch sand drainage layer, and 24 inches of topsoil.
- **Capillary Barrier.** The capillary barrier consists of a 12-inch sand drainage layer, 18 inches of barrier soil, 9 inches of gravel, 3 inches of sand, and 12 inches of topsoil.
- **Anisotropic Barrier.** The anisotropic barrier consists of 6 inches of gravel, 6 inches of sand, a 24-inch soil layer, and 6 inches of topsoil.
- **Evapotranspiration Cover.** This cover consists of approximately 36 inches of lightly compacted native soil covered with 6 inches of topsoil.

2.4 General Approach to Investigating and Evaluating Potential Corrective Measures

The aforementioned corrective measure technologies/alternatives for the LF-01 site shall be evaluated based upon the ability of the alternative to meet (1) the corrective measure objectives; (2) conceptual design criteria (i.e., design storm, control of run-on and runoff, function of cover, etc.); and (3) selection criteria. The selection criteria are site specific and generally include the recommended criteria presented in the RCRA Corrective Action Plan. The selection criteria to be used in evaluating the various cover systems are:

Effectiveness. A key aspect in evaluating a cover system is the system's effectiveness at minimizing percolation of rainfall into the waste and consequent leachate generation. The cover system's reliability is evaluated based on its demonstrated reliability in areas with similar climate and vegetation.

Risk Mitigation. The risk mitigation criterion evaluates the cover system based on protecting human health and the environment.

Habitat. This criterion pertains to the loss of habitats for species using the LF-01 area.

Ease of Construction. This criterion addresses the feasibility of constructing a cover system and the availability of various services and materials required during its implementation. Technical feasibility refers to construction equipment requirements, local availability of construction materials, time required to construct the cover system, and the types of existing cover material. In evaluating the availability of select services and materials, the ability to competitively bid materials and services to construct the cover systems must be considered. Additional considerations are the extent of side slope flattening required.

Ease of Maintenance. A cover system requires monitoring, regular maintenance, and repairs after construction is complete. This criterion evaluates these factors.

Relative Cost. The relative capital costs and maintenance costs are considered in comparing cover systems. Capital costs include expenditures for the materials, equipment, labor, and tools necessary to construct the cover system. Maintenance costs incurred after construction include routine monitoring, maintenance, and repair of the cover system.

Flexibility of Future Uses. The potential future use of the site as a range land/open space recreation area must be taken into consideration, as several of the alternative covers depend heavily upon evapotranspiration to function properly. Incompatible future uses would adversely affect the cover system performance.

These technologies/alternatives will be assigned a number value (score) for each of the evaluation criteria and displayed in a table format. Each selection criterion will be weighted equally, and several alternatives may have an equal score if there is not a discernable difference among the alternatives. The point totals for each alternative will be evaluated and a corrective action alternative will be recommended. It should be noted that only plausible cover systems alternatives will be screened. The recommended alternative will be evaluated in greater detail during the corrective measures design (CMD) phase of this project.

2.5 Proposed Treatability, Pilot, Laboratory, and/or Bench Scale Studies

It is not anticipated that any treatability, pilot, laboratory, or bench scale studies will be required for the closure design of the LF-01 site.

Section 3

3. FOCUSED CORRECTIVE MEASURES STUDY—LF-08

3.1 Site-Specific Description of Overall Purpose of CMS

LF-08 is a high relative risk site located on the northwest region of Kirtland AFB and bounded by the Tijeras Arroyo to the north and the covered slope of the active landfill about 150 ft east of Powerline Road to the east (See Figure 3-1) (USAF, 1997b). The CMS will include a summary of risk assessment results available for the site based on the most recently collected results. This risk assessment will include discussion of both baseline human health risk assessment results and screening level ecological risk assessment results where appropriate. At LF-08, a 6-ft-thick non-RCRA native soil cover was installed in the fall of 1992. Current conditions show ponding, lack of vegetation, and erosion on the sides. Results of the long-term monitoring (LTM) program have identified perched water tables above the regional aquifer (USAF, 1999). Several groundwater contaminants have been identified; the source of the contaminants is being evaluated and may not be site related (USAF, 1995; 1998b). Background concentrations for groundwater at the site have just been determined and detection monitoring will continue for release determination (USAF, 1998a). In addition, not all groundwater contaminants were detected in the subsurface soils, and the ones detected were below action levels.
Due to these factors, a focused CMS for LF-08 will be completed. This focused CMS will target source control to improve site conditions with eventual site closure anticipated.

The focused CMS for LF-08 will primarily evaluate six plausible cover systems to achieve proper closure and erosion control for the landfill site. The CMS will assess both prescribed cover systems (RCRA Subtitle C and D) and alternative cover systems (geosynthetic clay liner, capillary barrier, anisotropic barrier, and evapotranspiration). In addition, regardless of which cover system is recommended in this CMS, the design will (1) minimize leachate generation; (2) provide proper grading of the landfill cover to facilitate surface water drainage; (3) provide adequate surface water control measures (i.e., interceptor ditches, down drains, and toe of slope protection adjacent to the Tijeras Arroyo); and (4) construct a landfill gas venting system.

Additionally, three groundwater monitoring wells will be installed in support of the final CMD at this site. The work plan for the well installation was provided to Kirtland AFB under separate cover in July 1998.

3.2 Potentially Applicable Regulatory Requirements

This section identifies potentially applicable regulatory requirements to be complied with during the planned actions at LF-08. The activities are being completed under the IRP, which provides certain flexibility regarding permitting and waste management. While specific permits will not be obtained for the response actions as planned, per CERCLA regulations, Kirtland AFB will ensure permit equivalency. This study also addresses requirements set forth in New Mexico Solid Waste Management Regulations (NMSWMR) because Kirtland AFB intends to remove LF-08 from the RCRA Part B permit and transfer jurisdiction to the NMED Solid Waste Bureau.

Table 3-1 presents potentially applicable regulatory requirements for LF-08 based on the anticipated corrective actions to be implemented at this site.

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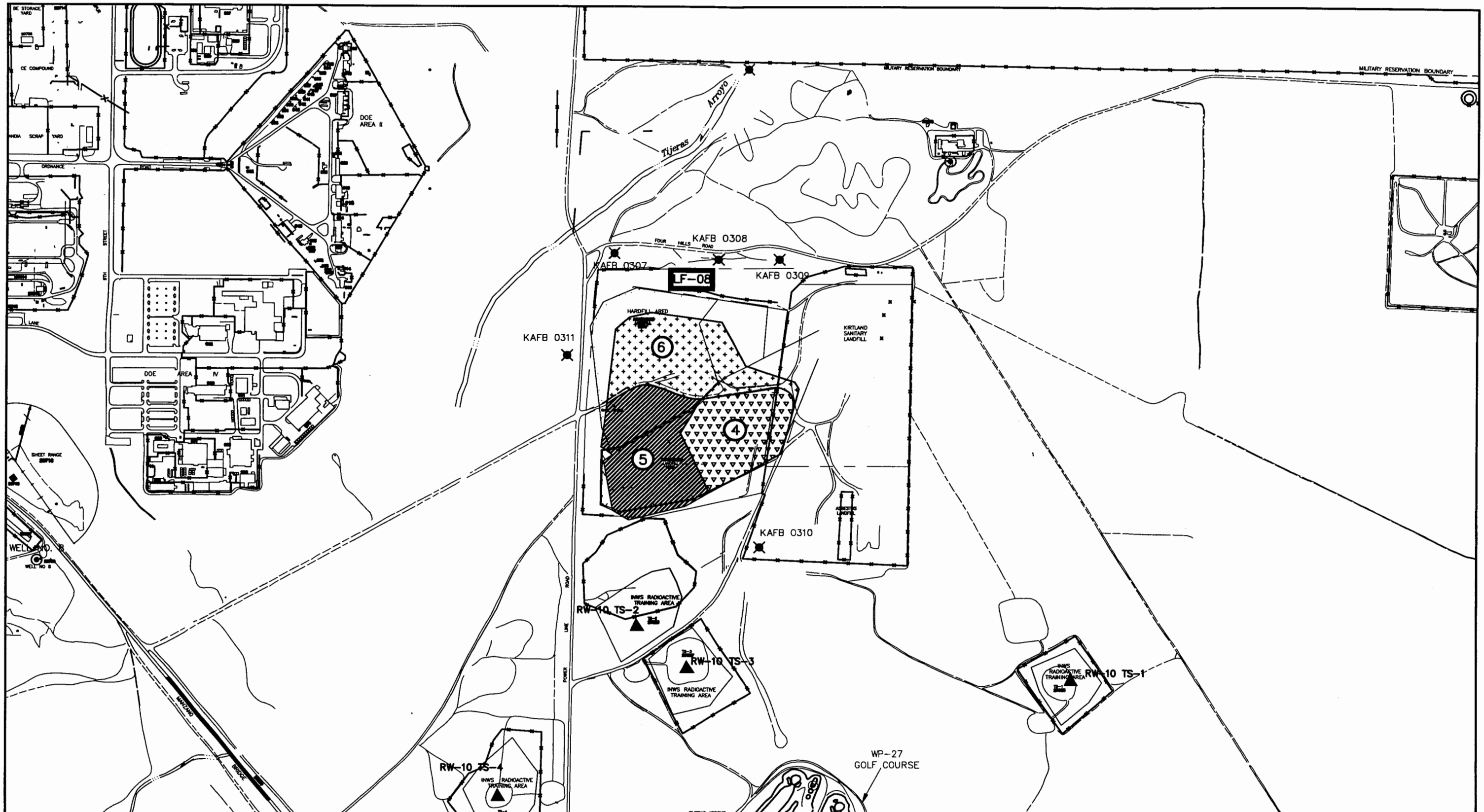

LEGEND

- MONITORING WELL LOCATIONS
- FENCE
- ROAD
- LF-04
- LF-05
- LF-06

N

400 0 400 800 1200
Scale in Feet

KIRTLAND AIR FORCE BASE
LF-08 FOCUSED CORRECTIVE MEASURES STUDY

Site Location Map

Date: 9/18/98
File Name:

Figure 3-1

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Table 3-1. Summary of Potentially Applicable Environmental Regulations at LF-08

Requirement	Citation	Description
LOCATION-RELATED REGULATORY REQUIREMENTS		
Protection of Floodplains	Executive Order 11988 40 CFR 257.3-1(a) 40 CFR 264.18(b) 40 CFR Part 6, Appendix A 40 CFR 6.302(b)Section 3(a), 3(b), and 3(b)(4) 44 FR 43239 (July 24, 1979)	Potentially applicable to activities occurring within the 100-year floodplain
CHEMICAL-RELATED REGULATORY REQUIREMENTS		
New Mexico Standards for Groundwater	20 NMAC 6 Part 2, Subpart III, Section 3104	Unless otherwise provided by this Part, no person shall cause or allow effluent, leachate, or water/liquid to discharge so that it may move directly or indirectly into groundwater unless they are discharging pursuant to a discharge plan approved by the NMED secretary.
New Mexico Standards for Groundwater	20 NMAC 6 Part 2, Subpart III, Section 3101	The following standards apply to discharges of water to the ground (chemical-specific standards to be included in Work Plan): A. Human Health Standards—Groundwater: Nonaqueous phase liquid shall not be present floating atop of or immersed within groundwater, as can be reasonably measured. B. Other Standards for Domestic Water Supply C. Standards for Irrigation Use: Groundwater shall meet the standards of Subsections A, B, and C unless otherwise provided.
ACTION-RELATED REGULATORY REQUIREMENTS		
New Mexico Surface Water Standards	20 NMAC 6, Part 2, Subpart II, Section 2101	Discharges to surface waters cannot exceed constituent parameters listed under this regulation.
National Ambient Air Quality Standards	40 CFR Part 50	Sources cannot cause or contribute to an exceedance of a national ambient air quality standard.
New Mexico and Bernallilo County Ambient Air Quality Standards	20 NMAC 2 Part 3, Section 109 20 NMAC 11.01.II.2	Sources cannot cause or contribute to an exceedance of national, New Mexico, or Bernallilo County ambient air quality standards for total suspended solids, particulate matter, carbon monoxide, and nitrogen dioxide.

Table 3-1. Summary of Potentially Applicable Environmental Regulations at LF-08 (Continued)

Requirement	Citation	Description
ACTION-RELATED REGULATORY REQUIREMENTS (Continued)		
Air Emissions		
Air Emissions from Diesel-powered Vehicles Associated with Excavation and Backfill Operations	20 NMAC 2 Part 61, Section 110 20 NMAC 11 Part 103, Section II.1.4	A. No person shall permit, cause, suffer, or allow the emission into the open air of any smoke having an opacity greater than 30% for any period greater than 10 seconds from any diesel-powered vehicle operating below 8,000 ft (mean sea level). B. No owner shall cause to be emitted from any diesel powered nonhighway motor vehicle continuous visible air contaminant emission while the vehicle is in operation for a period greater than 10 consecutive seconds, which is a shade or density of more than 40% opacity.
Surface Disturbance	20 NMAC 11 Part 20, Subpart II, Section 3	SOIL: Except for an area zoned for agriculture that grows a crop, no responsible party shall engage in an activity disturbing ¾ acre (32,670 square ft) or more of surface area, if the activity may result in transported material or particulate matter becoming airborne, without having a valid Surface Disturbance/Demolition permit issued by NMED. If the applicant and NMED agree, the permit application and any resulting programmatic permit may include multiple locations, if the surface disturbance activities are similar.
Surface Disturbance/ Demolition Permitting Procedures	20 NMAC 11 Part 20, Subpart II, Section 9	APPLICATIONS: An application for a permit shall be made on forms provided by NMED and shall include a particulate matter control plan. Within 10 days of receiving the completed permit application, NMED shall grant or deny the permit. The NMED may reject and return an incomplete or illegible application.
Design/ Installation of Caps/Covers	Final Covers on Hazardous Waste Landfills and Surface Impoundments (EPA/530/SW-89/047)	Caps and covers must be designed and installed to prevent wind dispersal of hazardous wastes. They should be designed, constructed, and installed as specified in this EPA report.

Table 3-1. Summary of Potentially Applicable Environmental Regulations at LF-08 (Continued)

Requirement	Citation	Description
Waste Characterization		
Determination of Hazardous Waste	40 CFR 262.11 40 CFR Part 261 20 NMAC 4 Part 1, Subpart II	Any wastes generated during corrective action activities must be characterized and evaluated according to the following method to determine whether the waste is hazardous: • Determine whether the waste is excluded from regulation under 40 CFR Part 261.4 • Determine whether the waste is listed under 40 CFR Part 261 • Determine whether the waste is identified in 40 CFR Part 261 by testing the waste according to specified test methods or by applying knowledge of the hazardous characteristics of the waste in light of the materials or the process used.
Waste Management		
Hazardous Waste Generator Standards	40 CFR Part 262 20 NMAC 4 Part 1, Subpart III—Generator Standards 20 NMAC 4 Part 1, Subpart VIII—Land Disposal Restriction Standards	Hazardous wastes generated during corrective action activities must be managed and disposed of per RCRA requirements pertaining to storage (i.e., container requirements) and disposal at approved offsite permitted hazardous treatment, storage, and disposal facilities.
Treatment, Storage, or Disposal of RCRA Hazardous Waste	40 CFR 264.310(a)(4), (5), (b)(1) and (5) 40 CFR 264.117 through 264.120 20 NMAC 4 Part 1, Subpart V	Closure and cover requirements for landfills Post-closure requirements
	40 CFR Part 264.95	Groundwater protection standard point of compliance
	40 CFR 264.16 (a)(1) 20 NMAC 4 Part 1, Subpart V	Personnel training

Table 3-1. Summary of Potentially Applicable Environmental Regulations at LF-08 (Continued)

Requirement	Citation	Description
Solid Waste		
Solid Waste Landfill Closure Requirements	20 NMAC 9 Part 1, Subpart V, Section 501 20 NMAC 9 Part 1, Subpart V, Section 502 RCRA Nonhazardous Solid Waste Landfills: 40 CFR 258.60 and 40 CFR 258.61 RCRA Hazardous Waste Landfills: 40 CFR 264.310	Owners and operators shall install a final cover system that consists of the following: • An erosion layer consisting of a minimum of 6 inches of earthen material that is capable of sustaining native plant growth • Cover system meeting closure and post-closure requirements for landfills • Side slopes that shall not exceed a 25% grade (4H:1V), such that the final cover of the top portion of a landfill shall have a gradient of 2% to 5% and that the slope shall be sufficient to prevent the ponding of water and erosion of the cover material.
Health and Safety Requirements		
Health and Safety Requirements	29 CFR 1910.120	Hazardous waste site supervisors, workers, and visitors are required to comply with the training and medical surveillance requirements detailed in this citation.
Storm Water Management		
Discharge of Storm Water to On-post Surface Waters	40 CFR Parts 122–125	Storm water runoff, snow melt runoff, and surface runoff and drainage associated with industrial activity (as defined in 40 CFR Part 122) or such activities that disturb 5 acres or more and that discharge to surface waters must be conducted in compliance with the storm water management regulations (Note: New Mexico is a nondelegated state with regard to NPDES permits).

%	percent
CFR	Code of Federal Regulations
EPA	United States Environmental Protection Agency
FR	Federal Register
ft	feet
H:V	horizontal to vertical
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NPDES	National Pollution Discharge Elimination System
RCRA	Resource Conservation and Recovery Act

3.3 Specific Corrective Measure Technologies and/or Alternatives

The appropriate corrective measures to be evaluated for the landfill cover system shall include:

No Action—This alternative is the baseline against which other alternatives are compared and consists of allowing the existing conditions to continue at LF-08. The poor vegetative cover, as it presently exists,

would continue to grow and the existing steep side slopes would continue to erode, possibly uncovering solid waste and/or hazardous waste. Currently exposed debris would remain. It is unlikely this alternative will be acceptable to the NMED Solid Waste Bureau as a closure action.

Construct a Cover System—This alternative requires that the entire cover area of LF-08 be regraded to be between a 2 and 5 percent slope and the steep side slopes would be flattened to be a 25 percent slope (4H:1V) or flatter. Following grading/subsurface preparation, a cover system will be installed. The appropriate cover systems are described below.

- **Soil Cover—RCRA Subtitle D/NMSWMR**. This cover consists of 18 inches of soil compacted to achieve a hydraulic conductivity of 1×10^{-5} cm/s or less covered with 6 inches of topsoil.
- **Compacted Clay Cover—RCRA Subtitle C**. The compacted clay cover consists of 24 inches of clay compacted to achieve a hydraulic conductivity of 1×10^{-7} cm/s or less, a geomembrane, a 12-inch sand drainage layer, and 24 inches of topsoil.
- **Geosynthetic Clay Liner Cover.** This cover consists of a geosynthetic clay liner, a geomembrane, a 12-inch sand drainage layer, and 24 inches of topsoil.
- **Capillary Barrier.** The capillary barrier consists of a 12-inch sand drainage layer, 18 inches of barrier soil, 9 inches of gravel, 3 inches of sand, and 12 inches of topsoil.
- **Anisotropic Barrier**. The anisotropic barrier consists of 6 inches of gravel, 6 inches of sand, a 24-inch soil layer, and 6 inches of topsoil.
- **Evapotranspiration Cover**. This cover consists of approximately 36 inches of lightly compacted native soil covered with 6 inches of topsoil.

3.4 General Approach to Investigating and Evaluating Potential Corrective Measures

The aforementioned corrective measure technologies/alternatives for the LF-08 site shall be evaluated based upon the ability of the alternative to meet (1) the corrective measure objectives; (2) conceptual design criteria (i.e., compliance with laws and regulations, design life, landfill gas collection and venting, the Tijeras Arroyo, etc.); and (3) selection criteria. The selection criteria are site specific and generally include the recommended criteria presented in the RCRA Corrective Action Plan. The selection criteria to be used in evaluating the various cover systems are:

Effectiveness. A key aspect in evaluating a cover system is the system's effectiveness at minimizing percolation of rainfall into the waste and consequent leachate generation. The cover system's reliability is evaluated based on its demonstrated reliability in areas with similar climate and vegetation.

Risk Mitigation. The risk mitigation criterion evaluates the cover system based on protecting human health and the environment.

Habitat. This criterion pertains to the loss of habitats for species using the LF-08 area.

Ease of Construction. This criterion addresses the feasibility of constructing a cover system and the availability of various services and materials required during its implementation. Technical feasibility refers to construction equipment requirements, local availability of construction materials, time required to construct the cover system, and the types of existing cover material. In evaluating the availability of select services and materials, the ability to competitively bid materials and services to construct the cover systems must be considered. Additional considerations are the extent of side slope flattening required.

Ease of Maintenance. A cover system requires monitoring, regular maintenance, and repairs after construction is complete. This criterion evaluates these factors.

Relative Cost. The relative capital costs and maintenance costs are considered in comparing cover systems. Capital costs include expenditures for the materials, equipment, labor, and tools necessary to construct the cover system. Maintenance costs incurred after construction include routine monitoring, maintenance, and repair of the cover system.

Flexibility of Future Uses. The potential future use of the site as a range land/open space recreation area must be taken into consideration, as several of the alternative covers depend heavily upon evapotranspiration to function properly. Incompatible future uses would adversely affect the cover system performance.

These technologies/alternatives will be assigned a number value (score) for each of the evaluation criteria and displayed in a table format. The alternative with the lowest point total will be the recommended corrective action alternative. It should be noted that only plausible cover systems alternatives will be screened. The recommended alternative will be evaluated in greater detail during the CMD phase of this project.

3.5 Proposed Treatability, Pilot, Laboratory, and/or Bench Scale Studies

It is not anticipated that any treatability, pilot, laboratory, or bench scale studies will be required for the closure design of the LF-08 site.

Section 4

4. FOCUSED CORRECTIVE MEASURES STUDY—OT-46

4.1 Site-Specific Description of Overall Purpose of CMS

OT-46 (Lake Christian) is a high relative risk site located in the southern region of Kirtland AFB, about 1,000 ft west-northwest of LF-15 (See Figure 4-1) (USAF, 1997b). The CMS will include a summary of risk assessment results available for the site based on the most recently collected results. This risk assessment will include discussion of both baseline human health risk assessment results and screening level ecological risk assessment results where appropriate. At OT-46, previous investigation results and the LTM program have identified localized groundwater mounding with several groundwater contaminants. The source of the contaminants is being evaluated and may not be site related. Background concentrations for groundwater at the site have just been determined, and detection monitoring will continue for release determination. In addition, not all groundwater contaminants were detected in either the subsurface soils, sediments, or lake waters, and the ones detected were below action levels.

This man-made lake does not have a source stream or natural drain point. To stop groundwater mounding and minimize potential future degradation of groundwater quality, an Interim Corrective Measure (ICM) and focused CMS will be completed. The focused CMS will evaluate options for lake backfilling. The ICM will precede the focused CMS and consist of draining the lake, relocating fish, conducting sediment sampling, and conducting shallow soil sampling immediately below the sediment. Data produced as part of the ICM will be used to confirm previous sediment sampling results and evaluate final disposition alternatives for lake sediments. Based on previous analytical results, the anticipated final disposition of the lake sediments is to remain in place and be covered. Also, the intent would be to further investigate the lake as a potential source of the fluoride and selenium detected in the groundwater. The subsurface soil has not been previously sampled due to the overlying lake.

Data quality objectives (DQOs) for sampling the ICM are necessary to ensure that data are adequate to evaluate final disposition of sediments and evaluate risk to potential human and ecological receptors. The DQO development process includes using available guidance and data previously collected during the Phase 2 RCRA Facility Investigation (RFI) (USAF, 1997a). The procedure for developing DQOs for the sediment/soil sampling will include the following steps.

1. State the problem
2. Identify the decision
3. Identify inputs to the decision
4. Define boundaries
5. Develop decision rule
6. Specify limits on the decision error
7. Optimize the design.

Detailed development of these DQOs will occur during planning stages of the ICM.

The focused CMS for OT-46 will detail several conceptual design criteria and evaluate two approaches to restoration/closure of the site. These options will involve (1) draining Lake Christian, (2) using either C&D demolition debris or native soil to backfill Lake Christian, (3) grading the site to facilitate surface water drainage, (4) revegetating, and (5) using appropriate erosion control measures.

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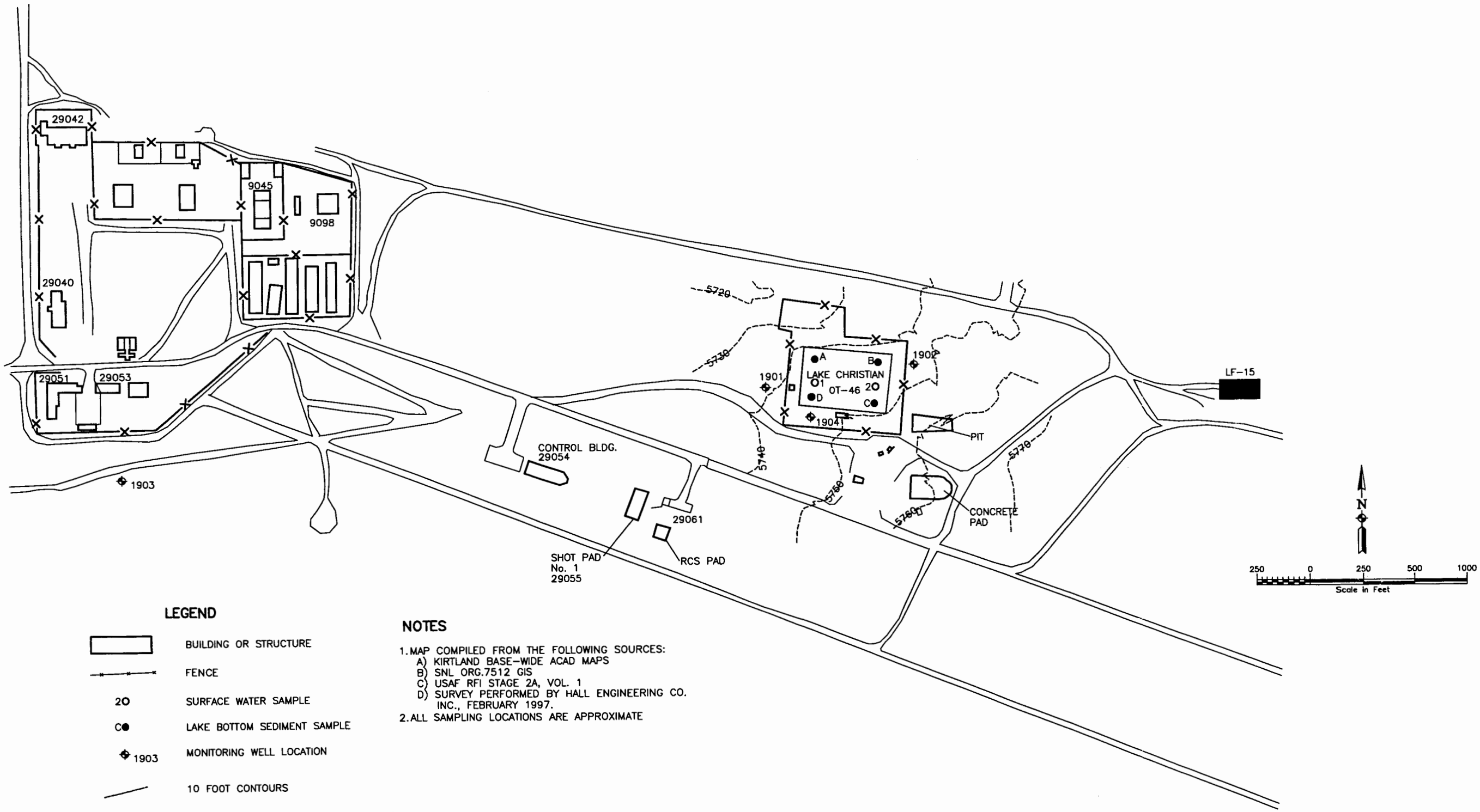

LEGEND

- BUILDING OR STRUCTURE
- FENCE
- 2O SURFACE WATER SAMPLE
- C● LAKE BOTTOM SEDIMENT SAMPLE
- ◆ 1903 MONITORING WELL LOCATION
- 10 FOOT CONTOURS
- ROAD

NOTES

1. MAP COMPILED FROM THE FOLLOWING SOURCES:
   A) KIRTLAND BASE-WIDE ACAD MAPS
   B) SNL ORG.7512 GIS
   C) USAF RFI STAGE 2A, VOL. 1
   D) SURVEY PERFORMED BY HALL ENGINEERING CO. INC., FEBRUARY 1997.
2. ALL SAMPLING LOCATIONS ARE APPROXIMATE

KIRTLAND AIR FORCE BASE
OT-46 FOCUSED CORRECTIVE MEASURES STUDY

Site Location & Previous Sampling Locations for OT-46

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File Name:

Figure 4-1

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4.2 Potentially Applicable Regulatory Requirements

This section identifies potentially applicable regulatory requirements to be complied with during the planned actions at OT-46. The activities are being completed under the IRP, which provides certain flexibility regarding permitting and waste management. While specific permits will not be obtained for the response actions as planned, per CERCLA regulations, Kirtland AFB will ensure permit equivalency.

Table 4-1 presents potentially applicable regulatory requirements for OT-46 based on the anticipated corrective actions to be implemented at this site.

4.3 Specific Corrective Measure Technologies and/or Alternatives

No Action—This alternative is the baseline against which all other alternatives are compared and consists of allowing the existing conditions at the site to continue without any environmental improvements.

Backfill with C&D Materials—This alternative involves performing final dewatering of lake; backfilling and compacting the lake with clean C&D, recycled, or other approved materials; installing thick, native topsoil layer and appropriate vegetation; and installing erosion control measures (if necessary).

Backfill with Native Soil Materials—This alternative includes performing final dewatering of lake; backfilling and compacting the lake with clean soils (i.e., clays or fine silty sands); installing a thick, native topsoil layer and appropriate vegetation; and installing erosion control measures (if necessary).

4.4 General Approach to Investigating and Evaluating Potential Corrective Measures

The aforementioned corrective measure technologies/alternatives for the OT-46 site shall be evaluated based upon the ability of the alternative to meet (1) the corrective measure objectives; (2) conceptual design criteria (i.e., permeability of backfill, design life, erosion control, vegetation, etc.); and (3) selection criteria (i.e., effectiveness, cost, risk, final use, aesthetics, etc.). These technologies/alternatives will be assigned a number value (score) for each of the evaluation criteria and displayed in a table format. The alternative with the lowest point total will be the recommended corrective action alternative. It should be noted that only plausible cover systems alternatives will be screened. The recommended alternative will be evaluated in greater detail during the CMD phase of this project.

Table 4-1. Summary of Potentially Applicable Regulatory Requirements at OT-46

Requirement	Citation	Description
LOCATION-RELATED REGULATORY REQUIREMENTS		
Clean Water Act	33 CFR Part 323 Sec 404 (33 USC 1344)	Permits for discharges of dredged or fill material to waters of the United States
CHEMICAL-RELATED REGULATORY REQUIREMENTS		
Clean Water Act	40 CFR Part 403	Pretreatment standards for discharges into POTWs. POTWs regulate discharges into their systems to meet three objectives: (1) prevent introduction of pollutants that would interfere with equipment or operations, (2) prevent introduction of pollutants that would cause pass through or be incompatible with the POTW, and (3) improve opportunities to recycle and reclaim municipal and industrial wastes and sludges.
New Mexico Standards for Groundwater	20 NMAC 6 Part 2, Subpart III, Section 3104	Unless otherwise provided by this Part, no person shall cause or allow effluent, leachate, or water/liquid to discharge so that it may move directly or indirectly into groundwater unless they are discharging pursuant to a discharge plan approved by the secretary of the NMED.
New Mexico Standards for Groundwater	20 NMAC 6 Part 2, Subpart III, Section 3101	The following standards apply to discharges of water to the ground (chemical specific standards to be included in Work Plan): A. Human Health Standards—Groundwater: Nonaqueous phase liquid shall not be present floating atop of or immersed within groundwater, as can be reasonably measured. B. Other Standards for Domestic Water Supply C. Standards for Irrigation Use: Groundwater shall meet the standards of Subsections A, B, and C unless otherwise provided.

Table 4-1. Summary of Potentially Applicable Regulatory Requirements at OT-46 (Continued)

Requirement	Citation	Description
CHEMICAL-RELATED REGULATORY REQUIREMENTS (Continued)		
National Ambient Air Quality Standards	40 CFR Part 50	Sources cannot cause or contribute to an exceedance of a national ambient air quality standard.
New Mexico and Bernallilo County Ambient Air Quality Standards	20 NMAC 2 Part 3, Section 109 20 NMAC 11.01.II.2	Sources cannot cause or contribute to an exceedance of national, New Mexico, or Bernallilo County ambient air quality standards for total suspended solids, particulate matter, carbon monoxide, and nitrogen dioxide.
ACTION-RELATED REGULATORY REQUIREMENTS		
Air Emissions		
Air Emissions from Diesel-powered Vehicles Associated with Excavation and Backfill Operations	20 NMAC 2 Part 61, Section 110 20 NMAC 11 Part 103, Section II.1.4	A. No person shall permit, cause, suffer, or allow the emission into the open air of any smoke having an opacity greater than 30% for any period greater than 10 seconds from any diesel-powered vehicle operating below 8,000 ft (mean sea level). B. No owner shall cause to be emitted from any diesel-powered nonhighway motor vehicle continuous visible air contaminant emission while the vehicle is in operation for a period greater than 10 consecutive seconds, which is a shade or density of more than 40% opacity.
Surface Disturbance	20 NMAC 11 Part 20, Subpart 2, Section 3	SOIL: Except for an area zoned for agriculture that grows a crop, no responsible party shall engage in an activity disturbing ¾ acre (32,670 square ft) or more of surface area, if the activity may result in transported material or particulate matter becoming airborne, without having a valid Surface Disturbance/Demolition permit issued by NMED. If the applicant and NMED agree, the permit application and any resulting programmatic permit may include multiple locations, if the surface disturbance activities are similar.

Table 4-1. Summary of Potentially Applicable Regulatory Requirements at OT-46 (Continued)

Requirement	Citation	Description
Waste Characterization		
Determination of Hazardous Waste	40 CFR 262.11 40 CFR Part 261 20 NMAC 4 Part 1, Subpart II	Any wastes generated during corrective action activities must be characterized and evaluated according to the following method to determine whether the waste is hazardous: • Determine whether the waste is excluded from regulation under 40 CFR 261.4 • Determine whether the waste is listed under 40 CFR Part 261 • Determine whether the waste is identified in 40 CFR Part 261 by testing the waste according to specified test methods or by applying knowledge of the hazardous characteristics of the waste in light of the materials or the process used.
Waste Management		
Hazardous Waste Generator Standards	40 CFR Part 262 20 NMAC 4 Part 1, Subpart III—Generator Standards 20 NMAC 4 Part 1, Subpart VIII—Land Disposal Restriction Standards	Hazardous wastes generated during corrective action activities must be managed and disposed of per RCRA requirements pertaining to storage (i.e., container requirements) and disposal at approved offsite permitted hazardous treatment, storage, and disposal facilities.
Treatment, Storage, or Disposal of RCRA Hazardous Waste	40 CFR 264.310(a)(4), (5), (b)(1) and (5) 40 CFR 264.117 through 264.120 20 NMAC 4 Part 1, Subpart V 40 CFR Part 264.95 40 CFR 264.16 (a)(1) 20 NMAC 4 Part 1, Subpart V	Closure and cover requirements for landfills Post-closure requirements Groundwater protection standard point of compliance Personnel training

Table 4-1. Summary of Potentially Applicable Regulatory Requirements at OT-46 (Concluded)

Requirement	Citation	Description
Waste Management (Continued)		
Treatment and Disposal of Hazardous Debris	40 CFR 268.45 20 NMAC 4 Part 1, Subpart VIII	Hazardous debris generated during corrective action activities must be treated using specific technologies to extract, destroy, or immobilize hazardous constituents on or in the debris if placement occurs. In certain cases, the debris may no longer be subject to RCRA Subtitle C regulations after treatment.
Health and Safety Requirements		
Health and Safety Requirements	29 CFR 1910.120	Hazardous waste site supervisors, workers and visitors are required to comply with the training and medical surveillance requirements detailed in this citation.

% percent
CFR Code of Federal Regulations
ft feet
NMAC New Mexico Administrative Code
NMED New Mexico Environment Department
POTW Publicly Owned Treatment Works
RCRA Resource Conservation and Recovery Act
USC United States Code

4.5 Proposed Treatability, Pilot, Laboratory, and/or Bench Scale Studies

Due to the nature of the Lake Christian site, the sediment/soil in the lake bottom must be fully characterized via sampling. Sediment/soil sampling is anticipated to occur during the design phase of the project. Based on sediment sample results obtained during the Phase 2 RFI (USAF, 1997a) and Phase II Stage 2A RFI (USAF, 1993), these results of the new sediment/soil sampling are anticipated to confirm leaving sediment onsite. Samples will be collected, based on discussions with Kirtland AFB, following lake dewatering.

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Section 5

5. PROJECT MANAGEMENT

5.1 Project Team

Figure 5-1 depicts the proposed project team to develop the CMSs for LF-01, LF-08, and OT-46. The key parties for this project are the Kirtland AFB Restoration Branch; USACE—Omaha; USACE—Albuquerque; and Foster Wheeler. The Delivery Order Manager is Mr. William Foley who is responsible for the direction, execution, and successful completion of the report.

The Task Manager is Mr. Derek Johnson. The Task Manager is the primary author of the CMS with assistance from a multidisciplinary team comprised of representatives from geomorphology, hydraulic engineering, civil engineering, regulatory compliance, quality assurance, and technical editing.

Additional details regarding the project organization and responsibilities are discussed and presented in Section 2 of the Base-Wide Project Management Plan (USAF, 1996).

5.2 Project Schedule

A summary of the anticipated schedule to provide the work plan, draft report, and final reports is presented below.

Submittal of Final CMS Work Plan	June 11, 1999
Development of Draft CMS Report	June 11, 1999
Submittal of Final CMS Report	June 25, 1999

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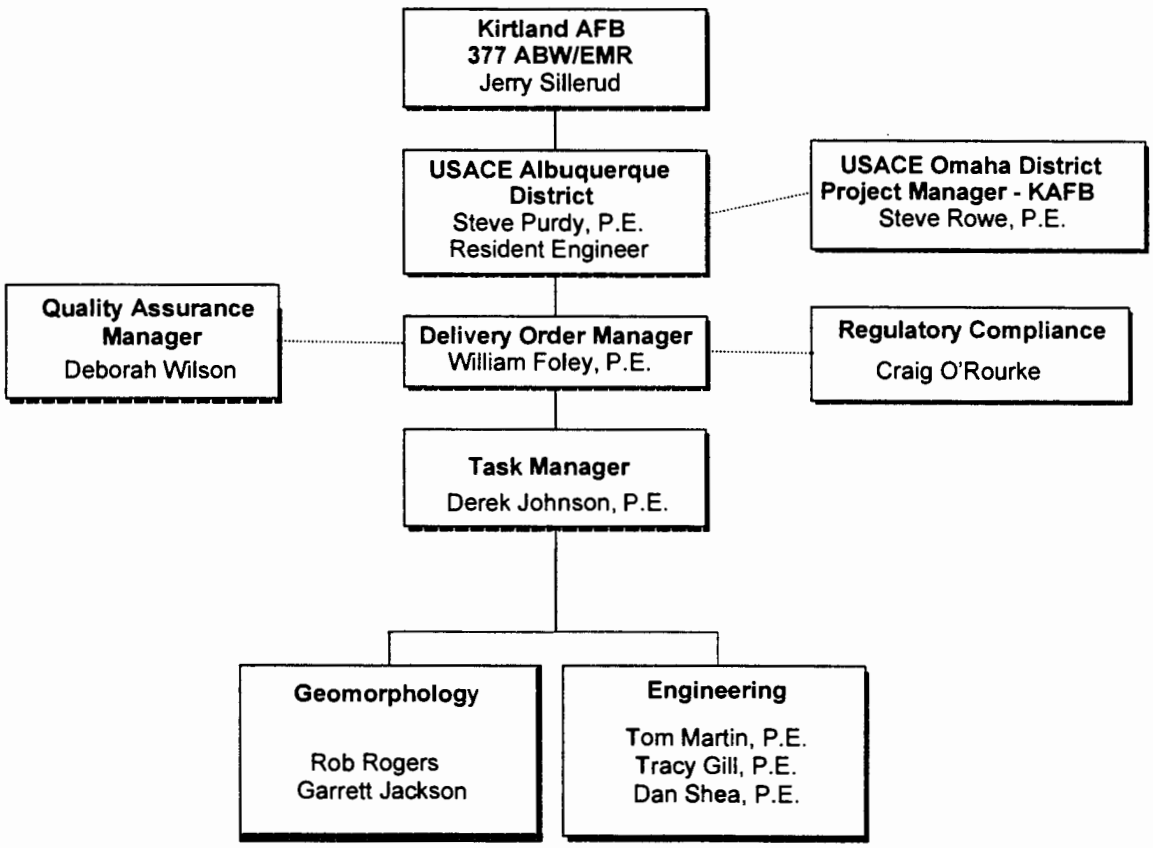

Figure 5-1. Project Organization Chart

REFERENCES

EPA, 1989. *Final Covers on Hazardous Waste Landfills and Surface Impoundments.*

EPA, 1993. Presumptive Remedies: Policy and Procedures.

EPA, 1994. *RCRA Corrective Action Plan.*

USAF, 1993. *IRP Phase II, Stage 2A, RCRA Facility Investigation.* Kirtland AFB, New Mexico.

USAF, 1995. *Kirtland Air Force Base Phase 2 RFI Report—Appendix III Wasteline Sites.* Kirtland AFB, New Mexico.

USAF, 1996. *Final Base-Wide Plans for Investigations* Under the Installation Restoration Program. Kirtland AFB, New Mexico.

USAF, 1997a. *Phase 2 RCRA Facility Investigation Report.* Kirtland AFB. New Mexico.

USAF, 1997b. *Final Management Action Plan.* Kirtland AFB. New Mexico.

USAF, 1998a. *Supplemental Background Determination Report for the Kirtland Air Force Base Landfill.* Kirtland AFB, New Mexico.

USAF, 1998b. *Groundwater Monitoring System Plan September 1998 Detection Monitoring Event Report for the Kirtland Air Force Base Landfill.* Kirtland AFB, New Mexico.

USAF, 1999. *Long-Term Groundwater Monitoring (LTM) Summary Report, Fiscal Year 1998.* Kirtland AFB, New Mexico.

Appendix A

Appendix A

Annotated Outline for the Focused Corrective Measures Studies for LF-01, LF-08, And OT-46

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ANNOTATED OUTLINE FOR THE FOCUSED CORRECTIVE MEASURES STUDIES for LF-01, LF-08, AND OT-46

Certification

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Appendix Detailed Cost Estimates

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1. INTRODUCTION

1.1 Project Overview and Purpose

Document each project overview, scope of work, and contract mechanism.

1.2 Regulatory Framework

RCRA/CERCLA Application (Presumptive Remedies, Focused Definition)

IRP vs. CERCLA issues (fulfill substantive requirements, not obtain permit)

Organization of Document

Section 2: All information specific to LF-01

Section 3: All information specific to LF-08

Section 4: All information specific to OT-46

2. FOCUSED CORRECTIVE MEASURES STUDY—LF-01

2.1 Site Description/Background

(From Management Action Plan [USAF, 1997b])

LF-01 is a high relative risk site located on the west side of Kirtland Air Force Base (AFB) south of the main east-west runway and east of the former Federal Aviation Administration (FAA) control tower. It is bounded by Southgate Avenue on the north, a spur of the Atchison, Topeka, and Santa Fe Railroad on the south, an access road to the munitions storage area on the east, and a line from the southwest corner of the landfill scarp to a prominent turn in Southgate Avenue to the west (Figure A3-1). Albuquerque International Airport is approximately 100 feet (ft) from the northern edge of LF-01. Kirtland AFB production well No. 2 is located approximately 150 ft northeast of the landfill.

LF-01 overlies the Santa Fe Formation Aquifer, west of the Hubbell Springs Fault, an area that is characterized by an up to 15,000-ft-thick unconsolidated alluvial fill covering the Precambrian igneous/metamorphic and Paleozoic sedimentary rocks of the graben floor.

The most prominent topographic feature of the landfill cover is a modified, naturally occurring drainage channel meandering from north to south. It is usually dry but carries storm water runoff during rainfall events. The channel also once served as a drain for the runway area. In most events, the flow infiltrated into the channel bottom before reaching the railroad spur culvert, 1 mile before reaching the Tijeras Arroyo. There is evidence of erosion where the channel banks have cut into the landfill and uncovered fill material. In 1994, the City of Albuquerque extended one of the taxiways and rebuilt another. As a result, an Air Force project (MILCON Project MHMV 96310 - Drain Diversion) was completed to redirect drainage from the runway area into a new storm sewer line discharging parallel and to the east into an

unamed arroyo below LF-01. The major concern prompting this was the potential of the increased flow from better drained runways causing the erosion of trash that might make its way to the Tijeras Arroyo.

Although disposal activities date back to 1951, the landfill was operated primarily between 1960 and 1975 for general use as an area trench and fill landfill. According to the 1988 Kearney/Centaur report, no written records of the quantities or nature of the materials disposed in LF-01 have been recovered. Interviews conducted during previous investigations implied that the landfill contained general refuse, hardfill, and possibly hazardous waste including chemical drums, oil-soaked insulation, and numerous 5-gallon cans containing unknown liquid. Photographs taken in 1971 showed numerous 55-gallon drums at this site. The depths of these materials ranged from 10 to 30 ft over approximately 57 acres. Construction and demolition debris is exposed on the southern edge of the landfill. The volume of the landfill's constituents was estimated to be 600,000 cubic yards in the 1981 Phase I report.

2.2 Site History

2.2.1 Summary of IRP Activities at LF-01

LF-01 was originally identified in the Phase I Records Search and included in the original RCRA Part B permit. An adjacent area south of LF-01 was discovered as a result of the arroyo cleanup in September 1994 when buried wastes, including rocket motors, practice bombs, fire extinguishers, 55-gallon drums containing petroleum product, and metal containers, were discovered. Regulatory agencies were notified, and EPA designated the site as Solid Waste Management Unit (SWMU) DP-69 in November 1994. Shortly thereafter, a Class I permit modification formally identified the site. In April 1995, Kirtland AFB requested DP-69 be incorporated into LF-01 because DP-69 was determined to be an extension of LF-01 not previously identified for investigation. On April 6, 1995, EPA approved a request to move DP-69 from Appendix VI to Appendix I classification of the Part B permit to accelerate its investigative schedule. DP-69 and LF-01 were formally combined in a Class I permit modification dated April 7, 1995.

2.2.2 Investigation Summary

Phase II, Stage I Confirmation/Quantification (1985)

This investigation was executed to determine if soil contamination and leachate were present immediately beneath the fill material and to investigate groundwater and soil quality adjacent to the drainage channel and downgradient of the landfill. Data collection activities included seismic exploration, the drilling of one exploratory boring, the installation of lysimeters in two slanted boreholes, and the installation of one groundwater monitoring well (DA-01, later renumbered KAFB-0107). Soil samples were analyzed for total organic halides (TOX), oil and grease, metals, pesticides, and herbicides, while groundwater samples were analyzed for total organic carbon (TOC), TOX, and nitrate as nitrogen. The data collected from these samples were inconclusive with respect to background values.

Phase II, Stage 2 Remedial Investigation (RI) (1993)

During this investigation, soil samples were collected at six locations using a hand auger, surface water and sediment samples were collected at two locations from the drainage channel crossing the site, and groundwater was sampled (USAF, 1993a). The hand auger and streambed samples were analyzed for total petroleum hydrocarbon (TPH), volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), metals, nitrogen (nitrate/nitrite, ammonia, total Kjeldhal nitrogen [TKN]) and explosives. No analytes exceeded or approached action levels. The surface water samples were analyzed for TPH, VOCs, SVOCs, total and dissolved metals, nitrogen (as above), and explosives. No analytes were found in

concentrations above or approaching action levels. The geophysical survey yielded no evidence of buried metal or other conductive material.

Phase II, Stage 2A RCRA Facility Investigation (RFI) (1991–1993)

This RCRA Facility Investigation (RFI) was executed to characterize the unsaturated zone (0–100 ft) and the upper 20 ft of groundwater, to determine whether shallow soil gas contamination was present, to delineate the boundaries of the landfill, and to locate major trenches and concentrations of buried metallic waste (USAF, 1993b). Eight boreholes were drilled to 100 ft below ground surface (bgs) and seven wells were installed adjacent to seven of the boreholes. Eighteen soil gas locations were sampled and a geophysical survey was conducted. Beryllium and manganese were found above action levels, although both occur naturally and had been detected at elevated concentrations in all previous investigations. VOC contamination in three of the boreholes (benzene, ethylbenzene, toluene, and tetrachloroethene) suggested minor contamination in the shallow soils although these were well below action levels. Other VOC hits were suspected artifacts of laboratory contamination. The soil gas survey detected VOCs in four of the sampling locations in concentrations ranging from 2 to 49 micrograms per liter (µg/l). The geophysical survey revealed north-south trenches in the northern half of the site. Groundwater samples revealed several detections of TPH, TOC, and various dissolved metals at low concentrations.

Phase 2 RFI (1996)

This RFI was executed to determine vertical and lateral extent of potential contamination, support a risk assessment, and support a potential restoration activity (cover system) (USAF, 1997a). Field activities included a geophysical survey of the area previously identified as DP-69, seven auger and five direct-push technology (DPT) borings, chemical and geotechnical soil sampling, and a topographic survey of the site. Soil borings from the perimeter of the site revealed little or no contamination. Soil borings from the interior with samples analyzed for VOCs, SVOCs, herbicides, pesticides/polychlorinated biphenyls (PCBs), and metals indicate that all detected concentrations are below applicable Region 6 human health media-specific screening levels for residential soil ingestion, with the exception of beryllium. Groundwater monitoring also revealed little or no contamination (VOCs, pesticides/herbicides, metals, radioactivity) above applicable NMSWMR health-based groundwater standards.

Long-Term Monitoring (LTM) (1999)

A total of eight monitoring wells have been installed at this site. Historically, quarterly sampling had been conducted at the site, but currently the site is being sampled semiannually. In 1998, all detected concentrations for this site were below applicable New Mexico Solid Waste Management Regulations (NMSWMR) health-based groundwater standards and Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs) for radioactivity. In addition, concentrations detected exceeded baseline concentrations for sodium once in three wells, total organic carbon twice in one well and once in three additional wells, and barium once in three wells. The concentrations of analytes with corresponding NMSWMR standards, barium and chloride, did not exceed standards (USAF, 1999).

Nature and Extent of Contamination

The Stage 2A RFI revealed the presence of four VOCs in three boreholes, suggesting minor shallow soil contamination. Subsequent investigations reveal little or no contamination of either soil or groundwater above action levels or groundwater standards, except those metals that are thought to occur at naturally elevated levels.

2.3 Corrective Action Objectives—LF-01

2.3.1 Potential Applicable Requirements

Identify potentially applicable requirements (i.e., RCRA)

2.3.2 Conceptual Design Criteria

(i.e., Design storm (25 yr-24 hour), Control run-on and run-off, Positive surface drainage across cover, Fill center drainage ditch to provide relatively flat final surface, Function of cover system [revegetation, enhance evapotranspiration, Acceptable Soil Loss])

2.3.3 Selection Criteria

(i.e., Effectiveness, Cost, Risk, Habitat, Maintenance, Final Use, etc.)

2.4 Technology Screening/Corrective Measures Development—LF-01

2.4.1 Development and Screening of Corrective Measures

(i.e., No Action, Various Cover Systems, Erosion Control [toe of slope southeast corner])

2.4.2 Screening of Technologies

(i.e., Monolithic Cover, GCL, RCRA Prescribed, etc.)

2.4.3 Development of Corrective Measures Alternatives

Use table format to develop corrective measure alternatives including "No Action."

2.5 Evaluation of Corrective Measure Alternatives—LF-01

Use Tables when possible

General evaluation of corrective action alternatives developed in Section 2.4.3 to meet the corrective measures objectives, conceptual design criteria and selection criteria.

2.6 Recommendation and Justification of a Corrective Measure—LF-01

2.6.1 Recommendation of Corrective Action Alternatives

Based on the evaluation presented in Section 2.5, recommend a corrective action alternative.

2.6.2 Justification of Corrective Action Alternatives

Detailed justification of corrective measure using RCRA CMS guidelines. Specifically, these standards are:

- Protect human health and the environment
- Attain media cleanup standards set by the implementing agency

- Control the source of releases so as to reduce or eliminate, to the extent practicable, further releases that may pose a threat to human health and the environment
- Comply with all applicable standards for management of wastes, and

Other factors (Long term reliability and effectiveness, reduction in the toxicity, mobility or volume of wastes, short term effectiveness, implementability, and cost)

2.6.3 Cost Estimates

2.6.3.1 Basis of Estimates

3. FOCUSED CORRECTIVE MEASURES STUDY—LF-08

3.1 Site Description/Background

(From Management Action Plan [USAF, 1997b])

LF-08 is a high relative risk site located in the northwest region of Kirtland AFB. It is bounded by Tijeras Arroyo to the north, a drainage berm to the south, an unpaved road to the west, and the covered slope of the active landfill about 150 ft east of Powerline Road to the east. The site covers an area of approximately 76 acres and is protected from surface drainage by a system of earthen dikes. The depths of fill are estimated to have been 2 ft deep on the north and south edges and 40 ft deep near an east-west centerline. The volume of fill has been estimated at 600,000 cubic yards. Although it is generally well covered, this site has some topographic depressions that cause some accumulation and channeling of precipitation. This has resulted in erosion of some of the cover material on the western surface of the landfill.

Positioned west of the Hubbell Springs Fault, this site is unaffected by the complex fault system of the Kirtland AFB area. Characterized by the simple geology of the region, this zone consists primarily of a thick sequence of the Santa Fe Group, which is characterized by up to 15,000 ft of thick unconsolidated alluvial fill covering the Precambrian igneous/metamorphic and Paleozoic sedimentary rocks of the graben floor. Depth to groundwater in the region ranges from 365 to 495 ft for the perched and regional aquifers, respectively. SNL studies concluded that the randomly encountered shallow saturation of the area is associated with either a system of multiple perched aquifers or a groundwater mound. Groundwater flows appears to be to the south-southeast for an identified perched aquifer in the area. For a more complete discussion please refer to Appendix A2, Section A2.2 of the Final Management Action Plan (USAF, 1997b). The landfill can be divided into three areas, based on periods of use.

The southwestern portion of the site (former Landfill 5) covers an area of approximately 26 acres and was operated from 1960 to 1989. Now abandoned, it served as a construction/demolition debris disposal site for the base, and wastes were disposed in unlined trenches. No records were kept concerning the types of wastes disposed, and wastes were not inspected before placement in the landfill.

The southeastern portion of the site (former Landfill 4) was operated from 1980 to 1994. This portion occupies an area of approximately 22 acres, including a soft-fill area (commercial, residential, yard/landscape, and agricultural refuse), a hard-fill area (construction and demolition debris), and an asbestos disposal area. Records exist for the asbestos landfill for 1991 through 1994. No hazardous or

liquid wastes are known to have been disposed in this portion of the site. Wastes were disposed in unlined cells using the area fill method.

The northern portion of the site (Former Landfill 6; 28 acres) was used for disposal of construction debris from 1989 to 1994. Prior to 1989, laboratory wastes (such as carcasses of laboratory animals and rubber gloves) and hazardous materials may have been disposed in the landfill.

An additional 5 to 25 ft of fill from excavation of the current landfill has been placed on this site by base CE between 1993 and 1997.

3.2 Site History

3.2.1 Summary of IRP Activities at LF-08

Formerly separate SWMUs 6-4 (IRP site LF-08), 6-5, and 6-6 (IRP site LF-12) were combined into one SWMU to simplify funding requests, streamline planning, and, because these sites are interrelated, improve corrective action planning. The combination occurred formally in a Decision Document dated September 1994, which administratively closed SWMUs 6-5 and 6-6 and combined them into SWMU 6-4 (closed LF-12 and combined it into LF-08). On June 20, 1994, EPA approved a Class I permit modification that added LF-08 to Appendix I.

3.2.2 Investigation Summary

Phase II, Stage 1 Confirmation/Quantification (1985)

The investigation consisted of seismic exploration, the drilling of an exploratory borehole, and the installation of a lysimeter. The seismic-refraction sections indicated a maximum landfill depth of nearly 40 ft. The borehole was drilled to 100 ft at the western edge of the landfills to investigate a suspected increase in moisture associated with surface water flow-path disruption caused by Powerline Road. The penetrated soil was composed of mixtures of silty sand, sandy silt, clay, and gravel. The lysimeter borehole was drilled at an angle of 50 degrees below horizontal to place the porous section of the lysimeters under the edge of the landfills. The attempt to draw liquid from the lysimeter was unsuccessful.

Phase II, Stage 2A RFI (1993)

During the investigation, the USGS drilled 5 boreholes, sampled 17 soil gas locations, conducted a geophysical survey, and installed and sampled 5 monitoring wells (USAF, 1993b). VOCs were detected in three samples from two boreholes at concentrations below action levels. VOCs were also detected in 12 of the 17 soil gas locations. The geophysical survey indicated potentially large amounts of metal buried in pits and trenches. Methylene chloride and acetone were detected but were indicative of laboratory contamination. Bis(2-ethylhexyl)phthalate, also indicative of laboratory contamination, was detected above action levels in four of the five wells.

Phase 2 RFI (1996)

The objectives of the RFI were to determine the vertical and lateral extent of contamination, to support a risk assessment, and to support potential restoration activities (USAF, 1997a). Activities included drilling seven hollow-stem auger (HSA) and three DPT soil borings, soil sampling for chemical and geotechnical analysis, and a topographic survey. Ten VOCs were detected at levels below applicable EPA Region 6 human health media-specific screening levels for residential soil ingestion (Appendix F). SVOCs (23 in all) were detected at elevated levels, with 8 SVOCs detected in borehole F at levels exceeding applicable

EPA screening levels (indeno(1,2,3-cd)pyrene, pentachlorophenol, anthracene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene). All detected herbicide, pesticide, and PCB concentrations were below applicable EPA Region 6 human health media-specific screening levels (Appendix F). Beryllium concentrations in two samples exceeded a calculated UTL (USAF, 1995). Manganese was detected above the EPA screening level in three samples, but concentrations were below the UTL.

LTM Program (1999)

A total of nine wells have been installed at this site. Three of the wells were installed during 1998 and sampling efforts have just begun (see Monitoring Well Installation [1998], below). Of the nine wells four are located within the perched zone. One of these wells is located upgradient, with three located downgradient. Five of the nine wells are located within the regional aquifer, with one upgradient and four downgradient. Sampling parameters include groundwater quality parameters, contaminant indicator parameters, radionuclides, VOCs, SVOCs, and RCRA metals, pesticides, and herbicides.

The six wells previously installed had been sampled quarterly but are currently being sampled semiannually. Background determinations for the 88 SWMR parameters have been completed for these six wells (USAF, 1998a).

During the 1998 semiannual sampling event, four VOCs were detected below the NMSWMR health-based groundwater standard. Several metals were also detected below the NMSWMR, with the exception of selenium, which has also been detected upgradient of the site. All other detected concentrations were below NMSWMR health-based standards. Concentrations of sulfate and TDS exceeded the NMSWMR aesthetic groundwater standards in one well and two wells, respectively. One well also exceeded the NMSWMR aesthetic standard for pH. These exceedances were all below the assessment monitoring level (AML). One VOC, trichloroethene, exceeded the AML in one upgradient perched zone well; this concentration was below the NMSWMR standard. The exceedance is not indicative of a release from the landfill but is further evidence of documented basewide perched groundwater impacts (USAF, 1998b).

Monitoring Well Installation (1998)

This paragraph will summarize the monitoring well installation activities intended to identify the perched groundwater zone

Nature and Extent of Contamination

During the Stage 2A RFI, 12 of 17 soil gas locations yielded detectable concentrations of VOCs. Bis(2-ethylhexyl)phthalate was detected above action levels in four out of five wells. During the Phase 2 RFI, eight SVOCs exceeding action levels were detected in one borehole (F). No other detections occurred above action levels or groundwater standards, except those metals that are thought to occur at naturally elevated levels.

During the 1998 semiannual sampling, event four VOCs were detected below the NMSWMR health-based groundwater standard. Several metals were also detected below the NMSWMR, with the exception of selenium, which has also been detected upgradient of the site. All other detected concentrations were below NMSWMR health-based standards. Concentrations of sulfate and TDS exceeded the NMSWMR aesthetic groundwater standards in one well and two wells, respectively. One well also exceeded the NMSWMR aesthetic standard for pH. These exceedances were all below the AML. One VOC, trichloroethene, exceeded the AML in one upgradient perched zone well; this concentration was below the NMSWMR standard. The exceedance is not indicative of a release from the landfill but is further

evidence of documented basewide perched groundwater impacts (USAF, 1998b).

3.3 Geomorphic/Hydrologic/Hydraulic Conditions—Tijeras Arroyo

3.3.1 Geomorphic Conditions—Tijeras Arroyo

Compare Arroyo Maps and Aerial Photos

Arroyo Stability/Migration potential

3.3.2 Hydrologic Conditions—Tijeras Arroyo

Design Storm

Insert Photographs of existing conditions

3.3.3 Hydraulic Conditions—Tijeras Arroyo

Determine water surface profile

Evaluation of Erosion of Landfill Cover

3.4 Corrective Action Objectives—LF-08

3.4.1 Potential Applicable Requirements

Identify potentially applicable requirements (i.e., RCRA, New Mexico Solid Waste Management Regulations)

3.4.2 Conceptual Design Criteria

(i.e., Design storm [25 yr-24 hour], Control run-on and runoff, Positive surface drainage across cover, Fill center drainage ditch, Function of cover system [revegetation, enhance evapotranspiration, Acceptable Soil Loss], Erosion control)

3.4.3 Selection Criteria

(i.e., Effectiveness, Cost, Risk Mitigation, Habitat, Maintenance, Final use, etc.)

3.5 Technology Screening/Corrective Measures Development—LF-08

Use Tables when possible

3.5.1 Development and Screening of Corrective Measures

(i.e., No Action, Various Cover Systems)

3.5.2 Screening of Technologies

(i.e., Monolithic Cover, GCL, RCRA Prescribed, etc.)

3.5.3 Development of Corrective Measures Alternatives

Use table format to develop corrective measures alternatives including "No Action."

3.6 Evaluation of Corrective Measures Alternatives

Use Tables when possible

General evaluation of corrective action alternatives developed in Section 3.5.3 to meet the corrective measures objectives, conceptual design criteria and selection criteria.

3.7 Recommendation and Justification of a Corrective Measure—LF-08

3.7.1 Recommendation of Corrective Action Alternatives

Based on the evaluation presented in Section 2.5, recommend a corrective action alternative.

3.7.2 Justification of Corrective Action Alternatives

Detailed justification of corrective measure using RCRA CMS guidelines. Specifically, these standards are:

- Protect human health and the environment
- Attain media cleanup standards set by the implementing agency
- Control the source of releases so as to reduce or eliminate, to the extent practicable, further releases that may pose a threat to human health and the environment
- Comply with all applicable standards for management of wastes, and
- Other factors (Long term reliability and effectiveness, reduction in the toxicity, mobility or volume of wastes, short term effectiveness, implementability, and cost)

3.7.3 Cost Estimates

3.7.3.1 Basis of Estimates

4. FOCUSED CORRECTIVE MEASURES STUDY—OT-46

4.1 Site Description/Background

(From Management Action Plan [USAF, 1997b])

OT-46 is a high relative risk site located in the southeastern region of Kirtland AFB, about 1,000 ft west-northwest of Landfill B (LF-15). Lake Christian is a manmade lake which is 200 ft by 100 ft by 40 ft deep. The lake has approximately 1 ft of freeboard, and is immediately surrounded by typical lacustrine vegetation including cottonwoods and cattail. An open drainage ditch is located less than 250 ft north of the site. There are no existing tributaries which feed the lake and the AFB has been required to refill the lake in order to mitigate the effects of evaporation.

Positioned in Hydrogeologic Region 3, the hydrology of the area is poorly characterized and may include shallow, unconfined alluvial aquifers or multiple confined bedrock aquifers. The vadose zone on the east (upthrown) side of the fault ranges from 50 to 150 ft in thickness and is composed primarily of alluvial fan materials.

4.2 Site History

OT-46 was constructed in the 1950s for use as an underwater explosives testing facility. This unit was active until the mid-1960s. Submerged laboratory animals were used to study the effects of underwater detonation of explosives such as TNT and pentolite. The lake and its banks are surrounded by an 8-foot-high chain-link fence which limits access to the site by non-Kirtland AFB personnel and most wildlife in the area.

4.2.1 IRP/RCRA History

This site was identified in the Phase I Records Search. In June 1992 a Class I modification transferred the site from Appendix II to Appendix I.

4.2.2 Investigations Summary

Phase II, Stage 2A RFI (1991–1993)

The objectives of the Phase II, Stage 2A RFI were to characterize the unsaturated zone (from the surface to 85 ft bgs) and the upper 20 ft of groundwater and to determine whether the water or bottom sediment in Lake Christian was contaminated (USAF, 1993b). Two boreholes were drilled and two monitoring wells were installed. Groundwater samples and two surface water samples were also collected. Soil samples were collected from each boring for chemical analysis. Five lake bottom-sediment samples also were collected. Beryllium was detected in all but one of the samples at concentrations exceeding action levels but below basewide UTLs. Beryllium occurs at naturally elevated concentrations at Kirtland AFB. VOCs were only detected in the sediment samples but not at concentrations that exceeded action levels. SVOCs detected in the sediment did not exceed action levels. Of the detected VOCs and SVOCs, only acetone, benzene, and butyl benzyl phthalate exceeded the QLs. Trace concentrations of acetone, 2-butanone, bis(2-ethylhexyl)phthalate, and methylene chloride suggested possible laboratory contamination, although these contaminants may also be present in the sediments. Two surface water samples were obtained—one collected near the bottom of the lake and one near the surface. Heptachlor epoxide was detected from the sample near the bottom. This compound was not detected in the duplicate sample, and reaffirmation sampling was to be completed during subsequent investigations. Groundwater samples were analyzed for a full suite of parameters. Two VOCs were detected (chloroform and methylene chloride). Methylene chloride also was detected in one or more QC blank samples associated with the sampling event; its presence was attributed to laboratory contamination. Two SVOCs were detected (di-n-octylphthalate and bis(2-ethylhexyl)phthalate). Both of these compounds also were detected in one or more QC blank samples associated with the sampling event; their presence was attributed to laboratory contamination. One pesticide, heptachlor epoxide, was detected. Iron and manganese were detected in one well but may be related to the steel well construction. Fluoride was detected in all three wells. Sulfate and TDS were also detected.

A production well (redesignated KAFB-1903) located approximately 1,600 ft southwest of Lake Christian was used to control the water level in the lake. This well was sampled by SNL in April 1991 for VOCs, SVOCs, metals, cyanide, and radioactivity. The only constituents detected were gross alpha and gross beta radioactivity, with gross beta exceeding New Mexico Solid Waste Management Regulations standards.

Phase 2 RFI (1996)

The objectives of the Phase 2 RFI at Lake Christian were to gather data to complete characterization of the bottom sediments in the lake and of groundwater downgradient of the lake, to support a risk assessment, and to support potential corrective measures, if appropriate (USAF, 1997a). RFI activities included the drilling of one monitoring well, collection of two surface water samples and four bottom sediment samples, and the chemical analysis of soil, groundwater, and surface water samples. Lake-bottom sediment samples were analyzed for VOCs, SVOCs, herbicides, pesticides/PCBs, metals, and explosives. All detected concentrations are below applicable EPA Region 6 human health media-specific screening levels (Appendix F) for residential soil ingestion. Surface water samples were analyzed for herbicides, pesticides/PCBs, TAL metals, and explosives. Only calcium, copper, magnesium, sodium, and zinc were detected; however, none exceeded the NMSWMR standards for drinking water. The groundwater monitoring results yielded no detections of pesticides/PCBs or explosives. All other detected constituents were below applicable NMSWMR standards.

LTM Program (1999)

A total of four monitoring wells have been installed at this site. Historically, quarterly sampling had been conducted at the site. During the Phase II, Stage 2A RFI heptachlor epoxide had been detected, which resulted in subsequent groundwater sampling. Currently, the site is being sampled semiannually. In 1998, all detected concentrations for this site were below applicable NMSWMR health-based groundwater standards, with the exception of fluoride and selenium. Fluoride was detected above the standard in all wells during both sampling events. Selenium exceeded the standard in one well during both events. NMSWMR aesthetic groundwater standards were exceeded for iron in one well for both events and for manganese and sulfate in one well for both events. The SDWA MCL for gross alpha was exceeded for all wells during one or both events.

In 1998, concentrations detected exceeded baseline concentrations for iron three times, for chloride once, for nitrate once, and for total organic carbon once (USAF, 1999).

4.3 Corrective Action Objectives

4.3.1 Potential Applicable Requirements

Identify potentially applicable requirements (i.e. RCRA, NPDES, Clean Water Act, etc.)

4.3.2 Conceptual Design Criteria

- Total volume of water to be pumped from OT-46
- Time to discharge the water from OT-46 to the designated sanitary sewer discharge location
- Contaminant loading of the designated water treatment plant
- Permeability of the intended backfill material(s) for the dewatered lake
- Design life of the corrective measure
- Adequate surface drainage of the proposed cover
- Design Storm Event (25 year-24 hour)
- Appropriate erosion control measures in order to protect the corrective measure from the erosive forces of wind and storm water runoff

- Vegetation (native seed mix, mulching requirements, etc.)
- Aesthetic aspects of the corrective measure
- An ICM (sediment sampling) , preceding the focused CMS, will produce data used to confirm previous sediment sampling results and evaluate final disposition alternatives for lake sediments. Based on previous analytical results, the anticipated final disposition of the lake sediments is to remain in place and be covered. Also, the intent would be to further investigate the lake as a potential source of the fluoride and selenium detected in the groundwater. The subsurface soil has not been previously sampled due to the overlying lake.

4.3.3 Selection Criteria

(i.e., Effectiveness, Risk Mitigation, Relative Cost, Aesthetics, Ease of Construction, Ease of Maintenance)

4.4 Technology Screening and Corrective Measures Development—OT-46

4.4.1 Development and Screening of Focused Corrective Measures

From review of the information obtained during the Phase II, Stage 2A RFI (1991-1993) and the Phase 2 RFI (1996), it is anticipated that the corrective measure for the OT-46 site will involve: (1) dewatering of the lake; (2) additional sedimentation sampling of the lake bottom; (3) partial/interim backfill of the lake with water (prevention of sediment migration); (4) final dewatering of lake; (5) backfilling of lake with clean materials and/or soil(s); (6) vegetation; and (7) potential placement of erosion protection.

4.4.2 Development of Focused Corrective Measures Alternatives

This section will utilize a table format (Table 4-1) which will be developed during the preparation of the Draft CMS. The Table 4-1 shall include the alternative of performing "No Action" at the site.

4.5 Evaluation of Focused Corrective Measures Alternatives—OT-46

Table 5-1 (TO BE PROVIDED) provides a general evaluation of the ability of the corrective action alternatives developed in Section 4 to meet the corrective measures objectives, conceptual design criteria, and the selection criteria discussed in Section 3 of this report. Only plausible corrective action alternatives were screened. These alternatives will be evaluated in detail during the CMD phase of this project.

4.6 Recommendation and Justification of a Corrective Measure—OT-46

Recommend a corrective measure

Detailed justification of corrective measure using RCRA CMS Guidelines

4.6.1 Recommendation of Corrective Action Alternatives

Brief discussion of the selected alternative. In addition, this section will also include discussion of the potential impacts on the implementation of the corrective action measures if the sediment samples show contamination above the established action levels for the site(i.e. excavation of lake contaminated sediment and/or potential natural or synthetic capping scenario). From the test results obtained during the

previous surface water and sediment samples taken during the Phase II, Stage 2A RFI (USAF, 1993b) and Phase 2 RFI (USAF, 1997a), it is anticipated that the sediment samples will show no contamination above the action levels for the site.

4.6.2 Justification of Corrective Action Alternatives

Documenting how the alternatives comply with the standards listed in the RCRA CMS Guidelines provides justification for the recommended corrective action alternatives. Specifically, these standards are:

- Protect human health and the environment
- Attain media cleanup standards set by the implementing agency
- Control the source of releases so as to reduce or eliminate, to the extent practicable, further releases that may pose a threat to human health and the environment
- Comply with all applicable standards for management of wastes, and
- Other factors (Long term reliability and effectiveness, reduction in the toxicity, mobility or volume of wastes, short term effectiveness, implementability, and cost)

4.6.3 Cost Estimate

4.6.3.1 Basis of Estimates

5. PUBLIC INVOLVEMENT PLAN

6. PROPOSED SCHEDULES

Provide schedule to implement CMD/CMI for each site

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REFERENCES

USAF, 1981. *IRP Phase I Records Search—Hazardous Materials Disposal Sites.* Kirtland AFB, New Mexico.

USAF, 1985. *IRP Phase II Confirmation/Quantification Stage.* Kirtland AFB. New Mexico.

USAF, 1988. *Preliminary Review/Visual Site Inspection.* Kirtland AFB, New Mexico.

USAF, 1993a. *Phase II, Stage 2 Remedial Investigation.* Kirtland AFB, New Mexico.

USAF, 1993b. *IRP Phase II, Stage 2A, RCRA Facility Investigation.* Kirtland AFB, New Mexico.

USAF, 1995. *Kirtland Air Force Base Phase 2 RFI Report—Appendix III Wasteline Sites.* Kirtland AFB, New Mexico.

USAF, 1997a. *Phase 2 RCRA Facility Investigation Report.* Kirtland AFB, New Mexico.

USAF, 1997b. *Final Management Action Plan.* Kirtland AFB, New Mexico.

USAF, 1998a. *Supplemental Background Determination Report for the Kirtland Air Force Base Landfill.* Kirtland AFB, New Mexico.

USAF, 1998b. *Groundwater Monitoring System Plan September 1998 Detection Monitoring Event Report for the Kirtland Air Force Base Landfill.* Kirtland AFB, New Mexico.

USAF, 1999. *Long-Term Groundwater Monitoring (LTM) Summary Report, Fiscal Year 1998.* Kirtland AFB, New Mexico.

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Appendix

Detailed Cost Estimates