CAFB 02

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

07 AUG 2002

Mr. Robert S. Pyeatt
Deputy Base Civil Engineer
506 N DL Ingram Blvd
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Mr. James Bearzi, Chief
Chief Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe NM 87505-6303

Dear Mr. Bearzi

Enclosed for your records are two copies of the Final Revised Long-Term Monitoring Work Plan (LTMWP) for Environmental Restoration Program site numbers LF-03 (SWMU 105), LF-04 (SWMU 104), and LF-25 (SWMU 97) located at Cannon Air Force Base (CAFB), Clovis, New Mexico. This LTMWP supports the following fieldwork being performed at CAFB:

- The annual (2002) sampling of groundwater wells at LF-03 (well O), LF-04 (well N), the semi-annual sampling of groundwater at LF-25 (well Ra)
- The development of a Groundwater Monitoring Report for the 2002 sampling events.

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

Sincerely

ROBERT S. PYEATT, GS-13

cc:
NMED HWB (G. von Gonten) wo Atch
NMED HWB (J. Jacobs) wo Atch
EPA Region VI (B. Sturdivant)

LIBRARY COPY

FINAL REVISED
LONG-TERM MONITORING WORK PLAN

Sampling and Analysis Plan
Site Safety & Health Plan

ERP Site Nos. LF-03, LF-04 & LF-25

Cannon Air Force Base
Clovis, New Mexico
July 2002
Revision 2

SECTION IA

Field Sampling Plan

FINAL REVISED LONG-TERM MONITORING WORK PLAN

SAMPLING AND ANALYSIS PLAN
&
SITE SAFETY AND HEALTH PLAN

LANDFILL NO. 03 (SWMU 105)

LANDFILL NO. 04 (SWMU 104)

LANDFILL NO. 25 (SWMU 97)

CONTRACT NO. DACA45-99-D-0017

DELIVERY ORDER NO. 10

Prepared For

Cannon Air Force Base

Air Combat Command

Clovis, New Mexico

Prepared By

BHATE Environmental Associates, Inc.

Birmingham, Alabama

Under Contract To

U.S. Army Corps of Engineers

Omaha, Nebraska

July 2002

WORK PLAN

ORGANIZATION

SECTION		TITLE
I		**SAMPLING & ANAYLSIS PLAN**
	IA	Field Sampling Plan
	IB	Quality Assurance Project Plan
II		**SITE SAFETY & HEALTH PLAN**
III		**APPENDICES**
	IIIA	General Chemistry Supplement To The Scope of Services For Studies/Geology Supplement
	IIIB	Cannon AFB Basewide Health and Safety Plan
	IIIC	Field Forms

FIELD SAMPLING PLAN

FINAL REVISED LONG -TERM MONITORING WORK PLAN, REVISION 0

LANDFILL NO. 03 (SWMU 105)

LANDFILL NO. 04 (SWMU 104)

LANDFILL NO. 25 (SWMU 97)

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ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
BHASP	Basewide Health and Safety Plan
BHATE	Bhate Environmental Associates, Inc.
bgs	Below Ground Surface
CAFB	Cannon Air Force Base
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
COC	Chain of Custody
DQO	Data Quality Objectives
EPA	Environmental Protection Agency
ERP	Environmental Restoration Program
FSP	Field Sampling Plan
GCS	General Chemistry Supplement
GRO	Gasoline Range Organics
GS	Geology Supplement
HTW	Hazardous or Toxic Waste
ID/IQ	Indefinite Delivery/Indefinite Quantity
IDLH	Immediately Dangerous to Life or Health
IDW	Investigation Derived Waste
LF	Landfill
LTM	Long-Term Monitoring
MAP	Management Action Plan
MDL	Method Detection Limit
MSDS	Material Safety Data Sheet
NAPL	Non-Aqueous Phase Liquid
NFA	No Further Action
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
OSHA	Occupational Safety and Health Administration
PCBs	Polychlorinated Biphenyls
PPB	Parts Per Billion
PPE	Personal Protective Equipment
PM	Project Manager
PPM	Parts Per Million
PQL	Practical Quantitation Limit
PVC	Polyvinyl Chloride
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation

ACRONYMS AND ABBREVIATIONS-Continued

SAP	Sampling and Analysis Plan
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
SVOC	Semi-volatile Organic Compound
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TBD	To be Determined
TLV	Threshold Limit Value
TWA	Time-Weighted Average
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USGS	United States Geological Survey
VOCs	Volatile Organic Compounds
WP	Work Plan

Symbols

<	Less Than
mg/kg	Milligrams per Kilogram (synonymous with Parts Per Million)
µg/l	Micrograms Per Liter (synonymous with Parts Per Billion)

1.0 INTRODUCTION

The United States Army Corps of Engineers (USACE), Omaha District, has retained Bhate Environmental Associates, Inc. (BHATE) to prepare a Revised Long-Term Monitoring Work Plan (WP) for the following fieldwork at Cannon Air Force Base (CAFB) in Clovis, New Mexico:

- The annual (2002) sampling of groundwater monitoring wells at LF-03 (well O), LF-04 (well N), the Semi-Annual Sampling of groundwater at LF-25 (well Ra), and
- The development of a Groundwater Monitoring Report for the 2002 sampling events.

The following WP and its ancillary documents have been prepared for CAFB and the USACE by BHATE under an Indefinite Delivery/Indefinite Quantity (ID/IQ) contract with the USACE, Omaha District (Contract No. DACA45-99-D-0017).

The Long-Term Monitoring will be conducted in accordance with BHATE's SAP and the SSHP, Sections I and II, respectively. The SAP is comprised of two sections: the Field Sampling Plan (FSP) – Section IA and the Quality Assurance Project Plan (QAPP) - Section IB. These plans have been developed by applying the USACE Omaha District's General Chemistry Supplement (GCS), and the Geology Supplement (GS) to the Scope of Services (Appendix IIIA), and by referencing existing documents in an effort to reduce the redundancy of information and cost to the US Air Force (USAF).

1.1 OBJECTIVES

The objective of the long-term monitoring (LTM) and reporting program is to assess whether the associated Solid Waste Management Units (SWMUs) have released and/or leached contaminants into the groundwater.

The LTM program meets requirements under 40 Code of Federal Regulations (CFR) 264.97, and meets the New Mexico Environment Department (NMED) Solid Waste Management

Regulations (20 New Mexico Administrative Code [NMAC] 9.1, Subpart VIII and the New Mexico Hazardous Waste Management Regulations 20 NMAC 4.1).

The primary objective of this WP is to describe the fieldwork and the methodologies required to complete the LTM. For streamlining purposes, many of the following task methodologies reference appropriate sections in the USACE GCS and GS (Appendix IIIA and CAFB Basewide Health and Safety Plan (BHASP; Foster Wheeler, February 2000 - Appendix IIIB).

1.2 APPROACH

The approach adopted to meet the stated objective is to collect, analyze and evaluate the quality of groundwater samples with respect to the potential contaminants leaching from the former landfills. A more complete description of the fieldwork is presented in Section 3.0 of this document.

2.0 SITE LOCATION AND HISTORY

CAFB is located approximately 6 miles west of the community of Clovis, New Mexico on approximately 3,782 acres of land (Figures 1 and 2). The majority of the base is bound to the north by US Highway 60/84 with the exception of a housing area which is located north of 60/84. The remaining areas bordering the base include agricultural and residential land, according to information provided in the USAF Management Action Plan (MAP) for CAFB (USAF, December 2000).

Prior to the existence of the base, the surrounding areas were primarily used for agricultural purposes. In 1929 Portair Field was established on the land as a transcontinental air terminal. In 1942, the Department of Defense (DoD) took control of Portair Field and re-named it Clovis Army Air Base. Clovis Army Air Base was subsequently closed in 1947 (USAF, December 2000).

In 1951, the Air Base was reopened and assigned to the Tactical Air Command as Clovis Air Force Base. In 1957, the base was renamed Cannon Air Force Base. At the present, CAFB is part of the Air Combat Command. The current mission of CAFB is to maintain a combat-ready force capable of day, night and all weather operations and to provide replacement training of combat aircrews for tactical operations worldwide. As part of these operations, large quantities of petroleum, oils and lubricants as well as solvents and protective coatings have been and are currently used on base (USAF, December 2000).

2.1 LANDFILL NO. 03 (LF-03)

According to background information provided in the MAP for CAFB (USAF, December 2000), LF-03 is an inactive cut and burn landfill that was operated from 1959 to 1967. The area of the landfill is approximately nine acres and it is situated along the eastern boundary of the Base (Figure 3). The ground surface in this area is slightly hummocky and is covered with prairie grasses with no visual evidence of stressed vegetation. The landfill was reported to have received domestic and industrial wastes including solvents, paints, thinners, waste oils, and peroxide containers.

Twenty-seven soil samples were collected from 9 soil borings advanced within the landfill during the Environmental Restoration Program (ERP) Phase II study. The samples were analyzed for total priority pollutant metals, total iron, total nickel, and total zinc, oil and grease, and Appendix IX volatile organic compounds (VOCs). No VOCs were detected, and metal concentrations were within the range of background values. Oil and grease values ranged from less than (<) 1.0 milligram per kilogram (mg/Kg) to 83 mg/Kg (USAF, December 2000).

In October 1994, a downgradient-monitoring well (MW-O) was installed at this site. In January 1995, MW-O was sampled. Laboratory analytical results for this groundwater sample indicated a carbon tetrachloride concentration of 1.6 micrograms per liter (µg/l) and a toluene concentration of 6.8 µg/l. Gasoline-range organic (GRO) compounds were detected at a concentration of 16 µg/l. Metal analytes detected included arsenic, barium, selenium, and vanadium at 0.022 milligrams per liter (mg/l), 0.064 mg/l, 0.0025 mg/l, and 0.018 mg/l, respectively (USAF, December 2000). The presence of VOCs and GRO are likely attributable to failure of the activated carbon filtration system on the compressor used for circulation of soil cuttings during drilling of the soil boring for the installation of the monitoring well.

This site was further investigated along with LF-04 during a RCRA Facility Investigation (RFI; Radian Corporation, 1994). The RFI Report recommended no further action (NFA). However, the Environmental Protection Agency (EPA) Region VI requested the location of boundary markers at the site and the installation of one downgradient monitoring well. This site was included in a September 2000 Class 3 Permit Modification Request for removal from the permit (USAF, December 2000). The groundwater at this site is currently being monitored on an annual basis to meet the long-term monitoring requirements.

2.2 LANDFILL NO. 04 (LF-04)

LF-04 is an inactive seven acre cut and burn landfill that was operated from 1967 to 1968. LF-04 is immediately north of Playa Lake, on the eastern base boundary (Figure 4). The landfill received domestic and industrial wastes including solvents, paints, thinners, waste oils, and

peroxide containers. The area is currently covered with prairie grasses with no visual evidence of stressed vegetation (USAF, December 2000).

Twenty-one soil samples were collected from 7 soil borings advanced within the boundaries of the landfill during the ERP Phase II Study. The soil samples were analyzed for the presence of priority pollutant metals, oil and grease, and Appendix IX VOCs. No VOCs were detected, and metals concentrations were within the range of background values. Oil and grease was detected at concentrations ranging from 18 mg/Kg to 45 mg/Kg (USAF, December 2000).

A downgradient-monitoring well (MW-N) was installed in December 1994. The well was initially sampled in January 1995 and results of the groundwater analyses indicated the presence of toluene at a concentration of 5.7 μg/l. GRO was also detected in the sample at a concentration of 17 μg/l. Metals concentrations detected in the groundwater samples from this well were as follows: arsenic (0.0033 mg/l), barium (0.047 mg/l), copper (0.0059 mg/l), selenium (0.0068 mg/l), tin (0.32 mg/l), vanadium (0.019 mg/l), and zinc (0.013 mg/l), USAF, December 2000. The presence of VOCs and GRO are likely attributable to failure of the activated carbon filtration system on the compressor used for circulation of soil cuttings during drilling of the soil boring for the installation of the monitoring well.

This site was also investigated along with LF-03 during the RFI (Radian Corporation, 1994). This RFI Report recommended NFA. However, the EPA Region VI requested the location of boundary markers and the installation of one downgradient monitoring well. A Class 3 Permit Modification Request for removal of this site from the permit was submitted in September 2000 (USAF, December 2000). The groundwater at this site is currently being monitored on an annual basis to meet the long-term monitoring requirements.

2.3 LANDFILL NO. 25 (LF-25) CONCRETE RUBBLE PILE

LF-25 encompasses approximately thirty acres of land located adjacent to perimeter road, on the east area of the Base (Figure 5). A Rubble Pile, which appeared to consist primarily of construction debris, bricks, concrete blocks, and asphalt road and runway material, can be seen

on the mid-1950s historical aerial photographs. Most of the material originated from demolished World War II era facilities (USAF, December 2000).

An environmental assessment was performed on the Rubble Pile by the USACE (USACE, 1991). Material from nine test pit trenches were sampled for asbestos, polychlorinated biphenyls (PCBs), Appendix IX VOCs, pesticides, herbicides and metals. None of the above parameters were detected in the samples collected from rubble material. However, at least two cut and burn landfill trenches were encountered beneath the rubble material. Newspaper material, dated 1943, was recovered from one of the trenches. Detectable levels of barium and cadmium were found in one trench. However, the levels were well below background. Benzidine, an SVOC, was also detected at extremely low levels (USAF, December, 2000).

The Rubble Pile was scheduled for investigation during the Phase I RFI (Appendix III) investigation. However, because munitions personnel wanted to construct a facility over the northern half of this rubble pile, the site was investigated in conjunction with the Phase I RFIs conducted at LF-03 and LF-04. Due to the presence of asbestos material at the site and the unknown nature of the buried materials within the landfill, CAFB ERP personnel recommended that no construction be performed at the site. In 2000, the mounds of asbestos siding material were removed from the site, and the landfill was covered with topsoil (USAF, December, 2000).

The Phase I RFI Report recommended NFA, but the EPA directed CAFB to monitor Well K as a downgradient monitoring well for LF-25. Well K was originally installed to monitor the Old Entomology Rinse Area. Due to declining regional groundwater levels, groundwater samples could no longer be collected from Well K, therefore Well R was subsequently installed on the eastern edge of the landfill in 1998. A review of the groundwater analytical results over the past few years indicated that chromium, iron, and nickel concentrations have been increasing. Due to the highly corrosive nature of the groundwater in the aquifer it has been suggested that the stainless steel screen in the well may be corroding and thus producing anomalous analytical results. Therefore, MW-R was replaced with monitoring well MW-Ra on June 25, 2001. MW-Ra was constructed with Schedule 80 polyvinyl chloride (PVC) factory slotted screen. Since its

installation, monitoring well Ra has been sampled on a semi-annual basis. This site is scheduled for submittal of NFA Status in 2004 (USAF, December 2000). The groundwater at the site is currently being monitored twice a year to meet the long-term monitoring requirements.

3.0 SCOPE OF WORK

The field sampling activities and associated tasks associated with the work to be performed at CAFB include the following:

- Annual (2002) sampling of groundwater monitoring wells at LF-03 (well O), LF-04 (well N) and the Semi-Annual Sampling (2002) of groundwater at LF-25 (Well Ra), and
- Development of a Groundwater Monitoring Report for the 2002 sampling events.

All work will be performed in accordance with the requirements outlined in the following:

- SAP and SSHP,
- Site Specific Scope of Services for CAFB, dated January 30, 2001 (USACE, January 2001), and
- USACE Omaha District's General Chemistry Supplement and the Geology Supplement to the Scope of Services (USACE, January 2000)

3.1 GROUNDWATER SAMPLING

BHATE will collect groundwater samples to quantitatively assess the presence or absence of contaminants. Groundwater samples will be collected Semi-Annually (2002) from monitoring well Ra at LF-25 and annually (2002) from well O at LF-03, and well N at LF-04.

For each well, the depth to groundwater and the total well depth will be measured and recorded using an electronic water level probe. These measurements will be used to calculate the volume of groundwater to be purged. Prior to well purging, the presence or absence of non-aqueous phase liquids (NAPLs) at the top and bottom of the water column will be determined. If NAPLs are present, BHATE will notify the USACE-Project Geologist and Chemist for further instructions.

Assuming the absence of NAPLs, each well will be purged using the dedicated Bennett pumps to remove a quantity of water equal to or greater than three times the submerged volume of the casing and/or well screen. Field water quality parameters (pH, Dissolved Oxygen (DO), conductivity, turbidity, and temperature) will be measured and recorded during the purging

process. The field parameters will be measured at the start of purging and every 10 gallons thereafter. Purging shall continue beyond three casing volumes until these parameters have stabilized (0.2 pH units or a 10% change for the other parameters between four consecutive readings). The groundwater samples will be collected immediately following stabilization of the field parameters. The purge rate will be reduced to obtain the lowest flow possible during the purging of the last well volume to insure that the water is not cascading into and through the filterpack and into the well. If the well does not recharge sufficiently to permit removing three casing volumes, an alternate sampling method will be discussed with the USACE Project Geologist and Chemist.

The VOC samples will be collected first while the flow rate is low. If necessary, the flow rate can be increased following VOC collection as long as it does not increase the turbidity of the samples. Samples will be collected in appropriate sample containers, properly labeled, packaged for transportation to the laboratory. The samples will be immediately packed on ice in a cooler to insure that the samples will arrive at the laboratory at or less than 4°C. Samples will be packaged and shipped as specified in the GCS (USACE, January 2000) Appendix IIIA. A blank copy of the Groundwater Sampling Log is included in Appendix IIIC.

The groundwater sampling techniques shall be in accordance with Section 5.3 of the GS (USACE, January 2000 - Appendix IIIA) and are designed to achieve the objectives outlined in this work plan.

Monitoring well Ra (LF-25) will be sampled semi-annually (2002) and well N (LF-04) and well O (LF-03) will be sampled annually (2002). The analytical laboratory will be responsible for employing proper analytical protocols to produce accurate data that will be reproducible and legally defensible. At least one field duplicate will be submitted during each sampling event and will be submitted to the USACE QA lab: Environmental Chemistry Branch Lab, 420 S 18th Street, Omaha, NE, 68102. The point of contact is Laura Percifield at 402-444-4314. The assigned LIMS number for this project is 6184.

Groundwater samples collected during the CAFB LTM events will be analyzed for the parameters listed below in Sections 3.5.1 and 3.5.2. All analytical methods used will be in accordance with SW-846 methods, (USPEA, April 1998), unless otherwise stated. Practical quantitation limits are provided in the QAPP (Section IB). Sampling container requirements, preservatives and other pertinent information for each of the analytical methods being performed on samples collected during this fieldwork is presented below.

Sample Containers, Preservatives, and Holding Times for Groundwater Samples
Long-Term Monitoring
CAFB, Clovis, New Mexico

Parameters	Container	Preservation	Maximum Holding Times[1]	
			Extraction	Analysis
TAL Metals	1-16oz polyethylene bottle	pH<2, HNO_3 Cool to 4°C	---	180d
VOCs	3-40 ml glass vials	pH<2, HCL Cool to 4°C	---	14d
SVOCs	1-L amber organic glass	Cool to 4°C	7d	40d
Mercury	1-16oz polyethylene bottle	pH<2, HNO_3 Cool to 4°C	---	28d
Herbicides	1-L amber organic glass	Cool to 4°C	7d	40d
Organochlorine Pesticides	1-L amber organic glass	Cool to 4°C	7d	40d
PCBs	1-L amber organic glass	Cool to 4°C	7d	40d
Organophosphate Pesticides	1-L amber organic glass	Cool to 4°C	7d	40d
Sulfate	1-L polyethylene	Cool to 4°C	---	28d
Nitrate				48 hr
Chloride				28d
Phenol	1-L organic glass	pH < 2; H_2SO_4 , Cool to 4°C	---	28d

Notes
[1] Holding time begins at time of collection
TAL = target analyte list
d = day
hr = hour

Data review and validation will be performed by applying the QC limits defined in the various analytical methodologies. Data validation will consist of examination of holding times, method blanks, quality assurance samples, surrogate spikes, matrix spike/matrix spike duplicates (MS/MSDs), and review of case narratives addressing sample receipt forms and Chains of Custody (COCs). A copy of the COC is included in Section IIIC. USEPA validation guidelines from the "National Functional Guidelines for Organic Data Review" (USEPA, 1994) and the "National Functional Guidelines for Inorganic Data Review" (USEPA, 1994) will be

used as reference resources to define validation criteria. Accepted validation qualifiers denoting various exceptions, estimations and usability of the data will be defined in the report and assigned to the data as applicable.

3.1.1. Semi-Annual Groundwater Sampling

Groundwater samples will be collected from LF-25 (MW-Ra) on a semi-annual basis. The groundwater sample along with applicable duplicates, blanks and QA/QC samples will be submitted to the contract and the USACE Environmental Chemistry Branch Lab in accordance with Section 5.3 of GS. The samples will be analyzed for the parameters listed below and presented in the QAPP (Section IB).

3.1.2. Annual Groundwater Sampling

Groundwater samples will be collected from monitoring wells located at LF-03 (MW-O) and LF-04 (MW-N). The groundwater sample along with applicable duplicates, blanks and QA/QC samples will be submitted to the Contract and the USACE Environmental Chemistry Branch Lab in accordance with Section 5.3 of GS. The samples will be analyzed for the parameters listed below and in the QAPP (Section IB).

Order of Sample Collection	Analyses	Method Number	Semi-Annual and Annual Event MW-O, -N and –Ra
1	Volatile Organic Compounds	SW 8260B	✓
2	Semi-Volatile Organic Compounds (including Petroleum Aromatic Hydrocarbons)	SW 8270C	✓
3	TAL Metals Mercury	SW 6010B SW 7470A	✓
4	Herbicides	SW 8151A	✓
5	Pesticides Organochlorinated	SW 8081A	✓

Order of Sample Collection	Analyses	Method Number	Semi-Annual and Annual Event MW-O, -N and –Ra
6	PCBs	SW 8082	✓
7	Pesticides Organophosphates	SW 8141	✓
8	Water Quality Indicators MCAWW --Sulfates --Nitrates --Chloride --Phenols	 EPA 300.0 EPA 300.0 EPA 300.0 EPA 420.2	✓

FR = Code of Federal Regulations
EPA = U.S. Environmental Protection Agency
MCAWW = Methods for Chemical Analysis of Water and Wastes
MW = monitoring well
PCBs = polychlorinated biphenyls
TAL = target analyte list

3.2 CHEMICAL ANALYSES

The groundwater samples collected will be submitted to TestAmerica of Nashville, Tennessee (a USACE-validated laboratory) under COC, in accordance with the GCS Guidelines (USACE, January 2000 Appendix C). Applicable QA/QC samples, duplicates, trips and spikes will be submitted under the same time constraints to the USACE Environmental Chemistry Branch Lab.

4.0 REPORTING AND PROJECT SCHEDULE

BHATE will prepare a Groundwater Monitoring Report in the format required by NMED. The report shall include a description of the base, description of the sites, documentation of the groundwater sampling activities, discussions of the QA/QC, the analytical results, and a summary of conclusions for each of the sites. The report will be submitted in Draft form for comments and review. Upon incorporation of USACE and CAFB comments, Final reports will be produced for submittal to NMED.

The schedule for the work will be as follows:

- June 2002 – Well O, N and Ra Sampling
- December 2002 – Well Ra Sampling

5.0 REFERENCES

Foster Wheeler Environmental Corporation, *Basewide Health and Safety Plan CAFB*, February 2000.

Radian Corporation, *LF-03 RFI Final Report,* 1994.

Radian Corporation, *LF-04 RFI Final Report,* 1994.

United States Air Force, *Managament Action Plan, CAFB*, Air Force Project No. ACCH20007544, December 2000.

United States Army Corps of Engineers, Omaha Distruct, *General Chemistry Supplement to the Scope of Services for Studies*, January 2000.

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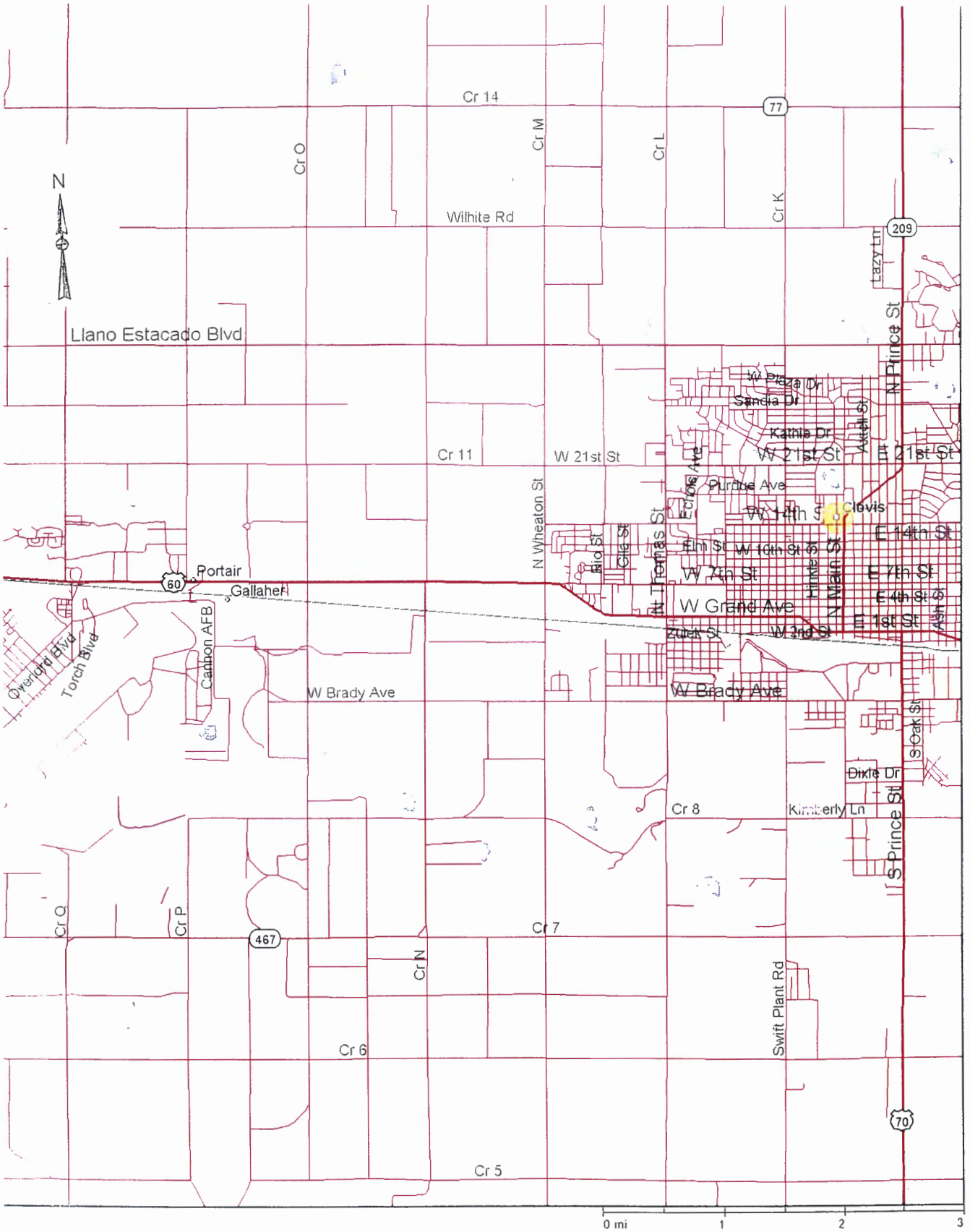
United States Army Corps of Engineers, Tulsa District, *LF-25 Environmental Assesment,* February, 1991.

United States Environmental Protection Agency, *Contract Laboratory Program National Functional Guidelines for Organic Data Review,* February, 1994.

United States Environmental Protection Agency, *Contract Laboratory Program National Functionals Guidelines for Inorganic Data Review,* February, 1994.

United States Environmental Protection Agency, *SW-846 Test Methods for Evaluating Solid Wastes Physical/Chemical Methods, Update III, Revision 5,* April, 1998.

Figures



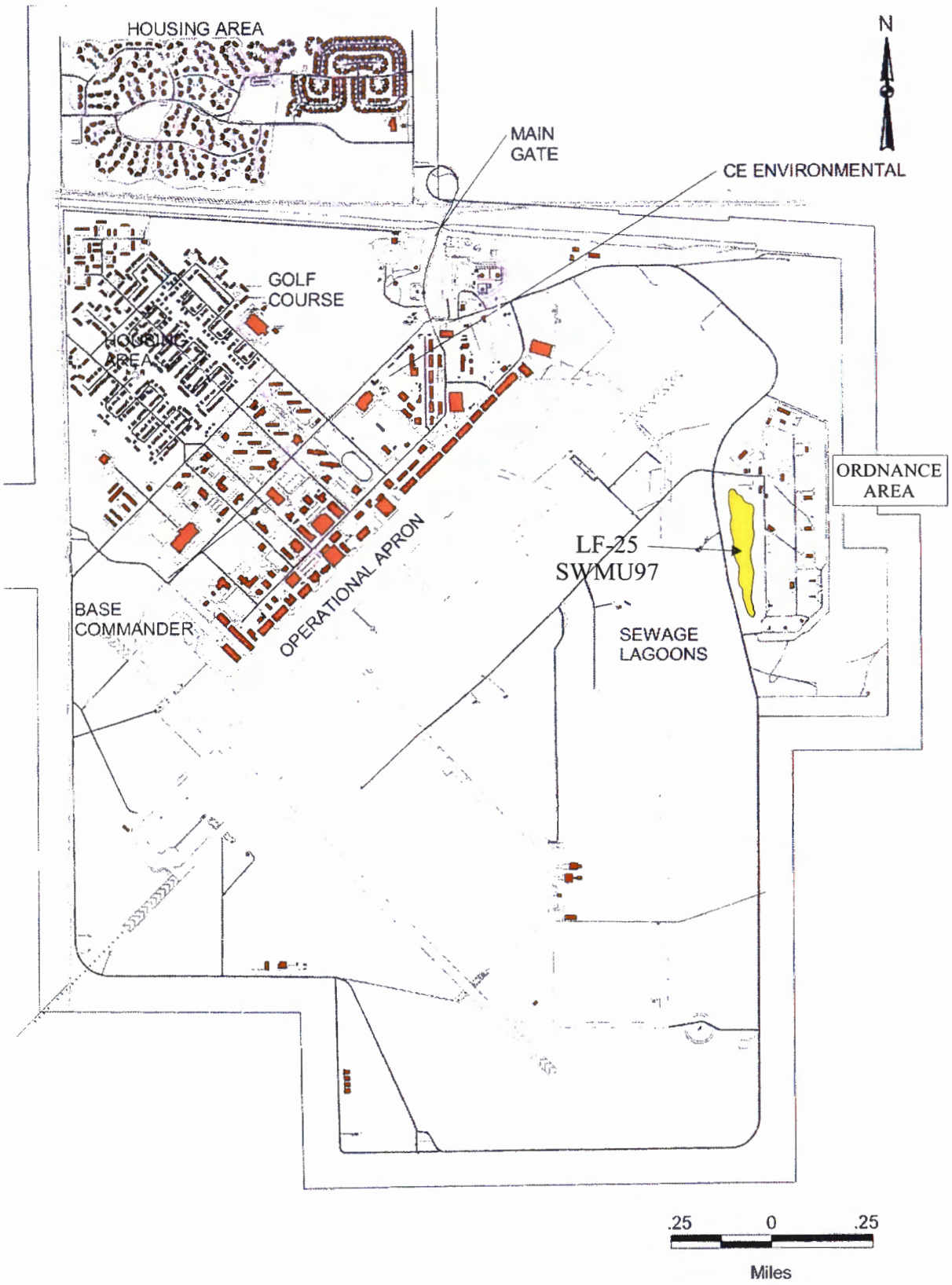
BHATE

SITE LOCATION MAP

PROJECT NO.	SCALE	DATE	DRAWN BY:
9010304	AS SHOWN	5/22/02	–
			DRAWING NO: fig1A

Figure 1

Cannon AFB
Clovis, New Mexico



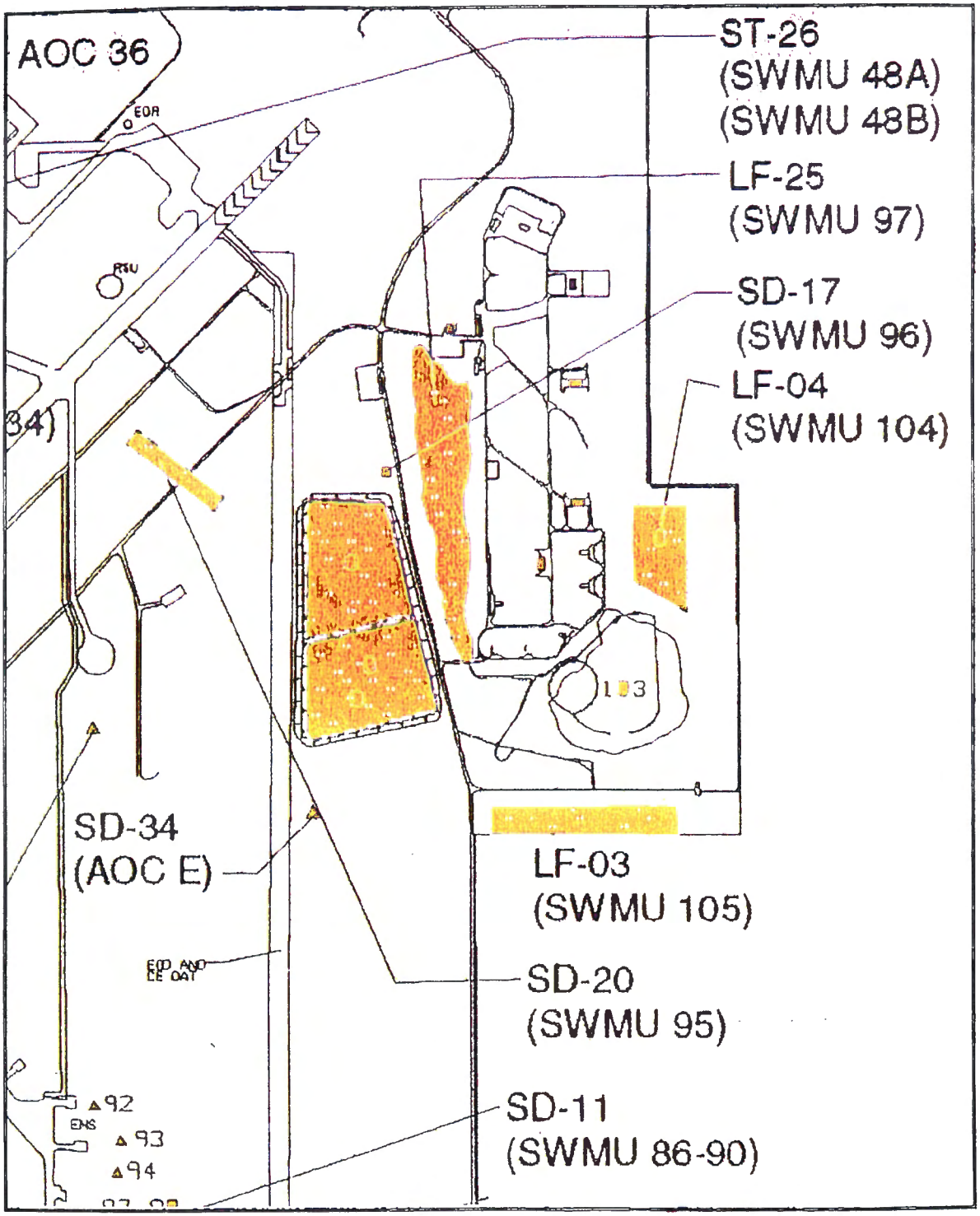
BHATE

BASE MAP

PROJECT NO.	SCALE	DATE	DRAWN BY:
9010304	AS SHOWN	5/22/02	–
			DRAWING NO: fig2

Figure 2

Cannon AFB
Clovis, New Mexico



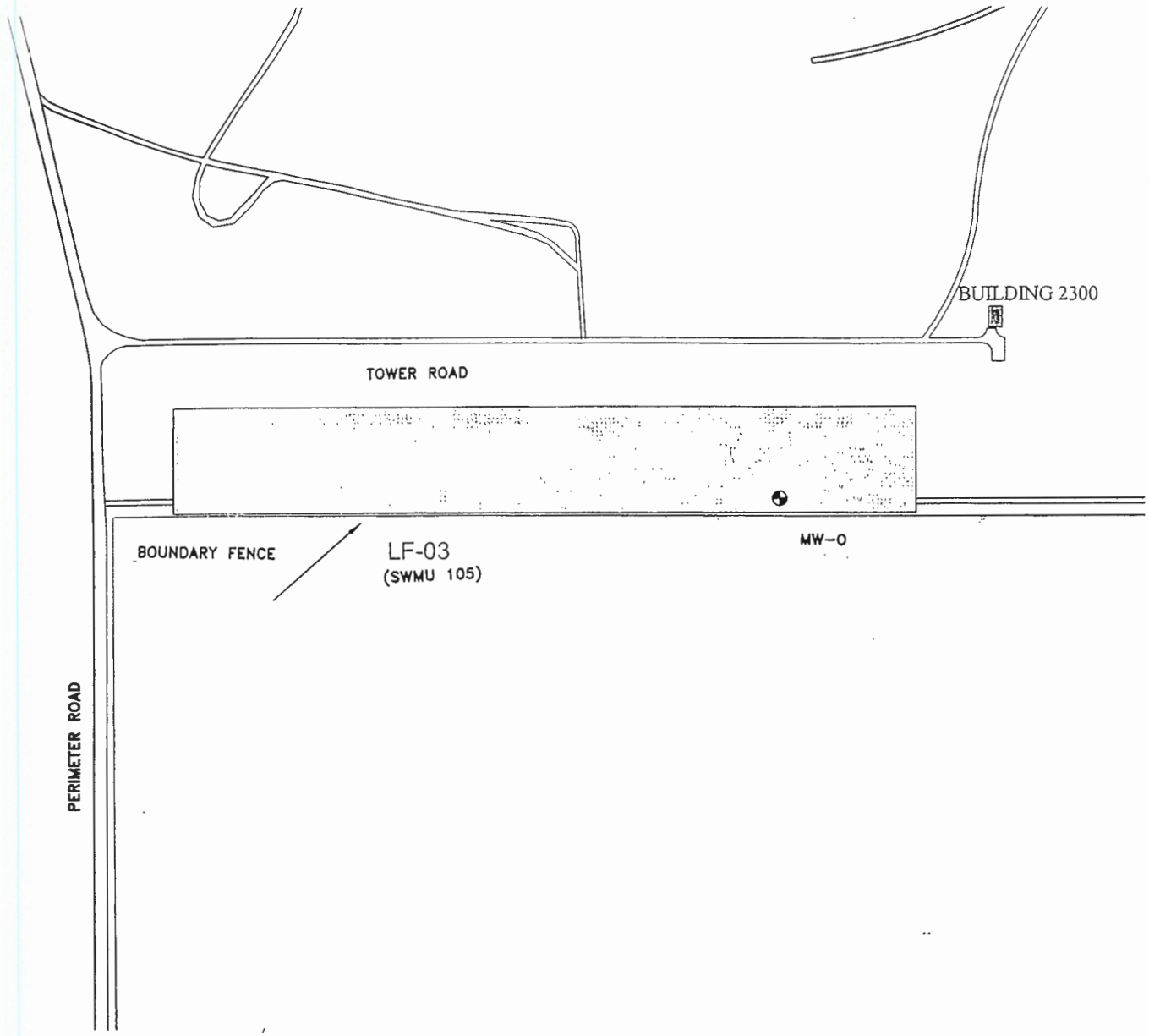
BHATE

LANDFILL LOCATION MAP

PROJECT NO.	SCALE	DATE	DRAWN BY:
9010304	AS SHOWN	5/22/02	–
			DRAWING NO: fig2(inset)

Figure 2(inset)

Cannon AFB
Clovis, New Mexico



Railroad

Fence

Storm Drain

Drainage Channel

Stream

Figure copied from USAF Management Action Plan January 2000.

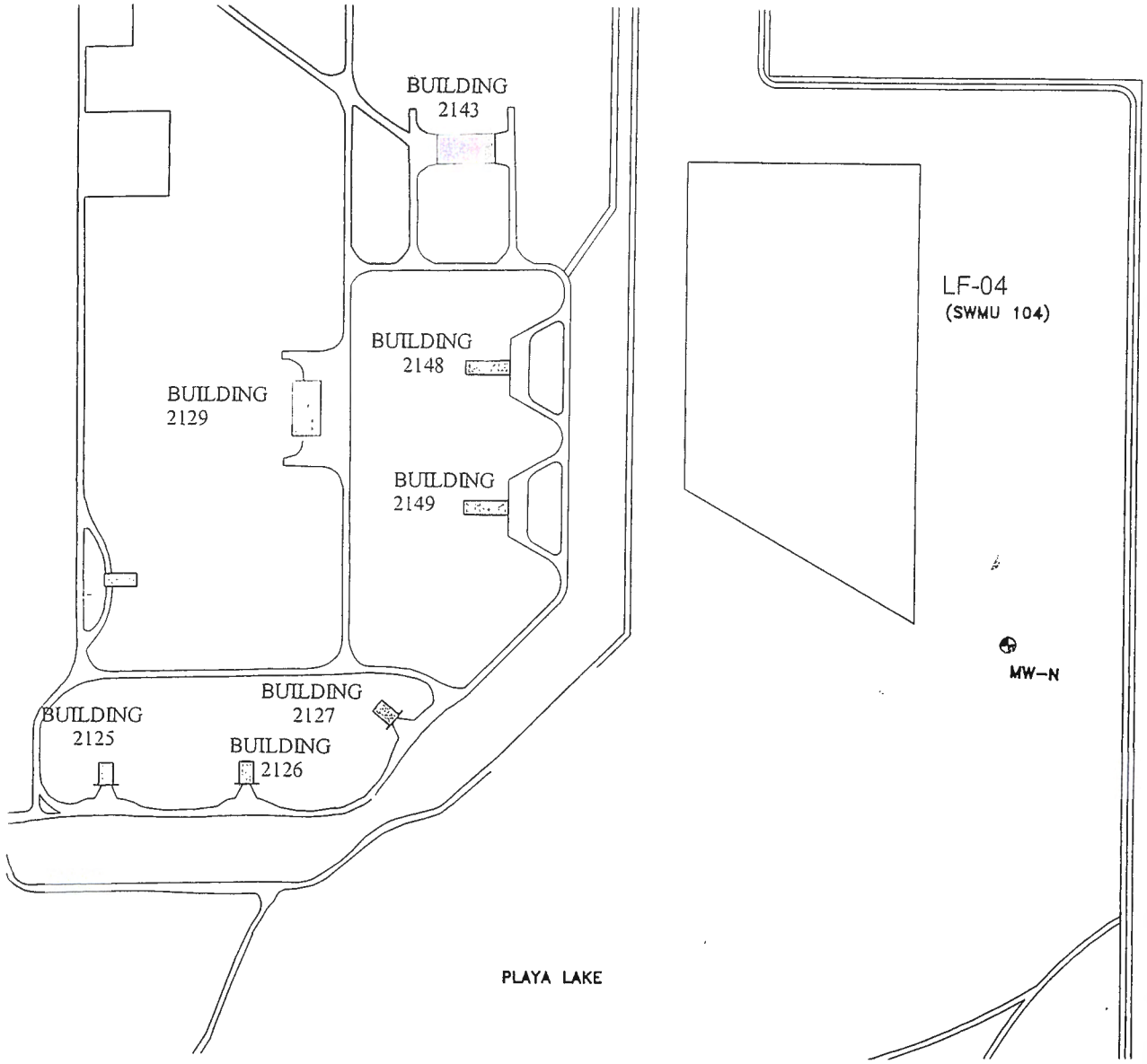
BHATE

LF-03 SITE PLAN

PROJECT NO.	SCALE	DATE	DRAWN BY:
9010304	1"=800'	5/22/02	–
			DRAWING NO: fig3

Figure 3

Cannon AFB
Clovis, New Mexico



Railroad

Fence

Storm Drain

Drainage Channel

Stream

N

500 0 500

Feet

Figure copied from USAF Management Action Plan January 2000.

BHATE

LF-4 SITE PLAN

PROJECT NO.	SCALE	DATE	DRAWN BY:
9010304	AS SHOWN	5/22/02	–
			DRAWING NO: fig4

Figure 4

Cannon AFB
Clovis, New Mexico

Figure copied from USAF Management Action Plan January 2000.

BHATE

LF-25 SITE PLAN

PROJECT NO.	SCALE	DATE	DRAWN BY:
9010304	AS SHOWN	5/22/02	–

DRAWING NO: FIG5

Figure 5

Cannon AFB
Clovis, New Mexico

SECTION IB

Quality Assurance Project Plan

FINAL REVISED LONG-TERM MONITORING WORK PLAN

FINAL QUALITY ASSURANCE PROJECT PLAN

LANDFILL NO. 25 (SWMU 97)

LANDFILL NO. 03 (SWMU 105)

LANDFILL NO. 04 (SWMU 104)

CONTRACT NO. DACA45-99-D-0017

DELIVERY ORDER NO. 10

Prepared For

Cannon Air Force Base

Air Combat Command

Clovis, New Mexico

Prepared By

BHATE Environmental Associates, Inc.

Birmingham, Alabama

Under Contract To

U. S. Army Corps of Engineers

Omaha, Nebraska

Richard L. Burdine, P.G.
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July 2002

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LIST OF ACRONYMS AND ABBREVIATIONS

%D	percent difference
%R	percent recovery
°C	degrees Celsius
µg/L	micrograms per liter
AA	Atomic absorption
CAFB	Cannon Air Force Base
CFR	Code of Federal Regulations
CMQA	Chemistry and Materials Quality Assurance
COC	chain-of-custody
DOT	Department of Transportation
DQCR	daily quality control report
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
ERPIMS	Environmental Resources Program Information Management System
BHATE	Foothill Engineering Consultants, Inc.
FSP	Field Sampling Plan
GC	gas chromatography
GRO	gasoline range organic
IATA	International Air Transportation Association
ICP	inductively coupled plasma
IS	internal standard
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LTMP	Long-term monitoring program
MCAWW	Methods for Chemical Analysis of Water and Wastes
MCL	Maximum Contaminant Level
MD	matrix duplicate
MDL	method detection limit
mg/L	milligrams per liter
mg/kg	milligrams per kilogram
MS	matrix spike
MSA	method of standard additions
MSP	mass spectrometry
MSD	matrix spike duplicate
MW	monitoring well
NA	not applicable
NMED	New Mexico Environment Department
PCB	polychlorinated biphenyl
PID	photoionization detector
QA	quality assurance
QAPP	Quality Assurance Project Plan

LIST OF ACRONYMS AND ABBREVIATION-Continued

QC	quality control
RCRA	Resource Conservation and Recovery Act
RPD	relative percent difference
RSD	relative standard deviation
SOP	standard operating procedure
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
SVOC	semivolatile organic compound
TAL	target analyte list
TM	technical manager
USACE	U.S. Army Corps of Engineers
VOC	volatile organic compound

1.0 PROJECT DESCRIPTION

Bhate Environmental Associates, Inc. (BHATE) has prepared this Quality Assurance Project Plan (QAPP) to address field and laboratory Quality Assurance (QA)/Quality Control (QC) activities associated with the semi-annual monitoring program for Landfill 25 and the annual monitoring programs for Landfills 03 and 04 at Cannon Air Force Base (CAFB), Clovis, New Mexico. The Scope of Work for this project is described in the U.S. Army Corps of Engineers (USACE) "Scope of Services, Long-Term Monitoring, Landfill Nos. 03, 04, and 25," dated January 30, 2001, and include all tasks necessary to collect and analyze groundwater samples from monitoring wells MW-O (Landfill 3), MW-N (Landfill 4), and MW-Ra (Landfill 25). These activities involve the collection, analysis, and evaluation of groundwater samples from the three monitoring wells and preparation of semi-annual and annual monitoring reports for the U.S. Environmental Protection Agency (EPA) and the New Mexico Environmental Department (NMED). This QAPP is part of a Long-Term Monitoring (LTM) Work Plan that is comprised of a Sampling and Analysis Plan (SAP), Field Sampling Plan (FSP) and QAPP and the Site Safety and Health Plan (SSHP).

1.1 PURPOSE AND SCOPE

This QAPP is designed to provide specific guidance and QA requirements for tasks associated with the monitoring programs at Landfills Nos. 03, 04, and 25. It presents the purpose, organization, and standard operating procedures (SOPs) necessary to conduct the long-term monitoring activities in a manner consistent with specific quality goals of precision, accuracy, representativeness, completeness, and comparability. Implementation of the procedures described in this QAPP is required for the acquisition of data of known and sufficient quality.

1.2 POTENTIAL CONTAMINANTS

Potential contaminants of concern include volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), herbicides, and inorganics. Past waste disposal practices and previous investigations have identified these compounds as contaminants of concern. In addition to the parameters mentioned above, water samples collected during the LTM will also be analyzed for sulfate, nitrate, chloride, and phenol.

Groundwater quality indicators, which include pH, turbidity, temperature, and conductivity will be measured in the field.

1.3 SELECTION OF ANALYTICAL METHODS

The analytical methods and protocols used for organic and inorganic analyses on this project will be in accordance with the EPA's SW-846 Test Methods For Evaluating Solid Wastes - Physical/Chemical Methods, Update III, Rev. 5, April, 1998 (EPA, April, 1998). The specific analytical methods identified for the LTM are presented in Table 2-1.

2.0 QUALITY ASSURANCE OBJECTIVES AND AUDIT PROCEDURES

2.1 DATA QUALITY OBJECTIVES

BHATE applied the EPA's *Guidance for the Data Quality Objectives Process* (EPA, 1994), in determining the data objectives and QA objectives for the CAFB monitoring programs including semi-annual sampling at Landfill 25 and annual sampling at Landfills 03 and 04. By implementing procedures outlined in the QAPP, BHATE will ensure that data collected for the LTM at the three sites will be of sufficient quality for use in the statistical validation of the monitoring program data. Established data quality objectives (DQOs) for the semi-annual and annual monitoring program are described below.

Data Quality Objectives -Data for this project will be defined per the EPA guidance as either screening or definitive data.

Screening Data - Screening data are usually generated by rapid field or laboratory methods, which have minimal QC inherent to the instrumentation used for analysis. Sample preparation steps may be restricted to simple procedures such as dilution in appropriate reagents, pH, or temperature adjustments. Screening data provides analyte identification and quantification, although the quantification may have a margin of imprecision or of error to the reported value. Some data, which were analyzed using more precise and rigorous methods, may be used as screening data when QC objectives were not met for the analysis, and reported values are considered to be estimated.

Definitive Data - Definitive data are generated using rigorous analytical methods such as approved EPA reference methods. Data are analyte-specific, with confirmation of analyte identity and concentration. The method deliverables include QC samples with established acceptance limits and verifiable raw data such as chromatograms and spectra for organic analyses or instrument printouts for inorganic compounds. Data may be generated at the project site or at a fixed laboratory, as long as the QA/QC requirements are met and method protocols are followed. Data generated under the definitive objective must meet the specific end use of the data. When the project manager determines that these criteria have not been met, but the data are still usable, data may be re-assessed for use as screening data.

The data objectives for the LTM at Landfills 03, 04, and 25 are as follows:

- To collect the quantity and quality of data sufficient to support a determination of any impact to the water quality as a result of Department of Defense-related activities at the three sites.
- To collect data of sufficient quality and quantity to assess the presence, amount, and location of chemical contaminants.
- To obtain data of sufficient quality to support the development of a scope of services for a corrective measures study, an interim corrective action, or a compliance monitoring program. The data obtained will also be sufficient in quantity and quality to support the recommendation for no further action, if appropriate.

The detailed sampling scheme for the analytical program at these three sites are presented in Table 2.2. Reporting limits for all analytical methods will be such that the DQOs are attained. Tables 2-3 through 2-10 contain the EPA Maximum Contaminant Level (MCL) and New Mexico Environment Department standard levels for the analyses being performed. The Quantitation Limits for each applicable method are presented in Tables 2-11 through 2-24. For the metals, the full target analyte list (TAL) is requested. For the semi-volatile Method 8270C compounds, the laboratory routinely includes the applicable organophosphate compounds. The Method 8141 organophosphates are being requested in order to meet project detection limits so they are not included in the tables, but may be present in the laboratory deliverable. The organochloride pesticides and herbicides are being analyzed by gas chromatography Methods 8081A and 8151, respectively, in order to meet project detection limits. Specific task objectives are presented in Section 4.2.

2.2 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT OF DATA

2.2.1 General

The overall QA objective is to develop and implement QC procedures for obtaining field measurements, performing sampling, assessing and reporting laboratory analyses, and reviewing data derived from the sampling effort at Landfill Nos. 03, 04, and 25. These procedures will provide information of a quality necessary to accomplish project objectives. The sample set, chemical analysis results, and interpretations will be based on data that meet or exceed QA

objectives established for the LTMP. The quality of analytical data generated by EPA SW-846 methods is suitable for accomplishing project objectives. These methods are characterized by QA/QC protocols and documentation providing qualitative and quantitative analytical data. EPA SW846 methods will generate data of known quality using established methods. The presentation of complete analytical data deliverables (Section 6.7) required for this project will further enhance the documentation and quality of project data.

QA objectives and procedures for field measurement systems are also important components of the LTMP. The objectives and the QA procedures for the acquisition of nonchemical data are discussed in the FSP (Section IA).

QA objectives are usually expressed in terms of accuracy or bias, precision, completeness, representativeness, and comparability. Target ranges for these objectives are presented for analytical testing and field measurements. Variance from the QA objectives will result in the implementation of appropriate corrective measures and an assessment of the impact on the usability of the data in the decision-making process.

2.2.2 Required Level of Analysis and Review

To generate data of sufficient quality to meet the project objectives, the following approach will be used:

- EPA SW-846 methods will be used to analyze groundwater samples for specific metals, chloride, nitrate, sulfate, total recoverable phenols, and volatile and semivolatile organic compounds. Lower detection limits are required for the following semi-volatiles which will be analyzed by the appropriate gas chromatography (GC) methods: organophosphate and organochloride pesticides, polychlorinated biphenyls, and herbicides. Portable field instrumentation will be used to measure pH, temperature, dissolved oxygen, turbidity, and conductivity.
- Internal QC samples and procedures to be used by the contract laboratory for analysis are specified in Section 6.4.

- A comprehensive data deliverable will be obtained from the contract laboratory for the purpose of reviewing data for completeness and validity. Raw data will be retained by the laboratory for a minimum of 5 years from the time of submittal.
- A QC review, as defined in Section 6.7, rather than full validation, will be completed for all project data. Analytical data packages will be obtained from the laboratory, as noted above, and checked for completeness as part of the data validation and review process.
- One field duplicate will be collected during each sampling event and submitted "blindly" to the contract laboratory for analysis. For each sampling event, one split sample will be sent to the USACE Environmental Chemistry Branch laboratory for analysis of constituents where they will be analyzed using the same methods and detection limits defined in this QAPP.

2.2.3 Quality Control Samples

One field duplicate per sampling event will be collected and submitted to the analytical laboratory to provide a means to assess the quality of the data resulting from the field sampling program. The field duplicate sample will be analyzed for constituents to monitor for sampling and laboratory reproducibility. A set of trip blanks will accompany each cooler that contains aqueous samples for VOC analysis. Surrogate compounds and laboratory control samples will be analyzed to measure the accuracy of the analytical method. Matrix spike (MS) samples will be analyzed to determine the matrix-specific accuracy of the analysis. Laboratory duplicates for inorganic analysis and matrix spike duplicates (MSD) for organic analytes will be analyzed to evaluate laboratory reproducibility or precision. Specific QC sample descriptions are given in Section 6.4, Internal Quality Control Checks. The specific level of field QC effort is summarized in Section 4.6. The project analytical methods specific surrogate recovery ranges are provided in Table 2-25.

2.2.4 Quality Assurance Objectives - Quantitative

Within this QAPP, quantitative goals are defined for reporting limits and analytical completeness, as well as for accuracy and precision. Reporting limits used by the contract laboratory are based on historical data for similar environmental matrices. Tables 2-11 through 2-24 list the project-required Quantitation Limits (reporting limits) for analyses to meet project DQOs. These limits are attainable by the laboratory, and based on analyses of pure water using

the analytical methods specified in Table 6-1. The reporting limits for samples from matrices other than pure water may be considerably higher.

2.2.4.1 Accuracy

Accuracy is defined as the degree of agreement of a measurement with an accepted reference or true value, usually expressed as the difference between the two values. It is a measure of the bias in a system. Accuracy will be measured as the percent recovery (%R) of an analyte in a reference standard or spiked sample. Accuracy of organic calibrations is measured as the percent difference (%D) between the initial calibration factors and the continuing calibration factors. The procedure for calculating percent recovery is specified in Section 6.6.1. Control limits for accuracy (laboratory control sample [LCS], surrogate, internal standard, and MS/MSD and matrix duplicate [MD] percent recoveries) are presented in Tables 2-11 through 2-23. Accuracy, or bias, is also determined by contamination which will be assessed from field, laboratory calibration, and laboratory method blanks. For metals analyses, the laboratory will spike samples with the full TAL metals. QC limits are only required and defended for the metals of interest to this project. These will be the metals and limits applicable to the data validation process.

2.2.4.2 Precision

Precision is defined as the degree of mutual agreement among individual measurements of a sample analyte as the result of repeated application of the same process under similar conditions. Precision is routinely expressed as the relative percent difference (RPD) between two measurements or the relative standard deviation (RSD) between more than two measurements. Precision will be measured between the two values for matrix duplicates, between the %R for MS/MSD pairs, and the RSD between the response or calibration factors for organic calibrations. The procedures for calculating precision are specified in Section 6.6.2. Control limits for precision are presented in Tables 2-11 through 2-23.

Analytical completeness is defined as the percentage of analytical results requested, which are determined as usable for project purposes through validation and review process. The procedure for calculating analytical completeness is specified in Section 6.6.3. The analytical completeness goal for this project will be 90 percent.

2.2.5 Quality Assurance Objectives - Qualitative

Project data will also be evaluated for qualitative goals such as representativeness and comparability.

2.2.5.1 Representativeness

Representativeness is the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness will be maintained during the sampling effort by performing all sampling in compliance with the procedures described in the FSP. The measurement of representativeness is assured by having field personnel choose samples, which are most representative of the matrix being sampled for use as field duplicates and inter-laboratory splits. Representative samples will also be collected with extra volume and designated to the laboratory for use as the laboratory QC samples (MS, MSD, or MD). In this way, precision and accuracy statistics will apply to the maximum number of samples in the set.

2.2.5.2 Comparability

Comparability expresses the confidence with which one data set can be compared to another. Comparability can be related to accuracy and precision, as these parameters measure data reliability. Data are comparable if site considerations, data collection techniques, measurement procedures, methods, and reporting limits are equivalent for the samples within a sample set. A qualitative assessment of data comparability will be made of applicable data sets. Comparability is assured by consistently using approved EPA or similar agency methods and documenting all methods used for analysis and associated QA/QC programs.

2.3 PERFORMANCE AND SYSTEMS AUDITS

The laboratory performing sample analyses for the CAFB LTMP is a USACE-validated laboratory, implying that the laboratory has successfully analyzed performance evaluation samples. As part of the USACE QA Program, the laboratory is also required to undergo and successfully pass an on-site inspection/audit by USACE.

The BHATE field team leader is responsible for supervising and ensuring that samples are collected and handled in accordance with approved procedures. The BHATE field team leader is also responsible for complete documentation, indicating that work is performed adequately. The BHATE project manager is responsible for overseeing that the project performance satisfies the QA objectives as set forth in this QAPP. Reports and technical correspondence will be reviewed by an assigned qualified individual, otherwise external to the project, before being finalized. It is not anticipated that performance audits will be necessary for field sampling activities due to the limited sampling required for completion of this task.

3.0 PROJECT ORGANIZATION AND FUNCTIONAL AREA RESPONSIBILITIES

3.1 RESPONSIBILITIES OF KEY PERSONNEL

The organizational structure and responsibility, defined below, is designed to assure adequate project control and proper QA for groundwater sampling activities at Landfills 03, 04, and 25. BHATE has been contracted by the USACE (Omaha District) to perform tasks involved with the LTMP at CAFB. The following key BHATE project personnel are described below:

- Project Manager
- Project QA/QC Officer
- Field Geologist/Leader
- Project Staff
- Senior Chemist
- Site Safety and Health Officer

3.1.1 Project Manager

Mr. Richard L. Burdine will serve as the project manager for this work effort. The project manager has the primary responsibility for the completion of all project activities. His responsibilities include controlling day-to-day project planning, scheduling, cost control, and ensuring implementation of project activities. The project manager is ultimately responsible for the development of the technical reports and other project documents. The project manager is responsible for assuring that personnel assigned to the project are trained adequately and sufficiently, relative to the requirements of the QA/QC program. The project manager monitors all project personnel in planning, coordinating, and controlling all technical aspects of the tasks. The BHATE project manager is the main point of contact for USACE and the USACE technical manager (TM).

3.1.2 Project QA/QC Officer

Ms. Diane Lazarus will serve as the project QA/QC officer. The project QA/QC officer reports to the project manager and works directly with the project manager and other project personnel.

The project QA/QC officer reviews and approves the project QAPP, monitors and verifies that the work is performed in accordance with the QAPP, Work Plans, and other applicable procedures. The project QA/QC officer also assesses the effectiveness of the QA/QC program and recommends modifications to the program when applicable. The project QA/QC officer may coordinate project activities with the contract laboratory and with the Government Quality Assurance Laboratory, which has been designated as the USACE Environmental Chemistry Branch Laboratory. The QA/QC officer will assure that data are reviewed per standard procedures and report data usability in terms of the project DQOs to the project manager.

3.1.3 Field Geologist/Leader

Mr. Jerry Pelfrey will be the BHATE field geologist and leader for this work effort. The field team leader is responsible for completing assigned project tasks at the site. The field team leader is responsible for implementing the QA/QC program related to assigned tasks at CAFB.

3.1.4 Project Staff

Each member of the project staff is responsible for completing assigned project activities. Members of the project staff are responsible for understanding and implementing the QA/QC program as it applies to their project activities.

3.1.5 Senior Chemist

Mr. Premal Bhatt will be the BHATE Senior Chemist for this work effort. As the Senior Chemist he reports to the QA/QC Officer and works directly with the project manager and other project personnel. He will develop the project QAPP, monitor and verify that the work is performed in accordance with the QAPP, Work Plans, and other applicable procedures. The Senior Chemist will work with the project QA/QC officer monitor the effectiveness of the QA/QC program and recommend modifications to the program when applicable. The Senior Chemist will coordinate project activities with the contract laboratory and with the Government Quality Assurance Laboratory, which has been designated as the USACE Environmental Chemistry Branch Laboratory. The Senior Chemist will assure that data are reviewed per standard procedures and report data usability in terms of the project DQOs to the project manager.

3.1.6 Site Safety and Health Officer

The site safety and health officer (SSHO) monitors all site activities and is responsible for the implementation of and compliance with the Site Safety and Health Plan (SSHP) at the site. The SSHO reports directly to the project manager. Mr. Jerry Pelfrey will serve as the SSHO.

3.2 QUALIFICATIONS OF PERSONNEL

All personnel assigned to the project, including employees and consultants, are qualified to perform the tasks to which they are assigned.

Appraisal of the qualifications of technical personnel assigned to the project will be made by the project manager. The appraisal will include comparing the requirements of the job assignment to the relevant experience and training of the prospective assignee; it will also include determining whether further training is required and, if required, by what method. On-the-job training is an acceptable method, provided such training is provided by a person qualified to perform the trainee's assignment and the results of that training are documented.

3.3 LABORATORY AND SUBCONTRACTOR ASSIGNMENT

The contract laboratory selected to perform sample analyses is TestAmerica, Inc., a USACE-validated laboratory, located in Nashville, Tennessee. The USACE validation for TestAmerica expires in April 2004. TestAmerica, a full-service analytical laboratory that contracts with numerous state and federal agencies, is currently providing analytical services to BHATE on other USACE projects.

4.0 FIELD ACTIVITIES

4.1 LISTS OF FIELD EQUIPMENT, CONTAINERS, AND SUPPLIES

Lists of pertinent field equipment, sample containers, and supplies used during groundwater sampling activities are contained in the FSP.

4.2 INVESTIGATION OBJECTIVES, SAMPLING FREQUENCY, AND LOCATIONS

Field activities for this project will include groundwater sampling at three separate well locations. Field activities will be conducted in accordance with relevant guidelines and regulations, including those of the NMED.

4.2.1 Purge Water Storage Tanks and Locks

Purge water generated by purging the wells will be containerized in the appropriate plastic or metal drums/storage tank at each well. Upon completion of sampling activities at each well, keyed-alike locks will be used to secure the existing monitoring wells.

4.2.2 Groundwater Sampling

Groundwater samples will be collected from existing monitoring wells using procedures described in the FSP. Samples will be analyzed for constituents listed in 40 CFR Part 264. Water quality indicators will be analyzed following procedures described in Methods for Chemical Analysis of Water and Wastes (MCAWW) EPA-600. Well Ra will be sampled semi-annually and wells O and N will be sampled annually (2002).

4.3 SAMPLING AND PRESERVATION PROCEDURES

4.3.1 Sampling and Preservation Procedures for Groundwater Samples

Procedures for collecting groundwater samples, recommended sample containers and procedures for preserving the samples, and holding times for groundwater samples are summarized in Table 4-1 and in the FSP. Observations made during sample collection will be recorded in the field notebook and on a well purge data sheet.

4.4 EQUIPMENT DECONTAMINATION

Prior to collecting groundwater samples, all sampling equipment will be decontaminated and rinsed with deionized water. Mobile decontamination supplies will be provided so that equipment can be decontaminated at each well location. Used solutions will be disposed of in the purge water holding tank. A more detailed discussion of equipment decontamination is contained in the FSP.

4.5 INSTRUMENT CALIBRATION

Portable field instruments used during sampling activities will consist of a photoionization detector (PID), a water quality tester, and a water-level indicator. The PID and water quality tester require daily calibration and post-use calibration. Before beginning work at each site, the field personnel will verify that the field equipment is calibrated according to the manufacturer's specifications and is operating properly. Pre- and post-use calibration times and readings will be recorded in the field logbook and maintained by the field team leader. Field instrument calibration procedures are included with each instrument.

4.6 FIELD DOCUMENTATION

Thorough documentation in the field is required to ensure proper labeling and tracking of samples, to identify potential sources of error, and to maintain accountability of field personnel. This section describes documentation required in the field logbook, the daily quality control report (DQCR), and the sample designation scheme for the CAFB LTMP.

4.6.1 Written Documentation

Documentation of observations and data acquired in the field will provide information on the acquisition of samples and also provide a permanent record of field activities.

4.6.1.1 Field Notes

Field observations and data will be recorded with ink in a permanently bound waterproof field logbook. The field logbook will contain consecutively numbered pages. The information entered into the field logbook will include the following, as a minimum:

- project name
- sample location

- sampler's signature
- date and time of sample collection
- sample identification numbers
- description of samples (matrix sampled)
- analyses to be performed
- sample number and volume
- description of QA/QC samples (if collected)
- sampling methods or reference to the appropriate FSP
- sample handling, including preservation; as appropriate for samples
- field observations
- results of any field measurements
- personnel present

Changes or deletions in the field logbook will be lined out with a single strike mark, initialed, and dated by the person making the change. The original entry will remain legible. Sufficient information should be recorded to allow the sampling event to be reconstructed without relying on the field personnel's memory. Each page of the field logbook will be signed by the person making the entry. Anyone making entries in another person's field logbook will sign and date those entries.

4.6.1.2 Daily Quality Control Reports

To supplement the information recorded in the completed field logbook, DQCRs will also be maintained to document daily field activities and will note any nonconformances and corrective actions taken at every sampling location. An example of the DQCR is contained in Section IIIC of this work plan. DQCRs will be maintained by the field team leader and cross-checked for completeness at the end of each day by designated field personnel. Each DQCR will be signed and dated by the individuals making entries. Copies of the DQCR will be submitted to the USACE TM on a weekly basis.

4.6.2 Sample Designation Scheme/Sample Numbering System

All samples for analysis, including QC Samples, will be given unique sample numbers. A listing of sample numbers, cross-referenced to the chain-of-custody (COC) and shipment documents, will be maintained in the field logbook.

An example sample number is provided below:

Example: CAFB-MWO-060199-1

- CAFB - Project identifier. A four character designation will be used to identify the facility from which the sample was collected. For this project, CAFB indicates Cannon Air Force Base.
- MWO - Monitoring well number. In this instance the sample was collected from Monitoring Well "O".
- 060199-1 - Date sample was collected and the type of sample. In this example a groundwater analytical sample was collected. The key for sample type is provided below. This example illustrates a sample collected on June 1, 1999 and is a groundwater analytical sample.

Sample Type Key:	-1	Groundwater analytical
	-2	Groundwater Field Duplicate
	-3	USACE-ECB Lab Duplicate

4.7 FIELD PREVENTIVE MAINTENANCE

To ensure that analytical data generated for the CAFB LTMP is of sufficient quality to meet QA objectives, all equipment and instruments will have a prescribed routine maintenance schedule that will be performed and documented by qualified project personnel. All field instrumentation, sampling equipment, and accessories will be maintained in accordance with manufacturer's specifications and established field practice. All maintenance will be performed and documented by qualified project personnel.

The field team leader will review calibration and maintenance records on a regular basis to ensure that required maintenance is addressed. These activities will be recorded in the field

logbook to document that established calibration and maintenance procedures have been followed. Field instruments will be checked and calibrated prior to their use on site, and batteries will be charged and checked daily where applicable. Non-operational field equipment will be removed from service and a replacement will be obtained. Field equipment will not be repaired in the field.

All field instruments will be properly protected against inclement weather conditions during field activities. At the end of each working day, all field equipment will be maintained in a cool, dry room for overnight storage.

4.8 FIELD QUALITY CONTROL CHECKS

Field QC checks will include the review and approval of all field documentation by the field team leader. This approval will imply that the provisions outlined in the FSP, QAPP, and SSHP have been appropriately implemented.

Field duplicate and split samples will be collected for analysis. Groundwater samples for QC analysis will be submitted to both TestAmerica and to the USACE ECB laboratory. One of each of field duplicate and split sample will be collected per sampling event. Trip blank(s) will be prepared and submitted to each laboratory along with the field samples during each sampling event to monitor potential VOC cross-contamination.

MS/MSD (analysis for organics) and MS/MD (for inorganics) analytes provide a measurement of long-term precision and accuracy of the analytical method on various matrices and demonstrate acceptable compound recovery by the laboratory on the site-specific matrix. For many analyses, including the MS/MSD or MS/MD extra sample volume must be collected in the field. MS/MSD and MS/MD analyses will be carried out at a frequency of one per sampling event and will be chosen by the field personnel to best represent the matrix of the sample batch.

4.9 FIELD DATA REDUCTION

The field and technical (non-laboratory) data to be collected at CAFB can generally be characterized as either objective or subjective data. Objective data include all direct

measurements such as analytical parameters and water-level measurements. Subjective data include certain descriptions and observations pertaining to an event.

4.9.1 Field and Technical Data Reduction

All field data will be recorded by field personnel in bound field logbooks and on standard forms (Section IIIC). It will be the responsibility of all field personnel to photocopy all field logs (including logbook pages and standard forms) generated during a given field day. Copies will be maintained by the field team leader in the appropriate project files.

4.9.2 Field and Technical Data Review

Review of field and technical data will be performed at two different levels. On the first level, data will be reviewed at the time of collection by following standard procedures and QC checks. At the second level, data will be reviewed by the field team leader who will review the data to ensure that the correct qualifiers and units have been included. The field team leader will review data sets for any inconsistencies or anomalies and resolve them immediately, if possible, by seeking clarification from the field personnel responsible for collecting the data. Subjective field and technical data will be validated by the project manager who will verify that field reports ~~for~~ are both reasonable and complete.

4.10 FIELD CORRECTIVE ACTION

The field team leader will review the procedures being implemented in the field for consistency with the established protocols. Sample collection, preservation, and labeling will be checked for completeness. Where procedures are not strictly in compliance with the established protocol, deviations will be documented and immediately reported to the project manager and the USACE TM. Any and all nonconformances with the established QC procedures will be expeditiously identified and controlled. Additional work that is dependent on the nonconforming activity will not be performed until the identified nonconformance is corrected. Upon notifying the USACE TM, corrective actions will be determined by the field team leader and project manager and documented as appropriate. Upon implementation of the corrective action, the field team leader will provide the project manager with a written memorandum documenting field implementation. The memo will become part of the CAFB project file.

The project QA/QC officer will review the field and laboratory data generated for this project to ensure that all project QA objectives are met. If any nonconformances are found in the field procedures, sample collection procedures, or field documentation procedures, the impact of those nonconformances on the overall project QA objectives will be assessed. Appropriate actions, including resampling and reanalysis, may be recommended to the project manager so the project objectives can be accomplished.

5.0 SAMPLE CHAIN-OF-CUSTODY, PACKING, AND TRANSPORTATION

This section discusses the protocol that will be followed during sample packing, shipping and documentation.

5.1 CHAIN-OF-CUSTODY PROTOCOL

This section discusses the protocols, which will be used in completing and submitting COC forms.

5.1.1 Field Protocol

Each cooler containing groundwater samples for laboratory analysis will be accompanied by a COC form (Section IIIC). This section briefly describes the procedures for sample documentation using COC protocol. The primary purpose of the COC procedures is to document the possession of the samples from collection through storage and analysis to reporting. COC forms will become the permanent records of all sample handling and shipment. The field team leader will be responsible for ensuring compliance with COC procedures.

All field personnel will be responsible for the care and custody of the samples until they are transferred to another party (i.e., dispatched to the laboratory). The field team, under the direction of the field team leader, will be responsible for enforcing COC procedures during field activities. The COC procedures are provided below:

- At the time of sample collection, the COC form is completed for the sample collected. The sample identification number, sample date, type and size of sample container, analysis requested, and preservative is recorded on the form. In addition, the COC for samples being submitted to the USACE QA laboratory will have the LIMS section filled in. The LIMS No. for this project is 6184.
- When the form is completed or when all samples that will fit in a single cooler have been collected, the field team members will cross-check the form for possible errors and sign the COC form. Corrections are made to the record with a single strike mark and dated and initialed. All entries will be made in blue or black ink. Each cooler will be accompanied by a

separate COC form, sealed in a gallon-size Ziploc™ bag, and taped to the inside the cooler lid.

- Two custody seals will be placed in a staggered configuration on the outside surface of the cooler lid.
- The field team leader will complete and maintain shipping bills for samples shipped to the analytical laboratory by a delivery service.

When transferring custody of the samples, the individual relinquishing custody of the samples will verify sample numbers and condition and will document the sample acquisition and transfer by signing and dating the COC. This process documents sample custody transfer from the sampler, usually through an express courier, to the sample custodian/analyst at the contract analytical laboratory. A copy of each COC form is retained by the field team leader for the project file and the original is shipped with the samples. Copies of the way bills used by a courier service for sample shipment will also be retained as part of the documentation for the COC records.

5.1.2 Laboratory Protocol

Upon receipt at the laboratory, the designated laboratory sample custodian shall sign the COC form indicating receipt of the incoming field samples. General conditions of the samples will be recorded on a USACE cooler receipt form (to be completed for every cooler). The samples shall be checked against the COC form upon arrival at the laboratory. The receiving personnel will properly document the receipt of all arriving samples and note any problems or discrepancies pertaining to the sample, COC forms, and sample container and seal conditions and report them immediately to the BHATE field team leader or project manager. The samples shall be assigned a unique laboratory number for preparation and analysis. This number will be cross-referenced to the original field sample number, recorded in the laboratory notebook, and reported in the laboratory deliverable. In conjunction with data reporting, a copy of the COC form shall be returned to the project manager for inclusion in the central project file. The original shall be retained by the laboratory/sample custodian.

5.2 SAMPLE HANDLING, PACKAGING, AND SHIPPING

Samples that are to be shipped for laboratory analysis will comply with appropriate Department of Transportation (DOT) or International Air Transportation Association (IATA) regulations for environmental samples.

6.0 LABORATORY ANALYTICAL PROCEDURES

6.1 ANALYTICAL LABORATORY PROCEDURES

Analytical laboratory methods and procedures that will be applied in analyzing groundwater samples from CAFB are specified in Table 6-1. Applicable analytical methods are briefly discussed below.

6.1.1 Volatile Organic Compounds

VOCs include compounds of varying classes such as halogenated organics, nonhalogenated organics, and aromatic organics. The first two classes generally contain contaminants associated with solvents; the third class includes compounds associated with fuels. Method SW 8260B employs gas chromatography (GC) for separation and mass spectrometry (MS) for detection. GC/MS methods are indicated where the volatile contaminants that may be present are not well defined. The power of GC/MS lies in the capacity for positive identification of a wide range of compounds at relatively low detection limits. Reporting limits, acceptance criteria for surrogate spike recoveries, MS/MSDs, and LCSs for Method SW 8260B are presented in Table 2-11, 2-12, and 2-13

6.1.2 Semi-Volatile Organic Compounds

Method SW 8270C will be used to analyze the annual samples of MWs O and N for SVOCs. Method SW 8270C is a GC/MS method for determining extractable base/neutral and acid compounds such as phenols, nitrosamines, polynuclear aromatic hydrocarbons, phthalate esters, nitrotoluenes, etc.. Method EPA 420.1 will be used to analyze the semi-annual samples of well Ra for total recoverable phenols only. Reporting limits, acceptance criteria for surrogate spike recoveries, MS/MSDs, and LCSs (as applicable) for Method SW 8270C are shown in Table 2-14 and 2-15. Method EPA 420.1 are shown in Table 2-24.

6.1.3 Organochlorine Pesticides and Polychlorinated Biphenyls

Method SW 8081A and SW 8082 will be used for analyzing samples for organochlorine pesticides and PCBs. These methods are a GC method employing an electron capture detector. Reporting limits, acceptance criteria for surrogate spike recoveries, MS/MSDs, and LCSs for Method SW 8081A and SW 8082 are shown in Table 2-20 and 2-21.

6.1.4 Organophosphorous Pesticides

Method SW 8141 will be used for analyzing samples for organophosphate pesticides and is a GC method employing a nitrogen phosphorous detector. Reporting limits, acceptance criteria for surrogate spike recoveries, MS/MSDs, and LCSs are for Method SW 8141 are shown in Table 2-22 and 2-23.

6.1.5 Herbicides

Method SW 8151 will be used for analyzing samples for chlorinated herbicides. Method SW 8151 is a GC method employing an electron capture detector. The method requires derivatization and measurement of resulting esters. Reporting limits, acceptance criteria for MS recoveries and LCSs for Method SW 8151 are shown in Table 2-18 and 2-19.

6.1.6 Metals

Method SW 6010B will be used to analyze samples for TAL metals. The following are various factors which influence the use of the inductively coupled plasma (ICP) method:

- detection limits
- interference
- stability

Most metals, with a few exceptions (see Table 2-16 and 2-17), are detected at appropriate levels (for CAFB project objectives) by ICP and ICP trace emission spectroscopy, Method 6010B. Reporting limits, and acceptance criteria for MS/MSDs and LCSs for metals are specified in Table 2-16 and 2-17.

Method SW 7470A will be used to analyze samples for mercury. Reporting limits and acceptance criteria for MS/MSDs and LCSs are specified in Table 2-24.

6.1.7 Sulfate, Chloride, Nitrate and Total Recoverable Phenols

Sulfate, chloride and nitrate will be determined by EPA Method 300.0. Total recoverable phenols will be determined by EPA Method 420.1. Reporting limits for wet chemistry analyses, and acceptance criteria for the QC samples are specified in are shown in Table 2-24.

6.1.8 Groundwater Quality Indicator Parameters

Groundwater quality indicator parameters of pH, conductivity, turbidity, and temperature will be measured in the field during groundwater sampling activities and entered into the field log book. All activities required by groundwater quality indicator parameter measurements will be performed in accordance with FSP.

6.2 PREVENTIVE MAINTENANCE

The contract laboratory is responsible for the maintenance of its laboratory equipment. Preventive maintenance will be provided on a scheduled basis to minimize down time and the potential interruption of analytical work. Instruments will be maintained in accordance with manufacturer's recommendations and normal approved laboratory practices.

Designated laboratory personnel will be trained in routine maintenance procedures for major instrumentation. When repairs become necessary, they will be performed by either trained staff or trained service engineers/technicians employed by the instrument manufacturer. The laboratory shall have multiple instruments that will serve as backup to minimize the potential for down time. All maintenance will be documented and kept in permanent logs. These logs will be available for review by auditing personnel.

Both scheduled maintenance and unscheduled maintenance required by operational failures will be recorded. The designated laboratory operations coordinator will review maintenance records on a regular basis to ensure that required maintenance is being performed.

6.3 INSTRUMENT CALIBRATION AND FREQUENCY

Calibration of all analytical instrumentation is required to ensure that the analytical system is operating correctly and functioning at the required sensitivity to meet project-specific data quality requirements. Each instrument will be calibrated with standard solutions appropriate to the instrument and analytical method in accordance with the methodology specified in Table 6-1. The following paragraphs outline important concerns and provide specific information regarding calibration.

6.3.1 Standard/Reagent Preparation

A critical element in the generation of quality data is the purity/quality and traceability of the standard solutions and reagents used in the analytical operations. To ensure the highest purity possible, all primary reference standards and standard solutions will be obtained from the National Institute of Standards and Technology, the USACE, or other reliable commercial sources. All standards and standard solutions are logged into a database that identifies the supplier, lot number, purity/concentration, receipt/preparation date, name of preparer, method of preparation, expiration date, and all other pertinent information.

Standard solutions are validated prior to use. Validation procedures can range from a check for chromatographic purity to verification of the concentration of the standard using a standard prepared at a different time or obtained from a different source. Stock and working standards are checked regularly for signs of deterioration, such as discoloration, formation of precipitates, or change of concentration. Care is exercised in the proper storage and handing of standard solutions, and all containers are labeled as to compound, concentration, solvent, expiration date, and preparation data (initials of preparer/date of preparation). Reagents are examined for purity by subjecting an aliquot or subsample to the corresponding analytical method, as well.

A database is used to store essential information on specific standards or reagents. The system is designed to serve various functions (e.g., the system issues warnings on expiration dates and allows chemists to obtain a list of all working standard solutions prepared from the same stock solution). The program also facilitates the management and audit of reagents and standards.

6.3.2 Gas Chromatography

GC involves a variety of detection systems. While calibration standards and acceptance criteria vary depending on the type of system and analytical methodology required for a specific analysis, the general principles of calibration apply uniformly. Each GC system is calibrated prior to the performance of analyses. Initial calibration consists of determining the linear range, establishing limits of detection, establishing relative response or calibration factors, establishing calibration curves, and establishing retention time windows. The calibration is checked at a frequency that ensures that the system remains within specifications. The criteria for initial and ongoing

calibration of GC methods are based upon established EPA standards of performance contained in the applicable SW846 method protocol.

6.3.3 Gas Chromatography/Mass Spectrometry

Each day, prior to analysis of samples, the instrument is tuned with bromofluorobenzene for volatile compounds and decafluorotriphenylphosphine for semi volatile compounds, and must meet the tuning criteria specified in the respective methods prior to conducting analyses. Tuning ensures that the instrument can generate appropriate responses to the mass weights of ions that determine the characteristic mass spectra.

The instrument is calibrated per the GC calibration criteria for all target compounds. An initial calibration curve is produced, and certain key calibration compounds and continuing calibration compounds are evaluated on a daily basis to ensure that the system is within calibration criteria.

6.3.4 Spectrophotometric Unit

Each spectrophotometric unit is calibrated prior to analyses being conducted. A calibration curve is prepared with a minimum of a calibration blank and five standards. The calibration is verified on an ongoing basis with a midpoint calibration standard to ensure that the instrument meets established acceptance criteria.

6.3.5 Metals

Metals analysis basically involves two types of analytical instrumentation: ICP and cold vapor atomic absorption spectroscopy (CVAA) for mercury only.

Each ICP unit is calibrated prior to the analyses being performed using criteria prescribed in the respective methods. The calibration is then verified using standards from an independent source. The linear range of the instrument is established using a linear range verification check standard. No values are reported above this upper concentration value without dilution.

A calibration curve is established daily by analyzing a minimum of two standards and a calibration blank. The calibration is monitored throughout the day by analyzing a continuing calibration blank and calibration verification standard. The standard must meet established criteria as described in the method.

An interelement check standard is analyzed at the beginning of each analytical run to verify that interelement (between analyte metals) and background correction factors have remained constant. Results outside of the established criteria triggers reanalysis of samples.

Each CVAA unit is calibrated prior to analyses being conducted. A calibration curve is prepared with a minimum of a calibration blank and three to five standards, and then verified with a standard that has been prepared from an independent source at a concentration near the middle of the calibration range. The calibration is verified on an ongoing basis with a midpoint calibration standard to ensure that the instrument meets established acceptance criteria.

6.3.6 Documentation

Documentation of all calibration activities will be maintained by the laboratory. This information will become a part of the permanent project record and should be retrievable as necessary.

6.4 INTERNAL QUALITY CONTROL CHECKS

Two types of QA checks will be utilized to assess the production of analytical data of known and documented quality. These include

- program QA
- analytical method QC

6.4.1 Program Quality Assurance

The stated objectives of the laboratory QA/QC program are to

- Ensure that all procedures are documented, including any changes in administrative and/or technical procedures.
- Ensure that all analytical procedures are conducted according to sound scientific principles and have been validated.
- Monitor the performance of the laboratory by a systematic inspection program and provide for corrective action as necessary.
- Collaborate with other laboratories in establishing quality levels, as appropriate.
- Ensure that all data are properly recorded and archived.

All laboratory procedures are documented in writing as either SOPs or method procedures, which are edited and controlled. Internal QC procedures for analytical services will be conducted by the laboratory in accordance with their corporate QA plan and SOPs. These specifications include the types of QC checks required (sample spikes, surrogate spikes, reference samples, controls, blanks), the frequency of each QC check, the compounds to be used for sample spikes and surrogate spikes, and the QC acceptance criteria (control limits) for the QC analyses.

The laboratory will document, in each data package deliverable submitted, that QC control limits/criteria have been met. Any samples analyzed in nonconformance with the QC criteria will be reanalyzed by the laboratory if the laboratory procedures were not in control as assessed by laboratory control samples and other data specific to the analysis, and if sufficient sample volume is available.

6.4.2 Analytical Method Internal Quality Control

6.4.2.1 Matrix Spike

An MS is an environmental sample to which known concentrations of analytes have been added. The MS is taken through the entire analytical procedure and the recovery of the analytes calculated. Results are expressed as %R of the known amount spiked. The MS is used to evaluate the effect of the sample matrix on the accuracy of the analysis. Samples for MS analysis will be designated on the COC by field personnel. Extra sample volume will be collected for this purpose if necessary. A determination will be made in the field concerning representative matrices.

6.4.2.2 Matrix Spike Duplicate

An MSD is a split of the same environmental sample used for the MS that is also spiked with known concentrations of analytes. The MS and MSD are processed separately but in identical fashion and the results compared to evaluate the precision and accuracy of the laboratory analysis. Results are expressed as %R and as RPD between the MS and the MSD percent recoveries. Samples for MSD analysis will be designated on the COC by field personnel. For inorganic analyses, a matrix duplicate (unspiked sample) is compared to the original

environmental sample and the RPD calculated to determine method precision and sample homogeneity.

6.4.2.3 Surrogate

A compound or compounds are added to every blank, environmental sample, QC sample and standard if specified in the analytical methodology. The results are utilized to evaluate the accuracy of analytical measurement on a sample-specific basis. Surrogates are generally brominated, fluorinated, or isotopically labeled compounds not expected to be detected in environmental media. Results are expressed in percent recovery %R of the surrogate spike.

6.4.2.4 Internal Standards

Internal standards (IS) are added to every sample and standard analyzed by GC or GC/MS methods. ^{13}C-isotopically labeled internal standards are used for dioxin analyses to quantify sample concentrations and to evaluate stability of the GC/MS system throughout the analytical run. The IS is a measure of the consistency of the instrument response and is used in the quantification calculation for GC/MS analyses.

6.4.2.5 Method Blanks

A method blank consists of analyte-free deionized water. The method blank is carried through each step of the analytical method. The method blank data will be used to evaluate laboratory contamination during analysis.

6.4.2.6 Laboratory Control Samples

LCSs are well-characterized samples, or spiked laboratory blank samples, used to monitor the laboratory's day-to-day performance of routine analytical methods. Certain LCS are used to monitor the precision and accuracy of the analytical process independent of matrix effect. Other LCS are used to identify any background interference or contamination of the analytical system that may lead to the reporting of elevated concentration levels or false positive data. The results of the LCS are compared to well-defined laboratory acceptance criteria or vendor specified limits to determine whether the laboratory system is "in control.". Controlling laboratory operations with LCS (as opposed to MS/MSD samples) offers the advantage of being able to differentiate low recoveries due to procedural errors from those due to matrix effect.

6.5 LABORATORY CORRECTIVE ACTION

The laboratory QA/QC officer or the officer's designee shall be responsible for initiating corrective action as necessary. Corrective action will be required if analyses of QC samples or laboratory conditions do not meet criteria specified in the respective methods, the laboratory QA plan, or the SOPs.

The BHATE project QA officer will review the field and laboratory data generated for this project to ensure that all project QA objectives are met. If any nonconformances are found in the laboratory analytical and documentation procedures or data assessment and validation procedures, the impact of those nonconformances on the overall project QA objectives will be assessed. Appropriate actions, including resampling, reanalysis, etc., may be recommended to the project manager so the project objectives can be accomplished. In the event of any non-conformances and/or laboratory corrective actions which impact the quality of the data, the USACE TM will be informed immediately.

6.6 DATA ASSESSMENT PROCEDURES

The reliability and credibility of analytical laboratory results are evaluated by the inclusion, as an integral part of any analytical procedure, of a program of randomly selected replicate analyses, and analysis of standards and spiked samples. Precision of analytical results will be evaluated as the relative percent difference or relative standard deviation from the mean of replicate analyses. Accuracy is reported as the percent recovery of a parameter from a sample of known value with a given analytical procedure or the level of blank contamination.

The procedures described herein are designed to ensure precise and accurate data for each analytical method. To ensure that reliable data continue to be produced, systematic checks must show that test results remain reproducible and that the methodology is actually measuring the quantity of analyte in each sample. QA must begin with sample collection and not end until the resulting data have been reported.

The project QA/QC officer will be responsible for data assessment and review. The project QA/QC officer will review the analytical results for compliance with the established QC criteria as described below. Problems arising during sample collection, packing, shipping, or analysis

will be taken into consideration in the data assessment. The following procedures will be used to evaluate data precision, accuracy, and analytical completeness for the analyses conducted.

6.6.1 Accuracy

Accuracy will be expressed as percent recovery for laboratory control samples as follows:

$$\text{Percent Recovery} = \frac{x}{T} \; x \; 100$$

where

x	=	observed value
T	=	"true" value

Recoveries will be compared with the applicable control limits (Section 2.0) and the data associated with outliers will be evaluated to determine its usability. The surrogate recoveries will also be calculated as above and compared against the limits shown in Tables 2-25. If the surrogate percent recovery limits are exceeded, the data will be assessed to determine the potential effect of the poor surrogate recovery on the reported results.

In addition, the MS and MSD sample results will be used to calculate the percent recovery.

$$\text{Percent Recovery} = \frac{X - S}{T} \; x \; 100$$

where

X	=	observed value after spike
S	=	sample value
T	=	amount spiked

These MS and MSD percent recoveries will be compared with the applicable control limits (Tables 2-24) and the data associated with outliers will be assessed in conjunction with other QC data to determine if the sample matrix is adversely affecting the data.

6.6.2 Precision

Precision will be expressed as RPD for duplicate environmental samples and for duplicate control samples, as follows:

$$\text{RPD (\%)} = \frac{|S - D|}{(S + D)/2} \; x \; 100$$

where

S = first sample value (original)

D = second sample value (duplicate)

For MS/MSD samples, S is the first %R and D is the second %R. The RPDs will be compared with the applicable control limits in Tables 2-25, and the effect of inadequate precision on the associated sample data will be assessed.

6.6.3 Assessment of Data for Completeness and Usability

Following validation of the data packages, assessment of the data with respect to fulfillment of QA objectives and usability will be accomplished by the joint efforts of the project QA/QC officer and the project manager. This assessment will include sample collection, sample handling, field data, consideration of blank values and field duplicate values, and qualifying data for use at each site.

The analytical completeness will be calculated by the ratio of acceptable analytical results to the total number of analytical results requested on samples submitted for analysis. Unacceptable data are those that have been rejected "R" as unusable for project purposes.

$$\% \text{ Completeness} = \frac{\text{Acceptable Analytical Results}}{\text{Total Number of Analytical Results Requested}} \; x \; 100$$

The percent completeness will be compared against the overall program goal of 90 percent. If the goal is not met, the project QA/QC officer and the project manager will decide if the data are sufficient for the site characterization or other types of data uses. If it is judged that the data are inadequate, additional field samples will be collected to accomplish the project goals. Decisions to repeat sample collection and analysis may be made by the project manager based on the extent of the deficiencies and their importance in the overall context of the project.

6.7 DATA REDUCTION, VALIDATION, AND DOCUMENTATION

The analytical data generated by the laboratory will be reviewed for accuracy, precision, completeness, representativeness, and comparability. The data validation process for this project will consist of data generation, reduction, and two levels of review, the first by the analytical laboratory and the second through an independent data review.

6.7.1 Analytical Laboratory Data Review and Reporting

The first level of review, which may contain multiple sublevels, will be conducted by the laboratory QA/QC officer who has the initial responsibility for the correctness and completeness of the data. All data are generated and reduced in accordance with protocols specified in the analytical methodology. The laboratory QA/QC officer will evaluate the quality of the work based on an established set of laboratory guidelines and this QAPP. This person will review the data package to ensure that

- sample preparation information is correct and complete
- analysis information is correct and complete
- appropriate methods have been followed
- analytical results are correct and complete
- QC samples are within appropriate QC limits
- special sample preparation and analytical requirements have been met
- documentation is complete (all anomalies in the preparation and analysis have been documented; out-of-control forms, if required, are complete; holding times are documented)

The laboratory QA/QC officer is responsible for assessing data quality and advising the BHATE project QA/QC officer of any data which were rated "preliminary" or "unacceptable", or other notations that would caution the data user of possible unreliability. Data reduction, QA review, and reporting by the laboratory will be conducted as follows:

- Raw data produced by the analyst are processed and reviewed for attainment of QC criteria as outlined in this QAPP and/or established EPA methods and for overall reasonableness.
- After entry into the Laboratory Information Management System, a computerized report is generated and sent to the laboratory QA/QC officer.
- The laboratory QA/QC officer will decide whether any sample reanalysis is required.
- Upon acceptance of the preliminary reports by the laboratory QA/QC officer, final reports will be generated.

The laboratory will prepare and retain full analytical and QC documentation. The following reporting requirements shall be met. The laboratory will report the data as a group of 20 samples

or less, along with QC supporting data, in a summary format that may be defined as a Contract Laboratory Program-like data package. The laboratory will provide electronic deliverables in a format specified by BHATE which is based upon the Environmental Resources Program Information Management System (ERPIMS) format. The following hard copy information will be included in each analytical data package:

- COC forms
- cooler receipt forms
- cover sheet listing the samples included in the report and narrative comments describing problems encountered in analysis
- tabulated results of inorganic and organic compounds identified and quantified and reporting limits for all analytes
- summary QC tables for method blanks, MS/MSD samples, sample duplicates, initial and continuing calibration standards, surrogate spikes, laboratory control samples, and ICP interference check samples and serial dilutions
- tabulation of reporting limits related to the sample

The following information must be available to BHATE upon request:

- Raw data system printouts (or legible photocopies) identifying date of reported analysis, analyst, parameters analyzed, internal standards, instrument tunes or break down checks, spectra, calibration blanks, any reported sample dilutions, sample duplicates, spikes, and control samples; sample spiking levels, method of standard additions coefficients, preparation/extraction logs and run logs.

The narrative accompanying the data package will include the identification of samples not meeting QC criteria as specified in the analytical method and the laboratory data quality review SOPs. The data reduction and the QC review steps will be documented. The narrative will also include cautions regarding data usability due to out-of-control QC results.

6.7.2 Independent Data Review Process

Laboratory analytical data packages will receive a level of review by the BHATE project QA/QC officer or third party whose function is to provide an independent review of the data package. All data packages will be reviewed for the summary QC elements. Data for one sample per

sampling event may be subjected to full data validation. Laboratory results will be reviewed and data qualified, as required. Sample data may be qualified as "J" (estimated), "UJ" (not detected - estimated), or "R" (rejected). The qualifier "U" is used for analytes not detected by the laboratory. Rejected data are not usable for any purpose.

A summary of the elements to be checked in the data validation and review process is included below.

Review of Metals and Wet Chemistry Analyses

- holding times
- blanks
- laboratory control samples
- matrix duplicate sample
- matrix spike sample
- field duplicate sample
- laboratory flags
- overall assessment of data from a case narrative
- sample custody and preservation
- completeness of data package
- Review of Volatile and Semivolatile Organic Analyses
- holding times
- blanks (field and laboratory)
- surrogate recovery
- laboratory control samples
- MS/MSD
- field duplicates
- laboratory flags
- overall assessment of data from a case narrative
- sample custody and preservation
- completeness of data package

Additional Quality Assurance Data

In addition to the above specified QC data and validation guidelines, one sample from each sampling event will be sent to the USACE ECB laboratory. Comparison will be made between the analytical results for the samples split between the contract and USACE laboratories.

The project QA/QC officer will oversee all data management activities, establish priorities, and ensure that project objectives are met. Both the project manager and the project QA/QC officer will monitor the work conducted by the data management group and provide communications support with USACE and analytical subcontractors.

7.0 DELIVERABLES

Deliverables for this project include DQCRs, Analytical Data Package, NMED semi-annual monitoring reports, and an NMED annual report.

7.1 DAILY QUALITY CONTROL REPORT

The field team leader will report to the BHATE project manager on a daily basis regarding fieldwork progress and QC issues associated with the field activities. The field team leader will provide details in a DQCR, as described in Subsection 4.4.1.2. Should conditions require deviations from the approved Work Plan and Scope of Services, a report of non-routine occurrence shall be sent to the USACE TM within 48 hours of the occurrence. The report shall include problems identified, corrective actions, and verbal/written instructions for sampling or reanalysis. Two copies of each DQCR will be sent, via regular mail, at the end of each week to the USACE TM. BHATE will also provide a copy of each DQCR to the CAFB CEV Office daily.

7.2 SEMI-ANNUAL MONITORING REPORTS

After receipt and validation of the analytical data for both semi-annual sampling events of well Ra, the project QA/QC officer and project manager will prepare a report containing a summary of the analytical results. For each sampling event, a semi-annual monitoring report, meeting NMED format requirements, will be prepared. Investigation activities and other information reported by the field team leader, as well as all field and laboratory-related QC data, will be included in this report. In addition, a comparison of the QA sample analytical results and the normal environmental field sample results will be made and discussed within the report. After completion of the second semi-annual sampling event, an Annual Summary Report will also be completed encompassing all pertinent information acquired throughout the duration of the LTMP.

Copies of each semi-annual monitoring report and the annual summary report will be submitted to the USACE TM, the CAFB CE/CEV Office, Headquarters, Air Combat Command, EPA, and

NMED. These reports will be submitted in draft and final form. One copy of each semi-annual report will include the data validation summary. This copy will be submitted to CAFB.

7.3 ANNUAL REPORT

At the conclusion of the semi-annual and annual monitoring of LF-03, LF-04, and LF-25, BHATE will submit an annual report in a format established by NMED. This report will summarize the conclusions of all subsequent sampling events. This report will be submitted in draft and final status.

8.0 REFERENCES

U.S. Environmental Protection Agency, *Methods For The Chemical Analysis of Water and Wastewater,* 1973 (including current updates).

U.S. Environmental Protection Agency, *Federal Register, 40 CFR, Part 13b,* 1984 (including current updates).

U.S. Environmental Protection Agency, *SW-846 Test Methods For Evaluating Solid Waste, Physical/Chemical Methods, Update III, Rev. 5*, April 1998.

U.S. Environmental Protection Agency, *Contract Laboratory Program (CLP), National Functional Guidelines for Inorganic Data Review,* 1994.

U.S. Environmental Protection Agency, *Contract Laboratory Program (CLP), National Functional Guidelines for Organic Data Review,* 1994.

U.S. Environmental Protection Agency, *Guidance for the Data Quality Objective Process (QA/G-4),* September 1994.

Tables

Table 2-1
Monitoring Wells O, N, and Ra
Groundwater Samples Per Sampling Event

Analyses	Method Number	Semi-annual Event MW-Ra	Annual Event MW-O, -N and –Ra
Volatile Organic Compounds	SW 8260B	✓	✓
Semi-Volatile Organic Compounds (including Petroleum Aromatic Hydrocarbons)	SW 8270C	✓	✓
TAL Metals Mercury	SW 6010B SW 7470A	✓	✓
Herbicides	SW 8151A	✓	✓
Pesticides Organochlorinated	SW 8081A	✓	✓
PCBs	SW 8082	✓	✓
Pesticides Organophosphates	SW 8141	✓	✓
Water Quality Indicator MCAWW --Sulfates --Nitrates --Chloride --Phenols	 EPA 300.0 EPA 300.0 EPA 300.0 EPA 420.2	✓	✓

CFR = Code of Federal Regulations
EPA = U.S. Environmental Protection Agency
MCAWW = methods for chemical analysis of water and wastes
MW = monitoring well
PCBs = polychlorinated biphenyls
TAL = target analyte list

Table 2-2
Detailed Sampling Scheme and Quality Control Program
LF-25 – Well Ra
Semi-Annual Sampling Event
CAFB, Clovis, New Mexico

Sample Matrix: Groundwater

Sample Locations	Number of Samples per Site	VOCs	SVOCs	TAL Metals	Mercury	Herbicides	Organochlorine Pesticides	PCBs	Organophosphate Pesticides	Sulfate, nitrate and chlorine	Phenol
CAFB-LF25-MW-Ra	1	1	1	1	1	1	1	1	1	1	1
Quality Control Samples											
Field Duplicates	1	1	1	1	1	1	1	1	1	1	1
Equipment Blanks [4]											
Trip Blanks[2]											
Matrix Spike [3]	1	1									
Matrix Spike Duplicate [3]											
Splits [1,3]	1	1	1	1	1	1	1	1	1	1	1
Totals	**4**	**4**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

Notes:
(1) The field duplicate and split will be collected from the same location. The split will be submitted to the CQAB Laboratory.
(2) A trip blank will be submitted with each shipment that includes a request for VOC analysis on a water sample.
(3) This QC sample may be omitted if a QC sample collected from another site concurrently can be used to maintain a 1 in 20 (5% QC sample frequency) for all applicable analyses.
(4) This QC sample may be omitted if a QC sample collected from another site concurrently can be used to maintain a 1 in 10 (10% QC sample frequency) for all applicable analyses.

Table 2-2 (continued)
Detailed Sampling Scheme and Quality Control Program
LF-03 (well O), 04 (well N) and LF-25 (well Ra)
Annual Sampling Event
CAFB, Clovis, New Mexico

Sample Matrix: Groundwater

Sample Locations	Number of Samples per Site	VOCs	SVOCs	TAL Metals	Mercury	Herbicides	Organochlorine Pesticides	PCBs	Organophosphate Pesticides	Sulfate, nitrate and chlorine	Phenol
CAFB-LF25-MW-Ra	1	1	1	1	1	1	1	1	1	1	1
CAFB-LF03-MW-O	1	1	1	1	1	1	1	1	1	1	1
CAFB-LF04-MW-N	1	1	1	1	1	1	1	1	1	1	1
Quality Control Samples											
Field Duplicates	1	1	1	1	1	1	1	1	1	1	1
Equipment Blanks [4]	1	1	1	1	1	1	1	1	1	1	1
Trip Blanks[2]											
Matrix Spike [3]	1	1									
Matrix Spike Duplicate [3]											
Splits [1,3]	1	1	1	1	1	1	1	1	1	1	1
Totals	**7**	**7**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**

Notes:
(1) The field duplicate and split will be collected from the same location. The split will be submitted to the CQAB Laboratory.
(2) A trip blank will be submitted with each shipment that includes a request for VOC analysis on a water sample.
(3) This QC sample may be omitted if a QC sample collected from another site concurrently can be used to maintain a 1 in 20 (5% QC sample frequency) for all applicable analyses.
(4) This QC sample may be omitted if a QC sample collected from another site concurrently can be used to maintain a 1 in 10 (10% QC sample frequency) for all applicable analyses.

Table 2-3
EPA MCLs and NMED Standards
Volatile Organic Compounds
Groundwater

Compound	US EPA MCLs (mg/L)	NMED Standards (mg/L)
Acetone	---	N/A
Acetonitrile	N/A	N/A
Acrolein	N/A	N/A
Acrylonitrile	---	N/A
Allyl chloride	N/A	N/A
Benzene	0.005	0.01[1]
Bromodichloromethane	0.08	N/A
Bromoform	0.08	N/A
Bromomethane	---	N/A
2-Butanone (MEK)	---	N/A
Carbon disulfide	---	N/A
Carbon tetrachloride	0.005	0.01[1]
Chlorobenzene	0.01	N/A
Chloroethane	---	N/A
Chloroform	0.08	N/A
Chloromethane	---	N/A
3-Chloropropylene	N/A	N/A
Dibromochloromethane	---	N/A
1,2-Dibromo-3-Chloropropane	0.0002	N/A
1,2-Dibromoethane	---	N/A
Dibromomethane	---	N/A
trans-1,4-Dichloro-2-butene	N/A	N/A
Dichlorodifluoromethane	N/A	N/A
1,1-Dichloroethane	---	0.025[1]
1,2-Dichloroethane	0.005	0.01[1]
1,1-Dichloroethene	0.007	N/A
trans-1,2-Dichloroethene	N/A	N/A
cis-1,2-Dichloroethene	N/A	N/A
1,2-Dichloropropane	0.005	N/A
cis-1,3-Dichloropropene	N/A	N/A
trans-1,3-Dichloropropene	---	N/A
1,4-Dioxane	N/A	N/A
Ethylbenzene	0.7	0.75[1]
Ethyl Methacrylate	N/A	N/A
2-Hexanone	---	N/A
Iodomethane	N/A	N/A
Methacrylonitrile	N/A	N/A

[1] Denotes Human Health Standard

Table 2-3(continued)
EPA MCLs and NMED Standards
Volatile Organic Compounds
Groundwater

Compound	US EPA MCLs (mg/L)	NMED Standards (mg/L)
Methylene Chloride	0.005	N/A
Methyl methacrylate	N/A	N/A
4-Methyl-2-pentanone	---	N/A
Propionitrile	N/A	N/A
Styrene	0.1	N/A
1,1,1,2-Tetrachloroethane	---	N/A
1,1,2,2-Tetrachloroethane	---	0.01[1]
Tetrachloroethene	0.005	N/A
Toluene	1.0	0.75[1]
1,1,1-Trichloroethane	0.2	0.06[1]
1,1,2-Trichloroethane	0.005	0.01[1]
Trichloroethene	0.005	N/A
Trichlorofluoromethane	N/A	N/A
1,2,3-Trichloropropane	N/A	N/A
Vinyl acetate	N/A	N/A
Vinyl chloride	0.002	0.001[1]
Xylenes (total)	10	N/A

[1] Denotes Human Health Standard

--- Denotes a compound that was listed in the EPA or NMED MCL or Standards list, but no value has been established.

N/A Denotes a compound that was not listed in the EPA or NMED MCL or Standards lists. Therefore, no MCL or standard is established.

Table 2-4
EPA MCLs and NMED Standards
Semi-Volatile Organic Compounds with PAHs
Groundwater

Analyte	US EPA MCLs (mg/L)	NMED Standards (mg/L)
Acenaphthene	---	N/A
Acenaphthylene	---	N/A
Acetophenone	N/A	N/A
2-Acetylaminofluorene	N/A	N/A
4-Aminobiphenyl	N/A	N/A
Aniline	N/A	N/A
Anthracene	---	N/A
Aramite	N/A	N/A
Benz(a)anthracene	---	N/A
Benzo(b)fluoranthene	---	N/A
Benzo(k)fluoranthene	---	N/A
Benzo(g,h,i)perylene	---	N/A
Benzo(a)pyrene	0.0002	N/A
Benzyl alcohol	N/A	N/A
4-Bromophenyl phenyl ether	---	N/A
Butyl benzyl phthalate	---	N/A
2-sec-Butyl-4,6-dinitrophenol	N/A	N/A
4-Chloroaniline	---	N/A
bis(2-Chloroethoxy)methane	---	N/A
bis(2-Chloroethyl) ether	---	N/A
bis(2-Chloroisopropyl)ether*	N/A	N/A
4-Chloro-3-methylphenol	---	N/A
2-Chloronaphthalene	---	N/A
2-Chlorophenol	---	N/A
4-Chlorophenyl phenyl ether	---	N/A
Chrysene	---	N/A
Dibenzo(a,h)anthracene	N/A	N/A
Dibenzofuran	---	N/A
1,2-Dichlorobenzene	0.6	N/A
1,3-Dichlorobenzene	---	N/A
1,4-Dichlorobenzene	0.075	N/A
Di-n-butyl phthalate	---	N/A
3,3'-Dichlorobenzidine	---	N/A
2,4-Dichlorophenol	---	N/A
2,6-Dichlorophenol	N/A	N/A
Diethyl phthalate	---	N/A
p-Dimethylaminoazobenzene	N/A	N/A
7,12-Dimethylbenzo(a)anthracene	N/A	N/A
3,3'-Dimethylbenzidine	N/A	N/A
a,a-Dimethylphenethylamine	N/A	N/A
2,4-Dimethylphenol	---	N/A
Dimethylphthalate	---	N/A

Table 2-4 (continued)
EPA MCLs and NMED Standards
Semi-volatile Organic Compounds with PAHs
Groundwater

Analyte	US EPA MCLs (mg/L)	NMED Standards (mg/L)
p-Dimethylaminoazobenzene	N/A	N/A
7,12-Dimethylbenzo(a)anthracene	N/A	N/A
3,3'-Dimethylbenzidine	N/A	N/A
a,a-Dimethylphenethylamine	N/A	N/A
2,4-Dimethylphenol	---	N/A
Dimethylphthalate	---	N/A
1,3-Dinitrobenzene	---	N/A
4,6-Dinitro-2-methylphenol	---	N/A
2,4-Dinitrophenol	---	N/A
2,4-Dinitrotoluene	---	N/A
2,6-Dinitrotoluene	---	N/A
Di-n-octyl phthalate	---	N/A
Diphenylamine	---	N/A
bis(2-ethylhexyl)phthalate	0.006	N/A
Ethyl methanesulfonate	N/A	N/A
Fluoranthene	---	N/A
Fluorene	---	N/A
Hexachlorobenzene	0.001	N/A
Hexachlorobutadiene	---	N/A
Hexachlorocyclopentadiene	0.05	N/A
Hexachloroethane	---	N/A
Hexachloropropene	N/A	N/A
Hexachlorophene	N/A	N/A
Indeno(1,2,3-cd)pyrene	---	N/A
Isophorone	---	N/A
Isosafrole	N/A	N/A
Methapyrilene	N/A	N/A
3-Methylcholanthrene	N/A	N/A
Methyl methanesulfonate	N/A	N/A
2-Methylnaphthalene	---	N/A
2-Methylphenol	---	N/A
3&4-Methylphenol	---	N/A
Naphthalene	---	N/A
1,4-Naphthoquinone	N/A	N/A
1-Naphthylamine	N/A	N/A
2-Naphthylamine	N/A	N/A
2-Nitroaniline	---	N/A
3-Nitroaniline	---	N/A
4-Nitroaniline	---	N/A
Nitrobenzene	---	N/A
2-Nitrophenol	---	N/A

Table 2-4 (continued)
EPA MCLs and NMED Standards
Semi-volatile Organic Compounds with PAHs
Groundwater

Analyte	US EPA MCLs (mg/L)	NMED Standards (mg/L)
4-Nitrophenol	---	N/A
N-Nitroso-di-n-butylamine	N/A	N/A
N-Nitrosodiethylamine	N/A	N/A
N-Nitrosodimethylamine	N/A	N/A
N-Nitrosodiphenylamine	---	N/A
N-Nitrosodipropylamine	---	N/A
N-Nitrosomethylethylamine	N/A	N/A
N-Nitrosomorpholine	N/A	N/A
N-Nitrosopiperidine	N/A	N/A
N-Nitrosopyrrolidine	N/A	N/A
5-Nitro-o-toluidine	N/A	N/A
4-Nitroquinoline-n-oxide	N/A	N/A
Pentachlorobenzene	N/A	N/A
Pentachloroethane	---	N/A
Pentachloronitrobenzene	N/A	N/A
Pentachlorophenol	0.001	N/A
Phenacetin	N/A	N/A
Phenanthrene	---	N/A
Phenol	---	N/A
2-Phenylenediamine	N/A	N/A
4-phenylenediamine	N/A	N/A
2-Picoline	N/A	N/A
Pronamide	---	N/A
Pyrene	---	N/A
Pyridine	N/A	N/A
Safrole	N/A	N/A
1,2,4,5-Tetrachlorobenzene	N/A	N/A
2,3,4,6-Tetrachlorophenol	N/A	N/A
o-Toluidine	N/A	N/A
1,2,4-Trichlorobenzene	0.070	N/A
2,4,5-Trichlorophenol	---	N/A
2,4,6-Trichlorophenol	---	N/A
1,3,5-Trinitrobenzene	---	N/A

*Also known as oxybis(1-chloropropane)
=Will be analyzed as a tentatively identified compound (TIC).
PAH = polynuclear aromatic hydrocarbon

--- Denotes a compound that was listed in the EPA or NMED MCL or Standards list, but no value has been established.

N/A Denotes a compound that was not listed in the EPA or NMED MCL or Standards lists. Therefore, no MCL or standard is established.

Table 2-5
EPA MCLs and NMED Standards
Organochlorine Pesticides
Groundwater

Analyte	US EPA MCLs (mg/L)	NMED Standards (mg/L)
Aldrin	---	N/A
alpha-BHC	---	N/A
beta-BHC	---	N/A
delta-BHC	---	N/A
gamma-BHC (Lindane)	0.0002	N/A
alpha-Chlordane	0.002	N/A
gamma-Chlordane	0.002	N/A
Chlorobenzilate	N/A	N/A
4,4'-DDD	---	N/A
4,4'-DDE	---	N/A
4,4'-DDT	---	N/A
Diallate	N/A	N/A
Dieldrin	---	N/A
Endosulfan I	---	N/A
Endosulfan II	---	N/A
Endosulfan sulfate	---	N/A
Endrin	0.002	N/A
Endrin aldehyde	0.002	N/A
Heptachlor	0.0004	N/A
Heptachlor epoxide	0.0002	N/A
Isodrin	N/A	N/A
Kepone	N/A	N/A
Methoxychlor	0.04	N/A
Toxaphene	0.003	N/A

--- Denotes a compound that was listed in the EPA or NMED MCL or Standards list, but no value has been established.

N/A Denotes a compound that was not listed in the EPA or NMED MCL or Standards lists. Therefore, no MCL or standard is established.

Table 2-6
EPA MCLs and NMED Standards
PCBs
Groundwater

Analyte	US EPA MCLs (mg/L)	NMED Standards (mg/L)
Aroclor 1016	0.0005	N/A
Aroclor 1221	0.0005	N/A
Aroclor 1232	0.0005	N/A
Aroclor 1242	0.0005	N/A
Aroclor 1248	0.0005	N/A
Aroclor 1254	0.0005	N/A
Aroclor 1260	0.0005	N/A

PCBs = polychlorinated biphenyls

--- Denotes a compound that was listed in the EPA or NMED MCL or Standards list, but no value has been established.

N/A Denotes a compound that was not listed in the EPA or NMED MCL or Standards lists. Therefore, no MCL or standard is established.

Table 2-7
EPA MCLs and NMED Standards
TAL Metals
Groundwater

Analyte	US EPA MCLs (mg/L)	NMED Standards (mg/L)
Aluminum	0.05 to 0.2	5.0[2]
Antimony	0.006	N/A
Arsenic	0.05	0.1[1]
Barium	2.0	1.0[1]
Beryllium	0.004	N/A
Cadmium	0.005	0.01[1]
Calcium	---	N/A
Chromium	0.1	0.05[1]
Cobalt	---	0.05[2]
Copper	1.0	1.0[1]
Iron	0.3	1.0[1]
Lead	0.015	0.05[1]
Magnesium	---	N/A
Manganese	0.05	0.2[1]
Mercury (Method 7470A)	0.002	0.002[1]
Nickel	---	0.2[2]
Potassium	---	N/A
Selenium	0.05	0.05[1]
Silver	0.10	5.0[1]
Sodium	---	N/A
Tin	N/A	N/A
Vanadium	---	N/A
Zinc	5.0	10.0[1]

TAL = target analyte list
[1] Denotes Human Health Standard
[2] Denotes Irrigation Standards

--- Denotes a compound that was listed in the EPA or NMED MCL or Standards list, but no value has been established.

N/A Denotes a compound that was not listed in the EPA or NMED MCL or Standards lists. Therefore, no MCL or standard is established.

Table 2-8
EPA MCLs and NMED Standards
Chlorinated Herbicides
Groundwater

Analyte	US EPA MCLs (mg/L)	NMED Standards (mg/L)
2,4-D	0.07	N/A
2,4,5-T	---	N/A
2,4,5-TP (Silvex)	0.05	N/A
Dinoseb	0.007	N/A

--- Denotes a compound that was listed in the EPA or NMED MCL or Standards list, but no value has been established.

N/A Denotes a compound that was not listed in the EPA or NMED MCL or Standards lists. Therefore, no MCL or standard is established.

Table 2-9
EPA MCLs and NMED Standards
Organophosphate Pesticides
Groundwater

Analyte	US EPA MCLs (mg/L)	NMED Standards (mg/L)
Dimethoate	N/A	N/A
Disulfoton	N/A	N/A
Famphur	N/A	N/A
O,O,O-Triethylphosphothioate	N/A	N/A
Ethyl parathion	N/A	N/A
Methyl parathion	N/A	N/A
Phorate	N/A	N/A
Sulfotepp	N/A	N/A
Thionazin	N/A	N/A

--- Denotes a compound that was listed in the EPA or NMED MCL or Standards list, but no value has been established.

N/A Denotes a compound that was not listed in the EPA or NMED MCL or Standards lists. Therefore, no MCL or standard is established.

Table 2-10
EPA MCLs and NMED Standards
Miscellaneous Parameters
Groundwater

Analyte	Method	US EPA MCLs (mg/L)	NMED Standards (mg/L)
Nitrate	EPA 300.0	0.01	10.0[1]
Sulfate	EPA 375.4	0.5	600.0[1]
Chloride	EPA 300.0	N/A	250.0[1]
Phenols	EPA 420.2	N/A	0.005[1]

[1] Denotes Human Health Standard

--- Denotes a compound that was listed in the EPA or NMED MCL or Standards list, but no value has been established.

N/A Denotes a compound that was not listed in the EPA or NMED MCL or Standards lists. Therefore, no MCL or standard is established.

Table 2-11
Quality Assurance Objectives
Volatile Organic Compounds - Groundwater
(Method 5030B & 8260B)

Analyte	Matrix Precision %	Matrix Accuracy %	LCS Accuracy %	MDL µg/L	QL µg/L	LIMS Analyte Number
Acetone	35	34-166	48-149	6.60	50	18001, 4621
Acetonitrile	ID	ID	ID	ID	2	18011
Acrolein	43	16-172	45-149	6.46	10	18021
Acrylonitrile	25	47-148	57-140	2.54	10	18031
Allyl chloride	ID	ID	ID	ID	10	18051
Benzene	20	68-136	74-123	0.60	2	18061, 4610
Bromobenzene	20	76-130	79-121	0.51	2	18091
Bromochloromethane	26	63-143	67-133	0.83	2	18101
Bromodichloromethane	27	68-141	72-129	0.45	2	19031
Bromoform	30	54-139	60-133	0.34	2	18111
Bromomethane	37	33-166	45-154	0.72	2	18121
n-Butyl alcohol	ID	ID	ID	ID	10	ID
tert-Butyl alcohol	ID	ID	ID	ID	100	ID
n-Butylbenzene	29	45-161	56-138	0.55	2	18141
sec-Butylbenzene	24	62-146	69-131	0.54	2	18151
tert-Butylbenzene	22	64-145	70-130	0.62	2	18161
Carbon disulfide	29	53-147	62-130	0.54	2	18171, 4623
Carbon tetrachloride	31	61-151	65-138	0.44	2	18181, 4615
Chlorobenzene	21	73-131	81-118	0.66	2	18191, 4620
Chloroethane	30	46-157	56-140	0.72	2	18201
*2-Chloroethyl vinyl ether**	20	71-137	69-128	3.29	10	18221
Chloroform	24	65-140	71-123	0.64	2	18231, 4625
1-Chlorohexane	ID	ID	ID	ID	10	ID
Chloromethane	43	29-171	43-151	0.91	2	18241
Chloroprene	ID	ID	ID	ID	2	18251
2-Chlorotoluene	20	73-136	77-125	0.63	2	18271
4-Chlorotoluene	20	72-137	76-125	0.55	2	18281
Dibromochloromethane	27	68-138	72-130	0.53	2	18301
1,2-Dibromo-3-chloropropane	36	31-171	52-146	0.89	2	18291
1,2-Dibromoethane	36	58-145	70-130	0.29	2	18311
Dibromomethane	27	68-137	69-130	0.33	2	18321
1,2-Dichlorobenzene	21	66-139	73-127	0.32	2	18341
1,3-Dichlorobenzene	21	70-136	74-125	0.57	2	18351
1,4-Dichlorobenzene	21	68-138	73-126	0.48	2	18361
cis-1,4-Dichloro-2-butene	ID	ID	ID	ID	10	ID
trans-1,4-Dichloro-2-butene	36	22-160	47-141	0.66	2	18331
Dichlorodifluoromethane	41	41-158	48-143	0.65	2	18371
1,1-Dichloroethane	27	61-147	67-130	0.73	2	18381, 4634
1,2-Dichloroethane	25	60-150	64-136	0.43	2	18391, 4630

Table 2-11 (continued)
Quality Assurance Objectives
Volatile Organic Compounds - Groundwater
(Method 5030B & 8260B)

Analyte	Matrix Precision %	Matrix Accuracy %	LCS Accuracy %	MDL µg/L	QL µg/L	LIMS Analyte Number
1,1-Dichloroethene	24	60-145	67-128	0.57	2	18401, 4635
cis-1,2-Dichloroethene	25	61-150	71-130	0.64	2	18411, 4619
trans-1,2-Dichloroethene	21	65-145	69-129	0.66	2	18421, 4614
1,2-Dichloropropane	26	69-137	71-127	0.58	2	18441
1,3-Dichloropropane	25	68-134	68-127	0.41	2	18451
2,2-Dichloropropane	41	10-172	32-146	0.71	2	18461
1,1-Dichloropropene	22	70-139	73-127	0.47	2	18481
cis-1,3-Dichloropropene	27	56-136	58-131	0.52	2	18491
trans-1,3-Dichloropropene	26	52-143	56-133	0.28	2	18501
2,3-Dichloro-1-propene	28	48-146	55-136	0.46	2	17691
Diethyl ether	27	58-142	66-131	0.40	10	18981, 4636
1,4-Dioxane	ID	ID	ID	ID	10	18521
Ethylbenzene	22	71-136	80-121	0.68	2	18541, 4632
Ethyl methacrylate	23	60-143	65-134	2.11	10	18551
Hexachlorobutadiene	37	43-159	55-143	0.42	2	18561
2-Hexanone	27	52-148	59-137	5.77	10	18571
Iodomethane	35	17-170	42-148	2.76	10	18591
Isobutyl alcohol	ID	ID	ID	ID	10	18601
Isopropyl ether	24	64-140	66-133	0.31	10	19281
Isopropylbenzene	25	68-140	77-124	0.53	2	18611
p-Isopropyltoluene	24	58-149	66-133	0.53	2	18621
Methyacrylonitrile	ID	ID	ID	ID	10	18641
Methyl ethyl ketone (MEK)	25	49-146	59-135	5.92	50	18131, 4640
Methyl isobutyl ketone (MIBK)	23	54-144	62-134	3.41	10	18671, 4641
Methylene chloride	23	59-141	63-131	0.53	10	18681, 4637
Methyl methacrylate	ID	ID	ID	ID	10	18661
Methyl-tert-butyl ether (MTBE)	24	59-138	68-127	0.29	2	19241
Naphthalene	54	29-179	48-164	0.56	5	18691
Pentachloroethane	ID	ID	ID	ID	2	18701
Propionitrile	ID	ID	ID	ID	5	18731
n-Propylbenzene	22	68-139	74-126	0.55	2	18751
Styrene	25	66-137	79-122	0.48	2	18771
1,1,1,2-Tetrachloroethane	26	72-136	75-129	0.78	2	18781
1,1,2,2-Tetrachloroethane	25	56-146	65-133	0.64	2	18791
Tetrachloroethene	27	62-144	72-127	0.68	2	18801, 4645
Toluene	22	68-135	74-125	0.53	2	18811, 4642
1,2,3-Trichlorobenzene	52	35-166	76-120	0.74	2	18821
1,2,4-Trichlorobenzene	32	38-163	51-147	0.68	2	18831
1,1,1-Trichloroethane	25	64-149	71-130	0.45	2	18841, 4646
1,1,2-Trichloroethane	21	65-136	70-127	0.62	2	18851, 4652
Trichloroethene	24	61-147	72-128	0.51	2	18861, 4650
Trichlorofluoromethane	30	58-152	64-135	0.58	2	19121, 4647
1,2,3-Trichloropropane	23	52-141	64-129	0.61	2	18881
1,2,4-Trimethylbenzene	26	61-148	70-130	0.54	2	18891

Table 2-11 (continued)
Quality Assurance Objectives
Volatile Organic Compounds - Groundwater
(Method 5030B & 8260B)

Analyte	Matrix Precision %	Matrix Accuracy %	LCS Accuracy %	MDL µg/L	QL µg/L	LIMS Analyte Number
1,3,5-Trimethylbenzene	22	66-140	73-126	0.55	2	18901
Vinyl acetate	36	35-157	56-145	8.01	10	18911
Vinyl chloride	35	48-166	57-144	0.70	2	18921, 4655
m,p-Xylene	25	63-146	79-124	0.82	2	19051
o-Xylene	23	68-141	79-123	0.66	2	19041
Xylenes	23	66-142	80-122	(1)	2	18961, 4651

(1) See individual compounds

LCS = Laboratory Control Sample
MDL = Method Detection Limit (40 CFR 136, Appendix B Rev. 1.11)
QL = Quantitation Limit
LIMS Analyte Number = TAI -- Nashville Division's software designation for each specific analyte
ID = Insufficient Data
*Erratically poor behavior in acidified samples.

Matrix precision, matrix accuracy, and LCS accuracy are based on historical data.
Matrix precision and accuracy values are based on the low range of the analytical curve.

Table 2-12
Quality Assurance Objectives
Volatile Organic Compounds – Groundwater
(Methods 5030B & 8260B- 25ml Purge)

Analyte	Matrix Precision %	Matrix Accuracy %	LCS Accuracy %	MDL µg/L	QL µg/L	LIMS Analyte Number
Acetone	35	34-166	48-149	0.66	2.5	18002
Acrolein	43	16-172	45-149	1.87	2.5	18022
Acrylonitrile	25	47-148	57-140	0.46	2.5	18032
Benzene	20	68-136	74-123	0.06	0.5	18062
Bromobenzene	20	76-130	79-121	0.05	0.5	18092
Bromochloromethane	26	63-143	67-133	0.07	0.5	18102
Bromodichloromethane	27	68-141	72-129	0.04	0.5	19032
Bromoethane	ID	ID	ID	0.05	0.5	20942
Bromoform	30	54-139	60-133	0.09	0.5	18112
Bromomethane	37	33-166	45-154	0.14	0.5	18122
n-Butylbenzene	29	45-161	56-138	0.05	0.5	18142
sec-Butylbenzene	24	62-146	69-131	0.05	0.5	18152
tert-Butylbenzene	22	64-145	70-130	0.06	0.5	18162
Carbon disulfide	29	53-147	62-130	0.06	0.5	18172
Carbon tetrachloride	31	61-151	65-138	0.07	0.5	18182
Chlorobenzene	21	73-131	81-118	0.03	0.5	18192
Chloroethane	30	46-157	56-140	0.07	0.5	18202
*2-Chloroethyl vinyl ether**	20	71-137	69-128	0.17	2.5	18222
Chloroform	24	65-140	71-123	0.14	0.5	18232
1-Chlorohexane	ID	ID	ID	0.04	0.5	ID
Chloromethane	43	29-171	43-151	0.08	0.5	18242
2-Chlorotoluene	20	73-136	77-125	0.05	0.5	18272
4-Chlorotoluene	20	72-137	76-125	0.05	0.5	18282
Dibromochloromethane	27	68-138	72-130	0.06	0.5	18302
1,2-Dibromo-3-chloropropane	36	31-171	52-146	0.22	0.5	18292
1,2-Dibromoethane	36	58-145	70-130	0.05	0.5	18312
Dibromomethane	27	68-137	69-130	0.04	0.5	18322
1,2-Dichlorobenzene	21	66-139	73-127	0.05	0.5	18342
1,3-Dichlorobenzene	21	70-136	74-125	0.05	0.5	18352
1,4-Dichlorobenzene	21	68-138	73-126	0.06	0.5	18362
trans-1,4-Dichloro-2-butene	36	22-160	47-141	0.20	0.5	18332
Dichlorodifluoromethane	41	41-158	48-143	0.07	0.5	18372
1,1-Dichloroethane	27	61-147	67-130	0.07	0.5	18382
1,2-Dichloroethane	25	60-150	64-136	0.03	0.5	18392
1,1-Dichloroethene	24	60-145	67-128	0.08	0.5	18402
cis-1,2-Dichloroethene	25	61-150	71-130	0.06	0.5	18412
trans-1,2-Dichloroethene	21	65-145	69-129	0.03	0.5	18422
1,2-Dichloropropane	26	69-137	71-127	ID	0.5	18442
1,3-Dichloropropane	25	68-134	68-127	0.04	0.5	18452
2,2-Dichloropropane	41	10-172	32-146	0.12	0.5	18462
1,1-Dichloropropene	22	70-139	73-127	0.06	0.5	18482

Table 2-12 (continued)
Quality Assurance Objectives
Volatile Organic Compounds – Groundwater
(Methods 5030B & 8260B- 25ml Purge)

Analyte	Matrix Precision %	Matrix Accuracy %	LCS Accuracy %	MDL µg/L	QL µg/L	LIMS Analyte Number
cis-1,3-Dichloropropene	27	56-136	58-131	0.10	0.5	18492
trans-1,3-Dichloropropene	26	52-143	56-133	0.06	0.5	18502
2,3-Dichloro-1-propene	28	48-146	55-136	0.11	0.5	17692
Diethyl ether	27	58-142	66-131	0.15	2.5	18982
Ethylbenzene	22	71-136	80-121	0.04	0.5	18542
Ethyl methacrylate	23	60-143	65-134	0.23	2.5	18552
Hexachlorobutadiene	37	43-159	55-143	0.09	0.5	18562
2-Hexanone	27	52-148	59-137	0.34	2.5	18572
Iodomethane	35	17-170	42-148	0.21	0.5	18592
Isopropanol	ID	ID	ID	0.18	0.5	17682
Isopropyl ether	24	64-140	66-133	0.04	2.5	19282
Isopropylbenzene	25	68-140	77-124	0.06	0.5	18612
p-Isopropyltoluene	24	58-149	66-133	0.05	0.5	18622
Methyl ethyl ketone (MEK)	25	49-146	59-135	0.61	2.5	18132
Methyl isobutyl ketone (MIBK)	23	54-144	62-134	0.20	2.5	18672
Methylene chloride	23	59-141	63-131	0.49	2.5	18682
Methyl-tert-butyl ether (MTBE)	24	59-138	68-127	0.07	0.5	19242
Naphthalene	54	29-179	48-164	3.34	05	18692
n-Propylbenzene	22	68-139	74-126	0.05	0.5	18752
Styrene	25	66-137	79-122	0.02	0.5	18772
1,1,1,2-Tetrachloroethane	26	72-136	75-129	0.22	0.5	18782
1,1,2,2-Tetrachloroethane	25	56-146	65-133	0.11	0.5	18792
Tetrachloroethene	27	62-144	72-127	0.07	0.5	18802
Toluene	22	68-135	74-125	0.04	0.5	18812
1,2,3-Trichlorobenzene	52	35-166	76-120	0.11	0.5	18822
1,2,4-Trichlorobenzene	32	38-163	51-147	0.06	0.5	18832
1,1,1-Trichloroethane	25	64-149	71-130	0.08	0.5	18842
1,1,2-Trichloroethane	21	65-136	70-127	0.08	0.5	18852
Trichloroethene	24	61-147	72-128	0.13	0.5	18862
Trichlorofluoromethane	30	58-152	64-135	0.06	0.5	19122
1,2,3-Trichloropropane	23	52-141	64-129	0.08	0.5	18882
Trichlorotrifluoroethane	ID	ID	ID	0.09	0.5	18992
1,2,4-Trimethylbenzene	26	61-148	70-130	0.06	0.5	18892
1,3,5-Trimethylbenzene	22	66-140	73-126	0.05	0.5	18902
Vinyl acetate	36	35-157	56-145	0.38	0.5	18912
Vinyl chloride	35	48-166	57-144	0.08	0.5	18922
m,p-Xylene	25	63-146	79-124	0.07	0.5	19052
o-Xylene	23	68-141	79-123	0.05	0.5	19042
Xylenes	23	66-142	80-122	(1)	0.5	18962

(1) See individual compounds
Italicized compounds are only available upon special request by this method.
LCS = Laboratory Control Sample
MDL = Method Detection Limit (40 CFR 136, Appendix B Rev. 1.11)
QL = Quantitation Limit
ID = Insufficient Data
LIMS Analyte Number = TAI -- Nashville Division's software designation for each specific analyte
*Erratically poor behavior in acidified samples.
Matrix precision, matrix accuracy, and LCS accuracy are based on historical data.
Matrix precision and accuracy values are based on the low range of the analytical curve.

Table 2-13
Quality Assurance Objectives
Volatile Organic Compounds – Soils
(Method 5035 & 8260B For Sediments, Soils, Hazardous Wastes)

Analyte	Matrix Precision %	Matrix Accuracy %	LCS Accuracy %	MDL µg/kg	QL µg/kg	LIMS Analyte Number
Acetone	49	18-153	53-143	7.46	50	18006
Acetonitrile	ID	ID	ID	ID	2	18016
Acrolein	66	10-155	50-147	ID	10	18026
Acrylonitrile	45	21-149	61-145	4.16	10	18036
Allyl chloride	ID	ID	ID	ID	10	18056
Benzene	37	45-135	77-124	0.29	2	18066
Bromobenzene	45	26-135	73-125	0.46	2	18096
Bromochloromethane	36	43-142	76-133	0.45	2	18106
Bromodichloromethane	35	37-137	74-126	0.28	2	19036
Bromoform	36	20-139	68-128	0.71	2	18116
Bromomethane	39	24-147	56-135	0.83	2	18126
n-Butyl alcohol	ID	ID	ID	ID	10	ID
tert-Butyl alcohol	ID	ID	ID	ID	100	ID
n-Butylbenzene	53	11-143	57-138	0.48	2	18146
sec-Butylbenzene	54	19-142	70-128	0.42	2	18156
tert-Butylbenzene	50	24-142	74-127	0.35	2	18166
Carbon disulfide	42	35-143	70-131	0.36	2	18176
Carbon tetrachloride	44	35-143	70-130	0.33	2	18186
Chlorobenzene	42	33-133	77-119	0.35	2	18196
Chloroethane	46	42-151	70-138	0.60	2	18206
*2-Chloroethyl vinyl ether**	30	23-148	66-132	1.49	10	18226
Chloroform	35	42-135	76-121	0.31	2	18236
1-Chlorohexane	ID	ID	ID	ID	10	ID
Chloromethane	40	29-151	55-139	0.57	2	18246
Chloroprene	ID	ID	ID	ID	10	ID
2-Chlorotoluene	45	23-139	72-126	0.40	2	18276
4-Chlorotoluene	47	19-139	69-128	0.60	2	18286
Dibromochloromethane	37	30-138	75-123	0.39	2	18306
1,2-Dibromo-3-chloropropane	45	11-141	61-131	0.79	2	18296
1,2-Dibromoethane	36	29-138	76-124	0.72	2	18316
Dibromomethane	38	36-135	74-124	0.67	2	18326
1,2-Dichlorobenzene	48	13-144	68-133	0.44	2	18346
1,3-Dichlorobenzene	50	13-144	64-135	0.46	2	18356
1,4-Dichlorobenzene	52	12-142	62-133	0.55	2	18366
cis-1,4-Dichloro-2-butene	ID	ID	ID	ID	10	ID
trans-1,4-Dichloro-2-butene	43	12-135	49-144	0.60	2	18336
Dichlorodifluoromethane	47	23-150	54-139	0.52	2	18376
1,1-Dichloroethane	36	50-135	78-125	0.40	2	18386
1,2-Dichloroethane	35	37-135	70-126	0.39	2	18396
1,1-Dichloroethene	42	43-142	75-129	0.53	2	18406
cis-1,2-Dichloroethene	37	44-137	79-123	0.35	2	18416

Table 2-13 (continued)

Quality Assurance Objectives
Volatile Organic Compounds – Soils
(Method 5035 & 8260B For Sediments, Soils, Hazardous Wastes)

Analyte	Matrix Precision %	Matrix Accuracy %	LCS Accuracy %	MDL µg/kg	QL µg/kg	LIMS Analyte Number
trans-1,2-Dichloroethene	41	43-136	76-124	0.41	2	18426
1,2-Dichloropropane	34	45-134	77-125	0.37	2	18446
1,3-Dichloropropane	36	34-137	75-124	0.28	2	18456
2,2-Dichloropropane	37	42-134	66-132	0.90	2	18466
1,1-Dichloropropene	40	39-141	79-125	0.34	2	18486
cis-1,3-Dichloropropene	37	32-140	77-127	0.54	2	18496
trans-1,3-Dichloropropene	37	26-137	71-124	0.31	2	18506
2,3-Dichloro-1-propene	38	40-135	65-131	0.47	2	17696
Diethyl ether	33	39-142	71-135	0.79	10	18986
1,4-Dioxane	ID	ID	ID	ID	5	18526
Ethylbenzene	45	34-133	77-118	0.37	2	18546
Ethyl methacrylate	56	14-149	74-129	2.06	10	18556
Hexachlorobutadiene	61	10-149	57-141	0.63	2	18566
2-Hexanone	40	16-148	62-139	4.39	10	18576
Iodomethane	41	34-161	64-160	4.12	10	18596
Isobutyl alcohol	ID	ID	ID	ID	10	18606
Isopropyl ether	34	44-140	61-121	0.32	10	19286
Isopropylbenzene	46	27-139	76-123	0.44	2	18616
p-Isopropyltoluene	56	16-143	67-130	0.46	2	18626
Methacrylonitrile	ID	ID	ID	ID	2	18646
Methyl ethyl ketone	44	24-148	63-144	5.03	50	18136
Methyl isobutyl ketone	36	24-146	69-134	2.83	10	18676
Methyl methacrylate	ID	ID	ID	ID	2	18666
Methylene chloride	34	33-151	62-142	1.09	10	18686
Methyl-tert-butyl ether	35	38-142	52-126	0.42	2	19246
Naphthalene	52	10-150	57-144	2.19	5	18696
Pentachloroethane	ID	ID	ID	ID	2	18706
Propionitrile	ID	ID	ID	ID	2	18736
n-Propylbenzene	51	22-140	73-126	0.31	2	18756
Styrene	45	24-137	75-123	0.46	2	18776
1,1,1,2-Tetrachloroethane	40	37-137	77-124	0.80	2	18786
1,1,2,2-Tetrachloroethane	37	25-139	68-134	0.88	2	18796
Tetrachloroethene	50	28-141	75-123	0.40	2	18806
Toluene	40	32-139	76-120	0.36	2	18816
1,2,3-Trichlorobenzene	56	10-146	48-148	0.64	2	18826
1,2,4-Trichlorobenzene	57	10-149	41-154	0.70	2	18836
1,1,1-Trichloroethane	37	46-136	77-123	0.34	2	18846
1,1,2-Trichloroethane	37	33-137	76-123	0.53	2	18856
Trichloroethene	40	33-142	72-125	0.57	2	18866
Trichlorofluoromethane	42	37-145	69-131	0.45	2	19126
1,2,3-Trichloropropane	38	23-138	66-137	0.35	2	18886
1,2,4-Trimethylbenzene	51	20-139	66-131	0.30	2	18896
1,3,5-Trimethylbenzene	50	22-139	71-126	0.43	2	18906
Vinyl acetate	74	10-172	68-142	2.82	10	18916
Vinyl chloride	41	35-155	67-138	0.37	2	18926
M,p-Xylene	47	34-134	75-119	0.82	2	19056

Table 2-13 (continued)

Quality Assurance Objectives
Volatile Organic Compounds – Soils
(Method 5035 & 8260B For Sediments, Soils, Hazardous Wastes)

Analyte	Matrix Precision %	Matrix Accuracy %	LCS Accuracy %	MDL µg/kg	QL µg/kg	LIMS Analyte Number
o-Xylene	44	36-134	77-120	0.50	2	19046
Xylenes	47	30-135	76-119	ID	2	18966

Itallicized compounds are only available upon special request by this method.
LCS = Laboratory Control Sample
MDL = Method Detection Limit (40 CFR 136, Appendix B Rev. 1.11)
QL = Quantitation Limit
LIMS Analyte Number = TAI -- Nashville Division's software designation for each specific analyte
ID = Insufficient Data
*Erratically poor behavior in acidified samples.

Matrix precision, matrix accuracy, and LCS accuracy are based on historical data.
Matrix precision and accuracy values are based on the low range of the analytical curve.

Table 2-14

Quality Assurance Objectives
Semi-Volatile Organic Compounds – Groundwater
(Method 3510C & 8270C)

Analyte	Matrix Precision %	Matrix Accuracy %	LCS Accuracy %	MDL µg/L	QL µg/L	LIMS Analyte Number
Acenaphthene	39	30-109	35-116	0.80	10	15000, 6018
Acenaphthylene	ID	ID	38-115	0.87	10	15010
Acetophenone	ID	ID	ID	ID	10	15020
2-Acetylaminofluorene	ID	ID	ID	ID	50	15040
4-Aminobiphenyl	ID	ID	ID	ID	50	15070
Aniline	ID	ID	32-103	1.20	10	15090, 6029
Anthracene	ID	ID	42-112	0.75	10	15110, 6014
Aramite	ID	ID	ID	ID	10	15120
Benzidine	ID	ID	10-76	2.63	50	15150
Benzoic acid	ID	ID	22-109	5.17	50	15160
Benzo(a)anthracene	ID	ID	38-121	1.05	10	15180, 6019
Benzo(a)pyrene	ID	ID	38-126	1.13	10	15190, 6024
Benzo(b)fluoranthene	ID	ID	30-122	1.19	10	15200, 6021
Benzo(g,h,i)perylene	ID	ID	14-150	1.87	10	15210, 6025
Benzo(k)fluoranthene	ID	ID	37-133	1.11	10	15220, 6022
Benzyl alcohol	ID	ID	ID	1.87	50	16960
Bis(2-chloroethoxy) methane	ID	ID	34-111	0.85	10	15370
Bis(2-chloroethyl) ether	ID	ID	30-115	0.83	10	15380
Bis(2-chloroisopropyl) ether	ID	ID	32-111	0.77	10	15390
Bis(2-ethylhexyl) phthalate	ID	ID	35-129	1.63	10	16660
4-Bromophenylphenyl ether	ID	ID	38-119	0.84	10	15230
Butyl benzyl phthalate	ID	ID	38-126	1.15	10	15250
Carbazole	ID	ID	39-114	0.95	10	15290
4-Chloro-3-methylphenol	39	35-119	38-117	0.87	10	15330
4-Chloroaniline	ID	ID	34-113	1.47	10	15340
2-Chloronaphthalene	ID	ID	35-114	0.82	10	15420
2-Chlorophenol	40	33-115	31-114	1.07	10	15430
4-Chlorophenylphenyl ether	ID	ID	38-115	1.03	10	15440
Chrysene	ID	ID	38-122	1.05	10	15450, 6023
Dibenzofuran	ID	ID	39-115	0.82	10	15520
Dibenzo(a,h)anthracene	ID	ID	20-140	1.62	10	15540, 6027
1,2-Dichlorobenzene	ID	ID	34-114	0.85	10	15570, 4681
1,3-Dichlorobenzene	ID	ID	34-114	0.84	10	15580
1,4-Dichlorobenzene	40	31-103	33-111	0.91	10	15590
3,3'-Dichlorobenzidine	ID	ID	29-132	2.50	10	15600
2,4-Dichlorophenol	ID	ID	34-116	1.21	10	15620
2,6-Dichlorophenol	ID	ID	ID	ID	50	15630
Diethyl phthalate	ID	ID	39-119	1.02	10	15660
p-Dimethylaminoazobenzene	ID	ID	ID	ID	50	15700

Table 2-14 (continued)
Quality Assurance Objectives
Semi-Volatile Organic Compounds – Groundwater
(Method 3510C & 8270C)

Analyte	Matrix Precision %	Matrix Accuracy %	LCS Accuracy %	MDL µg/L	QL µg/L	LIMS Analyte Number
7,12-Dimethylbenz(a)anthra-cene	ID	ID	ID	ID	50	15720
a,a-Dimethylphenethylamine	ID	ID	ID	ID	10	15750
2,4-Dimethylphenol	ID	ID	23-106	2.40	10	15730, 6032
Dimethyl phthalate	ID	ID	40-116	1.36	10	15740
Di-n-butyl phthalate	ID	ID	39-122	0.96	10	15760
1,3-Dinitrobenzene	ID	ID	ID	ID	50	ID
4,6-Dinitro-2-methylphenol	ID	ID	33-132	2.50	25	15770
2,4-Dinitrophenol	ID	ID	28-128	2.15	25	15810
2,4-Dinitrotoluene	37	41-123	42-129	0.99	10	15820
2,6-Dinitrotoluene	ID	ID	39-127	0.87	10	15830
Di-n-octyl phthalate	ID	ID	27-143	4.32	10	15840
Diphenylamine	ID	ID	ID	ID	50	15860
1,2-Diphenylhydrazine	ID	ID	35-120	1.03	10	15880
Ethyl methanesulfonate	ID	ID	ID	ID	50	ID
Fluoranthene	ID	ID	41-119	1.05	10	15920, 6020
Fluorene	ID	ID	38-117	0.93	10	15930, 6015
Hexachlorobenzene	ID	ID	38-123	0.91	10	15950
Hexachlorobutadiene	ID	ID	33-127	1.16	10	15970
Hexachlorocyclopentadiene	ID	ID	17-135	2.23	10	15980
Hexachloroethane	ID	ID	32-114	4.61	10	15990
Hexachlorophene	ID	ID	ID	ID	10	16000
Hexachloropropene	ID	ID	ID	ID	50	16010
Indeno(1,2,3-c,d)pyrene	ID	ID	19-136	1.82	10	16030, 6026
Isophorone	ID	ID	35-118	0.78	10	16050
Isosafrole	ID	ID	ID	ID	50	16060
Methapyrilene	ID	ID	ID	ID	50	16080
3-Methylcholanthrene	ID	ID	ID	ID	50	16100
Methyl methanesulfonate	ID	ID	ID	ID	50	ID
1-Methylnaphthalene	ID	ID	ID	ID	10	17030, 1854
2-Methylnaphthalene	ID	ID	35-122	0.77	10	16130, 1859
2-Methylphenol	ID	ID	32-112	0.76	10	16140, 4666, 6034
3,4-Methylphenol	ID	ID	31-114	4.76	10	16160, 4676, 6033
Naphthalene	ID	ID	34-112	0.79	10	16170, 6035
1,4-Naphthoquinone	ID	ID	ID	ID	50	16180
1-Naphthylamine	ID	ID	ID	ID	50	16200
2-Naphthylamine	ID	ID	ID	ID	50	16190
2-Nitroaniline	ID	ID	38-120	0.92	25	16230
3-Nitroaniline	ID	ID	39-122	1.39	25	16240
4-Nitroaniline	ID	ID	39-120	0.94	25	16250
Nitrobenzene	ID	ID	34-113	1.80	10	16260
5-Nitro-o-toluidine	ID	ID	ID	ID	50	16290
2-Nitrophenol	ID	ID	34-120	1.41	10	16300
4-Nitrophenol	42	25-139	36-133	1.91	25	16310
Nitroquinoline-1-oxide	ID	ID	ID	ID	10	16320
N-nitrosodiethylamine	ID	ID	ID	ID	50	16340

Table 2-14 (continued)
Quality Assurance Objectives
Semi-Volatile Organic Compounds – Groundwater
(Method 3510C & 8270C)

Analyte	Matrix Precision %	Matrix Accuracy %	LCS Accuracy %	MDL µg/L	QL µg/L	LIMS Analyte Number
N-nitroso-dimethylamine	ID	ID	25-114	1.00	10	16370
N-nitroso-di-n-propylamine	41	32-117	34-114	0.79	10	16350
N-nitroso-diphenylamine	ID	ID	39-118	0.87	10	16360
N-nitrosomethylethylamine	ID	ID	ID	ID	50	16380
N-nitrosomorpholine	ID	ID	ID	ID	10	16390
N-nitrosopiperdine	ID	ID	ID	ID	50	16400
N-nitrosopyrrolidine	ID	ID	ID	ID	50	16410
Pentachlorobenzene	ID	ID	ID	ID	50	16450
Pentachloronitrobenzene	ID	ID	ID	ID	50	16470
Pentachlorophenol	41	36-129	35-123	2.09	25	16480, 6036
Phenacetin	ID	ID	ID	ID	50	16490
Phenanthrene	ID	ID	40-116	0.94	10	16500, 6016
Phenol	41	20-115	31-114	1.04	10	16510, 4661
1,4-Phenylenediamine	ID	ID	ID	ID	10	16520
2-Picoline	ID	ID	ID	ID	10	16550
Pronamide	ID	ID	ID	ID	50	16570
Pyrene	37	26-102	36-121	0.95	10	16590, 6017
Pyridine	ID	ID	24-113	0.88	10	16600
Safrole	ID	ID	ID	ID	50	16620
1,2,4,5-Tetrachlorobenzene	ID	ID	ID	ID	50	16650
2,3,4,6-Tetrachlorobenzene	ID	ID	ID	ID	50	ID
o-Toluidine	ID	ID	ID	ID	50	16720
1,2,4-Trichlorobenzene	42	32-114	33-117	0.92	10	16730
2,4,5-Trichlorophenol	ID	ID	39-109	1.04	25	16750
2,4,6-Trichlorophenol	ID	ID	36-118	1.76	10	16760
1,3,5-Trinitrobenzene	ID	ID	ID	ID	50	16800
Cresols, TCLP	45	18-115	33-104	5.52	10	4660
1,4-Dichlorobenzene, TCLP	50	24-111	36-109	0.91	10	4665
2,4-Dinitrotoluene, TCLP	45	27-128	39-119	0.99	10	4670
Hexachlorobenzene, TCLP	45	15-94	22-90	0.91	10	4675
Hexachlorobutadiene, TCLP	55	22-123	40-117	1.16	10	4680
Hexachloroethane, TCLP	55	22-112	31-116	4.61	10	4685
Nitrobenzene, TCLP	46	29-113	38-107	1.80	10	4690
Pentachlorophenol, TCLP	49	27-125	35-115	2.09	10	4695
Pyridine, TCLP	74	10-129	28-120	0.88	10	4700
2,4,5-Trichlorophenol, TCLP	49	28-122	40-111	1.04	10	4705
2,4,6-Trichlorophenol, TCLP	52	28-118	41-108	1.76	10	4710

Italicized compounds are only available upon special request by this method.
ID = Insufficient data
LCS = Laboratory Control Sample
MDL = Method Detection Limit (40 CFR 136, Appendix B Rev. 1.11)
QL = Quantitation Limit
LIMS Analyte Number = TAI -- Nashville Division's software designation for each specific analyte

Matrix precision, matrix accuracy, and LCS accuracy are based on historical data.
Matrix precision and accuracy values are based on the mid range of the analytical curve.

Table 2-15
Quality Assurance Objectives
Semi-Volatile Organic Compounds – Soil
(Method 3550B & 8270C For Sediments, Soils, Hazardous Wastes)

ANALYTE	Matrix Precision %	Matrix Accuracy %	LCS Accuracy %	MDL mg/kg	QL mg/kg	LIMS Analyte Number
Acenaphthene	41	22-105	48-113	0.05	0.333	15005
Acenaphthylene	ID	ID	49-115	0.05	0.333	15015
Acetophenone	ID	ID	ID	ID	0.333	15025
2-Acetylaminofluorene	ID	ID	ID	ID	1.70	15045
4-Aminobiphenyl	ID	ID	ID	ID	1.70	15075
Aniline	ID	ID	45-103	0.05	1.70	15095
Anthracene	ID	ID	51-115	0.05	0.333	15115
Aramite	ID	ID	ID	ID	0.333	15125
Benzidine	ID	ID	10-74	0.06	1.70	15155
Benzoic acid	ID	ID	26-117	0.19	1.70	15165
Benzo(a)anthracene	ID	ID	49-122	0.04	0.333	15185
Benzo(a)pyrene	ID	ID	47-128	0.05	0.333	15195
Benzo(b)fluoranthene	ID	ID	42-122	0.05	0.333	15205
Benzo(g,h,i)perylene	ID	ID	23-153	0.08	0.333	15215
Benzo(k)fluoranthene	ID	ID	48-132	0.05	0.333	15225
Benzyl alcohol	ID	ID	ID	ID	1.70	16955
Bis(2-chloroethoxy) methane	ID	ID	46-110	0.06	0.333	15375
Bis(2-chloroethyl) ether	ID	ID	42-115	0.05	0.333	15385
Bis(2-chloroisopropyl) ether	ID	ID	45-110	0.05	0.333	15395
Bis(2-ethylhexyl) phthalate	ID	ID	46-129	0.06	0.333	16665
4-Bromophenylphenyl ether	ID	ID	50-119	0.06	0.333	15235
Butyl benzyl phthalate	ID	ID	48-126	0.04	0.333	15255
Carbazole	ID	ID	50-114	0.05	0.333	15295
4-Chloro-3-methylphenol	41	29-116	50-118	0.05	0.333	15335
4-Chloroaniline	ID	ID	45-114	0.05	0.333	15345
2-Chloronaphthalene	ID	ID	48-114	0.05	0.333	15425
2-Chlorophenol	43	27-103	48-110	0.05	0.333	15435
4-Chlorophenylphenyl ether	ID	ID	48-117	0.05	0.333	15445
Chrysene	ID	ID	49-124	0.05	0.333	15455
Dibenzofuran	ID	ID	50-115	0.05	0.333	15525
Dibenz(a,h)anthracene	ID	ID	29-143	0.06	0.333	15545
1,2-Dichlorobenzene	ID	ID	47-114	0.05	0.333	15575
1,3-Dichlorobenzene	ID	ID	49-113	0.05	0.333	15585
1,4-Dichlorobenzene	43	22-96	47-111	0.04	0.333	15595
3,3'-Dichlorobenzidine	ID	ID	53-132	0.08	0.333	15605
2,4-Dichlorophenol	ID	ID	47-116	0.05	0.333	15625
2,6-Dichlorophenol	ID	ID	ID	ID	1.70	15635
Diethyl phthalate	ID	ID	50-119	0.05	0.333	15665
p-Dimethylaminoazobenzene	ID	ID	ID	ID	1.70	15705

Table 2-15 (continued)
Quality Assurance Objectives
Semi-Volatile Organic Compounds – Soil
(Method 3550B & 8270C For Sediments, Soils, Hazardous Wastes)

ANALYTE	Matrix Precision %	Matrix Accuracy %	LCS Accuracy %	MDL mg/kg	QL mg/kg	LIMS Analyte Number
7,12-Dimethylbenz(a)anthra-cene	ID	ID	ID	ID	1.70	15725
a,a-Dimethylphenethylamine	ID	ID	ID	ID	0.333	15755
2,4-Dimethylphenol	ID	ID	34-107	0.05	0.333	15735
Dimethyl phthalate	ID	ID	50-117	0.05	0.333	15745
Di-n-butyl phthalate	ID	ID	51-121	0.05	0.333	15765
1,3-Dinitrobenzene	ID	ID	ID	ID	1.70	15785
4,6-Dinitro-2-methylphenol	ID	ID	42-138	0.06	0.830	15775
2,4-Dinitrophenol	ID	ID	29-140	0.06	0.830	15815
2,4-Dinitrotoluene	44	29-121	52-132	0.05	0.333	15825
2,6-Dinitrotoluene	ID	ID	50-129	0.05	0.333	15835
Di-n-octyl phthalate	ID	ID	40-141	0.05	0.333	15845
Diphenylamine	ID	ID	ID	ID	1.70	15865
1,2-Diphenylhydrazine	ID	ID	45-122	0.04	0.333	15885
Ethyl methanesulfonate	ID	ID	ID	ID	1.70	16965
Fluoranthene	ID	ID	52-118	0.05	0.333	15925
Fluorene	ID	ID	48-116	0.05	0.333	15935
Hexachlorobenzene	ID	ID	51-123	0.04	0.333	15955
Hexachlorobutadiene	ID	ID	47-130	0.05	0.333	15975
Hexachlorocyclopentadiene	ID	ID	33-137	0.03	0.333	15985
Hexachloroethane	ID	ID	45-116	0.04	0.333	15995
Hexachlorophene	ID	ID	ID	ID	0.333	16005
Hexachloropropene	ID	ID	ID	ID	1.70	16085
Indeno(1,2,3-c,d)pyrene	ID	ID	27-141	0.06	0.333	16035
Isophorone	ID	ID	48-119	0.05	0.333	16055
Isosafrole	ID	ID	ID	ID	1.70	16085
Methapyrilene	ID	ID	ID	ID	1.70	16085
3-Methylcholanthrene	ID	ID	ID	ID	1.70	16105
Methyl methanesulfonate	ID	ID	ID	ID	1.70	ID
1-Methylnaphthalene	ID	ID	ID	ID	0.333	17035, 1361
2-Methylnaphthalene	ID	ID	44-125	0.05	0.333	16135, 1371
2-Methylphenol	ID	ID	47-110	0.04	0.333	16145
3,4-Methylphenol	ID	ID	46-110	0.05	0.333	16165
Naphthalene	ID	ID	46-114	0.05	0.333	16175
1,4-Naphthoquinone	ID	ID	ID	ID	1.70	16185
1-Naphthylamine	ID	ID	ID	ID	1.70	16205
2-Naphthylamine	ID	ID	ID	ID	1.70	16195
2-Nitroaniline	ID	ID	50-121	0.04	0.830	16235
3-Nitroaniline	ID	ID	49-125	0.05	0.830	16245
4-Nitroaniline	ID	ID	48-123	0.05	0.830	16255
Nitrobenzene	ID	ID	48-113	0.05	0.333	16265
5-Nitro-o-toluidine	ID	ID	ID	ID	1.70	16295
2-Nitrophenol	ID	ID	47-120	0.04	0.333	16305
4-Nitrophenol	42	33-125	46-136	0.04	0.830	16315
Nitroquinoline-1-oxide	ID	ID	ID	ID	0.333	16325

Table 2-15 (continued)
Quality Assurance Objectives
Semi-Volatile Organic Compounds – Soil
(Method 3550B & 8270C For Sediments, Soils, Hazardous Wastes)

ANALYTE	Matrix Precision %	Matrix Accuracy %	LCS Accuracy %	MDL mg/kg	QL mg/kg	LIMS Analyte Number
N-nitrosodiethylamine	ID	ID	ID	ID	1.70	ID
N-nitrosodimethylamine	ID	ID	34-118	0.05	0.333	16375
N-nitroso-di-n-propylamine	42	23-110	45-115	0.05	0.333	16355
N-nitroso-diphenylamine	ID	ID	50-117	0.05	0.333	16365
N-nitrosomethylethylamine	ID	ID	ID	ID	1.70	16345
N-nitrosomorpholine	ID	ID	ID	ID	0.333	16395
N-nitrosopiperdine	ID	ID	ID	ID	1.70	16405
N-nitrosopyrrolidine	ID	ID	ID	ID	1.70	ID
Pentachlorobenzene	ID	ID	ID	ID	1.70	16455
Pentachloronitrobenzene	ID	ID	ID	ID	0.333	16475
Pentachlorophenol	46	28-126	45-127	0.03	0.830	16485
Phenacetin	ID	ID	ID	ID	1.70	16495
Phenanthrene	ID	ID	51-115	0.05	0.333	16505
Phenol	42	26-97	46-113	0.05	0.333	16515
1,4-Phenylenediamine	ID	ID	ID	ID	0.333	16525
2-Picoline	ID	ID	ID	ID	0.333	16555
Pronamide	ID	ID	ID	ID	1.70	16575
Pyrene	42	19-100	47-121	0.05	0.333	16595
Pyridine	ID	ID	31-118	0.04	0.333	16605
Safrole	ID	ID	ID	ID	1.70	16625
1,2,4,5-Tetrachlorobenzene	ID	ID	ID	ID	1.70	16655
2,3,4,6-Tetrachlorobenzene	ID	ID	ID	ID	1.70	ID
o-Toluidine	ID	ID	ID	ID	1.70	ID
1,2,4-Trichlorobenzene	45	20-111	47-117	0.05	0.333	16735
2,4,5-Trichlorophenol	ID	ID	51-119	0.05	0.830	16755
2,4,6-Trichlorophenol	ID	ID	48-119	0.04	0.333	16765
1,3,5-Trinitrobenzene	ID	ID	ID	ID	1.70	16805

Italicized compounds are only available upon special request by this method.
LCS = Laboratory Control Sample
MDL = Method Detection Limit (40 CFR 136, Appendix B Rev. 1.11)
QL = Quantitation Limit
LIMS Analyte Number = TAI -- Nashville Division's software designation for each specific analyte
ID = Insufficient Data
Matrix precision, matrix accuracy, and LCS accuracy are based on historical data.
Matrix precision and accuracy values are based on the middle range of the analytical curve.

Table 2-16
Quality Assurance Objectives
TAL Inorganics – Groundwater
(Method 3010A & 6010B
Method 3015 6010B For TCLP Extracts)

Analyte	Matrix Precision %	Matrix Accuracy %	LCS Accuracy %	MDL µg/L	QL µg/L	LIMS Analyte Number
Aluminum	20	75-125	80-120	28.1	50	3500, 4515, 3300, 3409, 3501
Antimony	20	75-125	80-120	4.0	6	3510, 3514, 4605, 3410, 3511
Arsenic	20	75-125	80-120	3.6	5	3520, 3524, 4500, 3313, 3400
Barium	20	75-125	80-120	0.5	10	3530, 3534, 4510, 3301, 3401
Beryllium	20	75-125	80-120	0.3	4	3540, 3544, 4511, 3411
Boron	20	75-125	80-120	2.0	50	3770, 4572, 3427
Cadmium	20	75-125	80-120	0.5	1	3550, 3554, 4520, 3302
Calcium	20	75-125	80-120	3.6	1000	3560, 4602, 3303, 3412
Chromium	20	75-125	80-120	0.7	5	3570, 3574, 4530, 3304, 3403, 3432
Cobalt	20	75-125	80-120	2.9	20	3590, 4531, 3415
Copper	20	75-125	80-120	3.3	10	3600, 3604, 4540, 3305, 3407
Iron	20	75-125	80-120	28.8	50	3610, 3614, 4551, 3416
Lead	20	75-125	80-120	1.5	3	3620, 3624, 4550, 3306, 3404
Lithium	20	75-125	80-120	0.5	50	3810, 4607, 3429
Magnesium	20	75-125	80-120	8.0	1000	3630, 4594, 3307, 3417
Manganese	20	75-125	80-120	0.3	15	3640, 3644, 4595, 3418
Molybdenum	20	75-125	80-120	1.4	50	3660, 3664, 4604, 3419
Nickel	20	75-125	80-120	3.2	10	3670, 3674, 4570, 3408
Potassium	20	75-125	80-120	147.1	1000	3680, 4573, 3309, 3420
Selenium	20	75-125	80-120	3.4	5	3690, 3694, 4580, 3314, 3405
Silver	20	75-125	80-120	0.9	5	3700, 3704, 4590, 3310, 3406
Sodium	20	75-125	80-120	168	1000	3710, 4517, 3311, 3421
Strontium	20	75-125	80-120	0.1	50	3800, 4536, 3414
Thallium	20	75-125	80-120	2.1	2	3720, 3724, 4521, 3422
Tin	20	75-125	80-120	4.6	50	3730, 4603, 3423
Titanium	20	75-125	80-120	0.5	50	3760, 3426
Vanadium	20	75-125	80-120	1.4	20	3740, 3744, 4596, 4606, 3424
Zinc	20	75-125	80-120	1.3	20	3750, 3754, 4600, 3312, 3425

LCS = Laboratory Control Sample
MDL = Method Detection Limit (40 CFR 136, Appendix B Rev. 1.11)
QL = Quantitation Limit
LIMS Analyte Number = TAI -- Nashville Division's software designation for each specific analyte
Shaded cells show QC limits specified by the method.
Matrix precision and accuracy values are based on the low range of the analytical curve.

Table 2-17
Quality Assurance Objectives
TAL Inorganics – Soils
(Method 3051 & 6010B For Sediments, Soils, Hazardous Wastes)

Analyte	Matrix Precision %	Matrix Accuracy %	LCS Accuracy %	MDL mg/kg	QL mg/kg	LIMS Analyte Number
Aluminum	20	75-125	80-120	2.04	10.0	4000
Antimony	20	75-125	80-120	1.28	10.0	4010
Arsenic	20	75-125	80-120	0.89	1.0	4020
Barium	20	75-125	80-120	0.23	1.0	4030
Beryllium	20	75-125	80-120	0.22	1.0	4040
Boron	20	75-125	80-120	0.21	10.0	4260
Cadmium	20	75-125	80-120	0.22	1.0	4050
Calcium	20	75-125	80-120	3.67	10.0	4060
Chromium	20	75-125	80-120	0.28	1.0	4070
Cobalt	20	75-125	80-120	0.22	1.0	4080
Copper	20	75-125	80-120	0.22	1.0	4090
Iron	20	75-125	80-120	7.04	10.0	4100
Lead	20	75-125	80-120	0.95	1.0	4110
Lithium	20	75-125	80-120	0.22	10.0	4300
Magnesium	20	75-125	80-120	4.18	10.0	4120
Manganese	20	75-125	80-120	0.21	1.0	4130
Molybdenum	20	75-125	80-120	0.31	1.0	4150
Nickel	20	75-125	80-120	0.25	1.0	4160
Potassium	20	75-125	80-120	6.87	10.0	4170
Selenium	20	75-125	80-120	0.92	1.0	4180
Silver	20	75-125	80-120	0.19	1.0	4190
Sodium	20	75-125	80-120	8.83	10.0	4200
Strontium	20	75-125	80-120	0.72	1.0	4290
Thallium	20	75-125	80-120	0.57	1.0	4210
Tin	20	75-125	80-120	0.73	10.0	4220
Titanium	20	75-125	80-120	0.75	1.0	4250
Vanadium	20	75-125	80-120	0.19	10.0	4230
Zinc	20	75-125	80-120	0.23	10.0	4240

LCS = Laboratory Control Sample
MDL = Method Detection Limit (40 CFR 136, Appendix B Rev. 1.11)
QL = Quantitation Limit
LIMS Analyte Number = TAI -- Nashville Division's software designation for each specific analyte

Shaded cells show QC limits specified by the method.

Matrix precision and accuracy values are based on the low range of the analytical curve.

Table 2-18

Quality Assurance Objectives
Herbicides - Groundwater
(Method 8151A)

Analyte	Matrix Precision %	Matrix Accuracy %	LCS Accuracy %	Col.Set 1 MDL µg/L	Col.Set 2 MDL µg/L	QL µg/L	LIMS Analyte Number
Acifluorfen	ID	ID	ID	0.109	ID	5	ID
Bentazon	ID	ID	ID	0.271	ID	5	ID
Chloramben	ID	ID	ID	0.157	ID	5	ID
2,4-D	34	37-138	45-129	0.238	0.08	5	21000, 4720
Dalapon	81	10-124	10-144	1.039	0.91	10	21030
2,4-DB	35	19-148	28-142	0.292	1.86	5	21040
DCPA	ID	ID	ID	0.130	ID	5	ID
3,5-Dichlorobenzoic acid	ID	ID	ID	0.313	ID	5	ID
Dicamba	44	39-145	36-133	0.173	0.14	0.5	21050
Dichloroprop	29	36-132	44-123	0.174	0.13	5	21060
Dinoseb	58	10-127	12-128	0.097	0.11	3	21070
MCPA	30	33-138	38-135	25	15.5	500	21080
MCPP	32	36-137	38-136	27	20.9	500	21090
4-Nitrophenol	39	37-139	40-135	0.277	ID	1	21240
Pentachlorophenol	30	25-140	37-130	0.225	0.96	1	21230
Picloram	58	12-132	20-120	0.271	ID	1	22790
2,4,5-T	41	35-137	41-133	0.292	0.08	0.5	21010
2,4,5-TP (Silvex)	37	40-129	47-120	0.133	0.07	0.5	21020, 4750

Italicized compounds are available only upon special request by this method.
LCS = Laboratory Control Sample
MDL = Method Detection Limit (40 CFR 136, Appendix B Rev. 1.11)
QL = Quantitation Limit
ID = Insufficient Data
LIMS Analyte Number = TAI -- Nashville Division's software designation for each specific analyte
Matrix precision, matrix accuracy, and LCS accuracy are based on historical data.
Matrix precision and accuracy values are based on the middle range of the analytical curve

Table 2-19

Quality Assurance Objectives
Herbicides - Soils
(Method 8151A For Sediments, Soils, Hazardous Wastes)

Analyte	Matrix Precision %	Matrix Accuracy %	LCS Accuracy %	Col.Set 2 MDL µg/kg	QL µg/kg	LIMS Analyte Number
Acifluorfen	ID	ID	ID	ID	167	ID
Bentazon	ID	ID	ID	ID	167	ID
Chloramben	ID	ID	ID	ID	167	ID
2,4-D	57	14-120	35-123	7.8	167	21005
Dalapon	95	10-102	10-112	20.8	333	21035
2,4-DB	67	17-123	35-120	26.2	167	21045
DCPA	ID	ID	ID	ID	167	ID
Dicamba	71	10-115	32-116	9.69	17	21055
3,5-Dichlorobenzoic acid	ID	ID	ID	ID	167	ID
Dichloroprop	65	17-111	34-110	9.8	167	21065
Dinoseb	84	10-100	10-110	11.3	83	21075
MCPA	67	14-116	33-117	1039	1670	21085
MCPP	57	16-136	36-132	1021	1670	21095
4-Nitrophenol	74	10-125	10-124	ID	33	21245
Pentachlorophenol	54	10-102	36-101	10.1	33	21235
Picloram	70	10-138	10-130	ID	33	22795
2,4,5-T	59	10-103	22-108	4.58	17	21015
2,4,5-TP (Silvex)	62	12-107	29-112	5.2	17	21025

Italicized compounds are available only upon special request by this method.
LCS = Laboratory Control Sample
MDL = Method Detection Limit (40 CFR 136, Appendix B Rev. 1.11)
QL = Quantitation Limit
ID = Insufficient Data
LIMS Analyte Number = TAI -- Nashville Division's software designation for each specific analyte

Matrix precision, matrix accuracy, and LCS accuracy are based on historical data.
Matrix precision and accuracy values are based on the middle range of the analytical curve.

Table 2-20

Quality Assurance Objectives
Pesticides (Organochlorinated) & PCB's - Groundwaters
(Method 3510C, 8081A and 8082)

Analyte	Matrix Precision %	Matrix Accuracy %	LCS Accuracy %	Col.Set 1 MDL µg/L	Col.Set 2 MDL µg/L	QL µg/L	LIMS Analyte Number
8081A							
Alachlor	ID	ID	ID	ID	ID	0.10	22660
Aldrin	40	48-137	57-133	0.024	0.018	0.05	21500
a-BHC			54-137	0.031	0.014	0.05	21580
g-BHC (Lindane)	37	51-138	55-136	0.033	0.021	0.05	21610, 4735
b-BHC	ID	ID	56-136	0.018	0.017	0.05	21590
d-BHC	ID	ID	48-140	0.024	0.019	0.05	21600
a-Chlordane	ID	ID	59-132	0.025	0.018	0.05	21820, 4715
g-Chlordane	ID	ID	60-133	0.028	0.016	0.05	21830
4,4'-DDD	ID	ID	53-143	0.034	0.027	0.10	21630
4,4'-DDE	ID	ID	59-134	0.036	0.017	0.10	21640
4,4'-DDT	37	43-146	53-141	0.032	0.032	0.10	21650
Dieldrin	37	53-141	58-138	0.021	0.018	0.10	21660
Endosulfan I	ID	ID	57-137	0.022	0.017	0.05	21670
Endosulfan II	ID	ID	59-135	0.019	0.017	0.10	21680
Endosulfan sulfate	ID	ID	57-132	0.023	0.019	0.10	21690
Endrin	38	52-142	56-139	0.019	0.019	0.10	21700, 4725
Endrin aldehyde			56-131	0.033	0.045	0.10	21710
Endrin ketone			60-134	0.021	0.021	0.10	21720
Heptachlor	40	50-137	57-134	0.022	0.021	0.05	21730, 4730
Heptachlor epoxide	ID	ID	59-131	0.042	0.027	0.05	21740, 4755
Hexachloro-benzene	ID	ID	47-154	0.021	0.014	0.05	21750
Methoxychlor	ID	ID	49-142	ID	ID	0.10	21760, 4740
Mirex	ID	ID	ID	ID	ID	0.10	
Permethrin	ID	ID	ID	ID	ID	0.10	22740
Propachlor	ID	ID	ID	ID	ID	0.10	21280
Toxaphene	ID	ID	ID	ID	ID	5	21770, 4745
Trifluralin	ID	ID	ID	ID	ID	0.10	22610

Table 2-20 (continued)

Quality Assurance Objectives
Pesticides (Organochlorinated) & PCB's - Groundwaters
(Method 3510C, 8081A and 8082)

Analyte	Matrix Precision %	Matrix Accuracy %	LCS Accuracy %	Col.Set 1 MDL µg/L	Col.Set 2 MDL µg/L	QL µg/L	LIMS Analyte Number
8082							
PCB 1016	ID	ID	65-145	0.260	0.172	0.5	21510, 21900, 6040
PCB 1221	ID	ID	ID	0.688	0.739	1.0	21520, 21910, 6050
PCB 1232	ID	ID	ID	0.235	0.292	0.5	21530, 21920, 6060
PCB 1242	ID	ID	ID	0.277	0.345	0.5	21540, 21930, 6070
PCB 1248	ID	ID	ID	0.145	0.207	0.5	21550, 21940, 6080
PCB 1254	ID	ID	ID	0.228	0.241	0.5	21560, 21950, 6090
PCB 1260	ID	ID	60-149	0.148	0.178	0.5	21570, 21960
PCB 1262	ID	ID	ID	0.106	0.155		ID
PCB 1268	ID	ID	ID	0.671	0.709	1.0	ID

Italicized compounds are only available upon special request by this method.
LCS = Laboratory Control Sample
MDL = Method Detection Limit (40 CFR 136, Appendix B Rev. 1.11)
QL = Quantitation Limit
LIMS Analyte Number = TAI -- Nashville Division's software designation for each specific analyte
ID = Insufficient Data
Matrix precision, matrix accuracy, and LCS accuracy are based on historical data.
Matrix precision and accuracy values are based on the middle range of the analytical curve.

Table 2-21
Quality Assurance Objectives
Pesticides (Organochlorinated) PCB's – Soils
(Method 3550B, 8081A, and 8082 For Sediments, Soils, Hazardous Wastes)

ANALYTE	Matrix Precision %	Matrix Accuracy %	LCS Accuracy %	Col.Set 1 MDL µg/kg	Col.Set 2 MDL µg/kg	QL µg/kg	LIMS Analyte Number
8081A							
Alachlor	ID	ID	ID	ID	ID	3.33	22665
Aldrin	42	41-148	65-134	0.82	0.89	1.67	21505
a-BHC	ID	ID	60-136	0.86	0.68	1.67	21585
b-BHC	ID	ID	65-135	1.19	0.74	1.67	21595
d-BHC	ID	ID	55-137	0.82	0.66	1.67	21605
g-BHC (Lindane)	41	45-139	63-134	0.77	0.63	1.67	21615
a-Chlordane	ID	ID	69-133	0.71	1.35	1.67	21825
g-Chlordane	ID	ID	71-133	0.59	1.20	1.67	21835
4,4'-DDD	ID	ID	59-145	1.29	1.33	3.33	21635
4,4'-DDE	ID	ID	63-140	1.36	0.73	3.33	21645
4,4'-DDT	42	42-150	61-138	1.16	0.86	3.33	21655
Dieldrin	40	44-147	63-141	0.82	1.40	3.33	21665
Endosulfan I	ID	ID	68-136	0.90	1.28	1.67	21675
Endosulfan II	ID	ID	71-133	0.90	0.92	3.33	21685
Endosulfan sulfate	ID	ID	65-136	1.36	0.70	3.33	21695
Endrin	40	46-151	65-140	1.12	1.61	3.33	21705
Endrin aldehyde	ID	ID	65-137	0.90	1.21	3.33	21715
Endrin ketone	ID	ID	67-138	0.94	0.63	3.33	21725
Heptachlor	33	49-142	65-136	0.62	0.59	1.67	21735
Heptachlor epoxide	ID	ID	67-135	0.64	1.46	1.67	21745
Hexachloro-benzene	ID	ID	58-142	0.71	0.77	1.67	21755
Methoxychlor	ID	ID	58-145	1.24	1.02	16.7	21765
Mirex	ID	ID	ID	ID	ID	1.67	
Permethrin	ID	ID	ID	ID	ID	3.33	22745
Propachlor	ID	ID	ID	ID	ID	3.33	21285
Toxaphene	ID	ID	77-146	ID	ID	166.7	21775
Trifluralin	ID	ID	ID	ID	ID	3.33	22615

Table 2-21 (continued)
Quality Assurance Objectives
Pesticides (Organochlorinated) PCB's – Soils
(Method 3550B, 8081A, and 8082 For Sediments, Soils, Hazardous Wastes)

ANALYTE	Matrix Precision %	Matrix Accuracy %	LCS Accuracy %	Col.Set 1 MDL µg/kg	Col.Set 2 MDL µg/kg	QL µg/kg	LIMS Analyte Number
8082							
PCB 1016	ID	ID	73-162	8.83	9.28	33.3	21515, 21905
PCB 1221	ID	ID	ID	12.0	18.0	66.7	21525
PCB 1232	ID	ID	ID	14.5	7.68	33.3	21535
PCB 1242	ID	ID	ID	9.34	4.43	33.3	21545
PCB 1248	ID	ID	ID	6.91	9.34	33.3	21555, 21945
PCB 1254	ID	ID	ID	7.38	4.54	33.3	21565
PCB 1260	ID	ID	58-169	9.14	13.7	33.3	21575, 21965
PCB 1262	ID	ID	ID	13.8	5.65	33.3	ID
PCB 1268	ID	ID	ID	4.24	5.91	33.3	ID

Italicized compounds are only available upon special request by this method.
LCS = Laboratory Control Sample
MDL = Method Detection Limit (40 CFR 136, Appendix B Rev. 1.11)
QL = Quantitation Limit
LIMS Analyte Number = TAI -- Nashville Division's software designation for each specific analyte
ID = Insufficient Data
Matrix precision, matrix accuracy, and LCS accuracy are based on historical data.
Matrix precision and accuracy values are based on the middle range of the analytical curve.

Table 2-22
Quality Assurance Objectives
Pesticides (Organophosphates) – Groundwater
(Method 3510C & 8141A)

Analyte	Matrix Precision %	Matrix Accuracy %	LCS Accuracy %	RTXOP MDL µg/L	RTX5 MDL µg/L	QL µg/L	LIMS Analyte Number
Atrazine	ID	ID	ID	ID	ID	10	ID
Bolstar	ID	ID	24-174	0.57	0.42	1	22010
Coumaphos	ID	ID	39-177	0.38	0.29	1	22030
Demeton	ID	ID	25-164	1.11	1.28	2	22040, 22050
Diazinon	ID	ID	54-164	0.54	0.39	1	22060
Dichlorvos	ID	ID	52-164	2.21	1.84	5	22070
Dimethoate	50	31-142	29-149	1.75	1.29	2	22670
Disulfoton	ID	ID	38-162	0.36	0.37	1	22080
Dursban;Chlorpyrifos	ID	ID	50-170	0.44	1.18	2	22020
EPN	44	45-187	47-174	0.47	0.40	1	22680
Ethoprop			52-159	0.48	0.45	2	22090
Ethyl parathion	49	57-154	50-163	0.53	0.51	1	22710
Fensulfothion	ID	ID	20-164	1.19	1.17	2	2h2100
Fenthion	ID	ID	51-164	0.49	1.18	2	22110
Guthion; Azinphos-methyl	ID	ID	52-169	0.52	0.50	1	22000
Malathion	34	62-159	58-160	0.42	0.42	1	22690
Merphos	ID	ID	44-185	0.32	0.43	1	22120
Methylparathion	ID	ID	67-156	0.44	0.52	2	22150
Mevinphos	ID	ID	31-149	2.08	1.97	5	22130
Naled	ID	ID	ID	2.84	2.93	10	22140
Phorate	ID	ID	45-154	0.34	0.47	2	22160
Ronnel	ID	ID	57-166	0.48	0.42	1	22170
Simazine	ID	ID	ID	ID	ID	1	21140
Stirofos	ID	ID	43-176	0.72	0.63	1	22180
Sulfotepp	39	34-153	27-161	0.45	0.64	2	22720
Tokuthion	ID	ID	51-164	0.54	0.43	1	22190
Trichloronate	ID	ID	54-164	0.61	0.65	1	22200

Italicized compounds are only available upon special request by this method.
ID = Insufficient data
LCS = Laboratory Control Sample
MDL = Method Detection Limit (40 CFR 136, Appendix B Rev. 1.11)
QL = Quantitation Limit
LIMS Analyte Number = TAI -- Nashville Division's software designation for each specific analyte
Matrix precision, matrix accuracy, and LCS accuracy are based on historical data.
Matrix precision and accuracy values are based on the middle range of the analytical curve.

Table 2-23

Quality Assurance Objectives
Pesticides (Organochlorophosphates) – Soils
(Method 3540C or 3550B & 8141A For Sediments, Soils, Hazardous Wastes)

Analyte	Matrix Precision %	Matrix Accuracy %	LCS Accuracy %	RTXOP MDL µg/kg	RTX5 MDL µg/kg	QL µg/kg	LIMS Analyte Number
Atrazine	ID	ID	ID			100	21105
Bolstar	ID	ID	31-177	45.3	54.3	100	22015
Coumaphos	ID	ID	51-176	47.5	45.7	100	22035
Demeton	ID	ID	28-177 27-175	53.1	44.3	100	22045, 22055
Diazinon	ID	ID	63-158	51.2	43.6	100	22065
Dichlorvos	ID	ID	62-163	75.8	58.6	100	22075
Dimethoate	ID	26-153	20-156	59.8	29.5	100	22675
Disulfoton	ID	ID	51-164	46.4	59.7	100	22085
Dursban; Chlorpyrifos	ID	ID	50-169	43	160	200	22025
EPN	58	32-179	51-167	50.3	52.3	100	22685
Ethoprop	ID	ID	60-159	42.8	45.2	100	22095
Ethyl parathion	44	40-179	54-169	30.5	30.1	100	22715
Fensulfothion	ID	ID	35-173	58.6	49.5	100	22105
Fenthion	ID	ID	54-163	62.9	160	200	22115
Guthion; Azinphos-methyl	ID	ID	50-171	63.5	31.5	100	22005
Malathion	45	46-167	53-167	44.8	29.1	100	22695
Merphos	ID	ID	39-186	58.0	59.6	100	22125
Methylparathion	ID	ID	54-169	38.3	79.9	100	22155
Mevinphos	ID	ID	47-150	61.2	43.1	100	22135
Naled	ID	ID	46-179	96.4	69.0	200	22145
Phorate	ID	ID	36-169	58.6	81.6	100	22165
Ronnel	ID	ID	66-167	79.6	45.2	100	22175
Simazine	ID	ID	ID	ID	ID	200	21145
Stirofos	ID	ID	52-176	78.1	39.0	100	22185
Sulfotepp	43	40-151	37-155	39.0	44.3	200	22725
Tokuthion	ID	ID	65-158	45.8	47.6	100	22195
Trichloronate	ID	ID	60-164	51.8	70.2	100	22205

Italicized compounds are only available upon special request by this method.
LCS = Laboratory Control Sample
MDL = Method Detection Limit (40 CFR 136, Appendix B Rev. 1.11)
QL = Quantitation Limit
LIMS Analyte Number = TAI -- Nashville Division's software designation for each specific analyte
ID = Insufficient Data
Matrix precision, matrix accuracy, and LCS accuracy are based on historical data.
Matrix precision and accuracy values are based on the middle range of the analytical curve.

Table 2-24
Quality Assurance Objectives
Miscellaneous Methods For Surface Waters, Wastewaters (CWA/Standard Methods)
and For Groundwaters, Sediments, Soils, Hazardous Wastes (SW-846/ASTM)

Miscellaneous Methods Parameter	CWA/ STD.MTD Method	SW-846/ ASTM Method	Matrix	Matrix Precision %	Matrix Accuracy %	LCS Accuracy %	MDL mg/L (Water) mg/kg (Soil)	QL mg/L (Water) mg/kg (Soil)	LIMS Analyte Number
Chloride (Cl^-)	325.2	9251	Water	20		90-110	0.56	1.0	7440
	300	9056	Water	20	90-110 N	90-110	0.43	1.0	7441
		9056	Soil	20	90-110 N	90-110	1.47	10	8131
Mercury (Hg)	245.1		Water	20	85-115	85-115	0.000121	0.0002	3150
		7470A	Water			90-110	0.000118	0.0002	3650,4560,4562
	245.5		Soil			85-115	0.033	0.10	4140
		7471A	Soil			80-120	0.033	0.10	
Nitrate (NO_3^{-2})	353.2		Water	20		90-110	0.010	0.10	7050
	300	9056	Water	20	90-110 N	90-110	0.04	0.1	7051
		9056	Soil	20	90-110 N	90-110	0.79	1.0	8151
Nitrate + Nitrite (NO_3^{-2} + NO_2^-)	353.2		Water	20		90-110		0.10	7055
	300	9056	Water	20	90-110 N	90-110		0.1	
		9056	Soil	20	90-110 N	90-110		1.0	
Nitrite (NO_2^-)	353.2		Water	20		90-110	0.011	0.10	7060
	300	9056	Water	20	90-110 N	90-110	0.06	0.1	7061
		9056	Soil	20	90-110 N	90-110	0.35	1.0	8141
Phenolics; Total Phenols	420.2M[8], 420.4[5]	9066M[8]	Water	20	90-110 N	90-110	0.002, 0.008	0.005, 0.05	7220, 7221
		9066M[8]	Soil	20	90-110 N	90-110	0.166	0.5	8060
Sulfate (SO_4^{-2})	375.4	9038	Water	20		90-110	0.072	1.0	7080
	300	9056	Water	20	90-110 N	90-110	0.46	1.0	7081
		9056	Soil	20	90-110 N	90-110	0.76	10	8161

[1]M=modified for midi-distillation with Lachat procedure
[2]M=modified by using Hach reagents
[3]colonies/100 mls
[4]and 335.2 (CLP-M) distillation.
[5]75-125% for pre-digestion spike; 85-115% for post-digestion spike.
[6]M=modified by not distilling
[7]Default values until sufficient historical data is available.
[8]For Total Phenolics: 420.2 for CWA and 420.4 for SDWA; M=modified for midi-distillation with Lachat procedure
CWA = Clean Water Act
SDWA = Safe Drinking Water Act

Table 2-24 (continued)
Quality Assurance Objectives
Miscellaneous Methods For Surface Waters, Wastewaters (CWA/Standard Methods)
and For Groundwaters, Sediments, Soils, Hazardous Wastes (SW-846/ASTM)

SM = Standard Methods number from Standard Methods for the Examination of Water and Wastewater, 18th Edition
SW-846 = Resource Conservation and Recovery Act methods manual
LCS = Laboratory Control Sample
MDL = Method Detection Limit (40 CFR 136, Appendix B Rev. 1.11)
QL = Quantitation Limit
LIMS Analyte Number = TAI -- Nashville Division's software designation for each specific analyte
MfS = Modified for Soil
NA = Not applicable
N = NELAC requirement
Shaded cells show QC limits specified by the method.
Matrix precision and accuracy values are based on the mid-level range of the analytical curve; however, cyanide is based on the low and mid-level range.

Table 2-25
Quality Assurance Objectives
Surrogate Recovery Ranges

Method	Matrix	Compound	Range	LIMS Analyte Numberf
8081A		Tetrachloro-m-xylene	46-127	33305
		Decachlorobiphenyl	33-163	33316
8081A		Tetrachloro-m-xylene	10-159	33300
		Decachlorobiphenyl	10-136	33311
8082	SED, S, HW	Decachlorobiphenyl	10-157	33312
		Tetrachloro-m-xylene	23-156	33306
8082	GW	Decachlorobiphenyl	10-117	33310
		Tetrachloro-m-xylene	10-164	33301
8141A	SED, S, HW	Bromo-2-Nitrobenzene	39-128	33275
8141A	GW	Bromo-2-Nitrobenzene	32-143	33270
8151A	SED, S, HW	Dichloroacetic Acid	20-140	33325
8151A	GW	Dichloroacetic Acid	10-158	33320
8260B	SED, S, HW	1,2-Dichloroethane-d4	56-143	33106
		Toluene-d8	75-141	33116
		4-Bromofluorobenzene	70-131	33126
		Dibromofluoromethane	76-136	33136
8260B	GW	1,2-Dichloroethane-d4	68-143	33101
		Toluene-d8	78-127	33111
		4-Bromofluorobenzene	73-127	33121
		Dibromofluoromethane	76-135	33131
8270C	SED, S, HW	Nitrobenzene-d5	26-110	33205
		2-Fluorobiphenyl	28-112	33215
		Terphenyl-d14	40-124	33225
		Phenol-d5	29-121	33235
		2-Fluorophenol	20-113	33245
		Tribromophenol	29-144	33255
8270C	GW	Nitrobenzene-d5	20-118	33200
		2-Fluorobiphenyl	18-116	33210
		Terphenyl-d14	10-119	33220
		Phenol-d5	10-69	33230
		2-Fluorophenol	10-148	33240
		Tribromophenol	17-155	33250

Table 4-1
Sample Containers, Preservatives, and Holding Times for Groundwater Samples
Long-Term Monitoring
CAFB, Clovis, New Mexico

Parameters	Container	Preservation	Maximum Holding Times[1]	
			Extraction	Analysis
TAL Metals	1-16oz polyethylene bottle	pH<2, HNO_3 Cool to 4°C	---	180d
VOCs	3-40 ml glass vials	pH<2, HCL Cool to 4°C	---	14d
SVOCs	1-L amber organic glass	Cool to 4°C	7d	40d
Mercury	1-16oz polyethylene bottle	pH<2, HNO_3 Cool to 4°C		28d
Herbicides	1-L amber organic glass	Cool to 4°C	7d	40d
Organochlorine Pesticides	1-L amber organic glass	Cool to 4°C	7d	40d
PCBs	1-L amber organic glass	Cool to 4°C	7d	40d
Organophosphate Pesticides	1-L amber organic glass	Cool to 4°C	7d	40d
Sulfate	1-L polyethylene	Cool to 4°C	---	28d
Nitrate				48 hr
Chloride				28d
Phenol	1-L organic glass	pH < 2; H_2SO_4 , Cool to 4°C	---	28d

Notes
[1] Holding time begins at time of collection
TAL = target analyte list
d = day
hr = hour

Table 6-1
Analytical Methods

Parameter	MCAWW Method	SW-846 Method
VOCs	NA	SW 8260B
SVOCs	NA	SW 8270C
Organochlorine Pesticides	NA	SW 8081A
Organophosphate Pesticides	NA	SW 8141
PCBs	NA	SW 8082
Chlorinated Herbicides	NA	SW 8151A
TAL Metals and Mercury	NA	SW 6010B/7470A
Chloride	EPA 300.0	NA
Sulfate	EPA 300.0	NA
Nitrate	EPA 300.0	NA
Phenols	EPA 420.1	NA

App. = Appendix
MCAWW = Methods for Chemical Analysis of Water and Wastes
NA = not applicable
PCBs = polychlorinated biphenyls
SVOCs = semi-volatile organic compounds
VOCs = volatile organic compounds

FINAL REVISED LONG-TERM MONITORING WORK PLAN
SITE SAFETY AND HEALTH PLAN

LANDFILL NO. 25 (SWMU 97)

LANDFILL NO. 03 (SWMU 105)

LANDFILL NO. 04 (SWMU 104)

CONTRACT NO. DACA45-99-D-0017

DELIVERY ORDER NO. 10

Prepared For

Cannon Air Force Base

Air Combat Command

Clovis, New Mexico

Prepared By

BHATE Environmental Associates, Inc.

Birmingham, Alabama

Under Contract To

U. S. Army Corps of Engineers

Omaha, Nebraska

July 2002

FINAL REVISED LONG-TERM MONITORING WORK PLAN
SITE SAFETY AND HEALTH PLAN

LANDFILL NO. 25 (SWMU 97)

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BHATE Environmental Associates, Inc.

Birmingham, Alabama

for Richard L. Burdine, P.G.
Project Manager

Judith McBride, CIH
Certified Industrial Hygienist

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FIGURE

FIGURE 1 — **HOSPITAL ROUTE**

APPENDICES

APPENDIX A — **HAZARD TASK ANALYSIS FORMS AND GENERAL SAFETY RULES FOR CONTRACTORS**

1.0 INTRODUCTION

This Site Safety and Health Plan (SSHP) describes the site-specific health and safety requirements, which are to be followed for the WP for CAFB in Clovis, New Mexico. BHATE has prepared this document for CAFB under an ID/IQ contract with the USACE, Omaha District (Contract No. DACA45-99-D-0017).

The SSHP provides site-specific field activities and health and safety requirements applicable to field operations and is based upon and references a BHASP completed for CAFB by Foster Wheeler Environmental Corporation (Foster Wheeler, January 2000). Bhate will enforce the requirements of all of the project health and safety plans for site personnel. BHATE and subcontractor personnel are required to comply with the requirements of all project health and safety plans and the OSHA standards contained in Title 29 of the CFR 1910 and 1926. Subcontractors will also be responsible for site safety related to or affected by their operations (e.g., drill rig safety and construction safety).

2.0 TRAINING

The SSHP and the BHASP will be provided to all personnel before initiating field operations. The BHATE designated Site Safety Health Officer (SSHO), responsible to BHATE's CIH, will be continually on site to implement and enforce the health and safety procedures outlined in the SSHP during all site operations. The SSHO will issue a copy of both plans to all personnel, and will review all applicable information to ensure worker understanding of the measures employed to guard health and safety.

The BHATE CIH, experienced in hazardous waste site operations, will be responsible for the implementation and oversight of the project health and safety program as presented in this SSHP. This SSHP will be signed and dated by the BHATE CIH and SSHO/PM prior to commencing any field activities. Before work area entry, all site personnel and visitors must attend a general safety and health briefing session, to be conducted by the SSHO. The briefing will cover potential site hazards and specific requirements of the SSHP.

3.0 SITE HISTORY

Detailed information is provided in the Site Location and History Section (Section 2.0) of the FSP. Therefore, the information will not be presented again here.

4.0 SCOPE OF WORK

Detailed information is provided on the project scope of work in Section 3.0 of the FSP. Therefore, the information will not be presented again here.

4.1 PROJECT PERSONNEL

A list of personnel participating in the field project is presented below. Medical and training certificates for all identified project personnel will be maintained at the Bhate office with a copy of each in a site field folder.

Bhate Project Health and Safety Manager:	Judith McBride, CIH (205) 918-4000
Bhate Project/Program Manager:	Richard Burdine, P.G. (877) 849-0513 (Office) (850) 585-7813 (Cellular phone)
Site Safety and Health Officer:	Jerry Pelfrey (205) 918-4000
USACE Project Manager:	Tom Zink (402) 221-7666

5.0 SITE CHEMICALS OF CONCERN

Health and safety information for the contaminants known to be present are summarized below and on the applicable material safety data sheet located in the Appendix of the BHASP (Foster Wheeler, February 2000). The following constituents are known to have been detected in some concentration above the method detection limits in the groundwater in areas LF-03, LF-04 and LF-25.

Constituent	Detected Concentration
Carbon tetrachloride	1.6µg/l
Toluene	6.8 µg/l
Arsenic	0.022 mg/l
Barium	0.064 mg/l
Copper	0.0059 mg/l
Selenium	0.0068 mg/l
Tin	0.32 mg/l
Vanadium	0.019 mg/l
Zinc	0.013 mg/l

6.0 HAZARD ASSESSMENT

Hazards associated with the work activities include safety around heavy machinery, heat stress, safety from indigenous life (i.e. snakes) and physical safety hazards in the form of fallen trees, branches, briars, debris piles and uneven terrain are present at the job site. Care should be taken when working in the area. These hazards are discussed in detail beginning in Section 4.0 of the BHASP (Foster Wheeler, February 2000) (Appendix III B). The Hazard Task Analysis (HTA) forms are included as an Appendix to this SSHP. BHATE and all its subcontractors will adhere to the General Safety Rules for contractors which is also presented as an Appendix to this SSHP.

7.0 ENVIRONMENTAL MONITORING

7.1 CONTAMINATED AIRBORNE DUST

No contaminants have been detected in the soils of the site; hence, contaminated airborne dust is not expected to be of concern. As a preventative measure, site personnel will monitor the breathing zone of sample collection personnel during sample collection tasks with an organic vapor analyzer equipped with a flame ionization detector.

7.2 NOISE

During the use of heavy equipment or work near a potential noise hazard(s), site personnel will use appropriate hearing protection.

8.0 PERSONAL PROTECTIVE EQUIPMENT

8.1 RESPIRATORY PROTECTION

If VOC vapor concentrations in the breathing zone exceed the 5% of the ambient background value, all site personnel in the exclusion zone shall cease work and allow conditions to stabilize for a period of 10 minutes. If after restarting work, vapor concentrations again exceed the 5% value, all workers will move to Level D modified or Level C PPE. The SSHO may require greater levels of respiratory protection.

8.2 NON-RESPIRATORY PROTECTION

At a minimum, non-respiratory PPE will consist of Tyvek coveralls, neoprene steel-toe/shank boots, and chemical-resistant gloves. If wet/free product conditions are encountered and contact/splash hazards exist, Saranex coveralls and chemical/splash goggles will be worn.

9.0 DECONTAMINATION CONTROL MEASURES

A detailed discussion of decontamination control measures including site organization and control, decontamination procedures, medical emergencies, and first aid, is presented in Section 9.0 of the BHASP (Foster Wheeler, February 2000).

10.0 EMERGENCY CONTACTS

Emergency contact numbers shall be conspicuously posted on site for easy access by all personnel.

Emergency Telephone Numbers	
Fire Department (Base)	(505) 784-2578
Off-Site Emergency Services	911
On-Site Emergency Services	475-1117
Ambulance Service	911 or 784-4033
Police	911 or 784-4111
Ambulance (Base)	(505) 784-4033 or 911
Base Hospital	(505) 432-6866
Plains Regional Medical Center 2100 North Dr. Martin Luther King Jr. Blvd Clovis, NM 88101	(505) 763-1511

Information and Response Organizations	
CHEM TREC	1-800-424-9300
Poison Control Center (National)	1-800-432-6866
Poison Control Center (New Mexico)	1-800-432-8802
Toxic Substances Control Act Hotline	(202) 554-1404
National Response Center	1-800-424-8802
Resource Conservation and Recovery Act Hotline	1-800-424-9346

11.0 HOSPITAL DIRECTIONS

Personnel should be transported to the Plains Regional Medical Center ((505) 769-2141) in the event of an emergency. Directions to the hospital are described below and a Hospital Route Map is included as Figure 1.

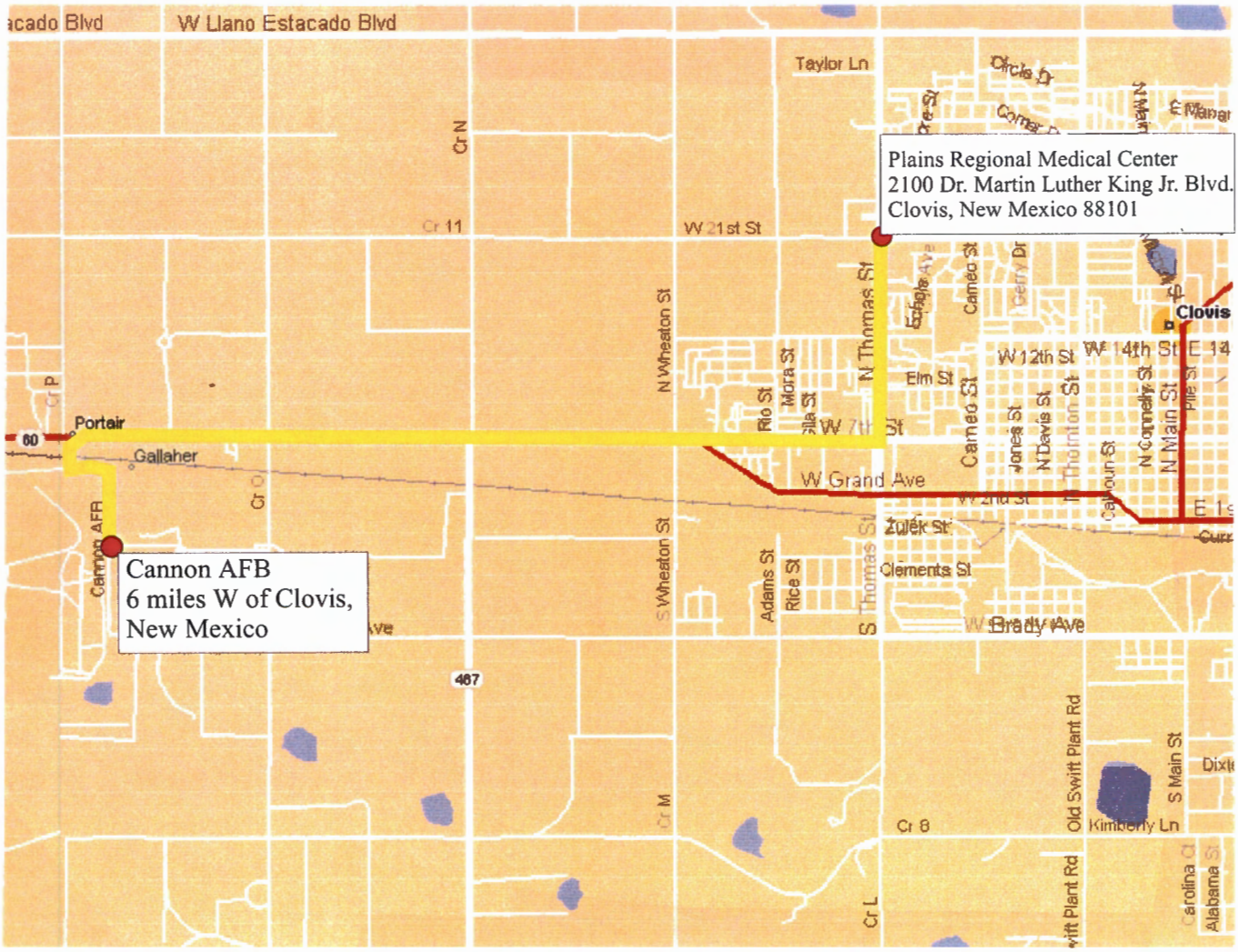
1. Go EAST on US Highway 60/84 for approximately 4 miles
2. Turn LEFT on 2100 N Dr Martin Luther King Jr Blvd (formerly North Thomas Street) for approximately 1 mile.

12.0 REFERENCES

Foster Wheeler Environmental Corporation, *Basewide Health and Safety Plan Cannon Air Force Base,* February 2000

USACE, Omaha District, *General Chemistry Supplement to the Scope of Services for Studies*, January 2000

Figure



BHATE	HOSPITAL ROUTE MAP CANNON AFB TO PLAINS REGIONAL MEDICAL CENTER				Figure 1 Cannon AFB Clovis, New Mexico
	PROJECT NO. 9010304	SCALE AS SHOWN	DATE 3/28/01	DRAWN BY: – DRAWING NO: fig1	

Appendix A
Hazard Task Analysis Forms and General Safety Rules for Contractors

CANNON AIR FORCE BASE, MONITORING WELL INSTALLATION AND LONG-TERM MONITORING – HAZARD TASK ANALYSES

TASK/ACTIVITY: Mobilization/Demobilization	PREPARED BY/DATE: Jeffrey Kogut, April 2001	
TASK DESCRIPTION	**Potential Hazard(s) & Controls**	**REQUIRED PPE:** Level D 6.4
Since mobilization/demobilization activities will occur without contact with contaminated materials.	Slips, Trips, Falls ..... 8.1 Heavy Equipment 8.13	• Hard Hat • Full-length Pants • Safety-toe Boots

EQUIPMENT TO BE USED	MONITORING REQUIREMENTS	PROJECT/TASK SPECIFIC REQUIREMENTS	TRAINING/MEDICAL MONITORING REQUIREMENTS
Site Support Vehicles Truck-Mounted Drilling Rig	Noise Exposure ..... 8.29 Heat Stress Monitoring 8.6	General Site Safety Rules for Contractors	Section 5.0

CANNON AIR FORCE BASE, MONITORING WELL INSTALLATION AND LONG-TERM MONITORING – HAZARD TASK ANALYSES

TASK/ACTIVITY: Groundwater Sample Collection	PREPARED BY/DATE: Jeffrey Kogut, April 2001	
TASK DESCRIPTION	**POTENTIAL HAZARD(S) & CONTROLS**	**REQUIRED PPE:** Modified Level D..... 6.4
Collection of groundwater samples presents the potential for skin contact with contaminated water and the inhalation of fine mists through mucous membranes (eyes, nasal passages). This will be controlled by use of protective clothing and the monitoring of the breathing zone with a potable flame-ionization detector.	Slips, Trips, Falls..... 8.1 Splashes and Spills..... 8.2 **SEE MSDS FOR THE FOLLOWING:** PCBs Pesticides Volatile Organic Compounds Semi-volatile Organic Compounds Metals	• Hard Hat • Full-length Pants • Safety-toe Boots • Safety Glasses • Hearing Protection • Outer Prot. Gloves • Inner Prot. Gloves • Full-face Respirator (available for use) • Organic Vapor Cartridges (available for use)

EQUIPMENT TO BE USED	MONITORING REQUIREMENTS	PROJECT/TASK SPECIFIC REQUIREMENTS	TRAINING/MEDICAL MONITORING REQUIREMENTS
1. Excavation Equipment 2. Hand and Portable Power Tools 3. Sample Collection Equipment	Workspace ..... 6.1 Work Area..... 6.1 Noise..... 7.8 Heat Stress Monitoring..... 8.6	Site Control And Work Zones. 6.1 General Decon Procedures.... 9.0 Personnel Decontamination ... 9.1 Equipment Decontamination 9.2-9.3 Emergency Procedures..... 10.3	Section 5.0

CANNON AIR FORCE BASE, MONITORING WELL INSTALLATION AND LONG-TERM MONITORING – HAZARD TASK ANALYSES

TASK/ACTIVITY: Soil Boring Advancement and Soil Sample Collection Monitoring Well Installation	PREPARED BY/DATE: Jeffrey Kogut, April 2001

TASK DESCRIPTION	POTENTIAL HAZARD (S) & CONTROLS		REQUIRED PPE: Level D..... 6.4
Ground personnel will be subject to the physical hazards associated with moving heavy machinery, and potentially to hazardous noise levels. Generation of noxious vapors from subsurface sources is a possibility. Monitoring of breathing zone will be required during drilling and well construction activities since site contaminants may be released. Borings may encounter underground piping, electrical lines or other utilities, and facility diagrams shall be consulted during work planning to minimize this hazard. The work area shall be considered a controlled work area.	Slips, Trips, Falls..... 8.1 Heavy Equipment..... 8.13 Fall Protection..... 8.28 Power Tool Safety..... 8.4 Overhead Utilities..... 8.8 Buried Utilities..... 8.9	**SEE MSDS FOR THE FOLLOWING:** PCBs Pesticides Volatile Organic Compounds Semi-volatile Organic Compounds Metals	• Hard Hat • Full-length Pants • Safety-toe Boots • Safety Glasses • Hearing Protection • Full-face Respirator (available for use) • Organic Vapor Cartridges (available for use)

EQUIPMENT TO BE USED	MONITORING REQUIREMENTS	PROJECT/TASK SPECIFIC REQUIREMENTS	TRAINING/MEDICAL MONITORING REQUIREMENTS
1 Drilling Equipment 2. Hoisting and Rigging Equipment 3. Portable Hand and Power Tools 4. Steam Cleaner	Workspace..... 6.1 Work Area Boundary..... 6.1 Organic Vapors..... 7.2 Noise Exposure..... 7.8 Heat Stress..... 8.6	Site Control And Work Zones. 6.1 General Decontamination..... 9.0 Personnel Decontamination ... 9.1 Equipment Decontamination 9.2-9.3 Emergency Procedures..... 10.3	Section 5.0

CANNON AIR FORCE BASE, MONITORING WELL INSTALLATION AND LONG-TERM MONITORING – HAZARD TASK ANALYSES

TASK/ACTIVITY: **Monitoring Well Abandonment**			**PREPARED BY/DATE: Jeffrey Kogut, April 2001**
TASK DESCRIPTION	**POTENTIAL HAZARD (S) & CONTROLS**		**REQUIRED PPE:** Level D..... 6.4
Ground personnel will be subject to the physical hazards associated with moving heavy machinery and exposure to potentially hazardous noise levels. Generation of noxious/hazardous vapors from subsurface sources is a possibility.	Slips, Trips, Falls..... 8.1 Heavy Equipment Operations 8.13 Overhead Utilities..... 8.8 Buried Utilities..... 8.9 Power Tool Safety..... 8.15	**SEE MSDS FOR THE FOLLOWING:** PCBs Pesticides Volatile Organic Compounds Semi-volatile Organic Compounds Metals	• Hard Hat • Full-length Pants • Safety-toe Boots • Safety Glasses • Hearing Protection • Full-face Respirator (available for use) • Organic Vapor Cartridges (available for use)

EQUIPMENT TO BE USED	**MONITORING REQUIREMENTS**	**PROJECT/TASK SPECIFIC REQUIREMENTS**	**TRAINING/MEDICAL MONITORING REQUIREMENTS**
2 Drilling Equipment 2. Hoisting and Rigging Equipment 3. Portable Hand and Power Tools 4. Steam Cleaner	Workspace..... 6.1 Work Area Boundary..... 6.1 Organic Vapors..... 7.2 Noise..... 8.29 Heat Stress..... 8.6	Site Control And Work Zones. 6.1 General Decon Procedures.... 9.0 Personnel Decontamination ... 9.1 Equipment Decontamination 9.2-9.3 Emergency Procedures..... 10.3	Section 5.0

GENERAL SAFETY RULES FOR CONTRACTORS

Introduction

The rules and requirements contained in this attachment have been written for the guidance of Contractors who are performing work under contract with Bhate Environmental Associates, Inc. (Bhate). This booklet prescribes general requirements. Additional specific rules may be necessary to ensure the safety of workers on a particular job. The Contractor, working in collaboration with the Bhate representative, will be expected to establish such additional rules and procedures as may be necessary to conduct a safe operation and comply with all Bhate, regulatory, and insurance requirements and those of our clients. Bhate health and safety professionals are available to assist.

The term Contractor, as used in this attachment, shall be understood to include any and all persons, sole proprietorships, partnerships, corporations, or other business ventures under contract, oral or written, to Bhate.

Contractor is responsible for informing its subcontractors of these requirements, for directing and supervising work of subcontractors, and for assuring that its subcontractors adhere to the requirements herein. Bhate may request Contractor to provide proof of its subcontractor's adherence to all rules and regulations and will prohibit access to Bhate property or job sites or our client's property for those Contractors not in compliance.

In order to assist Contractor in following these instructions, a Bhate Representative will be assigned to the Contractor to act as Bhate's agent in all matters relative to work activities at Bhate facilities or job sites. Under no circumstances shall any work be started until the Bhate Representative has been contacted, a job orientation has been conducted by the Bhate Representative, and all permits, insurance, Bhate, client, and regulatory pre-job requirements met.

The Bhate Representative and the Bhate Health and Safety professionals are authorized to stop any work which they may consider hazardous to Bhate personnel or equipment or Contractor personnel. This authority may be delegated to appropriate individuals.

General Safety Rules and Requirements

Accident Reporting

All accidents (personal and property damage) shall be reported orally to the Bhate Representative as soon as emergency conditions no longer exist. A written report shall follow within 7 days after emergency conditions are resolved.

Alcohol, Firearms, etc.

Alcoholic beverages, illegal drugs or narcotics, or guns and ammunition are not permitted on Bhate property or job sites. Personnel under the influence of alcohol or drugs shall not be allowed on Bhate property or job sites.

Approvals

The Contractor shall be required to obtain pertinent work permits or authorization and approval from the Bhate Representative before:

- Working on existing pipelines or equipment
- Entering tanks or closed vessels
- Entering any designated high-hazard areas
- Using torches, electrodes, electronic motors, forges, soldering irons, any open flames, or any device which could produce sparks or ignition source
- Closing walkways, roads, or restricting traffic
- Starting excavations
- Removing tanks from excavations
- Backfilling excavations
- Using utilities such as steam, water, compressed air, or electricity
- Sandblasting, spray painting, or guniting
- Storing flammable materials such as gasoline, oil, paints, oxygen cylinders, etc.
- Walking or working on roofs of buildings or equipment
- Drilling, boring, preparing test pits, or using geophysical equipment or any other exploratory equipment requiring penetration of surfaces
- Operating cranes or similar equipment near overhead power lines or pipelines
- Opening cutting through firewalls or berms
- Fueling or repairing Contractor operating equipment on Bhate property or job sites.

Security

For security reasons, entrance to and exit of Bhate facilities and job sites is restricted to those areas designated as the Contractor's work area.

Speed Limits

All vehicles on Bhate job sites and facilities must observe a maximum speed limit of 10 mph unless otherwise posted.

Vehicle Safety

- All vehicles must be parked in authorized areas only.
- There will be no passing of moving vehicles at job sites where there are narrow roads and short-sight distances.
- Vehicles will only be operated by personnel with valid licenses and good driving records.
- Vehicles shall have all required inspection and operating permits.
- Seat belts shall be used.

Safe Work Practices

Communication

Communication and coordination is vital to prevent accidents on construction sites. Every worker must be aware of equipment operating in his vicinity.

Confined Space Entry

Confined spaces include storage tanks, bins, sewers, in-ground vaults, degreasers, boilers, vessels, tunnels, manholes, pits. etc. These enclosures, because of inadequate ventilation and/or the introduction of hazardous gases and vapors, may present conditions that could produce asphyxiation or injury.

Before entering a confined space, Contractor must notify the Bhate Representative of intent to enter. The Bhate Representative will review with Contractor the safe entry requirements which include:

Removal of Contents. Before entering, confined spaces should be as clean and free of hazardous materials and chemicals as possible. Where appropriate, confined spaces may be purged by water or other suitable means. Purging with hazardous solvents should be avoided where possible.

Isolation. All input lines, which discharged into the confined space, shall be disconnected and capped or isolated. The use of a single in-line valve shut-off as the sole means of isolating the confined space from any input lines is prohibited.

However, the use of a double in-line valving arrangement with a vent or drain in between the two valves is acceptable provided that dangerous air contaminants are not introduced by such venting. Isolation valves shall be locked closed, vent or drain valves shall be locked open, and that person performing the job shall keep the key.

Electrical Lockout. Where electrical devices located within the confined space (motors, switches, etc.) are to be repaired or worked on, the line-disconnect switches supplying the power must be tagged and locked in the "OFF" position. The lock key is to be kept by the person performing the job, and only this person is authorized to unlock the switch and remove the tag upon completion of the job. Where more than one person is working on the line, each must place a lock on the switch and retain his own key.

- Where there are multiple sources of power to an electrical device that supplies power to the device through an automatic or manual bus transfer switch, lockout devices must be placed on the breaker nearest to the electrical device that is to be isolated, and an electrician shall test the power supply lines to ensure that power has been secured.
- Line-disconnect switches supplying power to any mechanical apparatus in the confined space (mixers, conveyors, etc.) must also be tagged and locked in the "OFF" position. This must be done for any entry, even though work will not be performed on the apparatus itself.

Securing of Covers. All manhole and cleanout covers shall be removed and the openings maintained clear of any obstructions. When hinged doors or lids are provided, they shall be secured so they cannot close. See **Excavations and Trenches** for guarding requirements.

Testing Atmosphere. A qualified person (NIOSH Publication No. 80-106) using only equipment approved and tagged for Class 1, Division 1 locations shall make appropriate tests of the atmosphere in the confined space and place a record of the test results at the entrance to the confined space. Testing shall ensure the following:

- Combustible gas and vapor concentrations do not exceed 10 percent of the lower explosive limit
- Oxygen content is no less than 20 percent and no greater than 25 percent
- Appropriate respiratory protective equipment and other appropriate personal protective devices have been provided for all employees when concentrations of toxic materials exceed established threshold limit values (TLVs).

Continuous Monitoring. If the nature of the work to be performed introduces, or has the potential to introduce, harmful air contaminants, continuous monitoring of the atmosphere and/or the oxygen content drops below 20 percent, all personnel shall evacuate the confined space immediately.

Ventilation. All confined spaces found to be unsafe must be ventilated by means of mechanical exhaust systems arranged so as to avoid recirculating contaminated air. The Contractor must contact the Bhate Representative to obtain approval not to ventilate. Personnel shall be evacuated immediately in the event of failure of the mechanical ventilation system. The confined space shall be retested prior to reentry following ventilation system repair.

Buddy System. At least two workers shall remain outside the confined space. One standby worker shall

be stationed just outside the access opening of the any confined space while such space is occupied. This person shall:

- Maintain continuous awareness of the activities and well-being of the occupant in the confined space
- Be able to maintain communication at all times
- Be alert and fully capable of quickly summoning help
- Be physically able and equipped to assist in the rescue of an occupant from a confined space under emergency conditions.

Safety Gear and Personal Protective Equipment. All Contractor employees must be instructed in accordance with OSHA regulations regarding safety gear and personal protective clothing, hard hats, respirators, lifelines, and harnesses. Such instructions shall be received and documented before entering any confined space.

Compressed Gas Cylinders

Valve protection caps. Valve protection caps shall be in place when compressed gas cylinders are transported, moved, or stored.

Cylinder valves. Cylinder valves shall be closed when work is finished and when cylinders are empty or are moved.

Compressed gas cylinders. Compressed gas cylinders shall be secured against rolling or tipping (roped or chained) at all times, except when cylinders are actually being hoisted or carried.

Gas regulators. Gas regulators shall be in proper working order while in use.

Leaks. If a leak develops in a gas cylinder, after donning appropriate safety equipment, immediately remove it to a safe location. If the leak cannot be corrected, report it to the Bhate Representative.

Identification of Contents. Cylinders should be permanently marked or stenciled to identify the type of gas in the cylinder.

Breathing Air. All compressed breathing air shall meet OSHA specifications for breathing air quality. All compressed breathing air cylinders shall have their contents checked at the job site for correct oxygen concentration and rejected for breathing air if the oxygen concentration is not 20.7% ±0.2%.

Oil and oily rags. Oil and oily rags shall be kept away from oxygen equipment.

Cranes, Hoists, and Other Heavy Equipment

Contractor personnel will not be permitted to use hoists and powered apparatus belonging to Bhate unless approval is obtained in each instance from the Bhate Representative.

ROPs. Roll over protection shall be used when conditions or regulations call for such use.

Cutting or Welding

Hot Work/Welding/Burning. "Hot Work" authorization must be obtained from the Bhate Representative before any welding, cutting, or other "hot work" is done. "Hot work" permits and results of tests are to be submitted to the Bhate Representative at the completion of the job or at the end of each workday.

Welding Flash. Noncombustible or flame-proof shields or screens must be provided to protect welder or others who might be harmed by direct rays or arc.

Personal Protective Equipment. Goggles, gloves, aprons, and other personal protective equipment appropriate to the job shall be used.

High Fire-Hazard Areas

- Contractor personnel are responsible to see that a fire watch is maintained and all adjacent combustible materials are protected or removed as designated by the Bhate Representative.
- Contractor shall provide his own calibrated combustible gas meter or other instruments for checking areas before hot work.
- Documentation of calibration shall be submitted to the Bhate Representative for review.
- Contractor is responsible for all testing and monitoring required by applicable regulations and to assure work place safety.
- Bhate shall have the right, not the responsibility, to perform additional testing. Bhate testing shall not be in lieu of Contractor's requirements.
- In the event of a bona fide emergency, such as emergency spill response work, and where the Contractor warrants that he cannot conduct the required testing, Bhate may upon written agreement then conduct all tests necessary to assure safety and regulatory compliance. The Contractor shall cosign the "hot work" permit form when Bhate personnel conduct tests.
- Contractor shall provide his own fire extinguisher(s) for welding and cutting, as designated by the Bhate Representative.

Electrical Safety

Grounding. The noncurrent-carrying metal parts of fixed, portable, or plug-connected equipment shall be grounded. Since ground wires can break, they shall be tested with an electrical resistance meter to assure conductivity as often as necessary to assure safety. Portable tools and appliances protected by an approved system of double insulation need not be grounded.

Extension Cords. Extension Cords shall be the three-wire type for grounded tools (two-wire is permissible for double-insulated tools) and shall be protected from damage; do not fasten with staples or extend across an aisle way or walkway. Worn or

frayed cords shall not be used. Cords shall not be run through doorways where the door could cut or damage them.

Light Bulbs. Exposed bulbs on temporary lights shall be guarded to prevent accidental contact, except where bulbs are deeply recessed in the reflector. Temporary lights shall not be suspended by their electric cords unless designed for this use. Explosion-proof bulb covers shall be used when contact with flammable vapors or gases is likely and shall meet Class I, Division I requirements.

Electrical Receptacles. Receptacles for attachment plugs shall be of the approved, dead-front, concealed contact type. Where different voltages, frequencies, or types of current are supplied, receptacles shall be of such design that attachment plugs are not interchangeable.

Wet Environments. Work done in wet environments shall require ground fault interrupters and water-tight connectors.

Emergency Equipment

Bhate's fire equipment is not to be moved, relocated, or otherwise rendered inaccessible unless the Bhate Representative grants specific permission in each case.

Self-contained breathing apparatus, first aid equipment, fire blankets, stretchers, eyewash fountains, and deluge showers are not to be moved, relocated, or blocked without the express permission of the Bhate Representative.

Excavations and Trenches

Permits. Before any excavation work begins, all required permits shall be obtained.

"Dig-Alert". Before any excavation work begins, the existence and location of underground pipes, electrical conductors, etc., must be determined by Contractor who shall in turn notify the Bhate Representative.

Cave In Protection. The walls and spaces of all excavations and trenches (which will be entered by people) more than 4 feet deep shall be guarded by shoring, sloping of the ground, or some other equivalent means, in accordance with Cal/OSHA regulations.

Daily Inspections. Daily inspections of excavations shall be made by the Contractor. If there is evidence of possible cave-in or slide, all work in the excavation shall cease until the necessary safeguards have been taken.

Egress. Trenches more than 4 feet deep shall have ladders or steps located so as to require 10 feet or less of lateral travel between means of access.

Backfill. All trenches shall be backfilled as soon as practical after work is completed and all associated equipment removed.

Housekeeping. All Contractor equipment, such as pipe, rebar, etc., shall be kept out of traffic lanes and access ways. Equipment shall be stored in a manner which ensures the safety of Bhate and Contractor employees at all times.

Fall In Protection. All trenches shall be completely guarded on all sides. Standard guardrails are preferred. However, when wooden or metal barricades are used for trench guarding, they shall be spaced no further apart than 20 feet, and at least two feet from the edge of the trench. Such barricades shall be at least 36 inches high when erected.

- Battery-lighted barricades shall be used as follows:

  (1) A minimum of two battery-lighted barricades shall be used at corners, one on each side of the barricade.

  (2) At least one battery-lighted barricade shall be used where vehicular traffic approaches the trench at right angles.

  (3) Where trenches parallel roadway, distance between battery-lighted barricades shall not exceed 40 feet unless this requirement conflicts with Item (1), above, and additional units are required.

  (4) All battery-lighted units shall be serviced as necessary to ensure equipment is operating.

- Caution tape shall be stretched securely between barricades. The caution tape shall be at least 3/4-inch-wide and shall be yellow or yellow and black and may have the words "CAUTION - DO NOT ENTER."

- Barricaded sections immediately adjacent to where pedestrians cross trenches shall be arranged to direct pedestrians to the walkway or bridge.

Encroachment. Use of other trench excavating equipment, or storage of equipment or supplies within a distance equal to the depth of the trench, will not be permitted without approval by the Bhate Representative.

Bridges. All pedestrian bridges shall be of sufficient strength to prevent no greater vertical deflection than one-half inch when a 250-pound weight is applied to the center of the bridge.

- Handrails shall consist of intermediate and top rails on both sides of the bridge. The top rail shall be between 42 and 45 inches above the walking surface and be capable of withstanding a lateral force of 200 pounds against the center of the top rail.

- All surfaces, which a person could reasonably contact, should be sufficiently free of splinters, nails, or protrusions which may cause injury.

- All bridges intended for vehicular traffic shall be constructed to withstand twice the load of the heaviest vehicle anticipated.

Earth Grading Activity

Vest. All persons within an area where earthmoving are operating shall wear a safety vest or jacket at all times. Vests may be red, orange, or day-glo green in color, but bright or fluorescent orange is preferred. Significantly faded or damaged vest must be replaced.

Communication. Anytime a test pit is to be excavated, the technician shall notify the grading contractor's **authorized** representative for that area. That individual may be acting in the capacity as a dump man, operator, or supervisor from an independent vehicle. Advise that representative of the test pit location and request their cooperation to promote safety during the test period. This should include their advising those under their supervision of your existence in the grading area. Make a notation on your records of the name of the individual with whom you spoke so that the communication is documented.

- Provide notice to the grading contractor
- Identify location of test pit
- Request the cooperation through the completion of the tests and document accordingly.
- A flag must be affixed to any vehicle driving in an earth grading activity area and hazard warning lights shall be operated.

Flags. Every over-the-road vehicle operating in the area of earthmoving equipment activity must carry a flag. The flag must be at least 300 square inches in area with no dimension less than 12 inches. Flags must be high visibility red, orange, day-glo green and mounted approximately 12 feet above grade level.

Hazard Warning Lights. Every over-the-road vehicle operating in the area of earthmoving equipment activity must operate the hazard warning flashers at all times.

Rotating or Flashing Beacon. All vehicles stationary in the grading area shall use a rotating or flashing amber beacon or strobe light on the top of the cab of the vehicle during all field testing.

Orientation of Test Pits. The technician is responsible for selecting a test pit location. Of paramount concern is the technician's safety. The test pit should be located behind the established pattern of grading equipment and outside any existing patterns. The orientation of the pit should include the use of the technician's vehicle as a barrier to potential oncoming traffic. The waste pile created from the excavation of the test pit should be opposite the vehicle so that the test pit is positioned between the vehicle and the waste pile. A flag shall be placed immediately on top of the waste (spoil) pile, satisfying the same requirements as the vehicle flag.

Zone of Non-Encroachment. The location of the test pit must be selected so that no earthmoving equipment will approach closer than 50 feet from the center of the test pit. This is not only for the technician's safety, but to ensure the integrity of the test. Excessive vibration from the operation of earthmoving equipment operating too closely may impair the accuracy or spoil the test results.

Completion of Tests. Immediately upon completion of tests, record the data and withdraw flags and vehicles outside the grading area to record notes and do calculations.

Fire Prevention

Bhate Representative, or his designee, is authorized to correct any condition which he may consider a fire hazard. In any emergency, the site personnel are authorized to act directly with Contractor's Foreman in regard to fire hazards without waiting for the Bhate Representative.

Floor Openings

Floor openings shall be guarded by substantial barriers, railings, and/or covering materials strong enough to sustain twice the load of pedestrians or vehicular traffic. Barriers will be supplied by the Contractor.

Where a danger of falling exists for personnel, elevated floor areas must be provided with guardrails. In addition, toeboards shall be provided when the possibility of falling objects striking personnel below exists.

High-Hazard Areas

Although this list may not be all-inclusive, there are certain areas and operations at Bhate facilities and job sites where extra precautions must be taken because of the nature of the hazards. When starting up any operation, the Contractor is required to check with the Bhate Representative for a review of the safety and health rules which apply before entering any of the following areas:

- Confined spaces (tanks, manholes, vaults, pits, etc.)
- Laboratories
- Chemical storage and disposal areas.

The contractor is also required to check with the Bhate Representative before any work is done on a flammable gas or solvent line; a tank or vessel that presently contains, or has contained, a flammable material; and before making an excavation anyplace on the site.

Housekeeping

Material should be carefully stacked and located so that it does not block aisles, doors, self-contained breathing apparatus, fire extinguishers, fire blankets, stretchers, emergency eyewash fountains, emergency safety showers, fixed ladders, stairways, or electrical breaker panels.

- Nails protruding from boards must be removed or bent over.
- All work areas shall be kept clear of form and scrap lumber and all other debris.

- Combustible scrap, waste materials, and debris shall be removed at regular and frequent intervals.
- Containers shall be provided for the collection and separation of refuse by type. Covers shall be provided on containers used for flammable, combustible, or harmful substances.
- Overhead storage of debris, tools, equipment, pipes, etc., is prohibited.
- At the end of each work day, Contractor shall provide for pick up of all debris such as paper, rags, empty cans and bottles, etc.

Ladders

The use of ladders with broken or missing rungs or steps, broken or split handrails, or with other faulty or defective construction is prohibited.

- Ladders must not be placed adjacent to a door unless the door is locked or guarded.
- Metal ladders shall not be used for electrical work.
- Tie off top of ladder to structure.

Medical Service and First Aid

Emergency Medical Service. Preplanned emergency medical service shall be provided as designated by Contractor and approved by the Bhate Representative.

First Aid Kit. Each Contractor shall provide a first aid kit for his employees which meets minimum OSHA requirements.

Mobile Cranes

Mobile cranes, including portable crane derricks, power shovels, or similar equipment, shall not be operated within ten feet of overhead electrical power lines.

Overhead Work

No overhead work shall be performed when, as a result of that work, the possibility of a falling object striking any person exists. Do not work above any person at any time.

Personal Protective Clothing and Equipment

In certain construction and maintenance operations, personal protective equipment such as safety glasses, chemical goggles, respirators, hard hats, and protective clothing is required. The type of protective equipment to be worn will be determined by the degree of exposure to the potential hazard. There will be very few occasions when hard hats and eye protection will not be required at Bhate job sites. When in doubt of the safety measures to be observed, Contractor shall contact the Bhate Health and Safety Section. This shall not, however, relieve Contractor of his responsibilities to determine appropriate protection.

Eye protection is required when engaging in such operations as the following:

- Drilling, chipping, grinding, wire brushing
- Handling caustics and acids
- Breaking bricks or concrete
- Hammering chisels, drift pins, etc.
- Burning or welding
- Other situations which create a possible eye hazard, e.g., chemical environments.

Photographs

Only Bhate photographers, with permission from DIPEF, are permitted to carry cameras or take pictures. If progress or finished construction photographs are desired, request for same should be made through the Bhate Representative.

Power Tools

Power and Air-Actuated Tools. Gasoline-powered, electric, or air-actuated tools are not to be used on Bhate property or job sites without prior approval of the Bhate Health and Safety Department. To obtain approval, Contractor must contact the Bhate Representative.

Explosive-Actuated Tools. Explosive-actuated (powder-actuated) fastening tools shall meet the design requirements in "American National Standard Safety Requirements for Explosive-Actuated Fastening Tools" (ANSI A10.3-1970). A tool which does not meet these design standards cannot be used.

- Power tools shall never be left unattended in a place where they would be available to unauthorized persons.
- Power tools shall not be used in explosive or flammable atmospheres.

Fall Protection

Appropriate fall protection, such as safety harness and lanyard, must be worn when worker is exposed to falling more than 6 feet. Lanyard or lifeline must be tied off to appropriate structure capable of supporting five times the weight of the person (nominal 1000 pounds).

- Appropriate fall protection, such as safety harness and lanyard, must be worn when working above eight feet on straight or extension ladders when the work involves pushing, pulling, or action which may dislodge the person from the ladder.
- Safety harnesses are also required on swinging or portable scaffolds when handrails and toeboards are not provided (eight feet or more above ground or floor level).

- Safety harnesses and lifelines (including extraction devices for top entry spaces) are required on all work performed in confined spaces where an oxygen deficiency or toxic vapors may exist.

- All lifelines shall be safety secured to stable and adequate supports.
- Safety harnesses and lifelines must be worn on rooftops where there are no guardrails and where the work is within ten feet of the edge.

Salamanders

- "Hot work" authorization must be obtained from the Bhate Representative before using a salamander.

- Salamanders must be a Factory Mutual or Underwriters Laboratories-approved type.

- Position salamanders away from all combustible material to reduce the possibility of uncontrolled fire.

- Guard salamanders from traffic to prevent them from being overturned.

Scaffolds

All scaffolds, whether fabricated on site, purchased, or rented, shall conform to the specifications found in ANSI A10.8, Safety Requirements for Scaffolding. Rolling scaffolds shall maintain a three-to-one height-to-base ratio.

- The footing or anchorage for a scaffold shall be sound, rigid, and capable of carrying the maximum intended load without settling or displacement.

- Unstable objects, such as barrels, boxes, loose bricks, or concrete blocks, shall not be used to support scaffolds or planks.

- No scaffold shall be erected, moved, dismantled, or altered except under the supervision of competent persons.

- Scaffolds and their components shall be capable of supporting at least four times the maximum intended load without failure.

- Guardrails and toeboards shall be installed on all open sides and ends of platforms more than 10 feet above the ground or floor.

- Scaffolds measuring four to ten feet in height, and having a horizontal dimension of less than 45 inches, shall have standard guardrails installed on all open sides and ends of the platform.

- Wire, synthetic, or fiber rope used for suspended scaffolds shall be capable of supporting at least six times the rated load.

- No riveting, welding, burning, or open flame work shall be performed on any staging suspended by means of fiber or synthetic rope.

- Tested fiber or approved synthetic ropes shall be used for or near any work involving the use of corrosive substances.

- All scaffolds, boatswain's (bosun's) chairs, and other work access platforms shall conform to the requirements set forth in the federal OSHA Regulations for Construction (29 CFR 1926.451) except where the specifications in ANSI A10.8 7 or state or local regulations are more rigorous.

Smoking and Open Flames

Smoking and the use of open flames are strictly prohibited in areas where flammable liquids, gases, or highly combustible materials are stored, handled, or processed. Obey "No Smoking" signs. Smoke only in designated areas.

Solvents and Paints

- Adequate ventilation must be maintained at all times when paints or solvents are used.

- Personnel should use proper respiratory protection and protective clothing when toxicity of the material requires such protection.

- Flammable solvents and materials must be used with extreme caution when possible sources of ignition exist.

- Flammable paints and solvents must be stored in an approved (Factory Mutual or Underwriters Laboratories) flammable liquids storage cabinet when storage is required inside the buildings. If an approved cabinet is not available, paints and solvents must be removed from the building when not in use.

- Flammable liquids must be dispensed in safety cans with flash arresters bearing a Factory Mutual or Underwriters Laboratories approval. These containers must be clearly identified as to their contents.

- Material Safety Data sheets, for materials used by the Contractor, shall be maintained by the Contractor, and a copy provided to the Bhate Representative.

Tarpaulins

When tarpaulins are required for the detection of hot slag, dust, paint drippings, etc., or as security barriers, they shall be flame-resistant and in good condition.

Tools

Hand and power tools shall be kept in safe operating condition. Mushroomed heads on cold chisels, star drills, etc., are unsafe and should not be used.

Hammers should have handles, which are not cracked, split, or broken.

Nonsparking tools may be necessary in certain areas where flammable materials are handled or where sparks could create an explosion.

Transporting Material and Equipment

Extreme care must be taken while carrying sections of pipe, conduit, and other materials to assure safety to Bhate, Contractor, and client personnel and property. This includes, but is not limited to, flagging and use of two people to carry pipe of lengths greater than 10 feet.

- Tools, materials, and equipment must not be left unattended in access ways.
- Tools, material, and equipment shall not be removed from the job site without permission of the Bhate Representative.

Walking and Work Surfaces

- Workroom floors shall be clean and, to the extent possible, dry.
- Drainage mats, platforms, or false floors should be used where wet processes are performed.
- Floors shall be free from protruding nails, splinters, holes, and loose boards or tiles.
- Permanent aisles or passageways shall be marked.
- Floor holes shall be protected by covers that eave no openings of more than one inch wide.
- Floor openings into which persons can accidentally walk shall be guarded by standard railing and toeboards.
- Open-sided floors, platforms, and runways higher than four feet shall be guarded by standard railings.
- Toeboards shall be used wherever people can pass below, or where hazardous equipment or materials are located below.

Warning Signs

All posted warning, safety, and security signs and barriers shall be observed. Additionally, Contractor shall provide warning signs, barriers, barricades, etc. wherever such protection is needed. Where signs and barricades do not provide adequate protection, particularly along a road, flagmen shall be used.

Regulatory References

(a) *Standard Operating Safety Guides*, USEPA, November 1984

(b) *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*, NIOSH 85-115, 1985

© Title 29 of the Code of Federal Regulations, Part 1910 (29 CFR 1910), Occupational Safety and Health Standards (USDOL/OSHA), with special attention to Section .120, Hazardous Waste Operations and Emergency Response

(d) Title 29 of the Code of Federal Regulations, Part 1926 (29 CFR 1926), Safety and Health Regulations for Construction (USDOL/OSHA), with special attention to Section 1926.65, Hazardous Waste Operations and Emergency Response

(e) Title 8 of the California Code of Regulations, Chapter 4, Subchapter 7, (commencing with Section 3200) General Industry Safety Orders (Cal/OSHA), with special attention to Section 5192, Hazardous Waste Operations and Emergency Response

(f) Title 8 of the California Code of Regulations, Chapter 4, Subchapter 4, (commencing with Section 1500) Construction Safety Orders (Cal/OSHA)

(g) Title 22 of the California Code of Regulations, Division 4, Chapter 30 (commencing with Section 66000) Environmental Health Standards for the Management of Hazardous Waste (California Environmental Protection Agency, Department of Toxic Substances Control)

(h) Title 22 of the California Code of Regulations, Division 2, Chapter 3, (commencing with Section 12000) Safe Drinking Water and Toxic Enforcement Act Regulations (California Health and Welfare Agency)

(I) National Oil and Hazardous Substances Contingency Plan

Contractors are expected to brief their employees on these requirements and enforce these rules with their employees. Bhate management may stop or suspend work at any time the Contractor fails to comply with Bhate rules and regulations.

SECTION IIIA

General Chemistry Supplement To The Scope of Services For Studies/Geology Supplement

U.S. ARMY CORPS OF ENGINEERS
OMAHA DISTRICT

GENERAL CHEMISTRY

SUPPLEMENT TO THE

SCOPE

OF

SERVICES for STUDIES

January 2000

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Acronym List

AA	Atomic Absorption
ACC	US Air Force Air Combat Command
ADP	Analytical Data Package
A-E	Architect Engineer
AFB	Air Force Base
ARAR	Applicable or Relevant and Appropriate Requirements
ASTM	American Society for Testing and Materials
BNA	Base-Neutral-Acid Extractable
CDLT	Contractor Data Loading Tool
CENWO	Corps of Engineers Northwestern Division Omaha District
CENWO-HX	CENWO Center of Expertise
CERCLA	Comprehensive, Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CQAB	Chemical Quality Assurance Branch Laboratory
COC	Chain-of-Custody
CQAR	Chemical Quality Assurance Report
CV	Cold Vapor
DA	Design Analysis
DQCR	Daily Quality Control Report
DQO	Data Quality Objectives
ECD	Electron Capture Detector
EDM	Electronic Data Management
EPA	Environmental Protection Agency
ER	Engineering Regulation
ERPIMS	Environmental Resources Program Information Management System
FCS	Field Control Sample
FID	Flame Ionization Detector
FS	Feasibility Study
FSP	Field Sampling Plan
GC	Gas Chromatography
GF	Graphite Furnace
GIS	Graphical Information System
HPLC	High Performance Liquid Chromatography

HTRW	Hazardous, Toxic, and Radioactive Waste
ICP	Inductively Coupled Plasma
IDW	Investigation Derived Waste
IMAP	ACC Information Management Action Plan
IR	Infra-red
IRP	Installation Restoration Program
LIMS	Laboratory Information Management System
LRL	Laboratory Reporting Limit
MCL	Maximum Contaminant Levels
MDL	Method Detection Limit
MQL	Method Quantitation Limit
MS	Mass Spectrometry
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MSDS	Material Safety Data Sheet
NAPL	Non-Aqueous Product (Phase) Liquid
NIOSH	National Institute for Occupational Safety and Health
NWD	Northwestern Division
OSWER	Office of Solid Waste and Emergency Response
PA	Preliminary Assessment
PARCC	Precision, Accuracy, Representativeness, Comparability, and Completeness
PA/SI	Preliminary Assessment/Site Inspection
Pest/PCB	Pesticides and Polychlorinated Biphenyls
PID	Photo Ionization Detector
PM	Preventive Maintenance
PM	Project Manager
PMS	Preventive Maintenance Schedule
POC	Point-of-Contact
POL	Petroleum, Oil and Lubricants
PP	Priority Pollutant (13 metals)
PPE	Personnel Protective Equipment
PQL	Practical Quantitation Limits
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QASD	Quality Assurance Support Document
QC	Quality Control
QCSR	Quality Control Summary Report
RA	Remedial Action
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RI	Remedial Investigation

RPD	Relative Percent Difference
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SI	Site Inspection
SSRL	Site Specific Reporting Limit
SOP	Standard Operating Procedures
SOS	Scope of Services
SW-846	Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd edition and Updates
TAL	Target Analyte List (23 Metals and cyanide)
TCL	Target Compound List (VOC, BNA, Pest/PCB)
TCLP	Toxicity Characteristic Leaching Procedure
TPH	Total Petroleum Hydrocarbons (GC Method)
TRPH	Total Recoverable Petroleum Hydrocarbons (IR Method)
UV	Ultraviolet
TSD	Treatment, Storage, and Disposal
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VIS	Visible
VOC	Volatile Organic Compounds

1 Introduction to General Chemistry Supplement to the Scope of Service for Studies

1.1 Purpose. This General Chemistry Supplement to the Scope of Services for Studies serves the purpose of providing guidance for other, non-project-specific, Omaha District (CENWO) general-chemistry requirements. These general-chemistry requirements are necessary to accomplish the chemistry-related tasks identified in the Site Specific Scope of Services, and to ensure that legally defensible data are obtained.

1.2 Overview of The General Chemistry Supplement. The General Chemistry Supplement to the Scope of Services for Studies describes some necessary requirements for compliance with Federal guidance and CENWO needs.

1.2.1 Quality Assurance Project Plan (QAPP) Guidance Most CENWO HTRW work falls under EPA environmental regulations, which mandate the preparation of a plan to assure sufficient chemical data quality. Guidance for the preparation of a Quality Assurance Project Plan (QAPP) follows, which outlines the necessary format for preparing a QAPP, and describes the USACE expectations/requirements for the QAPPs content. The QAPPs content requirements describe the CENWO criteria for acceptable performance of SOPs or equipment or instrumentation.

1.2.2 USACE Engineering Regulations. Other CENWO requirements mandated by USACE Engineering Regulations (See references 1 and 5) are presented in this supplement.

1.3 Applicability. This Supplement's requirements are applicable to CENWO, to Architect Engineer Contractors (hereafter referred to as A-E), and to any A-E subcontractors. Further, it is understood by all A-Es, all sub-contractors, and anyone performing work on CENWO behalf that this scope of services is contractually binding. All work shall be performed in accordance with the General Chemistry Supplement unless otherwise specified in the Site Specific Scope of Services. If there are any differences between this supplement and the Site Specific Scope of Services, the A-E shall implement the Site Specific instructions. If there are any questions regarding this supplement, the A-E shall contact the CENWO Project Chemist for clarification.

2 Introduction to the Quality Assurance Project Plan (QAPP)

2.1Purpose of the QAPP In order to obtain data of sufficient quality to satisfy data quality objectives for legally defensible data, the EPA requires a Quality Assurance Project Plan (QAPP) for all environmental measurements that will be used for environmental regulatory compliance. This QAPP describes how environmental data-collection operations are planned, carried out, and assessed. Accordingly, the purpose of the QAPP is to document in detail all aspects of quality assurance (QA) and quality control (QC) to be done during a projects field and laboratory activities. Additional guidance for the preparation of QAPPs can be found in EPA QA/R-5 (see reference 2). The QAPP is to provide information in sufficient detail regarding sample types, location, sampling methodology, and sample handling to collect data that meets the project objectives. The QAPP also describes the

organization and quality assurance objectives for field sampling and laboratory efforts, and the necessary analytical requirements for them. The QAPP serves as a mechanism for planning and approving field activities to be conducted during the investigation.

2.1 Functional Equivalence (1) The QAPP is required to be included in the RCRA Facility Investigation (RFI) Workplan for RCRA investigations (reference 3). (2) The Sampling and Analysis Plan (SAP) mandated by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 40 CFR Part 300 Subpart E-Hazardous Substance Response, is functionally equivalent to the EPA QA/R-5 promulgated QAPP. The CERCLA required SAP has two major subsections, the field-sampling plan (FSP), which deals only with field activities, and the Quality Assurance Project Plan (QAPP). For CENWO projects requiring a SAP, the content requirements for an EPA QA/R-5 QAPP, presented below, may be separated into two documents: the SAP QAPP and the FSP.

2.2 QAPP Requirement Criteria A QAPP is required when conducting environmental measurements for regulatory purposes. If the environmental measurements are being obtained for CERCLA, RCRA, TSCA, CAA, or CWA etc. a QAPP or SAP is required.

2.3 Numbering System. The outline numbering system for the EPA QA/R-5 is in parentheses, i.e. ( ) for the convenience of locating electronic word processing used for private clients and for the regulator's review.

3 General Administrative Requirements - Quality Assurance Project Plan

3.1 Introduction. During the evolutionary stages of a QAPP's development and utilization, several administrative requirements for the preparation, approval, implementation and revisions of QAPPs must be fulfilled.

3.2 QAPP Preparation Responsibilities and QAPP Approval Authority. The A-E is responsible for preparing a QAPP according to the EPA and CENWO specific guidance. All procedures and activities required for the acquisition of data shall be presented in the QAPP for approval by the CENWO technical team, State, and EPA authorities, as necessary, prior to initiation of any fieldwork. In limited circumstances, CENWO may grant conditional approval to the QAPP to permit some work to begin while non-critical deficiencies in the QAPP are being resolved. However, for this exception, it is the responsibility of the A-E performing the work to assure that no environmental data are acquired before the QAPP is approved and received by project personnel.

3.3 QAPP Implementation. All QAPPs shall be implemented as approved for the intended work. The A-E performing the work is responsible for implementing the approved QAPP and to ensure that all personnel involved in the work have access to the appropriate portion or to copies of the approved QAPP, before work begins.

3.4 QAPP Revision. The final decision to modify or revise the QAPP shall be initiated by

CENWO, if it is determined that conditions exist such that the technical or data quality objectives of the project cannot be obtained with the original QAPP. When a decision is reached to change the QAPP, the originator shall modify the QAPP, and then shall submit the revised QAPP to the same approval authorities that approved the original QAPP. As with the original QAPP implementation and approval process, no revisions shall be implemented until the approved QAPP revisions have been received by project personnel.

3.5 Addendums to the QAPP. For purposes of cost savings, sometimes-new phases or new sites at a Site will create an addendum to a QAPP previously used at the Site. This QAPP Addendum must be updated to show any changes for the new project which reflect new site-specific requirements; contractor changes, including new laboratories, and new requirements by stakeholders such as regulatory agencies. The QAPP Addendum must undergo the same level of review and approval as the original QAPP.

QAPP and CENWO General Chemistry Requirements. Listed below are the elements that the A-E shall incorporate into a QAPP or into any Sampling and Analysis Plan (SAP). These elements describe the CENWO requirements which are required for project execution.

4.1 (A1) Title and Approval Sheet. The A-E shall include a Title and Approval Sheet in the front of the QAPP to include:

Title of the plan
Titles, names, signatures of appropriate approving officials, and their approval dates for the following officials:
A-E Project Manager
A-E QA Manager
CENWO Project Manager
Regulators' Project Manager (e.g., State, EPA, authorized substitutes)
Date of Revision and Document Control Number (the Date of Revision and File Location must appear in footers at the bottom of every page of the document.)

4.1.1(A2) Table of Contents. The A-E shall outline the content requirements of the QAPP to include references, appendices, a list of acronyms, and a list of tables and figure

4.1.2(A3) Distribution List. The A-E shall list the individuals and the organizations that will receive copies of the approved QAPP and any subsequent revisions. Include on the distribution list all managers who are responsible for implementing the plan, all persons responsible for implementation, and the QA managers and representatives of all groups involved.

4.1.3(A4) Project/Task Organization. The project organization for the A-E and any subcontractors shall be clearly defined with a discussion of quality control responsibilities for both laboratory and field operations. CENWO requires a chemist and a Quality Assurance Officer to be active on the Project and have experience in environmental clean-up and chemical measurements. The A-E Quality

Assurance (QA) Officer shall report to a responsible senior officer of the company and shall not be functionally involved in data generation, data use, or decision-making. The A-E shall identify individuals with the following functions: initiating and carrying out corrective actions, those involved in the data reporting sequence, those involved in system and performance audits, and any chemistry support. The A-E shall also discuss the specific responsibilities and qualifications of key project personnel (ie. Training, college degree etc.) in a narrative form. An organizational chart shall show the relationships and the lines of communication among all project participants.

4.1.4(A5) Problem Background This section shall present a summary of background information that is pertinent to the investigation, including:

- a site description-topographical, geological, and hydrological
- a site history narrative detailing prior site uses and occupants
- known or suspected site contaminant releases, and the cause of such releases
- a summary of previous investigations at the site including past multi-media chemical data of significance
- site specific sampling and analysis problems

4.1.5(A6) Project/Task Description. The A-E shall describe the technical scope of work to be performed. The description of the technical scope of work shall elaborate on the types of samples to be collected, methods of sample analysis, any ARARs, and special personnel or equipment required. The A-E shall describe in general terms their project technical review/QA program. The A-E shall name and briefly describe the types of reports (see section 5) to be generated. The A-E shall provide a project schedule that focuses on the major milestones associated with the project such as initiation and completion of field activities, deliverables, the CENWO and Agency review periods, and identify the primary objectives of the investigation. The A-E shall provide in this section a description of the work site and any unusual conditions. The locations of site(s) to be investigated shall be shown on a detailed location map. Further, the A-E shall present the environmental setting of the areas by providing a general description of the physiography, topography, geology, hydrogeology, climate, ecology, demography and land use.

4.1.6(A7) Quality Objectives and Criteria for Measurement Data. The A-E shall design a data collection program that addresses the precision, accuracy, representativeness, completeness, comparability (the PARCC parameters), the quantity, and the quality of data required to support the project's quality objectives. For a decision, use the Data Quality Objectives Process (DQO) (reference 4) to state the problem, identify the decision, identify inputs to the decision, define the study boundaries, and develop a decision rule. Explain the full development of each of these steps in the DQO Process. This use of the Data Quality Objectives (DQO) process shall assist in determining the appropriate quantitation, detection and reporting limits, analytical methods, Quality Control (QC), sample collection, handling procedures, and analytical data submittals. The DQOs presented in the Site Specific Scope of Services shall also be addressed for all disciplines and expanded where necessary. The QAPP shall address the EPA level of data quality (definitive or non-definitive) appropriate for the project's needs.

4.1.7(A8) Project Narrative. The narrative should demonstrate, to technical or QA reviewers, that the project or task will achieve its stated quality objectives.

4.1.8(A9) Special Training Requirements/Certification/Validations.

4.1.8.1Laboratory Validation. Any laboratory performing chemical analysis must be validated by CENWO-HX or have NELAP certification. Laboratories must be validated for each environmental matrix and each specific analytical method to be employed on a project specific basis. The A-E shall notify the CENWO Project Chemist of the analytical laboratory to be used on the project, the Laboratory's Point of Contact, and the Laboratory's address, as soon as possible. The Laboratory must obtain proper certification prior to development of the QAPP. Samples may not be subcontracted to another laboratory without the approval of the CENWO Project Chemist. The period typically required for the CENWO laboratory validation program is 3 to 6 months with the renewal of a validation requiring at least 2 months.

4.1.8.2Personnel. Identify and describe any specialized training or certification requirements needed by personnel, in order to complete the project or task successfully. Further discuss in this section how such training or skills are assured and documented. For examples, discuss any field-sampling training, Hazardous Waste Operations and Emergency Response 40-Hour training, etc. Discuss number of years and education for laboratory personnel on specialized instrumentation.

4.1.9(A10) Documentation and Records. Itemize the information and records which must be included in the required data-deliverables, field-logs, and reports, and specify the required reporting formats. Discuss the frequency of data-deliverable and report generation, and the organization or personnel to which they shall be delivered. Specify any requirements for the final disposition of records and documents, including location and length of retention period. The actual data-deliverables are not to be included here.

4.1.9.1Field Logs. All field logs shall follow the guidelines presented in the General Geology Scope of Services. Sample collection data as well as visual observations shall be documented in the field logbook. Any sample collection equipment, field analytical equipment, and equipment used to make physical measurements shall be identified in the field logbook. Calculations, results, and calibration data for field sampling, field analytical, and field physical measurements equipment shall also be recorded.

4.1.9.2 Data Deliverables (See Section 6)

4.2(B) Measurement/Data Acquisition. This group of QAPP elements covers all aspects of measurement systems design and implementation, which ensures that appropriate methods for sampling, analysis, data handling, and QC are employed and documented.

4.2.1(B1) Sampling Process Design. The A-E shall develop a conceptual understanding of the site based on the evaluation of existing data, monitoring wells, and topographical features (drainage patterns etc.). The A-E shall provide a site map that identifies the boundaries, and roads. The A-E shall develop and elaborate upon their sampling scheme for each type of matrix encountered at the

site. The A-E shall describe the sampling locations and rationale for the sampling selection. The location of each sampling point shall be identified on a site map. These locations shall be identified by the A-E after a visual inspection if they are not already specified. The site-specific details and requirements for the fieldwork shall be discussed and the Standard Operating Procedures (SOP) provided. The A-E shall also summarize the types of field activities required by the project. Summary tables that list matrices, parameters, sample collection frequency, and the distribution of QA/QC samples shall be provided. The A-E shall also include a discussion on the purpose of sample selection (e.g., samples collected from background locations or to provide data for risk assessment). The A-E shall specify the criteria for field sample selection when using field-screening techniques. All measurements shall be classified as critical (i.e., required to achieve project objectives) or non-critical (informational purposes only). Summarize the methods used for sample analysis. For standard methods, state the method numbers for the analysis and extraction, the regulatory citation or methods reference with the date and edition number, and state precisely the actual methodology (surrogates, internal standards, detectors, etc.) utilized. For non-standard methods or unusual matrices, provide references for the method validation study. To aid in the conduct of field-activities, the A-E shall prepare a Field Sampling Plan (FSP), which shall be excerpts from the QAPP, concerning field-activities for the use of field-workers. The FSP shall have the contents and the format organized as in the appropriate sections of EM-200-1-3 (reference 5) concerning FSPs. The contents of the FSP shall be the appropriate sections copied from the QAPP, and the FSP shall not describe actions or procedures that are contrary to those in the QAPP. If the QAPP references the FSP for portions of its content, the FSP shall be appended to the QAPP as an attachment. The FSB portions of the QAPP can be separated from the QAPP as a part of the SAP for use in the field, especially containing field SOPs.

4.2.2(B2) Sampling Methods Requirements. In general, the A-E shall provide and describe the procedures for field-screening and collecting samples from each type of matrix encountered at the site and for each sampling method used. These descriptions shall include, as appropriate, any special implementation requirements or support facilities needed, calibrations, any specific performance requirements for the method, and a description of the sampling equipment (brand, model, serial number). The A-E shall provide detailed Standard Operating Procedures (SOPs) for any field sampling instruments, field laboratories, or sampling procedures. The A-E shall discuss appropriate corrective-action procedures, and who is responsible for corrective action, which will be implemented as needed. Discuss for each sampling method the decontamination procedures (attachment 2). Further CENWO requirements appropriate for this section, such as the equipment and procedures for soil boring and monitoring well installation, can be found in the General Geology Scope of Services; these requirements shall also be addressed in the QAPP. Listed below are the CENWO sampling guidance requirements for each particular type of environmental matrix. Further, explanation of sampling procedures and equipment can be found in the appropriate sections of EM-200-1-3 (reference 5).

4.2.2.1Field Control Samples. Field Control Samples (FCS) must be collected in a similar manner to the environmental samples, according to the appropriate methods listed below. The number and location of the field control samples to be collected shall be detailed in the QAPP.

4.2.2.2Quality Assurance Samples (QA) QA samples are collocated or homogenized replicates of field samples, except that the samples are sent to the CQAB laboratory for analysis. QA samples for aqueous, sediment or soil samples must be collected in a similar manner to environmental samples, according to the appropriate methods listed below. Sediment/Soil QA samples will be a homogenized replicate of a field sample. The number and location of the QA samples to be collected shall be detailed in the QAPP.

4.2.2.3 Soil Sampling Procedure. The CENWO recommends the following soil sampling procedure. Use stainless steel or Teflon sampling equipment to remove enough soil at a specified depth to fill the required number of containers (see Attachment 1- sections F-1 and F-2 for containers, preservatives and holding times). The volatile organic samples should be removed first with as little mixing as possible. When the type of sample (e.g., sludge or sediment) could interfere with rapid and complete filling (no voids) of 40 ml septa vials, CENWO recommends using short wide-mouth 125 ml (4-oz) septa jars, with threaded lids. The remaining soil should be placed in a clean stainless steel bowl and mixed thoroughly with clean stainless steel implements (spoons, spades, etc.) until homogenized. The homogenized soil is then divided into equal parts, and the sample containers are filled by scooping material alternatively from each part. Once the containers are full, they must be properly preserved. When Field Control Samples (FCS) and or Quality Assurance (QA) samples are required, their sample containers shall be filled from the same soil mixture as one of the primary samples, in the manner described above. Grab samples, or non-homogenized samples, are recommended for VOA samples. If other sampling methodologies are warranted to fulfill the DQOs, they must be clearly defined in the QAPP.

4.2.2.4Water Sampling Procedure. The CENWO recommends the following water sampling procedure (see Attachment 1- sections F-1 and F-2 for containers, preservatives and holding times). An attempt should be made to obtain the most representative water samples, which includes ground water and source water by low-flow sampling techniques where appropriate. Containers whose contents will be analyzed for volatiles should be filled first allowing no headspace and with little as possible disturbance of the water. If preservatives are added to the bottles before shipment to the field, care must be taken not to overfill the containers, and the pH must be measured in the field for all samples, which require a specific pH for preservation. The A-E shall not measure the sample pH by inserting any object (pH paper or probe etc.) into the sample container, instead CENWO recommends the use of a separate sacrificial 40-ml septa vial per sample location to be used for pH measurement. The A-E shall describe in the QAPP how the preservation (pH) of water samples will be verified in the field without risking the loss of volatile organics. For shipping, one set of trip blanks shall be included per shipping cooler containing water samples to be analyzed for volatile organics.

4.2.2.5Air Samples. Sampling methods and equipment used shall meet the requirements of appropriate EPA methods. The CENWO does not require QA sample collection for air samples.

4.2.2.6Other Sampling/Planning Requirements. Listed below are other sampling/planning requirements to be addressed in the QAPP.

4.2.2.6.1Source Water Analysis. The A-E shall identify the source water required for the site activities (i.e., steam-cleaning and decontamination), and the analysis of the source water shall be included in the analytical tables. The samples shall be collected from the delivery vehicle once at the beginning of field investigations and analyzed for the same contaminants of concern as those found or suspected at the site.

4.2.2.6.2Risk Assessment Schematic. The A-E shall develop a simple schematic outlining the actual and potential 1) source area(s) for all contaminated media, 2) intermediate release mechanisms; air dispersion, infiltration, and water runoff, 3) transport pathways, 4) exposure routes for potential human and environmental receptors contact by ingestion, inhalation, and dermal and 5) exposed receptor populations.

4.2.2.6.3Field Screening Procedures. The A-E shall describe all field screening methods employed to select samples for analyses. The General Geology Scope of Services contains the recommended field soil volatile vapor headspace screening procedure.

4.2.2.6.4Decontamination. The A-E shall summarize the decontamination procedures to be implemented at the site. Attachment 2 is the CENWO recommended decontamination procedure.

4.2.2.6.5Investigative Derived Waste (IDW) shall be handled in accordance with applicable federal, state and local regulations or guidance. Drill cuttings, well development water, well purge water, and decontamination water should be left in the area of contamination (AOC) whenever possible. Used PPE is often not a hazardous waste and can often be disposed as non-hazardous waste. If the PPE is determined to be hazardous waste it shall be placed in a secure location, as directed by the CENWO.

4.2.3(B3) Sample Handling and Custody Requirements. The A-E shall maintain adequate sample custody by means of approved field and analytical documentation. All sample handling, labeling, packing, transportation and chain-of-custody (COC) procedures shall follow the CENWO Sample Handling Protocol (Attachment 1). The majority of samples collected for CENWO projects are considered low-level environmental samples for packaging and shipping purposes, but the A-E is responsible for determining the proper shipping/packaging appropriate for the samples. All field documentation shall be done in indelible ink.

4.2.3.1Sample Chain of Custody. Describe in this section the Sample Custody system to be implemented for identifying and tracking the samples from the point of field-collection to final disposition. Present a table and narrative describing each type of custody document (label, log-book, chain-of-custody etc.) and their interrelation to each another, and describe who is responsible for each. All documentation shall be done in indelible ink. Upon request of the CENWO project chemist, the A-E shall provide copies of any chain-of-custody document.

4.2.3.2Sample Numbering Scheme. The A-E shall detail the sample numbering system to be implemented during the investigation. Each sample shall be assigned a unique number which will be alphanumeric but no longer than 20 characters. The identity of field duplicate/split samples (if any) shall be kept blind to the laboratory by assigning sample numbers which indicate they were collected

from separate sample locations. Samples collected for MS/MSDs and trip blanks shall be clearly identified as such by adding an appropriate suffix to the sample number assigned to the corresponding environmental sample.

4.2.3.3Sample Handling and Preservation Procedures. The A-E shall specify the composition and volume of sample containers along with a description of their preparation and cleaning. Sampling equipment directly contacting the sample shall be stainless steel, PVC or Teflon. The Sample Handling Protocol (Attachment 1) presents the required sample containers, preservatives and holding times for environmental samples. The A-E shall include a table that lists the sampling locations, type of sample matrix (waste, soil, sediment, groundwater, surface water, etc.), number of primary environmental samples, number of field-control samples (trip-blanks, field-replicates etc.), number of QA samples, and the number of Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples.

4.2.3.4Coordination of Sample Shipment to the Government QA Laboratory. The A-E shall notify the QA Laboratory one (1) week before the first delivery of QA samples and provide at least 24 hours notice for Saturday sample delivery. The A-E shall denote on the chain-of-custody sheet, when the final shipment of samples shipped, at the completion of field sampling activities.

4.2.3.5 Quality Assurance Sample Handling and Custody Requirements. All QA sample handling and custody requirements shall be administered by the A-E similar to the environmental samples. The QA samples shall be sent to the CENWO QA laboratory shown below, by overnight delivery, for Governmental contract compliance monitoring. The A-E shall include the below named Government QA laboratory in the QAPP.

U.S. Army Corps of Engineers
Chemical Quality Assurance Branch (CQAB)
ATTN: CEERD-EE-Q (Sample Custodian)
420 South 18th Street
Omaha, NE 68102
Telephone: (402) 444-4314

4.2.3.6CENWO Project Identification for QA Samples. The A-E shall be responsible for inscribing the Project ID "CENWO LIMS #" onto the labels and chain-of-custody records for all QA samples shipped to CQAB. The CENWO Project Chemist will set up an account and LIMS # during project scope development, and depending upon the size and duration of the sampling effort, several LIMS #s may be set up initially or throughout the sampling effort to avoid excessively large or delayed data deliverables. If the CENWO LIMS # is not provided in the site-specific scope of services, the CENWO Project Chemist shall be notified by the A-E.

4.2.3.7Sample Handling and Custody Requirements of Field Control Samples. All field control samples shall be collected and handled by the A-E similar to the environmental samples, and they shall be analyzed by the contract laboratory. The identity of all field control samples collected (except for trip-blanks) must be held blind to the laboratory.

4.2.3.8Sample Handling and Shipping Policy The A-E shall explain in this section how the required CENWO Sampling Handling Protocols (attachment 1) will be implemented. The A-E shall be responsible for arranging and procuring a means of delivering samples to the appropriate laboratories such that all samples are delivered at the proper temperature and time to allow the laboratory time to analyze or to perform an extraction on the sample within holding times. In the event that samples do not meet holding times or samples are observed to be not properly preserved upon inspection by the contract laboratory or the Quality Assurance Laboratory, the CENWO project chemist shall be notified immediately, and re-sampling may be warranted at no additional expense to the Government.

4.2.4(B4) Analytical Methods Requirements. EPA SW-846 methods shall be used whenever possible (reference 7). Summarized in Attachment 3 is the EPA SW-846 matrix-specific analytical and extraction methods recommended by CENWO. In special cases that require the consideration of nonstandard methods, the contract laboratory shall be prepared to provide method validation data, and the use of proposed nonstandard methods requires prior approval of the CENWO Project Chemist. If the A-E or contract laboratory does not follow the approved methods identified in the QAPP, the A-E or contract laboratory shall be required to re-sample and re-analyze at their own expense. The following tables shall be presented in this section: A table shall be included which lists for each sample matrix, the sample preparation/extraction method number and the analytical method number to be used. Include tables that shall list for each analytical method utilized the detectable analytes, and for each analyte list its associated Method Detection Limit (MDL), Laboratory Reporting Limit (LRL), and Site-Specific Reporting Limit (SSRL). For each analytical/extraction method, the A-E shall include a SOP to be attached to the QAPP as an appendix, which describes the apparatus utilized and describes any specific performance requirements associated with it. This SOP shall describe the procedures used to clean/decontaminate such equipment, and sample waste disposal shall be documented. The A-E shall elaborate on the procedures for corrective action on this laboratory equipment and analysis method.

4.2.5(B5) Quality Control Requirements. Quality Control (QC) is necessary to evaluate the laboratory's ability to perform consistently from day to day and to verify that the method used is applicable to the matrix of the field samples submitted. Because of the importance of this, the A-E shall describe the Quality Control Procedures implemented to assure the precision and accuracy of analytical measurements. In this section, the laboratory's established procedures for including QC samples among the samples analyzed and any additional controls required by the present project shall be described. The number and types of internal laboratory QC checks (e.g., method blanks, field-replicates, matrix-spike, matrix-spike duplicates, surrogates, Laboratory Control Samples (LCS), and reference standards, etc. as applicable) and other QC samples proposed shall be described. For the analysis of organic parameters, the contract laboratory shall use dedicated project samples for matrix spike/matrix spike duplicate (MS/MSD) analyses. For the analysis of inorganic parameters, the contract laboratory shall use project samples for matrix spike and internal laboratory duplicate analyses. Through proper sample management, incorporation of site-specific samples should allow no disruption to the laboratory's operation. All of these quality control checks, described above, shall be included with each batch of samples processed in the laboratory. At a minimum, these must be run at the rates prescribed in the individual methods, as described in Chapter 1 of SW-846 and as specified in the site specific scope of services, and these QC checks shall be included with each batch of

samples processed in the laboratory. At a minimum, internal quality control samples shall be analyzed at rates specified in the specific methods or at higher rates, if required to meet project specific Data Quality Objectives. All controls and samples shall be identified as belonging to a specific batch. The A-E shall ensure that results from the laboratory internal quality control checks are reported with the analytical data, and that the sample results and the QC results can be easily correlated. When reporting QC results, any QC result out of acceptable parameters shall be identified or flagged, as appropriate. The A-E shall be aware that should the results exceed the QC limits of acceptability that samples shall be rerun at no additional cost to the Government. The A-E shall prepare the following tables summarizing the QC protocols required.

A) For each analytical/extraction method prepare a table describing the types of QC checks and their frequency per batch.
B) Tabulate the spiking compounds, the levels used, and the acceptance criteria.
C) Tabulate the surrogate compounds, the levels used, and the acceptance criteria.
D) Tabulate the LCS compounds, the levels used, and the acceptance criteria.
E) Tabulate the acceptance criteria for field-replicates.
F) Tabulate the acceptance criteria for method-blanks.

4.2.5.1Corrective Action. The A-E shall propose and describe the corrective actions to be taken when results appear unusual, questionable, or the limits of acceptability are exceeded. When the limits of acceptability are exceeded, information justifying the poor recovery or precision shall be documented, and when QA/QC problems are identified, the A-E shall notify the CENWO Project Chemist as soon as possible. If holding times are exceeded the justification shall also be documented, and notification of the Project Chemist will normally be expected to occur within 48 hours. Further, the A-E shall propose and describe how re-establishment of control is demonstrated. Should the results exceed the limits of acceptability, samples shall be rerun at no additional cost to the Government. The A-E shall describe or reference to an appendix the procedures used to calculate all of the QC statistics. Formulas must be included along with the definitions of all variables. Additionally, describe the corrective-actions used to calculate the QC statistics under conditions of missing data, incomplete data, unreproducible data, and estimated data-values.

4.2.6(B6) Instrument/Equipment Testing, Inspection, and Maintenance Requirements. The A-E shall describe the implementation of their Preventive Maintenance (PM) system and their Preventive Maintenance Schedule (PMS) to be used to ensure the proper functioning of all laboratory and field apparatus used to acquire environmental data. In the PMS, the A-E shall identify the equipment by the manufacturer's name, model number, accessories, inspections, documentation, and testing procedures, etc. required for all equipment. Preventive maintenance shall be performed only by qualified personnel, and any records of repairs, adjustments, and calibrations, etc. shall be maintained and made available for inspection by the CENWO on request.

4.2.7(B7) Instrument Calibration and Frequency. The laboratory shall perform MDL studies on an annual basis, as a minimum, and whenever the basic chemistry of the procedures is changed. MDLs shall be determined in at least two interference-free matrices; reagent water and a purified solid matrix (i.e., sand, etc.). Method detection limits shall be estimated for each method target analyte using the

procedures presented in 40 CFR, Part 136, Appendix B. These MDLs shall be extraction/digestion method specific and instrument specific and shall include any clean-up methods used. The determination of method detection limits in site-specific matrices may be required for certain projects. For organics and explosives typically analyzed by Gas Chromatography/Mass Spectrometry (GC/MS), Gas Chromatography (GC), or Liquid Chromatography (LC) analyses, a five point initial calibration curve shall be produced, and for inorganic analysis by ICP, AA, or cold-vapor AA, a calibration curve shall be established by analyzing a minimum of three standards and a calibration blank. The low level standards used for the calibration shall be set at approximately ten times the standard deviation as determined from the MDL study. For each analyte, the values of these low-level standards are then the Laboratory Reporting Limit (LRL) or the Method Quantitation Limit (MQL) for the particular analytes. All target analytes reported, as positive hits, shall be bracketed by appropriate calibration standards. The A-E's contract laboratory shall then report all detected analytes as positive hits (unqualified detections), which are detected above the laboratory's LRL and below the upper calibration standard. Analytes detected below the LRL but above the Method Detection Limit (MDL) shall be reported as estimated values. Further, all analytes shall be appropriately qualified. Target analytes detected above the upper calibration standard shall be diluted and re-analyzed. For all instruments used in the laboratory or in the field, the A-E shall describe the procedure used for calibrations and the frequency and types of checks required. These shall be consistent with the requirements of the scope of services and of the analytical method. The A-E shall indicate how the records of calibrations shall be maintained, and they shall be traceable to the instrument.

4.2.8(B8) Inspection/Acceptance Requirements for Supplies and Consumables. The A-E shall document the inspection and acceptance requirements for supplies and consumables. Supplies and Consumables include sample bottles, calibration gases, reagents, hoses, etc.

4.2.8.1Supplies and Consumables Custody Procedures. The A-E shall document by whom and how the project's supplies and consumables will be inspected and accepted.

4.2.8.2 Supplies and Consumbles Acceptance Criteria. The A-E shall document in this section the acceptance criteria for such supplies and consumables. Containers used for submitting samples for chemical analysis shall meet or exceed the criteria specified for either I-CHEM QUALITY ASSURED (formerly referred to as the 200 Series), or Eagle-Picher Level 2, or equivalent. The manufacturer and quality of containers shall be specified in the QAPP for CENWO approval. These brand names are not intended to be a CENWO endorsement for these products. Instead, the brand names products are presented as being typical of the acceptable criteria for containers, because of the lack of applicable regulation pertaining to sample containers.

4.2.9(B9) Data Acquisition Requirements (Non-direct Measurements). The A-E shall identify any type of data acquired from non-measurement sources such as computer databases, spreadsheets, programs, and literature files, etc. The A-E shall define the acceptance criteria for the use of such data in this project. The A-E shall discuss any limitations on the use of the data based on the uncertainty in the quality of the data and the nature of that uncertainty.

4.2.10(B10) Data Management. The A-E shall implement a data management system and describe its operation and organization herein this section. The data management system implemented shall manage the data from its generation in the field or laboratory to its final use and storage. The contract laboratory or the A-E (specify in the QAPP which party) shall hold and make available all the project's raw data for a minimum period of ten years after samples have been analyzed. The data management system will include, but not be limited to, the use of standard record-keeping practices, standard document control systems, and the ERPIMS (Environmental Resources Program Information Management System) electronic data management system. All formats, procedures, and forms etc. for data management must meet CENWO approval. All data handling equipment and procedures used to compile, process, and analyze the data must be discussed. This discussion must include procedures for addressing data generated or referenced from other sources (i.e., databases, prior studies, literature references etc.). The A-E shall also describe the procedures or methods used to maintain control of this data management system and the control mechanisms for detecting and correcting errors. The A-E shall describe how to prevent loss of data during data reduction, data reporting, and data entry to forms, reports and databases. The A-E shall also present in a flow-chart format, a conceptual overview of the data management scheme to include to whom or which organization documents are presented and at what frequency. This chart will include the field, the laboratory, the A-E, and CENWO, and it will depict the flow of data/documents between the A-E and the contract laboratory and the A-E's sub-contractors.

4.2.10.1Electronic Data Management. The A-E shall include separate descriptions for data handling/processing ERPIMS or other electronic media (i.e. software and hardware used for data analysis, compilation, word processing etc.). The A-E shall describe the types of hardware/software used for all electronic data management, and demonstrate that they can implement such an electronic data management system.

4.2.10.2ERPIMS. CENWO has adopted the ERPIMS electronic data requirements as the operative policy for all projects. The contractor shall establish a strategy that will devote the necessary resources to the task of electronic data management. This proposed strategy shall be stated in detail in the QAPP. The ERPIMS requirements are discussed in detail in section 5.1.3.

4.2.10.3Forms. The A-E shall present in this section copies of the actual forms.

4.3(C) Assessment/Oversight.

4.3.1(C1) Assessments and Response Actions. The A-E shall be responsible for overseeing the contractor laboratory and the field-sampling efforts, and for proposing and implementing a system to assess their effectiveness. The A-E shall identify and discuss he assessment activities required to be performed by the A-E, to ensure that the provision of the QAPP and this Supplement are implemented. The A-E shall describe the acceptance criteria for each assessment activity, and the A-E shall provide a schedule of such assessments. The A-E shall address the system-audit protocols for field and laboratory operations and for any deliverables produced. All performance audits for measurement systems, field-activities, and Performance and Evaluation (PE) samples shall be identified, and their frequency shall be provided. Further, the A-E shall identify the appointed

assessor by name, identify the assessors' relationship to the A-E, delineate the assessors' authority to affect the A-E, and define explicitly the unsatisfactory conditions under which the assessors are authorized to act. The A-E shall describe how and to whom the results of the assessments will be reported. The A-E shall discuss how response actions to unsatisfactory conditions will be addressed, by whom, and the system for documenting such response actions. The A-E shall maintain communication with the Contract laboratory and oversee their performance to ensure that the proper analytical methodologies and QA/QC protocols are being followed. As part of the assessment and oversight requirements, the A-E shall propose solutions to any laboratory or field sampling problems that may arise. For field work the A-E shall staff or supervise the field sampling teams, and ensure that the sampling SOPs are being correctly executed. The A-E shall ensure that any field laboratory or field instrumentation is being correctly performed, and the A-E shall ensure that samples are being collected in accordance with the approved workplan. Further, the A-E shall ensure that the sample handling procedures are being implemented as described in this supplement.

4.3.2(C2) Reports to Management. The A-E shall identify the types, frequency, and the recipients of Assessment/Oversight reports generated internally (for A-E use) and required externally (outside of the A-Es organization). The content of the reports should include the following: status of the project, results of performance and system audits, results of periodic data quality assessments, significant quality assurance problems, and recommended solutions. The A-E, upon request of CENWO, shall be provided any type of internally generated document or report concerning the project. Other types of reports and data deliverables not expressly concerning Assessment/Oversight, but required for reporting data and project information are presented in section 5.

4.4(D) Data Validation and Usability. The A-E shall be responsible for ensuring the subcontract laboratory produces usable data by overseeing the subcontract laboratory. Further, the A-E shall be responsible for ensuring that the contract laboratory extensively reviews all data prior to release of that data to the A-E. After the laboratory releases its report to the A-E, the A-E shall conduct its own independent data validation of the laboratory's results.

4.4.1(D1) Data Review, Validation, and Verification Requirements. All criteria used to validate and review data by the laboratory and by the independent A-E data validation shall be described in this section. Equations, including units, that are required to calculate the concentration or value of the measured parameter, shall be included. If statistical procedures are used for data review before reporting, descriptions shall be included. All data flags to be used shall be identified and defined in the QAPP. The criteria to be used to review and validate data shall be the most current editions of the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (reference 8) and the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (reference 9), as appropriate. Described below are some of the criteria and procedures to be used for such laboratory and independent A-E data validations.

4.4.1.1Laboratory Data Verification. The laboratory data verification process shall entail three levels of documented review: Level 1) Analyst Review; Level 2) Technical Review; and Level 3) Administrative Data Review. For an explanation of these levels of review see Reference 5, page B-11.

4.4.1.2Independent A-E Data Validation. The A-E shall follow the criteria in the National Functional Guidelines to review and validate the contract laboratory's results based on the evaluation of the following: Holding Times, Blanks, Surrogate Recovery, Matrix Spike/Matrix Spike Duplicates, Field Replicates, Laboratory Control Samples, Completeness of Data Package, and an Overall Assessment of Data for the Project. Should the Laboratory have difficulties meeting the QC acceptance limits, the A-Es Laboratory shall promptly contact the A-E, and the A-E shall discuss the problems with the CENWO Project Chemist. The A-E shall be actively involved in overseeing the Contract Laboratory's performance and in resolving QA/QC problems with the CENWO Project Chemist. Further, the A-E shall meet the required QA/QC acceptance limits, and if they are exceeded the A-E shall provide an adequate explanation and implement corrective action to resolve any problems.

4.4.2(D2) Validation and Verification Methods. The A-E shall discuss the process, procedures, and organization to be used for validating and verifying data. This discussion shall cover the three levels of laboratory data verification, as well as an in-depth discussion of the A-Es data validation procedures. Further, the A-E shall discuss the procedures to be followed for resolution of problems or issues associated with the laboratory data, A-E reports or with the CENWO interpretation of such data and reports. The A-E shall understand that the CENWO project chemist will be the final decision maker regarding resolution of issues or problems between any parties involved with this project. The contract laboratory or the A-E (specify in the QAPP which party) shall hold and make available all project raw data for a minimum period of ten years after samples have been analyzed.

4.4.3(D3) Reconciliation with User Requirements The A-E shall describe how the results obtained shall be reconciled with the results of the DQO process and the DQO and discuss how limitations on the use of the data will be reported.

5Data Deliverables and Reports to CENWO. This section of the General Chemistry Supplement describes the additional CENWO documents, in addition to a QAPP (whose format and content are presented above) that the A-E must generate periodically throughout the course of this HTRW project. For each of the data-deliverables and reports, the guidance presented below outlines the CENWO expectations/requirements for preparing these data-deliverables and reports. Included with the guidance are instructions on the necessary generation frequency of such documents and the CENWO personnel or organization to whom they are to be delivered. Upon receipt of such documents, the CENWO Project Chemist will review them and then make oral or written comments on the documents that must be addressed in a timely written manner by the A-E.

5.1Data Deliverables

5.1.1Analytical Data Package (ADP). The contract laboratory's analytical data associated with each LIMS number must be submitted in one complete package to the CENWO-PM within forty-five (45) days after the last sample is submitted to the laboratory. The data shall be submitted in three ring binder(s) with bound edge punched with large holes. The ADP is designed to allow the CENWO project chemist to evaluate the contract laboratory's sample receipt conditions, custody documentation, and analytical results for all primary field samples, QC duplicates/splits, sampling equipment rinsate

blanks, trip blanks, MS/MSD and associated QC analyses.

5.1.1.1ADP Minimum Data Reporting Requirements. The ADP shall include all sample and internal quality control results such as method blanks, spike and surrogate recoveries, and replicate analyses which shall meet or exceed the HTRW minimum data reporting (MDR) requirements. Interim data reports may be requested if the project warrants. The following are minimum data reporting requirements:

5.1.1.2 Cover Letter. The cover letter shall identify the project identification number (the Chemical Quality Assurance Branch Laboratory (CQAB) LIMS # assigned to the project), the date when the last sample was collected under the assigned LIMS #, and that the sampling activity under that LIMS # is complete. This notification is important as it serves as the signal for CQAB to prepare the Chemical Quality Assurance Report (CQAR, see attachment 5) and to close that LIMS number. A copy of the cover letter shall also be sent to the CENWO-PM on the same day that the QASD is sent to the CQAB.

5.1.1.3 Sample Identification. The A-E shall prepare a tabular presentation which shall identify all the QA samples which were split and sent to the contract laboratory and to the CQAB. This table shall match the contract laboratory's sample identifications to the CQAB's sample.

5.1.1.4Sample Receipt. The A-E shall include all Cooler Receipt Forms and Chain-of-Custody forms associated with the required sample results. (See Attachment 4 for example.)

5.1.1.5General Organic And Inorganic Reporting. For each analytical method run, the A-E shall report all analytes for each sample as a detected concentration or as less than the specific limits of quantitation. Each analytical method run shall be clearly identified as belonging to a specific analytical batch. All samples must be reported with dates of collection, preparation, and analysis. Summary reports may be used to supplement but not replace individual data reports. Generally, all samples with out-of-control spike recoveries being flagged for matrix interferences shall be designated as such. Appropriate data flags such as National Functional Guidelines shall be used, and the flag definitions used for the project shall be given. All soil samples shall be reported on a dry-weight basis with percent moisture also reported unless otherwise approved. The A-E shall also report dilution factors for each sample as well as the date of extraction (if applicable) and date of analysis.

5.1.1.6Internal Quality Control Reporting. A complete set of Quality Control results shall be reported for each analytical batch. The QC results shall include but are not limited to laboratory blanks, surrogate and matrix spike recoveries, laboratory duplicates and/or matrix spike duplicate pairs.

5.1.1.6.1Laboratory Blanks (Method Blanks and Instrument Blanks). All analytes shall be reported for each laboratory blank. All sample results shall be designated as corresponding to a particular laboratory blank in terms of analytical batch processing.

5.1.1.6.2Surrogate Spike Samples. Surrogate Spike Recoveries shall be reported with all organic method reports where appropriate (i.e. when the method requires surrogate spikes). The report shall

also specify the control limits for surrogate spike results as well as the spiking concentration. Any out-of-control recoveries as defined in the specified method shall result in the sample being rerun (both sets of data are to be reported) at no additional cost to the government.

5.1.1.6.3Matrix Spike Samples. Matrix Spike Recoveries shall be reported for all organic and inorganic analyses. All general sample results shall be designated as corresponding to a particular matrix spike sample. The report shall indicate what field sample was spiked. The report shall also specify the control limits for matrix spike results for each method for each matrix.

5.1.1.6.4Laboratory Duplicates and/or Matrix Spike Duplicate Pairs. Relative Percent Difference shall be reported for all duplicate pairs as well as analyte/matrix specific control limits. Report all control limit ranges for all QA/QC samples (specifically those that may have changed from the original QAPP). The report shall also indicate which field sample was spiked.

5.1.1.6.5Laboratory Control Samples. Laboratory Control Sample (LCS) data shall be reported for all organic and inorganic analyses. The purpose of the LCS is to provide a consistent matrix with which baseline performance data can be generated. To ensure that analytical control is provided with each batch of samples, an LCS sample shall be prepared along with each batch of samples which requires a pre-treatment step for the analyses. Report all control limit ranges for all QA/QC samples (specifically those that may have changed from the original QAPP).

5.1.1.6.6Other Method Quality Control. Additional Quality Control checks such as method of standard additions and serial dilutions for the analysis of metals, analytical spikes for metals, initial and continuing calibration data for all analytes, internal standard areas and tunes shall be reported. The A-E shall also report all control limit ranges for all QA/QC samples (specifically those that may have changed from the original QAPP).

5.1.2Quality Assurance Support Document (QASD). The A-E shall submit a Quality Assurance Support Document to the CQAB Laboratory within forty-five (45) days after the last sample is submitted to the laboratory. The QASD reports to the CQAB Laboratory a subset of the data reported in the ADP, for comparison of the A-E's Quality Assurance (QA) duplicates/splits analytical results with the CQAB Laboratory's QA results. Additionally, the QASD allows the CQAB Laboratory to evaluate the sample receipt conditions, custody documentation, and associated QC analyses.

5.1.2.1QASD Minimum Data Reporting Requirements. The following are the QASD minimum data reporting requirements:

5.1.2.2 Cover letter. The cover letter shall identify the project identification number (the CQAB Laboratory's LIMS # assigned to the project), the date when the last sample was collected under the assigned LIMS #, and that the sampling activity under that LIMS # is complete. This notification is important as it serves as the signal for the CQAB Laboratory to prepare the Chemical Quality Assurance Report (CQAR, see attachment 5) and to close that LIMS number. A copy of the cover letter shall also be sent to the CENWO-PM on the same day that the QASD is sent to the CQAB Laboratory.

5.1.2.3Sample Identification. The A-E shall prepare a tabular presentation which shall identify and match all the QA samples which were split and sent to the contract laboratory and to the CQAB QA laboratory.

5.1.2.4Sample Receipt. The A-E shall include all Cooler Receipt Forms and Chain-of-Custody forms associated with the required sample results.

5.1.2.5Laboratory Case Narrative. The associated laboratory case narratives shall be included in the results if the reported sample results are affected.

5.1.2.6 Analytical Results. Primary field sample results (laboratory data sheets such as EPA Form I or equivalent) and associated batch QC results which match to the QA samples submitted to the CQAB Laboratory for analysis shall be submitted. Results from field QC duplicate/split samples (if any) shall also be included only when such samples match QA duplicate/split samples submitted to the CQAB Laboratory for analysis. Results from trip blanks (corresponding to aqueous samples for VOCs analysis) and field blanks (if any) shall be included only when an associated QA sample is submitted.

5.1.2.7QASD QC Reporting Requirements. A complete set of QC results shall be reported for each analytical batch associated with the specific sample results described for the QASD. The batch QC results shall include, but is not limited to, laboratory blanks, surrogate and matrix spike recoveries, laboratory duplicates and/or matrix spike duplicate pairs, and control standards. At a minimum, internal QC samples shall be analyzed at rates specified in the specific methods or higher rates if required to meet project specific Data Quality Objectives.

5.1.3Electronic Data Management. CENWO has adopted the ERPIMS requirements as the operative electronic data management for all projects. The contractor shall establish a strategy that will devote the necessary resources to the task of electronic data management. This proposed strategy shall be stated in detail in the QAPP. The Contractor shall submit a cost proposal for the ERPIMS requirements in a detailed task-by-task format. Data management activities that are part of the creation of a specific deliverable shall be included in that section of the cost proposal. This proposal will include the disciplines involved and the number of hours for each. The Contractor will designate an Electronic Data Management Point-of-Contact (EDM POC) for this task. The EDM POC must be accessible via INTERNET E-mail. If the Contractor does not already have an E-mail connection, they may obtain a Defense Environmental Network Information Exchange (DENIX) account. The Contractor can obtain information on how to apply for a no cost DENIX account through the PETRO Service Center.

The Contractor must submit non-ERPIMS electronic files associated with all spatial data or modeling, electronic files corresponding to any graphic figures included in the hard copy report deliverables, and text files corresponding to the word processed portion of the hard copy deliverable. The Contractor shall utilize whichever GIS or CADD-based system they select to generate the files; however, the Contractor must submit metadata identifying software type used, version, file format type, date, and other information required to catalog those files with sufficient specificity to allow satisfactory transfer

to other IRP users. Guidelines for metadata contents can be obtained from the PETRO Service Center. All spatial data should be consistent with the most current installation map. This map should be obtained by contacting the PETRO Response Line at 402-221-7752.

The Contractor will adhere to the electronic deliverable time frames for ERPIMS submissions as listed below. These ERPIMS data submissions will be made to USACE Omaha District directly. The transmittal letter shall include the **AF Project Number**. This number should also be entered as the Project Name, i.e. PROJECT_ID, to identify the submission. Two complete copies of the submittal as specified in Appendix E of the ERPIMS 98 Data Loading Handbook (DLH) Version 4.0 [October 1997] (reference 10), should be mailed to the PETRO Service Center, ATTN Michael Watson CENWO-ED-GC. A copy of the transmittal letter should be sent to the USACE Project Manager to confirm submission receipt. USACE will forward acceptable Air Force project data files to the AFCEE central archive. Projects conducted at locations other than active Air Force installations will be maintained at the Omaha District.

The ERPIMS deliverable time frames are as follows (Contractors are required to submit certain groups of file submissions as applicable to the specific project):

Project.sgl: This submission group containing the CON, LDI, SCC, SLX, WCI, WINT, WMI, ZDI, ZLX, LOCALIAS, and SITEALIAS information, must be submitted no later than 30 days after site and sampling location assignments have been determined or after borehole installations have been completed, whichever is later.

Project.sg2: This submission group containing the ATI, CALC, GWD, HSU, LTD, OWL, PUMPINT, PUMPRATE, STU, TOW, TRI, and TWI information, must be submitted no later than 40 days after sample collection has taken place in the field or after field tests have been performed, whichever is later.

Project.sg3: This submission group containing EMI, RES, SAMP, and TEST information, must be submitted no later than 30 days after obtaining analytical results from the laboratory.

Project.sg4: This submission group containing LOX, LSX, LTX, OU, OUC, ROX. RSI, RSP, RSX, RTI, RTP, and SOX information must be submitted no later than 40 days after the remediation system and/or technology is monitored.

USACE Omaha District will enforce strict compliance with these not-to-exceed deliverable deadlines and will look favorably upon quicker turnaround of electronic submissions. The electronic submissions are considered part of the analytical data package, and failure to meet these deliverable deadlines will be construed as a failure to meet appropriate standards of project performance, and will result in withholding payment for the analytical data package until the package is complete. The final electronic data set should reflect the full complement of qualifiers and corrections that result from the dialogue between the Contractor, CENWO and other stakeholders at the installation during the course of the project review phase.

In all other respects, the ERPIMS deliverables will be consistent with the requirements of the ERPIMS 98 Data Loading Handbook (DLH) Version 4.0 [October 1997] (reference 10), and the requirements of the DLH are incorporated by reference in this Scope of Services. CENWO expects the Contractor to perform their own automated or semi-automated quality checks on electronic data submissions beyond the format-based screening provided by ERP Tools/PC v.3.0. Especially when bringing a new subcontract laboratory on line, the Contractor must check the *contents* of the data files to ensure that they accurately reflect the hard copy reports, report correct analyte lists, units, etc., and provide the complete set of QC sample results specified in the Quality Assurance Project Plan. CENWO can assist Contractors who have concerns or questions about their electronic deliverables. This assistance can be obtained by calling the PETRO Response Line 402-221-7752.

5.2Reports.

5.2.1Daily Quality Control Report (DQCR). During the field investigation activities, the A-E shall provide Daily Quality Control Reports (DQCRs) to the Government. These reports shall be compiled and sent to the CENWO-Project Manager (PM) once every week in the event that no problems or deviations from the schedule arise. However, should problems arise the A-E shall notify the CENWO-PM immediately and send the DQCRs by telefax or express mail on a daily basis until the problem has been corrected. These reports shall include, but not be limited to, the following list of topics:

- Date (and corresponding sequential report number);
- Location of the work (including installation, site, boring, etc.);
- Weather information (including temperature, wind speed and direction, humidity, precipitation, etc.);
- Work performed;
- Sampling performed (including specifics such as location, type of samples, log number, etc.);
- Field analysis performed (including results, instrument checks and calibration, problems, etc.);
- Problems encountered and corrective actions taken (including specifics regarding sampling problems and alternate sampling methods utilized);
- Quality control activities;
- Verbal or written instructions from government personnel;
- Calibration procedures and recording;
- Names of all personnel on-site (including their corporate, government, or other affiliations, their job titles, and their job functions and/or reasons for being on-site);
- equipment used;
- Health and Safety considerations (including site control measures, levels of personal protection required, on-site monitoring activities and results, accidents, etc.);
- Deviations from approved workplan;
- General and specific remarks;
- Expected activities for the next working day;
- Distribution list for the DQCR's;

- Signature and job title of the DQCR's preparer;
- Drill logs completed as outlined in the General Geology Scope of Work;
- Chain-of-Custodies completed during the reporting period.

5.2.2 Quality Control Summary Report (QCSR). This document addresses quality control practices employed and summarizes the problems identified in the DQCR which are likely to impact the quality of the data. Issues covered in this report shall include a discussion of all data points which may have been influenced or compromised and their impact on the Data Quality Objectives or remedial decisions. An example of the elements required for this level of effort is presented below, but are not limited to the following items.

5.2.2.0.1 Project Description. The A-E shall include report organization, background information and site description.

5.2.2.0.2 Sample Collection. The A-E shall provide a summary of sampling procedures, sample packaging and transportation and decontamination procedures.

5.2.2.0.3 Laboratory Quality Control Activities. The A-E shall provide a summary of laboratory analytical methods, detection limits, quality control activities, a summary of any deviations from planned activities, and a summary of the evaluation of the data quality for each analysis and matrix.

5.2.2.0.4 Field Quality Control Activities. The A-E shall provide a summary of any deviations from planned activities, and a summary of the evaluation of the quality of the sampling.

5.2.2.0.5 Data Presentation and Evaluation. The A-E shall provide an assessment of sampling and analysis techniques, an evaluation of the data quality of each matrix and parameter, and an evaluation of the usability of the data. The ADP Minimum Data Reporting Requirements shall serve as a basis for evaluating and discussing impacted data. The assessment of data quality indicators (PARCC parameters) shall also be addressed.

5.2.2.0.6 Lessons Learned. The A-E shall include a summary of field or analytical procedures that could be changed or modified to better characterize chemical contamination in future work efforts.

5.2.2.0.7 DQCR Consolidation. The A-E shall include a summary and consolidation of the deficiencies found in the Daily Quality Control Reports.

5.2.2.0.8 Conclusions/Recommendations. The A-E shall include a discussion of the quality of the environmental data collected during the investigation and state whether it meets the project objectives.

REFERENCES

1. Engineer Regulation 1110-1-263 Chemical Data Quality Management for Hazardous Waste Site Remedial Activities 30 April 1998.

2. EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, Interim final, August 1994, EPA QA/R-5.

3. EPA RCRA Facility Investigation (RFI) Guidance, Volume 4, EPA/530/SW-89/031, May 1989.

4. EPA Data Quality Objectives Process for Superfund, Interim final guidance, September 1993, EPA/540/R-93/071.

5. USACE Requirements for the Preparation of Sampling and Analysis Plans, September 1994, EM-200-1-3.

6. Annual Book of ASTM Standards, American Society for Testing and Materials, 1990.

7. EPA SW-846, Test Methods for Evaluating Solid Waste Physical/Chemical Methods, 3rd Edition, Final Update III (December 1996).

8. USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, February 1994, EPA/540/R-94/012.

9. USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, February 1994, EPA/540/R-94/013.

10. ERPIMS 98 Data Loading Handbook, Version 4.0, October 1997.

ATTACHMENT 1

APPENDIX F TO ER 1110-1-263 (Updated January 2000)

SAMPLE HANDLING PROTOCOL FOR LOW, MEDIUM AND HIGH CONCENTRATION SAMPLES OF HAZARDOUS WASTE

1. Purpose. This protocol provides guidance on sample volumes, containers, packing, and shipping for low, medium, and high concentration environmental samples taken for chemical analysis.

2. Applicability. The guidance in this appendix applies to all samples taken by CENWO for HTRW chemical analysis. The requirements are consistent with those of the Environmental Protection Agency and all standard chemical methods generally used are included.

3. Low Concentration Samples. Low level samples are considered to be those collected off-site, around the perimeter of a waste site, or in areas where hazards are thought to be significantly reduced by normal environmental processes.

a. Waters.

(1) Organics.

(a) Bottle and Preservative Requirements.

Four 1-liter amber glass bottles (Teflon-lined caps), iced to 4°C (may not be held at site over 24 hours). Remember: Leave some headspace!

Three 40 Ml glass VOA vials (with Teflon septa), iced to 4°C (may not be held at site over 24 hours). Fill completely! All air bubbles must be excluded. Add HCl (4 drops of concentrated HCl) or $NaHSO_4$ to pH < 2.

The samples above are needed when Method 8260B is used to analyze volatile (or purgeable) organics, when Methods 8270C is used to analyze for Base/Neutral /Acid (B/N/A) extractable organics, and when Methods 8081A/8082 are ~~8080 is~~ used to analyze for pesticides and PCB's. Two of the 1-L bottles are needed for 8270C and two for 8081A/8082.

Oil and Grease, Total Organic Carbon (TOC) or TRPH. For each analyte, two 1-liter glass bottles (Teflon-lined cap), 5 ml 1:1 HCl (to pH. < 2), and 4°C. Leave headspace.

(b) Paperwork/Labels.

(ENG Form 5021-R) Chain of Custody Record. It is important to note that only one site may be listed per form even if the sites have the same project number. Top original goes with the samples; a copy should be saved for the sampler's files.

Receipt for Samples. This form complies with the requirements that the owner, operator, or agent-in-charge is legally entitled to : (1) a receipt describing the samples obtained from the site and; (2) a portion of each sample equal in volume or weight to the portion retained, if requested. The original form is retained for the Project Coordinator and a copy is given to the owner, operator, or agent-in-charge.

Sample Labels/Tags. You must label the sample with a date, time of collection, site name, and brief description on a label that will not float/soak off - no masking tape, please. Use only indelible ink on all labels. Numbered sample labels should be used on all samples. Some projects may also require the use of sample tags in addition to labels.

(c) Packaging and Shipping.

Waterproof metal (or equivalent strength plastic) ice chests or coolers only.

After filling out the pertinent information on the sample label and tag, put the sample in the bottle or vial and screw on the lid. For bottles other than VOA vials, secure the lid with strapping tape. (Tape on VOA vials may cause contamination.) Then, secure the string from the numbered approved tag around the lid.

Mark volume level on bottle with grease pencil.

Place about 3 inches of inert cushioning material such as vermiculite in the bottom of the cooler.

Enclose the bottles in clear plastic bags through which sample tags and labels are visible, and seal the bag. Place bottles upright in the cooler in such a way that they do not touch and will not touch during shipment.

Put in additional inert packing material to partially cover sample bottles (more than halfway). Place bags of ice around, among, and on top of the sample bottles. If chemical ice is used, it should be placed in a plastic bag.

Fill cooler with cushioning material.

Put paperwork (chain of custody record) in a waterproof plastic bag and tape it with masking tape to the inside lid of the cooler.

Tape the drain shut.

Secure lid by taping. Wrap the cooler completely with strapping tape at a minimum of two locations. Do not cover any labels.

Attach completed shipping label to top of the cooler.

Put "This Side Up" labels on all four sides and "Fragile" labels on at least two sides.

Affix numbered and signed custody seals on front right and back left of cooler. Cover seals with wide, clear tape.

Remember that each cooler cannot exceed the weight limit set by the shipper.

(2) Inorganics.

(a) Bottle and Preservative Requirements.

Metals. One 1-liter high density polyethylene bottle (Teflon-lined cap), adjust to pH < 2 with 1:1 HNO_3 (usually 3 ml).

Cyanides. One 1-liter high density polyethylene bottle (Teflon-lined cap), adjust to pH > 12 with NaOH (usually 2 ml of 10N NaOH or 4 pellets), and 4°C.

Sulfide. One 1-liter high density polyethylene bottle (Teflon-lined cap), 4 ml 2.0 N zinc acetate and adjust pH > 9 with NaOH, and 4°C.

Fluoride. One 1-liter high density polyethylene bottle (Teflon-lined cap), no preservative, and 4°C.

pH.. No preservative. Must be measured twice immediately in field. Do not ship.

Ammonia, Total Kjeldahl Nitrogen (TKN), Nitrate/Nitrite. For each analyte, one 1-liter high-density polyethylene bottle (Teflon-lined cap), adjust to pH. < 2 with H_2SO_4 (usually 4 ml 1:1 H_2SO_4), and 4°C.

(b) Paperwork/Labels.

Inorganic Paperwork is the same as described for organics (see Section 3.a.(1).(b). above) and includes the Chain of Custody Record, Receipt for Samples, and Labels/Sample Tags. See previous examples and explanations.

(c) Packaging and Shipment.

Follow packaging and shipping requirements listed for organics (see Section 3.a.(1).(c). above). "Fragile" labels are optional for coolers not containing glass bottles. In cases where ice is not required (metals), fill cooler with only packing material. Once again, remember that the cooler must not exceed the shipper's weight limit.

b. Soils/Sediments (Organics and Inorganics).

(1) Bottle and Preservative Requirements.

Two 8-ounce glass wide mouth jars at least 3/4 full (Teflon-lined caps), iced to 4°C - one jar for organics (non-VOA) and one jar for inorganics. For analysis of volatiles in soil, two 40 ml VOA vials or two 125 ml jars with Teflon septa are used. These should be completely filled and iced to 4°C.

(2) Paperwork/Labels.

Follow paperwork requirements listed for water samples in Section 3.a.(1).(b). above.

(3) Packaging and Shipping.

Follow packaging and shipping requirements in Section 3.a.(1).(c). above. Be sure that the shipping cooler does not exceed the shipper's weight limits.

4. Medium Concentration Samples. Medium level samples are most often those collected on-site, in areas of moderate dilution by normal environmental processes.

a. Water/Liquids (Organics and Inorganics).

Note: Samples are not known to contain highly toxic compounds.

(1) Bottle and Preservative Requirements.

Four 32-ounce wide mouth glass jars (Teflon-lined caps), no preservatives, and iced to 4°C for B/N/A extractable organics and PCB/Pesticides (two jars for each method). Remember: Leave some headspace.

Two 40 ml glass VOA vials (Teflon septa), Iced to 4°C. Fill completely. No headspace.

Two 16-ounce wide mouth glass jars nearly full (Teflon-lined caps) one for metals and one for cyanides. (Preserved as for low level. See Section 3.a.(2).(a).)

(2) Paperwork/Labels.

See previous examples. Follow paperwork requirements in Section 3.a.(1).(b). for low concentration samples.

(3) Packaging and Shipping.

Secure sample jar lids with strapping tape or evidence tape. At the same time secure string from USEPA numbered tag around lid.

Mark volume level of bottle with grease pencil.

Position jar in Ziploc bag so that tags may be read.

Place about 1/2 inch of cushioning material in the bottom of metal can.

Place jar in can and fill remaining volume of can with cushioning material.

Close the can using three clips to secure lid.

Write sample number on can lid. Indicate "This Side Up" by drawing and arrow and place "Flammable Liquid N.O.S." label on can. Personnel who ship samples must be sure to comply with DOT shipping regulations and not knowingly over-classify a sample prior to shipment. If the person shipping a sample knows that the sample is not a "Flammable Liquid" (i.e., a water phase sample or a soil sample), he should not classify it as "Flammable Liquid."

Place about 1 inch of packing material in bottom of cooler.

Place cans in cooler and fill remaining volume of cooler with packing material. Add ice bags if required.

Put paperwork in plastic bags and tape with masking tape to inside lid of cooler.

Tape drain shut.

After acceptance by shipper, tape cooler completely around with strapping tape at two locations. Secure lid by taping. Do not cover any labels.

Place lab address on top of cooler.

Note: Write "Flammable Liquid N.O.S." on side of cooler if this is not marked on the margin of your DOT label.

For all medium and high concentration shipments, complete shipper's hazardous material certification form.

Put "This Side Up" labels on all four sides, "Flammable Liquid N.O.S." and "Danger-Peligro" on all sides.

Note: "Danger-Peligro" labels should be used only when net quantity of samples in cooler exceeds 1 quart (32 ounces) for liquids or 25 pounds for solids. In other words, for our purposes "Danger-Peligro" labels will never be used for Flammable Solids N.O.S.

Affix number custody seals on front right and back left of cooler. Cover seals with wide, clear tape.

b. Soils/Sediments/Solids (Organics and Inorganics).

(1) Bottles and Preservatives Requirements.

For analysis of volatiles, two 40 ml VOA vials or two 125 ml jars with Teflon septa are used. These should be completely filled and iced to 4°C.

Two 8-ounce wide mouth glass jars, 3/4 full (Teflon-lined caps), no preservatives, one jar for organics (non-VOA) and one jar for inorganics (metals and cyanide) or

Four 4-ounce wide mouth glass jars each 3/4 full (Teflon-lined caps), no preservative; two jars for organics (non-VOA) and two jars for inorganics.

(2) Paperwork/Labels.

See previous examples. Follow paperwork requirements listed in Section 3.a.(1).(b). for low concentration samples.

(3) Packaging and Shipping.

Follow packaging and shipping requirements listed in Section 3.a.(1).(c). for medium concentration water/liquids above substituting "Flammable Liquid N.O.S." with "Flammable Solid N.O.S."

5. High Concentration Samples (Hazardous: Determined Not to be D.O.T.-Defined Poison A). High concentration samples include those from drums, surface impoundments, direct discharges, and chemical spills, where there is little or no evidence of environmental dilution. High concentration (or high hazard) samples are suspected to contain greater than 15% concentration of any individual chemical constituent.

a. Liquids (Organics and Inorganics).

(1) Bottle and Preservative Requirements.

One 8-ounce wide mouth glass jar filled 1/2 to 3/4 full (Teflon-lined cap). No preservative.

(2) Paperwork/Labels.

See previous examples. Follow paperwork requirements listed in Section 3.a.(1).(b). above.

Shipper may require special forms to be completed before shipment of high hazard concentration samples.

(3) Packaging and Shipping.

Follow packaging and shipping requirements listed in Section 3.a.(1).(c). above for medium concentration water/liquids.

b. Soils/Sediments/Solids (Organics and Inorganics).

(1) Bottle and Preservative Requirements.

One 8-ounce wide-mouth glass jar filled 1/2 to 3/4 full (Teflon-lined cap). No preservative.

(2) Paperwork/Labels.

Follow paperwork requirements in Section 3.a.(1).(b). above.

(3) Packaging and Shipping.

Follow packaging and shipping requirements listed in Section 3.a.(1).(c). for medium concentration water/liquids, substituting "Flammable Liquid N.O.S." with "Flammable Solid N.O.S."

TABLE F-1

SAMPLE CONTAINERS, PRESERVATIVES, AND HOLDING TIMES

Low Concentration Samples

Matrix	Parameter[1]	Container[2]	Preservation[3]	Extraction[4]	Maximum Holding Times: Analysis	
Water	Volatiles	2 x 40 mL[8] G, Septa vial	Ice to 4°C 4 drops con. HCL or $NaHSO_4$ to pH<2	---	14 d	
Water	B/N/A	2 x 1 L[5,8] amber G	Ice to 4°C		7 d	40 d
Water	PCBs, Pesticides	2 x 1 L[5,8] amber G	Ice to 4°C		7 d	40 d
Water	Metals[6]	1 x 1 L P	HNO_3 to pH<2			
-all metals except Hg & Cr(VI)						6 mo[6]
-Mercury (Hg)						28 d [6]
-Hexavalent Chromium Cr(VI)						24 hr [6]
Water	TRPH	2 x 1 L G	Ice to 4°C		---	28 d
Water	Common	1 x 1 L[7] G	Ice to 4°C		---	28 d[7]
Water	Explosives	2 x 1 L G (amber)	Ice to 4°C		7 d	40 d
Water	Cyanide	1 x 1 L P	NaOH to pH>12 Ice to 4°C		---	14 d

Soils/ Sediments	Volatiles	2 x 40 mL G or 2 x 125 mL G, Septa vial	Ice to 4°C	---	14 d
Soils/ Sediments	B/N/A,PCBs, Pesticides	1 x 8 oz G	Ice to 4°C	14 d	40 d
Soils/ Sediments:	Metals, Cyanide	1x 8 oz G	Ice to 4°C		
-All metals, except Hg & Cr(VI)				--	6 mo.[6]
- Mercury (Hg)				--	28 d [6]
- Hexavalent Chromium Cr(VI)				1 mo [6]	4 d [6]
Cyanide					14 d
TRPH					28 d
Soils/ Sediments	Explosives	1 x 4 oz G	Ice to 4°C	14 d	40 d

TABLE F-2

SAMPLE CONTAINERS AND PRESERVATIVES[9]

Medium Concentration Samples

Matrix	Parameter[1]	Container[2]	Preservation[3]
Water/Liquid	Volatiles	2 x 40 mL G,	Ice to 4°C[8]
Water/Liquid	BNA[5]	2 x 32 oz wide mouth jars, G	Ice to 4°C[8]
Water/Liquid	PCBs[5], Pesticides	2 x 32 oz wide mouth jars, G	Ice to 4°C[8]
Water/Liquid	Metals	1 x 16 oz wide mouth jar, G	HNO_3 to pH<2
Water/Liquid	Cyanide	1 x 16 oz wide mouth jar, G	Ice to 4°C
Water/Liquid	Explosives	2 x 1 L G (Amber)	Ice to 4°C
Soils/ Sediments	Volatiles	2 x 40 mL G or 2 x 125 mL G	Ice to 4°C

Soils/ Sediments	B/N/A, PCBs, Pesticides	1 x 8 oz wide mouth jar, G	---
Soils/ Sediments	Metals, Cyanide, TRPH	1 x 8 oz wide mouth jar, G	Ice to 4°C (Cyanide & TRPH)
Soils/ Sediments	Explosives	1 x 4 oz wide mouth jar, G	Ice to 4°C

High Concentration Samples

Matrix	Parameter[1]	Container[2]	Preservation
Liquid	All organic and inorganic analyses	1 x 8 oz wide mouth jar, G	----
Solid	All organic and inorganic analyses	1 x 8 oz wide mouth jar, G	----

1. B/N/A = Base/Neutral/Acid Extractables; TRPH = Total Recoverable Petroleum Hydrocarbons.

2. All containers must have Teflon-lined seals (Teflon-lined septa for VOA vials). G = Glass; P = High Density polyethylene.

3. Sample preservation will be done in the field immediately upon sample collection. If water samples are filtered in the field, differential pressure methods using 45 micron filters will be used, and preservatives added after filtration. VOA samples should never be filtered.

4. When only one holding time is given, it implies total holding time from sampling until analysis.

5. Three bottles are required on at least 5-10% (but at least one) sample so that the laboratory can perform all method QC checks for SW-846 method.

6. The holding times for metals is from Table 3-1, Chapter 3, SW 846 (Update III, Dec. 1996.

7. Cl^-, Br^-, F^-, NO_3^-, NO_2^-, PO_4^{3-}, SO_4^{2-}; 1 L for each method; orthophosphate requires filtration. Holding time for extraction is 48 hours for NO_2^-, NO_3^-, and PO_4^{3-} if not preserved with H_2SO_4 to pH < 2.

8. Samples with residual chlorine present will be dechlorinated with sodium thiosulfate as specified in SW-846 (Third edition).

9. Holding times for medium concentration samples are the same as those specified for low concentration samples.

ATTACHMENT 2
DECONTAMINATION PROTOCOL

The decontamination area shall be established in an area of the site considered free from contamination. Equipment and personnel decontamination activities shall be centralized in this area. Decontamination water shall be collected and allowed to evaporate. At project completion, any remaining water that has not evaporated shall be disposed of in an environmental safe manner. Prior to arrival on-site, all heavy equipment shall be steam cleaned. Equipment used for excavation and sampling shall be decontaminated prior to use in accordance with the following cleaning procedures:

1. The backhoe and all support equipment shall be free from excess grease, oils, and caked-on soils from previous work prior to arrival at the site. Equipment which leaks fuel, coolant, and lubricants shall be removed from the site and repaired prior to use.

2. Equipment or materials not used immediately after decontamination shall be placed on a plastic sheet, covered with plastic, and secured to avoid potential contamination.

3. Clean with tap water and laboratory detergent, (Liquinox or equivalent) using a brush if necessary to remove particulate matter and surface films.

4. Rinse thoroughly (3X) with potable water.

4a. Rinse with 10% Nitric Acid (only in areas of elevated metals contamination).

5. Rinse thoroughly (3X) with deionized water and allow to air dry.

6. Wrap sampling equipment completely with aluminum foil, shiny side out, to prevent contamination if equipment is to be stored or transported.

7. Equipment such as pumps, flow lines, etc. shall be flushed thoroughly with potable water prior to use.

Clean, disposable gloves shall be worn while handling sampling equipment during the final stages of decontamination. Deionized water shall be stored in glass or Teflon containers and applied via Teflon squeeze bottles. Hexane may be used to remove greasy contamination from fuel hydrocarbons.

Geology Supplement

GEOLOGY SUPPLEMENT TO THE

SCOPE OF SERVICES

REVISED: 21 JANUARY 2000

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1.0 INTRODUCTION.

This supplement serves as the specifications for accomplishing the geology related tasks identified in the Scope of Services, to which this supplement is attached. All work shall be performed in accordance with this supplement unless otherwise specified in the site specific Section of the Scope of Services. If there are any differences between this supplement and the Site Specific Section of the Scope of Services, the Architect-Engineer (A-E) shall implement the Site Specific instructions.

- The *A-E shall disregard* all sections of this supplement that do not apply to the tasks as outlined in the Site Specific Scope of Services. For example, if no new monitoring wells are to be installed, then the A-E has no reason to refer to the sections on monitoring well installation, construction diagrams, etc.

- The Draft Project Report and Final Project referenced in this document shall be defined in the Site Specific Section of the Scope of Services. If there are any questions regarding this supplement, the A-E shall contact the USACE Project Geologist for clarification.

- **Regulatory Requirements.** Field investigation procedures shall be conducted in accordance with all federal, state, and local requirements. If the specifications as set forth in this Scope of Services do not meet state of local requirements, contact the USACE Project Manager (USACE-PM) for resolution of differences. The A-E is responsible for determining applicable federal, state, and local requirements.

2.0 QUALITY ASSURANCE/QUALITY CONTROL.

2.1 Work Plans

A plan shall be submitted by the A-E for approval before any field work for the project is begun which addresses all quality assurance/quality control (QA/QC) procedures to be implemented in the field. This plan shall comply with the appropriate regulatory requirements as referenced in the Scope of Services (SOS) for this project. This plan shall include, at a minimum, the A-E's methods, equipment, and procedures for carrying out all field work including drilling, (sampling soils, sediment, ground water, soil vapor and surface water, etc.) monitoring well installation, well development, decontamination procedures, aquifer testing, geophysics, and surveying. This plan is not a separate document. This information shall be incorporated into the A-E work plans, which address overall project QA/QC.

2.2 Qualified Personnel

The A-E shall provide a qualified geologist or geotechnical engineer who shall be on site and responsible for all logging and sampling during all soil/rock sampling activities. A qualified geologist shall be on site and responsible for all monitoring well drilling, installation, development and testing activities. The qualifications of the on-site geologist and/or geotechnical engineer shall be included in the A-E work plans. A person meeting these requirements shall be dedicated to each activity. The A-E shall notify the U.S. Army Corps of Engineers (USACE) representative at least 1 week prior to the initiation of any field investigations so that a USACE representative can plan to be present for field oversight.

3.0 SOIL BORINGS AND MONITORING WELL BORINGS.

Soil borings and monitoring wells may be required to investigate the vertical and horizontal extent of site-specific contaminants. Soil samples for chemical analysis may also be required from borings drilled for monitoring well installations, as directed in the Site Specific Section of the Scope of Services. Guidance for all field activities may be obtained from USACE ETL 1110-1-154 (Feb. 1994): "**Standard Outlines for Scopes-of-Work for Investigations and Studies at Hazardous, Toxic, and Radioactive Waste Sites under CERCLA, RCRA, and NEPA.**" All borings for soil sampling and monitoring well installations shall be drilled and sampled according to the following requirements.

3.1 Utility Clearances and Permits.

The A-E shall be responsible for obtaining and coordinating all utility clearances and drilling permits. If it is necessary to move a boring in order to avoid utilities, the A-E shall be responsible for relocating the boring to a suitable location which accomplishes the intent of the original location. The new location shall be as close as possible to the original location. Both locations shall be shown on the boring log. The A-E shall take all reasonable precautions to protect persons and property near the drill site.

3.2 Drilling Methods.

All borings shall be drilled by a method of the A-E's choosing unless otherwise specified under the Site Specific Section of the Scope of Service. The method(s) shall be proposed by the A-E and approved by the USACE Project Geologist (PG) prior to use. The method(s) shall be discussed in the A-E work plans. The drilling method must allow, or provisions must be made for, accurate determination of the depth to ground water surface. If a well is to be installed in a boring, the boring shall be of sufficient diameter to permit at least two inches of annular space between the boring wall and the sides of the centered riser and screen. The boring diameter shall be of sufficient size to allow for the accurate placement of the screen, riser, and centralizers, filter pack, bentonite and grout. The A-E's drilling method shall maintain the integrity of the borehole (i.e. prevent collapse) during backfilling or well installation. No grease shall be used on drill pipe joints. The use of any lubricants shall be submitted for approval in the A-E work plans and shall be noted on the boring logs. The A-E shall provide documentation (brand name, chemical analysis of product composition, etc.) for all materials introduced into the boring during drilling, for approval prior to use.

3.3 Aquifer Protection.

If other than the uppermost water-yielding zone is penetrated during drilling, precautions shall be taken to prevent the downward (or upward) movement of any contaminants. The drilling method and procedure to be employed shall be described in detail in the work plans for USACE review and approval prior to field deployment.

3.4 Decontamination.

All sampling equipment shall be decontaminated according to the requirements stated in the Chemistry supplement to this Scope of Services. All drill pipe, drilling tools, bits, etc. shall be free of potentially contaminating materials (i.e. grease, oil, paint, etc.) and shall be steam cleaned prior to use at each well boring. Drilling equipment that may potentially cross contaminate samples, such as auger center plugs, core barrels, clean out bits, etc. shall be decontaminated between each boring location. The drill rig shall be steam cleaned prior to use at each site if the project consists of more than one site. The rig shall be free of leaks, which could contaminate the holes (i.e. hydraulic fluid, oil, gas, loose paint, etc.).

3.5 Geotechnical Sample Requirements.

During drilling of all borings, soil sampling shall be performed at regular intervals to allow for accurate logging of the soil lithology and to obtain material for geotechnical testing. Sampling may be performed using a split spoon sampler or thin wall (Shelby tube) sampler using the techniques given in ASTM D 1586-84 and ASTM D 1587-94, respectively. Other type samplers (California split tube, hollow stem auger continuous sampler, etc.) may also be used if included in the A-E work plans for approval. All samplers used to collect samples for chemical analysis shall be stainless steel. Samples to be used only for logging and geotechnical testing may be taken with sampling devices that are not stainless steel.

3.5.1 Unless otherwise indicated in the Site Specific Section of the Scope of Services, soil samples for lithologic logging shall be collected continuously for the first ten feet and every five feet for the remaining depth of each boring. Material recovered from geotechnical sample intervals may also be utilized to meet the requirements for chemical sampling, i.e. a sample for

geotechnical testing and a sample for chemical analysis may be taken from the same split spoon after the material is logged. Where the material quality is insufficient to meet all needs, samples for chemical analysis shall be collected first.

3.5.2 All soil samples shall be visually classified in the field using the Unified Soil Classification System (ASTM D 2488-93). In order to verify the field classifications and to obtain additional data on the composition of the subsurface materials, the A-E shall retain samples for laboratory geotechnical testing. Refer to the site-specific section of the SOS for specific sampling and testing requirements. This testing shall consist of Grain Size Distribution (ASTM D 421-85 & 422-63), Atterberg Limits (ASTM D 4318-95), and moisture content (ASTM D 2216-92). If multiple borings are performed at a site, the A-E shall attempt to select samples for geotechnical analysis which are representative of all materials on site. In monitoring well borings, one sample shall be collected from the screened portion of the aquifer to confirm validity of the screen design.

3.6 Logs.

All drill logs shall subscribe to the following requirements:

3.6.1 Logs shall be prepared in the field, as borings are drilled, by a qualified, experienced geologist or geotechnical engineer. Each log shall be signed by the preparer.

3.6.2 All log entries shall be printed. Photo reproductions shall be clear and legible. **Illegible or incomplete logs shall not be accepted.** One legible copy of each field log shall be completed and sent to the USACE <u>within five days of completion</u> of each boring. The boring shall not be accepted by the USACE before the drilling logs are received and approved.

3.6.3 Borehole depth information shall be from direct measurements accurate to one-tenth of a foot.

3.6.4 Logs shall be prepared on the HTW Drilling Log form that accompanies this supplement.

3.6.5 All relevant information blanks in the log heading and log body shall be completed. If surveyed horizontal control is not available at the time of drilling, location sketches referenced by measured distances from prominent surface features, shall be shown on, or attached to the log. If vertical control is not available, the depth measurement shall be measured below ground (grade) surface.

3.6.6 Log scale shall be 1-inch = 1-foot unless otherwise specified in the Site Specific Section of the Scope of Services.

3.6.7 Each material type encountered shall be described in column c of the log form. (Material types are to be logged directly from samples and indirectly interpolated using professional judgement, drill cuttings, drill action, etc., between sampling intervals.

3.6.8 Unconsolidated materials shall be described as outlined below and in the following sequence:

3.6.8.1 Descriptive USCS classification in accordance with ASTM D 2488-84;

3.6.8.2 Consistency of cohesive materials or apparent density of non-cohesive materials;

3.6.8.3 Moisture content assessment, e.g., moist, wet, saturated, etc.;

3.6.8.4 Color;

3.6.8.5 Other descriptive feature (bedding characteristics, organic materials, macrostructure of fine-grained soils e.g., root holes, fractures, etc.);

3.6.8.6 Depositional type (alluvium, till, loess, etc.,)

3.6.9 Rock materials shall be described in the sequence outlined below and in accordance with ASTM C 294-86 and other standard geologic nomenclature including:

3.6.9.1 Rock type;

3.6.9.2 Relative hardness;

3.6.9.3 Density;

3.6.9.4 Texture;

3.6.9.5 Color;

3.6.9.6 Weathering;

3.6.9.7 Bedding;

3.6.9.8 Fractures, joints, bedding planes, and cavities, including any filling material and whether open or closed;

3.6.9.9 Rock Quality Designation (RQD);

3.6.9.10 Other descriptive features (fossils, pits, crystals, etc.).

3.6.10 Stratigraphic/lithologic changes shall be identified in column c by a solid horizontal line at the appropriate scale depth on the log, which corresponds to measured borehole depths at which changes occur, measured and recorded to the nearest one-tenth of a foot. Gradational transitions, changes identified from cuttings or methods other than direct observation and measurement shall be identified by a horizontal dashed line at the appropriate scale depth based on the best judgment of the logger. All lines shall be drawn with a straight edge and not by free hand.

3.6.11 Logs shall clearly show in columns e and f, the depth intervals from which all samples are retained, complete with sample number.

3.6.12 Logs shall identify the depth at which water is first encountered, the depth to water at the completion of drilling and the stabilized depth to water. The absence of water in borings shall also be indicated. Stabilized water level data shall include time allowed for levels to stabilize and amount of bore hole collapse.

3.6.13 Logs shall show borehole and sample diameters and depths at which drilling or sampling methods or equipment change.

3.6.14 Logs shall show total depth of penetration and sampling. The bottom of the hole shall be clearly identified on the log with the notation "Bottom of Hole."

3.6.15 Logs shall identify any drilling fluid losses including depths at which they occur, rate of loss and total volume lost.

3.6.16 Logs shall show drilling fluids used including, as appropriate:

3.6.16.1 Source and volume of make-up water;

3.6.16.2 Drill fluid additives by brand and product name, and mixture proportions; and

3.6.16.3 Type of filter for compressed air.

3.6.17 Logs shall show depths and types of any temporary casing used.

3.6.18 Logs shall identify any intervals of hole instability.

3.6.19 Intervals of lost bedrock core shall be shown in column e. Intervals of intact soil sampling attempts shall also be shown in column e, including depths from which attempts were made and length of sample recovered from each attempt. Bedrock coring information shall be recorded in consecutively numbered runs in column h and shall include the following:

3.6.19.1 Start and stop time of each core run;

3.6.19.2 Depth to top and bottom of each core run;

3.6.19.3 Length of core recovered from each run;

3.6.19.4 Size and type of coring bit and barrel; and

3.6.19.5 Measured depth to the bottom of the hole after core is removed from each run.

3.6.20 Any special drilling or sampling problems shall be recorded on logs, including descriptions of problem resolutions.

3.6.21 Logs shall include all other information relevant to a particular investigation, including but not limited to;

3.6.21.1 Odors;

3.6.21.2 PID/FID measurements or other field screening or test results; and

3.6.21.3 Any observed evidence of contamination in samples, cuttings or drilling fluids.

3.6.22 Copies of the field logs shall be included in the Draft Project Report and Final Project Report; drafted boring logs shall be submitted in the Final Project Report.

3.7 Backfilling.

All borings shall be backfilled with grout or tamped cuttings in accordance with the Site Specific Section of the Scope of Services. Grout backfill shall be placed consistent with paragraph 4.6 of this supplement. The borings shall be backfilled immediately after the sampling is completed unless saturated conditions have been encountered or a monitoring well is installed. In borings encountering saturated conditions, a 24-hour ground-water level shall be measured before backfilling. Borings left open overnight shall be covered to lessen the potential for injury to personnel and to minimize the potential for any surface drainage entering the boring.

3.8 Site Restoration.

The site shall be restored to the condition proper to field work that is acceptable to the owner/base/facility within 5 days of the completion of the site investigation. **High visibility areas or high traffic areas shall be immediately restored upon completion of the site investigation.** Drums (if used) shall be staged to a pre-designated drum staging area specified by the owner as part of this site restoration. The drum staging area shall be identified in the work plans. The drums shall be placed on wooden pallets for temporary storage. The USACE shall provide the final approval of the site restoration.

4.0 WELL DESIGN AND INSTALLATION.

The wells shall be constructed according to all applicable federal, state, and local requirements. If the specifications as set forth in the Scope of Services do not meet regulatory guidance or requirements, contact the USACE Technical Manager (USACE-PM) for resolution of differences. The A-E is responsible for determining all applicable regulatory agency requirements and for obtaining all state and local well permits required for wells with the yields anticipated during development and sampling.

All well materials (except for "factory sealed" plastic wrapped pipe) shall be steam cleaned immediately before installation and shall remain clean until installed in the boring or the material shall be steam cleaned again. The following specifications shall be followed except when site specific requirements may be different where noted in the Site Specific Section of the Scope of Services. The A-E shall provide documentation (brand name, sizes, etc.) for all well and seal materials that shall be used for well installation. This data shall be presented in the work plan.

4.1 Well Riser.

Well riser shall consist of poly-vinyl chloride (PVC) or stainless steel. PVC pipe (if used) shall be new, threaded, flush joint, and as a minimum, conform to the requirements of ASTM F 480-81 SDR 13.5 (Schedule 40). It shall bear markings that shall identify the materials and shall carry the seal of the National Sanitation Foundation. If not specified otherwise, stainless steel pipe (if used) shall consist of new, flush jointed and threaded, type 304 or 316, corrosion resistant steel. Riser sections shall be joined by threaded flush-joint couplings with chemically inert O-rings, to form watertight unions. Adhesives or solvents shall not be used to join the casing sections. The use of Teflon tape on threaded joints is acceptable and shall be noted on the well construction log. No lead shot or lead wool is to be employed in producing seals at any point in the well.

4.2 Well Screen.

The A-E shall have the responsibility of selecting the screened area of the borehole so that the completed monitoring well provides data that meets the project data quality objectives. Well screen shall be constructed of the same size and strength material as the well riser. The screen material shall be non-contaminating, non-clogging, *continuous slot, wire wrap design.* All screen sections shall be threaded, flush joint design. **Field slotted or factory slotted screen is <u>not</u>** *permitted* unless otherwise specified in the site-specific requirements. The slot size shall be determined by the A-E based upon available subsurface data and designed to be compatible with aquifer and gravel pack material. For water table wells, normal, seasonal fluctuations in the water table elevation shall be taken into consideration when

placing the well screen so that monitoring shall be possible throughout an average year. Normal fluctuations shall be determined through a review of local well records and available literature. Sediment traps (sumps, tailpipe) shall not be used below the screened portion in monitoring wells unless directed by the USACE-Omaha District Project Geologist. The procedure to be used in the field for determining the screen placement shall be presented in the A-E work plans.

4.3 Filter Pack.

The annular space around the well screen shall be backfilled with clean, washed, well-rounded silica sand sized to perform as a filter between the formation material and the well screen. The grain size of the filter pack that is used shall be included in the A-E work plans (with selection rationale) and shall be shown on the well construction log. A grain-size distribution curve for all filter pack material shall be submitted by the A-E in the work plan and in the Final Project Report along with the well construction diagrams. Unless otherwise specified in the site specific SOS, the A-E shall collect and test for grain size distribution a minimum of one representative sample of the filter pack material to assure compliance with the work plan. This sample shall be collected at the site. The filter pack material shall be tremied into place to avoid bridging and ensure a continuous filter pack throughout the screened interval of the well. The filter pack shall extend approximately 1 foot below, and 3 to 5 feet above the well screen. If the boring extends more than 1 foot below the bottom of the screen, the A-E shall propose backfilling methods and materials in the A-E work plan.

4.4 Well Plumbness and Alignment.

All riser and screen casing shall be allowed to hang in tension during the installation process in order to be set round, plumb, and true to line. A 10-foot long section of pipe, ½ to ¾ inch less in diameter than the inner diameter of the well riser pipe, shall be run through the entire length of the well to check the alignment. The result of such test shall be recorded on the Daily Quality Control Reports and the installation diagram. If the pipe does not pass freely for the entire depth of the well, the A-E shall replace or repair the well at no additional cost to the Government, if so directed by the Contracting Officer. The pipe section shall be decontaminated with steam prior to the test. Adequate precautions shall be taken to prevent cross-contamination of wells by changing the rope attached to the pipe or decontaminating the cable prior to each alignment test.

4.5 Bentonite Seal.

A 3-5 foot thick bentonite seal shall be placed in the annular space above the well screen and filter pack sand. The seal shall be composed of commercially manufactured sodium bentonite pellets. Bentonite pellets shall not exceed one-half inch diameter. The bentonite pellet seal shall be allowed to hydrate a minimum of 4 hours before grouting begins. If the bentonite seal is positioned above the water table, the bentonite shall be installed in 1-foot lifts with each hydrated a minimum of 30 minutes between lifts before proceeding. Clean, potable water shall be added to hydrate the bentonite. After the placement of the final lift, the bentonite seal shall be allowed to hydrate an additional two hours before grouting begins.

The bentonite seal shall be placed immediately after installing the filter pack, unless the well is going to be developed prior to placement of the seals, in which case, the seal shall be placed immediately upon completion of development.

4.6 Annular Seal.

Grout shall be placed by pumping through a side discharging tremie pipe with the lower end of the tremie pipe located within 3 feet of the top of the bentonite seal. Pumping shall continue until undiluted grout flows from the boring at the ground surface. The annular seal shall be placed within 48 hours, but no sooner than 4 hours of the bentonite seal installation.

Cement grout shall be placed above the bentonite seal to the ground surface. The cement trout shall consist of a mixture of Portland Cement (ASTM C 150) and water in the proportion of not more than 7 gallons of approved water per bag of cement (94 pounds). Additionally, 3 percent by weight of sodium bentonite powder shall be added unless prohibited by state or local regulations. Grout shall be placed by pumping through a side discharging tremie pipe with the lower end of the tremie pipe located within 3 feet of the top of the bentonite seal. Pumping shall continue until undiluted grout flows from the boring at the ground surface.

4.7 Protection of Well.

At all times during the progress of the work, precautions shall be taken to prevent tampering the well or the entrance of foreign material into it. Run-off shall be prevented from entering the well during construction. Upon completion of the well, a suitable vented or loose fitting cap shall be installed to prevent material from entering the well. A vent hole of 1/8-inch diameter shall be drilled into the cap. The well riser shall be surrounded by a larger diameter protective non-corrosive steel or aluminum casing rising 2 to 3 feet above ground level and set an equal distance below the ground surface into the cement grout backfill. The casing shall be installed in a manner that does not hinder access to the monitoring well for purposes of cap removal, taking samples or water level measurements. The outside of all protective casings shall be painted a color specified by the USACE-PM. Refer to Site Specific Section for color requirements (the default color-blaze orange). The protective casing shall be provided with a locking cap and lock. The cap shall be designed to prevent water from entering the protective casing. All locks shall be brass (non-rusting) and keyed alike. Three (3) duplicate keys shall be provided: two to the USACE-PM and one to the owner unless otherwise specified. A minimum 2 feet by 2 feet square by 4 inches thick concrete (cement, aggregate, water) pad, sloped away from the well, shall be constructed around the well casing with the top outer edge at the final ground level elevation. Care shall be taken not to lock the concrete pad to the protective casing. Three 2-inch diameter or larger concrete filled steel posts shall be equally spaced around the well and cemented in place 2 to 3 feet below ground, outside the concrete pad. The posts shall be a minimum of 3 feet above ground. The ground immediately surrounding the top of the well shall be sloped away from the well.

4.7.1 Flush Finish Completion.

Some wells may be required to be finished flush with the ground or pavement if they are in areas of heavy traffic. This requirement shall be stipulated in the Site Specific Section of the Scope of Services or determined by the site owner. If this is required, the A-E shall submit the proposed locations and flush mounted well designs in the A-E work plan for approval. Flush finished wells shall also be equipped with a lock and shall be protected from the entry of surface fluids into the well. Protective posts shall not be required on flush-finished wells.

4.7.2 Cold Climate Completion.

In climates with alternating freezing and thawing conditions, the well must be designed to minimize the potential for damage caused by frost heaving. The A-E shall determine the frost heave potential and include damage minimizing surface completion design details such as a gravel blanket in lieu of the concrete pad, in the A-E work plan.

4.8 Monitoring Well Installation Diagrams.

Suitable diagrams detailing the as-built configuration of each monitoring well shall be prepared for inclusion in the Project Report. The diagrams shall be prepared by a qualified geologist present during all drilling operations. Two legible copies of each well installation diagram shall be completed and sent to the USACE within five days of completion of each well. The well shall not be accepted by the USACE before the drill logs and installation diagrams are received and approved. Information provided on all diagrams shall include, but not be limited to the following:

4.8.1 Project and site names, well number, and the total depth of completed well.

4.8.2 Depth of any grouting or sealing, and the amount of cement and/or bentonite used, and the total boring depth.

4.8.3 Depth and type of well casing.

4.8.4 Static water level upon completion of the well and after well development.

4.8.5 Installation date or dates, and name of the driller and the geologist installing the well. Each installation diagram shall be signed by the preparer.

4.8.6 All pertinent construction details of monitoring wells, such as depth, volume and description of all backfill materials installed (such as gravel pack, bentonite, and grout); gradation of gravel pack; length, location, diameter, slot size, material (PVC, etc.), and manufacturer of well screen(s); position of centralizers; and location of any blank pipe installed in the well.

4.8.7 Source and volume of water added during drilling and well installation.

4.8.8 Descriptions of surface completion, including protective steel casing, protective pipes, and concrete surface seal.

4.8.9 A description of any difficulties encountered during well installation.

4.8.10 Surveyed coordinates and elevation of top of ground and top of well riser where ground water is measured. A notch or mark on the casing where ground water is measured should be noted. (Generally, a mark or notch should be made on the north side of the casing.)

4.9 Temporary Capping.
Any well that is to be temporarily removed from service or left incomplete due to delay in construction shall be capped wit a watertight cap and equipped with a "vandal proof" cover satisfying applicable state or local regulations or recommendations.

4.10 Identification of Wells.
The A-E shall securely affix a permanent corrosion resistant tag to the outer steel protective casing of each well which clearly identifies the well number, depth, date of installation, the A-E company name and the top of riser measuring/point elevation. The well shall also be clearly identified as a ground water monitoring well, (or other type of well as applicable) either on the tag or by other means which must be approved by the USACE. On flush finished wells, the tag shall be fixed to the inside of the cover and the outside clearly labeled as a monitoring well.

4.11 A-E Responsibility for Monitoring Wells.
It is the responsibility of the A-E to properly plan, design, install, develop, and test monitoring wells so that they are suitable to produce representative ground water samples in sufficient quantity and quality for geochemical testing. The A-E shall ensure that the intentions of this Scope of Services and best construction practices are carried out.

4.11.1 Well Replacement. If the A-E, due to his inadequate design or construction, installs monitoring wells that are not suitable for their intended use or not in accordance with specifications, the Contracting Officer shall disapprove the well and direct the A-E to repair or

replace it at the Contracting Officer's discretion. This work shall be done at no additional cost to the Government.

4.11.2 Abandoned Wells. If a monitoring well is disapproved by the USACE or is abandoned by the A-E for any reason, the hole shall be abandoned in accordance with paragraph: Well Abandonment. Such work shall be done at no additional cost to the Government.

4.12 Well Development.

4.12.1 Procedures

Within one week after each well has been constructed, but no sooner than 48 hours after grouting is completed, the A-E shall direct a program for the development of the well without the use of dispersing agents, acids, or explosives. The A-E has the option of developing the well prior to placing the annular seal providing borehole stability can be maintained throughout the development and seal placement activities. This should be considered if significant settlement of the filter pack during development is anticipated. The objectives of well development are to: (a) assure that ground water enters the well screen freely, thus yielding a representative ground water sample and an accurate water level measurement, b) remove all water that may have been introduced during drilling and well installation, c) remove very fine-grained sediment in the filter pack and nearby formation so that ground water samples are not highly turbid and so that silting of the well does not occur. Development shall consist of mechanical surging and bailing until little or no sediment enters the well. This shall continue for a minimum of 2 hours. Sediment that enters the well during this process shall be removed. At the end of that time, the well shall be continuously pumped using an electric submersible, or pneumatic drive positive displacement or bladder pump. Temperature, pH, specific conductivity, dissolved oxygen and turbidity shall be monitored during pumping (one reading per well volume). Pumping shall continue until these parameters have stabilized (less than 0.2 pH units or a 10 percent change for the other parameters between four consecutive readings) and the water is clear and free of fines. If these parameters have not stabilized after 4 hours of continuous pumping, then the USACE shall be contacted for further direction.

If the addition of water is required to facilitate surging and bailing only formation water from that well shall be used. If this is not practical due to tightness of the formation than only bailing shall be done. In all cases, the utmost care shall be taken not to collapse well screens during development activities and at least as much water as was introduced during drilling shall be removed from each well. The A-E shall collect approximately 1 liter of the last water withdrawn from the well during development in a clear glass jar, label and immediately photograph it with a 35 mm color photo, and submit the photo as part of the well development form. The photograph shall be a suitably back-lit close up which shows the clarity of the water. Fines remaining in the water shall not be allowed to settle out prior to taking the photograph. The depth of any sediment that collects in the bottom of the jar after the sample is allowed to settle shall be noted on the Well Development Form. The nephelometric turbidity of the water shall be determined in accordance with ASTM D-189 and shown on the final Well Development Form. Part of well development should be the washing of the entire well cap and interior of the well casing above the water table using only water from that well. The result of this operation should be a well casing free of extraneous materials (grout, bentonite, sand, etc.). This washing should be conducted during development, not after development is completed. This washing should not be performed where free phase contaminants (i.e. petroleum products) are present.

4.12.2 Well Development Records.

A legible well development form shall be prepared and completed for each monitoring well installed. The form shall be prepared by the geologist present during the well development operations. A copy of the well development records, complete with original photos, shall be submitted to the USACE project geologist within 5 days of completion of well development activities. A sample form shall be submitted in the A-E work plan. Copies of the completed well development records shall be included in the Draft

Project Report and Final Project Report. Information provided on the well development record shall include, but not be limited to the following:

4.12.2.1 Name of project and site, well identification number, and date(s).

4.12.2.2 Date, time, and elevation of the static water level and bottom of well before development.

4.12.2.3 Method used for development, to include equipment, size, type and make of bailer and/or pump used during development.

4.12.2.4 Time spent developing the well by each method, to include the typical pumping rate if a pump was used in development.

4.12.2.5 Volume and physical character of water removed, to include changes during development in clarity, color, particulates, and odor.

4.12.2.6 Volume and source of any water added to the well, and chemical analysis of the added water.

4.12.2.7 Volume and physical character of sediment removed, to include changes during development in color and odor.

4.12.2.8 Clarity of water before, during, and after development, including a backlit photo, and depth of any sediment which settles to the bottom of the jar containing the last one liter of water withdrawn from the well during development.

4.12.2.9 Total depth of well and the static water level immediately after, and 24 consecutive hours after development.

4.12.2.10 Readings of pH, specific conductance, temperature, dissolved oxygen, and turbidity taken before, during and after development.

4.12.2.11 Name(s) and job title of individual(s) developing well.

4.12.2.12 Name and/or description of the disposal facility/area for the waters removed during development.

4.12.2.13 Photograph.

4.13 In-situ Permeability Testing (Slug Testing).

After development of monitoring wells, the A-E shall determine for each new well at each site the in-situ permeability of the screened formation using an appropriate method. Slug tests shall be performed for all new wells at each site unless otherwise specified in site specific SOS. The A-E shall propose the methods expected to be used and references for those methods in the A-E work plans. No water or other liquid may be introduced into the well. Only the rising head portion of slug tests shall be analyzed in well screened partially in the unsaturated zone. All instrumentation and materials placed into the well shall be decontaminated according to the requirements given for sampling equipment. If for any reason in-situ tests cannot be completed at any well, the A-E shall contact the USACE-PM immediately for instructions.

4.14 Water Source.

Water for drilling, steam cleaning, and other necessary field activities shall be arranged by the A-E and approved by the USACE. Chlorine-free water shall be used if a suitable source is available. The A-E shall be responsible for collecting and transporting all water to the drilling areas for required uses. The A-E shall sample the water at each source and test it for the same parameters specified for ground water samples under the Site Specific Section of the Scope of Services. In addition, a sample shall be obtained at the site from the delivery/transport vehicle and tested for the same parameters as the source sample. This information and documentation of the source of the water (i.e. fire hydrant location, etc.) which was used and any impact it may have on any of the analytical results performed under this Scope of Services shall be included in both the Draft and Final Project reports. The A-E shall be responsible for providing any deionized water required to perform this work.

4.15 Monitoring Well Log Book.

A log book shall be prepared by the A-E for maintaining a record of all personnel who access the monitoring wells. The notebook shall be permanently bound and have at least one page for each well and shall contain the keys to the well caps. The book shall be kept with the site owner. The log book shall include a listing of all existing and newly installed monitoring wells on the site or installation and shall identify their locations by site location and/or number and horizontal coordinates.

A warning shall be clearly visible in the log book stating the responsibility of all individuals to use any special procedures required to protect the integrity of the wells and of the data obtained from them. The log book shall also contain a detailed description of the decontamination procedures required for any equipment that enters the well. The book shall contain log pages that shall include, as a minimum, labeled columns for the date, individual's name and organization, well number, well location and purpose of activity performed (i.e. sampling, water level measurement, etc.), and the condition of the well. The book shall be organized such that additional entries and new wells can be added at a later date.

If a logbook already exists for the site or installation, the A-E shall add the data for newly installed wells to the existing book.

5.0 SAMPLING TECHNIQUES-EQUIPMENT AND METHODS.

5.1 Soil Sampling.

Sampling for chemical analysis shall be performed using a stainless steel split-spoon sampler. Alternate sampling methods may be proposed for approval in the A-E work plans. Soil grab samples for volatile organic or semi-volatile analyses shall be obtained sub-sampling the material retrieved in the split spoon. Sub-sampling shall be done immediately upon opening the split spoon, and shall be done as soon as possible once the split-spoon sample is taken from the boring. The portion of the split-spoon sample, which represents slough, shall not be sum-sampled. The A-E is responsible to recover adequate soil volume for all analytical requirements. If the sample volume of the first sample is not adequate, another sample shall be attempted from immediately below the previous sample or from the same depth in a boring drilled immediately adjacent to the boring in which the sample failed. This shall be done at no additional cost to the Government. The A-E shall include in the A-E work plans methods to be used to recover additional samples that are consistent with the project data quality objectives. Shallow soil samples for chemical analysis may be obtained with a stainless steel hand auger or a similar device if approved by the USACE Project Geologist in the A-E work plans.

Homogenizing (mixing) of soil samples shall be performed in a stainless steel bowl using stainless steel stirring devices that have been decontaminated prior to each homogenizing procedure.

Sampling equipment, sampling methods and decontamination procedures shall be clearly indicated in the A-E work plans.

5.2 Headspace Screening Method.

When the Site Specific section of the SOS specifies headspace screening, the A-E shall screen soil samples for volatile organic compounds in the field at the time of sample collection. Field screening shall utilize either an organic vapor analyzer equipped with a photo-ionization detector (PID) or a flame-ionization detector (FID). If a high humidity condition exists during the time when field activity is to be performed, the FID is recommended since a PID is not reliable screening instrument under these conditions. The ionization potential of lamp for the PID shall be optimum for the contaminants of concern. The A-E shall perform field screening in accordance with the following procedures unless alternate procedures are submitted and approved in the A-E work plans.

5.2.1 Immediately upon opening the split-spoon (or other sample retrieval device) and after collecting the volatile organic sample (if required), a representative portion of the sample shall be collected and placed in a clean, contaminate-free jar. (The sample may be placed in a new, clean, plastic sandwich bag inside a jar to minimize the number of new jars required. **If the plastic bag method is utilized, readings shall be taken inside empty bags to ensure no external contamination is being introduced.**)

5.2.2 If the volume of sample recovered is insufficient for all analytical requirements, then the material used in the headspace readings could be utilized for any non-volatile sampling requirements (i.e. the headspace material could be used to fulfill the geotechnical requirements). NOTE: If due to insufficient sample volume a additional sample was retrieved immediately below the initial attempt, an additional headspace reading is not required.

5.2.3 Seal each jar with at least on continuous sheet of aluminum foil, using the jar lid to secure the foil.

5.2.4 Vigorously agitate the sample jar for at least fifteen seconds and then allow a minimum of ten minutes (or as the environmental conditions dictate) for the sample to adequately volatilize.

5.2.5 During cold weather, the samples shall be warmed to near room temperature prior to taking the headspace measurement.

5.2.6 Re-shake the jar and then remove the jar lid. Quickly insert the vapor sampling probe through the aluminum foil and record the maximum meter response (which should be within the first two to five seconds). Erratic responses should be evaluated in terms of high organic vapor concentrations or conditions of elevated headspace moisture.

5.2.7 Record headspace screening data on the boring log and any other appropriate documentation (e.g. sample transmittals, field notebooks, etc.) as appropriate.

5.2.8 The screening instrument shall be calibrated according to the appropriate standard span gas and shall be calibrated a minimum of twice daily and before use after a long shut down period (i.e. lunch breaks, equipment breakdowns, weather caused breaks, etc.).

5.2.9 If sample jars are to be re-used in the field, jars must be cleaned according to field decontamination procedures for cleaning of sampling equipment. In addition, headspace readings must be taken to ensure no residual organic vapors exist in the cleaned sample jars.

5.2.10 Any deviation(s) from the approved procedures must be noted on the drill logs and the Daily Quality Control Report (DQCR) and a basis stated for the deviation(s).

5.3 Monitoring Well Sampling.

The A-E shall include in the A-E work plans all methods and equipment to be utilized in the purging and sampling of monitoring wells. After development, all wells shall be allowed to stabilize for a minimum of 2 weeks prior to sampling. For all wells, the A-E shall determine (measure and record) depth to water and the total well depth using an electronic water level probe to determine the water volume to be purged. Prior to purging, determine the presence of Non-Aqueous Phase Liquids (NAPLs) at the top and bottom of the water column. If NAPLs are present, contact the USACE-PM for further instructions. The well shall then be pumped or bailed with clean equipment to remove a quantity of water equal to at least three times the submerged volume of the casing and screen. The same parameters as specified in Paragraph: Well Development, shall be measured and recorded during the purging process. Field parameters shall be measured at the start of purging and twice per casing volume removed. Purging shall continue beyond three casing volumes until these parameters have stabilized (0.2 pH units or a 10 percent change for the other parameter between four consecutive readings). The water sample shall be collected immediately after purging is complete. If the well does not recharge fast enough to permit removing three casing volumes, the well shall be pumped or bailed dry and sampled, as soon as sufficient recharge has occurred. Samples shall be drawn and placed in the appropriate sample bottles immediately upon receipt of water at the surface. The samples shall then be placed immediately in a cooler with a temperature of 4 C. Samples shall be packaged and shipped as specified in the Chemistry supplement to this Scope of Services. Specific details are to be outlined in the A-E's work plans. All data generated during purging and sampling shall in included in the A-E QCSR.

5.4 Water Level/NAPL Measurement.

Immediately prior to purging and sampling monitoring wells (paragraph 5.3) the A-E shall conduct a complete round of ground-water elevation and Non-Aqueous Product Layer (NAPL) thickness measurements from all newly installed and existing wells at each site. The water level, NAPL thickness (actual and apparent), time of measurement, well depth, weather conditions at time of measurement and date shall be recorded. Measurements from all wells shall be completed within the smallest timeframe possible to reduce external variables (weather conditions). A maximum 24-hour interval shall be accepted for all measurements. This data shall be included in tabular form in the Draft and Final reports.

6.0 INVESTIGATION DERIVED WASTES (IDW).

Drill cuttings, excess sample materials, drilling fluids, and water removed from a well during installation, development, and aquifer testing shall be disposed of in a manner prescribed in the A-E work plan. Disposal shall be consistent with applicable federal, state, and local regulations or guidance. (Reference EPA/540/G-91/009 Management of Investigation Derived Wastes During Site Inspection) The A-E shall develop field protocols to minimize the amount of waste generated and to segregate clean materials from potentially contaminated materials. These protocols shall be described in the A-E work plans. Site specific disposal options should be discussed with the appropriate regulatory agencies prior to their inclusion in the A-E work plans.

- All materials generated during field activities that are segregated as potentially contaminated shall be placed in watertight containers supplied by the A-E. If drums are utilized, they shall be new, DOT and EPA approved for transport of hazardous materials. The use of reconditioned drums may be proposed for approval in the A-E work plans. Any drum used shall be sealed, labeled, and recorded so that its contents can be identified as to material and source. At a minimum, drums shall be labeled as to type of material contained, site number and location, boring number (and depths for soils), A-E firm, point of contact and telephone, and date. All materials shall be segregated in separate drums (i.e. soil, water, PPE, etc.). Labeling shall be of a permanent nature, unaffected by exposure to

outdoor elements for an extended period. Labels shall be placed on the side of the drum and positioned to be easily viewed when drums are staged.

- All potentially contaminated IDW shall be transported to a secured centralized location, on site, at the completion of each boring, well development, or purging event of daily unless otherwise specified in the Site Specific Section of the SOS. Drums shall be secured on wooden pallets and shall not be stacked. The A-E shall include disposal methods for uncontaminated materials in the A-E work plans.

- Results from laboratory analysis of soil and ground water samples collected during the field investigation shall be utilized to further segregate contaminated and uncontaminated drummed materials. Drummed materials identified as clean shall be disposed of in the manner stated in the A-E work plans for uncontaminated materials. Drums containing potentially hazardous materials shall be sampled to characterize the material for off-site disposal. These analysis shall identify the potentially hazardous characteristics of the material, including flammability, corrosivity, reactivity, and TCLP. The A-E shall utilize the analyses to prepare a waste manifest for ultimate shipment of the material to a TSD facility. The A-E is responsible for off-site disposal of any contaminated material. The A-E shall determine the most cost-effective method of disposal and furnish an estimated cost to the USACE-PM.

7.0 WELL ABANDONMENT.

All well abandonment procedures shall be in accordance with this SOS and/or all federal, state, and local requirements. If the specifications as set forth in the Scope of Services do not meet state or local requirements, contact the USACE-PM for resolution of differences. The A-E is responsible for determining applicable federal, state, and local requirements. For each well abandonment, the documents outlined below shall be completed. The A-E shall be responsible for submittal of all required documentation to the respective state agency and copies shall be provided to the USACE project geologist.

7.1 Well Abandonment Methods.

A description of the methods and procedures to be used for well abandonment shall be submitted with the A-E work plans. The plans shall include, but not be limited to the following:

7.1.1 Applicable regulations.

7.1.2 Description of well abandonment procedures including drilling and placement of grout.

7.1.3 Description of drilling equipment.

7.1.4 Description of well abandonment material.

7.1.5 Description of quality control procedures including depth measurements, placement of grout. Include also example forms for well abandonment logs and diagrams.

7.2 Well Abandonment Records.

Well abandonment records summarizing the field performance of the items listed in paragraph 7.1 shall be prepared by a qualified geologist or hydrogeologist present on-site during all well abandonment activities. Copies of the records shall be submitted in the draft and final reports.

7.3 Abandonment Procedures.

If there are no state or local regulations governing well abandonment, the following procedures shall be followed:

7.3.1 Grout. Grout for well abandonment shall consist of the same mixture specified under paragraph: Annular Seal, of this supplement.

7.3.2 Grout Placement. The grout shall be placed by tremie pipe, submerged in the grout at all times. The tremie pipe may be raised as the grout is placed al long as the discharge end remains submerged in the grout. The grout shall be placed from the bottom to the top of the hole in one continuous operation.

8.0 SURVEYS (GENERAL).

All sampling locations shall be staked to facilitate subsequent surveying. The A-E shall perform all surveys required for this project and shall supply this office with the original or a legible reproducible copy of the surveys and field books. The surveys shall at least conform to the requirements stated in the following paragraphs.

8.1 Monitoring Wells.

Coordinates and elevations shall be established for each monitoring well. The coordinates shall be to the closest one foot and referenced to the State Plane Coordinate System. If the State Plane Coordinate System is not available, an existing local grid system shall be used. A ground elevations to the closest 0.10-foot and an elevation for the top of the well riser to the closest 0.01 foot shall be obtained at each well. These elevations shall be referenced to Mean Sea Level, specifically to the National Geodetic Vertical Datum (NGVD) of 1983. If the 1988 Datum is not available, the NGVD 1929 Datum shall be used. All positions and coordinates of all permanent points within the control traverse shall be shown.

8.2 Soil Borings/Sampling Points.

All soil-sampling locations shall be located horizontally and vertically following procedures outlined in paragraph 8.1 Monitoring Wells.

8.3 Physical Features.

At each site, all above ground and, where possible, underground physical features shall be either verified with previous mapping or determined as required. All above ground physical features shall be located/verified to the nearest foot. Permanent control monuments shall be placed in accessible locations within the limits of the work if existing permanent monuments are not located within 1000 feet of a site. One set of monuments is allowable for adjacent sites. These monuments shall be set no closer than 500 feet to each other.

8.4 Documentation.

The location, identification, coordinates and elevations of the wells and monuments shall be plotted on maps with a scale large enough to show their locations with reference to other structures at the individual sites. A tabulated list of the monitoring wells and monuments, copies of all field books, and all computations sheets shall be prepared and submitted to the USACE-PM. The tabulations shall consist of the designated number of the well or monument, the X and Y coordinates, and all the required elevations. These items shall be submitted to Omaha District no later than the Draft Project Report.

SECTION IIIB

Cannon AFB Basewide Health and Safety Plan

FINAL
BASEWIDE HEALTH AND SAFETY PLAN
FOR
CANNON AIR FORCE BASE
CLOVIS, NEW MEXICO

Prepared for:

27 CE/CEV
Cannon Air Force Base, NM

and

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U.S. Army Corps of Engineers
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APPENDIX A MATERIAL SAFETY DATA SHEET (MSDS)

ACRONYMS

AFB	Air Force Base
CFR	Code of Federal Regulations
CGI	combustible gas indicator
CIH	Certified Industrial Hygienist
COR	Contracting Officer's Representative
CPR	cardiopulmonary resuscitation
°F	degrees Fahrenheit
dBA	decibel A-weighted
DO	Delivery Order
EHS	Environmental Health and Safety
ERP	Emergency Response Plan
ESS	Environmental Safety Specialist
FID	flame ionization detector
FOL	Field Operations Leader
Foster Wheeler	Foster Wheeler Environmental Corporation
GFCI	ground-fault circuit interrupter
HASP	Health and Safety Plan
LEL	lower explosive limit
MSDS	Material Safety Data Sheet
O_2	oxygen
OHST	Occupational Health and Safety Technician
OSHA	Occupational Safety and Health Administration
PHSM	Project Health and Safety Manager
PID	photo ionization detector
PM	Program Manager
PPE	personal protective equipment
PVC	polyvinyl chloride
TERC	Total Environmental Restoration Contract
TWA	time-weighted average
USACE	United States Army Corps of Engineers

1.0 GENERAL

This Basewide Health and Safety Plan (HASP) provides the general health and safety policies, responsibilities, procedures, and controls that Foster Wheeler Environmental Corporation (Foster Wheeler) will implement while conducting environmental services for the United States Army Corps of Engineers (USACE), Omaha District, Total Environmental Restoration Contract (TERC) No. DACW-45-94-D-003, at Cannon Air Force Base (AFB), New Mexico. Elements of this plan include description of scope of work; hazard assessment and control measures; key personnel, authorities, and responsibilities; personnel monitoring and protection; site control; and decontamination. The HASP also details emergency response and first aid practices.

Implementation of this HASP ensures that operations at Cannon AFB comply with Foster Wheeler health and safety policies, procedures, and guidelines; contract requirements; USACE and Base requirements; and all applicable laws and regulations. This HASP applies to all personnel conducting activities under the TERC, including Foster Wheeler employees, subcontractors, and site visitors.

This HASP is a Basewide health and safety plan that addresses all aspects of health and safety for field activities at Cannon AFB that remain constant. Specific work efforts involving a change in site conditions or project scope shall require development of a site-specific addendum that addresses and clarifies all elements covered by this Basewide plan. The health and safety addendum shall be generated prior to beginning work and describes the site-specific conditions, scope of work, site activities, key personnel, hazard assessment, and procedures. Where hazards associated with a specific site are not addressed by this plan, site-specific addenda shall describe the hazards and outline specific hazard control measures. Where site hazards are covered by information contained in this HASP, the addenda shall reference the appropriate section of this plan and expand on the general control descriptions provided.

This Basewide HASP and any site-specific addenda shall be maintained on site at all times; the referenced corporate health and safety policies, procedures, and guidelines are accessible in the Foster Wheeler corporate reference library.

2.0 ORGANIZATION/KEY PERSONNEL AND RESPONSIBILITIES

The following sections describe key project personnel and their responsibilities and authorities relative to implementing this HASP in accordance with the Foster Wheeler corporate policies, procedures, and guidelines; contract requirements; USACE and Base requirements; and applicable laws and regulations. Additional responsibilities relative to implementing this HASP are contained in Environmental, Health and Safety (EHS) procedure EHS 1-1, Responsibility for Program Implementation.

2.1 PROJECT MANAGEMENT

The Program Manager (PM) and Delivery Order (DO) Manager are responsible for overall operations during on-site fieldwork, including the health and safety of personnel conducting site activities. Specific responsibilities under this HASP include:

- Ensuring that all projects are implemented in compliance with this HASP; environmental, safety, and health laws and regulations; Foster Wheeler policies, procedures, and guidelines; and USACE and Base requirements
- Ensuring that site-specific HASPs are identified during the planning phase of the project, and developed, approved, and implemented in accordance with Foster Wheeler, USACE, and Base requirements
- Integrating loss control principles into all operations
- Ensuring that safe work rules and practices are enforced
- Ensuring that incident investigations are conducted per program requirements
- Performing on-site inspections to ensure the HASP is being implemented
- Determining and implementing corrective actions following audits, inspections, incident investigations, etc.
- Coordinating with the Project Health and Safety Manager (PHSM) and Environmental Safety Specialist (ESS) on health and safety issues
- Ensuring that the PHSM and ESS are informed of project changes that require modifications to the HASP
- Ensuring that resources are available for all health and safety requirements
- Ensuring that personnel have all required training and assigning trained and qualified personnel to project tasks
- Ensuring that personnel understand the requirements of the project and health and safety plans, and individual responsibility for plan implementation
- Providing the appropriate monitoring and safety equipment necessary for implementing this HASP

The PM and DO Manager have the ability to authorize the following safety-related suspensions:

- Temporary suspension of field activities if the health and safety of personnel are endangered (pending an evaluation by the PHSM)
- Temporary suspension of an individual from field activities for infraction of the HASP

2.2 FIELD OPERATIONS LEADER

The Field Operations Leader (FOL) provides project management with administrative support, and assists management with implementation of the Foster Wheeler health and safety policies, procedures, and guidelines; this HASP and any addenda; USACE and Cannon AFB requirements; and applicable laws and regulations. The responsibilities of the FOL include:

- Assisting the PM or DO Manager to implement all health, safety, and loss-control requirements
- Ensuring site safety
- Implementing the HASP and site-specific addenda
- Enforcing safe work practices
- Participating in field health and safety inspections
- Ensuring that all contractual requirements are met
- Informing facility personnel of scheduled activities
- Ensuring that site permits are obtained before work begins
- Communicating work schedules to the ESS

2.3 PROJECT HEALTH AND SAFETY MANAGER

The PHSM is responsible for ensuring that this HASP meets all Foster Wheeler corporate health and safety policies, procedures, and guidelines; USACE and Base requirements; and applicable laws and regulations. The responsibilities of the PHSM include:

- Establishing project goals, direction, and health and safety standards and guidelines
- Reviewing and approving changes to this plan
- Investigating serious accidents
- Planning, coordinating, and implementing project health and safety services
- Providing industrial hygiene and safety guidance to the ESS
- Ensuring that health and safety records are maintained and updated
- Conducting site inspections, including inspections of subcontractors

- Maintaining a working knowledge of applicable federal, state, and U.S. Department of Defense health and safety standards
- Making technical and regulatory interpretations, as required

2.4 ENVIRONMENTAL SAFETY SPECIALIST

The ESS assists the PM, DO Manager, and FOL with implementation of this plan and ensures that site operations are in compliance with Foster Wheeler health and safety policies, procedures, and guidelines; USACE and Base requirements; and applicable laws and regulations. Specific responsibilities of the ESS include:

- Conducting site-specific health and safety training to ensure team members understand the requirements of this HASP and all project health and safety requirements
- Ensuring daily health and safety meetings are conducted
- Modifying and/or developing procedures or revisions to this plan after consultation with the PHSM if the scope of work is changed through natural causes or contract modifications
- Developing or assisting with the development of site-specific HASPs in conjunction with project management
- Approve or obtain approval of all site-specific HASPs
- Fulfill the specific responsibilities for project health and safety personnel that are identified within Foster Wheeler policies, procedures, and guidelines
- Investigating all accidents and incidents
- Calibrating, maintaining, and overseeing the use of monitoring equipment and documenting the results
- Maintaining site health and safety records
- Maintaining access on site to Foster Wheeler corporate health and safety policies, procedures, and guidelines in the corporate reference library; copies of this HASP; and any site-specific addenda
- Monitoring compliance with this plan and documenting work and safety practices
- Conducting site inspections to assess safety practices used by on-site project teams
- Taking corrective actions, as necessary, to remediate nonconformances and prevent their reoccurrence
- Directing health and safety activities on site, distributing health and safety equipment, and initiating emergency services

The ESS has "stop-work authorization" if an imminent danger or potentially dangerous work practice exists. Authorization to proceed with work will be verified by the PHSM. The ESS

shall coordinate with the Cannon AFB Safety Office, Industrial Hygiene Office, and Security Office to ensure compliance with all site requirements.

2.5 TEAM MEMBERS

All team members have the responsibility to:

- Understand and comply with all project and site-specific health and safety requirements
- Strive for Zero Incident Performance
- Attend training regarding the hazards and levels of protection required for individual projects before field work begins
- Attend required safety briefings during conduct of work activities
- Notify supervisor immediately of any work-related injury, illness, spill release, permit exceedance, or loss potential incident; any environmental or safety hazard issue at the work site; or any concern regarding the Foster Wheeler health and safety requirements
- Stop work in conditions Immediately Dangerous to Life and Health

3.0 PROJECT DESCRIPTION

Activities that may be accomplished under this HASP and governed by this plan include the following:

- Soil sampling
- Water sampling
- Drilling with hollow-stem auger, mud rotary, air rotary, or cable tool equipment
- Well and piezometer installation
- Geophysical surveys
- Direct push technology surveys
- Biota studies
- Radiological investigations
- Construction activities associated with remediation and restoration activities including, but not limited to, the following:
  - Excavation/backfill
  - Clearing and grubbing
  - Confined space entry
  - Operations and maintenance of treatment system
  - Utilities installation/removal
  - Demolition
  - Road construction

4.0 HAZARD ASSESSMENT

This section describes the chemical and biological hazards that may be encountered at Cannon AFB.

4.1 ACTIVITY HAZARD ANALYSIS

A site-specific hazard analysis will be generated for each addendum that describes the specific control measures to be used for each hazard.

The preliminary analysis for each activity shall be reviewed prior to the beginning of each activity or when work specifications or scope are changed. Any scope of work changes will be announced during meetings between project, Cannon AFB, and USACE personnel, at which time the updated analysis shall be reviewed to inform personnel of the presence or absence of additional health and safety hazards and actual field conditions. The revised analysis will be included in a site-specific addendum to this HASP and be reviewed with affected personnel prior to starting all activities. All reviews shall be documented.

4.2 CHEMICAL HAZARDS

Several potential site contaminants were identified during the review of existing project documentation. Information on the signs and symptoms of overexposure for each chemical and exposure limits for and the physical properties of each identified chemical will be addressed on a project-specific basis in subsequent basewide health and safety plan addenda. Proper implementation of hazard-control methods, monitoring, personal protective equipment (PPE), and good-work practices should result in very low exposure hazards. Exposures via skin contact may pose an additional concern for unprotected personnel at some sites.

4.3 HAZARD COMMUNICATION

Information regarding chemical hazards not addressed in Section 4.2 of this HASP may be obtained through the Foster Wheeler Hazard Communication Program contained in procedure EHS 4-2, Hazard Communication. This corporate program was implemented in accordance with 29 Code of Federal Regulations (CFR) 1910.1200 to ensure that a list of hazardous chemicals is developed for each work site and that current Material Safety Data Sheets (MSDSs) are obtained and maintained on site for all chemicals procured. Each container of hazardous chemicals at the work site shall be labeled, tagged, or marked in accordance with the Hazard Communication

Program. Additional safe work practices relative to the Hazard Communication Program are included in the Foster Wheeler Project Rules Handbook, Sections 2.28 and 2.29.

The ESS will ensure that personnel working under this HASP receive site-specific training covering the chemical hazards associated with the tasks to which they are assigned. This training will include the potential hazards of chemicals procured for each activity, how to read an MSDS, and the location where the MSDSs are maintained. Additional training requirements are contained in procedure EHS 4-2.

4.4 BIOLOGICAL HAZARDS

The following sections address biological hazards that may be present at Cannon AFB. These hazards include poisonous plants, insects, and rattlesnakes.

4.4.1 Poisonous Plants

Although contact with poisonous plants is not anticipated at the site, personnel should be aware of the presence of poisonous plants in areas adjacent to the site. Poison ivy is a climbing plant with alternate leaves (arranged in threes that are green to red in color) and with white berries. Poison oak is similar to poison ivy and sumac, but its leaves are oak-like in form. The leaves of these poisonous plants produce an irritating oil that causes an intensely itchy skin rash and blister-like lesions.

Cactus spines can inflict painful injuries to unwary site personnel. Prior to access, each work site should be visually surveyed to identify areas where cacti may grow. Workers should be particularly alert to cacti that grow low to the ground. Avoid stepping on or scraping up against cactus plants, and be aware that spines may not always be readily apparent to the casual observer.

4.4.2 Insects

Stinging insects, primarily spiders, scorpions, bees, and wasps, are prevalent during the warmer months at Cannon AFB. Field personnel should try to avoid contact by first surveying the areas they will be reaching into, walking, standing, sitting, leaning, grabbing, or lifting.

Many insects bite or sting, but few can cause serious symptoms by themselves, unless the person is allergic to them. However, some insects transmit diseases. For example, certain types of

mosquitoes transmit malaria, yellow fever, and other diseases; certain types of ticks transmit spotted or Rocky Mountain fever; and certain types of biting flies transmit tularemia or rabbit fever. Occasionally, stinging or biting insects that have been feeding on or have been in contact with poisonous substances can transmit this poison at the time of the sting or bite.

Persons who have experienced serious reactions from previous insect bites should be urged to secure any possible immunization or have an antidote readily available to prevent more serious reactions from future insect bites and stings.

The signs and symptoms of insect bites and stings are as follows:

- The stings of bees and the bites of mosquitoes, ticks, fleas, and bedbugs usually cause only local irritation and pain in the region stung or bitten.
- Moderate swelling and redness may occur and some itching, burning, and pain may be present.

The effect of stings and bites of spiders, centipedes, tarantulas, and scorpions in some instances are much more severe than those of the insects previously mentioned. They may cause alarming symptoms.

The signs and symptoms of these bites are as follows:

- Generally, the bite consists of two small pinpoint punctures of the skin and produces local swelling and redness with a smarting, burning pain.
- Exhaustion, sweating, and nausea may appear.
- Pain or cramping may develop in the back, shoulders, chest, and limbs.
- In some instances, the symptoms are mild and subside within 6 to 12 hours, but occasionally they are severe and can cause a state of collapse.

The black widow spider is a moderately large, glossy black spider with very fine hairs over the body that give it a silky appearance. On the abdomen is a characteristic red or crimson marking in the form of an hourglass. Only the female is poisonous; the male, which is smaller, is harmless.

The brown recluse spider injects venom that causes a limited destruction of red blood cells and certain other blood changes. The victim may develop chills, fever, joint pains, nausea, or vomiting. A rash may also develop within 24 to 48 hours.

Tarantulas are hairy spiders. Those found in the southwestern United States are not poisonous, but occasionally a victim will have an allergic reaction to the injected venom. Tarantulas coming into the country with imported fruit may be poisonous. Their bites may cause marked pain and local redness with swelling. Death is extremely rare.

Most species of scorpions in this country inject a toxin that is generally not harmful to humans. The sting may result in local swelling and discoloration, similar to a wasp sting, and may sometimes cause allergic reactions. The sting of the more dangerous species of scorpions causes little or no swelling or discoloration, but locally there will be a tingling or burning sensation. Considerable discomfort may ensure. Death, although unlikely, occurs occasionally in infants and young children and might conceivably occur in older persons. The poison acts mainly on the nervous system.

4.4.3 Rattlesnakes

Poisonous snakes (rattlesnakes) could be encountered during site activities. Employees are advised to be alert to this danger. Snakebites can be painful and lead to serious illness if not treated immediately. If bitten, employees must seek medical attention immediately. The best thing to do, however, is to avoid contact. Wear sturdy leather boots, avoid walking in areas where snakes may hide, and use extreme caution when moving or lifting objects that could be used by snakes as cover. Never reach under or behind such objects or into other areas where snakes may hide.

The signs and symptoms of a snakebite are as follows:

- A sharp, stinging pain with one or more puncture marks in the area
- Swelling, discoloration, and pain in the bitten area

As the poison goes through the body, other symptoms develop such as:

- Weakness
- Nausea and vomiting
- Weak and rapid pulse
- Respiratory distress
- Shock

5.0 TRAINING

Personnel covered by this HASP must be active participants in the Foster Wheeler Hazardous Waste Operation and Health and Safety Training Program, which complies with the Occupational Safety and Health Administration (OSHA) 29 CFR 1910.120(e), OSHA 29 CFR 1926.20, and the USACE Safety and Health Requirements Manual EM 385-1-1 (Section 28.D) (1996). Foster Wheeler training requirements are presented in procedure EHS 1-11, Training. All site personnel shall be trained to recognize hazards and implement the hazard-control provisions of this HASP. The following sections address training requirements, including the conduct of site safety meetings.

5.1 PREASSIGNMENT TRAINING

Before arrival on site, each employer will be responsible for certifying that field personnel meet the requirements 29 CFR 1910.120 paragraph (e)(3). Each employer will provide a document certifying dates of the 40-hour hazardous waste health and safety training to the ESS. Personnel must also receive 8 hours of refresher training on an annual basis and must provide 8-hour refresher certificates to the ESS.

5.2 SUPERVISOR TRAINING

The ESS and FOL will have completed the basic 40-hour training course, 3 days of on-the-job training, first-aid training, and at least 8 hours of supervisor training. The supervisor training includes specialized instruction relating to the management of hazardous waste operations.

5.3 3-DAY ON-THE-JOB TRAINING

All employees shall be required to receive a minimum of 3 days of on-the-job training, documented by an experienced supervisor. Employers are required to provide documentation of this training to the ESS.

If employers cannot provide documentation or if a new employee is assigned to the site, the FOL and ESS will complete the site training. Completion of the training will be documented on a form kept in the individual's on-site health and safety file.

5.4 SITE-SPECIFIC TRAINING

The ESS shall conduct site-specific training for all field employees, including subcontractors, before starting field and/or laboratory activities. The following topics will be discussed:

- Names of health and safety personnel and alternates responsible for site health and safety
- Health and safety organization
- Locations where the site-specific health and safety plan can be found
- Hazards at the site
- Hazard communication program
- Exposure risk
- PPE to be used
- Personnel and equipment decontamination procedures
- Air monitoring
- Emergency procedures

Additionally, all field personnel are responsible for knowing and understanding the information contained in this HASP. At the end of the meeting, the ESS shall informally quiz the attendees to assess their understanding of the health and safety requirements. Attendees shall also sign a Field Team Review Sheet stating that they have been trained in, understand, and agree to comply with the provisions of this HASP. Anyone refusing to sign the form will be prohibited from working at the site.

When a new employee has been assigned to the site, the ESS must present a similar briefing before the new employee participates in any field activities. All new employees must sign the Field Team Review Sheet after receiving training and prior to beginning fieldwork.

5.5 SITE SAFETY MEETINGS

Site safety orientation/training meetings shall be conducted by the FOL or ESS before field personnel begin work at specific sites, when there are modifications to this HASP, or when additional personnel begin fieldwork. All personnel involved in field activities will attend meetings. Additionally, a daily site safety meeting will be held before the start of field activities. All field personnel must attend this meeting and document their attendance. The minutes for the

meeting will be documented in the site logbook. The meeting agenda will include the following activities:

- Description of the assigned tasks and their potential hazards
- Coordination of site activities
- Identification of methods and precautions to prevent injuries
- Discussion of emergency planning
- Any modifications to the site-specific HASP
- Input from field personnel on health and safety issues pertaining to site activities

General requirements for meetings conducted in support of field operations are contained in the Foster Wheeler procedure EHS 1-6, Meetings.

5.6 FIRST AID AND CARDIOPULMONARY RESUSCITATION TRAINING

At least two site employees per shift shall be currently certified in first aid and cardiopulmonary resuscitation (CPR) consistent with the requirements of the American Red Cross Association. In accordance with the Foster Wheeler procedure EHS 1-11, Training, one certified individual must be a Foster Wheeler employee. The certified individuals must be working in close enough proximity to other team members so that they can administer CPR or first aid in a timely manner.

5.7 RECORDKEEPING

The ESS shall ensure that all health and safety recordkeeping requirements mandated by 29 CFR 1910.1904, 1910.120, and any other applicable standard are complied with. Records to be maintained include on-site logs, accident/incident reports, OSHA Form 200s, exposure monitoring records, training certificates, and health and safety field logbooks. Records shall be maintained in a consistent manner that meets applicable laws and regulations and contract requirements. Recordkeeping requirements are presented in Foster Wheeler procedure EHS 1-9, Recordkeeping.

6.0 WORK ZONES, PERSONAL PROTECTION, AND COMMUNICATION

This section describes the work-zone, personnel protection, and communications requirements of this HASP. Requirements for site and contamination control are contained in Foster Wheeler procedure EHS 3-4, Site Contamination Control.

6.1 CONTROLLED WORK ZONES

The ESS shall ensure that work sites are controlled to reduce the possibility of exposure to any on-site contaminants or the potential off-site transport of these contaminants by personnel or equipment. The possibility of exposure or translocation of substances shall be reduced or eliminated in a number of ways, including the following:

- Setting up security and physical barriers to exclude unnecessary personnel from the general area
- Minimizing the number of personnel and equipment on site consistent with effective operations
- Establishing work zones within the site
- Establishing control points to regulate access to work areas or zones
- Conducting operations in a manner to reduce the exposure of personnel and equipment and to eliminate the potential for airborne dispersion
- Implementing appropriate decontamination procedures

Work zones shall be established by the ESS on a case-by-case basis. These controlled zones may consist of a single area designed to prevent unauthorized personnel from entering or may include a complex system using exclusion, contamination reduction, and support zones. Each zone shall be marked with caution tape and/or traffic cones, with designated access points clearly identified. Decontamination areas will be collocated with the access points.

6.2 SITE VISITORS

Access to the site by visitors shall be restricted as follows:

- All site visitors must notify the FOL and the ESS or his/her designee before obtaining access to a support zone.
- Site visitors entering controlled work zones will be strictly limited. The ESS must approve entry and the visitor must demonstrate medical and training clearance to enter a controlled work zone and must be given site-specific training.
- Visitors shall sign a copy of the Field Team Review Sheet contained in Section 13.0 after completing site-specific training.

- All site visitor access must be clearly documented, and visitors must comply with all provisions of the site HASP.

6.3 BUDDY SYSTEM

The buddy system shall be used during all field activities. At no time will an individual work alone in a controlled work zone.

6.4 PERSONNEL PROTECTION

Personnel shall wear PPE during any of the following conditions: (1) field activities involving the potential for exposure to contaminants; (2) site activities that may present physical hazards such as overhead, eye, and hearing; (3) site activities which may generate vapors, gases, particulates, mists or aerosols; or (4) direct contaminant contact with skin. The type of required PPE is categorized into a level of protection. For specific work activities at specific sites, levels of protection and the specific PPE to be worn for each level will be defined in site-specific addenda to this plan. The levels of protection and accompanying PPE requirements shall be determined based upon the actual contaminants present at each site.

The ESS shall determine whether the level of protection needs to be upgraded or downgraded. In this instance, the appropriate documentation shall be forwarded to the PHSM. Foster Wheeler procedure EHS 5-1, Personal Protective Equipment provides general requirements to ensure that PPE is selected in accordance with 20 CFR 1910.132, properly used and maintained, and that users of PPE are properly trained in its use. The proper selection, use, and care of respiratory protection equipment by site workers to ensure compliance with OSHA, 29 CFR 1910.134 is presented in Foster Wheeler procedure EHS 5-2, Respiratory Protection.

6.4.1 Level D Protection

The following PPE shall be considered typical Level D protection:

- Coveralls
- Leather or chemical-resistant boots with a steel toe and shank
- Work gloves
- Safety glasses, chemical splash goggles, or face shield (as determined by the ESS)
- Hard hat (as determined by the ESS)
- Hearing protection (as determined by the ESS)

- Outer latex disposable boots (optional)

Level D protection is used when the following criteria are met:

- No hazardous air pollutants are measured.
- Work functions preclude splashes, immersion, or potential for unexpected inhalation or dermal contact with any chemicals at potentially hazardous concentrations, or for unsafe exposure durations.

Level D protection is primarily a work uniform and will be worn only in areas where there is a low potential for exposure to toxic substances.

6.4.2 Level D Modified Protection

Level D Modified protection shall be used when an increased need for dermal protection is recognized but respiratory protection is not indicated. The following equipment shall be used for Level D Modified protection:

- Chemical-resistant clothing (Tyvek® coveralls for particulate hazard or Saranex coveralls or rubber outer gear for liquid hazard)
- Disposable nitrile outer gloves (glove selection based on the site-specific contaminant hazard)
- Nitrile or latex inner gloves (glove selection based on the site-specific contaminant hazard)
- Polyvinyl chloride (PVC) boots (chemical-resistant) with a steel toe and shank
- Hard hat (as determined by the ESS)
- Hearing protection (as determined by the ESS)
- Latex outer booties (optional)
- Safety glasses

6.4.3 Level C Protection

The following PPE shall be considered Level C protection:

- Full-face piece air-purifying cartridge respirator with organic vapor/high-efficiency particulate filter cartridges (As site conditions warrant, a different APR cartridge may be specified in site-specific addenda.)
- Chemical-resistant clothing (Tyvek® coveralls for particulate hazard or Saranex coveralls or rubber outer gear for liquid hazard)
- Disposable nitrile outer gloves (glove selection based on the site-specific contaminant hazard)

- Nitrile or latex inner gloves (glove selection based on the site-specific contaminant hazard)
- PVC boots (chemical-resistant) with a steel toe and shank
- Hard hat (as determined by the ESS)
- Hearing protection (as determined by the ESS)
- Latex outer booties (optional)
- Two-way radio communications

The use of a full-face piece air-purifying respirator is approved only if the following applies:

- Substances are identified and their concentrations measured.
- Individual passes a qualitative fit test for the assigned respirator.
- An appropriate cartridge is selected based on the hazard.
- The PHSM has approved use and has established a cartridge change schedule.

It is particularly important that the air monitoring is effectively implemented when personnel are wearing Level C protection.

6.4.4 Level B Protection

Level B protection is not anticipated for use during the activities to be conducted. If action levels for Level C are exceeded, work will be stopped and the PHSM and the Contracting Officer's Representative (COR) will be contacted for assistance. If work is identified that will require the use of Level B protection, all necessary provisions will be included as addenda to this HASP.

6.5 COMMUNICATIONS

At a minimum, for emergency purposes, each work site must have immediate access to a phone or cellular phone. If radios are used, they must be able to immediately contact someone who has access to a phone. Verbal communications on site may be impeded by background noise caused by heavy equipment. Accordingly, hand signals will be used by personnel within the work zone. Communications requirements will be reviewed during the site safety meetings.

The following hand signals shall be used in the event of an emergency where audible communication is not possible:

Hand Signal	Meaning
Hand gripping throat	Out of air, cannot breath
Gripping partner's wrist or both hands on waist	Leave area now, no debate
Hands on top of head	Need assistance
Thumbs up	OK, I'm all right, I understand
Thumbs down	No, negative

7.0 MONITORING

This section describes implementation requirements for direct-reading instrumentation, including calibration and maintenance of instrumentation and integrated personal air sampling. General information for the use, maintenance, and calibration of various types of monitoring equipment (as applicable) is presented in the Foster Wheeler Health and Safety Guidelines HSG1-1 through HSG1-12. The manufacturer's instruction manuals should be used in conjunction with this HASP and health and safety guidelines as appropriate.

7.1 REAL-TIME MONITORING

Photoionization detectors (PIDs), flame ionization detectors (FIDs), combustible gas indicators (CGIs), hydrogen sulfide (H_2S) detectors, and oxygen meters (O_2) can be used to measure airborne concentrations of suspected contamination and flammable/explosive environments. Colorimetric detector tubes will be used for specific chemicals of concern. As directed by the ESS, these instruments will be used to monitor entry into controlled work zones at site perimeters and specific work locations.

The majority of exposure monitoring will be conducted using direct-reading instruments in the workers' breathing zone. Initial upwind background and work-zone readings will be obtained before the initiation of activities. Readings of breathing zones will be taken periodically during all activities as required by site-specific health and safety plans. Monitoring results will be recorded in a health and safety logbook. Monitoring, calibrating, and maintaining instruments are be the responsibility of the ESS or a designee.

7.2 ORGANIC VAPOR MONITORING

A PID or FID will be used to measure airborne levels of organic vapors during activities to determine the need for level C protection. For the PID, a 10.2 or greater electron volt (eV) lamp will be used, depending on site requirements. The monitoring strategy is presented in Section 7.1. Action levels for PIDs and FIDs will be addressed on a project-specific basis in subsequent Basewide health and safety plan addenda.

7.3 COLORIMETRIC TUBES

Direct-reading colorimetric tubes will be used to monitor for site-specific contaminants at the direction of the PHSM. Site-specific addenda to this plan shall specify type of tubes to be used, any special information required for use, and action levels to be used in conjunction with tube readings.

In general, the ESS shall follow these procedures:

- Leak-test each pump prior to use and document the results in the calibration logbook
- Take readings from workers breathing zones
- Correct readings for pressure as directed by the tube manufacturer
- Maintain the equipment in accordance with manufacturers instructions

7.4 COMBUSTIBLE GAS/OXYGEN MONITORING

The ESS shall ensure that combustible gas/oxygen levels are measured prior to entry into open excavations, sumps, confined spaces, or other sites/conditions where a flammable, combustible, or oxygen-deficient atmosphere may be present. To ensure accurate measurements, the O_2 concentration must be measured before the lower explosive limit (LEL) concentration.

Action levels for LEL and O_2 concentrations will be addressed on a project-specific basis in subsequent Basewide health and safety plan addenda. When used, CGIs/O_2 meters will be maintained and calibrated before and after use in accordance with manufacturers' instructions.

7.5 INTEGRATED PERSONAL AIR SAMPLING

Personal air sampling shall be conducted for potential contaminants at the direction of the ESS. Sample results will be used to validate employee exposures and the adequacy of PPE used on the project or to satisfy a regulatory requirement. Sampling procedures shall be as follows:

- Conduct sampling in accordance with National Institute for Occupational Safety and Health analytical methods
- Calibrate sampling pumps before and after use
- With the concurrence of the PHSM, initiate sampling if Level C action levels are reached
- Develop a sampling strategy with the PHSM
- Use sample seals and chain-of-custody documentation to ensure the integrity of samples and results

- Submit field blanks in conjunction with exposed sorbent media for analysis
- Notify the employees in writing of the results. The ESS, who is directly responsible for this activity, must offer the employees an opportunity to discuss the significance of the results
- Forward field results to Corporate Health and Safety for inclusion in each employee's medical record

7.6 DIRECT-READING INSTRUMENTATION ACTION LEVELS

The PHSM shall set action levels for work to be performed under this plan on a site-by-site basis. Such changes will be included in the site-specific health and safety addenda. In general, the setting of action levels considers the number and type of contaminants present, applicable exposure limits, and relevant toxicological and epidemiological data.

7.7 MEDICAL SURVEILLANCE REQUIREMENTS

All Foster Wheeler personnel and subcontractors who will be performing field work on site are required to have current medical approval for hazardous waste site work. The medical exams shall be performed by an occupational physician or equivalent and shall include a written opinion on the person's ability to perform work on a hazardous waste site. The medical records to be maintained on site by the ESS include the following:

- Qualification statement for hazardous waste work
- Qualification for respirator use
- Respirator fit test results
- Emergency Medical Data Sheet (see Section 12.0)

Foster Wheeler's Medical Surveillance Program is included in procedure EHS 4-5, Medical Surveillance.

7.8 NOISE LEVEL MONITORING

Noise level monitoring will be performed for operations having the potential for generating noise levels that could result in overexposures. Monitoring will be accomplished in accordance with the following:

- Monitoring will be performed using a Type I sound level meter.
- Sound level meters will be calibrated and operated in accordance with manufacturers' instructions.
- Noise level readings will be documented in health and safety logbooks.

- Calibration check results will be documented in the site calibration logbook.
- Hearing protection shall be used in accordance with the action levels provided in project-specific addenda to the Basewide health and safety plan.
- Employees will be notified in writing of all noise monitoring results pertinent to their work activities.
- Results will be forwarded to Corporate Health and Safety for inclusion in their medical record.

Requirements for the use, maintenance, and calibration of sound level meters and personal noise dosimeters and general guidelines for conducting noise surveys are contained in Health and Safety Guideline HSG1-5, Noise Monitoring.

8.0 SAFETY CONSIDERATIONS FOR SITE OPERATIONS

Because of the nature of work to be conducted, physical hazards pose the greatest potential health and safety concern during this project. The ESS shall perform frequent and regular inspections of the site, materials, and equipment to identify site hazards in accordance with 29 CFR 1926.20. All personnel on site will be provided with the information and training necessary to avoid accidental injury, including maintaining the site in such a way slip, trip, and fall hazards are recognized and eliminated or controlled. Basic PPE must be available and its use will be enforced by site management. This section provides a review of practices that will be followed to control physical hazards.

8.1 SLIPS, TRIPS, AND FALLS

Field personnel shall 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. Accordingly, field personnel must remain alert to surrounding conditions and inspect the work area for tripping or other hazards. These hazards will either be removed from the immediate area or marked to prevent injuries.

All fall protection hazards will be addressed independently in the site-specific addenda

8.2 SPLASHES AND SPILLS

Field personnel shall wear the appropriate chemical-resistant clothing to prevent dermal exposure from accidental splashes and spills.

8.3 ILLUMINATION

Artificial/supplementary lighting shall be provided when field operations continue past dusk. The lighting shall illuminate the entire work area to an intensity equal to 5 foot-candles. All temporary lamps for general illumination must be protected from accidental breakage. Metal case sockets must be grounded.

8.4 ELECTRICALLY POWERED EQUIPMENT

All electrical equipment, including portable tools, lighting, and power and extension cords, shall comply with 29 CFR 1926.400. Site workers who may be exposed to electrical equipment shall be trained to recognize the potential hazards and identify the appropriate control methods in

accordance with OSHA regulations. Safe work practices relative to electrical safety are included in the Foster Wheeler Project Rules Handbook, Sections 2.24 and 2.33.

All extension cords used for portable tools or other equipment must be designed for hard or extra hard usage and must be three-wire grounded. All 120-volt, single-phase, 15- and 20-ampere receptacle outlets on construction sites and other locations where moisture/water contact may occur must be equipped with ground-fault circuit interrupter (GFCI) units. The site-specific addenda shall provide specific requirements for use of electric equipment on site.

All electrical equipment must be visually inspected prior to use and equipment that could expose personnel to electric shock must be removed from service. A weekly inspection of power tools shall be performed and recorded. All temporary electricity for construction applications shall be GFCI-protected.

Whenever conducting maintenance on electrical equipment, lockout/tagout procedures to isolate the unit and all associated equipment must be used. Lockout/tagout procedures are contained in Foster Wheeler procedure EHS 6-4, Lockout/Tagout.

8.5 BLOODBORNE PATHOGEN EXPOSURE

Bloodborne pathogen exposure risks are associated with medical emergencies requiring CPR; the stabilization of a victim bleeding or with an open wound; or cleanup of blood, body fluids or tissues, or broken or sharp objects that might be contaminated with blood. Personnel trained in CPR and first aid shall be trained in the Foster Wheeler corporate bloodborne pathogens program, provided in procedure EHS 4-1, Bloodborne Pathogens.

8.6 HEAT STRESS

The ESS shall provide work conditions that prevent heat stress. In general, the ESS shall follow these procedures to reduce heat stress:

- Have workers drink 16 ounces of water before beginning work, i.e., in the morning or after lunch. 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 in 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 workloads, 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 cotton long underwear, which acts as a wick to help absorb moisture and protect the skin from direct contact with heat-absorbing protective clothing.
- Make certain 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.

The following are examples of heat-related stress that may be encountered:

- Heat rash: caused by continuous exposure to heat and humid air, aggravated by chafing clothes. Signs: A decreased ability to tolerate heat and obvious signs of discomfort.
- Heat cramps: caused by profuse perspiration with inadequate fluid intake and chemical replacement (especially salts). Signs: muscle spasm and pain in the extremities and abdomen.
- Heat exhaustion: caused by increased stress on various organs to meet increased demands to cool the body. Signs: shallow breathing; pale, cool, moist skin; profuse sweating; dizziness; and fatigue.

For strenuous field activities that are part of ongoing site work activities in hot weather, the following procedures shall be used, even if workers are not wearing impervious clothing, to monitor the body's physical response to heat and to manage the work cycle. These procedures shall be implemented when the ambient temperature of the work area exceeds 70°F.

Work-rest regimes are based on ambient temperature and level of PPE worn. Three means are available to measure the physiologic responses to heat stress: heart rate, oral temperature, and body water loss. A Wet-Bulb Globe Temperature index shall be calculated for Level D applications. This index is not valid when higher levels of protection are worn. One or both 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 resting pulse rate is maintained below 110 beats per minute.

- Measure body temperature 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 make sure that it has dropped below 99°F. Anyone with an oral temperature exceeding 100.6°F shall not wear impermeable clothing.

8.7 COLD STRESS

Cold injury (frostbite and hypothermia) and the impaired ability to work are dangers at low temperatures when the windchill factor is high.

Personnel working outdoors in temperatures at or below freezing may become frostbitten. Extreme cold for a short time may cause injury to the surface of the body or result in profound generalized cooling. Areas of the body that have high surface-area-to-volume ratio, such as fingers, toes, and ears are the most susceptible.

Localized injuries resulting from cold are included in the generic term "frostbite." There are several degrees of damage. Frostbite of the extremities can be placed into the following categories:

- Frost nip or incipient frostbite, which is characterized by sudden blanching or whitening of skin.
- Superficial frostbite, which is characterized by skin that presents a waxy or white appearance and that is firm to the touch and by resilient tissue.
- Deep frostbite, which is characterized by cold, pale, and solid tissue. This condition indicates an extremely serious injury.

Systemic hypothermia is caused by exposure to freezing or rapidly dropping temperature. Its symptoms usually present in five stages: (1) shivering; 2) apathy, listlessness, sleepiness, and (sometimes) rapid cooling of the body to less than 95° F; (3) unconsciousness, glassy stare, slow pulse, and slow respiratory rate; (4) freezing of the extremities; and (5) death.

The ESS shall control exposures to cold temperature extremes in accordance with the American Conference of Governmental Industrial Hygienists cold stress threshold limit values. In general, the ESS shall follow these procedures to reduce cold stress:

- Install heaters in the support zone and/or trailers to provide a warming area for site personnel.
- Provide warm, sweet drinks and/or soups at the work site to provide caloric intake and fluid volume. Note: The intake of coffee should be limited because of diuretic and circulatory effects.
- Rotate shifts of workers.
- Carefully schedule work and rest periods.
- Monitor workers' physical conditions.

Additional information concerning prevention of cold-stress-related injuries and illnesses is included in Foster Wheeler procedure EHS 4-6, Temperature Extremes.

8.8 OVERHEAD UTILITIES

Any overhead wire shall be considered an energized line unless the person owning that line or the electrical utility authorities verify and provide documentation that it is not an energized line and that it has been visibly grounded.

A person shall be designated to observe excavation or other equipment and to give timely warning of all operations where it is difficult for the operator to maintain the desired clearance by visual means. Parameters for minimum clearance from energized overhead lines are presented in Table 8-1. The only acceptable method of proving inactive or de-energized state is through an effectively implemented and documented control of hazardous energy program.

Electricity in all structures shall be considered to be on until proven inactive.

Table 8-1. Minimum Clearance from Energized Overhead Electric Lines

Nominal System Voltage (kilovolts [KV])	Minimum Required Clearance
0-50 KV	10 Feet
51-100 KV	12 Feet
101-200 KV	15 Feet
201-300 KV	20 Feet
301-500 KV	25 Feet
501-750 KV	35 Feet
751-1000 KV	45 Feet

8.9 BURIED UTILITY LINES

A review shall be made of any available property maps, red lines, or as-built drawings before sampling activities are conducted to identify potential buried utilities. A utility screen is required in addition to records review. Cannon AFB utilities-locating personnel shall also be utilized to identify, mark, and de-energize buried utilities prior to starting intrusive activities. If additional concerns remain regarding the location of buried utilities, the PHSM shall be contacted for guidance.

8.10 INCLEMENT WEATHER

Natural phenomena, e.g., 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 ESS shall discuss potential weather issues that could affect workers. Additionally, extremes in temperature and moisture could affect the function of monitoring instrumentation and PPE. It is the responsibility of the ESS to recognize weather conditions and adjust site activities accordingly.

8.11 MANUAL LIFTING

Personnel performing material handling shall abide by the following guidelines:

- **DO** design manual lifting and lowering out of the task and workplace. If manual lifting must be accomplished, perform it between knuckle and shoulder height.
- **DO** be in good physical shape. 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 your 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 your 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 lifting when the load is not of a manageable weight.

8.12 PORTABLE LADDERS

All portable ladders shall be used for their designated purposes only, and shall be constructed, maintained, and used in accordance with American National Standards Institute Standards A-14.1 and A-14.2, OSHA 29 CFR 1926 Subpart X, and manufacturers' instructions. Before use, each ladder shall be inspected to verify that all parts are in good condition and all components function properly. Defective ladders shall be tagged "do not use" by the ESS.

In general, personnel shall follow these guidelines when using portable ladders:

- Set ladders on flat, firm surfaces.
- Contact both handrails of a straight ladder with the upper support.
- To prevent slippage of a straight ladder, use another person to hold the ladder in place or tie the ladder securely to the upper support.
- Retain a ratio of 4 to 1 regarding the height of extension related to the distance of the bottom of the ladder to the well or vertical plane (1 foot out for every 4 feet up).
- Extend the handrails of a straight ladder at least 36 inches above the upper support.
- Do not use metal ladders around electrical conductors.
- Do not allow a second person to use the same ladder that you yourself are using.
- Do not stand on the top rung of ladders.
- Position the ladder so that no more than half of your body extends beyond either handrail during the work activity.
- Review ladder raising and usage techniques as applicable under the guidance of the ESS.

Safe work practices for performing overhead work and using ladders, scaffolds, guardrails, barricades, hole covers, and stairs are included in the Foster Wheeler Project Rules Handbook, Sections 2.17, 2.18, 2.19, and 2.20.

8.13 HEAVY EQUIPMENT SAFETY

Heavy equipment can present a variety of hazards. In general, the ESS shall observe the following procedures:

- Require subcontractors to provide equipment that meets the requirements of all relevant OSHA standards.
- Inspect equipment before use. At a minimum, guarding, hydraulics, hoisting, rigging, and overall condition should be reviewed. Correct deficiencies before equipment is used.
- Verify operator qualifications before beginning work.

- Conduct noise monitoring to ensure that personnel are adequately protected.
- Equip all equipment with operational backup alarms and a fire extinguisher.
- Review copies of all pertinent inspections before the start of work.
- Investigate any safety and health concerns arising during the course of work.

8.14 DRIVER SAFETY

During the performance of this work, all personnel using project vehicles shall possess a valid driver's license and obey all posted speed limits, traffic signs, and traffic signals. Personnel riding in project vehicles shall wear seat belts at all times. The FOL shall coordinate with Cannon AFB Police to procure any necessary permits.

Additional safety requirements for operating heavy equipment are contained in Foster Wheeler Construction procedure CP-7, Construction Tools and Equipment. Safe work practices for operating heavy equipment are included in the Foster Wheeler Project Rules Handbook, Sections 2.7 through 2.12.

8.15 POWER AND HAND TOOLS

Personnel shall use power and hand tools in accordance with the following procedures:

- Maintain tools in good condition and inspect them prior to use.
- Use electrical tools that are double-insulated or have a ground plug.
- Use tools for their intended purpose only.
- Remove unsafe tools from service.

Additional requirements governing the use of power and hand tools are included in the Foster Wheeler Construction procedure CP-7, Construction Tools and Equipment. Safe work practices for use of power and hand tools are contained in the Foster Wheeler Project Rules Handbook, Sections 2.1, 2.2, and 2.3.

8.16 HAND PROTECTION

In addition to the PPE required for work in contaminated areas, personnel shall wear heavy leather gloves when handling materials or performing other work that could result in hand injuries.

8.17 LOCKOUT/TAGOUT

In accordance with 29 CFR 1910.147, the site personnel shall use lockout/tagout procedures as necessary to control employee exposure to hazardous energy sources, particularly underground and aboveground utilities and services. Subcontractors shall present their lockout/tagout procedures to the PHSM. Requirements for performing lockout/tagout on machines and equipment are included in Foster Wheeler procedure EHS 6-4, Lockout/Tagout. Safe work practices for conducting activities involving lockout/tagout or line breaking procedures are included in the Foster Wheeler Project Rules Handbook, Sections 2.23 and 2.24.

8.18 TRAFFIC CONTROL

The FOL shall coordinate with the Cannon AFB Police all activities impacting Base traffic. Unauthorized vehicles shall be controlled through the use of barricades, cones, or other warning devices.

8.19 EXCAVATION SAFETY

The ESS shall ensure that excavations are maintained in accordance with 29 CFR 1926, Subpart P, Excavations and in accordance with USACE EM 385-1-1, Section 25 (1996). These standards provide the requirements for daily inspections, work practices, soil testing, and protective systems. Subcontractors shall provide copies of their excavation safety procedures to the PHSM, who will coordinate the review and approval process.

General requirements for activities involving excavations and trenching are included in Foster Wheeler procedure EHS 6-3, Excavation and Trenching. Safe work practices for conducting excavation and trenching activities are included in the Foster Wheeler Project Rules Handbook, Section 2.21.

8.20 CRANE OPERATIONS

The ESS shall ensure that crane operations are conducted in accordance with 29 CFR 1926.550 and USACE EM-385-1-1, Section 15 and 16C (1996). All site workers will also follow the safe work practices included in the Foster Wheeler Project Rules Handbook, Sections 2.4, 2.5, 2.6, 2.8, and 2.13. All subcontractors shall generate a prelift plan that addresses the following points for critical lifts:

- Centers of gravity for loads

- Lift points
- Sling types, attachment method, and capacities
- Safety practices to be used during lifts

The PHSM, Project Superintendent, and COR are responsible for reviewing and approving these plans. Further information concerning critical lifts is contained in the Foster Wheeler Construction procedure CP-13, Critical Lifts.

8.21 HOT WORK

The ESS shall ensure that all work involving the use of cutting or welding equipment is conducted using a hot work procedure. The ESS shall coordinate permits with Cannon AFB Fire Department. If it is necessary to use internal procedures, the PHSM, Project Superintendent, and COR shall review and approve these procedures. General information concerning fire prevention as a result of welding and hot work is included in Foster Wheeler procedure EHS 6-5, Welding/Hot Work. Safe work practices for performing welding activities are included in the Foster Wheeler Project Rules Handbook, Section 2.30.

8.22 LEAD-EXPOSURE CONTROL

If cutting or welding is performed, the subcontractor shall conduct an evaluation to determine the potential for lead exposure during the operations. If lead is present, the subcontractor shall implement an exposure control program to be reviewed and approved by the PHSM, PM, and COR. The lead exposure control program will be drafted in compliance with the OSHA lead standard 29 CFR 1926.62.

8.23 DRILLING SAFETY

The ESS shall ensure that all drilling and associated subsurface activities are conducted in accordance with the Foster Wheeler corporate health and safety manual procedure EHS 6-2, Drill Rigs. No leaks from any system will be acceptable, and all safety devices will be fully operational.

8.24 CONFINED SPACE ENTRY

Confined space entries will be performed in accordance with Foster Wheeler procedure EHS 6-1, Confined Space Entry. Safe work practices for conducting confined space entries are included

in the Foster Wheeler Project Rules Handbook, Section 2.22. Project-specific addenda will detail specific confined space procedures. The PHSM must review and approve confined space entry procedures prior to field implementation.

8.25 MATERIAL STORAGE

Storage of flammable and combustible liquids, compressed gasses, and corrosives shall be done in accordance with Foster Wheeler Corporate Health and Safety Procedure 3-7, Material Storage.

8.26 FIRE PREVENTION

To prevent the occurrence of fires on the project, the following will be completed in accordance with 29 CFR 1926.151:

- Electrical installations shall meet the requirements of 29 CFR 1926, Subpart K.
- Potential sources of fire ignition shall be located away from fuel sources.
- Hot work shall be performed using hot work permits in accordance with Section 8.22 of this plan.
- Flammable and combustible liquids and compressed gasses shall be stored in accordance with Section 8.26 of this plan.
- Fire extinguishers will be provided for the job site in accordance with applicable portions of 29 CFR 1926.150(c).

8.27 INSPECTIONS

To ensure that general safety and health hazards and unsafe work practices are identified and corrected, site inspections shall be conducted in accordance with Foster Wheeler Health and Safety Procedure, HS 3-3, Inspections. Planning for inspection is part of the project planning process described in the Task Initiation Procedure, A-8, and the project risk management plan.

8.28 FALL PROTECTION

To prevent injuries to site personnel due to falls from elevated work surfaces and to comply with OHSA 29 CFR 1926, Subpart M, the ESS shall implement the fall protection program contained in Foster Wheeler procedure EHS 3-8, Fall Protection. All work performed on surfaces (other than ladders and scaffolds with guardrails) where exposures to falls of 6 feet or more are possible will be completed using 100 percent fall protection in accordance with EHS 3-8.

8.29 NOISE

Noise is a potential hazard associated with the operation of heavy equipment, power tools, pumps, and generators. To reduce noise exposure, personnel working in the presence of such equipment should use appropriate hearing protection (ear plugs or ear muffs). Potential high-noise operations will be evaluated by the ESS; all employees are required to wear hearing protection when the OSHA action level of 85 decibels (dBA) is reached or exceeded for an 8-hour time-weighted average (TWA) exposure. The ESS will make this determination and document when hearing protection is required in the health and safety logbook. Site workers with an 8-hour TWA exposure exceeding 85 dBA, will be included in a hearing conservation program in accordance with 20 CFR 1910.95 and the Foster Wheeler procedure, EHS 4-4, Hearing Conservation. Additional information of noise monitoring is contained in Section 7.8.

9.0 DECONTAMINATION

It is the responsibility of the FOL and ESS to make certain that all personnel and pieces of equipment leaving the site are properly decontaminated according to the procedures outlined in this section. Additional requirements for developing site and activity-specific decontamination procedures are contained in Foster Wheeler procedure EHS 3-4, Site Contamination Control. Documentation of decontamination must be made in the field log notebook that will become part of the permanent project file.

9.1 PERSONNEL

All personnel exiting controlled work zones must follow decontamination procedures. Only during an emergency evacuation will personnel be allowed to leave the site before decontamination. Generalized decontamination procedures for use of Levels C and D modified PPE shall be performed as follows:

- Remove and wipe clean hard hat.
- Rinse boots and gloves of gross contamination.
- Scrub boots and gloves clean.
- Rinse boots and gloves.
- Remove outer boots.
- Remove outer gloves.
- Remove Tyvek coveralls.
- Remove respirator, wipe clean and store.
- Remove inner gloves.

Boots that have been decontaminated can be worn into the support zone.

Respirators shall be decontaminated daily. Taken from the drop area, the face pieces shall be disassembled, the cartridges disposed of, and all other parts placed in a cleansing solution. After an appropriate time in the solution, the parts shall be removed and rinsed with tap water. Face pieces shall be allowed to air dry before placing in sanitized bags. Personnel shall inspect their respirators on a daily basis to make certain they are in proper operation.

Decontamination procedures for the use of Level D PPE shall be modified from the procedures above to include removal of loose debris, washing or rinsing of disposable garments, and

discarding of disposable materials. Subsequent to personal decontamination, all personnel (regardless of level of protection worn) will shower as soon as possible upon leaving the site.

At a minimum, disposable items (e.g., Tyvek® coveralls, inner gloves, and latex overboots) shall be changed on a daily basis. Decontamination solutions will be changed daily or as conditions require.

The ESS may simplify the procedures in the field if minimal contamination has occurred to specific protective equipment.

9.2 SAMPLING EQUIPMENT

Small equipment shall be protected from contamination by draping, masking, or otherwise covering as much of the instrument as possible with plastic, without hindering the operation of the unit. As necessary, air monitoring equipment will be placed in clear plastic bags that allow reading of the scale and operation of the knobs. The sensors or probes can be partially wrapped, keeping the sensor tip and discharge port clear.

Contaminated equipment will be taken from the drop area and the protective coverings removed and disposed in the appropriate containers. Any dirt or obvious contamination will be brushed or wiped with a disposable paper wipe.

9.3 HEAVY EQUIPMENT

To prevent translocation of contaminants and inadvertent exposures to personnel, heavy equipment used in contaminated areas shall be decontaminated prior to moving to a new location and before leaving Cannon AFB. When decontaminating equipment, the following requirements will be implemented:

- A job built decontamination pad will be constructed to contain decontamination fluids. Construction materials may be varied to meet job requirements but must effectively contain all fluids.
- The equipment will be inspected for gross debris. Where possible, contaminated soil deposits will be removed and containerized.
- After removal of gross debris, the equipment will be steam cleaned using a high pressure washer (i.e., Hotsy).
- After steam cleaning, the equipment will be allowed to dry and will be reinspected. Any remaining visible debris will be recleaned through additional pressure washing.

- After all debris is removed the equipment will be released for transport to another location.
- Decontamination fluids collected on the decontamination pad will be containerized and disposed of in accordance with the site-specific work plan.
- Inspections of equipment for release from Cannon AFB will be completed by the site manager, site superintendent, or Environmental Safety Specialist. Inspection results will be documented in field logbooks.

9.4 DISPOSAL OF MATERIALS GENERATED ON SITE

Investigation-derived materials (to include PPE, decontamination fluid, etc.) shall be contained and placed in a secure area before final disposition on site. Disposal shall be completed in accordance with the site-specific workplan.

10.0 EMERGENCY RESPONSE PLAN

Prior to working on site, all personnel are responsible for becoming familiar with the Emergency Response Plan (ERP), notifying the ESS of actual or impending emergencies, and for cooperating fully once the ERP is implemented. In the event of injury, accident, or other emergency, all personnel are responsible for following the provisions of this HASP.

A copy of this HASP will be kept at Foster Wheeler support areas or in the support zone during conduct of field operations. Guidance relating to the implementation of the ERP is provided in EHS Procedure HS 2-3, Emergency Response Plans.

This ERP addresses the following:

- Pre-emergency planning and coordination with on-Base and off-Base facilities
- Personnel roles, lines of authority, training, and communication
- Emergency recognition and prevention
- Safe distances and places of refuge
- Site security and control
- Evacuation procedures and routes
- Decontamination
- Emergency medical treatment and first aid
- Emergency response procedures
- Critique of response and follow up
- PPE and emergency equipment

10.1 EMERGENCY COMMUNICATIONS

The emergency communication system for field operations at Cannon AFB are discussed in Section 6.5 of this HASP.

10.2 EMERGENCY CONTACTS

The following information will be conspicuously posted at the field site:

- Procedures to follow when overexposures occur
- Location of fire extinguishers and diagram of emergency exits
- Locations of emergency eyewash and deluge systems

Emergency contact numbers shall be conspicuously posted on site for easy access by all personnel.

10.2.1 Emergency Telephone Numbers

Fire Department (Base)	(505) 784-2578
Off-Site Emergency Services	911
On-Site Emergency Services	475-1117
Ambulance Service	911 or 784 4033
Police	911 or 784-4111

10.2.2 Medical Treatment

Ambulance (Base)	(505) 784-4033 or 911
Base Hospital	(505) 432-6866
Plains Regional Federal Medical Center	(505) 769-2141

Emergency Route to Hospital: The routes to the Cannon AFB hospital and the Plains Regional Medical Center (Civilian Hospital) are shown in Figure 10-1.

10.2.3 Information and Response Organizations

CHEMTREC	1-800-424-9300
Poison Control Center (National)	1-800-432-6866
Poison Control Center (New Mexico)	1-800-432-8802
Toxic Substances Control Act Hotline	(202) 554-1404
Center for Disease Control	(404) 452-4100
ATF (Explosive Information)	(800) 424-9555
National Response Center	1-800-424-8802
Resource Conservation and Recovery Act Hotline	1-800-424-9346

10.2.4 Incident Reporting Procedures

In the event of an accident or incident, an Accident/Incident Report Form (Foster Wheeler form, Attachment B) and Accident Report ENG Form 3394 must be completed within 24 hours. Depending upon the nature of the incident, additional agencies or individuals that may need to be

notified, including the United States Environmental Protection Agency, New Mexico Environment Department, OSHA, and Base Point of Contact. Unless otherwise mandated by law, no outside agency may be contacted without explicit approval by the Cannon AFB.

All incidents resulting in injury, illness, or property damage require completion of an accident investigation and report. The investigation should be initiated as soon as emergency conditions are under control. The purpose of this investigation is not to attribute blame but to determine the pertinent facts so that repeat or similar occurrences can be avoided.

The investigation should begin while details are still fresh in the mind of the personnel involved. The person administering first aid may be able to start the fact gathering process if the injured are able to speak. Pertinent facts must be determined. Questions beginning with who, what, when, where, and how are usually most effective in discovering ways to improve job performance in terms of efficiency and quality of work as well as safety and health concerns.

10.2.5 Project Personnel

Project Health and Safety Manager:	Roger Margotto, CIH (619) 234-8696
Program Manager:	Sina Seyedian (303) 980-3573
DO Manager:	Carol Bieniulis (505) 878-8924
Site Environmental Safety Specialist:	James Morning, OHST (303) 479-2668
Emergency Coordinator:	James Morning, OHST (505) 479-2668
Base Remedial Project Manager:	John Pike or Sanford Hutsell (505) 784-6378

Off-site emergency response agencies shall not be contacted without Base approval.

10.3 EMERGENCY PROCEDURES

The following standard emergency procedures shall be followed by all on-site personnel. The ESS shall be notified of any on-site emergencies and shall be responsible for ensuring that the appropriate procedures are followed. The ESS will notify the PHSM of any emergency situation and keep the PHSM informed of the status throughout the emergency. As a part of site mobilization the ESS shall also pre-notify local hospitals of the work to be performed. Pre-notification information will include an explanation of work to be performed and associated contaminants.

10.3.1 Personal Injury

Upon notification of an injury, the ESS shall assess the nature of the injury and notify the appropriate response agency. If the cause of the injury does not affect the performance of site personnel, operations may continue with the appropriate on-site field personnel initiating the appropriate first aid and necessary follow-up. In the event that the injury increases the risk to others, all field personnel shall move to a designated location until further instructions. On-site activities shall cease until the added risk is removed or minimized.

The Cannon AFB Ambulance Service will provide emergency medical treatment and ambulance service in support of this activity.

10.3.2 Fire and Explosion

All personnel must be aware of the location of fire extinguishers and emergency communications. Upon notification of an on-site fire or explosion, all site personnel will assemble at the decontamination area. The fire department will be alerted by calling 911 (off site), 911 (on site), or 784-2578 (on site). All site personnel will be moved a safe distance from the involved area and follow evacuation procedures if initiated. In no case will untrained personnel fight a fire.

10.3.3 Evacuation

In the event of an evacuation of site personnel and/or the public is required (e.g., fire, explosion, or significant release of toxic gases), an air horn will be sounded for approximately 10 seconds to indicate initiation of evacuation procedures. When two-way radios are used, instructions will be given over the radio for evacuation. All unnecessary conversations will be suspended until the

emergency is over. All field personnel in both the controlled and uncontrolled areas will evacuate and assemble in the contamination reduction zone, other safe area as identified by the ESS, or as designated in each project-specific addendum. The location will be upwind of the situation if at all possible. As the safety of all field personnel is being established, appropriate emergency services will be contacted by the ESS via telephone to respond to the emergency.

For efficient and safe site evacuation and assessment of the emergency situation, the ESS will coordinate with the Cannon AFB Installation On-Scene Coordinator if outside services are required. Under no circumstances will incoming personnel or visitors be allowed to proceed into the area once the emergency signal has been given. The ESS must designate a person to immediately notify the Cannon AFB Fire Department, see that access for emergency equipment is provided, and verify that all combustion apparatuses have been shut down once the alarm has been sounded.

Emergency response groups should be provided with the following information:

1. Is an explosion or fire involved?
2. What kind of emergency is it and where is it located?
3. What type of material is involved? Was contamination released?
4. What is the nature of any injuries?

Personnel will not re-enter an evacuated area until instructed to do so by the ESS. In addition, if site operations are halted in response to an emergency, the ESS will see to it that valves, pipes, and other equipment are monitored for leaks, pressure buildup, gas generation, or ruptures.

10.3.4 Personal Protective Equipment Failure

If PPE worn by personnel fails, or is otherwise altered in such a manner that the level of protection is affected, the workplace must be vacated. The person affected and his or her buddy shall immediately leave the work zone. Re-entry shall not be permitted until the equipment has been repaired or replaced.

10.3.5 Other Equipment Failure

Field personnel must notify the ESS when any on-site equipment fails to operate properly. The ESS shall determine the effect of this failure on continuing operations on site. If the failure affects the safety of personnel or prevents completion of assigned tasks, all personnel shall leave the work zone until the situation is evaluated and appropriate actions taken.

10.3.6 Physical Injury

In the event of physical injury, the following actions will be taken by the ESS:

- Evaluate the extent of injuries.
- Summon emergency help.
- Modify decontamination procedures as appropriate considering the actual levels of contaminants on the person (if any) and types or severity of injuries.
- Apply first aid.
- If minor injuries occur, decontaminate and transport the individual to the appropriate first aid or medical facility.
- If major or life-threatening injuries occur transport by ambulance. If this is not possible, make arrangements to transfer the injured person to paramedics within Cannon AFB.

10.3.7 Injury from Chemical Exposure

This section describes procedures to follow when it is suspected that a person has suffered from chemical exposure.

10.3.7.1 Skin Contact

1. Flush with water.
2. Remove clothing, if necessary.
3. Wash and rinse affected area for at least 20 minutes. Decontaminate and provide appropriate medical attention.

10.3.7.2 Inhalation

1. Move person away from area.
2. Administer CPR as needed.
3. Decontaminate and transport to hospital for medical attention.

10.3.7.3 Ingestion

1. Decontaminate and transport to hospital for medical attention.

10.3.7.4 Eye Contact

1. Irrigate with water for at least 15 minutes.
2. Decontaminate and transport to hospital for medical attention.

10.4 EMERGENCY RESPONSE FOLLOWUP

In the event of a serious accident/injury, the ESS shall make an immediate telephone report to the PHSM outlining all details of the accident/injury and action(s) taken. In addition, the ESS shall provide documentation regarding all incidents involving personal injury or exposure to potentially hazardous materials during any activity to the PHSM, the Cannon AFB Safety Office, Contracting Officer/COR, and Cannon Contracting Officer. This reporting procedure will be accomplished using the Foster Wheeler Accident/Incident Report. The report shall include the following information:

- Chronological history of the incident
- Facts concerning the incident and when they became available
- Title and names of personnel involved
- Actions (decisions made and by whom) orders given (to whom, by whom, and when) action taken (who did what, when, where, and how)
- Possible exposure(s) of site personnel
- History of all injuries or illnesses during or as a result of the emergency

10.5 SPILL RESPONSE

In the event of a spill of hazardous materials on site, the ESS shall control the spill and proceed to absorb and containerize the material. In addition, the ESS may conduct air monitoring to characterize exposure hazards from the incident.

If the spill results in the formation of a toxic vapor cloud (by reaction with surrounding materials or by outbreak of fire), site evacuation will take place.

The ESS will perform the following six steps when responding to a spill or environmental release:

1. Determine the nature and major components of the spill.
2. Make sure that all unnecessary persons are removed from the spill area.
3. Notify the Cannon AFB Fire Prevention and Protection Branch; the Safety, Health, and Environment Office; the PHSM; the Regional ESQ Manager; and the Base Environmental Office for large spills and significant environmental releases.
4. If a flammable liquid, gas, or vapor is involved, remove all ignition sources, and use spark- and explosion-proof equipment and clothing or clean up the spill or release.
5. If possible, try to contain the leak or spill with the materials that are kept on hand for such instances.
6. Remove all surrounding materials that could react with materials in the spill.

11.0 AUTHORIZATIONS

The USACE and the ESS must approve personnel authorized to enter controlled work zones while operations are being conducted. Authorization shall involve completion of appropriate training courses, medical examination requirements as specified by the 29 CFR 1920.120, and review and signoff of this HASP. All personnel must use the buddy system or trained escort, and check in with the ESS. Authorized personnel will be designated on an individual basis.

12.0 MEDICAL DATA SHEETS

This brief Medical Data Sheet is to be completed by all on-site personnel and will be kept in the Support Zone by the ESS during the conduct of site operations. Completion of this form in addition to compliance with the Medical Surveillance Program requirements is mandatory. This data sheet will accompany any personnel when medical assistance is needed or if transport to hospital facilities is required.

Project_____

Name:_____ Home Telephone:_____

Address:_____

Age:_____ Height:_____ Weight: _____ Blood Type: _____ DOB_____

Emergency contact:_____

Drug or other allergies:_____

Particular sensitivities:_____

List previous illnesses: :_____

Do you wear contacts?_____

_____

Have you had any previous exposures to hazardous chemicals? Please detail:_____

_____

What medications are you presently using?_____

Do you have any medical restrictions? Please detail._____

_____

Name, address, and phone number of personal physician:

_____

13.0 FIELD TEAM REVIEW SHEET

Each field team member shall sign this section after site-specific training is completed and before commencing work on site.

I have been trained in the contents of the Cannon AFB Basewide Health and Safety Plan and have been advised of the locations of copies available for review. I will comply with the provisions contained therein.

Name:	Date:

14.0 APPROVALS

By their signature, the undersigned certify that this HASP is approved and will be used for operations to be conducted at Cannon AFB.

Program Manager	Date
Delivery Order Manager	Date
Project Health and Safety Manager	Date
Environmental Safety Specialist	Date

15.0 REFERENCES

ACGIH, Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, 1999.

Foster Wheeler Environmental, Corporate Reference Library, Policies, Procedures, and Guidelines, current version.

Foster Wheeler Environmental, Project Rules Handbook, Volumes I and II. October 1996.

U.S. Department of Labor, Title 29 CFR Part 1910.

U.S. Department of Labor, Title 29 CFR Part 1920.

U.S. Department of Labor, Title 29 CFR Part 1926.

U.S. Department of Health and Human Services, NIOSH, Pocket Guide to Chemical Hazards, 1999.

USACE, EM 385-1-1, Safety and Health Requirements Manual, September 1996.

Attachment
Material Safety Data Forms (MSDS)

CARBON TETRACHLORIDE

MSDS Number: C0979 --- *Effective Date: 12/08/96*

1. Product Identification

Synonyms: Tetrachloromethane, carbon tet, carbon chloride
CAS No.: 56-23-5
Molecular Weight: 153.84
Chemical Formula: CCl4

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Carbon tetrachloride	56-23-5	99 - 100%	Yes

3. Hazards Identification

Emergency Overview

MAY BE FATAL IF SWALLOWED, INHALED OR ABSORBED THROUGH SKIN. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. SUSPECT CANCER HAZARD. MAY CAUSE CANCER. Risk of cancer depends on level and duration of exposure. AFFECTS CENTRAL NERVOUS SYSTEM, LUNGS, LIVER AND KIDNEYS.

J.T. Baker SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 3 - Severe (Cancer Causing)
Flammability Rating: 0 - None
Reactivity Rating: 1 - Slight
Contact Rating: 3 - Severe (Life)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code:
Blue (Health)

Potential Health Effects

Inhalation:
Inhalation has a narcotic effect. Symptoms include headache, dizziness, nausea and dullness. Following exposures of high concentrations, victim may become unconscious, and if exposure is not terminated, death can result from respiratory failure.

Ingestion:
Abdominal pain, vomiting, diarrhea, visual disturbances, dizziness and unconsciousness can occur. Severe gastrointestinal upset progressing to serious kidney and liver damage can occur. Death can occur immediately or be delayed for as much as one week.

Skin Contact:
Can be absorbed through skin, with symptoms paralleling ingestion exposure. A dermatitis may be produced following long or repeated contact. Skin oils are removed upon contact, and the skin becomes red, cracked, and dry.

Eye Contact:
Severe irritant as vapor or liquid. Symptoms of burning and intense irritation occur.

Chronic Exposure:
Affects nervous system. Delayed effects from exposure include damage to the heart, liver and kidneys. Repeated or prolonged exposures may cause skin irritation, optic nerve damage with possible blindness, and hearing loss. Symptoms of darkened urine and liver cirrhosis have been reported.

Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or eye problems, or impaired liver, kidney or respiratory function may be more susceptible to the effects of the substance.

---

4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Ingestion:
Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention immediately.

Skin Contact:
Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention immediately. Wash clothing before reuse. Thoroughly clean shoes before reuse.

Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

Note to Physician:
To minimize hepatorenal damage, consider intravenous acetylcysteine. Hyperbaric oxygen is also utilized for significant exposures. Dialysis has also been suggested in severe cases. Give cardiorespiratory support as indicated and carefully monitor fluid and electrolytes. Closely monitor hepatic and renal functions. Avoid epinephrine because of myocardial sensitization and potential for inducing ventricular arhythymias.

---

5. Fire Fighting Measures

Fire:
Not considered to be a fire hazard. Under fire conditions, produces hydrochloric acid and phosgene.

Explosion:
Not considered to be an explosion hazard.

Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire.

Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

---

6. Accidental Release Measures

---

7. Handling and Storage

Keep in a tightly closed container. Protect from physical damage. Store in a cool, dry, ventilated area away from sources of heat, moisture and incompatibilities. Wear special protective equipment (Sec. 8) for maintenance break-in or where exposures may exceed established exposure levels. Wash hands, face, forearms and neck when exiting restricted areas. Shower, dispose of outer clothing, change to clean garments at the end of the day. Avoid cross-contamination of street clothes. Wash hands before eating and do not eat, drink, or smoke in workplace. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

---

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
- OSHA Permissible Exposure Limit (PEL): 10 ppm (TWA); ceiling = 25 ppm, maximum 200 ppm (5-minute maximum peak in any 4 hours); - ACGIH Threshold Limit Value (TLV): 5 ppm (TWA), 10 ppm (STEL), skin; A2 suspected human carcinogen - NIOSH Recommended Expoisure Limits (RELs): 2 ppm, 60-minute (STEL).

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices* , most recent edition, for details.

Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded, wear a supplied air, full-facepiece respirator, airlined hood, or full-facepiece self-contained breathing apparatus.

Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.

Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

---

9. Physical and Chemical Properties

Appearance:
Clear, colorless liquid.

Odor:
Ether odor.

Solubility:
Negligible in water.

Specific Gravity:
1.59 @ 20C(68F)

pH:
No information found.

% Volatiles by volume @ 21C (70F):

100

Boiling Point:
76.8C (171F)

Melting Point:
-23C (-9F)

Vapor Density (Air=1):
5.3

Vapor Pressure (mm Hg):
91 @ 20C (68F)

Evaporation Rate (BuAc=1):
No information found.

---

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.

Hazardous Decomposition Products:
May produce carbon monoxide, carbon dioxide, hydrogen chloride and phosgene when heated to decomposition.

Hazardous Polymerization:
Will not occur.

Incompatibilities:
Reacts violently with fluorine gas, alkali metals, and aluminum. Incompatible with chemically active metals such as sodium, potassium, and magnesium. Will attack some forms of plastics, rubber, and coatings.

Conditions to Avoid:
Heat, flames, ignition sources and incompatibles.

---

11. Toxicological Information

Oral rat LD50: 2350 mg/kg; skin rat LD50: 5070 mg/kg. Oral rat LD50: 2350 mg/kg; Inhalation rat LC50: 8000 ppm/4H; Skin rabbit LD50: >20 gm/kg; Irritation data, rabbit - std Draize: skin 4 mg, mild; eye 500 mg/24H, mild. Investigated as a tumorigen, mutagen, reproductive effector.

--------\Cancer Lists\----------

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Carbon tetrachloride (56-23-5)	No	Yes	2B

12. Ecological Information

Environmental Fate:
When released into the soil, this material may leach into groundwater. When released into the soil, this material is expected to quickly evaporate. When released to water, this material is expected to quickly evaporate. This material has an experimentally-determined bioconcentration factor (BCF) of less than 100. This material is not expected to significantly bioaccumulate. When released into the air, this material is expected to have a half-life of greater than 30 days.

Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

--------\Chemical Inventory Status - Part 1\--------

Ingredient	TSCA	EC	Japan	Australia
Carbon tetrachloride (56-23-5)	Yes	NE*	Yes	Yes

--------\Chemical Inventory Status - Part 2\--------

Ingredient	Korea	--Canada-- DSL	NDSL	Phil.
Carbon tetrachloride (56-23-5)	Yes	Yes	No	Yes

*NE - Not Evaluated

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--------\Federal, State & International Regulations - Part 1\----------------
                                                -SARA 302-    ------SARA 313------
Ingredient                                      RQ    TPQ     List  Chemical Catg.
----------------------------------------------  ---   -----   ----  --------------
Carbon tetrachloride (56-23-5)                  No    No      Yes        No

--------\Federal, State & International Regulations - Part 2\----------------
                                                              -RCRA-    -TSCA-
Ingredient                                      CERCLA        261.33    8(d)
----------------------------------------------  ------        ------    ---
Carbon tetrachloride (56-23-5)                  10            U211      No


Chemical Weapons Convention:  No     TSCA 12(b):  No     CDTA:  No
SARA 311/312:  Acute: Yes      Chronic: Yes  Fire: No  Pressure: No
Reactivity: No          (Pure / Liquid)
```

Prop 65:
THIS PRODUCT CONTAINS A CHEMICAL(S) KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER.

Australian Hazchem Code: 2Z
Poison Schedule: S7

WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

---

16. Other Information

Health: 3 **Flammability:** 0 **Reactivity:** 0

Label Hazard Warning:
DANGER! MAY BE FATAL IF SWALLOWED, INHALED OR ABSORBED THROUGH SKIN. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. SUSPECT CANCER HAZARD. MAY CAUSE CANCER. Risk of cancer depends on level and duration of exposure. AFFECTS CENTRAL NERVOUS SYSTEM, LUNGS, LIVER AND KIDNEYS.

Label Precautions:
Do not breathe vapor or mist. Do not get in eyes, on skin, or on clothing. Keep container closed. Use only with adequate ventilation. Wash thoroughly after handling.

Label First Aid:
If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Get medical attention immediately.

Product Use:
Laboratory Reagent

Revision Information:
New 16 section MSDS format, all sections have been revised.

****

Mallinckrodt Baker, Inc. provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. This document is intended only as a guide to the appropriate precautionary handling of the material by a properly trained person using this product. Individuals receiving the information must exercise their independent judgment in determining its appropriateness for a particular purpose. MALLINCKRODT BAKER, INC. MAKES NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE INFORMATION SET FORTH HEREIN OR THE PRODUCT TO WHICH THE INFORMATION REFERS. ACCORDINGLY, MALLINCKRODT BAKER, INC. WILL NOT BE RESPONSIBLE FOR DAMAGES RESULTING FROM USE OF OR RELIANCE UPON THIS INFORMATION.

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TOLUENE

MSDS Number: T3913 --- *Effective Date: 11/17/99*

1. Product Identification

Synonyms: Methylbenzene; Toluol; Phenylmethane
CAS No.: 108-88-3
Molecular Weight: 92.14
Chemical Formula: C6H5-CH3
Product Codes:
J.T. Baker: 5375, 5584, 5809, 5812, 9336, 9351, 9364, 9456, 9457, 9459, 9460, 9462, 9466, 9472, 9476
Mallinckrodt: 4483, 8091, 8092, 8604, 8608, 8610, 8611, V560

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Toluene	108-88-3	100%	Yes

3. Hazards Identification

Emergency Overview

POISON! DANGER! HARMFUL OR FATAL IF SWALLOWED. HARMFUL IF INHALED OR ABSORBED THROUGH SKIN. VAPOR HARMFUL. FLAMMABLE LIQUID AND VAPOR. MAY AFFECT LIVER, KIDNEYS, BLOOD SYSTEM, OR CENTRAL NERVOUS SYSTEM. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT.

J.T. Baker SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 2 - Moderate
Flammability Rating: 3 - Severe (Flammable)
Reactivity Rating: 0 - None
Contact Rating: 1 - Slight
Lab Protective Equip: GOGGLES; LAB COAT; VENT HOOD; PROPER GLOVES;

CLASS B EXTINGUISHER
Storage Color Code: Red (Flammable)

Potential Health Effects

Inhalation:
Inhalation may cause irritation of the upper respiratory tract. Symptoms of overexposure may include fatigue, confusion, headache, dizziness and drowsiness. Peculiar skin sensations (e. g. pins and needles) or numbness may be produced. Very high concentrations may cause unconsciousness and death.
Ingestion:
Swallowing may cause abdominal spasms and other symptoms that parallel over-exposure from inhalation. Aspiration of material into the lungs can cause chemical pneumonitis, which may be fatal.
Skin Contact:
Causes irritation. May be absorbed through skin.
Eye Contact:
Causes severe eye irritation with redness and pain.
Chronic Exposure:
Reports of chronic poisoning describe anemia, decreased blood cell count and bone marrow hypoplasia. Liver and kidney damage may occur. Repeated or prolonged contact has a defatting action, causing drying, redness, dermatitis. Exposure to toluene may affect the developing fetus.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or impaired liver or kidney function may be more susceptible to the effects of this substance. Alcoholic beverage consumption can enhance the toxic effects of this substance.

---

4. First Aid Measures

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. CALL A PHYSICIAN IMMEDIATELY.
Ingestion:
Aspiration hazard. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. Get medical attention immediately. If vomiting occurs, keep head below hips to prevent aspiration into lungs.
Skin Contact:
In case of contact, immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Call a physician immediately.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

---

5. Fire Fighting Measures

Fire:
Flash point: 7C (45F) CC
Autoignition temperature: 422C (792F)
Flammable limits in air % by volume:
lel: 3.3; uel: 19
Flammable liquid and vapor!
Dangerous fire hazard when exposed to heat or flame. Vapors can flow along surfaces to distant ignition source and flash back.
Explosion:
Above flash point, vapor-air mixtures are explosive within flammable limits noted above. Contact with strong oxidizers may cause fire or explosion. Sensitive to static discharge.
Fire Extinguishing Media:
Dry chemical, foam or carbon dioxide. Water may be used to flush spills away from exposures and to dilute spills to non-flammable mixtures.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode. Water spray may be used to keep fire exposed containers cool.

---

6. Accidental Release Measures

Ventilate area of leak or spill. Remove all sources of ignition. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Use non-sparking tools and equipment. Collect liquid in an appropriate container or absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! If a leak or spill has not ignited, use water spray to disperse the vapors, to protect personnel attempting to stop leak, and to flush spills away from exposures. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker SOLUSORB(R) solvent adsorbent is recommended for spills of this product.

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7. Handling and Storage

Protect against physical damage. Store in a cool, dry well-ventilated location, away from any area where the fire hazard may be acute. Outside or detached storage is preferred. Separate from incompatibles. Containers should be bonded and grounded for transfers to avoid static sparks. Storage and use areas should be No Smoking areas. Use non-sparking type tools and equipment, including explosion proof ventilation. Containers of

this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
Toluene:
- OSHA Permissible Exposure Limit (PEL):
200 ppm (TWA); 300 ppm (acceptable ceiling conc.); 500 ppm (maximum conc.).
- ACGIH Threshold Limit Value (TLV):
50 ppm (TWA) skin, A4 - Not Classifiable as a Human Carcinogen.

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices* , most recent edition, for details.

Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded, a half-face organic vapor respirator may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. A full-face piece organic vapor respirator may be worn up to 50 times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. For emergencies or instances where the exposure levels are not known, use a full-face piece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.

Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
Clear, colorless liquid.

Odor:
Aromatic benzene-like.

Solubility:
0.05 gm/100gm water @ 20C (68F).

Specific Gravity:
0.86 @ 20C / 4 C

pH:

No information found.
% Volatiles by volume @ 21C (70F):
100
Boiling Point:
111C (232F)
Melting Point:
-95C (-139F)
Vapor Density (Air=1):
3.14
Vapor Pressure (mm Hg):
22 @ 20C (68F)
Evaporation Rate (BuAc=1):
2.24

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Containers may burst when heated.
Hazardous Decomposition Products:
Carbon dioxide and carbon monoxide may form when heated to decomposition.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Heat, flame, strong oxidizers, nitric and sulfuric acids, chlorine, nitrogen tetraoxide; will attack some forms of plastics, rubber, coatings.
Conditions to Avoid:
Heat, flames, ignition sources and incompatibles.

11. Toxicological Information

Toxicological Data:
Oral rat LD50: 636 mg/kg; skin rabbit LD50: 14100 uL/kg; inhalation rat LC50: 49 gm/m3/4H; Irritation data: skin rabbit, 500 mg, Moderate; eye rabbit, 2 mg/24H, Severe. Investigated as a tumorigen, mutagen, reproductive effector.
Reproductive Toxicity:
Has shown some evidence of reproductive effects in laboratory animals.

--------\Cancer Lists\----------

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Toluene (108-88-3)	No	No	3

12. Ecological Information

Environmental Fate:
When released into the soil, this material may evaporate to a moderate extent. When released into the soil, this material is expected to leach into groundwater. When released into the soil, this material may biodegrade to a moderate extent. When released into water, this material may evaporate to a moderate extent. When released into water, this material may biodegrade to a moderate extent. When released into the air, this material may be moderately degraded by reaction with photochemically produced hydroxyl radicals. When released into the air, this material is expected to have a half-life of less than 1 day. This material is not expected to significantly bioaccumulate. This material has a log octanol-water partition coefficient of less than 3.0. Bioconcentration factor = 13.2 (eels).
Environmental Toxicity:
This material is expected to be toxic to aquatic life. The LC50/96-hour values for fish are between 10 and 100 mg/l.

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13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved incinerator or disposed in a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

---

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: TOLUENE
Hazard Class: 3
UN/NA: UN1294
Packing Group: II
Information reported for product/size: 390LB

International (Water, I.M.O.)

Proper Shipping Name: TOLUENE
Hazard Class: 3.2
UN/NA: UN1294
Packing Group: II
Information reported for product/size: 390LB

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15. Regulatory Information

--------\Chemical Inventory Status - Part 1\----------

Ingredient	TSCA	EC	Japan	Australia
Toluene (108-88-3)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\----------

Ingredient	Korea	--Canada-- DSL	NDSL	Phil.
Toluene (108-88-3)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Toluene (108-88-3)	No	No	Yes	No

--------\Federal, State & International Regulations - Part 2\----------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Toluene (108-88-3)	1000	U220	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: Yes
SARA 311/312: Acute: Yes Chronic: Yes Fire: Yes Pressure: No
Reactivity: No (Pure / Liquid)

WARNING:
THIS PRODUCT CONTAINS A CHEMICAL(S) KNOWN TO THE STATE OF CALIFORNIA TO CAUSE BIRTH DEFECTS OR OTHER REPRODUCTIVE HARM.

Australian Hazchem Code: 3[Y]E
Poison Schedule: S6
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: **2** Flammability: **3** Reactivity: **0**
Label Hazard Warning:
POISON! DANGER! HARMFUL OR FATAL IF SWALLOWED. HARMFUL IF INHALED OR ABSORBED THROUGH SKIN. VAPOR HARMFUL. FLAMMABLE LIQUID AND VAPOR. MAY AFFECT LIVER, KIDNEYS, BLOOD SYSTEM, OR CENTRAL NERVOUS SYSTEM. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT.
Label Precautions:
Keep away from heat, sparks and flame.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.

Avoid breathing vapor.
Avoid contact with eyes, skin and clothing.

Label First Aid:

Aspiration hazard. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. If vomiting occurs, keep head below hips to prevent aspiration into lungs. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. In all cases call a physician immediately.

Product Use:

Laboratory Reagent.

Revision Information:

No changes.

Disclaimer:

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Prepared by: Strategic Services Division
Phone Number: (314) 539-1600 (U.S.A.)

International Chemical Safety Cards

ARSENIC

ICSC: 0013

ARSENIC
Grey arsenic
Metallic arsenic
As
Atomic mass: 74.9

CAS # 7440-38-2
RTECS # CG0525000
ICSC # 0013
UN # 1558
EC # 033-001-00-X

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Combustible. Gives off irritating or toxic fumes (or gases) in a fire.	NO open flames. NO contact with strong oxidizers. NO contact with hot surfaces.	Powder, water spray, foam, carbon dioxide.
EXPLOSION	Risk of fire and explosion is slight if in the form of fine powder or dust when exposed to hot surfaces or flames.	Prevent deposition of dust; closed system, dust explosion-proof electrical equipment and lighting.	
EXPOSURE		AVOID ALL CONTACT!	IN ALL CASES CONSULT A DOCTOR!
• **INHALATION**	Cough. Diarrhoea. Shortness of breath. Sore throat. Vomiting. Weakness. Grey skin.	Closed system and ventilation.	Fresh air, rest. Artificial respiration if indicated. Refer for medical attention.
• **SKIN**	Redness.	Protective gloves. Protective clothing.	Remove contaminated clothes. Rinse skin with plenty of water or shower.
• **EYES**	Redness.	or eye protection in combination with breathing protection if powder.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
• **INGESTION**	Diarrhoea. Nausea. Sore throat. Unconsciousness. Vomiting (further see Inhalation).	Do not eat, drink, or smoke during work. Wash hands before eating.	Rinse mouth. Induce vomiting (ONLY IN CONSCIOUS PERSONS!). Refer for medical attention.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Evacuate danger area! Sweep spilled substance into sealable containers. Carefully collect remainder, then remove to safe place. Do NOT let this chemical enter the environment (extra	Provision to contain effluent from fire extinguishing. Separated from strong oxidants, acids, halogens, food and feedstuffs. Well closed. Keep in a well-ventilated room.	Do not transport with food and feedstuffs. T symbol R: 23/25 S: (1/2-)20/21-28-45

personal protection: complete protective clothing including self-contained breathing apparatus).		UN Hazard Class: 6.1 UN Packing Group: II Marine pollutant.

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0013

Prepared in the context of cooperation between the International Programme on Chemical Safety & the Commission of the European Communities © IPCS CEC 1993

International Chemical Safety Cards

ARSENIC

ICSC: 0013

IMPORTANT DATA

PHYSICAL STATE; APPEARANCE:
ODOURLESS, BRITTLE, GREY, METALLIC-LOOKING CRYSTALS.

PHYSICAL DANGERS:

CHEMICAL DANGERS:
Upon heating, toxic fumes are formed. Reacts violently with strong oxidants and halogens causing fire and explosion hazard. Reacts with nitric acid, hot sulfuric acid. Toxic arsine gas may be formed in contact with acid or acidic substances and certain metals, such as galvanized or light metals.

OCCUPATIONAL EXPOSURE LIMITS (OELs):
TLV: ppm; 0.01 mg/m^3 (as TWA) A1 (ACGIH 1994-1995).

ROUTES OF EXPOSURE:
The substance can be absorbed into the body by inhalation of its aerosol, through the skin and by ingestion.

INHALATION RISK:
Evaporation at 20°C is negligible; a harmful concentration of airborne particles can, however, be reached quickly.

EFFECTS OF SHORT-TERM EXPOSURE:
The substance irritates the eyes, the skin and the respiratory tract. The substance may cause effects on the circulatory system, nervous system, kidneys and gastrointestinal tract , resulting in convulsions, kidney impairment, severe hemorrhage, losses of fluids, and electrolytes, shock and death. Exposure may result in death. The effects may be delayed. Medical observation is indicated.

EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:
Repeated or prolonged contact with skin may cause dermatitis. Repeated or prolonged contact may cause skin sensitization. The substance may have effects on the mucous membranes, skin, kidneys, liver , resulting in neuropathy, pigmentation disorders, perforation of nasal septum and tissue lesions. This substance is carcinogenic to humans.

PHYSICAL PROPERTIES	Sublimation point: 613°C Relative density (water = 1): 5.7	Solubility in water: none
ENVIRONMENTAL DATA	The substance is toxic to aquatic organisms. It is strongly advised not to let the chemical enter into the environment because it persists in the environment.	

NOTES

The substance is combustible but no flash point is available in literature. Depending on the degree of exposure, periodic medical examination is indicated. Do NOT take working clothes home. Refer also to cards for specific arsenic compounds, e.g., Arsenic pentoxide (ICSC # 0377), Arsenic trichloride (ICSC # 0221), Arsenic trioxide (ICSC # 0378), Arsine (ICSC # 0222).

ADDITIONAL INFORMATION	
ICSC: 0013	**ARSENIC**

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International Chemical Safety Cards

BARIUM

ICSC: 1052

BARIUM
Ba
Atomic mass: 137.3

CAS # 7440-39-3
RTECS # CQ8370000
ICSC # 1052
UN # 1400

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Flammable.	NO open flames.	Special powder, dry sand, NO hydrous agents, NO water.
EXPLOSION	Finely dispersed particles form explosive mixtures in air.	Prevent deposition of dust; closed system, dust explosion-proof electrical equipment and lighting.	
EXPOSURE		PREVENT DISPERSION OF DUST! STRICT HYGIENE!	
• **INHALATION**	Cough. Sore throat.	Local exhaust or breathing protection.	Fresh air, rest. Refer for medical attention.
• **SKIN**	Redness.	Protective gloves.	Remove contaminated clothes. Rinse skin with plenty of water or shower. Refer for medical attention.
• **EYES**	Redness. Pain.	Safety goggles.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
• **INGESTION**		Do not eat, drink, or smoke during work.	Rinse mouth. Refer for medical attention.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Sweep spilled substance into containers. Carefully collect remainder, then remove to safe place (extra personal protection: complete protective clothing including self-contained breathing apparatus).	Separated from halogenated solvents, strong oxidants, acids. Dry. Keep under inert gas, petroleum or oxygen-free liquid.	UN Hazard Class: 4.3 UN Packing Group: II

SEE IMPORTANT INFORMATION ON BACK

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International Chemical Safety Cards

BARIUM

ICSC: 1052

IMPORTANT DATA	**PHYSICAL STATE; APPEARANCE:** YELLOWISH TO WHITE LUSTROUS SOLID IN VARIOUS FORMS. **PHYSICAL DANGERS:** **CHEMICAL DANGERS:** The substance may spontaneously ignite on contact with air (if in powder form). The substance is a strong reducing agent and reacts violently with oxidants and acids. Reacts with water, forming combustible gas (hydrogen - see ICSC # 0001) and barium hydroxide. Reacts violently with halogenated solvents causing fire and explosion hazard. **OCCUPATIONAL EXPOSURE LIMITS (OELs):** TLV: ppm; 0.5 mg/m^3 (as TWA) (ACGIH 1992-1993).	**ROUTES OF EXPOSURE:** The substance can be absorbed into the body by ingestion. **INHALATION RISK:** **EFFECTS OF SHORT-TERM EXPOSURE:** The substance irritates the eyes, the skin, and the respiratory tract. **EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:**
PHYSICAL PROPERTIES	Boiling point: 1640°C Melting point: 725°C Relative density (water = 1): 3.6	Solubility in water: reaction Vapour pressure, kPa at 1049°C: 1.3
ENVIRONMENTAL DATA		

NOTES

Reacts violently with fire extinguishing agents such as water, bicarbonate, powder, foam, and carbon dioxide. Rinse contaminated clothes (fire hazard) with plenty of water.

Transport Emergency Card: TEC (R)-43G14

ADDITIONAL INFORMATION

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COPPER METAL

MSDS Number: C5170 --- *Effective Date: 05/17/01*

1. Product Identification

Synonyms: C.I. 77400; Arwood Copper
CAS No.: 7440-50-8
Molecular Weight: 63.546
Chemical Formula: Cu
Product Codes:
J.T. Baker: 1714, 1720, 1732, 1736
Mallinckrodt: 1733, 4649

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Copper	7440-50-8	90 - 100%	Yes

3. Hazards Identification

Emergency Overview

WARNING! HARMFUL IF SWALLOWED OR INHALED. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. AFFECTS THE LIVER AND KIDNEYS. CHRONIC EXPOSURE MAY CAUSE TISSUE DAMAGE.

J.T. Baker SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 0 - None
Flammability Rating: 0 - None
Reactivity Rating: 0 - None
Contact Rating: 1 - Slight
Lab Protective Equip: GOGGLES; LAB COAT
Storage Color Code: Orange (General Storage)

Potential Health Effects

Inhalation:
Inhalation of dusts and fumes of metallic copper causes irritation of the upper respiratory tract, congestion of nasal mucous membranes, ulceration and perforation of the nasal septum, and pharyngeal congestion. Inhalation of copper fumes may give rise to metal fume fever (high temperature, metallic taste, nausea, coughing, general weakness, muscle aches, and exhaustion).
Ingestion:
Copper ingestion causes nausea, vomiting, abdominal pain, metallic taste, and diarrhea. Ingestion of large doses may cause stomach and intestine ulceration, jaundice, and kidney and liver damage.
Skin Contact:
Causes irritation to skin. Symptoms include redness, itching, and pain. Exposure to copper dust may cause a greenish-black skin discoloration.
Eye Contact:
Small copper particles in the eyes may cause irritation, discoloration, and damage.
Chronic Exposure:
Prolonged or repeated exposure to copper can discolor skin and hair and irritate the skin; may cause mild dermatitis, runny nose, and irritation of the mucous membranes. Repeated ingestion may damage the liver and kidneys. Repeated inhalation can cause chronic respiratory disease.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or impaired liver, kidney, or pulmonary function or pre-existing Wilson's disease may be more susceptible to the effects of this material.

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4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.
Ingestion:
Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person.
Skin Contact:
Immediately flush skin with plenty of soap and water for at least 15 minutes. Remove contaminated clothing and shoes. Get medical attention. Wash clothing before reuse. Thoroughly clean shoes before reuse.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

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5. Fire Fighting Measures

Fire:
Not considered to be a fire hazard since the bulk solid does not burn, but very finely divided particles (ultra-fine powder) may burn in air.
Explosion:
Not considered to be an explosion hazard. Reactions with incompatibles may pose an explosion hazard. Liquid copper explodes on contact with water. High concentrations of finely divided copper particles in the air may present an explosion hazard.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Sweep up and containerize for reclamation or disposal. Vacuuming or wet sweeping may be used to avoid dust dispersal. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Avoid exposure to air and moisture. Isolate from incompatible substances. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
Copper Dust and Mists, as Cu:
- OSHA Permissible Exposure Limit (PEL) -
1 mg/m3 (TWA)
- ACGIH Threshold Limit Value (TLV) -
1 mg/m3 (TWA)
Copper Fume:
- OSHA Permissible Exposure Limit (PEL) -
0.1 mg/m3 (TWA)
- ACGIH Threshold Limit Value (TLV) -

0.2 mg/m3 (TWA)

Ventilation System:

A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices* , most recent edition, for details.

Personal Respirators (NIOSH Approved):

If the exposure limit is exceeded, a full facepiece respirator with dust/mist filter may be worn up to 50 times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:

Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.

Eye Protection:

Use chemical safety goggles and/or full face shield where dusting or splashing of solutions is possible. Maintain eye wash fountain and quick-drench facilities in work area.

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9. Physical and Chemical Properties

Appearance:

Reddish, metallic solid.

Odor:

Odorless.

Solubility:

Insoluble in water.

Density:

8.94

pH:

No information found.

% Volatiles by volume @ 21C (70F):

0

Boiling Point:

2595C (4703F)

Melting Point:

1083C (1981F)

Vapor Density (Air=1):

Not applicable.

Vapor Pressure (mm Hg):

1 @ 1628C (2962F)

Evaporation Rate (BuAc=1):

No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Copper becomes dull when exposed to air; on exposure to moist air it gradually converts to the carbonate. On long standing, a white, highly explosive peroxide deposit may form.
Hazardous Decomposition Products:
No information found.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Copper is incompatible with oxidizers, alkalis, acetylene, chlorine plus oxygen difluoride, phosphorus, nitric acid, potassium peroxide, 1-bromo-2-propyne, sulfur plus chlorates. Reacts violently with ammonium nitrate, bromates, iodates, chlorates, ethylene oxide, hydrozoic acid, potassium oxide, dimethyl sulfoxide plus trichloroacetic acid, hydrogen peroxide, sodium peroxide, sodium azide, sulfuric acid, hydrogen sulfide plus air, and lead azide. A potentially explosive reaction occurs with actylenic compounds. Copper ignites on contact with chlorine, fluorine (above 121C), chlorine trifluoride, and hydrazinum nitrate (above 70C). An incandescent reaction occurs with potassium dioxide.
Conditions to Avoid:
Incompatibles and prolonged exposure to air and moisture.

11. Toxicological Information

No LD50/LC50 information found relating to normal routes of occupational exposure. Investigated as a tumorigen and a reproductive effector.

--------\Cancer Lists\----------

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Copper (7440-50-8)	No	No	None

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

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14. Transport Information

Not regulated.

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15. Regulatory Information

--------\Chemical Inventory Status - Part 1\--------

Ingredient	TSCA	EC	Japan	Australia
Copper (7440-50-8)	Yes	Yes	No	Yes

--------\Chemical Inventory Status - Part 2\--------

Ingredient	Korea	--Canada-- DSL	NDSL	Phil.
Copper (7440-50-8)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\--------

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Copper (7440-50-8)	No	No	Yes	No

--------\Federal, State & International Regulations - Part 2\--------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Copper (7440-50-8)	5000	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: Yes Fire: No Pressure: No
Reactivity: No (Pure / Solid)

Australian Hazchem Code: No information found.
Poison Schedule: No information found.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: **2** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
WARNING! HARMFUL IF SWALLOWED OR INHALED. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. AFFECTS THE LIVER AND KIDNEYS. CHRONIC EXPOSURE MAY CAUSE TISSUE DAMAGE.
Label Precautions:
Avoid contact with eyes, skin and clothing.
Wash thoroughly after handling.
Avoid breathing dust or vapors.
Keep container closed.
Use only with adequate ventilation.
Label First Aid:
If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. In all cases, get medical attention.
Product Use:
Laboratory Reagent.
Revision Information:
No changes.
Disclaimer:
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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

Selenium

MSDS Number: S1106 --- *Effective Date: 08/02/00*

1. Product Identification

Synonyms: Elemental Selenium; Selen; C.I. 77805
CAS No.: 7782-49-2
Molecular Weight: 78.96
Chemical Formula: Se
Product Codes: 3395

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Selenium	7782-49-2	90 - 100%	Yes

3. Hazards Identification

Emergency Overview

WARNING! CAUSES SEVERE IRRITATION TO EYES, SKIN AND RESPIRATORY TRACT. HARMFUL IF SWALLOWED OR INHALED. AFFECTS LIVER, KIDNEYS, BLOOD, SPLEEN.

J.T. Baker SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 3 - Severe (Life)
Flammability Rating: 0 - None
Reactivity Rating: 1 - Slight
Contact Rating: 2 - Moderate
Lab Protective Equip: GOGGLES; LAB COAT; VENT HOOD; PROPER GLOVES
Storage Color Code: Blue (Health)

Potential Health Effects

Inhalation:
Severe irritant to the respiratory system. Soreness, coughing, labored breathing are symptoms which may subside and return. Lung edema may occur in acute cases. Cases with flu-like symptoms resembling metal fume fever within 24 hours of exposure have been reported.
Ingestion:
May cause severe irritation to the mouth and throat. Gastrointestinal disturbances may be expected with nausea, abdominal pain, and vomiting.
Skin Contact:
Causes severe irritation. Symptoms include redness, itching and pain.
Eye Contact:
May cause severe irritation, redness, pain.
Chronic Exposure:
Chronic exposure may cause odor of garlic on breath, fatigue, irritability, repsiratory tract irritation, gastrointestinal irritation, metallic taste, and allergic eye reaction. Based on animal studies, may cause blood, liver, kidney and spleen effects.
Aggravation of Pre-existing Conditions:
Person with a history of asthma, allergies, or known sensitization to selenium, or with a history of other chronic respiratory disease, gastrointestinal disturbances, disorders of the liver or kidneys, or recurrent dermatitis would be expected to be at increased risk from exposure.

---

4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.
Ingestion:
Do NOT induce vomiting. Give large amounts of water. Never give anything by mouth to an unconscious person. Get medical attention.
Skin Contact:
Immediately flush skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Get medical attention. Wash clothing before reuse. Thoroughly clean shoes before reuse.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

---

5. Fire Fighting Measures

Fire:
Not considered to be a fire hazard.
Explosion:
Not considered to be an explosion hazard.

Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

---

6. Accidental Release Measures

Ventilate area of leak or spill. Keep unnecessary and unprotected people away from area of spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Pick up and place in a suitable container for reclamation or disposal, using a method that does not generate dust. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

---

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Isolate from incompatible substances. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

---

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
-OSHA Permissible Exposure Limit (PEL):
0.2 mg/m3, Selenium Compounds, as Se

-ACGIH Threshold Limit Value (TLV):
0.2 mg/m3, Selenium & Compounds, as Se
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices* , most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded, a half-face dust/mist respirator may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. A full-face piece dust/mist respirator may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency, or respirator

supplier, whichever is lowest. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:

Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.

Eye Protection:

Use chemical safety goggles and/or full face shield where dusting or splashing of solutions is possible. Maintain eye wash fountain and quick-drench facilities in work area.

---

9. Physical and Chemical Properties

Appearance:

Small blue-black metallic shot.

Odor:

Odorless.

Solubility:

Insoluble in water.

Specific Gravity:

4.26-4.81

pH:

No information found.

% Volatiles by volume @ 21C (70F):

0

Boiling Point:

690C (1274F)

Melting Point:

170 - 217C (338 - 423F)

Vapor Density (Air=1):

Not applicable.

Vapor Pressure (mm Hg):

Not applicable.

Evaporation Rate (BuAc=1):

Not applicable.

---

10. Stability and Reactivity

Stability:

Stable under ordinary conditions of use and storage.

Hazardous Decomposition Products:

Toxic oxides of selenium form when heated to decomposition.

Hazardous Polymerization:

Will not occur.

Incompatibilities:

Strong oxidizers, strong acids, and a wide range of other materials.
Conditions to Avoid:
Moisture and incompatibles.

11. Toxicological Information

Toxicological Data:
Oral Rat LD50: 6700 mg/kg. Investigated as a tumorigen and a reproductive effector.
Carcinogenicity:
EPA / IRIS classification: Group D1 - Not classifiable as a human carcinogen.

--------\Cancer Lists\----------

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Selenium (7782-49-2)	No	No	3

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

--------\Chemical Inventory Status - Part 1\----------

Ingredient	TSCA	EC	Japan	Australia
Selenium (7782-49-2)	Yes	Yes	No	Yes

--------\Chemical Inventory Status - Part 2\----------

Ingredient	Korea	--Canada-- DSL	NDSL	Phil.
Selenium (7782-49-2)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Selenium (7782-49-2)	No	No	No	Selenium cmp

--------\Federal, State & International Regulations - Part 2\----------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Selenium (7782-49-2)	100	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: Yes Fire: No Pressure: No
Reactivity: No (Pure / Solid)

Australian Hazchem Code: 2Z
Poison Schedule: No information found.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: **2** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
WARNING! CAUSES SEVERE IRRITATION TO EYES, SKIN AND RESPIRATORY TRACT. HARMFUL IF SWALLOWED OR INHALED. AFFECTS LIVER, KIDNEYS, BLOOD, SPLEEN.
Label Precautions:
Avoid contact with eyes, skin and clothing.
Wash thoroughly after handling.
Avoid breathing dust.
Do not breathe mist.
Use only with adequate ventilation.
Label First Aid:
If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. In all cases, get medical attention.

Product Use:
Laboratory Reagent.
Revision Information:
No changes.
Disclaimer:
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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

TIN METAL

MSDS Number: T3445 --- *Effective Date: 11/17/99*

1. Product Identification

Synonyms: Tin; tin flake; tin granular; stannum
CAS No.: 7440-31-5
Molecular Weight: 118.71
Chemical Formula: Sn
Product Codes: 4144, 4150

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Tin	7440-31-5	90 - 100%	Yes

3. Hazards Identification

Emergency Overview

CAUTION! MAY BE HARMFUL IF INHALED. MAY CAUSE IRRITATION TO SKIN, EYES, AND RESPIRATORY TRACT.

J.T. Baker SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 0 - None
Flammability Rating: 0 - None
Reactivity Rating: 0 - None
Contact Rating: 1 - Slight
Lab Protective Equip: GOGGLES; LAB COAT
Storage Color Code: Orange (General Storage)

Potential Health Effects

Inhalation:
No adverse effects expected but dust may cause mechanical irritation.
Ingestion:
Large doses may cause nausea, vomiting, and diarrhea.
Skin Contact:
No adverse effects expected. May cause mild irritation and redness.
Eye Contact:
No adverse effects expected but dust may cause mechanical irritation.
Chronic Exposure:
Prolonged inhalation of the dust or fume may result in a benign pneumoconiosis, producing distinctive changes in the lungs with no apparent disability or complications.
Aggravation of Pre-existing Conditions:
No adverse health effects expected.

---

4. First Aid Measures

Inhalation:
Not expected to require first aid measures. Remove to fresh air. Get medical attention for any breathing difficulty.
Ingestion:
Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person.
Skin Contact:
Not expected to require first aid measures. Wash exposed area with soap and water. Get medical advice if irritation develops.
Eye Contact:
Wash thoroughly with running water. Get medical advice if irritation develops.

---

5. Fire Fighting Measures

Fire:
Autoignition temperature:
Dust Cloud : 630C (1166F);
Dust Layer: 430C (806F).
Explosion:
Fine dust dispersed in air in sufficient concentrations, and in the presence of an ignition source is a potential dust explosion hazard. Minimum explosible concentration: 0.19 g/l
Particle size and air concentration determine reactivity.
Fire Extinguishing Media:
USE dry sand, graphite, dolomite, sodium chloride. NEVER USE water, halogenated agents, or class A, B, or C extinguishers.
Special Information:
Use protective clothing and breathing equipment appropriate for the surrounding fire.

---

6. Accidental Release Measures

Remove all sources of ignition. Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Clean up spills in a manner that does not disperse dust into the air. Use non-sparking tools and equipment. Reduce airborne dust and prevent scattering by moistening with water. Pick up spill for recovery or disposal and place in a closed container.

---

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Isolate from any source of heat or ignition. Avoid dust dispersal. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

---

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
-OSHA Permissible Exposure Limit (PEL):
2 mg/m3 (TWA)

-ACGIH Threshold Limit Value (TLV):
2 mg/m3 (TWA)
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices* , most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded, a half-face dust/mist respirator may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. A full-face piece dust/mist respirator may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency, or respirator supplier, whichever is lowest. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.
Skin Protection:
Wear protective gloves and clean body-covering clothing.
Eye Protection:
Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
Uniform, silvery granules or mossy flakes.
Odor:
Odorless.
Solubility:
Insoluble in water.
Density:
7.31
pH:
No information found.
% Volatiles by volume @ 21C (70F):
0
Boiling Point:
2507C (4545F)
Melting Point:
231.9C (450F)
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
1 @ 1609C (2928F)
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Powder will oxidize, especially in the presence of moisture. Metal normally has a protective film of stannic oxide which thickens as the temperature is raised.
Hazardous Decomposition Products:
No hazardous decomposition products.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Halogens and halogen trifluorides, cupric nitrate, sodium and potassium peroxide, sulfur, and some acids.
Conditions to Avoid:
Heat, flames, ignition sources and incompatibles.

11. Toxicological Information

No LD50/LC50 information found relating to normal routes of occupational exposure.
Investigated as a tumorigen.

--------\Cancer Lists\----------

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Tin (7440-31-5)	No	No	None

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

--------\Chemical Inventory Status - Part 1\----------

Ingredient	TSCA	EC	Japan	Australia
Tin (7440-31-5)	Yes	Yes	No	Yes

--------\Chemical Inventory Status - Part 2\----------

Ingredient	Korea	--Canada-- DSL	NDSL	Phil.
Tin (7440-31-5)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.

Tin (7440-31-5)	No	No	No	No

--------\Federal, State & International Regulations - Part 2\----------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Tin (7440-31-5)	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: Yes Fire: No Pressure: No
Reactivity: No (Pure / Solid)

Australian Hazchem Code: No information found.
Poison Schedule: No information found.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: **1** Flammability: **1** Reactivity: **1**
Label Hazard Warning:
CAUTION! MAY BE HARMFUL IF INHALED. MAY CAUSE IRRITATION TO SKIN, EYES, AND RESPIRATORY TRACT.
Label Precautions:
Avoid contact with eyes, skin and clothing.
Wash thoroughly after handling.
Avoid breathing dust.
Keep container closed.
Use with adequate ventilation.
Label First Aid:
If inhaled, remove to fresh air. Get medical attention for any breathing difficulty. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Get medical attention if irritation develops or persists.
Product Use:
Laboratory Reagent.
Revision Information:
No changes.
Disclaimer:
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Prepared by: Strategic Services Division
Phone Number: (314) 539-1600 (U.S.A.)

Vanadium Pentoxide

MSDS Number: V2220 --- *Effective Date: 12/18/00*

1. Product Identification

Synonyms: Vanadium (V) Oxide; Vanadic Anhydride
CAS No.: 1314-62-1
Molecular Weight: 181.88
Chemical Formula: V2O5
Product Codes: 4207

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Vanadium Pentoxide	1314-62-1	90 - 100%	Yes

3. Hazards Identification

Emergency Overview

POISON! DANGER! MAY BE FATAL IF SWALLOWED OR INHALED.
CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT.

J.T. Baker SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 3 - Severe (Life)
Flammability Rating: 0 - None
Reactivity Rating: 1 - Slight
Contact Rating: 2 - Moderate
Lab Protective Equip: GOGGLES; LAB COAT; VENT HOOD; PROPER GLOVES
Storage Color Code: Blue (Health)

Potential Health Effects

Inhalation:
Highly Toxic fume, mist, dust. Exposure can injure the lungs and bronchial airways. Symptoms include irritation and inflammation of the mucous membranes, nasal passages and pharnyx, a greenish-black discoloration of the tongue, persistent cough, shortness of breath, bronchiolar constriction, tightness in the chest. An asthma-like condition may occur. May result in pulmonary edema/pneumonia. May be fatal.
Ingestion:
Highly toxic. Ingestion may be fatal. Symptoms may include nausea, headache, and vomiting. Anemia may occur.
Skin Contact:
Causes irritation to skin. Symptoms include redness, itching, and pain. May develop skin rash or lesions with intense itching.
Eye Contact:
Vapor, mist and dust cause irritation with sensation of burning, redness, pain, and signs of conjunctivitis.
Chronic Exposure:
Repeated or prolonged exposure may cause lung damage, repsiratory tract sensitization or skin sensitization.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or eye problems or impaired respiratory function may be more susceptible to the effects of the substance.

---

4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.
Ingestion:
Get medical attention immediately. Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person.
Skin Contact:
Immediately flush skin with plenty of soap and water for at least 15 minutes. Remove contaminated clothing and shoes. Get medical attention. Wash clothing before reuse. Thoroughly clean shoes before reuse.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

---

5. Fire Fighting Measures

Fire:
May burn but will not ignite readily.
Explosion:
Not considered to be an explosion hazard.
Fire Extinguishing Media:

Water spray, dry chemical, alcohol foam, or carbon dioxide.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

---

6. Accidental Release Measures

Ventilate area of leak or spill. Keep unnecessary and unprotected people away from area of spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Pick up and place in a suitable container for reclamation or disposal, using a method that does not generate dust. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

---

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Isolate from incompatible substances. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

---

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
OSHA Permissible Exposure Limit (PEL):
Vanadium Respirable Dust, as V2O5, 0.5 mg/m3 (Ceiling)
Vanadium Fume, as V2O5, 0.1 mg/m3 (Ceiling)

ACGIH Threshold Limit Value (TLV):
Vanadium Pentoxide, as V2O5, respirable dust or fume,
0.05 mg/m3 (TWA), A4, Not classifiable as a human carcinogen
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices* , most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded, a half-face dust/mist respirator may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. A full-face piece dust/mist respirator may be worn up to 50 times the exposure limit, or the

maximum use concentration specified by the appropriate regulatory agency, or respirator supplier, whichever is lowest. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:

Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.

Eye Protection:

Use chemical safety goggles and/or full face shield where dusting or splashing of solutions is possible. Maintain eye wash fountain and quick-drench facilities in work area.

---

9. Physical and Chemical Properties

Appearance:

Yellow-brown crystalline solid.

Odor:

Odorless.

Solubility:

Slight (0.1-1%)

Specific Gravity:

3.36 @ 18C/4C

pH:

No information found.

% Volatiles by volume @ 21C (70F):

0

Boiling Point:

1750C (3182F) Decomposes.

Melting Point:

690C (1274F)

Vapor Density (Air=1):

6.3

Vapor Pressure (mm Hg):

0 @ 20C (68F)

Evaporation Rate (BuAc=1):

No information found.

---

10. Stability and Reactivity

Stability:

Stable under ordinary conditions of use and storage.

Hazardous Decomposition Products:

Oxides of vanadium.

Hazardous Polymerization:

Will not occur.

Incompatibilities:
Lithium, peroxyformic acid, and chlorine trifluoride. Mixtures of vanadium pentoxide with calcium + sulfur + water may ignite spontaneously.
Conditions to Avoid:
Incompatibles.

11. Toxicological Information

Toxicological Data:
For Vanadium Pentoxide Dust: Oral rat LD50: 10 mg/kg. Investigated as a mutagen, reproductive effector. For Vanadium Pentoxide Fume: Investigated as a tumorigen.
Reproductive Toxicity:
Has shown teratogenic effects in laboratory animals.

--------\Cancer Lists\----------

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Vanadium Pentoxide (1314-62-1)	No	No	None

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: VANADIUM PENTOXIDE
Hazard Class: 6.1
UN/NA: UN2862
Packing Group: II

Information reported for product/size: 500G

International (Water, I.M.O.)

Proper Shipping Name: VANADIUM PENTOXIDE, NON-FUSED FORM
Hazard Class: 6.1
UN/NA: UN2862
Packing Group: II
Information reported for product/size: 500G

International (Air, I.C.A.O.)

Proper Shipping Name: VANADIUM PENTOXIDE, NON-FUSED FORM
Hazard Class: 6.1
UN/NA: UN2862
Packing Group: II
Information reported for product/size: 500G

---

15. Regulatory Information

--------\Chemical Inventory Status - Part 1\--------

Ingredient	TSCA	EC	Japan	Australia
Vanadium Pentoxide (1314-62-1)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\--------

Ingredient	Korea	--Canada-- DSL	NDSL	Phil.
Vanadium Pentoxide (1314-62-1)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\--------

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Vanadium Pentoxide (1314-62-1)	1000	100*	No	No

--------\Federal, State & International Regulations - Part 2\--------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Vanadium Pentoxide (1314-62-1)	1000	P120	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: Yes Fire: No Pressure: No
Reactivity: No (Pure / Solid)

Australian Hazchem Code: 1Z
Poison Schedule: No information found.
WHMIS:

This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

---

16. Other Information

NFPA Ratings: Health: **3** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
POISON! DANGER! MAY BE FATAL IF SWALLOWED OR INHALED. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT.
Label Precautions:
Do not get in eyes, on skin, or on clothing.
Do not breathe dust, mist or vapor.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.
Label First Aid:
If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. In all cases get medical attention immediately.
Product Use:
Laboratory Reagent.
Revision Information:
No changes.
Disclaimer:
****

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****

Prepared by: Strategic Services Division
Phone Number: (314) 539-1600 (U.S.A.)

International Chemical Safety Cards

BENZIDINE

ICSC: 0224

BENZIDINE
(1,1'-Biphenyl)-4,4'-diamine
4,4'-Diaminobiphenyl
p-Diaminodiphenyl
$C_{12}H_{12}N_2/NH_2C_6H_4\text{-}C_6H_4NH_2$
Molecular mass: 184.2

CAS # 92-87-5
RTECS # DC9625000
ICSC # 0224
UN # 1885
EC # 612-042-00-2

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Combustible. See Notes. Gives off irritating or toxic fumes (or gases) in a fire.	NO open flames.	Powder, carbon dioxide.
EXPLOSION			
EXPOSURE		AVOID ALL CONTACT!	IN ALL CASES CONSULT A DOCTOR!
• **INHALATION**		Closed system and ventilation.	Fresh air, rest. Refer for medical attention.
• **SKIN**	MAY BE ABSORBED!	Protective gloves. Protective clothing.	Remove contaminated clothes. Rinse skin with plenty of water or shower. Refer for medical attention.
• **EYES**		Face shield or eye protection in combination with breathing protection if powder.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
• **INGESTION**		Do not eat, drink, or smoke during work. Wash hands before eating.	Rinse mouth. Give a slurry of activated charcoal in water to drink. Induce vomiting (ONLY IN CONSCIOUS PERSONS!). Refer for medical attention.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Evacuate danger area! Consult an expert! Sweep spilled substance into sealable containers; if appropriate,	Separated from strong oxidants, food and feedstuffs. Keep in the dark. Well closed.	Unbreakable packaging; put breakable packaging into closed unbreakable container. Do not transport with food

moisten first to prevent dusting. Carefully collect remainder, then remove to safe place. Do NOT let this chemical enter the environment (extra personal protection: complete protective clothing including self-contained breathing apparatus).		and feedstuffs. T symbol R: 45-22 S: 53-45 Note: E UN Hazard Class: 6.1 UN Packing Group: II

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0224

Prepared in the context of cooperation between the International Programme on Chemical Safety & the Commission of the European Communities © IPCS CEC 1993

International Chemical Safety Cards

BENZIDINE

ICSC: 0224

IMPORTANT DATA	**PHYSICAL STATE; APPEARANCE:** WHITE OR REDDISH CRYSTALLINE POWDER, TURNS DARK ON EXPOSURE TO AIR AND LIGHT. **PHYSICAL DANGERS:** **CHEMICAL DANGERS:** The substance decomposes on heating and on burning producing toxic fumes including nitrogen oxides. Reacts violently with strong oxidants, especially nitric acid. **OCCUPATIONAL EXPOSURE LIMITS (OELs):** TLV: ppm; mg/m^3 A1 (confirmed human carcinogen) (ACGIH 1994-1995).	**ROUTES OF EXPOSURE:** The substance can be absorbed into the body by inhalation of its aerosol, through the skin and by ingestion. **INHALATION RISK:** Evaporation at 20°C is negligible; a harmful concentration of airborne particles can, however, be reached quickly when dispersed, especially if powdered. **EFFECTS OF SHORT-TERM EXPOSURE:** **EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:** This substance is carcinogenic to humans.
PHYSICAL PROPERTIES	Boiling point: 401°C Melting point: 128°C (see Notes)°C Relative density (water = 1): 1.25	Solubility in water: none Relative vapour density (air = 1): 6.36 Octanol/water partition coefficient as log Pow: 1.34
ENVIRONMENTAL DATA	The substance is toxic to aquatic organisms.	

NOTES

Given melting point when anhydrous and rapidly heated, when slowly heated: 115-120°C. Addition of small amounts of a flammable substance or an increase in the oxygen content of the air strongly enhances combustibility.

Transport Emergency Card: TEC (R)-61G11b

ADDITIONAL INFORMATION	
ICSC: 0224	**BENZIDINE**

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SECTION IIIC

Field Forms

BHAE

Environmental Engineers and Scientists

Project Number: _____

Chain of Custody and Analytical Request

Chain of Custody Number [1]: _____

LIMS Number: _____

Facility/Base I.D.: Cannon Air Force Base / Cannon

Project Name / Site Name: Cannon Air Force Base /

Client Name: USACE-Omaha District

Collected by:

Field Sample ID (30 Characters Max)	ERPIMS LOCID (15 Characters Max)	Date Collected (dd-mmm-yyyy)	Time Collected (Military) (hhmm)	Sample Depth (beginning - ending)	SA Code [2]	Sample Number [3]	Sample Matrix [4]	Number of containers									Ambient Blank Lot Control Number	Equipment Blank Lot Control Number	Trip Blank Lot Control Number	Cooler ID
								Sample Analysis Requested [5]									Quality Assurance Samples [6]			
				-																
				-																
				-																
				-																
				-																
				-																
				-																
				-																
				-																
				-																
				-																

COMMENTS: _____

Custody Transfers Prior to Receipt by Laboratory

Relinquished By (Signed)	Date	Time	Received by (signed)	Date	Time
1.			1.		
2.			2.		
3.			3.		

Sample Delivery Details / Laboratory Receipt

Delivered Directly to Lab: _____ Shipped No.: _____

Method of Shipment: _____ Airbill Number: _____

Analytical Lab: _____ Delivery Location: _____

Lab Recipient: Delivery Date/Time:

1.) Chain of Custody Number = date collected + custody number (e.g. 09-02-1999-01)

2.) Sample Type (SA) Codes: N = Normal Sample, TB = Trip Blank (-c) Sample, FD = Field Duplicate (-a) Samples, FR = Field Replicate (-b) Samples, EB = Equipment Blank (-d) Samples, MS = Matrix Spike, SD = Matrix Spike Duplicate, AB = Ambient Blank (-e)

3.) Sample Number: Unique sample number collected from a particular location per day. (e.g. Groundwater sample collected from MW-1 on 10/10/99 = 01, if sampled again on 10/10/99 = 02, etc.)

4.) Matrix Codes: GS = Soil Gas, WG = Groundwater, WS = Surface Water, SO = Soil, SE = Sediment, SL = Sludge, SS = Surface Soil Samples, WQ = Aqueous Blank Samples (trip, equipment, ambient, etc), SQ = Soil Blanks

5.) Sample Analysis Requested: Analytical method requested and number of containers provided for each.

6.) Quality assurance samples are assigned by date (ddmmyy) and the sample number associated with the sample (01, 02, etc) (e.g. Equipment blank collected in association with MW-1 on 10/10/99 will be designated 10109901 in the Equipment Blank Lot Control

HTRW DRILLING LOG

DISTRICT		HOLE NUMBER
1. COMPANY NAME	2. DRILL SUBCONTRACTOR	SHEET SHEETS OF
3. PROJECT	4. LOCATION	
NAME OF DRILLER	6. MANUFACTURER'S DESIGNATION OF DRILL	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	8. HOLE LOCATION	
	9. SURFACE ELEVATION	
	10. DATE STARTED	11. DATE COMPLETED
12. OVERBURDEN THICKNESS	15. DEPTH GROUNDWATER ENCOUNTERED	
13. DEPTH DRILLED INTO ROCK	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOLAL CORE RECOVERY %
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR		

LOCATION SKETCH/COMMENTS	SCALE

PROJECT	HOLE NO.

HTRW DRILLING LOG (CONTINUATION SHEET)

HOLE NUMBER	
PROJECT	INSPECTOR
SHEET	SHEETS OF

ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	GEOTECH SAMPLE OR CORE BOX NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)

PROJECT	HOLE NO.

ENG FORM 5056A-R, AUG 94 (Proponent: CECW-EG)

DAILY QUALITY CONTROL REPORT

OJECT NUMBER _____ DATE _____ REPORT NUMBER: _____
PROJECT _____ SITE NO./NAME: _____
WEATHER _____ TEMPERATURE RANGE _____°F WIND _____
IRP CONTRACTOR PERSONNEL ON-SITE _____
ADDITIONAL PERSONNEL ON-SITE _____
VISITORS ON-SITE _____
TIME ON-SITE _____ TIME OFF-SITE: _____

SUMMARY OF WORK PERFORMED: _____

LEVEL OF HEALTH & SAFETY PROTECTION: _____

EQUIPMENT USED: _____

CALIBRATION(S) PERFORMED: _____

EQUIPMENT PROBLEM(S)/REMEDIES: _____

SAMPLES COLLECTED*: _____

SAMPLE COLLECTION METHOD(S): _____

QUALITY CONTROL: _____

PROPOSED SCHEDULE FOR TOMORROW:

ADDITIONAL REMARKS: _____

SIGNATURE: _____ DATE: _____

*INDICATE SAMPLE MEDIA: GROUNDWATER, SURFACE WATER, SOIL OR SEDIMENT; SAMPLE TYPE: COMPOSITE, GRAB, SPLIT, DUPLICATE, RINSATE; AND SAMPLE I.D. NUMBERS

GROUNDWATER MONITORING WELL INSTALLATION DETAIL

PROJECT: _____

LOCATION: _____

CLIENT: _____

CONTRACTOR: _____

DRILLER: _____ CERTIFICATION NO: _____

RUST FIELD REPRESENTATIVE: _____

JOB NO. _____

INSTALLATION NO. _____

TYPE OF INSTALLATION _____

BORING NO. _____

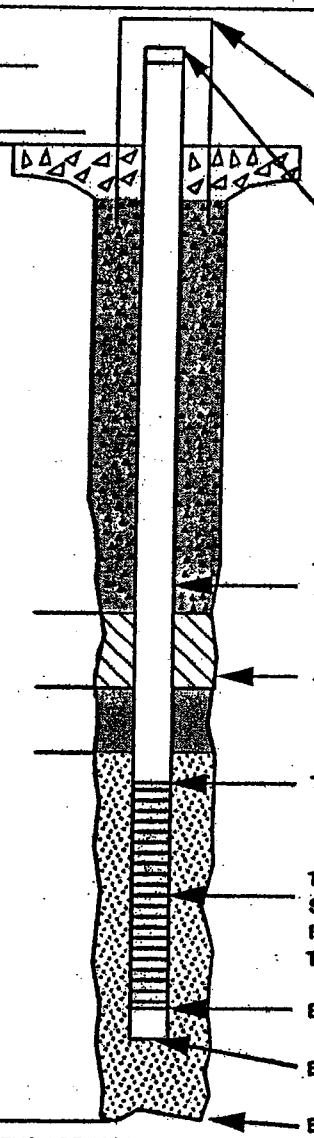
LOCATION _____

INSTALLATION DATE _____

SURVEY DATUM: _____

GROUND SURFACE ELEVATION: _____

SUMMARIZE SOIL CONDITIONS, BACKFILL AN ALS (NOT TO SCALE)



TOP OF PROTECTIVE CASING _____

INSIDE DIAMETER _____

TOTAL LENGTH _____

TYPE OF SURFACE SEAL _____

THICKNESS OF SURFACE SEAL _____

TOP OF WELL CASING OR RISER PIPE

EL. _____ STICKUP _____

TYPE OF WELL CASING OR RISER PIPE _____

INSIDE DIAMETER _____

APPROXIMATE DIAMETER OF BOREHOLE _____

TOP OF SCREENED INTERVAL

EL. _____ DEPTH _____

TYPE OF SCREEN _____

SCREEN GAUGE OR SIZE OF OPENINGS _____

INSIDE DIAMETER _____

TYPE OF BACKFILL AROUND SCREEN _____

BOTTOM OF SCREENED INTERVAL

EL. _____ DEPTH _____

BOTTOM OF WELL

EL. _____ DEPTH _____

BOTTOM OF BOREHOLE

EL. _____ DEPTH _____

• FIGURES ABOVE REFER TO DEPTH IN FEET

• ALL DEPTHS ARE REFERENCED TO GROUND SURFACE

*NOT TO SCALE

_____ LENGTH OF RISER PIPE + _____ LENGTH OF SCREEN + _____ LENGTH OF CAP/PLUG = _____ TOTAL

GROUT
BENTONITE SEALS
FINE SAND
FILTER PACK
CONCRETE

WCF 2
GW Detail/Exin

100-000-266

10/14/97 2:43 PM

Rev.

GROUNDWATER MONITORING WELL INSTALLATION DETAIL (FLUSH MOUNT)

PROJECT: _____

LOCATION: _____

CLIENT: _____

CONTRACTOR: _____

DRILLER: _____ CERTIFICATION NO: _____

RUST FIELD REPRESENTATIVE: _____

JOB NO. _____

INSTALLATION NO. _____

TYPE OF INSTALLATION _____

BORING NO. _____

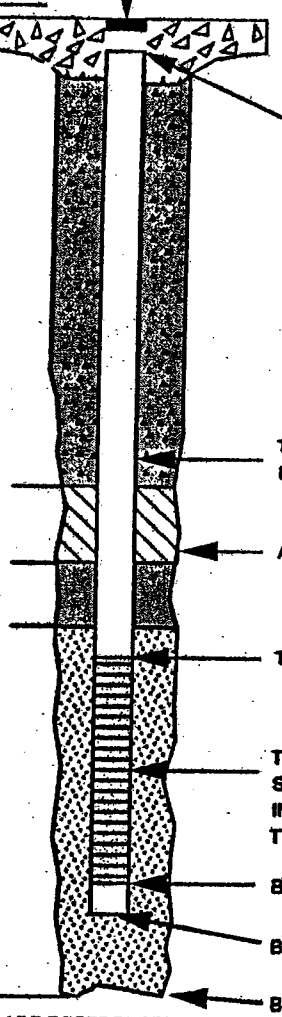
LOCATION _____

INSTALLATION DATE _____

SURVEY DATUM: _____

GROUND SURFACE ELEVATION: _____

SUMMARIZE SOIL CONDITIONS, BACKFILL AND SEALS (NOT TO SCALE)



TOP OF PROTECTIVE VAULT _____

INSIDE DIAMETER _____

TYPE OF SURFACE SEAL _____

THICKNESS OF SURFACE SEAL _____

TOP OF WELL CASING OR RISER PIPE

EL. _____ STICKUP _____

TYPE OF WELL CASING OR RISER PIPE _____

INSIDE DIAMETER _____

APPROXIMATE DIAMETER OF BOREHOLE _____

TOP OF SCREENED INTERVAL

EL. _____ DEPTH _____

TYPE OF SCREEN _____

SCREEN GAUGE OR SIZE OF OPENINGS _____

INSIDE DIAMETER _____

TYPE OF BACKFILL AROUND SCREEN _____

BOTTOM OF SCREENED INTERVAL

EL. _____ DEPTH _____

BOTTOM OF WELL

EL. _____ DEPTH _____

BOTTOM OF BOREHOLE

EL. _____ DEPTH _____

• FIGURES ABOVE REFER TO DEPTH IN FEET

• ALL DEPTHS ARE REFERENCED TO GROUND SURFACE

*NOT TO SCALE

_____ + _____ + _____ = _____

LENGTH OF RISER PIPE + LENGTH OF SCREEN + LENGTH OF CAP/PLUG = TOTAL

GROUT
BENTONITE SEALS
FINE SAND
FILTER PACK
CONCRETE

Monitoring Well Development Log

Page _____ of _____

Date Started (yr/mo/day) _____ Date Completed (yr/mo/day) _____

Field Personnel _____

Project _____

Site Name _____

Job No. _____ Well ID # _____

_____ Upgradient _____ Downgradient _____ Sidegradient

Weather Conditions _____

Air Temperature _____ °F

Total Well Depth (TWD)
From Top of Casing (TOC) = _____ 1/100 ft

Depth to Ground Water (DGW)
From Top of Casing (TOC) = _____ 1/100 ft

Length of Water Column (LWC) = TWD - DGW = _____ 1/100 ft

1 Casing Volume (OCV) = LWC x _____ = _____ gallons

5 Casing Volumes = _____ gallons

Method of Well Development _____

_____

Total Volume of Water Removed _____ gallons

Date/Time	Discharge Rate (gpm)	Cumulative Volume Purged (gallons)	Water Temperature (°C)	pH	Eh	Specific Conductivity	Turbidity/Color (NTU's)	Sand Content (%)	Remarks

COMMENTS/OBSERVATIONS: _____

_____

Rev. 6/95

Mont. Well Dev./Eglin

Monitoring Well Development Log (Continued)

Page _____ of _____

Project _____

Job No. _____ Well ID No. _____

Date/Time	Discharge Rate (gpm)	Cumulative Volume Purged (gallons)	Water Temperature (°C)	pH	Eh	Specific Conductivity	Turbidity/Color (NTU's)	Sand Content (%)	Remarks

COMMENTS/OBSERVATIONS: _____

Rev. 6/95

Mons. Well Dev./Eglin

FIELD DATA INFORMATION LOG FOR GROUNDWATER SAMPLING

Page ____ of ____

Date (yr/mo/day) _____

Field Personnel _____

Site Name _____

Job # _____

Well ID # _____

____ Upgradient ____ Downgradient

Weather Conditions _____

Air Temperature _____ °C

Total Well Depth (TWD) = _____ 1/100 ft

Depth to Ground Water (DGW) = _____ 1/100 ft

Length of Water Column (LWC) = TWD - DGW = _____ 1/100 ft

1 Casing Volume (OCV) = LWC x _____ = _____ gal

_____ gal = Standard Evacuation Volume

Method of Well Evacuation _____

Method of Sample Collection _____

Total Volume of Water Removed _____ gal

Casing Diameter _____ Inches

Casing Material _____

Measuring Point Elevation _____ 1/100 ft

Height of Riser (above land surface) _____ 1/100 ft

Land Surface Elevation _____ 1/100 ft

Screened Interval _____ 1/100 ft

Dedicated Pump or Bailer YES ____ NO ____ Type ____

Steel Guard Pipe Around Casing YES ____ NO ____

Locking Cap YES ____ NO ____

Protective Post/Abutment YES ____ NO ____

Well Integrity Satisfactory YES ____ NO ____

Well Yield LOW ____ MODERATE ____ HIGH ____

Comments/Observations

_____

_____

_____

FIELD ANALYSES

VOLUME PURGED (gallons)							
Pumping Rate (gpm)							
TIME (military)							
pH (S.U.)							
Specific Conductivity							
Water Temp. (°C)							
Turbidity (NTU)							
Dissolved Oxygen (mg/l)							
Water Level (ft. TOC)							

COMMENTS/OBSERVATIONS _____

_____

Rev. 4/93

FIELD DATA INFORMATION LOG FOR GROUNDWATER SAMPLING

Page ____ of ____

Site Name _____

Job No. _____ Well No. _____

FIELD ANALYSES

VOLUME PURGED (gallons)							
Pumping Rate (gpm)							
TIME (military)							
pH (S.U.)							
Specific Conductivity							
Water Temp. (°C)							
Turbidity (NTU)							
Dissolved Oxygen (mg/L)							
Water Level (ft. TOC)							

COMMENTS/OBSERVATIONS _____

FIELD ANALYSES

VOLUME PURGED (gallons)							
Pumping Rate (gpm)							
TIME (military)							
pH (S.U.)							
Specific Conductivity							
Water Temp. (°C)							
Turbidity (NTU)							
Dissolved Oxygen (mg/L)							
Water Level (ft. TOC)							

COMMENTS/OBSERVATIONS _____