SUPPLEMENTAL REMEDIAL INVESTIGATION FOR LUCKY FUSE SITE FTIR-07

FINAL

NATIONAL TRAINING CENTER
FORT IRWIN, CALIFORNIA

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FORT IRWIN NATIONAL TRAINING CENTER

TABLE OF CONTENTS

Section		Page
1.0	INTRODUCTION	1-1
1.1	OBJECTIVES	1-1
1.2	SITE LOCATION	1-2
1.3	PREVIOUS INVESTIGATIONS	1-2
1.4	REPORT ORGANIZATION	1-3
2.0	INVESTIGATIVE TECHNIQUES	2-1
2.1	UNEXPLODED ORDNANCE CLEARANCE AND TEST PIT EXCAVATION	2-1
2.2	TEST PIT SAMPLING	2-2
2.3	LAND SURVEY	2-3
2.4	ANALYTICAL PROCEDURES AND QUALITY ASSURANCE/QUALITY CONTROL EVALUATION	2-3
2.4.1	Analytical Methods and Sampling Program	2-4
2.4.2	Data Validation	2-6
2.4.3	Quality Control Results	2-8
2.4.4	Quality Control Summary	2-16
3.0	GEOLOGY, HYDROGEOLOGY, AND SURFACE WATER HYDROLOGY	3-1
4.0	RESULTS	4-1
4.1	SITE DESCRIPTION	4-1
4.2	TEST PIT AND SOIL SAMPLING	4-2
5.0	CONTAMINANT FATE AND TRANSPORT	5-1
6.0	HUMAN HEALTH RISK ASSESSMENT	6-1
6.1	INTRODUCTION	6-1
6.1.1	Purpose and Objectives	6-2
6.1.2	Scope	6-4
6.1.3	Organization of the Human Health Risk Assessment	6-5
6.2	SELECTION OF CHEMICALS OF POTENTIAL CONCERN	6-5
6.2.1	Frequency of Detection	6-7
6.2.2	Comparison with Blanks	6-8
6.2.3	Comparison with Background Concentrations	6-8

TABLE OF CONTENTS
(Continued)

Section		Page
	6.2.4 Essential Nutrient Status	6-9
	6.2.5 Chemicals of Potential Concern for Subsite FTIR-07/d	6-11
6.3	SCREENING OF HUMAN HEALTH RISK ASSESSMENT	6-12
	6.3.1 Screening Human Health Risk Assessment Methodology	6-12
	6.3.2 Screening Human Health Risk Assessment Results	6-13
6.4	BASELINE HUMAN HEALTH RISK ASSESSMENT	6-14
	6.4.1 Exposure Assessment	6-15
	6.4.2 Toxicity Assessment	6-24
	6.4.3 Risk Characterization	6-27
6.5	UNCERTAINTY ANALYSIS	6-32
	6.5.1 Characterization of Contaminant Sources	6-32
	6.5.2 Identification of Site Chemicals of Potential Concern	6-33
	6.5.3 Exposure Assessment	6-33
	6.5.4 Toxicity Assessment	6-34
	6.5.5 Risk Characterization	6-34
7.0	BASELINE ECOLOGICAL RISK ASSESSMENT	7-1
7.1	INTRODUCTION	7-1
	7.1.1 Purpose and Objectives	7-2
	7.1.2 Scope	7-3
	7.1.3 Organization of the Ecological Risk Assessment	7-3
7.2	HABITAT ASSESSMENT AND POTENTIAL ECOLOGICAL RECEPTORS	7-5
	7.2.1 Vegetation	7-5
	7.2.2 Wildlife	7-6
	7.2.3 Sensitive Species	7-11
7.3	IDENTIFICATION OF CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN	7-15
	7.3.1 Frequency of Detection	7-15
	7.3.2 Comparison with Blanks	7-15
	7.3.3 Comparison with Background Concentrations	7-16
	7.3.4 Essential Nutrient Status	7-16
	7.3.5 Summary of Chemicals of Potential Ecological Concern	7-16
7.4	ECOLOGICAL EXPOSURE ASSESSMENT	7-17
	7.4.1 Ecological Conceptual Site Model	7-18
	7.4.2 Indicator Receptors	7-18
	7.4.3 Selection of Endpoints	7-20
	7.4.4 Ecological Pathway and Exposure Route Analysis	7-21
	7.4.5 Exposure Point Concentrations	7-22
	7.4.6 Exposure Parameters	7-24

TABLE OF CONTENTS
(Continued)

Section		Page
	7.4.7 Exposure Dose Calculation	7-27
7.5	ECOLOGICAL TOXICITY ASSESSMENT	7-28
7.6	ECOLOGICAL RISK CHARACTERIZATION	7-29
	7.6.1 Methods	7-30
	7.6.2 Results	7-31
	7.6.3 Conclusions	7-33
7.7	UNCERTAINTY ANALYSIS	7-34
	7.7.1 Characterization of Contaminant Sources	7-34
	7.7.2 Identification of Site Chemicals of Potential Ecological Concern	7-35
	7.7.3 Exposure Assessment	7-35
	7.7.4 Toxicity Assessment	7-36
	7.7.5 Risk Characterization	7-38
8.0	CONCLUSIONS AND RECOMMENDATIONS	8-1
8.1	CONCLUSIONS	8-1
8.2	RECOMMENDATIONS	8-2
REFERENCES		R-1

APPENDICES

A – Land Survey Data

B – Analytical Results

C – Chain of Custody Forms

D – Data Validation Reports

E – Chemical Quality Assurance Report

F – Field Duplicate Summary

G – Letter to DTSC regarding Mercury data

H – Toxicology Profiles

I – Responses to Comments

LIST OF FIGURES

Figure No.	
1-1	Regional Location Map
1-2	Site Location Map
4-1	Site FTIR-07/d Test Pit Sample Locations
4-2	Test Pits 7d-1-Ts-1 and 7d-1-Tp-1
4-3	Test Pit 7d-2-Ts-1
6-1	Generalized Conceptual Site Model for Human Receptors
7-1	Ecological Conceptual Site Model
7-2	Simplified Exposure Model

LIST OF TABLES

Table No.	
2-1	Summary of Samples Collected and Analyses Performed
4-1	Fort Irwin Background Soil Concentrations
4-2	Test Pit 7d-1-Ts-1 Soil Sample Results
4-3	Test Pit 7d-1-Tp-1 Soil Sample Results
4-4	Test Pit 7d-2-Ts-1 Soil Sample Results
6-1	Background Summary Statistics for Soils
6-2	Selection of Chemicals of Potential Concern for Surface Soils
6-3	Selection of Chemicals of Potential Concern for Subsurface Soils
6-4	Summary of Chemicals of Potential Concern
6-5	Preliminary Remediation Goals (PRGs) for Risk Screening
6-6	Screening Noncancer Hazard for a Future Resident Exposed to Surface Soils
6-7	Screening Cancer Hazard for a Future Resident Exposed to Surface Soils
6-8	Screening Noncancer Hazard for a Future Resident Exposed to Subsurface Soils
6-9	Exposure Point Concentration Determination for Subsurface Soils
6-10	Exposure Parameters and Assumptions for Military Personnel Engaged in Field Training Exercises
6-11	Exposure Parameters and Assumptions for Industrial Workers
6-12	Toxicity Values Used in the Baseline Human Health Risk Assessment
6-13	Cancer Risk Calculations for Current/Future Military Personnel
6-14	Noncancer Hazard Calculations for Current/Future Military Personnel
6-15	Cancer Risk Calculations for a Future Industrial Worker
6-16	Noncancer Hazard Calculations for a Future Industrial Worker
7-1	Plants Known to Occur on Fort Irwin
7-2	Reptiles Know to Occur on Fort Irwin
7-3	Mammals Know to Occur on Fort Irwin
7-4	Birds Known to Occur on Fort Irwin
7-5	Selection of Chemicals of Potential Ecological Concern for Surface Soils
7-6	Selection of Chemicals of Potential Ecological Concern for Surface Soils
7-7	Summary of Chemicals of Potential Ecological Concern
7-8	Exposure Point Concentrations for Subsurface Soils
7-9	Transfer Coefficients for Ecological Food Chain Modeling
7-10	Exposure Parameters for Ecological Indicator Receptors
7-11	Ecological Toxicity Reference Values for the Mojave Ground Squirrel – Army Values
7-12	Ecological Toxicity Reference Values for the Mojave Ground Squirrel – Biological Toxicity Advisory Group (BTAG) Values
7-13	Ecological Toxicity Reference Values for the Golden Eagle – Army Values
7-14	Ecological Toxicity Reference Values for the Golden Eagle – Biological Toxicity Advisory Group (BTAG) Values

LIST OF TABLES
(Continued)

Table No.	
7-15	Mojave Ground Squirrel Dose and Hazard Quotient Calculations Using Army TRVs, Subsite FTIR-07/d Surface Soils
7-16	Mojave Ground Squirrel Dose and Hazard Quotient Calculations Using BTAG TRVs, Subsite FTIR-07/d Surface Soils
7-17	Mojave Ground Squirrel Dose and Hazard Quotient Calculations Using Army TRVs, Subsite FTIR-07/d Subsurface Soils
7-18	Mojave Ground Squirrel Dose and Hazard Quotient Calculations Using BTAG TRVs, Subsite FTIR-07/d Subsurface Soils
7-19	Golden Eagle Dose and Hazard Quotient Calculations Using Army TRVs, Subsite FTIR-07/d Surface Soils
7-20	Golden Eagle Dose and Hazard Quotient Calculations Using BTAG TRVs, Subsite FTIR-07/d Surface Soils
7-21	Golden Eagle Dose and Hazard Quotient Calculations Using Army TRVs, Subsite FTIR-07/d Subsurface Soils
7-22	Golden Eagle Dose and Hazard Quotient Calculations BTAG TRVs, Subsite FTIR-07/d Subsurface Soils
7-23	Summary of Ecological Risk Characterization Results Based on Army and BTAG TRVs, Site FTIR-07/d Soils

ABBREVIATIONS AND ACRONYMS

A	Advisory
ABS	absorption fraction
AF	adherence factor
APCL	Applied Physical & Chemical Laboratory
ATSDR	Agency for Toxic Substance and Disease Registary
bgs	below ground surface
BLM	US Bureau of Land Management
BTAG	Biological Toxicity Advisory Group
BUTL	background upper tolerance limit
BWs	Body Weights
C & T	Curtis and Tompkins, Ltd.
Cal-EPA	California Environmental Protection Agency
CCV	continuing calibration verification
CDAP	Chemical Data Acquisition Plan
CDFG	California Department of Fish and Game
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm^2	square centimeters
COPEC	Chemicals of Potential Ecological Concern
COPCs	Chemicals of Potential Concern
CrVI	Hexavalent chromium
CS	choking service
CSF	cancer slope factor
CSC	California Species of Special Concern
CSM	conceptual site model
CX	Center of Expertise
%D	percent difference
D/Fs	Dioxins/furans
DataChem	DataChem Laboratories
DHS	Department of Health Services
DPW	Department of Public Works
DQOs	Data Quality Objectives
DTSC	Department of Toxic Substances Control
ED	exposure duration
EF	exposure frequency
EM	electromagnetic
EPCs	Exposure Point Concentrations
ERA	ecological risk assessment
ET	exposure time
ELAP	Environmental Laboratory Accreditation Program
ESMP	Endangered Species Management Plan
FIR	Food ingestion rates
FS	Feasibility study
FTIR	Fort Irwin

ABBREVIATIONS AND ACRONYMS
(Continued)

Goldstone	Goldstone Deep Space Communications Complex
GC/MS	gas chromatography/mass spectrometry
GPR	ground-penetrating radar
GPS	Global Positioning System
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HI	hazard indices
HMX	octahydro-1357-tetranitro-1357-tetracine
HPLC	high performance liquid chromatography
HQs	hazard quotients
ICP	inductively coupled spectrophotometer method
ILCR	incremental lifetime cancer risk
InhR	inhalation rate
IR	ingestion rate
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
LC	liquid chromatography
LCS	Laboratory Control Samples
LDC	Laboratory Data Consultants, Inc.
LOAEL	lowest-observed-adverse-effects level
m^3/kg	cubic meters per kilogram
µg/m^3	micrograms per cubic meter
mg/day	milligrams per day
mg/dl	milligrams per deciliter
µg/dl	micrograms per deciliter
mg/kg	milligrams per kilogram
µg/kg	micrograms per kilogram
mg/kg/day	cubic meters per kilograms per day
MS/MSDs	Matrix Spike/Matrix Spike Duplicates
msl	mean sea level
NAD27	North American Datum of 1927
NASA	National Aeronautics and Space Administration
NFA	no further action
NGVD29	National Geodetic Vertical Datum of 1929
NOAEL	no-observable-adverse-effect level
NRC	National Research Council
NTC	National Training Center
OB/OD	open burn/open detonation
OCBA	ortho(o)-chlorobenzaldehyde
OCPs/PCBs	Organochlorine pesticides/polychlorinated biphenyls
OEW	ordnance and explosive waste
OSWER	Office of Solid Waste and Emergency Response

ABBREVIATIONS AND ACRONYMS
(Continued)

P	Protocol
PAHs	polycyclic aromatic hydrocarbons
PARCC	precision, accuracy, representativeness, completeness, and comparability
Parsons ES	Parsons Engineering Science
PCDD	polychlorinated dibenzo-p-dioxins
PCDF	polychlorinated dibenzofurans
PCE	tetrachloroethene
PEA	Preliminary Endangerment Assessment
PEF	particulate emission factor
PID	photoionization detector
ppbv	parts per billion by volume
PM	project manager
PMP	Programmatic Management Plan
ppm	parts per million
PRG	preliminary remediation goal (Region 9)
PQL	practical quantitation limit
QA	quality assurance
QC	quality control
Quanterra	Quanterra Environmental Services
RAGS	Risk Assessment Guidance for Superfund
RDA	recommended daily allowance
RDX	Cyclonite
RFD	reference dose value
RI	Remedial Investigation
RL	reporting limit
RPD	relative percent difference
%RSD	relative standard deviation
SA	surface area
SARA	Superfund Amendments and Reauthorization Act
SOPs	Standard Operating Procedures
SQL	sample quantitation limit
SUF	site utilization factor
SSA	skin surface area
SVOC	semi-volatile organic compound
2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
TEQs	toxicity equivalence
TNT	trinitrotoluene
2,4,5-TP	2,4,5-trichloro (phenoxyacetic) propionic acid
TRPH	total recoverable petroleum hydrocarbons
TRV	toxicity reference value
Td	duplicate test pit sample
Tp	peripheral test pit sample

ABBREVIATIONS AND ACRONYMS
(Continued)

Ts	source area test pit sample
UCL	upper confidence limit
USACE	United States Army Corps of Engineers
USACHPPM	United States Army Center for Health Promotion and Preventive Medicine
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
UXB	UXB International, Inc.
UXO	unexploded ordnance
VOCs	volatile organic compound

1.0 INTRODUCTION

Montgomery Watson was contracted by the United States Army Corps of Engineers, Sacramento District (USACE) under Contract No. DACW05-95-D-0023, Delivery Order 33 to perform a supplemental Remedial Investigation (RI) of the FTIR-07 Lucky Fuse Site at the National Training Center (NTC), Fort Irwin. An RI was previously conducted at Site FTIR-07 by Parsons Engineering Science, Inc. (Parsons ES) in 1997 (Parsons ES, 1998). Additional investigation of Subsite FTIR-07/d was recommended in this RI report. Subsequently, Montgomery Watson conducted a supplemental RI at Subsite FTIR-07/d in June 1998. Field investigations consisted of exploratory trenching and soil sample collection. This supplemental RI report describes the nature and extent of contamination based on the results of analytical samples collected during the field investigation, as well as the outcome of the human health and ecological risk assessments. Recommendations for future actions at Subsite FTIR-07/d are provided in Section 8.0 of this report.

1.1 OBJECTIVES

The purpose of this supplemental RI is to:

- Confirm or deny the presence of contamination at Subsite FTIR-07/d
- Identify and characterize maximum concentrations of contaminants to support screening level human and ecological risk assessments
- Evaluate the potential for migration of detected contaminants to groundwater
- Assess whether contamination is of limited extent and easily defined
- Assess risks posed by the site-related chemicals to human health
- Assess risks posed by the site-related chemicals to ecological resources
- Formulate recommendations for further action (or no further action) at this site

1.2 SITE LOCATION

Fort Irwin encompasses an area of approximately 1,000 square miles in the Mojave Desert in San Bernardino County, California (Figure 1-1) The community of Barstow is located approximately 35 miles southwest of the installation. The installation is bounded on the west by the U.S. Naval Weapons Center, China Lake; on the north by Death Valley National Park; and on the south and east by land under the jurisdiction of the United States Bureau of Land Management (BLM).

The Lucky Fuse sites are located in the western portion of Red Pass Valley, approximately 10 miles northeast of the Cantonment Area. The sites can be accessed from the "Four Corners" intersection by traveling 3 miles east on East Range Road, then taking an unpaved road north 1 mile to Hill 800, as shown in Figure 1-2. The Lucky Fuse Sites are located in the buffer zone of the Lucky Fuse Impact Area.

Subsite FTIR-07/d is located in the central portion of Site FTIR-07 on the southwest side of the dirt road that parallels the northeast flank of Hill 800. The area is relatively flat and underlain by sandy alluvium. Vehicle tracks and evidence of troop maneuvers are present throughout the site. No visual anomalies have been observed at the site.

1.3 PREVIOUS INVESTIGATIONS

A records search, historical aerial photograph survey, and aerial ground-penetrating radar (GPR) survey were conducted at Site FTIR-07 by Parsons ES. During the records search, several sources of information indicated that at least one, and perhaps several, drive-in chemical and explosive waste disposal pits and some smaller pits and open burn/open detonation (OB/OD) sites existed near the Lucky Fuse Sites. Subsite FTIR-07/d was identified as a potential disposal area. Wastes that were potentially disposed of at Site FTIR-07 include propellants, high explosives, pyrotechnics, acids, solvents, petroleum products, volatile fluorine and chlorine

compounds, sodium metals, potassium metals, flares, infectious waste, and choking service (CS) gas. A complete listing of potential wastes is provided in the Parsons ES RI (Parsons ES, 1998).

Several geophysical anomalies were identified during the aerial GPR survey conducted in 1996. Geophysical anomalies that exhibited the strongest evidence of previous disposal activities were investigated during the 1997 RI. Subsite FTIR-07/d exhibited only weak geophysical signatures and poor aerial photographic evidence of previous disposal activities.

A passive and active soil gas survey was conducted at Subsite FTIR-07/d. Three passive soil-gas samples were collected in March and April 1996 (Section 4.0). No target volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), or explosives were detected in the passive soil-gas samples. Active soil gas screening was conducted using a photoionization detector (PID) at the passive soil gas locations in May 1996. Based on screening results one soil gas sample was collected for laboratory analysis. Sampling location 07-D-A01 was selected for analysis because it had the highest PID reading. Tetrachloroethene (PCE) was detected in the soil gas sample at a concentration of 3.96 parts per billion per volume (ppbv), while acetone and 2-butanone were detected at estimated levels of 9.96 ppbv and 1.94 ppbv, respectively.

1.4 REPORT ORGANIZATION

This Supplemental RI report describes the field activities and results used to further characterize these sites. The organization of this report is as follows:

Section 1.0	Introduction
Section 2.0	Investigative Techniques
Section 3.0	Geology, Hydrology, and Surface Water Hydrology
Section 4.0	Results
Section 5.0	Contaminant Fate and Transport
Section 6.0	Human Health Risk Assessment
Section 7.0	Baseline Ecological Risk Assessment
Section 8.0	Conclusions and Recommendations

The following information is included in appendices:

Appendix A	Land Survey Data
Appendix B	Analytical Results
Appendix C	Chain of Custody Forms
Appendix D	Data Validation Reports
Appendix E	Chemical Quality Assurance Report
Appendix F	Field Duplicate Summary
Appendix G	Letter to DTSC regarding Mercury Data
Appendix H	Toxicology Profiles
Appendix I	Responses to Comments

2.0 INVESTIGATIVE TECHNIQUES

This section discusses the field methods and protocols used for the field-related activities at Fort Irwin during this Supplemental RI. Field activities included unexploded ordnance (UXO) clearance, test pit excavation and sampling, and land surveying. This section also presents a summary of the chemical analytical program which is described in the Chemical Data Acquisition Plan (CDAP) in the Parsons ES, Inc. Project Workplan for the Site Inspection and Remedial Investigation of 31 Sites (hereafter referred to as the Parsons ES Workplan), Appendix D (Parsons ES, 1995).

2.1 UNEXPLODED ORDNANCE CLEARANCE AND TEST PIT EXCAVATION

UXO has previously been encountered at many of the sites located at Fort Irwin. Because of this, Fort Irwin controls access to the range areas, provides range safety and UXO briefings, and authorizes access permits on a daily basis.

UXO clearance for field activities conducted for this project consisted of surface clearance for site walkovers and vehicle access as well as subsurface clearance during trenching. All UXO work was performed by UXB International, Inc. (UXB). Clearance of UXO for site walkovers and vehicle access was performed using a Schonstedt GA-72 C/V magnetometer (Schonstedt) and by visual inspection of the ground surface.

To minimize the risk of contacting or disturbing UXO, test pits were cleared for UXO between each lift. The excavation was completed under the supervision of two UXO specialists. One specialist operated the backhoe, while the second performed visual inspection of the test pit contents. Following excavation of each lift, the Schonstedt was lowered into the pit to clear for UXO. Metal objects (as determined by the magnetometer) within the excavation were visually inspected, and excavation continued under the direct supervision of the UXO specialist. UXB personnel also performed visual inspection of the contents of each backhoe bucket.

UXB personnel decontaminated the backhoe bucket after each test pit. Decontamination was performed over the area of excavation and consisted of:

- Removing large pieces of dirt and mud from the bucket with a brush or shovel
- Washing equipment surfaces with high-pressure steam

2.2 TEST PIT SAMPLING

Test pits were excavated using a backhoe. Soil samples were collected from test pits as described in Section 4.0, but generally at depths of 0.5, 2.5, 5, 10, and 15 feet bgs. Test pits were not shored, and personnel did not enter them at any time.

Subsurface samples were collected from the backhoe bucket. The upper 6 inches of soil in the center of the bucket were removed, and samples were collected below the area of removed soil. Brass sample sleeves were filled with soil using a trowel. The ends of the sample sleeves were sealed using Teflon™ tape and non-reactive plastic caps. Sample sleeves were then labeled, placed in sealable plastic bags, and put in coolers with wet ice.

Sample identification numbers were organized by site, anomaly number, test pit type ("Ts" for a source area test pit and "Tp" for a peripheral test pit), test pit number, and depth. Duplicate samples were sent blind to the laboratory and were identified with a test pit type of Td. Example sample identification numbers are as follows:

7d-1-Ts-1-5'	This test pit is located at Subsite FTIR-07/d within anomaly 1. This is the first excavated test pit within the source area and the sample was collected at 5 feet bgs.
7d-1-Tp-1-10'	This test pit is located at Subsite FTIR-07/d within anomaly 1. This is the first peripheral test pit and the sample was collected at 10 feet bgs.
7d-1-Td-1-5'	This test pit is located at Subsite FTIR-07/d within anomaly 1. This is a duplicate sample of sample 7d-1-Ts-1-5'.

Soil samples were screened for the presence of VOCs using a PID, as described in the Parsons ES Workplan. Soil from the test pit was placed into a clean, resealable plastic bag and left in the sun for approximately 15 minutes. The bag was then unsealed just enough to allow the tip of the PID to be inserted, and a headspace reading of soil vapor was measured and recorded in the field logbook. Soil samples were submitted for VOC analysis if PID readings exceeded 3 parts per million (ppm) or if other evidence of contamination (e.g., staining or odor) was observed. The analytical results are presented in Section 4.0.

Following completion of each test pit, the excavated soil was backfilled into the pit and compacted. After backfilling, the test pit was marked and labeled with wooden stakes for later location by a California-registered land surveyor. The backhoe bucket was decontaminated using high-pressure steam before moving to the next location.

2.3 LAND SURVEY

Land surveying for the site investigation was conducted by EDB and Associates (a California-registered land surveyor). All test pit locations were surveyed using Global Positioning System (GPS) techniques to establish horizontal control. All surveyed locations were tied to pre-existing permanent land monuments and the coordinate system that has been established at Fort Irwin. Coordinates are based on the North American Datum of 1927 (NAD27), and elevations are based on the National Geodetic Vertical Datum of 1929 (NGVD29) as noted on the land survey maps provided in Appendix A.

2.4 ANALYTICAL PROCEDURES AND QUALITY ASSURANCE/QUALITY CONTROL EVALUATION

Analytical procedures were outlined in the CDAP presented in the Parsons ES Workplan, Appendix D (Parsons ES, 1995). The laboratory subcontracted for the chemical analysis of soil samples was Quanterra Environmental Services (Quanterra), located in West Sacramento, California. Quanterra performed all the requested analyses with the exception of nitrosamines

which were analyzed by Applied Physical & Chemical Laboratory (APCL) located in Chino, California and o-chlorobenzaldehyde which was analyzed by DataChem Laboratories (DataChem) located in Salt Lake City, Utah. All three laboratories are validated by the USACE Center of Expertise (CX) and are certified by the California Environmental Protection Agency (Cal-EPA) Department of Health Services (DHS) through the Environmental Laboratory Accreditation Program (ELAP) to perform hazardous waste analyses.

Quality assurance (QA) split samples were collected at each of the locations where field duplicate samples were collected. The QA split samples were submitted to Curtis and Tompkins, Ltd. (C&T) in Berkeley, California for chemical analysis. The results of the QA split samples will be submitted directly by C&T to the USACE Project Manager (PM) and are not presented as part of this report.

2.4.1 Analytical Methods and Sampling Program

On June 27, 1998, a total of 16 samples (13 soil samples and 3 field duplicate samples) were collected at Subsite FTIR-7/d. Table 2-1 provides the field identification, laboratory identification, and the analyses requested for each sample. Analytical results of these samples are provided in a tabular format in Appendix B. Copies of all sample chain-of-custody documents are included in Appendix C. The analyses performed included the following:

- Metals (antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc) by United States Environmental Protection Agency (USEPA) Method 6010B
- Hexavalent chromium (CrVI) by USEPA Method 7196A
- SVOCs by USEPA Method 8270C
- Organochlorine pesticides (OCPs) by USEPA Method 8081A
- Polychlorinated biphenyls (PCBs) by USEPA Method 8082
- Chlorinated herbicides by USEPA Method 8151A
- Total recoverable petroleum hydrocarbons (TRPH) by USEPA Method 418.1
- pH by USEPA Method 9045

- Ammonia by USEPA Method 350.1
- Nitrate/nitrite as nitrogen by USEPA Method 353.2
- ortho(o)-Chlorobenzaldehyde (OCBA) by DataChem Standard Operating Procedure (SOP) "OP-DC-CSGAS"
- Nitrosamines by USEPA Method 8270C
- VOCs by USEPA Method 8260B
- Nitroaromatics and nitroamines by USEPA Method 8321
- Nitroglycerin and PETN by USEPA Method 8321
- Dioxins/furans (D/Fs) by USEPA Method 8290

All samples were analyzed in accordance with the protocols established in the CDAP, with the exception of the nitrosamines which were analyzed by gas chromatography/mass spectrometry (GC/MS) method 8270C, instead of GC method 8070A. Equivalent GC reporting and quality control (QC) limits could be achieved using the GC/MS which required no method development. Similarly, explosives (nitroaromatics, nitroamines, nitroglycerin, and PETN) were analyzed by the liquid chromatography (LC)/MS method instead of the high performance LC (HPLC) methods 8330 and 8332. The LC/MS method obtained comparable reporting and QC limits. These variances were discussed with and approved by the USACE chemist prior to implementation. Analyses not identified in the CDAP (i.e., o-chlorobenzaldehyde and the screening methods for Cyclonite (RDX) [draft USEPA Method 4051] and trinitrotoluene (TNT) [draft USEPA Method 4050]) were performed per the USEPA method criteria.

The analysis of samples for VOCs, dioxins/furans, and explosives was dependent upon field screening results, field observations, preliminary analytical results, and Ensys™ immunoassay screening tests, respectively.

Samples were screened in the field with a PID for the presence of organic compounds. If the PID reading was above 3 ppm, then the sample was submitted to Quanterra for VOC analysis by USEPA Method 8260B. Based on this screening, no samples from Subsite FTIR-7/d were selected for VOC analysis.

Dioxin/Dibenzofuran analyses were selected based on the following criteria:

Category 1: If the sample location had evidence of burning, then samples were selected for dioxins/furans analysis when preliminary, unvalidated, analytical data indicated the presence of VOCs, SVOCs, or chlorinated compounds.

Category 2: If the sample location had no evidence of burning, then samples were selected for dioxins/furans analysis when preliminary, unvalidated, analytical data indicated the presence of PCBs, hexachlorobenzene, pentachlorophenol, 2,4-D, or 2,4,5-T.

Based on these criteria, one sample from Subsite FTIR-7/d (7d-1-Ts-1-5) was analyzed for D/F.

All soil samples submitted to Quanterra were screened for explosives, specifically RDX and TNT using Ensys™ immunoassay test kits. If screening results were above the reporting limit (1.0 mg/kg for RDX and 0.7 mg/kg for TNT), then samples were submitted for explosives analysis by USEPA Method 8321. Ten percent of the samples with non-detect concentrations were also submitted for analysis per the Parsons ES CDAP. Based on these criteria, one sample from Subsite FTIR-7/d had concentrations greater than the reporting limit: 7d-1-Ts-1-15. The following two samples were analyzed to verify the non-detect screening data: 7d-2-Ts-1-2.5 and 7d-1-Tp-1-0.5. Due to an error in a correction factor calculation for the Ensys™ immunoassay analysis, one additional sample, 7d-2-Ts-1-10, was not identified for LC/MS explosive analysis until three days past the normal 14-day extraction holding time. The sample was analyzed by USEPA Method 8321, and the results were qualified as estimated with a J for detects and a UJ for non-detects.

2.4.2 Data Validation

Data validation of all sample results, using both USEPA Level III and IV guidelines, was performed by Laboratory Data Consultants, Inc. (LDC) located in Carlsbad, California. Level III data validation consisted of assessing the results of the laboratory quality control checks and analytical procedures and how these were applied to the data set. In addition to the Level III checks, Level IV data validation included a detailed review of the raw data to check for

calculation, compound identification, and transcription errors. Ten percent of the data was validated using the Level IV guidelines, and the remaining 90 percent was validated by the Level III guidelines. LDC validated the analyses using the following documents, as applicable to each method:

- USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, February 1994
- USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, February 1994
- USEPA SW 846, Third Edition, Test Methods for Evaluation Solid Waste, update 1, July 1992; update IIA, August 1993; update II, September 1994; update IIB, January 1995; update III, December 1996
- CDAP (Parsons ES, 1995)

The data validation reports, which include complete summaries of the data validation qualifiers, are included in Appendix D and are organized by analytical parameter. An overview of LDC's findings is presented in the following sections. LDC utilized several data validation flags. The definitions of these qualifier flags are as follows:

U	Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.
J	Indicates an estimated value.
R	Quality control indicates the data is not usable.
N	Presumptive evidence of the constituent presence.
UJ	Indicates the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

LDC classified flags as either protocol (P) or advisory (A) to indicate whether the flag was due to a laboratory deviation from a specified protocol (P) or was of a technical advisory (A) nature. All the flags have been incorporated into the data tables presented in this report.

2.4.3 Quality Control Results

This section provides a summary of the field and laboratory QC sample results which were used to meet the project data quality objectives (DQOs) for the investigation. The following subsections summarize LDC's validation findings in terms of the precision, accuracy, representativeness, completeness, and comparability (PARCC) criteria as defined in Section 7.6.5 of the CDAP (Parsons ES, 1995). The Chemical Quality Assurance Report, prepared by LDC, is included in Appendix E.

2.4.3.1 Precision and Accuracy. Precision and accuracy were evaluated based on the results from QC samples collected by the field team and QC samples that originated in the laboratory. The calculated relative percent difference (RPD) for matrix spike/matrix spike duplicates (MS/MSDs) and field duplicate pairs provided information on the precision of sampling and analytical procedures. Evaluation of the percent recovery of internal standards, surrogate compounds, and spiked analytes in MS/MSDs and laboratory control samples (LCSs) provided information on accuracy. In addition, the initial and continuing calibration results provided information on analytical accuracy. Acceptance criteria (control limits) were met with the exceptions noted below.

Initial Calibrations. Initial calibration met acceptance criteria for all samples with the following exceptions. The following is a summary of qualified compounds based on these nonconformances:

- For the initial calibration performed on June 27, 1998, the relative standard deviation (%RSD) for the herbicide MCPP (33 percent) was above the acceptance criteria of 20 percent. Associated samples include 7d-1-Td-1-2.5, 7d-1-Tdd-1-2.5, 7d-1-Tp-1-0.5, 7d-1-Tp-1-2.5, 7d-1-Tp-1-5, 7d-1-Tp-1-10, 7d-1-Ts-1-0.5, 7d-1-Ts-1-2.5, 7d-1-Ts-1-5, 7d-1-Ts-1-10, 7d-1-Ts-1-15, 7d-2-Td-1-0.5, 7d-2-Ts-1-0.5, 7d-2-Ts-1-2.5, 7d-2-Ts-1-5, and 7d-2-Ts-1-10. Compounds were qualified as estimated with a J flag for all detects and a UJ flag for all non-detects.
- For the initial calibration performed on July 21, 1998, %RSD for the explosive nitrobenzene (31 percent) was above the acceptance criteria of 30 percent. Associated samples include 7d-1-Ts-1-15, 7d-1-Tp-1-0.5, 7d-2-Ts-1-2.5, and 7d-

2-Ts-1-10. Compounds were qualified as estimated with a J flag for all detects and a UJ flag for all non-detects.

- For the initial calibration performed on July 21, 1998, RRF for the explosive 3-nitrotoluene (0.0404) was below the acceptance criteria of 0.05. Associated samples include 7d-1-Ts-1-15, 7d-1-Tp-1-0.5, 7d-2-Ts-1-2.5, and 7d-2-Ts-1-10. Compounds were qualified as estimated with a J flag for all detects and invalid with a R flag for all non-detects.

Continuing Calibrations. Continuing calibration met acceptance criteria for all samples with the following exceptions. The following is a summary of qualified compounds based on these nonconformances:

- For the continuing calibration verification (CCV) performed on July 20, 1998, the percent difference (%D) for the SVOCs benzoic acid (46.8 percent) and 3,3-dichlorobenzidine (24.1 percent) were above the acceptance criteria of 20 percent. Associated samples include 7d-1-Td-1-2.5, 7d-1-Tdd-1-2.5, and 7d-2-Td-1-0.5. Compounds were qualified as estimated with a J flag for all detects and with a UJ flag for all non-detects.
- For the CCV performed on July 22, 1998, the %D for the SVOCs bis(2-ethylhexyl)phthalate (21.9 percent) and di-n-octylphthalate (30.2 percent) were above the acceptance criteria of 20 percent. Associated samples include 7d-1-Ts-1-0.5, 7d-1-Ts-1-2.5, 7d-1-Ts-1-5, 7d-1-Ts-1-10, 7d-1-Ts-1-15, 7d-1-Tp-1-0.5, 7d-1-Tp-1-2.5, and 7d-2-Ts-1-0.5. Compounds were qualified as estimated with a J flag for all detects and with a UJ flag for all non-detects.
- For the CCV performed on July 23, 1998, the %D for the SVOCs 2-nitroaniline (21.5 percent), 2,2-oxybis(1-chloropropane) (22.2 percent), 4-nitrophenol (22.4 percent), benzoic acid (37.4 percent), and nitrobenzene (20.4 percent) were above the acceptance criteria of 20 percent. Associated samples include 7d-1-Tp-1-5, 7d-1-Tp-1-10, 7d-2-Ts-1-2.5, 7d-2-Ts-1-5, and 7d-2-Ts-1-10. Compounds were qualified as estimated with a J flag for all detects and with a UJ flag for all non-detects.
- For the CCV performed on July 17, 1998, the %D for the pesticide endrin aldehyde (46 percent) was above the acceptance criteria of 15 percent. Associated samples include 7d-1-Tp-1-0.5, 7d-1-Tp-1-2.5, 7d-1-Tp-1-5, 7d-1-Tp-1-10, 7d-1-Ts-1-5, 7d-1-Ts-1-10, 7d-1-Ts-1-15, and 7d-2-Ts-1-0.5. Compounds were qualified as estimated with a J flag for all detects and with a UJ flag for all non-detects.
- For the CCV performed on July 16, 1998, the %D for the pesticide endrin aldehyde (43 percent) was above the acceptance criteria of 15 percent. Associated

samples include 7d-1-Td-1-2 5 and 7d-1-Tdd-1-2 5 Compounds were qualified as estimated with a J flag for all detects and with a UJ flag for all non-detects

- For the CCV performed on July 17, 1998, the %D for the pesticide endrin aldehyde (47 percent) was above the acceptance criteria of 15 percent. Associated samples include 7d-1-Ts-1-0.5, 7d-1-Ts-1-2.5, and 7d-2-Td-1-0.5. Compounds were qualified as estimated with a J flag for all detects and with a UJ flag for all non-detects.
- For the CCV performed on July 17, 1998, the %D for the pesticide endrin aldehyde (39 percent) and methoxychlor (21 percent) were above the acceptance criteria of 15 percent. Associated samples include 7d-2-Ts-1-2.5, 7d-2-Ts-1-5, and 7d-2-Ts-1-10. Compounds were qualified as estimated with a J flag for all detects and with a UJ flag for all non-detects.
- For the CCV performed on July 14, 1998, the %D for the herbicides dalapon (16 percent), 2,4-D (17 percent), and 2,4-DB (17 percent) were above the acceptance criteria of 15 percent. Associated samples include 7d-1-Ts-1-0.5, 7d-1-Ts-1-2 5, and 7d-2-Td-1-0.5. Compounds were qualified as estimated with a J flag for all detects and a UJ flag for all non-detects
- For the CCV performed on July 15, 1998, the %D for the herbicide MCPP (20 percent) was above the acceptance criteria of 15 percent. Associated samples include 7d-2-Ts-1-2.5, 7d-2-Ts-1-5, and 7d-2-Ts-1-10 Compounds were qualified as estimated with a J flag for all detects and a UJ flag for all non-detects.
- For the CCV performed on July 30, 1998, the %D for the Dioxin/Dibenzofuran 1,2,3,6,7,8-HxCDF (28 percent) was above the acceptance criteria of 20 percent The associated samples include 7d-1-Ts-1-5. This compound was qualified as estimated with a J flag for all detects and a UJ flag for all non-detects.

Internal Standards. The internal standard area recoveries met acceptance criteria for all samples.

Laboratory Control Samples. The LCS recoveries met acceptance criteria for all samples, with the following exceptions

- The LCS result (108 percent) for the SVOC 1,2,4-trichlorobenzene analyzed on July 7, 1998, was above the upper control limit of 65 percent. Associated samples include 7d-1-Td-1-2 5, 7d-1-Tdd-1-2.5, and 7d-2-Td-1-0.5 Sample results were non-detect, therefore, no flags have been applied based on this non-conformance.
- The LCS result (0 percent) for OCBA was below the lower control limit of 70 percent. Associated samples include 7d-1-Td-1-2.5, 7d-1-Tdd-1-2 5, 7d-2-Td-1-

0.5, 7d-1-Ts-1-0.5, 7d-1-Ts-1-2.5, 7d-1-Ts-1-5, and 7d-1-Ts-1-10. See below for the corrective action for this nonconformance.

- The LCS result (0 percent) for OCBA was below the lower control limit of 70 percent. Associated samples include 7d-1-Ts-1-15, 7d-1-Tp-1-0.5, 7d-1-Tp-1-2.5, 7d-1-Tp-1-5, 7d-1-Tp-1-10, 7d-2-Ts-1-0.5, 7d-2-Ts-1-2.5, 7d-2-Ts-1-5, and 7d-2-Ts-1-10. See below for the corrective action for this nonconformance.

A spiking solution used to spike the LCS had been incorrectly prepared for the OCBA analysis. This situation resulted in zero percent LCS recoveries for all LCSs associated with Site FTIR-07 samples submitted for OCBA analysis. When a new spiking solution was prepared and analyzed with new blanks and MS/MSDs, all recoveries were acceptable. The data associated with this nonconformance are not qualified, since corrective action provided acceptable data and rationale for the occurrence.

Matrix Spike/Matrix Spike Duplicates. The MS/MSD recoveries met acceptance criteria for all samples, with the following exceptions for percent recovery or RPD nonconformances:

- The MS/MSD recoveries for the metals antimony (50 percent and 38 percent) and manganese (66 percent for the MS) in sample 7d-2-Ts-1-0.5 were below the lower control limit of 75 percent. The associated sample is 7d-2-Ts-1-0.5. Compounds were qualified as estimated with a J flag for all detects and a UJ flag for all non-detects.
- The MSD recovery for the herbicide 2,4-D (63 percent) in sample 7d-1-Tp-1-10 was below the lower control limit of 65 percent. The associated sample is 7d-1-Tp-1-10. Compounds were qualified as estimated with a J flag for all detects and a UJ flag for all non-detects.
- The MS/MSD recoveries for o-chlorobenzaldehyde (0 percent) in sample 7d-2-Ts-1-0.5 were below the lower control limit of 65 percent. The associated sample is 7d-2-Ts-1-0.5. See below for the corrective action for this nonconformance.
- The MS/MSD recoveries for the explosive 2,4,6-trinitrotoluene (137 and 143 percent) in sample 7d-2-Ts-1-10 were above the upper control limit of 135 percent. The associated sample is 7d-2-Ts-1-10. Compounds were qualified as estimated with a J flag for all detects.

A spiking solution used to spike the MS/MSD pairs had been incorrectly prepared for the OCBA analysis. This situation resulted in zero percent LCS recoveries for all LCSs associated with Site FTIR-07 samples submitted for OCBA analysis. When a new spiking solution was prepared and analyzed with new blanks and MS/MSDs, all recoveries were acceptable. The data associated with this nonconformance are not qualified, since corrective action provided acceptable data and rationale for the occurrence.

Surrogate Recoveries. The surrogate recoveries met acceptance criteria for all methods with the exceptions noted below:

- The recovery for the pesticide surrogate tetrachloro-m-xylene (63 percent) in sample 7d-1-Td-1-2.5 was below the lower control limit of 65 percent. A J flag has been applied to all detected results for this sample and a UJ flag has been applied to all non-detected results.
- The recovery for the pesticide surrogate tetrachloro-m-xylene (62 percent) in sample 7d-1-Ts-1-0.5 was below the lower control limit of 65 percent. A J flag has been applied to all detected results for this sample and a UJ flag has been applied to all non-detected results
- The recovery for the pesticide surrogate tetrachloro-m-xylene (1690 percent) in sample 7d-1-Ts-1-5 exceeded the upper control limit 135 percent. Sample results were non-detect, therefore, no flags have been applied based on this non-conformance.
- The recovery for the herbicide surrogate DCAA (42 percent) in sample 7d-2-Td-1-0.5 was below the lower control limit of 65 percent. A J flag has been applied to all detected results for this sample and a UJ flag has been applied to all non-detected results.
- The recovery for the herbicide surrogate DCAA (0 percent) in samples 7d-1-Ts-1-0.5, 7d-1-Ts-1-2.5, 7d-1-Ts-1-5, 7d-1-Ts-1-10, 7d-1-Ts-1-15, 7d-1-Tp-1-0.5, 7d-1-Tp-1-2.5, and 7d-2-Ts-1-5 was below the lower control limit of 65 percent. A J flag has been applied to all detected results for this sample and an R flag has been applied to all non-detected results.
- The recovery for the herbicide surrogate DCAA (42 percent) in sample 7d-2-Ts-1-0.5 was below the lower control limit of 65 percent. A J flag has been applied to all detected results for this sample and a UJ flag has been applied to all non-detected results.
- The recovery for the OCBA surrogate 2,4-dichlorobenzaldehyde (137 percent) in sample 7d-1-Tp-1-5 exceeded the upper control limit 135 percent. Sample results

were non-detect, therefore, no flags have been applied based on this non-conformance.

- The recovery for the OCBA surrogate 2,4-dichlorobenzaldehyde (138 percent) in sample 7d-1-Tp-1-10 exceeded the upper control limit 135 percent Sample results were non-detect, therefore, no flags have been applied based on this non-conformance.
- The recovery for the OCBA surrogate 2,4-dichlorobenzaldehyde (136 percent) in sample 7d-2-Ts-1-2 5 exceeded the upper control limit 135 percent Sample results were non-detect, therefore, no flags have been applied based on this non-conformance.
- The recovery for the OCBA surrogate 2,4-dichlorobenzaldehyde (136 percent) in sample 7d-2-Ts-1-5 exceeded the upper control limit 135 percent. Sample results were non-detect, therefore, no flags have been applied based on this non-conformance.

Field Duplicates. LDC summarized all the field duplicate results in each of the data validation reports by analytical parameter (summaries are provided in Appendix F). The criteria specified in the CDAP are included in the validation reports The following samples and compounds/analytes were qualified based on the field duplicate RPDs:

- 7d-1-Td-1-2.5 and 7d-1-Ts-1-2.5 for arsenic (94 percent) and calcium (114 percent) were above acceptance criteria of 70 percent.
- 7d-1-Tdd-1-2.5 and 7d-1-Tp-1-2.5 for barium (120 percent), copper (184 percent), molybdenum (102 percent), and zinc (160 percent) were above acceptance criteria of 70 percent
- 7d-1-Tdd-1-2.5 and 7d-1-Tp-1-2.5 for the herbicide 2,4,5-TP (130 percent) was above acceptance criteria of 50 percent. The compound was qualified as estimated with J flag for all detected results and a UJ flag for all non-detected results.
- 7d-2-Td-1-0.5 and 7d-2-Ts-1-0.5 for copper (166 percent) and zinc (130 percent) were above acceptance criteria of 70 percent.
- 7d-1-Td-1-2.5 and 7d-1-Ts-1-2.5 for ammonia (162 percent) was above the acceptance criteria of 70 percent.

2.4.3.2 Representativeness. Representativeness was assessed through the evaluation of blank samples (method, initial calibration, continuing calibration, preparation, and trip blanks)

and by the interference check samples for metals There were no detected concentrations of target analytes except as noted.

- The method blank from July 9, 1998, contained a detection of nitrobenzene (0.17 μg/kg). This situation was caused by the internal standard, 15N-nitrobenzene, creating false positive results. Associated samples and its corresponding modified final concentration include 7d-1-Ts-1-15 (0.25U μg/kg), 7d-1-Tp-1-0.5 (0.25U μg/kg), and 7d-2-Ts-1-2.5 (0.19U μg/kg). This occurrence did not impact the data usability.
- The method blank from July 13, 1998, contained a detection of nitrobenzene (0.12 μg/kg). This situation was caused by the internal standard, 15N-nitrobenzene, creating false positive results. The associated sample and its corresponding modified final concentration is 7d-2-Ts-1-10 (0.16U μg/kg). This occurrence did not impact the data usability

2.4.3.3 Completeness and Comparability. Completeness of data was evaluated by assuring that all the analytical requests were met, samples were received in the proper condition, and all analyses were performed within the appropriate holding times. The data were then evaluated for comparability of detection limits and associated dilution factors.

Metals were analyzed using USEPA Method 6010B, an inductively coupled spectrophotometer (ICP) method. The metals list should have included mercury; however, ICP is not an appropriate technique to analyze this slightly volatile metal. The appropriate technique utilizes USEPA Method 7471A, a cold vapor atomic absorption technique. By the time this oversight was detected, the 28-day holding time for mercury had expired. Mercury fulminate (a trigger source) is the most commonly used form of mercury at military facilities. It is an extremely sensitive compound that is most likely volatilized during the explosion of the munitions in which it is contained. Additionally, the concentrations of mercury detected during previous investigations at Fort Irwin range sites were not high enough to trigger a human health or ecological risk. Therefore, it was concluded that the analysis of mercury was not critical to the risk evaluation at Subsite FTIR-07/d. A letter addendum requesting permission to continue with the risk assessment without the mercury data was prepared and submitted to the California Department of Toxic Substances Control (DTSC) (presented in Appendix D). Following regulatory approval, it was determined that resampling would not be necessary.

LDC noted the holding time nonconformance for the explosives analysis caused by the screening calculation error described previously. Sample 7d-2-Ts-1-10 was extracted three days outside of the 14-day holding time. All detectable concentrations in this sample were qualified as estimated with a J flag while non-detects were qualified as UJ flag.

To ensure the comparability of the data, field procedures were standardized by adhering to the standard operating procedures (SOPs), and laboratory procedures followed USEPA analytical methods which utilize standard units of measurement. All project-required reporting limits were met with the following exceptions. These exceptions had no effect on data quality, since concentrations were reported to the method detection limit and qualified with a J flag if concentrations were found lower than the project-required reporting limits

- **SVOCs**: 3,3'-dichlorobenzidine was reported at 660 µg/kg, while the CDAP reporting limit requirement was 330 µg/kg; eight other compounds (benzoic acid, 4,6-dinitro-2-methylphenol, 2,4-dinitrophenol, 2-nitroaniline, 3-nitroaniline, 4-nitroaniline, 4-nitrophenol, and pentachlorophenol) were reported at 1,600 µg/kg while the CDAP reporting limit requirement was 330 µg/kg; the remaining target compounds were also reported above the CDAP reporting limit requirement (refer to Appendix D for complete list).
- **OCPs**: The following compounds were reported at 0.83 µg/kg, while the CDAP reporting limit requirement was 0.33 µg/kg: alpha-BHC, beta-BHC, delta-BHC, gamma-BHC, heptachlor, aldrin, heptachlor epoxide, and endosulfan I. The following compounds were reported at 1.7 µg/kg, while the CDAP reporting limit requirement was 0.33 µg/kg: dieldrin, 4,4'-DDE, endrin, endrin aldehyde, endosulfan II, 4,4'-DDD, endosulfan sulfate, and 4,4'-DDT. Methoxychlor was reported at 8.3 µg/kg, while the CDAP reporting limit requirement was 3.3 µg/kg
- **PCBs**: The seven arochlors were reported at 1.7 µg/kg while the CDAP reporting limit was 0.33 µg/kg.
- **Metals**: The following metals had reporting limits greater than those specified in the CDAP: arsenic (10 milligrams per kilogram (mg/kg) instead of 1 mg/kg), calcium (50 mg/kg instead of 15 mg/kg), iron (10 mg/kg instead of 8 mg/kg), lead (5 mg/kg, instead of 1 mg/kg), magnesium (50 mg/kg instead of 20 mg/kg), manganese (1 mg/kg instead of 0.5 mg/kg), potassium (500 mg/kg instead of 300 mg/kg), selenium (20 mg/kg instead of 1 mg/kg), sodium (500 mg/kg instead of 40 mg/kg), and thallium (7 mg/kg instead of 2 mg/kg). For use in the risk

assessment, concentrations of thallium were reported to the method detection limit and qualified as estimated.

- **Herbicides**: The following compounds had reporting limits greater than those specified in the CDAP: 2,4-D (25 µg/kg instead of 10 µg/kg), 2,4-DB (100 µg/kg instead of 10 µg/kg), MCPA and MCPP (5,000 µg/kg instead of 500 µg/kg), Dinoseb and Dichloropropene (25 µg/kg instead of 2 µg/kg), and Dicamba (10 µg/kg instead of 1 µg/kg).
- **Wet Chemistry**: Nitrate/nitrite had a reporting limit greater than that specified in the CDAP (0.25 mg/kg instead of 0.10 mg/kg).

Some samples required dilutions in order to quantify target compounds within the linear range of the analytical instruments. In general, the majority of the sample results were not affected by the need for dilution.

The completeness and comparability of the data presented in this report are acceptable with the exceptions noted above.

2.4.4 Quality Control Summary

The field and analytical procedures for this investigation were followed as described in the Workplan and CDAP with the exceptions noted above. All qualified data are summarized in Appendix D. With the exception of the rejected data, all analytical data associated with this investigation are considered accurate, precise, representative, comparable, and complete and should be considered usable in performing the human health risk assessment (HHRA). Rejected data were not selected for inclusion in the HHRA following criteria outlined in Section 6.2.

3.0 GEOLOGY, HYDROGEOLOGY, AND SURFACE WATER HYDROLOGY

Site FTIR-07 is located in the northern portion of the Red Pass Valley. Red Pass Valley is a long, east-west-trending valley that drains southeast to Red Pass (Figure 1-2). The valley is bounded on the north and south by granitic mountains, the Granite and Tiefort Mountains, respectively. The highest peak adjacent to the valley is at an elevation of 4,493 feet (mean sea level) msl and is located in the Granite Mountains. The Tiefort Mountains that bound the valley to the south are generally lower; the highest elevation is at 3,278 feet mean sea level (msl) (Parsons ES, 1997).

The site is adjacent to a small bedrock hill, "Hill 800," on a southward sloping alluvial fan. The geomorphic character of the range front, presence of numerous bedrock "islands" in the alluvial fans, and lack of any prominent range scarp indicate that the area surrounding the site is an alluviated pediment. The shape of the alluvium/bedrock contact is expected to approximate surface topography. Prior geologic investigations have mapped no known faults in the vicinity of the sites or range front. Therefore, alluvium is unlikely to be more than a few hundred feet thick within several miles of the site (Parsons ES, 1995)

Groundwater resources have not been developed in the Red Pass Valley Groundwater Basin. Two wells were installed in 1943 in conjunction with a study of potential water supply resources in the basin. One well was located approximately 12 miles east of Site FTIR-07. During the drilling of this well, alluvium was encountered to the total depth of 500 feet below ground surface (bgs). The static water level was 368 feet bgs. The well yielded 25 gallons per minute with a corresponding drawdown of 107 feet. The second well was located approximately 2 miles west of Site FTIR-07. Alluvium was encountered to a depth of 335 feet bgs, and bedrock was observed from 335 feet bgs to the total depth of 365 feet bgs. Groundwater was not observed in this well (Parsons ES, 1997).

There is very little surface water in the vicinity of Site FTIR-07. Surface water is characterized by intermittent streams that flow from the hills toward Red Pass Lake. The valley is

asymmetrical with much of the valley sloping gently southward toward the Tiefort Mountains. Therefore, much of the drainage is to the south toward an eastern flowing wash located near the base of the Tiefort Mountains. The playa deposits are fine-grained and greatly inhibit the infiltration of water into the subsurface; therefore, evaporation is the primary mechanism of water loss from the playas.

4.0 RESULTS

The following section provides a description of Subsite FTIR-07/d. A summary of the Supplemental RI activities conducted at the subsite and analytical results from samples collected are also included. Descriptions of the physical characteristics and history of each site were generally excerpted from the Parsons ES Workplan (Parsons ES, 1995). Additional information from Montgomery Watson's site reconnaissance, performed in 1998, is included where appropriate. Analytical results were evaluated against background levels established for inorganic material (Parsons ES, 1997) and industrial preliminary remediation goals (PRGs) established by the USEPA (USEPA, 1998) for organic materials (Table 4-1).

4.1 SITE DESCRIPTION

Subsite FTIR-07/d is located in the center of Site FTIR-07 and lies on the northeastern edge of Hill 800 (Figure 4-1). The site appears to have been disturbed during troop maneuvers; however, no evidence of landfill activities or soil staining was observed at the site.

Two geophysical anomalies were identified during the RI conducted by Parsons ES and as shown in Figure 4-1. Anomaly 1 is located in the northwest corner of the subsite. This large-scale and high magnitude electromagnetic (EM) anomaly was interpreted by Parsons ES to represent a potential disposal area. Anomaly 2 is located in the southwest corner of the subsite. This anomaly consists of a small-scale and low-magnitude magnetic anomaly that may indicate the presence of minor amounts of ferromagnetic metal. The absence of associated EM anomalies indicates that no significant subsurface disturbance is present at the location of Anomaly 2. Based on the geophysical evidence, Parsons ES interpreted Anomaly 2 as a small, isolated metal object rather than a potential disposal area.

4.2 TEST PIT AND SOIL SAMPLING

Following recommendations in the Parsons ES RI (Parsons ES, 1997), three test pits were excavated at Subsite FTIR-07/d. The locations of these test pits are presented in Figure 4-1 and analytical results are presented in Tables 4-2, 4-3, and 4-4.

One test pit (7d-1-Ts-1) was excavated to a depth of 15 feet bgs in the center of Anomaly 1. Various amounts of metal debris including rusted metal ammunition cases, iron-stained soil, steel 40-mm anti-aircraft casings, and warheads were discovered from 4 to 8 feet bgs. UXO specialists remarked that steel 40-mm casings are indicative of the World War II era (aluminum cases have been used more recently). Native soil was observed from 9 to 15 feet bgs, and a test pit diagram is presented in Figure 4-2.

Soil samples were collected from test pit 7d-1-Ts-1 at 0.5, 2.5, 5, 10, and 15 feet bgs and analyzed for metals, SVOCs, pesticides, herbicides, nitrosamines, TRPH, and general chemistry. Following explosives screening, one sample (7d-1-Ts-1-15') was analyzed for explosives. In addition, one sample (7d-1-Ts-1-5') was analyzed for dioxins/furans. Analytical results are summarized in Table 4-2. Explosives were detected in the 15-foot-bgs sample at an estimated 2,4-dinitrotoluene concentration of 0.027 mg/kg and a nitrobenzene concentration of 0.25 mg/kg. These concentrations are well below the PRG for 2,4-dinitrotoluene (1,800,000 mg/kg) and for nitrobenzene (110,000 mg/kg). The SVOCs 2,4-dinitrotoluene and di-n-butyl-phalate were detected in the 5-foot-bgs sample at concentrations of 45,000 μg/kg and 35,000 μg/kg, respectively. These concentrations are below the PRG for 2,4-dinitrotoluene (1,800,000 mg/kg) and for di-n-butyl-phthalate (110,000,000 mg/kg). Concentrations of the dioxin/furan cogeners 1,2,3,4,6,7,8-HpCDD (3.0 pg/g) and OCDD (20 pg/g) were also detected in the 5-foot bgs sample. These dioxin/furan cogeners have a calculated toxicity equivalence (TEQ) for 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) of 5.0×10^{-5} mg/kg which is below the PRG of 3.0×10^{-5} mg/kg for 2,3,7,8-TCDD (Section 6.4.2.3.1). TRPH, herbicides, nitrosamines, and pesticides were not detected in soil samples collected from test pit 7d-1-Ts-1.

The following metals were detected at concentrations greater than background in the 5-foot-bgs sample from test pit 7d-1-Ts-1: arsenic (9.8 mg/kg), cadmium (0.56 mg/kg), copper (33.0 mg/kg), lead (18.9 mg/kg), and zinc (824 mg/kg) Concentrations of metals in test pit 7d-1-Ts-1 were noted to decrease with increasing depth; only zinc was detected at concentrations greater than background (70.1 mg/kg) in the 15-foot bgs sample. Metals concentrations in all other samples collected from test pit 7d-1-Ts-1 were below background levels.

One peripheral test pit was excavated on the southwestern edge of Anomaly 1, approximately 40 feet south of test pit 7d-1-Ts-1 (Figure 4-1). Test pit 7d-1-Tp-1 was excavated to a depth of 10 feet as illustrated in Figure 4-2. No debris was discovered in this test pit, and the soil appeared to be native material

Soil samples were collected from test pit 7d-1-Tp-1 at 0.5, 2.5, 5, and 10 feet bgs and analyzed for metals, SVOCs, herbicides, pesticides, nitrosamines, and general chemistry. One sample at 0.5 feet bgs was analyzed for explosives. The explosive nitrobenzene was detected in the 0.5-foot-bgs sample at a concentration of 0.25 mg/kg, which is below the PRG for nitrobenzene (110,000 mg/kg). The herbicide 2,4,5-TP (Silvex) was detected in the 2.5-foot bgs sample at an estimated concentration of 1.2 μg/kg, which is well below the PRG of 8,600,000 μg/kg for this compound. Copper and zinc were detected above background levels in the 0.5-foot bgs sample at concentrations of 48.4 and 170 mg/kg, respectively. Arsenic and nitrate/nitrite were detected at levels only slightly greater than background in the 10-foot sample at concentrations of 9.8 and 10.3 mg/kg, respectively. Pesticides and nitrosamines were not detected in soil samples collected from this test pit.

One test pit was excavated in the center of Anomaly 2 on the southwestern edge of the subsite (Figure 4-1). Test pit 7d-2-Ts-1 was excavated to a depth of 10 feet bgs where bedrock was encountered. The soil appeared to consist of native material, and only a minor amount of metallic debris was encountered in the first 0.5 feet of the test pit (Figure 4-3).

Soil samples were collected from test pit 7d-2-Ts-1 at 0.5, 2.5, 5, and 10 feet bgs and analyzed for metals, SVOCs, herbicides, pesticides, nitrosamines, and general chemistry. Following explosives screening, two samples were selected for explosives analysis at 2.5 and 10 feet bgs The explosive nitrobenzene was detected in the 2.5-foot-bgs sample at a concentration of 0.19 mg/kg, which is below the PRG for nitrobenzene (110,000 mg/kg). The explosives octahydro-1357-tetranitro-1357-tetrazocine (HMX) and RDX were detected in the 10-foot bgs sample at estimated concentrations of 0.15 and 0.026 mg/kg, respectively. These concentrations are well below the PRGs for HMX and RDX (44,000 and 22 mg/kg, respectively). Copper (88.6 mg/kg) and zinc (115 mg/kg) were detected at concentrations greater than background in the 0.5-foot bgs sample. Metals concentrations in all other samples collected from test pit 7d-2-Ts-1 were below background levels Herbicides, pesticides, nitrosamines, and TRPH were not detected in soil samples collected from this test pit.

5.0 CONTAMINANT FATE AND TRANSPORT

This section evaluates the effects of site-specific conditions to qualitatively discuss the probable fate of each of the constituents detected in the soils at Subsite FTIR-07/d

SVOCs. Low levels of SVOCs, including polycyclic aromatic hydrocarbons (PAHs) and phthalates, were detected at Subsite FTIR-07/d. While phthalates are commonly found as sampling or laboratory artifacts, they may also be present in soils due to leaching/diffusion from disposed plastics. PAHs and phthalates have very low Henry's Law constant values, which limits volatilization. Thus sorption and biotransformation are the primary processes controlling these SVOCs in soil/water environments. SVOCs are also highly sorbed to soils. While degradation is expected to be slower than normal due to the limited available moisture, this process is expected to be the primary fate of the SVOCs detected at the site. The half-lives for transformation of phthalates, for example, are expected to be on the order of years

Dioxin/Furans. Two dioxin/furan cogeners were detected at 5-feet bgs in test pit 7d-1-Ts-1. These concentrations were well below the TEQ for 2,3,7,8-TCDD (Section 6.4.2.3.1). Dioxin/furan cogeners are generally not considered relatively mobile. In addition, no dioxin/furan concentrations were detected deeper within the test pit or within other test pits at Subsite FTIR-07/d.

Nitrosamines. The nitrosamine N-nitrosodiphenylamine was detected in test pit 7d-1-Ts-1 in the 5-foot bgs sample at a concentration below the PRG. Nitrosamines are considered relatively immobile compounds and are not expected to travel significant vertical distances. This statement is supported by the fact that N-nitrosodiphenylamine was not detected in the 10-, or 15-foot bgs samples collected within test pit 7d-1-Ts-1.

Herbicides. The herbicide 2,4,5-TP (Silvex) was detected in the 2.5-foot sample (1.2 J µg/kg) from test pit 7d-1-Tp-1 at a concentration below the PRG of 8,600,000 µg/kg. Although, herbicides are considered very mobile 2,4,5-TP was not detected in the 5- or 10-foot samples

Metals. Metals were detected in soil samples at concentrations above background levels. While specific reactions for individual metals vary slightly, the primary process affecting the fate of all metals is sorption. Most metals are precipitated, complexed with iron oxides, and sorbed onto soils soon after introduction to the environment. Because these metals are strongly sorbed onto soils, they are not expected to travel significant vertical distances through the subsurface or into groundwater. Because there are no known degradation reactions for most metals, they are expected to persist in soil.

In summary, only the herbicide 2,4,5-TP which was detected in test pit 7d-1-Tp-1 is considered to be relatively mobile. However, this compound was detected only at low concentrations. None of the other chemicals at Subsite FTIR-07/d are considered to be mobile. SVOCs, dioxin/furans, nitrosoamines, and metals are considered relatively immobile. As discussed in Section 3.0, groundwater is either absent or found at depths greater than 500 ft. Therefore, the probability of constituents detected in the soil migrating to groundwater is unlikely. The primary mechanism of transport for compounds that are highly sorbed to soils is surface water runoff.

6.0 HUMAN HEALTH RISK ASSESSMENT

The results of the HHRA conducted for Subsite FTIR-07/d are presented in this section. This HHRA was conducted in compliance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Response process, as amended by the Superfund Amendment and Reauthorization Act (SARA), integrated with Installation Restoration Program (IRP) requirements. The goal of the Remedial Response Process is to coordinate and conduct remedial actions as necessary to protect human health and the environment from releases of hazardous substances. This HHRA is intended to provide an analysis of the existing and potential risks that may be posed to human health by contaminants present in media associated with Subsite FTIR-07/d. The results of the HHRA provide the basis for determining the levels of chemicals that can remain on site and still be protective of public health. Additionally, the results of the HHRA, in conjunction with the results of the ecological risk assessment (ERA) (Section 7.0), will support the evaluation of a no-action alternative, or further action including the potential evaluation of remedial alternatives for Subsite FTIR-07/d.

6.1 INTRODUCTION

The HHRA presented in this report includes screening and baseline risk assessments. These risk assessments were conducted based on the risk assessment methodologies described in the approved *Project Workplan for the Site Inspection and Remedial Investigation of 31 Sites at the National Training Center Fort Irwin, California* (Parsons ES, 1995), hereafter referred to as the Workplan. Additionally, the screening HHRA presented in this report was conducted according to methods described in the *Recommended Outline for Using U.S. Environmental Protection Agency Region IX Preliminary Remediation Goals in Screening Risk Assessments at Military Facilities* (Cal-EPA, 1994a). The screening HHRA evaluates risks to current and potential future human receptors, based on protective assumptions relative to land use, complete exposure pathways, and chemical concentrations. The screening HHRA considers the potential for exposures to multiple site chemicals and presents the results as cumulative cancer risks and noncancer hazards. As such, the results of the screening HHRA represent a conservative

screening cancer risks and noncancer hazards are greater than 1×10^{-6} or 1.0, respectively, the site will be further evaluated in a baseline risk assessment.

A baseline HHRA will be conducted for Subsite FTIR-07/d depending upon the results of the screening HHRA, as described above. The objectives of the baseline HHRA for Subsite FTIR-07/d will be to quantitatively and qualitatively evaluate risks to human health based on current and anticipated future land uses. If estimated cumulative cancer risks and noncancer hazards are less than 1.0×10^{-6} and 1.0, respectively, the site will be recommended for NFA. If cumulative cancer risk estimates are between 1.0×10^{-6} and 1.0×10^{-4}, the site may be evaluated for potential NFA, depending upon site-specific considerations including current and potential future land uses. If cumulative baseline cancer risks or noncancer hazards exceed 1×10^{-4} or 1.0, respectively, the site will be recommended for evaluation of remedial alternatives in a Focused Feasibility Study (FS).

The HHRA for Subsite FTIR-07/d was conducted in accordance with the following guidance documents and reference sources prepared by the USEPA, DTSC, and USACE:

- Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual (Part A) (USEPA, 1989a)
- RAGS, Volume II: Environmental Evaluation Manual (USEPA, 1989b)
- Guidance for Data Useability in Risk Assessment - Interim Final (USEPA, 1990)
- Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions, OSWER Directive 9355.0-30 (USEPA, 1991a)
- Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors, OSWER Directive 9285.6-03, March, 1991 (USEPA, 1991b)
- Final Exposure Assessment Guidelines (USEPA, 1992a)
- Supplemental Guidance for Human Health Multimedia Risk Assessments for Hazardous Waste Sites and Permitted Facilities (DTSC, 1992)
- Recommended Outline for Using Environmental Protection Agency Region IX Preliminary Remediation Goals in Screening Risk Assessments at Military Facilities (Cal-EPA, 1994a)
- Preliminary Endangerment Assessment Guidance Manual (Cal-EPA, 1994b)
- Assessing Dermal Exposure in Soil (USEPA, 1995a)

- Health Effects Assessment Summary Tables (HEAST) (USEPA, 1995b)
- Risk Assessment Handbook Volume I: Human Health Evaluation (USACE, 1995a)
- Risk Assessment Handbook Volume II: Environmental Evaluation (USACE, 1995b)
- Selecting Inorganic Constituents as Chemicals of Potential Concern in Risk Assessments at Hazardous Waste Sites and Permitted Facilities (DTSC, 1997)
- Exposure Factors Handbook, Volume I, General Factors (USEPA, 1997a)
- Exposure Factors Handbook, Volume II, Food Ingestion Factors (USEPA, 1997b)
- Exposure Factors Handbook, Volume III, Activity Factors (USEPA, 1997c)
- RAGS – Supplemental Guidance Dermal Risk Assessment (USEPA, 1998)
- Region 9 PRGS Table 2000 Update (USEPA, 2000)
- Integrated Risk Information System (IRIS) database (USEPA, 2001).

6.1.2 Scope

This HHRA is intended to provide a quantitative and qualitative evaluation of the potential human health risks associated with site-related contaminants present in surface and subsurface soils associated with Subsite FTIR-07/d. A variety of wastes, including ordnance and explosive waste (OEW) and hazardous waste, were potentially disposed of at Subsite FTIR-07/d at estimated burial depths of 5 to 15 feet bgs (Section 1.3). Additionally, OB/OD operations may have been conducted on the site (Section 1.3). Consistent with these practices, the RI focused on the collection of soil samples at depths of 0.5 to 15 feet bgs (Section 4.1.2). Groundwater in the vicinity of the site is only present at depths greater than 365 feet bgs, and groundwater resources within the Red Pass Valley Groundwater Basin have not been developed (Section 3.0). Therefore, groundwater sampling was not conducted during this RI.

Consistent with the objectives of the RI, only soils data were evaluated in the HHRA for Subsite FTIR-07/d. Surface (0 – 0.5 feet bgs) and subsurface (>0.5 - 10 feet bgs) soil samples were segregated, and human health risks were evaluated for each of these depth intervals. As stated above, potential migration of contaminants to groundwater was not investigated in this RI and,

therefore, the HHRA did not evaluate the human health impacts of potential groundwater contamination.

6.1.3 Organization of the Human Health Risk Assessment

Section 6.1 - Introduction. This section presents a brief introduction to this document and identifies the objectives and scope of the HHRA for Subsite FTIR-07/d

Section 6.2 – Selection of Chemicals of Potential Concern. The methods used in the selection of chemicals of potential concern (COPCs) for evaluation in the screening and baseline HHRAs are described in this section. The COPCs that were identified for Subsite FTIR-07/d are summarized.

Section 6.3 – Screening Human Health Risk Assessment. This section presents the USEPA Region IX PRGs that were used in the screening-level assessment for Subsite FTIR-07/d, and the results of the screening HHRA.

Section 6.4 – Baseline Human Health Risk Assessment. This section evaluates the current and anticipated future land uses for Subsite FTIR-07/d; the human receptors potentially exposed; completed pathways of exposure; and the methods and assumptions used in modeling exposure doses for completed pathways.

Section 6.5 – Uncertainty Analysis. The uncertainties and limitations associated with the HHRA are discussed in this section

6.2 SELECTION OF CHEMICALS OF POTENTIAL CONCERN

The analytical data evaluated in this report was collected by Montgomery Watson during a sampling investigation conducted in June 1998. General descriptions of the sample collection and data quality requirements are presented in the Workplan (Parsons ES, 1995). Specific

sample collection procedures, and data quality requirements and issues for Subsite FTIR-07/d are described in Section 2.4.

According to the USEPA (1989a) and the Cal-EPA (1994b) guidance, only field investigation analytical data that meet specific requirements are appropriate for use in quantitative risk assessment. Only data collected and analyzed at a QC level equivalent to USEPA Level III or IV (USEPA, 1989a), meets appropriate usability criteria. USEPA Level III data provide the following:

- Low detection limits
- A wide range of calibrated analytes
- Matrix recovery information
- Laboratory process control information
- Known precision and accuracy

Sampling data were consistent with USEPA Level III and IV data quality requirements. Ninety percent of the data was validated consistent with Level III guidelines, and 10 percent of the data was validated based on Level IV guidelines.

The target reporting limits (RLs) for all analytes measured in soils were selected to be at or below applicable health-based criteria for soils. The health-based criteria used to establish RLs for soil analytes were USEPA Region IX PRGs for residential soil (USEPA Region IX, 1995), as described in the Workplan (Parsons ES, 1995). The actual RLs achieved for soil analytes and any deviations from target RLs are described in Section 2.4.

All validated chemical data derived from surface and subsurface soil samples were evaluated for potential inclusion in the risk assessment based on the following criteria:

1) If a single, unqualified value was provided for a given sample/location/data, the value was used "as is."

2) If a chemical was detected at least once in soil, the nondetects were included in the database at one-half the sample quantitation limit (SQL).

3) In the case of duplicate samples, the unqualified value and/or highest value was given priority and selected as the representative value.

4) Values identified as estimates ("J" flag) were used "as is."

5) Rejected values were not selected for inclusion in the risk assessment.

The chemicals positively identified in soil samples collected from Subsite FTIR-07/d were evaluated in a screening procedure to identify site-specific chemicals of potential concern (COPCs). The selection of site-specific COPCs is generally based on specific criteria, including:

- Frequency of detection
- Comparison with laboratory and field blanks
- Comparison with background concentrations
- Essential nutrient status.

Each of these criteria, as they apply to the selection of COPCs for Subsite FTIR-07/d, is described in the following subsections.

6.2.1 Frequency of Detection

As per USEPA guidance (USEPA, 1989a), if data from a minimum of 20 samples of a given media are available, chemicals detected in less than 5 percent of the samples may be eliminated from consideration as COPCs in that media. If data for less than 20 samples is available, this criterion for COPC identification should not be used (USEPA, 1989a). Fewer than 20 samples were collected at Subsite FTIR-07/d. In addition, the Workplan (Parsons ES, 1995) states that all chemicals detected at least once in a given medium are to be included in the quantitative risk assessment, with the exception of inorganic chemicals demonstrated to be within background levels and organic compounds demonstrated to be laboratory contaminants. Therefore, no chemicals were excluded as COPCs based on this criterion.

6.2.2 Comparison with Blanks

If a field sample has detectable concentrations of chemicals that are also detected in associated laboratory method blanks, trip blanks, or equipment rinsate blanks, field sample concentrations are compared to the associated blank concentrations. For chemicals commonly identified as artifacts resulting from laboratory or field procedures (e.g., methylene chloride, acetone, phthalates, etc.), the chemical detected in the field sample may not be considered to be site-related if the detected concentration is less than 10 times the blank concentration. For all other chemicals, the selection criterion used is five times the associated blank concentration. The comparison of field sample concentrations to associated blank concentrations was performed as part of the analytical data validation task (refer to Section 2.4). Therefore, the chemical concentrations evaluated in this risk assessment were previously evaluated by this criterion.

6.2.3 Comparison with Background Concentrations

Comparison of concentrations of chemicals detected in site media with background concentrations is appropriate for inorganic chemicals, or organic chemicals that represent 'regional' contaminants, the presence of which are not related to past site activities (USEPA, 1989a). Background upper tolerance limits (BUTLs) for NTC Fort Irwin soils have previously been determined. A detailed description of the methods used in the calculation of background concentrations for Fort Irwin soils is presented in the *Technical Memorandum NTC Fort Irwin Statistical Analysis of Background Data Fort Irwin, California* (Parsons ES, 1996).

Briefly, background data were collected by Parsons ES from areas of Fort Irwin determined to be outside the area of influence of military training activities. Over 119 surface (0 - 1 foot bgs) and subsurface (>1 foot bgs) soil samples were collected and analyzed in the determination of a background data set. The distribution of background data for each analyte was analyzed to determine whether the data resembled a normal or lognormal distribution. A BUTL was then calculated for each inorganic analyte detected in soil, where possible. The BUTL defines the

upper concentration limit, based on a 95 percent coverage and 95 percent confidence interval The background data statistics and BUTLs for Fort Irwin soils are summarized in Table 6-1.

The BUTLs presented in Table 6-1 were used in screening inorganic analytes as COPCs for site soils. The maximum detected concentration of each inorganic analyte detected in Subsite FTIR-07/d soils was compared to its respective BUTL. Derivation of BUTLs was not possible for selenium and silver, due to low detection frequencies for these chemicals (Parsons ES, 1996). Therefore, concentrations of selenium and silver detected in site soils were not screened using this criterion and were assumed as COPCs for evaluation in the HHRA.

6.2.4 Essential Nutrient Status

Calcium, iron, magnesium, potassium, and sodium are generally considered to be essential nutrients. Essential nutrients are not necessarily considered COPCs, even when media concentrations are a large fraction of what is necessary to induce a toxic response. This is because these concentrations may be beneficial, or even necessary. The following discusses nutritional requirements, typical intakes and toxic levels for these essential nutrients.

Calcium. Calcium is critical for bone formation. Other essential functions involving calcium include nerve conductions, muscle contraction, blood clotting, and membrane permeability. The recommended daily allowance (RDA) for calcium in adults is 800 milligrams per day (mg/day). For people between the ages of 11 and 24, the RDA is 1,200 mg/day; while for younger children, the RDA is between 400 and 800 mg/day depending on the age of the child. The average daily intake is 740 mg/day, and ranged from 530 mg/day in women 35 to 50 years old to 1,200 mg/day in boys 12 to 18 years old (USDA, 1986; 1987). Toxic levels of calcium are not well defined. No toxic effects have been observed in many healthy adults with intakes up to 2,500 mg/day, but high intakes also induce constipation and inhibit the absorption of other essential minerals such as iron and zinc. The National Research Council (NRC) does not recommend calcium intakes much above the RDA (NRC, 1989).

Iron. Iron is a constituent of hemoglobin, myoglobin, and several enzymes. The daily iron intake in the U.S. averages 10.7 mg/day, with most iron coming from food including vitamin-enriched foods (Murphy and Calloway, 1986). The RDA is 15 mg/day for adult women; the RDA for children, the elderly, and adult males is 10 mg/day (NRC, 1989). Adverse effects are unlikely in healthy adults with a daily intake between 25 and 75 mg. However, no data is available for the effects of doses in this range for sensitive individuals.

Magnesium. Magnesium is an essential component of numerous biochemical and physiological processes. Typical magnesium intakes in the U.S. have declined from about 410 mg/day for all adults in the early 1900s (Welsh and Marston, 1982) to current levels of 330 mg/day for adult men and 210 mg/day for adult women (USDA, 1986; 1987). The RDA is 280 mg/day for adult women, 350 mg/day for adult men, and 90 mg/day for young children. Toxic levels are not well defined, but some insight can be gained from noting that antacids and laxatives such as Maalox™ and Mylanta™ each have about 200 mg of magnesium per teaspoon, with a normal dose of one to two teaspoons and these products are generally regarded as safe. Thus, 200 to 400 mg/day of magnesium, in addition to what is ingested in a normal diet, should be safe

Potassium. Potassium is the principal intercellular cation in the body. Potassium also contributes to the transmission of nerve impulses, the control of skeletal muscle contractions, and the maintenance of normal blood pressure. The RDA for adults is between 1,600 and 2,400 mg/day (NRC, 1989). People who consume large amounts of fruits and vegetables have a higher potassium intake, on the order of 8,000 to 11,000 mg/day, with no apparent adverse effects (NRC, 1989).

Sodium. Sodium is the principal cation in the extracellular fluid of the body. In addition, sodium assists in regulating the membrane potential across cells. Estimates of sodium intake based on dietary surveys and analyses of urinary excretion have ranged from 1,800 to 5,000 mg/day (NRC, 1989). The range is much higher than minimum requirements. Concentrations associated with overt toxicity are not well-defined. However, chronic ingestion of high dietary sodium is associated with hypertension.

Essential nutrient status was considered in the evaluation of calcium, iron, magnesium, potassium, and sodium as COPCs for site soils.

6.2.5 Chemicals of Potential Concern for Subsite FTIR-07/d

All positively identified chemicals in soils collected from 0.5 to 10 feet bgs were screened as COPCs for evaluation in the HHRA. Chemical detection frequency was not considered in the selection of site COPCs (Section 6.2.1). Organic chemicals deemed to be representative of blank contamination (Section 2.4) and inorganic chemicals detected at concentrations below their respective BUTLs (Section 6.2.3) were excluded as COPCs. In addition, calcium, iron, manganese, potassium, and sodium were excluded from consideration as COPCs based on essential nutrient status (Section 6.2.4). Inorganic chemicals detected at concentrations greater than their respective BUTLs and all organic chemicals, other than those representing blank contamination, were included as COPCs for evaluation in the HHRA, consistent with the Workplan (Parsons ES, 1995).

Based on the above selection process, the chemicals that were identified as COPCs for Subsite FTIR-07/d surface soils (0 – 0.5 feet bgs) include two inorganic chemicals: copper and zinc (Table 6-2).

The COPCs that were identified for subsurface soils (>0.5 - 10 feet bgs) include various inorganics; the SVOC, di-n-butylphthalate; dioxins/furans; the herbicide, 2,4,5-trichloro (phenoxyacetic) propionic acid (2,4,5-TP); n-nitrosodiphenylamine; and the explosives 2,4-dinitrotoluene, HMX, and RDX (Table 6-3).

The COPCs that were selected for Subsite FTIR-07/d surface and subsurface soils are summarized in Table 6-4.

6.3 SCREENING HUMAN HEALTH RISK ASSESSMENT

The purpose of the screening HHRA is to identify sites that may be considered for NFA in regard to potential human health effects, or that require further evaluation in a baseline risk assessment. Based on the outcome of the screening HHRA presented in this report, Subsite FTIR07/d will be recommended for NFA in regard to human health considerations or for further evaluation in a baseline HHRA. The methods used in the screening HHRA for Subsite FTIR-07/d are presented in Section 6.3.1, and the results of this screening HHRA are presented in Section 6.3.2.

6.3.1 Screening Human Health Risk Assessment Methodology

The screening HHRA for Subsite FTIR-07/d was conducted according to methods described in the *Recommended Outline for Using U.S. Environmental Protection Agency Region IX Preliminary Remediation Goals in Screening Risk Assessments at Military Facilities* (Cal-EPA, 1994a). The screening HHRA evaluates risks to current and potential future human receptors, based on protective assumptions relative to land use, complete exposure pathways, and chemical concentrations. The guidance (Cal-EPA, 1994a) recommends that site screening be performed based on an "unrestricted" land use scenario and maximum concentrations of contaminants. Based on this guidance, the screening HHRA presented in this report evaluated human health risks for potential residential land uses based on maximum concentrations of contaminants detected in Subsite FTIR-07/d soils.

The first step involved the identification of COPCs appropriate for inclusion in site screening. Inorganic chemicals detected at concentrations greater than their respective BUTLs and all organic chemicals, other than those representing blank contamination, were included as COPCs for evaluation in the screening HHRA (Section 6.2.5). Separate lists of COPCs were generated for surface soils (0 – 0.5 feet bgs) and for subsurface soils (>0.5 - 10 feet bgs).

Once surface and subsurface soil COPCs were identified, PRGs were identified and tabulated. The PRGs used in this screening HHRA were obtained from *Region 9 PRGS Table 2000 Update*

(USEPA, 2000), and are based on the residential exposure scenario Cancer and noncancer health effects were evaluated separately and, where applicable, Cal-modified PRGs were used (USEPA, 2000). It should be noted that the USEPA's PRG for lead of 400 mg/kg is not included in Table 6-5. Consistent with DTSC policy, lead was evaluated using the California Lead Risk Assessment Spreadsheet (Bloodpb7.xls). The PRGs used in human health risk screening for Subsite FTIR-07/d are presented in Table 6-5.

Next, the maximum concentration of each COPC identified in surface or subsurface soils was compared to its respective PRG (for both cancer and noncancer health effects), and a ratio was calculated. For carcinogens, the calculated values were multiplied by 10^{-6} and tabulated. For noncarcinogens, the actual ratio was tabulated. Cumulative screening cancer risks and noncancer hazards were estimated by summing the cancer and noncancer ratios, respectively.

Finally, screening cancer risks and noncancer hazards for Subsite FTIR-07/d surface soils and subsurface soils were compared to appropriate screening criteria. Sites that have a cumulative cancer risk less than 1.0×10^{-6} and a cumulative noncancer hazard index less than 1.0 in the screening HHRA are generally not considered for further action in regard to human health concerns (USEPA, 1991a). Sites for which the cumulative cancer risk is greater than 1.0×10^{-6} or the cumulative noncancer hazard index is greater than 1.0 in the screening HHRA are generally recommended for further evaluation in a baseline risk assessment. Potential lead exposures were evaluated based on a blood-lead criterion of 10 micrograms per deciliter (ug/dl), assuming exposures to a residential child. The results of human health screening for Subsite FTIR-07/d are presented in Section 6.3.2.

6.3.2 Screening Human Health Risk Assessment Results

The results of the screening HHRA for Subsite FTIR-07/d are presented in this section. Risk screening was conducted separately for surface soils (Section 6.3.2.1) and subsurface soils (Section 6.3.2.2).

6.3.2.1 Surface Soils. No carcinogenic COPCs were identified in surface soil samples collected from Subsite FTIR-07/d. Therefore, a cumulative screening cancer risk was not estimated for Subsite FTIR-07/d surface soils. The cumulative noncancer hazard estimate for surface soils is presented in Table 6-6. The estimated hazard (0.038) is lower than the screening hazard criterion of 1.0. Based on these screening risk results, Subsite FTIR-07/d surface soils are appropriate for NFA in regard to human health concerns and were not evaluated further in a baseline HHRA.

6.3.2.2 Subsurface Soils. Cumulative screening cancer risks and noncancer hazards for subsurface soils are presented in Tables 6-7 and 6-8, respectively. The cumulative screening risk for subsurface soils was estimated as 2.5×10^{-5} (Table 6-7) and is higher than the screening risk criterion of 1.0×10^{-6}. The cumulative screening hazard for subsurface soils was estimated as 1.0 (Table 6-8) and is equal to the hazard criterion of 1.0. The maximum concentration of lead detected in subsurface soils (18.9 mg/kg) resulted in an estimated blood-lead concentration well below the generally accepted criterion of 10 ug/dl. Based on exceedence of the screening cancer risk criterion of 1.0×10^{-6}, Subsite FTIR-07/d subsurface soils were further evaluated in a baseline HHRA (Section 6.4).

6.4 BASELINE HUMAN HEALTH RISK ASSESSMENT

The results of the screening HHRA for Subsite FTIR-07/d indicated that subsurface soils may pose a human health risk based on the unrestricted land use scenario (Section 6.3.2). The screening HHRA evaluated risks to hypothetical future human receptors based on protective assumptions relative to land use (i.e., residential), complete exposure pathways, and maximum concentrations of COPCs. As such, the results of the screening HHRA represent a conservative (i.e., protective) evaluation of potential public health impacts.

The baseline HHRA is a quantitative and qualitative evaluation of risks to human health based on more realistic assumptions relative to land use and average exposure point concentrations (USEPA, 1989a). Sites for which the cumulative cancer risk is less than 1.0×10^{-6} and

cumulative noncancer hazard is less than 1.0 in the baseline HHRA are generally considered appropriate for NFA. For current and future industrial land uses, estimated cancer risks and noncancer hazards less than 1.0×10^{-5} and 1.0, respectively, are generally considered acceptable. Sites for which the cumulative cancer risk is between 1.0×10^{-6} and 1.0×10^{-4} in the baseline HHRA may be considered appropriate for NFA, depending upon site-specific considerations including current and potential future land uses. Sites that are associated with a cumulative cancer risk or noncancer hazard greater than these criteria are generally considered appropriate for further investigation or evaluation of remedial alternatives (USEPA, 1991a).

Based on the results of the screening HHRA, a baseline HHRA was performed for Subsite FTIR-07/d subsurface soils. Consistent with the Workplan (Parsons ES, 1995) and risk assessment guidance (USEPA, 1989a), the baseline HHRA presented in this report includes an exposure assessment (Section 6.4.1), toxicity assessment (6.4.2), and quantitative risk characterization (Section 6.4.3). The results of the baseline HHRA for Subsite FTIR-07/d are presented as a cumulative cancer risk and noncancer hazard (Section 6.4.3.2). The cumulative cancer risk and noncancer hazard for Subsite FTIR-07/d are evaluated and recommendations are made for NFA, or further investigation or evaluation of remedial alternatives (Section 6.4.4).

6.4.1 Exposure Assessment

The results of the exposure assessment for Subsite FTIR-07/d are presented in this section. The exposure assessment integrates information on the nature of site contaminant sources, the types of contaminants present, the receptors potentially exposed, and the potential migration and exposure pathways available. The exposure assessment includes the development of a conceptual site model (CSM) for each source area, where appropriate. These steps are discussed below as they relate to the baseline HHRA for Subsite FTIR-07/d.

6.4.1.1 Current and Future Land Uses. Current and future land uses for NTC Fort Irwin were described in detail in Section 4.0. The NTC Fort Irwin is currently an active military facility and is the U.S. Army's National Training Center. From 1940 to the present, the

installation (designated as the U.S. Army's National Training Center in 1981) has been used for military training, including large-scale war games. Subsite FTIR-07/d is one of the Lucky Fuse sites. The name "Lucky Fuse" refers to an artillery impact area (Lucky Fuse Impact Area) located near the center of Fort Irwin. Current and future land usage for Subsite FTIR-07/d is designated as "firing range" according to the Fort Irwin Master Plan. NTC Fort Irwin is not scheduled for base closure, and closure is unlikely in the foreseeable future since Fort Irwin is the National Training Center for the U.S. Army.

Future development of residential or commercial/industrial facilities are most likely to occur where an infrastructure (i.e., roads, power, water supply) is already in place. Subsite FTIR-07/d is located approximately 35 miles from the nearest city (Barstow, California) and approximately 10 miles northeast of the Cantonment Area of NTC Fort Irwin. As such, it is highly unlikely that Subsite FTIR-07/d would be developed for residential or industrial purposes under anticipated future land uses.

6.4.1.2 Identification of Receptors. The receptors that may be potentially exposed to site contaminants were identified, based on current and potential future land uses and exposure scenarios. Under current land uses, military personnel involved in training exercises at Subsite FTIR-07/d are the most likely receptors to be exposed to contaminants in site soils. This is also the most likely future receptor for Subsite FTIR-07/d under anticipated future land use plans (Section 6.4.1.1).

For the reasons described in Sections 4.0 and 6.4.1.1, it is highly unlikely that Subsite FTIR-07/d would be converted to residential or industrial/commercial land uses. Although unlikely, it is conceivable that some type of government industrial or research activities could be conducted on the site in the future. The National Aeronautics and Space Administration (NASA) currently operates the Goldstone Deep Space Complex in a former area of NTC Fort Irwin known as Goldstone (Section 4.0). In the context of human exposure assessment, such activities would most appropriately be considered "industrial" land uses.

Site visitors are potential receptors under both current and future land uses. However, the exposure frequency and duration of exposure for site visitors are anticipated to be far lower than those for current/future military personnel involved in training exercises, or hypothetical future workers routinely involved in government, industrial, or research activities. Therefore, quantitative risk evaluation for these latter two exposure scenarios would be protective of potential exposures and risks to site visitors.

Construction workers are potential receptors under a hypothetical future industrial land use scenario, because excavation and construction activities would presumably be required to build the necessary industrial or research facilities. Although construction activities tend to be associated with relatively high daily exposure doses, the typical exposure duration (e.g., several months to a year) is much lower than for current/future military personnel involved in training exercises (e.g., 4 years), or an industrial worker (e.g., 25 years). Therefore, quantitative risk evaluation for these latter two exposure scenarios would be protective of potential exposures and risks to construction workers.

Based on the above, the potential receptors that were selected for quantitative evaluation in this baseline HHRA were the following:

- Current/future military personnel involved in training exercises
- Hypothetical future industrial (i.e., government or research) worker.

6.4.1.3 Evaluation of Potential Exposure Pathways. Exposure pathways were identified based on current and hypothetical future land uses, and site-specific conditions. Exposure of current/future military personnel to soil COPCs was assumed to occur during field exercises and maneuvers. As a result, current/future military workers may receive exposures to COPCs in Subsite FTIR-07/d soils via the following exposure pathways:

- Incidental ingestion of soils
- Dermal contact with soils

- Inhalation of wind-borne particulates from soils.

The potentially complete exposure pathways considered for the hypothetical future industrial (i.e., government or research) worker are based on default exposure assumptions for an industrial/commercial worker (USEPA, 1989a; 1995; and 1998b). These exposure pathways include the following:

- Incidental ingestion of soils
- Dermal contact with soils
- Inhalation of wind-borne particulates from soils.

Exposures to COPCs in outdoor air were assumed to occur during current/future military or hypothetical future industrial (i.e., government or research) activities. Potential exposure to soil gas infiltrating to indoor air was assumed to be an insignificant pathway for Fort Irwin, consistent with the Workplan (Parsons ES, 1995), and because no volatile COPCs were identified.

Exposure doses for current/future military personnel involved in training exercises and hypothetical future industrial workers were modeled based on the above exposure pathways.

6.4.1.4 Conceptual Site Model. The CSM provides a summary representation of the potentially exposed receptors and potentially complete exposure pathways. The principle components of the CSM include the following:

- Identification of the contaminant sources
- Evaluation of contaminant migration pathways
- Identification of potential receptors
- Evaluation of potential exposure pathways.

A general CSM was developed for Subsite FTIR-07/d based on the receptors selected for evaluation in Section 6.4.1.2, and potentially complete exposure pathways identified in Section 6.4.1.3. The general CSM for Subsite FTIR-07/d is summarized in Figure 6-1.

6.4.1.5 Quantification of Exposures. The quantification of receptor exposures in human health risk assessment are typically based on protective assumptions relative to land use, complete exposure pathways, and calculation of exposure point concentrations. A health-protective assumption underlying all of the dose calculations is that constituent concentrations remain constant over the entire period of exposure.

6.4.1.5.1 Exposure Point Concentration. Calculation of the exposure point concentration was based on both measured concentrations (i.e., hits) and non-detect results. When a dataset contained non-detect results, one-half the sample quantitation limit was assumed for that sample. The exposure point concentrations were estimated as either the maximum or the 95% upper confidence limit (UCL) of the arithmetic mean concentration detected in site media. If the calculated 95% UCL of the mean concentration was greater than the maximum concentration detected, the maximum value was assumed as the exposure point concentration; otherwise the 95% UCL was used.

The 95% UCL of the arithmetic mean concentration was calculated based on a lognormal distribution, according to the methods described in Gilbert (1987). Four-point Lagrangian interpolation and an H table from Gilbert (1987) were used to determine H values for use in the UCL calculation. The equation for calculating the UCL of the arithmetic mean for a lognormal distribution (Gilbert, 1987) is given by:

$$UCL = e^{\bar{x} + 0.5 s^2 + sH/\sqrt{n-1}}$$

where:

UCL	= upper confidence limit
e	= constant (base of the natural log, equal to 2.718)
$\bar{x}$	= mean of the transformed data
s	= standard deviation of the transformed data

H = H-statistic (Gilbert, 1987)
n = number of samples

Exposure point concentrations for Subsite FTIR-07/d subsurface soils are presented in Table 6-9

6.4.1.5.2 Exposure Dose Calculation. The algorithms for calculating the exposure dose for each pathway are presented below. In quantifying exposures associated with inhalation of volatile or particulate COPCs in air, exposure dose calculations varied between the military personnel and industrial worker scenarios. Different methodologies were used for these two receptors because military personnel involved in field training and maneuvers have higher potential exposures to air contaminants than may be considered using default exposure dose calculations and assumptions (Section 6.4.1.5.3). Inhalation exposure dose calculations for military personnel were described in the Workplan (Parsons ES, 1995), and are consistent with methods presented in Cal-EPA, 1994b. Inhalation exposure dose calculations for the industrial worker are based on standard methods described in USEPA, 1989a. For potential carcinogenic effects, exposure doses were averaged over a lifetime; doses for potential non-carcinogenic effects were averaged over the actual exposure period (USEPA, 1989a).

For current/future military personnel and hypothetical future industrial workers, the algorithm for calculating the exposure dose due to ingestion of soil is the following:

$$Dose\ (mg/kg\text{-}day) = \frac{Cs \times IR \times EF \times ED \times UC}{BW \times AT}$$

where:

Cs = soil exposure point concentration (mg/kg)
IR = ingestion rate (mg/day)
EF = exposure frequency (days/year)
ED = exposure duration (years)
UC = unit conversion (10^{-6} kg/mg)
BW = body weight (kg)
AT = averaging time (period over which exposure is averaged) (days)

For current/future military personnel and hypothetical future industrial workers, the algorithm for calculating the exposure due to dermal contact with soil is the following:

$$Dose\ (mg/kg\text{-}day) = \frac{Cs \times SA \times AF \times ABS \times EF \times ED \times UC}{BW \times AT}$$

where:

Cs = soil exposure point concentration (mg/kg)
SA = skin surface area exposed (cm^2/day)
AF = soil to skin adherence factor (mg/cm^2)
ABS = absorption fraction of chemical from soil (unitless)
EF = exposure frequency (days/year)
ED = exposure duration (years)
UC = unit conversion (10^{-6} kg/mg)
BW = body weight (kg)
AT = averaging time (days)

For military personnel, only, the algorithm for calculating exposure due to inhalation of particulates from soil is the following:

$$Dose\ (mg/kg\text{-}d) = \frac{(Ca \times InhR_{normal} \times ET_{normal} \times EF \times ED) + (Ca \times InhR_{active} \times ET_{active} \times EF \times ED)}{BW \times AT}$$

where:

Ca = exposure point concentration of particulate in air (mg/m^3)
$InhR_{normal}$ = inhalation rate during normal activity or rest (m^3/hr)
$InhR_{active}$ = inhalation rate during moderate-to-high work
ET_{normal} = exposure time engaged in normal activity or rest (hr/day)
ET_{active} = exposure time engaged in moderate-to-high work (hr/day)
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (days)

For hypothetical future industrial workers, the algorithm for calculating exposure due to inhalation of particulates from soil is given by:

$$Dose\ (mg/kg\text{-}d) = Cs \times (1/PEF) \times InhR \times ET \times EF \times ED$$

$$BW \times AT$$

where:

Cs	=	exposure point concentration of particulate in soil (mg/kg)
PEF	=	particulate emission factor (m^3/kg)
InhR	=	inhalation rate (m^3/hr)
ET	=	exposure time (hr/day)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days)

6.4.1.5.3 Exposure Parameters and Assumptions. The parameters and assumptions used in modeling exposure doses for current/future military personnel and hypothetical future industrial workers are summarized in Tables 6-10 and 6-11, respectively. Standard, default assumptions were used in calculating daily exposure doses for each receptor, where appropriate. However, the unique nature of the current/future military personnel scenario required the development of some exposure assumptions that deviate from default assumptions. Overall, deviation from standard, default assumptions resulted in a more health-protective exposure assessment for current/future military personnel than would have resulted from the use of typical exposure assumptions. The basis and rationale for the assumptions used in calculating exposures for military personnel were presented in the Workplan (Parsons ES, 1995) and are summarized below.

Exposure point concentrations in air were modeled based on methods described in the approved Workplan (Parsons ES, 1995), and consistent with Preliminary Endangerment Assessment (PEA) guidance (Cal-EPA, 1994b). In accordance with PEA guidance (Cal-EPA, 1994b), it was assumed that a chemical originating in soil is transported in air either as a volatile or as a constituent of fugitive dust, but not both. No VOCs were identified as COPCs in Subsite FTIR-07/d subsurface soils. Therefore, methods identified in the Workplan (Parsons ES, 1995) for modeling exposure point concentrations of VOCs in air were not used in calculating exposures to current/future military personnel.

Fugitive dust emissions were assumed to result from wind dispersion during periods of light activity and rest, and soil disturbances from heavy vehicular traffic (e g., military trucks or tanks) during moderate-to-high activity. A particulate emission factor (PEF) of 1.6 x 10^7 cubic meters per kilogram (m^3/kg) for inhalation of particulates due to wind dispersion was assumed, based on a respirable particulate concentration of 61 micrograms per cubic meter ($\mu g/m^3$) [(1/61 $\mu g/m^3$) x 10^9 μgh/kg = 1.6 x 10^7 m^3/kg]. This respirable particulate concentration is the highest annual average value compiled over the last 4 years by the Mojave Desert Air Quality Management District in Victorville, California (Parsons ES, 1995). For estimating fugitive dust emissions associated with heavy vehicular traffic, a PEF of 3.3 x 10^6 m^3/kg was assumed. This PEF value is equivalent to a respirable particulate concentration of 305 $\mu g/m^3$, which is approximately 5-fold higher than the highest annual average value (61 $\mu g/m^3$) compiled over the last 4 years by the Mojave Desert Air Quality Management District.

The current/future military worker scenario is based on the following assumptions:

- Military workers can potentially be in the field for up to 2 weeks per month for 11 months per year
- Military workers could potentially camp in tents during each 2-week field exercise
- Daily activities of military workers consist of 12 hours moderate-to-heavy activity and 12 hours light activity or rest
- Military workers could potentially be stationed at Fort Irwin a maximum of 4 years.

Based on the above scenario, the following were assumed: an exposure time (ET) of 12 hours/day for light activity or rest and 12 hours/day moderate-to-high activity; an exposure frequency (EF) of 154 days per year; and an exposure duration (ED) of 4 years. A soil ingestion rate (IR) of 75 mg/day was assumed for light activity or rest, based on a default rate of 50 mg/day (USEPA, 1995a) for indoor exposures to dust (50 mg/day x 8 hours = 6.25 mg/hour; 6.25 mg/hour x 12 hours = 70 mg/day). A soil IR of 720 mg/day was assumed for moderate-to-high activity, based on a default rate of 480 mg/day (USEPA, 1995a) for outdoor exposures to dust (480 mg/day / 8 hours = 60 mg/hour; 60 mg/hour x 12 hours = 720 mg/day). An inhalation

rate (InhR) of 0.83 m^3/hour was assumed for light work or rest, and an InhR of 2.5 cubic meters per hour (m^3/hour) for moderate-to-heavy work was assumed, consistent with USEPA default guidance (USEPA, 1995a). Finally, a dermal surface area (SA) of 4,300 square centimeters (cm^2) was assumed based on exposure of the head, arms, and hands, consistent with typical military attire and body surface area measurements (USEPA, 1992b).

6.4.2 Toxicity Assessment

The toxicity assessment involves a critical review and interpretation of toxicology data from epidemiological, clinical, animal, and *in vitro* studies. The review of toxicology data ideally determines both the nature of the health effects associated with a particular chemical and the probability that a given dose of a chemical could result in an adverse health effect. Toxicology information considered important for quantitative risk assessment includes:

- The potential for carcinogenic health effects
- The potential for chronic noncarcinogenic, adverse health effects
- The ability to cause short-term, acute effects
- The ability to affect reproduction

For carcinogens, it is assumed that no threshold dose exists and that any dose may induce cancer. The probability of cancer development is described by the slope of the dose response curve. The doses from various known or suspected carcinogens are assumed to be additive. For noncarcinogens, it is assumed that a dose exists below which no adverse health effects are seen (i.e., threshold dose). Compounds with short-term, acute effects are also generally considered to have a threshold dose. Compounds that affect reproduction are considered to have threshold doses unless the mechanism of action of the compound has been confirmed as one for which no threshold exists.

For purposes of conducting quantitative human health risk assessments, toxic effects of chemicals are generally categorized as carcinogenic or noncarcinogenic. The carcinogenic

potential of a chemical is used in a quantitative estimate of potential cancer risk. The potential for a chemical to produce noncarcinogenic adverse health effects is used in a quantitative estimate of noncarcinogenic hazard.

6.4.2.1 Carcinogenic Effects of COPCs. The cancer slope factor (CSF) is the toxicity value used to quantitatively express the carcinogenic potential of cancer-causing constituents. The slope factor is expressed in units of milligrams per kilogram per day $(mg/kg/day)^{-1}$ and represents the cancer risk per unit daily intake of carcinogenic chemical. The CSF represents the upper 95 percent confidence interval of the slope of the dose response curve. The 95 percent upper confidence interval value assures a safety factor to protect the most sensitive receptors. The product of the CSF and the exposure dose is an estimate of the risk of developing cancer from exposure to the compound of interest. Current scientific policy regards carcinogens as having additive doses and not having a threshold dose.

6.4.2.2 Noncarcinogenic Effects of COPCs. The Reference dose value (RfD) is the toxicity value used to quantitatively express the potential for a chemical to produce noncarcinogenic effects. The RfD is expressed in units of mg/kg/day and represents a daily intake of contaminant per kilogram of body weight that is not sufficient to cause the threshold effect of concern for the contaminant. Exposure doses that are above the RfD, or the threshold dose for noncarcinogens, could potentially cause adverse health effects.

The RfD is usually based on a no-observable-adverse-effect-level (NOAEL) derived from animal studies. An uncertainty factor is typically incorporated into the RfD, resulting in a reduction in the numerical value (i.e., resulting in a more protective toxicity value). The uncertainty factor is intended to account for uncertainties associated with (1) the extrapolation of dose-response data from animal studies to humans; (2) the existence of sensitive subpopulations within the human population; and (3) the quality of the laboratory study and database from which the dose response information is derived. Confidence in the RfD is judgmental, based on USEPA review groups and the supporting quality of the database. Chemical-specific RfDs do not account for the potential effects of chemical mixtures.

6.4.2.3 Chemical-Specific Assumptions. Modeled exposure doses were compared to toxicity values established for cancer and noncancer endpoints in order to evaluate risks to each receptor. The toxicity values used in the baseline risk assessment are presented in Table 6-12. Toxicity values were obtained from the literature only for COPCs identified in subsurface soils associated with Subsite FTIR-07/d.

Oral and inhalation toxicity values were generally available for most chemicals identified at Subsite FTIR-07/d subsurface soils. However, the USEPA has not established toxicity values based on the dermal route of administration. For evaluating estimated exposure doses for the dermal pathway, oral toxicity values were used without modification, as specified in the approved Workplan (Parsons ES, 1995).

Following are several chemical-specific assumptions used in the toxicity assessment for Subsite FTIR-07/d.

6.4.2.3.1 Dioxins/Furans. For the toxicity evaluation of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans, the USEPA Region IX residential and industrial soil PRGs for 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) were used. The chlorine substitutions at positions 1-4 and 6-9 on either of the benzene rings of TCDD yield compounds commonly referred to as polychlorinated dibenzo-p-dioxins (PCDDs). Polychlorinated dibenzofurans (PCDFs) are a closely related family of compounds. There have been efforts from the scientific community to relate the toxic potency of PCDDs and PCDFs to TCDD. The most recent effort is the "I-TEF/89" method developed by USEPA in conjunction with scientists under the auspices of the North Atlantic Treaty Organization's Committee on Challenges in Modern Society.

The "I-TEF/89" approach was used in evaluating risks associated with dioxins and furans. Toxicity equivalents (TEQs) were assigned to each dioxin or furan congener, based on their potencies relative to 2,3,7,8-TCDD. The TEQ was used to modify the maximum concentration

measured in soil, and the toxicity equivalent concentration for each congener was summed resulting in a total 2,3,7,8-TCDD TEQ concentration. For laboratory results reported only as total pentachloro-, hexachloro-, heptachloro-, or octachlorodibenzo-p-dioxins or furans, toxicity equivalent concentrations were not assigned. These results were not evaluated quantitatively in this screening HHRA. This is because chlorination in the 2,3,7,8-positions is required for the carcinogenic effects of PCDDs and PCDFs (USEPA, 1994a). The total 2,3,7,8-TCDD TEQ concentration in Subsite FTIR-07/d subsurface soils was evaluated based on the cancer toxicity value (i.e., CSF) for 2,3,7,8-TCDD.

6.4.2.3.2 Lead. Currently there are no toxicity values (i.e., CSFs or RfDs) available for the quantitative evaluation of potential human health impacts associated with exposures to lead in soils. For evaluating the potential risks to current/future military workers and hypothetical future industrial workers from lead, the Lead Risk Assessment Spreadsheet (Bloodpb7.xls) developed by Cal-EPA was used.

6.4.2.4 Toxicity Information Sources. The primary sources of toxicity values used in this baseline HHRA were the IRIS (USEPA, 2001) compiled by USEPA, and HEAST (USEPA, 1995c). The Agency for Toxic Substance and Disease Registry (ATSDR) profiles for selected compounds were also reviewed.

Toxicity profiles for COPCs with available toxicology information are presented in Appendix H.

6.4.3 Risk Characterization

This section presents the methods and results of the risk characterization performed for Subsite FTIR-07/d subsurface soils. Risk characterization involves the integration of exposure estimates developed as part of the exposure assessment with dose-response information (toxicity values) developed as part of the toxicity assessment. The result is a quantitative estimate of the likelihood of chronic health effects, in the form of carcinogenic risks or noncarcinogenic hazards. The carcinogenic risk estimate is based on the premise that carcinogenicity is a non-threshold

effect (i.e., that even at the lowest dose there is some potential to develop carcinogenic effects). In contrast, the noncarcinogenic hazard estimate is based on the premise that for noncarcinogens there is a threshold dose below which adverse health effects will not occur.

6.4.3.1 Methods. Following are the methods that were used in the evaluation of carcinogenic risks and noncarcinogenic hazards for current/future military workers and hypothetical future industrial workers potentially exposed to site COPCs.

6.4.3.1.1 Carcinogenic Risks. Baseline human health risks were evaluated separately for carcinogenic effects and noncarcinogenic effects. The incremental lifetime cancer risk (ILCR) is an estimate of the increased risk of cancer due to lifetime exposure, at apportioned average daily doses, to constituents detected in each medium at the site. Carcinogenic risks were calculated as the product of the exposure dose and the carcinogenic toxicity value, the CSF (USEPA, 1989a).

The equation used to calculate carcinogenic risks for the current/future military worker and hypothetical future industrial worker is as follows:

$$\text{ILCR (unitless)} = \text{CSF} \times \text{Dose}$$

where:

CSF = Cancer slope factor (mg/kg-day)-1
Dose = Exposure dose (mg/kg-day)

Cancer risks from multiple COPCs were assumed to be additive and were summed to estimate a total cumulative ILCR for all carcinogenic site contaminants. The resulting risk estimates are an indication of the increased risk, above that applying to the general population, which may result from the exposures assumed for each scenario. The risk estimate is an upper bound estimate of risk, because of the protective assumptions used in the development of toxicity values and exposure estimates. Therefore, it is probable that the actual risks associated with potential exposures to site contaminants are lower than estimated risks.

6.4.3.1.2 Noncarcinogenic Hazards. To evaluate noncarcinogenic health effects due to potential exposures to site COPCs, a hazard quotient (HQ) was calculated for each COPC. The HQ is defined as the ratio of the exposure dose to the RfD (USEPA, 1989a)

The equation used to calculate noncarcinogenic hazards for the current/future military worker and hypothetical future industrial worker is as follows:

$$HQ\ (unitless) = \frac{Dose}{RfD}$$

where:

Dose = Exposure dose (mg/kg-day)
RfD = Reference dose (mg/kg-day)

A hazard quotient greater than 1.0 indicates that the estimated exposure dose for that COPC may exceed acceptable health-protective levels for noncarcinogenic effects. Although an HQ of less than 1.0 suggests that noncarcinogenic health effects should not occur, an HQ of slightly greater than 1.0 is not necessarily an indication that adverse effects will occur.

The individual HQs for site COPCs were summed to produce a total cumulative hazard estimate, termed the hazard index (HI). If the total HI estimate is less than 1.0, then no noncarcinogenic chronic health effects are expected to occur. If the total HI estimate is greater than 1.0, then adverse health risks are considered possible.

Sites for which the estimated cumulative cancer risk is between 1.0×10^{-6} and 1.0×10^{-4}, and the cumulative HI is less than 1.0 may be considered appropriate for NFA, depending upon site-specific considerations including current and potential future land uses (USEPA, 1991a). For current and future *industrial* land uses, estimated cancer risks and noncancer hazards less than 1.0×10^{-5} (i.e., 1 in 100,000) and 1.0, respectively, are generally considered acceptable.

6.4.3.2 Results. Following are the results of the risk characterization performed for Subsites FTIR-07/d. Carcinogenic risk and noncarcinogenic hazard calculations for each receptor are presented in Tables 6-13 through 6-16.

6.4.3.2.1 Current/Future Military Personnel. Cancer risk and noncancer hazard estimates for current/future military personnel are presented in Tables 6-13 and 6-14. The baseline cumulative cancer risk for current/future military personnel was estimated as 4.0×10^{-6} (Table 6-13). Greater than 99 percent of the cumulative cancer risk estimate was attributable to the presence of arsenic in site soil. The exposure point concentration for arsenic was 8.3 mg/kg which is less than the BUTL for arsenic in Fort Irwin soils. This suggests that the concentrations of arsenic in Subsite FTIR-07/d subsurface soils and corresponding cancer risk are representative of ambient conditions.

The baseline cumulative noncancer HI for current/future military personnel was estimated as 0.41 (Table 6-14). The majority of the noncancer HI was attributable to the presence of arsenic and 2,4-dinitrotoluene in soil.

Lead concentrations measured in subsurface soil were evaluated using the California Lead Risk Assessment Spreadsheet. The exposure point concentration for lead (9.0 mg/kg) corresponded to a 95th percentile blood-lead concentration equal to 3.3 micrograms per deciliter (ug/dl). This blood-lead concentration is significantly below the acceptable criterion of 10 ug/dl.

The estimated risks and hazards for current/future military personnel are less than the cancer risk and noncancer hazard criteria of 1.0×10^{-5} and 1.0, respectively, for industrial-type land uses.

6.4.3.2.2 Hypothetical Future Industrial Workers. Cancer risk and noncancer hazard estimates for hypothetical future industrial workers are presented in Tables 6-15 and 6-16. The baseline cumulative cancer risk for hypothetical future industrial workers was estimated as 2.4×10^{-6} (Table 6-15). Greater than 99 percent of the cumulative cancer risk estimate was attributable to the presence of arsenic in site soil. The exposure point concentration for arsenic was 8.3

mg/kg which is less than the BUTL for arsenic in Fort Irwin soils. This suggests that the concentrations of arsenic in Subsite FTIR-07/d subsurface soils and corresponding cancer risk are representative of ambient conditions.

The baseline cumulative noncancer hazard index (HI) for hypothetical future industrial workers was estimated as 0.042 (Table 6-16). The majority of the noncancer HI was attributable to the presence of arsenic and 2,4-dinitrotoluene in soil.

Lead concentrations measured in subsurface soil were evaluated using the California Lead Risk Assessment Spreadsheet. The exposure point concentration for lead (9.0 mg/kg) corresponded to a 95th percentile blood-lead concentration equal to 3.3 μg/dl. This blood-lead concentration is significantly below the acceptable criterion of 10 μg/dl.

The estimated risks and hazards for hypothetical future industrial workers are less than the cancer risk and noncancer hazard criteria of 1.0×10^{-5} and 1.0, respectively, for industrial-type land uses.

6.4.3.3 Risk Summary. No Carcinogenic COPCs were identified in surface soil for Subsite FTIR-07/d, and the screening noncancer hazard estimate for surface soil was less than the hazard criterion of 1.0. Consistent with these findings, surface soils associated with Subsite FTIR-07/d are proposed for NFA. The screening cancer risk estimate for subsurface soils exceeded the screening risk criterion of 1.0×10^{-6}, and the screening noncancer hazard estimate was equal to the hazard criterion of 1.0. Based on these results, subsurface soils were further evaluated in a baseline HHRA for current/future military personnel and hypothetical future industrial workers. [It should be noted, however, that the cumulative screening cancer risk estimate (2.6×10^{-5}) falls within the USEPA's risk range of 1.0×10^{-6} and 1.0×10^{-4}.]

Estimated baseline cancer risks and noncancer hazards for current/future military personnel and hypothetical future industrial workers were less than the generally accepted cancer risk and noncancer hazard criteria of 1.0×10^{-5} and 1.0, respectively, for industrial-type land uses. Greater than 99 percent of the estimated cancer risks, and a significant portion of the noncancer HI

estimates, were attributable to concentrations of arsenic in subsurface soil that are most likely representative of ambient conditions. Additionally, cancer risk estimates for these receptors are within the USEPA risk range of 1×10^{-6} and 1×10^{-4}. Sites for which the estimated cumulative cancer risk is between 1.0×10^{-6} and 1.0×10^{-4} and the cumulative HI is less than 1.0 may be considered appropriate for NFA, depending upon site-specific considerations including current and potential future land uses (USEPA, 1991a). Based on these results, Subsite FTIR-07/d is appropriate for NFA in regard to human health concerns.

6.5 UNCERTAINTY ANALYSIS

The presence of uncertainty is inherent in the risk assessment process. Generally, uncertainties in the risk assessment typically result from limitations in the available methods, information, and data used in the following:

- Characterization of contaminant sources
- Identification of site COPCs
- Evaluation of potential exposure scenarios and pathways
- Toxicity assessment
- Risk characterization

The uncertainties associated with each of these steps as they relate to the screening and baseline HHRA for Subsite FTIR-07/d are described below.

6.5.1 Characterization of Contaminant Sources

There is a degree of uncertainty in the characterization of contaminant sources, since it is not possible to sample an entire site. The site investigation was based on site history, suspected and known releases, and physical characteristics (e.g., the presence of waste materials or topographic anomalies). The nature of the site investigation focused on known or suspected sources of contamination. While it is believed that sufficient samples were collected to characterize the nature and extent of contamination at the sites, it is possible that areas not sampled may have

also contained contaminants. However, sample locations were generally chosen such that they represented the area with the greatest potential to detect contaminants, if present.

For Subsite FTIR-07/d surface soil, three samples were collected and analyzed. While this does not represent extensive sampling, it is believed to be sufficient based on the nature of the contamination source. Contamination of the site is believed to have resulted from disposal activities, which were primarily subsurface in nature; therefore, limited surface contamination was anticipated. This is supported by the results of the screening HHRA for Subsite FTIR-07/d, which indicated that risks and hazards associated with surface soils are below acceptable screening criteria (Section 6.3). Nine subsurface soil samples were collected at Subsite FTIR-07/d in areas of known or suspected contamination. These samples are believed to have been sufficient to characterize the nature and extent of contamination associated with subsurface soil at the site.

6.5.2 Identification of Site Chemicals of Potential Concern

The process used in the selection of site COPCs may also introduce a degree of uncertainty in the HHRA. However, protective assumptions were used in the selection of site COPCs. Chemicals selected for quantitative evaluation in the HHRA included all organic chemicals, and inorganic chemicals (other than essential nutrients) detected at concentrations above BUTLs established for Fort Irwin soils. For selenium and silver, BUTLs could not be established. To be protective, therefore, these chemicals were carried through the risk assessment as COPCs.

6.5.3 Exposure Assessment

Because the exposure assessment is based on the estimation of potential rather than actual exposures, there is a degree of uncertainty in the dose estimate. The evaluation of residential receptors under hypothetical, future land use conditions was included in the screening HHRA, to provide a basis for evaluating future unrestricted land uses. However, Fort Irwin is not undergoing base closure, and anticipated future land uses are military. The baseline HHRA was

conducted assuming exposures of current/future military personnel and hypothetical future industrial workers to COPCs in subsurface soils. The screening HHRA (Section 6.3) demonstrated that the concentrations of chemicals in *surface* soils are below acceptable screening risk levels (i.e., carcinogenic risk and noncarcinogenic hazards less than 1×10^{-6} and 1.0, respectively). In addition, exposure estimates for current/future military personnel and hypothetical future industrial workers in the baseline HHRA were based on protective exposure assumptions. Furthermore, exposure point concentrations for receptors evaluated in the baseline HHRA were based on the maximum or 95% UCL concentration of chemicals measured in site soil.

6.5.4 Toxicity Assessment

There are also sources of uncertainty in the derivation of the PRGs used in the screening HHRA, and the toxicity values (cancer slope factors and RfDs) used in the baseline HHRA. Generally, the toxicity values used represent upper bound estimates and incorporate uncertainty factors for extrapolation from animal data to humans, differences in individual sensitivity within populations, and the overall confidence in the dataset. Furthermore, the use of oral slope factors or oral RfDs for dermal toxicity values do not correct for differences in absorption and metabolism between the oral and dermal routes. Because the toxicity values established by USEPA are based on NOAEL concentrations and incorporate uncertainty factors, they are generally considered to be protective. The use of conservative toxicity values in the risk estimate tends to overestimate actual risks.

6.5.5 Risk Characterization

The different sources of uncertainty previously described are incorporated in the risk estimate. Because the majority of these uncertainties err on the conservative side, the risk estimate is considered to be protective. Furthermore, the 1.0×10^{-6} risk level does not equate to an actual cancer incidence of one-in-one-million for substances that may cause cancer. The risk assessment process uses animal data to predict the probability of humans developing cancer over

a 70-year lifetime The estimated risks presented in this HHRA represent upper bound estimates; the actual risks are anticipated to be less.

7.0 BASELINE ECOLOGICAL RISK ASSESSMENT

This section presents the methods and results of the baseline ecological risk assessment (ERA) conducted for Site FTIR-07/d – Lucky Fuse Site. The ERA is an evaluation of the potential for site-related chemicals to impact ecological habitats and receptors. The results of the ERA will be used in conjunction with the results of the baseline HHRA to provide the basis for determining whether risks associated with current concentrations of chemicals require no further action, or the need for further evaluation or consideration of remedial options.

7.1 INTRODUCTION

The ERA typically includes both qualitative and quantitative evaluations of potential risks to ecological habitats and receptors resulting from contaminants identified in biotic and abiotic media. The ERA evaluates contaminants detected in site media, the ecological receptors present or potentially present, the potential exposure pathways between contaminants and ecological receptors, and the potential ecological risks posed by exposures to site contaminants. As such, the ERA integrates the results of environmental sampling, biological characterization, ecological exposure assessment, and qualitative or quantitative risk characterization.

This qualitative and quantitative assessment of ecological risk includes an evaluation of chemical concentrations in abiotic media, as well as quantitative exposure modeling and risk characterization. All of this information is included in a weight-of-evidence evaluation for Site FTIR-07/d to determine the potential for site-related contaminants to impact ecological habitats and receptors. The results of this ERA will be used in conjunction with the results of the HHRA to support a no action alternative or to determine the need for further evaluation or potential remedial action at sites. The ERA results may also be used in the development of remediation goals for source areas.

7.1.1 Purpose and Objectives

The purpose of this baseline ERA is to provide an evaluation of the ecological risks associated with potential exposures of ecological receptors present, or potentially present, at NTC Fort Irwin to chemicals identified in soils at Site FTIR-07/d. As such, this ERA considers current impacts to ecological habitats and receptors, as well as future hazards based on anticipated future land uses. This screening ERA was conducted according to the ecological risk assessment methodologies outlined in the approved Workplan (Parsons ES, 1995).

As described in the Workplan (Parsons ES, 1995), the specific objectives of this baseline ERA include the following:

- Identify ecological habitats and receptors potentially exposed to site contaminants
- Identify chemicals of potential ecological concern (COPECs) for the site
- Quantify exposures of indicator receptors to site COPECs
- Perform a toxicity evaluation for site COPECs
- Provide a qualitative and quantitative evaluation of ecological risks for the site.

This ERA was conducted in accordance with the following guidance documents and reference materials prepared by Cal-EPA and USEPA:

- Risk Assessment Guidance for Superfund, Volume II: Environmental Evaluation Manual, Interim Final. U.S. Environmental Protection Agency, EPA/540/1-89/001, 1989b
- Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference. U.S. Environmental Protection Agency, Environmental Research Laboratory, EPA/600/3-89/013, 1989c
- Framework for Ecological Risk Assessment. U.S. Environmental Protection Agency, EPA/630/R-92/001, 1992c
- Wildlife Exposure Factors Handbook, Volumes I and II. U.S. Environmental Protection Agency, EPA/600/R-93/187a, 1993
- Role of the Ecological Risk Assessment in the Baseline Risk Assessment. U.S. Environmental Protection Agency, OSWER Directive Number 9285.7-17, 1994b

- Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities. California Environmental Protection Agency, July 1996
- Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final U S Environmental Protection Agency, June 1997b
- Guidelines for Ecological Risk Assessment, Final. U.S. Environmental Protection Agency, EPA/630/R-95/002F, 1998d

7.1.2 Scope

This baseline ERA is intended to provide an evaluation of the potential ecological risks associated with site-related contaminants present in soils. Surface (0 – 0.5 foot bgs) and subsurface (2.5 - 5 feet bgs) soil sampling data, where available, were evaluated in this baseline ERA. Contaminants in subsurface soils deeper than 5 feet bgs were not evaluated in this ERA, because plants and burrowing animals are not anticipated to be exposed to soils at this depth

7.1.3 Organization of the Ecological Risk Assessment

The USEPA's *Guidelines for Ecological Risk Assessment - Final* (USEPA, 1998d) describes the following major steps in the screening ERA process:

- Problem formulation
- Ecological effects evaluation
- Exposure assessment
- Risk estimation

The problem formulation step includes information on the following: (1) descriptions of the biological resources present or potentially present; (2) identification of COPECs; (3) identification of indicator receptors for evaluating the assessment and measurement endpoints; and (4) the assessment and measurement endpoints selected for evaluation. The ecological effects evaluation includes the establishment of ecotoxicity values for use in evaluating exposures to site COPECs. The exposure assessment includes the development of

exposure parameters for use in calculating exposure doses. Finally, the risk estimation step involves a calculation of ecological hazard based on comparison of the exposure doses and ecotoxicity values for each receptor-COPEC combination.

Each step in USEPA's ERA guidance (USEPA, 1998d) is included in the baseline ERA for NTC Fort Irwin. However, this information is organized in a manner consistent with the Workplan (Parsons ES, 1995), as follows:

Section 7.1 - Introduction. This section presents a brief introduction, and identifies the objectives and scope of the ERA conducted for Site FTIR-07/d.

Section 7.2 - Habitat Assessment and Potential Ecological Receptors. This section describes the ecological habitats and biological resources potentially impacted by site contaminants.

Section 7.3 - Identification of Chemicals of Potential Ecological Concern. This section describes the methods used in the identification of COPECs, and summarizes the COPECs for Site FTIR-07/d.

Section 7.4 - Ecological Exposure Assessment. This section describes the general methods used in ecological exposure assessment, including the ecological conceptual site model, identification of appropriate indicator species, selection of assessment and measurement endpoints, and the methods and assumptions used in ecological exposure modeling.

Section 7.5 - Ecological Toxicity Assessment. This section describes the development of toxicity criteria for use in the ecological risk characterization.

Section 7.6 - Ecological Risk Characterization. This section describes the methods and evaluation criteria used in the ecological risk characterization; and presents the results of the ERA.

Section 7.7 Uncertainty Analysis. This section presents a discussion of the potential uncertainties involved in the ERA performed for Site FTIR-07/d.

7.2 HABITAT ASSESSMENT AND POTENTIAL ECOLOGICAL RECEPTORS

A brief description of Site FTIR-07/d was presented in Section 1.0. As described in Section 1.0, NTC Fort Irwin is located in the Mojave Desert. Common desert plant communities are found throughout the facility. Additional information about each of the plant communities and associated wildlife is presented in the following section. An overview of the biological resources at NTC Fort Irwin was provided by Mickey Quillman, Natural and Cultural Resources Manager for NTC Fort Irwin, and is the basis for the descriptions provided in the following subsections.

7.2.1 Vegetation

A detailed list of plants occurring at NTC Fort Irwin is presented in Table 7-1. The most common vegetation associations providing habitat at NTC Fort Irwin are creosote bush scrub and saltbush scrub. Creosote bush scrub is the most widespread community at NTC Fort Irwin, occurring throughout the range below 3,600 feet (1,100m) on alluvial slopes, valley floors, and mountain slopes (Gibson et al., 1994). A sub-association of this vegetation type is described as the creosote-burrobush association based on the widespread dominance of the creosote bush (*Larrea tridentata*) and burrobush (*Ambrosia dumosa*). Burrobush is a much smaller shrub that may often be more abundant than creosote bush, but the projected foliar cover and volume is generally less than that provided by the creosote bush. Many subdominant shrubs occur in creosote bush scrub. These include range ratany (*Krameria erecta*), silver cholla (*Opuntia echinocarpa*), Anderson's boxthorn (*Lycium andersonii*), desert straw (*Stephanomeria pauciflora*), wishbone bush (*Mirabilis bigelovii*), and cheesebush (*Hymenoclea salsola*). At higher elevations, subdominant species include California buckwheat (*Erigonum faciculatum*), hopsage (*Grayia spinosa*), winter fat (*Krasheninnikovia lanata*), and bladdersage (*Salazaria mexicana*).

Saltbush scrub is characterized by the dominance of one or more species of saltbush. Saltbush scrub is associated with moderately alkaline soils toxic enough to inhibit most desert shrubs that occur in the creosote bush scrub. It commonly occurs on lower bajada slopes and plains, and around playas throughout most of the deserts (Holland, 1986; as cited in NTC Fort Irwin, 1996). Good examples of saltbush scrub can be found on the playas along the margins of dry lakes on the NTC. Common shrubs are shadscale (*Atriplex confertifolia*), Mojave saltbush (*A. spinifera*), four-winged saltbush (*A. canescens*), and allscale (*A. polycarpa*). Other shrubs found in association with saltbush scrub include budsage (*Artemisia spinecens*), winterfat, hopsage, and Anderson's boxthorn. Typically, one strongly dominant species of saltbush is found in association with a smaller number of saltbush species in a particular area. Russian thistle (*Salsola tragus*), commonly known as tumbleweed, can often be found in saltbush scrub, especially in sandy areas. A large, dense stand of this species occurs in the southwest portion of Langford Lake.

Other Mojave Desert plant associations occur at Fort Irwin, but are less common. These associations are:

- Blackbush Scrub
- Mojave Mixed Woody Scrub
- Mojave Desert Wash Scrub
- Alkalai Sink Scrub
- Seeps and Springs vegetation
- Joshua Tree Woodland
- Juniper Woodland

7.2.2 Wildlife

The wildlife species found at NTC Fort Irwin are presented in Tables 7-2 through 7-4. Although Fort Irwin and the surrounding desert appear uniform, the desert supports a variety of wildlife habitats. Wildlife habitats are described by the vegetation types that occur in a particular area. Fort Irwin consists primarily of creosote bush scrub habitat. While each vegetation type

identified previously (Section 7.2.1) contains similar faunal components, there are species that occur more abundantly or solely in certain habitat types. For example, the zebra-tailed lizard (*Callisaurus draconoides*) occurs in nearly all vegetation communities on the NTC, but is more common in desert washes; the common night lizard (*Xantusia vigilis*) occurs almost exclusively in Joshua tree woodland.

Most wildlife species that occur on the NTC are adapted to desert scrub habitats that provide little cover and xeric (i.e., dry) conditions. However, seeps and springs provide perennial sources of water and a high concentration of vegetation and cover that increase wildlife diversity in these areas. Large mammals such as bighorn sheep, coyote, and desert kit fox know the locations of these water sources and return to them regularly; bats typically forage over these areas because of the increased abundance of invertebrate prey. The continued use of springs by wild burros has resulted in highly disturbed areas that now require management. Bird species that migrate in the spring and fall (and are not usually associated with desert environment) may stop over in these areas to forage and rest during their migration.

Areas of rocky terrain, such as the Avawatz, Granite, and Tiefort mountains, as well as other mountainous and hilly ranges onsite, provide suitable habitat for many reptiles, rodents, and bird species. Along with the different vegetation communities that normally occur as one ascends these ranges, differences in slope, aspect, and elevation result in microhabitats that support different wildlife species. Notable species that occur in these areas include bats, which rely on rocky outcrops for roosting sites, and raptors, which use cliff faces and rocky ledges in mountain habitat as sites to roost or nest.

Several dry lakes occur on the NTC. These areas provide little wildlife habitat because they are basically devoid of vegetation. However, they do contain algae that support brine shrimp and form the base of a food chain. Migratory waterfowl and large mammals may visit these areas after periods of heavy rainfall.

As is typical of most desert systems, larger animal species are uncommon, widely dispersed, and often nocturnal. Smaller mammals and reptiles, highly adapted to desert conditions, are much more common, but are often either secretive, nocturnal, or active for only short periods of the year. Birds are among the most conspicuous species, usually occurring in greatest concentrations in the vicinity of washes and springs where more structured and complex vegetative assemblages occur. With some exceptions, wildlife (such as birds and larger mammals) is generally more mobile and not limited to a single habitat type. Therefore, it should be noted that the entire NTC is likely used in the course of an organism's daily and seasonal activity patterns, particularly for larger and/or more mobile species. It should also be noted that some species on site (e.g., fish, amphibians, and some reptiles and mammals) are highly adapted for one habitat type and restricted to these areas. Lack of these habitats might have contributed to the absence of native amphibians and fish populations on the installation.

Although wildlife surveys typically do not focus on invertebrate species, invertebrates are an essential component of desert ecosystems, providing food for numerous vertebrate species and acting as pollinators for a large number of plant systems. The seasonal reproductive cycle of some insect species results in an "explosion" of the population in a relatively short period of time. This "swarming" of individuals provides an important prey base for insectivores, such as smaller birds, reptiles, amphibians, and bats.

Work begun on the NTC in 1995 by Pratt suggests that high levels of invertebrate diversity can be found in isolated areas. Because the diversity of insects is often correlated with the diversity of plants in an area, the springs on the NTC are particularly important to the invertebrate populations. The Avawatz mountains above 4,000 feet msl exhibit high levels of endemism for a number of insect species (Pratt, 1996). The only known population of one subspecies of the square-spotted blue butterfly (*Euphilotes battoides ellisi*) occurs there.

The following section summarizes by taxon the biological diversity of Fort Irwin. Each vertebrate taxonomic group is addressed.

7.2.2.1 Fishes. Although numerous active perennial springs are located in the study areas, no documentation exists of native fish species occurring in any of these springs Non-native species, such as the mosquitofish (*Gambusia affinis*), occur in some ponds to control mosquitoes. No other native or non-native fish species are known to occur in any spring at Fort Irwin

7.2.2.2 Amphibians. No amphibians have been observed on Fort Irwin; however, any of the active springs could potentially support amphibian species, even springs that are active only part of the year. One amphibian species, the red-spotted toad (*Bufo punctatus*), is likely to occur on the NTC. The red-spotted toad is a widespread species that occurs in a variety of habitats, including desert oases and springs. However, it has not been observed on the base to date

7.2.2.3 Reptiles. The rich, diverse reptilian populations known to occur on the NTC are characteristic of those found in creosote scrub habitat (Table 7-2). Some diurnal (i.e., active during the day) lizards are widespread, while others are habitat specialists. Widespread and abundant species include zebra-tailed lizards (*Callisaurus draconoides*), side-blotched lizards (*Uta stansburiana*), and western whiptails (*Cnemidophorus tigris*). Other lizard species that are widespread but less abundant include the desert horned lizard (*Phrynosoma platyrhinos*), long-nosed leopard lizard (*Gambelia wislezenii*), and the desert iguana (Dipsosaurus dorsalis). Habitat specialists include collard lizard (*Crotaphytus insularis*), chuckwalla (*Sauromalus obesus*), sagebrush lizard (*Urosaurus graciosus*), and common night lizard (Morofka, 1993). There are two populations of Mojave fringe-toed lizard (*Uma scoparia*) on the NTC. The main population is found in the dunes just north of Bitter Spring. The other population is found in the dunes just east of Red Pass Lake.

The desert tortoise (*Gopherus agassizii*) occurs in varying densities throughout the area (MBA, 1991 and Chambers Group, 1992c,d; as cited in NTC Fort Irwin, 1996). This species is listed as threatened by the United States Fish and Wildlife Service (USFWS) and requires special management considerations. More information on this species is presented under sensitive species.

Some of the more common snake species occurring at NTC Fort Irwin include the coachwhip (*Masticophis flagellum*), gopher snake (*Pituaphis melanoleucus*), western patch-nosed snake (Salvadora hexalepis), western shovel-nose snake (*Chionactis occipitalis*), and the side-winder (*Crotalus cerastes*) (MBA, 1991 and Chambers Group, 1992b; as cited in NTC Fort Irwin, 1996). Less common species include the blind snake (*Leptotyphlops humulis*) and ground snake (*Sonora semiannulata*). Unlike the lizards, most of which are primarily diurnal, most of the snake species that occur on the NTC are nocturnal.

7.2.2.4 Birds. Most of the bird species that occur on the NTC are representative of creosote bush scrub habitat (Table 7-3). Some more common bird species include black-throated sparrow (*Amphispiza bilineata*), rock wren (*Salpinctes obsoletus*), horned lark (*Eremophila alpestris*), common raven (*Corvus corax*), and greater roadrunner (*Geococcyx californiaus*). The verdin (*Auriparus flaviceps*) and black-tailed gnatcatcher (*Polioptila melanura*) are more common in desert wash systems.

The greatest bird activity, as is true in most habitats, is concentrated in the immediate vicinity of water. On the NTC, springs are a valuable resource to most resident and migratory bird species. Not only is there increased structural diversity of the vegetation and habitat, invertebrate species that become abundant in the vicinity of the springs during the spring and summer provide an important food source to resident species. Representative birds include house finch (*Carpodacus mexicanus*), the flycatcher phainopepla (*Phainopepla nitens*), Northern mockingbird (*Mimus polyglottos*), and song sparrow (*Melospiza melodia*). Numerous birds occur as winter or summer residents, or migrants that occur only during brief periods in the spring and fall. Some of the more common representative species include yellow-rumped warbler (*Dendroica coronata*), Hutton's vireo (*Vireo huttoni*), cliff swallow (*Hirundo pyrrhonata*), ruby-crowned kinglet (*regulus calendula*), and white-crowned sparrow (*Zonotrichia leucophrys*).

Red-tailed hawks (*Buteo jamaicensis*), northern harriers (*Circus cyaneus*), golden eagles (*Aguila chrysaetos*), and prairie falcons (*Falco mexicanus*) are some of the raptors that occur on the

NTC. Many raptor species use the cliff faces and rocky ledges of mountain ranges as sites to roost or nest. Owl species that occur include burrowing owl (*Speotyto cunicularia*), barn owl (*Tyto alba*), and short-eared owl (*Asio flammeus*).

7.2.2.5 Mammals. Several mammal species are known to occur on the NTC (Table 7-4) The majority of desert mammals are nocturnal, but a few may be seen by day Small mammals most frequently observed throughout the NTC include blacktail jackrabbit (*Lepus californicus*) and white-tail antelope squirrel (*Ammospermophilus leucurus*). Common rodent species include the desert kangaroo rat (*Dipolomys deserti*), Merriam's kangaroo rat (*D. merriami*), long-tailed pocket mouse (*Perognathus formosus*), little pocket mouse (*P. longimembris*), and desert woodrat (*Neotoma lepida*) (RDN, 1995; USFWS, 1994; as cited in NTC Fort Irwin, 1996). The Mojave ground squirrel (*Spermophilus mojavensis*) also occurs within the NTC.

Larger mammal species occurring at the NTC include the badger (*Taxidea taxus*), kit fox (*Vulpes macrotis*), gray fox (*Urocyon cinereoargenteus*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), and mountain lion (*Felis Concolor*). The kit fox and coyote are expected to occur throughout the NTC, whereas the others are localized and fairly rare. Another large mammal is Nelson's bighorn sheep (*Ovis canadensis nelsoni*), a fully protected sensitive species.

Mines and natural caves located throughout the NTC provide potential roosting habitat for bats. Bats also use the many cliff faces and rocky ledges of the mountain ranges in the study area as sites for roosting. Seven bat species were detected on the NTC during recent surveys by Brown (1994). The western pipistrelle (*Pipistelle hesperus*) and California myotis (*Myotis californicus*) were the two most commonly observed species.

7.2.3 Sensitive Species

The NTC Fort Irwin provides habitat for certain sensitive species. Sensitive plant species include all listed federal or state threatened, endangered, or otherwise sensitive species, and species considered to be rare or declining by the California Native Plant Society. Sensitive

wildlife species include all listed federal and state threatened and endangered species, species that are candidates for such listing, and California Species of Special Concern (CSC)

An Endangered Species Management Plan (ESMP) is currently being prepared for all listed endangered, threatened, or otherwise sensitive wildlife and plant species on the NTC (Chambers Group as cited in NTC Fort Irwin, 1996, in preparation). In addition, a Programmatic Management Plan (PMP; Chambers Group, 1996a; as cited in NTC Fort Irwin, 1996) for the desert tortoise was prepared to guide the management of the desert tortoise at the NTC. These documents are to be used as a guide for the continued preservation and management of the desert tortoise and other sensitive species and their habitats within the NTC.

Sensitive species occurring at the NTC Fort Irwin are described below.

7.2.3.1 Plants. Federally listed plants are discussed below. There are no state-listed plant species on the NTC. Additional sensitive plant species are included in Table 7-1.

Lane Mountain Milk Vetch (*Astragalus jaegerianus*) - Federally Proposed Endangered. Lane mountain milk vetch is a fabaceous perennial herb threatened by grazing and vehicles, and potentially by maneuvers at Fort Irwin (Skinner and Pavlik, 1994; as cited in NTC Fort Irwin, 1996). It occurs in Joshua tree woodland and creosote bush scrub in poorly developed granitic, sandy, or gravelly soils. Two populations are known from the Goldstone area. The Lane Mountain and Goldstone areas, and the contiguous area on the NTC include the entire known existing and historic range of the species (Chambers Group, 1994; as cited in NTC Fort Irwin, 1996).

7.2.3.2 Wildlife. Wildlife currently listed as threatened or endangered by state or federal agencies are discussed in detail below. Additional sensitive wildlife species are included in Table 7-2.

Desert Tortoise (*Gopherus agassizii*). The desert tortoise is a large, herbivorous reptile found throughout much of the Mojave and Sonoran deserts; its range roughly approximates the distribution of creosote bush scrub. The desert tortoise spends much of the year underground to avoid the extreme temperatures during the summer and winter. It constructs and maintains single-opening burrows, of which there may be several within an individual's home range. The desert tortoise is active in the spring, summer and autumn when daytime temperatures are below 90 degrees Fahrenheit (°F) (32 degrees Celsius [°C]). Most activity occurs during spring and early summer when most wildflowers bloom.

The USFWS determined that the desert tortoise warranted listing in response to documented population declines over large portions of its range. The decline is thought to be due to a number of reasons, including upper respiratory tract disease exacerbated by the stress of several drought seasons, loss of habitat, predation by ravens, livestock grazing, and direct disturbance by humans. The USFWS emergency-listed the desert tortoise on 4 August 1989, and officially listed the Mojave population as federally threatened in April 1990 (USFWS, 1990; as cited in NTC Fort Irwin, 1996).

The desert tortoise on the NTC is well studied. Numerous surveys have been conducted over the past years to document the distribution and estimated size of tortoise populations throughout the NTC (Chambers Group, 1994 (as cited in NTC Fort Irwin, 1996); Krzysik and Woodman 1991; Woodman and Goodlet, 1990). The desert tortoise is known to occur throughout the NTC in low to moderate numbers, with the highest concentration along the southern boundary (Chambers Group, 1996a; as cited in NTC Fort Irwin, 1996).

As fully described in the PMP and the ESMP, the NTC Fort Irwin has adopted a series of programs intended to benefit the desert tortoise. Each program undertaken on behalf of the desert tortoise at Fort Irwin contributes to a better understanding of the species and the conservation and preservation of the species as a whole. These programs include education programs for military and civilian personnel, juvenile tortoise research, reconnaissance-level surveys for the tortoise as well as other general sensitive plant and wildlife species, and long-

term studies that include desert tortoise monitoring plots, tortoise relocation, upper respiratory tract disease, neonatal information, and desert tortoise predation (see Chambers Group, 1996a (as cited in NTC Fort Irwin, 1996) for a full description of desert tortoise programs).

California Black Rail (*Laterallus jamaicensis coturniculus*). The California black rail is listed as threatened by the California Department of Fish and Game (CDFG). The species is a very uncommon, local breeder inhabiting marshes, swamps, and wet meadows. Two large, disjunct populations occur in California: one in the San Francisco Bay area and the other along the Colorado River drainage in Imperial County. The black rail was observed at the sewage treatment ponds on the NTC during the fall of 1994 (Brydolf, 1994), but it has not been seen since. The occurrence of the species at the sewage ponds on the central Mojave desert is extremely unusual.

Swainson's Hawk (*Buteo swainsoni*). State Threatened. The Swainson's hawk was once a widespread breeder in the non-forested areas of northern California and in the Central Valley. Conversion of the Central Valley and other grassland areas from pastureland to cropland has probably been a major factor in the population's decline (Remsen, 1978; as cited in NTC Fort Irwin, 1996). The Swainson's hawk winters in South America. This species is migratory and not expected to occur regularly at the NTC or forage in the area for prolonged periods.

Southwestern Willow Flycatcher (*Empidonax traillii extimus*). State and Federally Endangered. The southwestern willow flycatcher is a summer resident species in the region that breeds in riparian woodland habitats consisting of willows, cottonwoods and/or alders. This species is not expected to occur regularly on the NTC because of the lack of appropriate habitat. It may occur at the springs during brief periods of migration.

7.3 IDENTIFICATION OF CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN

The basic criteria for selection of COPECs for the ecological assessment are described below. The selection of site COPECs considered the following:

- Frequency of detection
- Comparison with laboratory and field blanks
- Comparison with background concentrations
- Essential nutrient status.

7.3.1 Frequency of Detection

This criterion was previously discussed in regard to the identification of COPCs for quantitative evaluation in the HHRA (Section 6.2.1). It is stated in the Workplan (Parsons ES, 1995) that all chemicals detected at least once in a given medium are to be included in the quantitative risk assessment, with the exception of inorganic chemicals demonstrated to be within background levels and organic compounds demonstrated to be laboratory contaminants. Therefore, chemicals were not excluded as COPECs based on frequency of detection.

7.3.2 Comparison with Blanks

This criterion was previously described in regard to the identification of COPCs for quantitative evaluation in the HHRA (Section 6.2.2). The comparison of field sample concentrations to associated blank concentrations was performed as part of the analytical data validation task (refer to Section 2.0). Therefore, the chemical data used in this risk assessment were previously evaluated by this criterion.

7.3.3 Comparison with Background Concentrations

The determination of statistical background concentrations (i.e., BUTLs) for Fort Irwin soils was previously described (Section 6.2.3). The BUTLs for inorganic chemicals representative of background conditions are summarized in Table 6-1. These BUTLs were used in screening inorganic analytes as COPECs for site soils. As described in Sections 6.2.3, it was not possible to derive BUTLs for selenium and silver due to low detection frequencies for these inorganics. Therefore, concentrations of selenium and silver detected in site soils were not screened using this criterion, and were assumed as COPECs for evaluation in the screening ERA.

7.3.4 Essential Nutrient Status

Calcium, iron, magnesium, potassium, and sodium are generally considered to be essential nutrients for humans and other mammalian species (Section 6.2.4). These inorganic chemicals are not necessarily considered COPECs for animals, even when media concentrations are a large fraction of what is necessary to induce a toxic response. This is because these concentrations may be beneficial, or even necessary. Therefore, these inorganic chemicals were assumed to be essential nutrients for animals, and were eliminated as COPECs for quantitative evaluation of animal indicator species. The above-described chemicals are not necessarily considered to be essential nutrients for plant species, and may be phytotoxic at high concentrations. However, plants were not quantitatively evaluated in this ERA.

7.3.5 Summary of Chemicals of Potential Ecological Concern

Chemicals identified as COPECs for evaluation in the ERA differ from those chemicals identified as COPCs for evaluation in the HHRA based on two factors. The soil depth range considered in the evaluation of subsurface soil COPECs for the ERA was 2.5 - 5 feet bgs, consistent with the Workplan (Parsons ES, 1995). This is in contrast to a subsurface soil depth range of 2.5 - 10 feet bgs for the HHRA. Therefore, chemicals identified as COPCs for evaluation in the HHRA were not assumed to be COPECs for evaluation in the ERA.

The selection of COPECs for Site FTIR-07/d surface and subsurface soils is summarized in the following subsections.

7.3.5.1 Site FTIR-07/d - Surface Soil. Screening of COPECs for Site FTIR-07/d surface soil is summarized in Table 7-5. Several inorganic analytes (aluminum, arsenic, barium, beryllium, chromium, cobalt, lead, mercury, manganese, nickel, and vanadium) were eliminated from consideration as COPECs based on maximum detected concentrations below background. Calcium, iron, magnesium, potassium, and sodium were excluded as COPECs based on the assumption that these are essential nutrients in animals (refer to Section 6.2.4). The COPECs identified for Site FTIR-07/d surface soil include copper and zinc.

7.3.5.2 Site FTIR-07/d – Subsurface Soil. Screening of COPECs for Site FTIR-07/d subsurface soil is summarized in Table 7-6. Two inorganic analytes (aluminum, beryllium, chromium, cobalt, manganese, molybdenum, nickel, and vanadium) were eliminated from consideration as COPECs based on maximum detected concentrations below background. In addition, calcium, iron, magnesium, potassium, and sodium were excluded as COPECs based on the assumption that these are essential nutrients in animals (refer to Section 7.2.4). The COPECs identified for Site FTIR-07/d subsurface soil include inorganics (arsenic, barium, cadmium, copper, lead, and zinc); di-n-butyl phthalate; two dioxins; the herbicide, 2,4,5-TP; n-nitrosodiphenylamine; and 2,4-dinitrotoluene.

The COPECs selected for Site FTIR-07/d surface and subsurface soils are summarized in Table 7-7.

7.4 ECOLOGICAL EXPOSURE ASSESSMENT

The purpose of the exposure assessment phase of the ERA is to describe and quantify (when appropriate) the potential co-occurrence of receptors and COPECs. The development of an ecological conceptual site model (CSM) serves to identify all potentially exposed receptors and

potentially complete exposure pathways. Representative indicator receptors are selected for purposes of modeling exposures and evaluating potential impacts of COPECs on ecological receptors and habitats. Potential exposures are evaluated by estimating COPEC exposure point concentrations in abiotic and biotic media, and subsequent uptake by indicator receptors. The results of the exposure assessment are considered in relation to the results of the toxicity assessment to characterize ecological risk.

7.4.1 Ecological Conceptual Site Model

An ecological CSM was prepared for Site FTIR-07/d, consistent with Cal-EPA's *Guidance for Ecological Risk Assessment* (Cal-EPA, 1996) and USEPA's *Guidelines for Ecological Risk Assessment* (USEPA, 1998d). The ecological CSM is a graphic representation of the potential contaminant sources, migration and transport pathways, exposure pathways, and exposed populations. Consideration of the ecological conceptual site model is necessary in the identification of indicator receptors for evaluation in the quantitative ERA, and in ecological exposure modeling.

As described in Section 7.2, the ecological receptors occurring or potentially present at NTC Fort Irwin, including Site FTIR-07/d, are those associated with creosote scrub and saltbush scrub communities. Based on this, a general ecological CSM was developed for the site (Figure 7-1)

7.4.2 Indicator Receptors

Numerous plant and wildlife species are present, or potentially occurring, in the vicinity of NTC Fort Irwin and the subject site evaluated in this report (Section 7.2). It is not possible to evaluate potential impacts to all receptors inhabiting this ecosystem. Therefore, it is necessary to identify one or more representative indicator species for evaluation in the quantitative ERA. Information that is typically considered in the selection of indicator species includes, but is not limited to, the following:

- Representative of food webs and food guilds occurring or potentially occurring at the site
- Potential for exposure to site COPECs
- Availability of toxicity information or benchmark criteria
- Status as a 'threatened and endangered' or 'special status' species

For purposes of performing the quantitative ERA, indicator species were selected. The Mojave ground squirrel and the golden eagle were selected as indicator receptors for terrestrial consumer and upper-trophic level receptors, respectively. Although the desert tortoise is known to occur in low to moderate numbers at NTC Fort Irwin, it has not been observed in the area of Site FTIR-07/d (Mickey Quillman, Natural and Cultural Resources Manager for NTC Fort Irwin). Therefore, the desert tortoise was not selected as an indicator receptor for evaluation in this ERA.

The Mojave ground squirrel and the white-tailed antelope squirrel are important consumer species inhabiting the creosote shrub/saltbush scrub communities on NTC Fort Irwin. These rodent species are sympatric (i.e., share the same niche) and have been observed, trapped, or potentially occur at Site FTIR-07/d. Of the two species, the Mojave ground squirrel may have higher exposures to contaminants uptaken by plants because it is an obligate herbivore, while the white-tailed antelope squirrel is an omnivore; and the Mojave ground squirrel has a smaller home-range than the white-tailed antelope squirrel. The Mojave ground squirrel was selected as an indicator receptor because:

- It has been observed at Site FTIR-07/d, and prefers the creosote shrub/saltbush scrub communities present at this site
- It is an obligate herbivore and, therefore, is likely to have high exposure to contaminants assimilated by plants
- It has a smaller home range than other small rodents, such as the white-tailed antelope squirrel
- It is a special-status species.

A number of upper trophic level receptors occur at the NTC Fort Irwin including the kit fox, coyote, bobcat, mountain lion, and various raptor species including the red-tailed hawk, Cooper's

hawk, and golden eagle (Section 7.2.2). Of the mammals potentially present, the kit fox and coyote occur throughout the NTC, whereas the others are localized and fairly rare. Neither the kit fox or coyote are sensitive-status species and, therefore, were not selected as indicator species. Of the raptors potentially present, the golden eagle may be most likely to occur at Site FTIR-07/d because it prefers open desert communities for foraging, while the red-tailed hawk and Cooper's hawk tend to forage near trees used for roosting or nesting. The golden eagle is a California special status species. The golden eagle was selected as an indicator species based for the following reasons:

- It has been observed at NTC Fort Irwin, and prefers the open deserts and savannahs for foraging
- It is diurnal, like the Mojave ground squirrel
- It is a natural predator of the Mojave ground squirrel
- It is a special-status species

Based on the selection of indicator receptors, simplified food chains were identified for terrestrial receptors that are likely to be impacted by site contaminants. These simplified food chains represent potential pathways for transfer of contaminants through biota, and are evaluated quantitatively in the ecological risk characterization step (Section 7.6). The simplified food chain evaluated in this ERA is comprised of plants, the Mojave ground squirrel, and the golden eagle (Figure 7-2). Inclusion of an upper trophic level receptor such as the golden eagle allows for an evaluation of the potential for biomagnification of bioaccumulating chemicals.

7.4.3 Selection of Endpoints

As defined in USEPA's *Guidelines for Ecological Risk Assessment* (USEPA, 1998d), an assessment endpoint is an explicit expression of the environmental value that is to be protected (for example, a decline in a specific species population). A measurement endpoint is defined as a quantitative expression of an observed or measured effect of the hazard; that is, a measurable response to a stressor that is related to the ecological characteristic chosen as the assessment endpoint (USEPA, 1998d).

The objectives of the ERA for Site FTIR-07/d are reflected in the assessment endpoints that were selected. Appropriate assessment endpoints may be broad and general or very specific. A general assessment endpoint selected is the protection of the overall habitat. This assessment endpoint is conceptually broad and protective of the environment at the site. Specific assessment endpoints, that are consistent with this general endpoint, include protection of the growth and survival of organisms represented by the indicator receptors that were selected for the sites evaluated in this ERA.

The measurement endpoints selected for evaluation of the assessment endpoints are receptor-specific HIs for indicator receptors. The HIs are the sum of the HQs. HQs are calculated by estimating the exposure dose received by the receptor and dividing it by a reference dose that is either anticipated not to cause adverse effects or represents the lowest adverse effect level. The HI approach is applied in estimating the risk to the indicator receptor.

Adequate toxicity information for mammals and avians currently exists for most COPECs evaluated in this ERA. Therefore, potential ecological hazards for the Mojave ground squirrel and the golden eagle were quantitatively evaluated (i.e., HIs were estimated for both indicator receptors).

7.4.4 Ecological Pathway and Exposure Route Analysis

All potential exposure pathways for indicator receptors present or potentially occurring at each site were evaluated, and the potentially complete pathways were identified (Figure 7-1). Uptake through food chain transfer of chemicals in soil was identified as a complete exposure route for the Mojave ground squirrel and the golden eagle. Direct exposures of the Mojave ground squirrel and golden eagle to soil through incidental ingestion and dermal contact are also potentially complete exposure pathways. Other exposure routes (e.g., inhalation of particulates) may be potentially complete but were judged unlikely to result in significant exposures. The ingestion route typically dominates ecological exposures (Maughan, 1993). Migration of

COPECs to surface water and subsequent ingestion by the Mojave ground squirrel or the golden eagle were also deemed to be insignificant. Surface water is nonexistent or seasonal, at best, in the vicinity of the subject site and desert species are adapted to acquiring their water needs from dietary items (e.g., plants for the Mojave ground squirrel, and small mammals for the golden eagle).

For quantifying food chain exposures, simplified exposure models were developed based on indicator receptors for terrestrial food chains (Section 7.4.2). The following discussion refers to the simplified exposure model developed for the Mojave ground squirrel and the golden eagle. This exposure model consists of plant uptake of chemicals from soil, ingestion of plants by the Mojave ground squirrel, and ingestion of the Mojave ground squirrel by the golden eagle (Figure 7-2). Uptake of chemicals by producer species, such as plants, is generally dependent upon root uptake and translocation of soil contaminants. Consumer species, such as the Mojave ground squirrel, receive exposure through the diet, as well as direct exposure to soil COPECs through dermal contact and incidental ingestion. Higher trophic level receptors such as the golden eagle potentially receive increased relative exposures to COPECs due to the number of chemical transfers through the food chain. Thus, exposure modeling for these receptors allows for an evaluation of the impacts of potential biomagnification. In addition to food chain transfer, direct exposures to soil COPECs through dermal contact and incidental ingestion were considered.

7.4.5 Exposure Point Concentrations

The methods used in the derivation of exposure point concentrations (EPCs) for the ERA were the same as those used for the baseline HHRA, and were described previously (Section 6.4.1.5.1). Briefly, due to the small sampling size, the maximum concentration was selected as the EPC for surface soil, while the maximum or 95% UCL concentration was selected as the subsurface soil EPC (Table 7-8). Transfer coefficients from soil-to-biota were used to estimate COPEC concentrations in the dietary items of indicator receptors (i.e., plants for the

Mojave ground squirrel, and small mammals for the golden eagle). The methods used to estimate dietary concentrations are described in the following subsection.

7.4.5.1 Transfer Coefficients. Transfer coefficients from soil-to-biota were used to estimate exposure point concentrations in plants and the Mojave ground squirrel from concentrations measured in site-specific soils. Transfer coefficients were obtained from the literature for soil-to-plant, and plant-to-animal transfers of COPECs. Soil-to-plant transfer coefficients for inorganic COPECs were derived from Baes et al. (1984), based on root uptake studies of radionuclides from soils to above-ground plant parts. Plant-to-animal transfer coefficients for inorganic COPECs were also derived from Baes et al. (1984), based on transfer and retention of elements from feed to beef.

Plant or animal uptake studies are unavailable for most of the organic COPECs evaluated in this ERA. However, several linear regression equations have been developed to estimate soil-to-plant and plant-to-animal transfers for organic chemicals, based on their octanol-water partition coefficients (CalTOX, 1993; Travis and Arms, 1988).

The linear regression equation for calculating the soil-to-plant transfer coefficient for organic COPECs is the following:

$$TC_{s\text{-}p}\ (unitless) = 7.7\ x\ (K_{ow})^{-0.58}$$

where:

$TC_{s\text{-}p}$ = transfer coefficient from soil to above-ground plant parts (unitless)
K_{ow} = octanol-water partition coefficient (unitless)

The linear regression equation for calculating the plant-to-animal transfer coefficient for organic COPECs is the following:

$$TC_{p\text{-}a}\ (unitless) = 8\ x\ \log^{-1}(-7.6 + \log K_{ow})$$

where:

TC_{s-p} = transfer coefficient from plants to animal tissues (unitless)
K_{ow} = octanol-water partition coefficient (unitless)

The transfer coefficients used in the estimation of dietary exposure point concentrations for ecological receptors are presented in Table 7-9. The dietary (i.e., plant and small mammal) exposure point concentrations are included in the ecological hazard calculation tables presented in Section 7.6.

7.4.6 Exposure Parameters

Exposure parameters for each indicator receptor were required to estimate the exposure dose. Exposure parameters were obtained from USEPA's *Wildlife Exposure Factors Handbook* (USEPA, 1993), the National Audubon Society's *Field Guide to North American Birds* (Whitaker, 1977) and *Field Guide to North American Mammals* (Whitaker, 1996), and *California's Wildlife* (Zeiner et al., 1990). The exposure parameters required for the quantitative dose estimate include the receptor's:

- Body weight
- Ingestion rate of biotic and abiotic media
- Dermal contact rates with abiotic media (e g., soil)
- Site utilization factor (the area of contamination in relation to the receptor's home range)
- Exposure duration (time in a year that a receptor is exposed to site COPECs)
- Skin surface area
- Chemical-specific dermal absorption factors
- Soil adherence factors.

The assumptions used for each of these exposure parameters are presented in Table 7-10, and are described in more detail in the following subsection.

7.4.6.1 Body Weight. Body weights (BWs) for indicator receptors were obtained from the National Audubon Society's *Field Guide to North American Birds* (Whitaker, 1977), and *Field Guide to North American Mammals* (Whitaker, 1996). The average body weights reported for both males and females were used for each indicator receptor.

7.4.6.2 Biotic Ingestion Rates. Food ingestion rates (FIR) for each indicator receptor were obtained from the literature or calculated using allometric equations provided in USEPA's *Wildlife Exposure Factors Handbook* (USEPA, 1993) that are based on established relationships between body size and metabolic requirements. Food ingestion rates expressed in grams of food per day were calculated based on Equation 3-9 (USEPA, 1993) for the Mojave ground squirrel; and Equation 3-3 (USEPA, 1993) for the golden eagle. Ingestion rates were converted to milligrams of food per day prior to input to the dose calculation.

7.4.6.3 Abiotic Ingestion Rates. The abiotic ingestion rates (for incidental soil ingestion) were obtained from USEPA (1993). The abiotic ingestion rate for the Mojave ground squirrel was based on a reported soil ingestion rate for the meadow vole; and that for the golden eagle was based on a soil ingestion rate for passerine species. Soil ingestion rates are expressed in grams of soil ingested per day. These values were converted to milligrams of soil ingested per day prior to input to the dose equation.

7.4.6.4 Site Utilization Factor. The site utilization factor (SUF) describes the area of contamination that a receptor potentially contacts relative to its home range. Home range is the area of habitat required by an ecological receptor to meet its dietary needs. Home ranges vary between species depending upon differences in dietary requirements, and within a species depending upon the relative abundance of food items in a particular area in which the receptor feeds. Home range values were obtained from the National Audubon Society's *Field Guide to North American Birds* (Whitaker, 1977) and *Field Guide to North American Mammals* (Whitaker, 1996). Comparison of a receptor's home range to the areal extent of contamination of a site is used to determine the relative amount of potentially contaminated diet the receptor is exposed to. The SUF is calculated as the ratio of the area of contamination to a receptor's home

range. When the receptor's home range is greater than the area of contamination, the SUF is less than one. When a receptor's home range is less than or equal to the area of contamination the SUF is equal to one.

7.4.6.5 Exposure Duration. The ED refers to the fraction of the year that a receptor is likely to spend utilizing a site. This is frequently a function of migration and/or hibernation potential. The Mojave ground squirrel estivates and hibernates from approximately August to March. Therefore, the exposure duration for the Mojave ground squirrel was assumed to be 0.5 (Table 7-10). The golden eagle is potentially present and active at the NTC Fort Irwin all year. Thus, the exposure duration for the golden eagle was assumed to be 1.0.

7.4.6.6 Skin Surface Area. The skin surface area (SSA) is an exposure parameter used to estimate dermal exposure of indicator receptors to soil COPECs. This parameter was calculated based on methods outlined in the *Wildlife Exposure Factors Handbook* (USEPA, 1993). Equation 3-22 (USEPA, 1993) was used for the Mojave ground squirrel, and Equation 3-21 (USEPA, 1993) was used for the golden eagle. The calculation using this allometric equation yields an estimate of total skin surface area beneath the fur or feathers. For purposes of this assessment, the dermal portion of an indicator receptor's body that may receive potentially significant exposures to soil was assumed to be the feet (4 percent of total body surface area) for the Mojave ground squirrel; and the beak, legs and feet (8 percent of total body surface area) for the golden eagle. It was assumed that for the indicator receptors selected, fur or feathers would tend to protect other body surfaces from dermal exposure.

7.4.6.7 Chemical-Specific Dermal Absorption Fraction. The chemical-specific dermal absorption fraction (ABS) is used in the estimate of dermal exposure to contaminants in soil or sediment. The ABS represents the ratio of the absorbed dose to the applied dose of a chemical (USEPA, 1992b). An average dermal absorption fraction of 0.1 (i.e., 10 percent) for organic chemicals, and 0.01 (i.e., 1 percent) for inorganic chemicals, has been published by USEPA (1992b) for use in human health risk assessment. These dermal absorption fractions were used in this ERA for estimating doses derived from dermal exposures.

7.4.6.8 Soil Adherence Factor. The soil-to-skin adherence factor (AF) is also used in the estimation of dermal exposure to contaminants in soil. This parameter depends in part on chemical properties and in part on soil characteristics, such as total organic carbon and particle size. A soil-to-skin AF of 0.2 (USEPA, 1992b) was assumed for the Mojave ground squirrel and the golden eagle.

The exposure assumptions used in estimating doses for the indicator receptors evaluated in this screening ERA are summarized in Table 7-10.

7.4.7 Exposure Dose Calculation

The final phase of the exposure assessment consolidates the exposure pathways and exposure routes, exposure point concentrations, and exposure parameters into an equation that provides an exposure dose estimate in units of milligrams of COPEC per kilogram body weight per day. Ingestion dose estimates are calculated using the following general equation derived from USEPA's *Wildlife Exposure Factors Handbook* (USEPA, 1993):

$$Dose_{Ingestion} = \frac{[(IR_{Biotic} \times EPC_{Biotic}) + (IR_{Abiotic} \times EPC_{Abiotic})] \times ED \times SUF \times UC}{BW}$$

where:

$Dose_{Ingestion}$	=	Estimated exposure dose from ingestion of food and ingestion of abiotic media (mg/kg-day)
IR_{Biotic}	=	Food ingestion rate (mg/day)
$IR_{Abiotic}$	=	Abiotic media ingestion rate (mg/day)
EPC_{Biotic}	=	Concentration of COPEC in food item (mg/kg)
$EPC_{Abiotic}$	=	Concentration of COPEC in abiotic media (mg/kg)
ED	=	Exposure Duration (unitless)
SUF	=	Site Utilization Factor (unitless)
UC	=	Unit Conversion, 10^{-6} kg/mg
BW	=	Body weight (kg)

Dermal exposure estimates were calculated for indicator receptors using the following general equation:

$$Dose_{Dermal} = \frac{EPC_{Abiotic} \times SSA \times AF \times ABS \times ED \times SUF \times UC}{BW}$$

where:

$Dose_{Dermal}$	=	Estimated dose from dermal contact with soil (mg/kg-day)
$EPC_{Abiotic}$	=	Exposure point concentration in soil (mg/kg)
SSA	=	Skin Surface Area (cm2)
AF	=	Soil adherence factor
ABS	=	Chemical-specific dermal absorption fraction (unitless)
ED	=	Exposure Duration (unitless)
SUF	=	Site Utilization Factor (unitless)
UC	=	Unit Conversion, 10^{-6} (kg/mg)
BW	=	Body Weight (kg)

7.5 ECOLOGICAL TOXICITY ASSESSMENT

The ecological toxicity criteria that were used to evaluate the exposure doses calculated in Section 7.4 are presented in this section. The selected ecological toxicity criteria are toxicity reference values (TRVs) given in units of mg/kg-d. Two sets of TRVs are used for this ecological risk analysis:

- Army TRVs: These TRVs are presented in Tables 7-11 and 7-13. With the exception of mammalian value for lead, the Army adopted ecological toxicity benchmarks that are published in *Toxicological Benchmarks for Wildlife* (Sample et al., 1996) as their TRVs. The lead TRV was selected through an independent analysis of the literature by the US Army Environmental Center (USACE, 2001).
- Biological Toxicity Advisory Group (BTAG) TRVs: These TRVs are presented in Tables 7-12 and 7-14. At the request of DTSC, TRVs compiled by the USEPA Region 9 BTAG were also adapted for use in this assessment (EFA-West, 1998).

Whenever possible, Army TRVs and BTAG low TRVs were based on experimentally derived NOAELs or lowest-observed-adverse-effects levels (LOAELs). In cases where a NOAEL was not available for a particular COPEC, uncertainty factors were applied to reduce the TRV by an

order-of-magnitude or more. The BTAG high TRV in typically based on the mid-range of the reported LOAELs for a chemical and, as such, represents a dose level at which effects are anticipated (EFA-West, 1998). In both documents, emphasis was placed on studies in which reproductive and developmental endpoints were considered.

Sample et al. (1996) and EFA-West (1998) both report benchmarks for a test species. Since benchmarks were not specifically available for the Mojave ground squirrel and the Golden Eagle, toxicity benchmarks provided for the test species were allometrically converted to a representative species' TRV as described in Sample et al. (1996):

$$Dose_I = Dose_T \times (BW_T / BW_I)^X$$

where:

$Dose_I$	=	Toxicity reference value for indicator receptor (mg/kg-d)
$Dose_T$	=	Benchmark NOAEL dose for test species (mg/kg-d)
BW_T	=	Body weight for test species (kg)
BW_I	=	Body weight for indicator species (kg)
X	=	adjustment of linear equation; 0.25 for mammals, 1 for birds (unitless)

The toxicity benchmarks and their allometrically converted TRVs are provided in Tables 7-11 through 7-14.

7.6 ECOLOGICAL RISK CHARACTERIZATION

The methods and results of the risk characterization performed for Site FTIR-07/d are presented in this section.

7.6.1 Methods

The ecological risk characterization uses the information that was previously gathered to determine the potential ecological risks resulting from the presence of COPECs in environmental media Information regarding the presence and attributes of site receptors as well as the chemistry, toxicology, and distribution of site chemicals was synthesized in an evaluation of the potential for adverse effects to ecological receptors.

The overall goal of this ERA was to evaluate whether COPEC concentrations identified in soils associated with Site FTIR-07/d are sufficiently protective of ecological receptors or whether the concentrations are elevated and suggest potential risks to the ecosystem. Attainment of this goal is not directly measurable. To provide an indication of whether the ecosystem is protected, specific assessment endpoints were identified (Section 7.4.3) Measurement endpoints were also selected (Section 7.4.3) as tools for evaluating the assessment endpoints.

The measurement endpoints evaluated in this ERA include comparison of modeled exposure doses with toxicity reference values for mammalian and avian indicator receptors (i.e., Mojave ground squirrel and golden eagle). The comparison with toxicity reference values yields chemical specific HQs as follows:

$$HQ = \frac{Dose}{TRV}$$

where:

HQ	=	Hazard quotient (unitless)
Dose	=	Modeled exposure dose for the Mojave ground squirrel or golden eagle (mg/kg-d)
TRV	=	Toxicity reference value for the Mojave ground squirrel or golden eagle (mg/kg-d)

Additionally, to estimate the cumulative effects of COPECs, a hazard index (HI) was calculated for each indicator receptor. This HI was determined by adding the HQs obtained from food chain modeling for all COPECs identified at the site for each indicator receptor. HQ or HI

values which exceed 1 are generally considered to be indicative of potential biological or ecological effects on representative receptors. These values do not necessarily indicate that a biological or ecological effect will occur, but only that a lower threshold has been exceeded (Menzie, et al., 1992). In general, the evaluation of the significance of the HQ and HI values was conducted in a manner consistent with Menzie, et al. (1992), as follows:

- HQ or HI less than 1: no adverse effects on representative receptors is anticipated
- HQ or HI between 1 and 10: there is a limited potential for adverse effects on representative receptors
- HQ or HI between 10 and 100: there is potential for adverse effects on representative receptors
- HQ or HI exceeds 100: there is significant potential for adverse effects on representative receptors

Note that the above are only guidelines. Site-specific factors such as spatial distribution and frequency of detection of COPECs, uncertainty of assumptions used in exposure determination, and endpoint of study used to the determine the toxicity benchmarks need to be considered when reviewing specific HQs and HIs.

7.6.2 Results

The results of the ecological risk characterizations for the Mojave ground squirrel and the golden eagle are presented in the following subsections.

7.6.2.1 Mojave Ground Squirrel. Because risk management strategies differ with soil depth, ecological hazard estimates for the Mojave ground squirrel were calculated separately for surface soils and subsurface soils.

Surface Soils. Mojave ground squirrel surface soil HIs are presented in Tables 7-15 (Army TRVs) and 7-16 (BTAG TRVs). The estimated HI for the Mojave ground squirrel based on the Army TRV is <1.0, while the BTAG TRV based HI indicates a potential risk to the Mojave ground squirrel from zinc. Zinc contributed a HQ of 1.3 to BTAG TRV based HI of 2.0.

When looked at more closely, however, this suggested risk appears to be minimal. As shown in Table 7-23, the site's maximum surface soil zinc concentration is 103 mg/kg, within approximately two times the BUTL of 51 mg/kg. In addition, if the FTIR Site 38 and 40 soil-plant trophic transfer factor of 0.003 is used to model zinc exposure at FTIR Site 07/d, the zinc HQ using the Mojave ground squirrel BTAG based TRV is reduced to 0.02, well below the acceptable HQ of 1.0.

Subsurface Soils. Mojave ground squirrel subsurface soil HIs are presented in Tables 7-17 (Army TRVs) and 7-18 (BTAG TRVs). The estimated HI for the Mojave ground squirrel based on the Army TRV is <1.0, while the BTAG TRV-based HI indicates a potential risk to the Mojave ground squirrel from copper, lead and zinc. The BTAG TRV based HI was 14.0, with copper contributing a HQ of 1.8, lead contributing a HQ of 5.0 and zinc contributing a HQ of 6.5.

When looked at more closely, however, this suggested risk appears to be minimal. If the FTIR Site 38 and 40 soil-plant trophic transfer factor of 0.0003 is used to model zinc exposure at FTIR Site 07/d, the copper BTAG HQ for the Mojave ground squirrel is reduced to 0.1, well below the acceptable HQ of 1.0. If the FTIR Site 38 and 40 soil-plant trophic transfer factor of 0.00001 is used to model lead exposure-dose at FTIR Site 07/d, the lead BTAG HQ for the Mojave ground squirrel is reduced to 1.7, a low HQ considering the uncertainty associated with the BTAG TRV for lead. (See Uncertainty Section) If the FTIR Site 38 and 40 soil-plant trophic transfer factor of 0.003 is used to model zinc exposure at FTIR Site 07/d, the zinc HQ for the Mojave ground squirrel is reduced to 0.01, well below the acceptable HQ of 1.0.

7.6.2.2 Golden Eagle. Because risk management strategies differ with soil depth, ecological hazard estimates for the golden eagle were calculated separately for surface and subsurface soils

Surface Soils. Golden Eagle surface soil HIs are presented in Tables 7-19 (Army TRVs) and 7-20 (BTAG TRVs). Both the Army TRV based HI and the BTAG based HI are <1.0, suggesting no risk from site related chemicals in surface soil to the golden eagle

Subsurface Soils. Golden Eagle surface soil HIs are presented in Tables 7-21 (Army TRVs) and 7-22 (BTAG TRVs).). Both the Army TRV based HI and the BTAG based HI are <1.0, suggesting no risk from site related chemicals in surface soil to the golden eagle.

7.6.3 Conclusions

Hazard quotients and HIs calculated for the Mohave ground squirrel and Golden Eagle are summarized in Table 7-23. These risk characterization estimates indicate that,

- Based on Army TRVs, no adverse impacts to the Mojave ground squirrel are anticipated from exposures to surface and subsurface soils associated with the Site FTIR-07/d
- Based on BTAG TRVS, minimal impacts to the Mojave ground squirrel are anticipated from exposures to surface and subsurface soils associated with Site FTIR-07/d
- Based on Army TRVs and BTAG TRVs, no adverse impacts to the Golden Eagle are anticipated from exposures to surface and subsurface soils associated with Site FTIR-07/d.

Thus, as represented by the Mohave ground squirrel, impacts from chemicals in Site FTIR-07/d soils to representative small herbivorous or omnivorous mammals are expected to be insignificant or minimal. As represented by the Golden Eagle, impact from chemicals in Site FTIR-07/d soils to upper trophic level avian and mammalian species is not anticipated to occur

7.7 UNCERTAINTY ANALYSIS

The presence of uncertainty is inherent in the risk assessment process. Generally, uncertainties in the risk assessment typically result from limitations in the available methods, information, and data used in the following:

- Characterization of contaminant sources
- Identification of site COPECs
- Evaluation of potential exposure scenarios and pathways
- Toxicity assessment
- Risk characterization

The uncertainties associated with each of these steps are described below

7.7.1 Characterization of Contaminant Sources

There is a degree of uncertainty in the characterization of contaminant sources, since it is not possible to sample an entire site. The site investigations were based on site histories, known releases, or the results of previous investigations (i.e., soil gas measurements or preliminary monitoring). The nature of these site investigations focused on known or suspected sources of contamination. While it is believed that sufficient samples were collected to characterize the nature and extent of contamination at the sites, it is possible that areas not sampled may have also contained contaminants. However, it is believed that sufficient samples were collected to characterize the nature and extent of contamination at the site, since areas of geophysical disturbance or known contamination were targeted.

7.7.2 Identification of Site Chemicals of Potential Ecological Concern

The process used in the selection of site COPECs may also introduce a degree of uncertainty in the ERA. However, protective assumptions were used in the selection of site COPECs. Chemicals selected for quantitative evaluation in the Phase I ERA included all organic chemicals identified in soils and inorganic chemicals present at concentrations greater than background (Montgomery Watson, 1998). Chemicals selected for evaluation in the Phase II Ecological Validation Study had all contributed to a HI greater than 1 0 in the Phase I ERA.

The inorganics calcium, iron, magnesium, potassium, and sodium were eliminated from consideration as COPECs for the Mojave ground squirrel and the Golden Eagle, based on essential nutrient status. These inorganic chemicals have relatively low toxicities and are generally of low concern for potential impacts on non-plant terrestrial receptors. Zinc is also an essential nutrient that was eliminated as a potential COPC in the HHRA based on essential nutrient status. However, zinc is capable of producing adverse ecological impacts in some aquatic and terrestrial receptors at fairly low environmental concentrations. Therefore, zinc was not eliminated as a COPEC for this ERA.

7.7.3 Exposure Assessment

Uncertainties associated with the exposure assessment include: (1) the selection of indicator receptors; (2) the exposure assumptions and parameters used; and (3) the exposure dose estimates. Representative indicator receptors were selected for quantitative evaluation in the ERA based on the criteria identified in Section 7.42. The Mohave ground squirrel is believed to be a worst-case indicator receptor for small herbivorous and omnivorous mammals because it (1) is an obligate herbivore; (2) burrows extensively; and (3) has a small home range (i.e. foraging area).

The golden eagle was selected as an indicator receptor for higher trophic level receptors, based on the criteria described in Section 7.4.2. One of the factors contributing to the low hazard

estimates for the golden eagle was most likely the large home range for this species. As a result of its large home range, the SUF for the golden eagle was 1.7E-05. Other upper trophic level receptors represented by the golden eagle, such as the kit fox, may be expected to have home ranges smaller than that for the golden eagle. However, such receptors would have to have a SUF of approximately 1 to result in an excess hazard estimate, and it is unlikely that their energy requirements would be met foraging in such a small area.

Many exposure parameters (e.g., soil ingestion rates, dermal surface areas, and absorption fractions) were not available for the Mojave ground squirrel, and best estimates based on similar species or allometric equations were used. This introduces a level of uncertainty into the exposure estimate. However, appropriate exposure values and estimation methods were taken from the *Wildlife Exposure Factors Handbook* (USEPA, 1993), when available.

Uncertainties in the exposure point concentrations also result in uncertainty in the exposure dose estimate. Exposure point concentrations for receptors potentially exposed to surface soils were based on the maximum concentration of COPECs measured because the number of samples did not permit calculation of the 95% UCL concentration. Use of the maximum exposure point concentration results in a protective estimate of exposure, given that receptors tend to forage in different locations of a site and would not be exposed to the highest concentrations 100 percent of the time. The use of protective exposure assumptions and exposure point concentrations based on maximum COPEC concentrations in soil most likely results in an overestimation of ecological hazards for indicator receptors.

7.7.4 Toxicity Assessment

The toxicity benchmarks used in the quantitative evaluation of ecological hazards for the indicator receptors were generally derived from the lowest NOAEL or LOAEL data obtained from the literature. Uncertainty factors were applied where appropriate in deriving the benchmarks, and the most protective values from the literature were used. The use of conservative toxicity values in the risk estimate tends to overestimate actual risks.

The species upon which the benchmark criteria are based were different from those present at the site. Because toxicity values are often not available for a species, toxicity benchmarks derived for a surrogate species are selected for quantitative risk evaluation. Toxicity benchmarks derived from toxicology studies in rats and mice were allometrically converted for each indicator receptor, based on established methods (Opresko et al., 1994). It is not known whether the indicator receptors chosen may be more sensitive or less sensitive to the adverse effects of COPECs identified at the sites than the test species upon which the toxicity benchmark is based However, the benchmarks are thought to be protective because they are based on the lowest toxicity values from all test species reported in the literature.

An additional source of uncertainty results from a lack of toxicity values for some COPECs. Mammalian toxicity benchmarks were not available for n-nitrosodiphenylamine Avian toxicity benchmarks were not available for 2,4,5-TP, n-nitrosodiphenylamine, or 2,4-dinitrotoluene. Therefore, the potential hazard associated with these COPECs were not included in the respective HIs calculated using the Army TRVs or BTAG TRVs. Secondly, there is considerable variation in the magnitude of the Army TRV and BTAG TRVs for certain COPECs. For example, the mammalian BTAG low TRV for lead is approximately three orders of magnitude lower (i.e., more potent) than the Army TRV for lead. Consequently, the HQ estimates for lead also vary by approximately three orders of magnitude depending upon whether BTAG low TRVs or Army TRVs were used. This fact contributes to considerable uncertainty in the hazard estimates for lead. This issue has been the subject of several meetings between the Army and DTSC. In response to this issue, the United States Army Center for Health Promotion and Preventive Medicine (USACHPPM) has recently submitted a request for review of the BTAG TRV low for lead.

7.7.5 Risk Characterization

The sources of uncertainty previously described are incorporated in the risk estimate. Because the majority of these uncertainties err on the conservative side, the risk estimate is considered to be protective. Nevertheless, there is a degree of uncertainty in the quantitative hazard estimates presented in this ERA, based on the uncertainties previously described.

8.0 CONCLUSIONS AND RECOMMENDATIONS

The following section summarizes the supplemental RI findings and the results of the human health and ecological risk assessments. Sites are recommended for further evaluation in cases where human health risks or ecological hazards exceed generally accepted risk criterion. Recommendations for future actions at Subsite FTIR-07/d are provided in the following discussion.

8.1 CONCLUSIONS

Three test pits were excavated to investigate two geophysical anomalies identified in the Parsons ES RI at Subsite FTIR-07/d. Various amounts of metal debris including rusted metal ammunition cases, iron-stained soil, steel 40-mm anti-aircraft casings, and warheads were discovered in test pit 7d-1-Ts-1 in the center of Anomaly 1. Soil samples collected in this test pit contained detections of SVOCs, nitrosamines, and dioxin/furans below the PRGs. Cadmium, copper, lead, and zinc were detected above background levels in the 5-foot bgs sample. Concentrations of metals decreased with depth and only zinc was detected above background in the 15-foot bgs sample.

Another test pit, 7d-1-Tp-1, was excavated on the edge of Anomaly 1. No debris was identified in this test pit, and the soil appeared to be native material. Soil samples collected from this test pit had a single detection of the herbicide 2,4,5-TP (Silvex) below the PRG. Copper and zinc were detected above background levels in the 2.5-foot bgs sample. However, arsenic and nitrate/nitrite were detected at concentrations only slightly above background in the 10-foot sample.

One test pit, 7d-2-Ts-1, was excavated in the center of Anomaly 2. A minor amount of metallic debris was located on the surface of the test pit, and bedrock was encountered at 10 feet bgs. Soil samples collected from the test pit contained detections of explosives below the PRGs. Copper

and zinc were detected at concentrations above background levels in the 0.5-foot sample. All other metal concentrations were below background levels.

8.2 RECOMMENDATIONS

The screening HHRA results indicated cumulative screening cancer risks and noncancer hazards of 2.5×10^{-5} and 1.0, respectively, in subsurface soils. The screening cancer risk estimate exceeded the screening risk criterion of 1.0×10^{-6}. The results of the screening HHRA for Subsite FTIR-07/d indicated that subsurface soils might pose a human health risk based on the unrestricted land use scenario. The screening HHRA evaluated risks to hypothetical future human receptors based on protective assumptions relative to land use (i.e. residential), complete exposure pathways, and maximum concentrations of COPC's. As such, the results of the screening HHRA represent a conservative (i.e. protective) evaluation of potential pubic health impacts.

The baseline HHRA is a qualitative evaluation of risks to human health based on more realistic assumptions relative to land use and average exposure point concentrations. Estimated baseline cancer and noncancer hazards for current/future military personnel and hypothetical future industrial workers were less than generally accepted cancer risks and noncancer hazard criteria of 1.0×10^{-5} and 1.0, respectively, for industrial type land uses. Sites for which the estimated cumulative cancer risk is between 1.0×10^{-6} and 1.0×10^{-4}, and the cumulative HI is less than 1.0 may be considered appropriate for no further action (NFA), depending upon site specific considerations including current and potential future land uses (USEPA, 1991)

Ecological hazards for Subsite FTIR-07/d were calculated using two sets of TRVs, the Army TRVs and the BTAG TRVs. Results of the ERA for Subsite FTIR-07/d indicate that:

- Based on Army TRVs, no impacts to the Mojave ground squirrel or golden eagle are anticipated from exposures to surface and subsurface soils associated with the site;

- Based on BTAG TRVs, minimal impacts to the mojave ground squirrel, and no impacts to the golden eagle, are anticipated from exposures to surface and subsurface soils associated with the site;
- Ecological HQs in excess of 1.0 using BTAG TRVs were primarily attributable to zinc in surface soils and copper, lead, and zinc in subsurface soils [Note, however, that when soil-plant trophic transfer factors derived from Sites FTIR-38 and –40 were used in the calculation, only lead was associated with an HQ in excess of 1.0 (i.e., lead HQ = 1.7)];
- Given the highly protective nature of the BTAG low TRV for lead (refer to Section 7.7.4), the fact that the maximum lead concentration was approximately two times the BUTL for Fort Irwin soils, and that the HQ for lead is based on an upper bound estimate of risk, actual hazards to the mojave ground squirrel are anticipated to be minimal to insignificant

The results of the human health and ecological risk assessment suggest that Subsite FTIR-07/d is appropriate for NFA in regard to both human health risk considerations and ecological concerns

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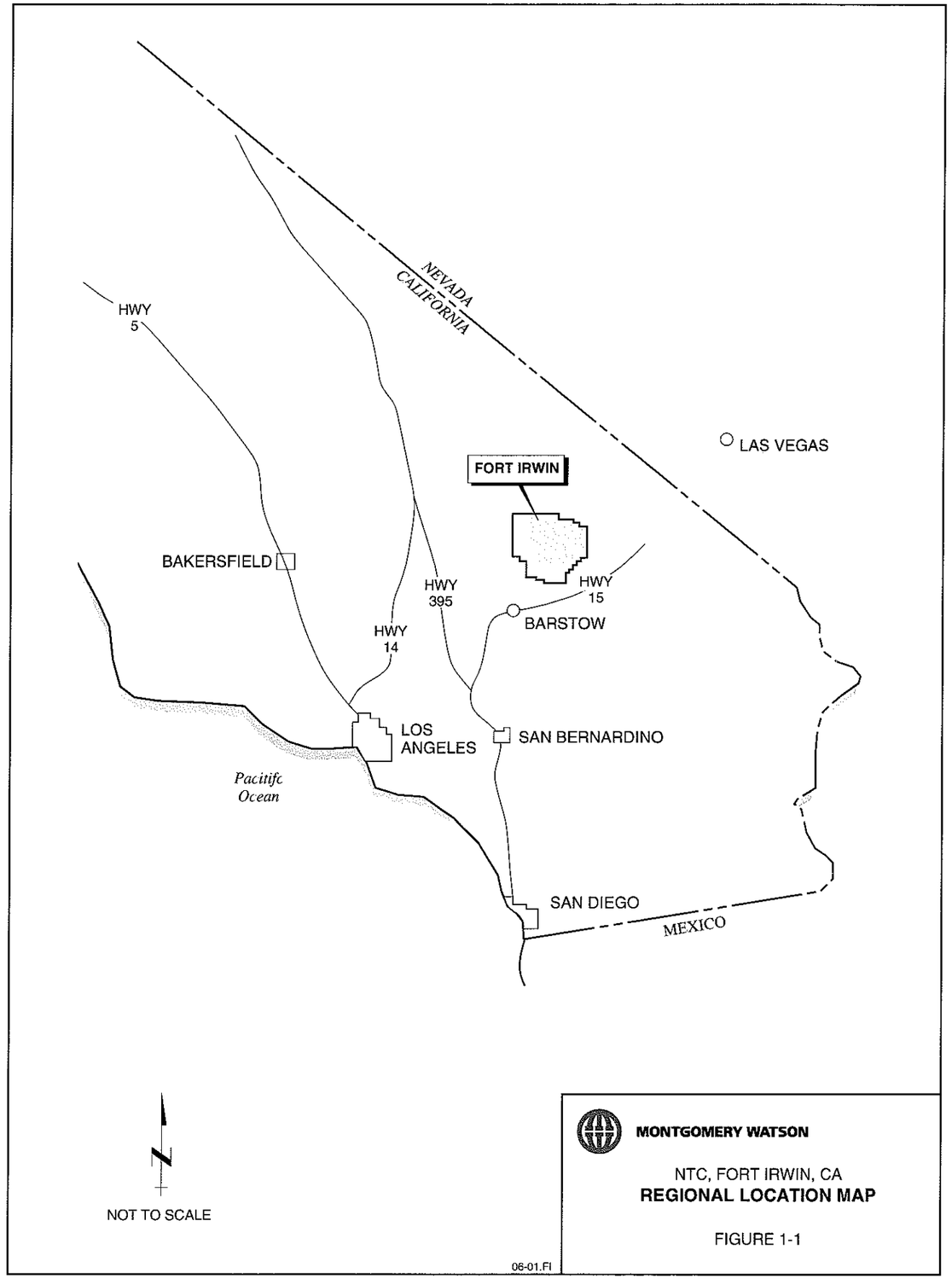
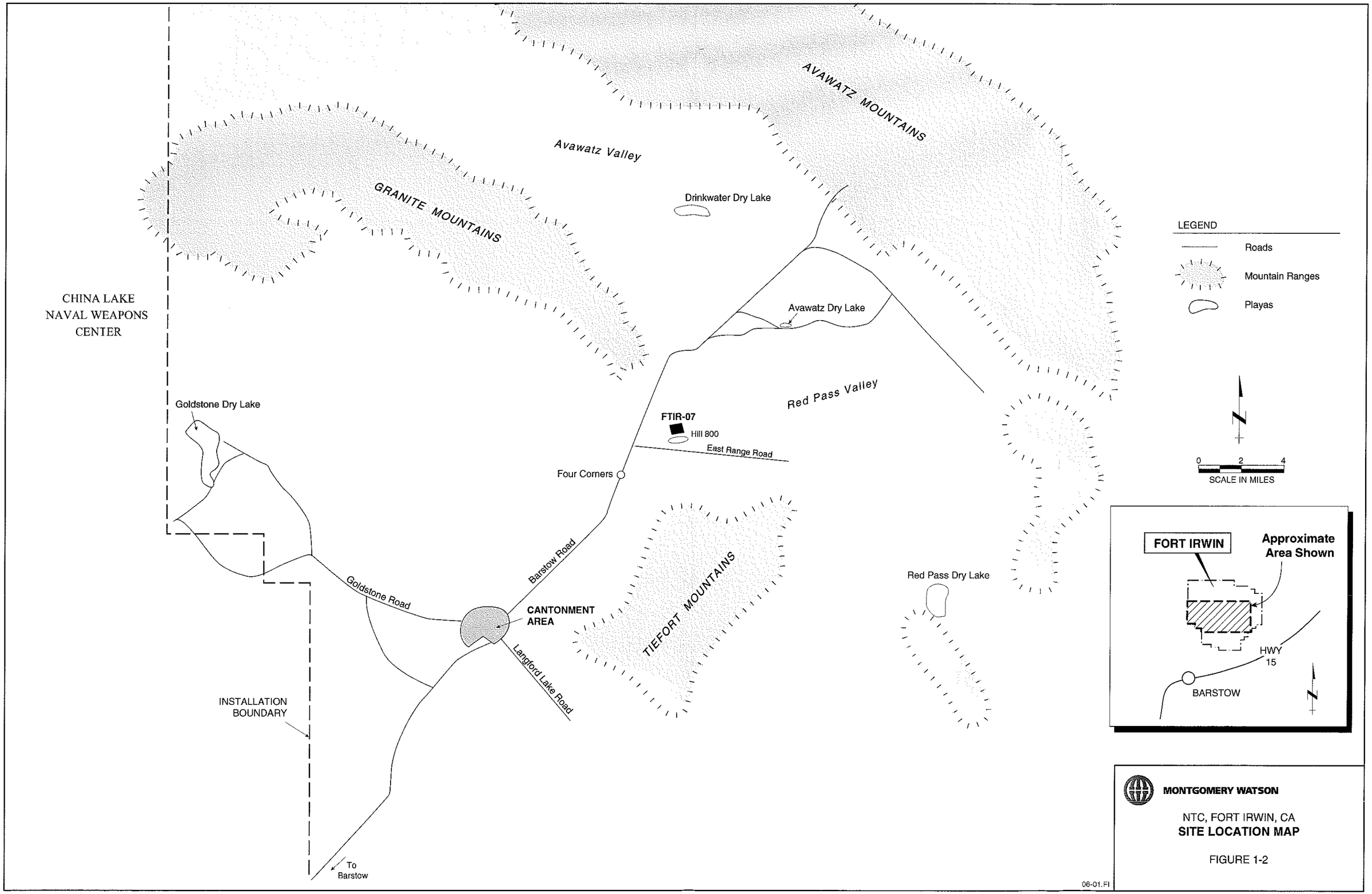
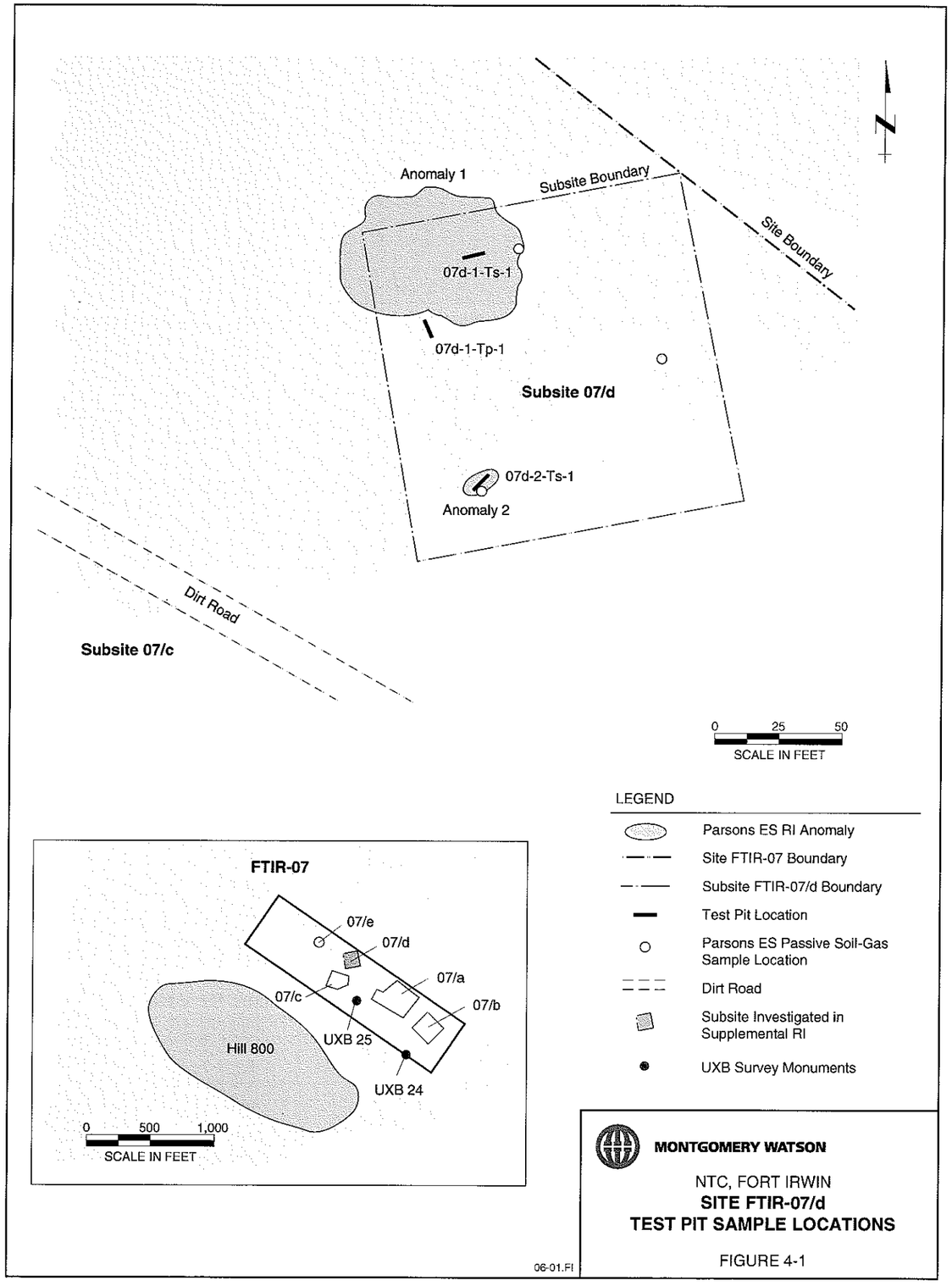

NEVADA
CALIFORNIA
HWY
5
LAS VEGAS
FORT IRWIN
BAKERSFIELD
HWY
395
HWY
15
BARSTOW
HWY
14
LOS
ANGELES
SAN BERNARDINO
Pacitifc
Ocean
SAN DIEGO
MEXICO
NOT TO SCALE
MONTGOMERY WATSON
NTC, FORT IRWIN, CA
REGIONAL LOCATION MAP
FIGURE 1-1
06-01.FI


AVAWATZ MOUNTAINS
Avawatz Valley
GRANITE MOUNTAINS
Drinkwater Dry Lake
CHINA LAKE
NAVAL WEAPONS
CENTER
Avawatz Dry Lake
Red Pass Valley
Goldstone Dry Lake
FTIR-07
Hill 800
East Range Road
Four Corners
Barstow Road
Goldstone Road
CANTONMENT
AREA
TIEFORT MOUNTAINS
Langford Lake Road
Red Pass Dry Lake
INSTALLATION
BOUNDARY
To
Barstow
LEGEND
Roads
Mountain Ranges
Playas
N
0
2
4
SCALE IN MILES
FORT IRWIN
Approximate
Area Shown
HWY
15
BARSTOW
N
06-01.FI
MONTGOMERY WATSON
NTC, FORT IRWIN, CA
SITE LOCATION MAP
FIGURE 1-2



MONTGOMERY WATSON

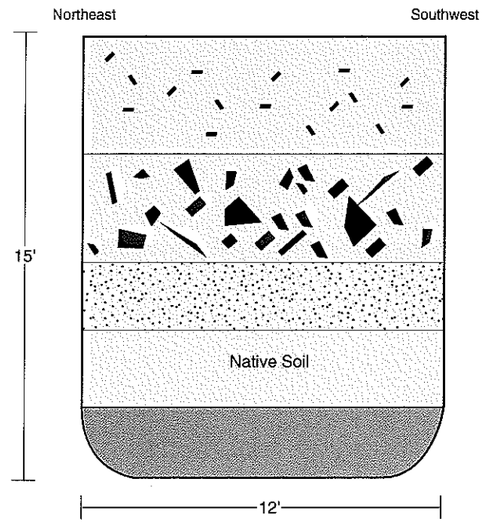
NTC, FORT IRWIN

SITE FTIR-07/d

TEST PIT SAMPLE LOCATIONS

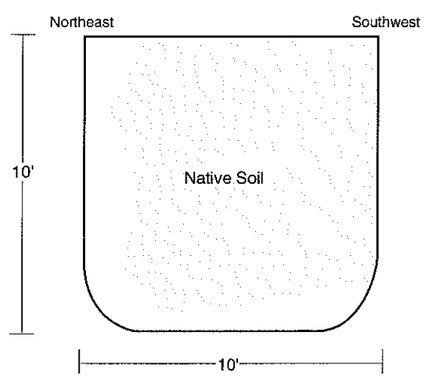
FIGURE 4-1

7d-1-Ts-1



0-4'	Traces of metallic debris. Rusted metal ammunition cases. Steel 40mm antiaircraft casings and warheads. Soil had iron oxide staining-heavy in areas. Sample 7d-1-Ts-1-0 5' collected at 0 5 ft bgs. Sample 7d-1-Ts-1-2 5' collected at 2.5 ft bgs.
5'	Sample collected: 7d-1-Ts-1-5'
8'-10'	Debris appears to end Disturbed sand Sample 7d-1-Ts-1-10 'collected at 10 ft. bgs
15'	Partially cemented sands. Sample collected: 7d-1-Ts-1-15'

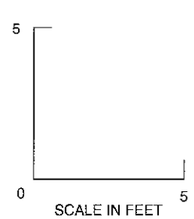
7d-1-Tp-1



0 5'	Sample 7d-1-Tp-1-0 5' collected at 0 5 ft bgs.
2.5'	Sample 7d-1-Tp-1-2.5' collected at 2.5 ft. bgs
5'	Sample 7d-1-Tp-1-5' collected at 5 ft bgs
10'	Sample 7d-1-Tp-1-10' collected at 10 ft. bgs

LEGEND

- Native Material
- Traces of Metallic Debris
- Metallic Debris
- Disturbed Sand
- Cemented Sand



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MONTGOMERY WATSON

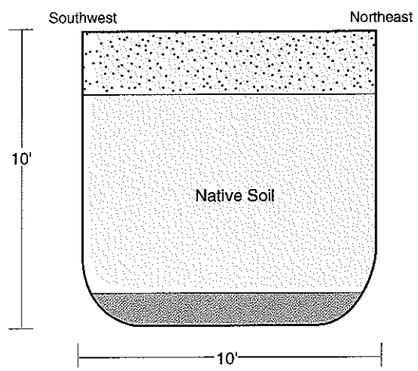
NTC, FORT IRWIN

TEST PITS

7d-1-Ts-1 AND 7d-1-Tp-1

FIGURE 4-2

7d-2-Ts-1



0-2.5' Sample 7d-2-Ts-1-0.5' collected at 0 5 ft bgs.
Disturbed sand to 2'.
Sample 7d-2-Ts-1-2 5' collected at 2 5 ft bgs

5' Sample collected: 7d-2-Ts-1-5'

10' Sample collected: 7d-2-Ts-1-10'. Cemented sands and gravels at 9' Refusal

LEGEND

- Native Material
- Disturbed Sand
- Cemented Sand

5
0 5
SCALE IN FEET

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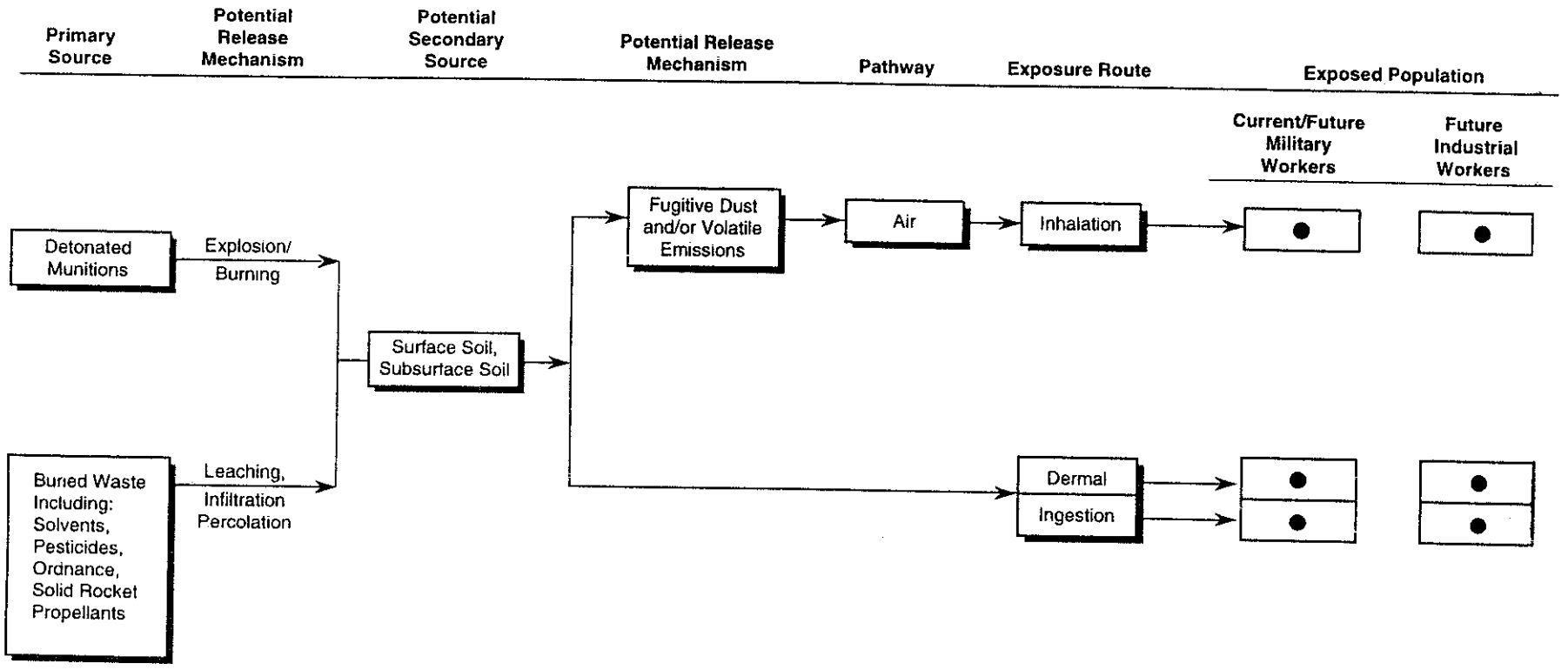
MONTGOMERY WATSON

NTC, FORT IRWIN
TEST PIT
7d-2-Ts-1

FIGURE 4-3



● Pathway Complete

MONTGOMERY WATSON

NTC, FORT IRWIN, CA

GENERALIZED CONCEPTUAL SITE MODEL FOR HUMAN RECEPTORS

FIGURE 6-1

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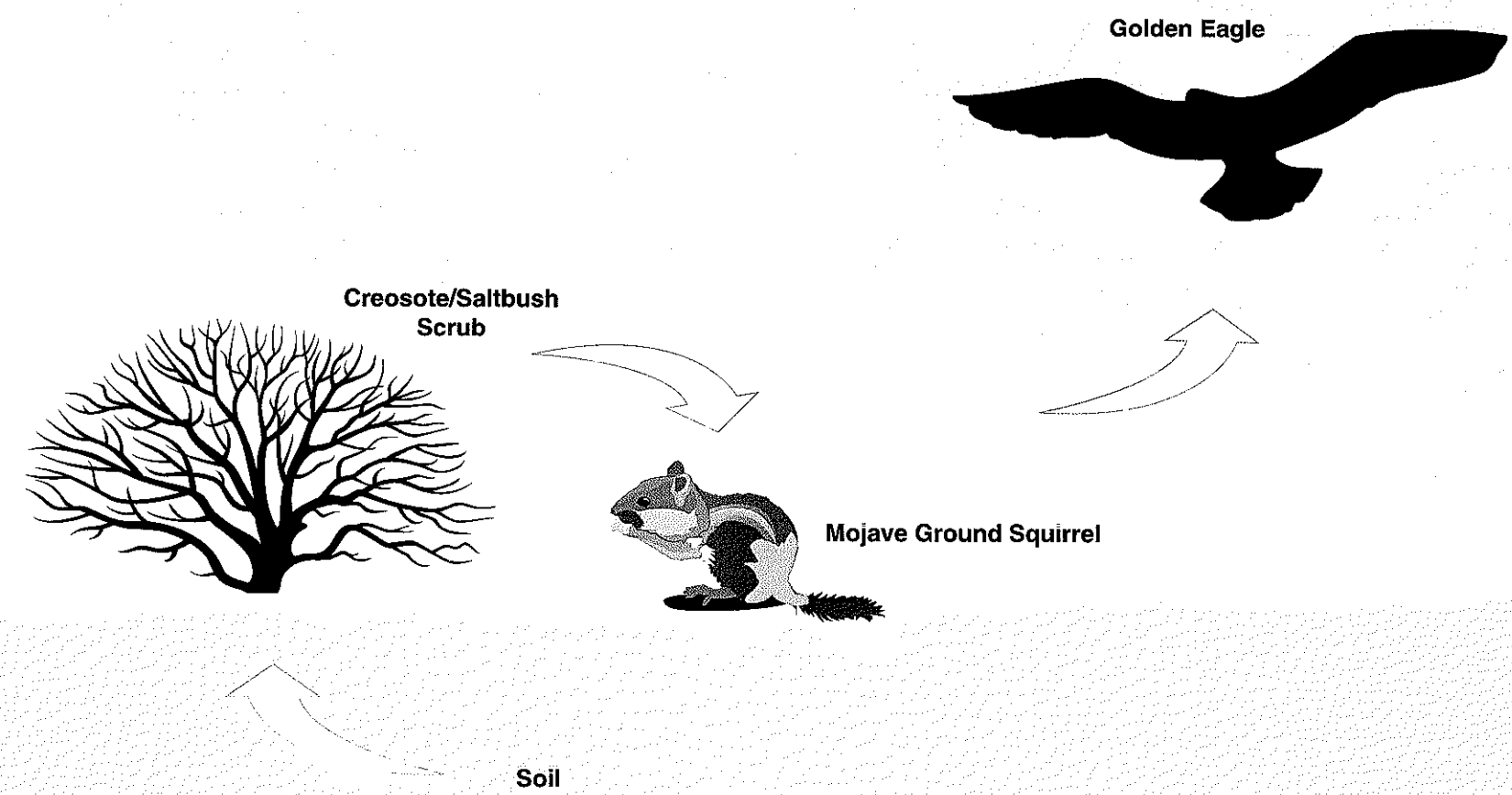

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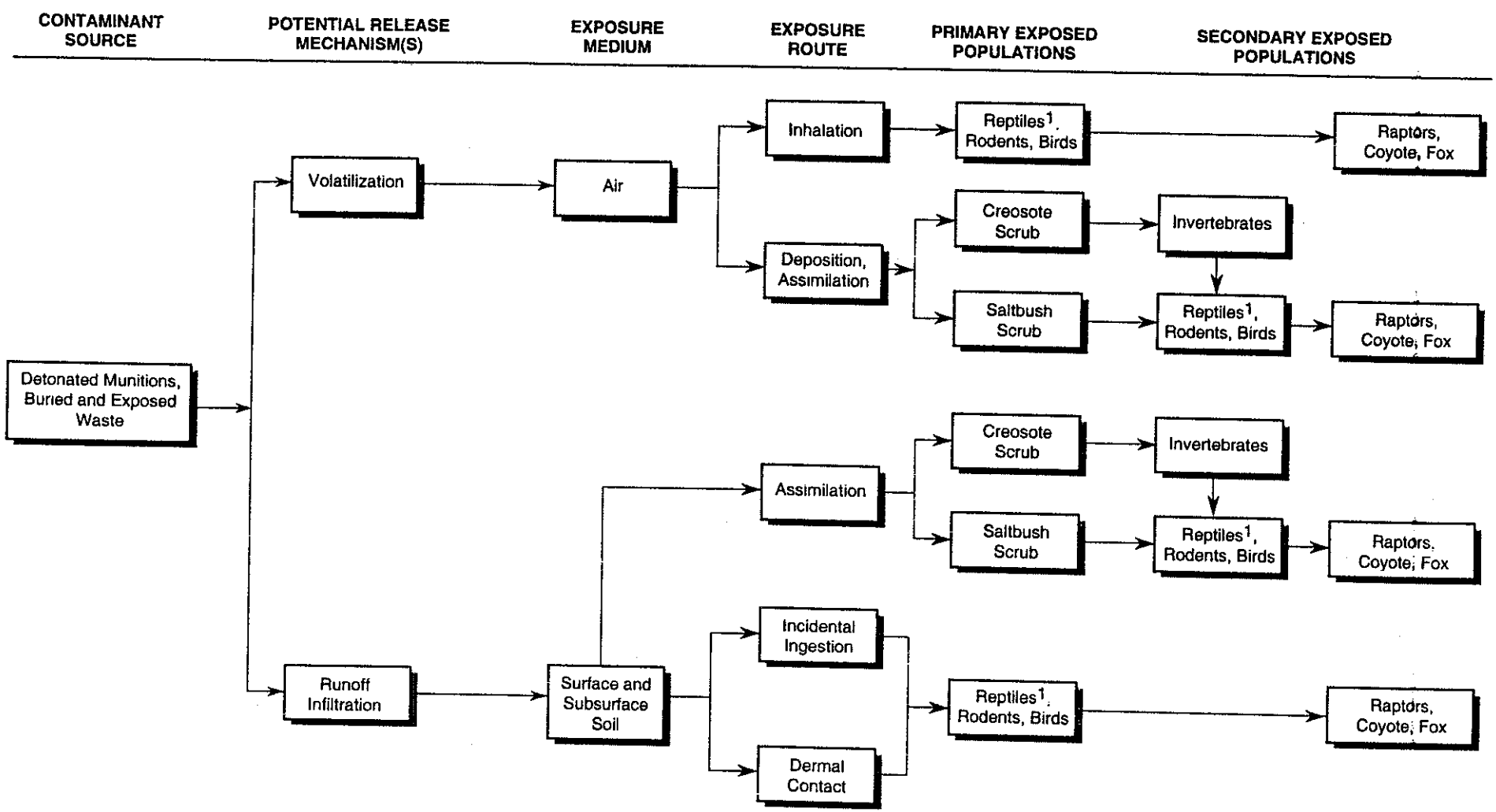
MONTGOMERY WATSON

NTC, FORT IRWIN

SIMPLIFIED EXPOSURE MODEL

FIGURE 7-2



[1] For Example, Desert Tortoise

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NTC, FORT IRWIN, CA

ECOLOGICAL CONCEPTUAL SITE MODEL

FIGURE 7-1

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TABLE 2-1

SUMMARY OF SAMPLES COLLECTED AND ANALYSES PERFORMED
SUPPLEMENTAL REMEDIAL INVESTIGATIONS SUBSITE FTIR-07/d
FORT IRWIN, CALIFORNIA

							Requested Analyses																
Field Sample ID	Depth	Quanterra Lab ID	APCL ID for Nitrosamines	DCL ID for OCBA	Date Sampled	Time Samp'd	Metals	CrVI	SVOCs	OCP/PCBs	Herbs	TRPH	pH	Ammonia	NO2/NO3	OCBA	Nitrosamines	RDX Scrn	TNT Scrn	Explosives	D/F	VOCs	Comment
7d-1-Ts-1	0.5	300141-0022	*98-03679-2*	*98E03558*	6/27/98	1220	X	X	X	X	X	X	X	X	X	X	X	X	X				
7d-1-Ts-1	2.5	300141-0023	*98-03679-5*	*98E03559*	6/27/98	1230	X		X	X	X	X	X	X	X	X	X	X	X				
7d-1-Ts-1	5	300141-0024	*98-03679-1*	*98E03560*	6/27/98	1245	X	X	X	X	X	X	X	X	X	X	X	X	X		x		D/F selected 7/24/98
7d-1-Ts-1	10	300141-0025	*98-03679-3*	*98E03561*	6/27/98	1305	X		X	X	X	X	X	X	X	X	X	X	X				
7d-1-Ts-1	15	300141-0026	*98-03679-4*	*98E03562*	6/27/98	1330	X		X	X	X	X	X	X	X	X	X	X	X	x			Explo based on scrn
7d-1-Td-1	*2.5*	*300141-0014*	*98-03679-6*	*98E03550*	*6/27/98*	*1010*	*X*		*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*				*Dup of 7d-1-Ts-1 @ 2.5*
7d-2-Ts-1	0.5	300141-0031	98-03679-14	98E03567	6/27/98	1115	X	X	X	X	X	X	X	X	X	X	X	X	X				
7d-2-Ts-1	2.5	300141-0032	98-03679-16	98E03570	6/27/98	1120	X		X	X	X	X	X	X	X	X	X	X	X	x			Explo based on scrn
7d-2-Ts-1	5	300141-0033	98-03679-13	98E3571	6/27/98	1130	X	X	X	X	X	X	X	X	X	X	X	X	X				
7d-2-Ts-1	10	300141-0034	98-03679-15	98E03572	6/27/98	1145	X		X	X	X	X	X	X	X	X	X	X	X				
7d-2-Td-1	*0.5*	*300141-0016*	*98-03679-12*	*98E03552*	*6/27/98*	*1000*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*				*Dup of 7d-2-Ts-1 @ 0.5*
7d-1-Tp-1	0.5	300141-0027	98-03679-9	98E03563	6/27/98	1350	X		X	X	X	X	X	X	X	X	X	X	X	x			Explo based on scrn
7d-1-Tp-1	2.5	300141-0028	98-03679-11	98E03564	6/27/98	1400	X		X	X	X	X	X	X	X	X	X	X	X				
7d-1-Tp-1	5	300141-0029	98-03679-8	98E03565	6/27/98	1415	X		X	X	X	X	X	X	X	X	X	X	X				
7d-1-Tp-1	10	300141-0030	98-03679-10	98E03566	6/27/98	1420	X		X	X	X	X	X	X	X	X	X	X	X				
7d-1-Tdd	*2.5*	*300141-0015*	*98-03679-7*	*98E03551*	*6/27/98*	*1500*	*X*		*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*				*Dup of 7d-1-Tp-1 @ 2.5*

Italics indicate duplicate and Quality Assurance split samples
x - Small x's indicate analyses selected after sample collection
ID - Identification
Dup - Duplicate
Explo - Explosives
APCL - Applied P & Ch Laboratory
DCL - DataChem Laboratories
OCBA -o-chlorobenzaldehyde
Samp'd - Sampled
CrVI - Hexavalent Chromium
SVOCs - Semivolatile Organic Compounds
OCP/PCBs - Organochlorine Pesticides/Polychlorinated Biphenyls
Herbs - Herbicides
TRPH - Total Recoverable Petroleum Hydrocarbons
NO2/NO3 - Nitrite/Nitrate
Scrn - Screening
D/F - Dioxins/Furans
VOCs - Volatile Organic Compounds

TABLE 4-1

FORT IRWIN
BACKGROUND SOIL CONCENTRATIONS
FORT IRWIN, CALIFORNIA

Parameter	Calculated Background UTL[a]	Guidance Levels[c]
SVOC (µg/kg)		
2,4-Dinitrotoluene	NA	1,800,000
Nitrobenzene	NA	110,000
Herbicides (µg/kg)		
2,4,5-TP (Silvex)	NA	8,600,000
Nitrosamines (µg/kg)		
N-Nitrosodiphenylamine	NA	500,000
Explosives (mg/kg)		
HMX	NA	44,000
RDX	NA	22
Metals (soil mg/kg)		
Aluminum	23,600	100,000
Antimony	6.34	820
Arsenic	9.14	440
Barium	175	100,000
Beryllium	1.17	2,200
Cadmium	0.416	810
Calcium	23,891[b]	NA
Chromium	27.7	64
Cobalt	12.9	100,000
Copper	28.7	76,000
Iron	23,739[b]	100,000
Lead	7.33	750
Magnesium	10,663[b]	NA
Manganese	361	32,000
Mercury	0.202	610
Molybdenum	4.58	10,000
Nickel	29.1	41,000
Nitrate/Nitrite	6.32	NA
Potassium	7,382[b]	NA
Selenium	NA	10,000
Silver	NA	10,000
Sodium	2,372[b]	NA
Thallium	1.91	130
Vanadium	97	14,000
Zinc	51	100,000

Notes:
[a] Parsons ES 1997
[b] Montgomery Watson. Remedial Investigation/Feasibility Study Report Fort Irwin Abandoned Landfill January 1996
[c] USEPA Region IX Preliminary Remediation Goals for Industrial Soil (2000)

mg/kg - milligrams per kilogram
µg/kg - micrograms per kilogram
SVOC= semi-volatile organic compound
UTL = upper tolerance limit with a 95-percent confidence

TABLE 4-2

TEST PIT 7d-1-TS-1 SOIL SAMPLE RESULTS
SUPPLEMENTAL REMEDIAL INVESTIGATION SUBSITE FTIR-07/d
FORT IRWIN, CALIFORNIA

Parameter	7d-1-Ts-1-0.5' 6/27/98		7d-1-Ts-1-2.5' 6/27/98		7d-1-Ts-1-5' 6/27/98		7d-1-Ts-1-10' 6/27/98		7d-1-Ts-1-15' 6/27/98	
	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Volatile Organic Compounds (µg/kg)	NA		NA		NA		NA		NA	
Semivolatile Organic Compounds (µg/kg)										
2,4 Dinitrotoluene	< 340		< 340		45,000		< 340		< 340	
Di-n-butyl phthalate	< 340		< 340		35,000		< 340		< 340	
Nitrobenzene	< 340		< 340		< 3,400		< 340		< 340	
Herbicides (µg/kg)										
2,4,5-TP (Silvex)	< 5.2	R	< 5.2	R	< 5.2	R	< 5.1	R	< 5.1	R
Pesticides (µg/kg)	ND		ND		ND		ND		ND	
Nitrosamines (µg/kg)										
N-Nitrosodiphenylamine	< 100		< 100		< 100		< 100		< 100	
Explosives (mg/kg)										
2,4 Dinitrotoluene	NA		NA		NA		NA		0.027	J
HMX	NA		NA		NA		NA		< 0.25	
Nitrobenzene	NA		NA		NA		NA		0.25	B
RDX	NA		NA		NA		NA		< 0.25	
Dioxins/Furans (pg/g)										
1,2,3,4,4,7,8-HpCDD	NA		NA		3.0	J	NA		NA	
OCDD	NA		NA		20		NA		NA	
o-Chlorobenzaldehyde (µg/kg)	ND		ND		ND		ND		ND	
Metals (mg/kg)										
Aluminum	7,240		6,300		6,340		4,840		4,480	
Antimony	< 6.2		< 6.3		< 6.2		< 6.1		< 6.1	
Arsenic	4.6	J	3.8	J	9.8	J	3.5	J	6.8	J
Barium	57.4		65.8		85.0		37.3		38.3	
Beryllium	0.27		0.22		0.24		0.23		0.22	
Cadmium	< 0.52		< 0.52		0.56		< 0.51		< 0.51	
Calcium	5,070		5,040		3,350		6,230		5,380	
Chromium	5.9		5.1		7.3		4.1		3.5	
Cobalt	3.5		3.2		4.2		2.4		1.7	
Copper	11.3		11.8		33.0		6.0		6.0	
Iron	8,250		7,080		14,600		6,250		6,080	
Lead	3.6	J	3.5	J	18.9		4.3	J	2.6	J
Magnesium	2,890		2,630		2,750		1,900		1,800	
Manganese	183		152		227		168		119	
Molybdenum	< 2.1		< 2.1		0.53	J	< 2.0		< 2.0	
Nickel	4.8		3.8	J	8.0		3.5	J	3.3	J
Potassium	1,910		1,610		1,660		1,360		1,150	
Selenium	< 20.7		< 20.9		< 20.6		< 20.5		< 20.5	
Silver	< 1.0		< 1.0		< 1.0		< 1.0		< 1.0	
Sodium	141	J	246	J	201	J	355	J	310	J
Thallium	< 7.4		< 7.5		< 7.4		< 7.4		< 7.4	
Vanadium	13.2		11.8		15.0		10.2		9.6	
Zinc	25.6		24.3		824		44.6		70.1	
General Chemistry (mg/kg)										
Ammonia	< 0.52		0.052	J	0.44	J	< 0.51		< 0.51	
Moisture	3.0		4.5		3.0		3.5		2.3	
Percent Water	3.2		4.2		3.0		2.4		2.3	
pH	8.5		9.0		7.9		9.1		9.1	
Nitrate + Nitrite as N	0.72		4.1		5.0		7.4		3.8	
Total Petroleum Hydrocarbons (mg/kg)	ND		ND		ND		ND		ND	

"<" results are below laboratory Practical Quantitation Limits (PQL)
µg/kg - micrograms per kilogram
B - Analyte was detected in the blank sample
J - Estimated value
mg/kg - milligrams per kilogram
NA - Analyte Not Analyzed
ND - Analyte Not Detected
pg/kg - picograms per kilogram
R - Data not valid
UJ - Compound was analyzed but not detected The sample detection limit is an estimated value

TABLE 4-3

TEST PIT 7d-1-Tp-1 SOIL SAMPLE RESULTS
SUPPLEMENTAL REMEDIAL INVESTIGATION SUBSITE FTIR-07/d
FORT IRWIN, CALIFORNIA

Parameter	7d-1-Tp-1-0.5' 6/27/98		7d-1-Tp-1-2.5' 6/27/98		7d-1-Tp-1-5' 6/27/98		7d-1-Tp-1-10' 6/27/98	
	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Volatile Organic Compounds (µg/kg)	NA		NA		NA		NA	
Semivolatile Organic Compounds (µg/kg)								
2,4 Dinitrotoluene	< 330		< 350		< 330		< 340	
Di-n-butyl phthalate	< 330		< 350		< 330		< 340	
Nitrobenzene	< 330		< 350		< 330	UJ	< 340	UJ
Herbicides (µg/kg)								
2,4 5-TP (Silvex)	< 5.0	R	1.2	J	< 5.1		< 5.2	
Pesticides (µg/kg)	ND		ND		ND		ND	
Nitrosamines (µg/kg)								
N-Nitrosodiphenylamine	< 100		< 110		< 100		< 100	
Explosives (mg/kg)								
2,4-Dinitrotoluene	< 0.25		NA		NA		NA	
HMX	< 0.25		NA		NA		NA	
Nitrobenzene	0.25	B	NA		NA		NA	
RDX	< 0.25		NA		NA		NA	
Dioxins/Furans (pg/g)								
1,2,3,4,4,7,8-HpCDD	NA		NA		NA		NA	
OCDD	NA		NA		NA		NA	
o-Chlorobenzaldehyde (µg/kg)	ND		ND		ND		ND	
Metals (mg/kg)								
Aluminum	4,240		6,550		1,380		2,870	
Antimony	< 6.0		< 6.4		< 6.1		< 6.2	
Arsenic	< 10.1		5.6	J	7.2	J	9.8	J
Barium	50.6		51.0		44.5		31.3	
Beryllium	0.16	J	0.29		0.043	J	0.15	J
Cadmium	< 0.50		< 0.54		< 0.51		< 0.52	
Calcium	2,130		13,400		5,350		2,210	
Chromium	3.6		5.0		1.1		2.2	
Cobalt	2.2		2.6		< 1.0		1.4	
Copper	48.4		9.5		8.8		4.3	
Iron	5,970		6,910		1,770		3,300	
Lead	6.9		4.2	J	< 5.1		< 5.2	
Magnesium	2,010		3,520		762		1,220	
Manganese	149		163		60.4		127	
Molybdenum	< 2.0		< 2.1		< 2.0		< 2.1	
Nickel	2.7	J	5.1		< 4.1		1.9	J
Potassium	1,530		1,610		405	J	716	
Selenium	< 20.2		< 21.4		< 20.3		< 20.7	
Silver	< 1.0		< 1.1		< 1.0		< 1.0	
Sodium	57.4	J	307	J	154	J	286	J
Thallium	< 7.3		< 7.7		< 7.3		< 7.4	
Vanadium	9.1		12.4		3.4		6.9	
Zinc	170		22.5		11.8		13.9	
General Chemistry (mg/kg)								
Ammonia	< 0.50		0.15	J	< 0.51		< 0.52	
Moisture	0.8		7.7		1.8		4.2	
Percent Water	0.75		6.7		1.4		3.2	
pH	8.6		9.1		9.3		8.7	
Nitrate + Nitrite as N	0.50		1.3		6.0		10.3	
Total Petroleum Hydrocarbons (mg/kg)	ND		ND		ND		ND	

"<" results are below laboratory Practical Quantitation Limits (PQL)
µg/kg - micrograms per kilogram
B - Analyte was detected in the blank sample
J - Estimated value
mg/kg - milligrams per kilogram
NA - Analyte Not Analyzed
ND - Analyte Not Detected
pg/kg - picograms per kilogram
R - Data not valid
UJ - Compound was analyzed but not detected The sample detection limit is an estimated value

TABLE 4-4

TEST PIT 7d-2-Ts-1 SOIL SAMPLE RESULTS
SUPPLEMENTAL REMEDIAL INVESTIGATION SUBSITE FTIR-07/d
FORT IRWIN, CALIFORNIA

Parameter	7d-2-Ts-1-0.5' 6/27/98 Result	Qualifier	7d-2-Ts-1-2.5' 6/27/98 Result	Qualifier	7d-2-Ts-1-5' 6/27/98 Result	Qualifier	7d-2-Ts-1-10' 6/27/98 Result	Qualifier
Volatile Organic Compounds (µg/kg)	NA		NA		NA		NA	
Semivolatile Organic Compounds (µg/kg)								
2.4 Dinitrotoluene	< 350		< 340		< 350		< 340	
Di-n-butyl phthalate	< 350		< 340		< 350		< 340	
Nitrobenzene	< 350		< 340	UJ	< 350	UJ	< 340	UJ
Herbicides (µg/kg)								
2,4,5-TP (Silvex)	< 5.4	UJ	< 5.1		< 5.3	R	< 5.1	
Pesticides (µg/kg)	ND		ND		ND		ND	
Nitrosamines (µg/kg)								
N-Nitrosodiphenylamine	< 110		< 100		< 110		< 100	
Explosives (mg/kg)								
2,4-Dinitrotoluene	NA		< 0.25		NA		< 0.25	
HMX	NA		< 0.25		NA		0.15	J
Nitrobenzene	NA		0.19	UJ	NA		0.16	UJ
RDX	NA		< 0.25		NA		0.026	J
Dioxins/Furans (pg/g)								
1,2,3,4,4,7,8-HpCDD	NA		NA		NA		NA	
OCDD	NA		NA		NA		NA	
o-Chlorobenzaldehyde (µg/kg)	ND		ND		ND		ND	
Metals (mg/kg)								
Aluminum	4,030		2,380		3,250		1,880	
Antimony	< 6.4		< 6.1		< 6.3		< 6.1	
Arsenic	< 10.7		5.4	J	< 10.6		< 10.2	
Barium	45.0		38.2		48.0		24.9	
Beryllium	0.20	J	0.091	J	0.15	J	0.12	J
Cadmium	< 0.54		< 0.51		< 0.53		< 0.51	
Calcium	1,750		4,540		12,400		878	
Chromium	3.6		2.2		2.7		1.7	
Cobalt	1.9		1.7		1.4		1.2	
Copper	88.6		6.9		5.0		4.0	
Iron	5,930		3,460		4,100		3,340	
Lead	5.2	J	< 5.1		< 5.3		< 5.1	
Magnesium	1,890		1,190		2,140		812	
Manganese	149		108		92.7		115	
Molybdenum	1.0	J	< 2.0		< 2.1		< 2.0	
Nickel	3.5	J	2.4	J	2.8	J	< 4.1	
Potassium	1,350		767		942		606	
Selenium	< 21.5		< 20.4		< 21.1		< 20.3	
Silver	< 1.1		< 1.0		< 1.1		< 1	
Sodium	53.1	J	40.4	J	62.3	J	85.6	J
Thallium	< 7.7		< 7.3		< 7.6		< 7.3	
Vanadium	9.0		5.9		7.0		6.9	
Zinc	115		14.5		14.5		10.7	
General Chemistry (mg/kg)								
Ammonia	< 0.54		< 0.51		< 0.53		< 0.51	
Moisture	10.4		1.8		5.3		2.3	
Percent Water	6.9		1.8		5.3		1.5	
pH	8.8		8.8		8.7		8.8	
Nitrate + Nitrite as N	0.18	J	< 0.25		0.51		5.6	
Total Petroleum Hydrocarbons (mg/kg)	ND		ND		ND		ND	

"<" results are below laboratory Practical Quantitation Limits (PQL)
µg/kg - micrograms per kilogram
B - Analyte was detected in the blank sample
J - Estimated value
mg/kg - milligrams per kilogram
NA - Analyte Not Analyzed
ND - Analyte Not Detected
pg/kg - picograms per kilogram
R - Data not valid
UJ - Compound was analyzed but not detected The sample detection limit is an estimated value

TABLE 6-1

BACKGROUND SUMMARY STATISTICS FOR SOILS[a]
FORT IRWIN, CALIFORNIA

Constituent	n	%nd	Range of SQLs for Non-detects[b]	Min (mg/kg)	Max (mg/kg)	Mean (mg/kg)	Median (mg/kg)	s	CV	BUTL (mg/kg)
Aluminum	119	0	NA - NA	2,920	29,900	9,790	8,420	4,980	0.509	23,600
Antimony	55	0	NA - NA	1.54	6.46	2.74	2.11	1.26	0.46	6.34
Arsenic	119	0	NA - NA	0.642	26.3	2.94	2.18	2.9	0.986	9.14
Barium	119	0	NA - NA	13.9	252	65.3	58.5	34	0.521	175
Beryllium	119	0	NA - NA	0.171	1.88	0.482	0.43	0.249	0.517	1.17
Cadmium	119	16.8	0.408 - 0.443	0.0417	0.668	0.184	0.193	0.109	0.594	0.416
Chromium	119	0	NA - NA	1.61	63.3	9.94	6.65	8.62	0.867	27.7
Cobalt	119	0	NA - NA	0.814	13.9	4.88	4.14	2.79	0.572	12.9
Copper	119	0	NA - NA	1.77	34.8	10.4	7.54	6.83	0.66	28.7
Hexavalent Chromium	59	96.6	0.218 - 1	0.109	0.62	0.398	0.392	0.0613	0.154	0.512
Lead	119	0	NA - NA	0.988	9.49	3.83	3.72	1.41	0.369	7.33
Manganese	118	0	NA - NA	80.3	402	203	200	66.2	0.326	361
Mercury	119	95.8	0.169 - 0.445	0.0587	0.39	0.129	0.0915	0.0511	0.397	0.202
Molybdenum	15	0	NA - NA	1.15	3.5	1.87	1.66	1.777	0.416	4.58
Nickel	119	0	NA - NA	1.34	35.9	8.24	7.1	5.94	0.721	29.1
Nitrate/Nitrite-Nitrogen	119	6.7	0.228 - 0.458	0.114	10.8	1.27	0.843	1.56	1.23	632
Selenium	1	0	NA - NA	0.553	0.553	0.553	0.553	NA	NA	NA
Silver	1	0	NA - NA	0.186	0.186	0.186	0.186	NA	NA	NA
Thallium	83	49.4	3.47 - 3.83	2.05	2.05	1.42	1.74	0.417	0.294	1.91
Vanadium	119	0	NA - NA	166	166	25.6	18.9	22	0.856	97
Zinc	119	0	NA - NA	79.2	79.2	29.2	26.4	11.3	0.385	51

Notes:

[a] One-half the reporting limit was used to calculate the summary statistics.

[b] Range of SQLs represent non-detects that were included in the data set; data with SQLs greater than 2 times the maximum site concentration are not included in the data set.

%nd - percentage of samples reported as non-detects.

BUTL - Background upper tolerance limit.

CV - Coefficient of variation.

Max - Maximum detected value.

mg/kg - Milligrams per kilogram.

Min - Minimum detected value.

n - Number of samples.

NA - Not applicable because there are 0 non-detects for these analytes.

s - Standard deviation.

SQL - Sample quantitation limit.

TABLE 6-2

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR SURFACE SOILS[a]
SUBSITE FTIR-07/d
FORT IRWIN, CALIFORNIA

Consituent	Soil Concentration (mg/kg) Maximum[b]		Minimum[c]		Mean[d]	Number of Samples[e]	Detections[f]	Detection Frequency	BUTL[g] (mg/kg)	COPC[h]
Inorganics										
Aluminum	7240		4030		5820	3	3	100%	23,600	No
Arsenic	4.6	J	4.6	J	5.0	3	1	33%	9.14	No
Barium	58.4		45.0		55.5	3	3	100%	175	No
Beryllium	0.27		0.16	J	0.22	3	3	100%	1.17	No
Calcium	5070		1750		3000	3	3	100%	na	No[j]
Chromium	5.9		3.6		4.7	3	3	100%	27.7	No
Cobalt	3.5		1.9		2.7	3	3	100%	12.9	No
Copper	88.6		8.1		49.4	3	3	100%	28.7	Yes
Iron	8250		5930		7490	3	3	100%	na	No[j]
Lead	6.9		2.6[i]	U	5.2	3	2	67%	7.33	No
Magnesium	2890		1890		2480	3	3	100%	na	No[j]
Manganese	183		149		171	3	3	100%	361	No
Nickel	4.8		2.7	J	4.0	3	3	100%	29.1	No
Potassium	1910		1350		1710	3	3	100%	na	No[j]
Sodium	141	J	53.1	J	88.5	3	3	100%	na	No[j]
Vanadium	13.2		9.0		11.8	3	3	100%	97	No
Zinc	170		24.6		103	3	3	100%	51	Yes

Notes:

[a] Surface soil depth equal to 0 - 0.5 ft bgs.

[b] Maximum detected concentration of original or duplicate soil samples (0 - 0.5 ft bgs).

[c] Minimum concentration of original or duplicate soil samples (0 - 0.5 feet).

[d] The arithmetic mean soil concetration for soil samples collected in the interval 0 - 0.5 ft bgs.

[e] Total number of soil samples collected in the 0 - 0.5 ft bgs (excludes duplicate samples).

[f] Total number of detections in soil samples collected in the interval 0 - 0.5 ft bgs (excludes duplicate samples).

[g] Background upper tolerance limit for Fort Irwin soils. Source: Parsons Engineering Science, Inc., 1996.

[h] Constituent is considered a chemical of potential concern (COPC) if maximum concentration exceeds BUTL.

[i] Minimum concentration is a non-detect value and is assumed to be one-half the detection limit.

[j] Analyte eliminated as a COPC based on its role as an essential dietary nutrient (refer to Section 6.2.4).

BUTL - Background upper tolerance limit.

COPC - Chemical of potential concern.

J - Estimated value.

mg/kg - Milligrams per kilogram.

na - Not applicable.

TABLE 6-3

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR SUBSURFACE SOILS[a]
SUBSITE FTIR-07/d
FORT IRWIN, CALIFORNIA

(Page 1 of 2)

Consituent	Soil Concentration (mg/kg) Maximum[b]		Minimum[c]		Mean[d]	Number of Samples[e]	Detections	Detection Frequency	BUTL (mg/kg)	COPC
Inorganics										
Aluminum	7750		1380		4110	9	9	100%	23,600	No
Arsenic	9.8	J	3.5	J	6.5	9	7	78%	9.14	Yes
Barium	203		24.9		64.2	9	9	100%	175	Yes
Beryllium	0.410		0.043	J	0.195	9	9	100%	1.17	No
Cadmium	0.56		0.255[f]	U	0.30	9	1	11%	0.416	Yes
Calcium	27700		878		9020	9	9	100%	na	No[j]
Chromium	7.3		1.1		3.7	9	9	100%	27.7	No
Cobalt	4.2		0.5[f]	U	2.1	9	8	89%	12.9	No
Copper	236		4.0		35.6	9	9	100%	28.7	Yes
Iron	14600		1770		5760	9	9	100%	na	No[j]
Lead	18.9		2.6[f]	U	5.1	9	4	44%	7.33	Yes
Magnesium	5370		762		2210	9	9	100%	na	No[j]
Manganese	227		60.4		135	9	9	100%	361	No
Molybdenum	0.68	J	0.5[f]	U	0.97	9	1	11%	4.58	No
Nickel	8.0		1.9	J	3.8	9	7	78%	29.1	No
Potassium	2100		405	J	1140	9	9	100%	na	No[j]
Sodium	449	J	40.4	J	216	9	9	100%	na	No[j]
Vanadium	15.0		3.4		9.1	9	9	100%	97	No
Zinc	824		10.7		129	9	9	100%	51	Yes
SVOC										
Di-n-butyl phthalate	35		0.17[f]	U	4.04	9	1	11%	na	Yes
Dioxins and Furans										
1,2,3,4,6,7,8-HpCDD	0.000003	J	0.000003	J	0.000003	1	1	100%		
OCDD	0.000020		0.000020		0.000020	1	1	100%		

TABLE 6-3

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR SUBSURFACE SOILS[a]
SUBSITE FTIR-07/d
FORT IRWIN, CALIFORNIA

Consituent	Soil Concentration (mg/kg) Maximum[b]		Minimum[c]		Mean[d]	Number of Samples[e]	Detections	Detection Frequency	BUTL (mg/kg)	COPC
TEQ (2,3,7,8-TCDD)	0.00000005								na	Yes
Herbicides										
2,4,5-TP (Silvex)	0.0012	J	0.0012	J	0.0024	5	1	20%	na	Yes
Nitrosamines										
N-Nitrosodiphenylamine	4.4		0.050[i]	U	0.36	9	1	11%	na	Yes
Explosives										
HMX	0.150	J	0.125[i]	U	0.138	2	1	50%	na	Yes
RDX	0.026	J	0.026	J	0.076	2	1	50%	na	Yes
2,4-Dinitrotoluene	45		0.125[i]	U	4.2	9	1	11%	na	Yes

Notes:

[a] Subsurface soil depth equal to >0.5 - 10 ft bgs.
[b] Maximum detected concentration of original or duplicate soil samples (>0.5 - 10 ft bgs).
[c] Minimum concentration of original or duplicate soil samples (>0.5 - 10 feet).
[d] The arithmetic mean soil concetration for soil samples collected in the interval >0.5 - 10 ft bgs.
[e] Total number of soil samples collected in the >0.5 - 10 ft bgs (excludes duplicate samples).
[f] Total number of detections in soil samples collected in the interval >0.5 - 10 ft bgs (excludes duplicate samples).
[g] Background upper tolerance limit for Fort Irwin Soils. Source: Parsons Engineering Science, Inc., 1996.
[h] Constituent is considered a chemical of potential concern (COPC) if maximum concentration exceeds BUTL.
[i] Minimum concentration is a non-detect value and is assumed to be one-half the detection limit.
[j] Analyte eliminated as a COPC based on its role as an essential dietary nutrient (refer to Section 6.2.4).

COPC - Chemical of potential concern.
HMX - Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetracine.
HpCDD - Heptachlorodibenzo-p-dioxin.
J - Estimated value.
mg/kg - Milligrams per kilogram.
na - Not applicable.
OCDD - Octachlorodibenzo-p-dioxin.
SVOC - Semivolatile organic compounds.
2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin.
2,4,5-TP - 2,4,5-Trichloro(phenoxyacetic)propionic acid.

TABLE 6-4

SUMMARY OF CHEMICALS OF POTENTIAL CONCERN[a]
SUBSITE FTIR-07/d
FORT IRWIN, CALIFORNIA

Surface Soils[b]	Subsurface Soils[c]
Inorganics	**Inorganics**
Copper	Arsenic
Zinc	Barium
	Cadmium
	Copper
	Lead
	Zinc
	SVOCs
	Di-n-butyl phthalate
	Dioxins and Furans
	1,2,3,4,6,7,8-HpCDD
	OCDD
	Herbicides
	2,4,5-TP (Silvex)
	Nitrosoamines
	N-Nitrosodiphenylamine
	Explosives
	2,4-Dinitrotoluene
	HMX
	RDX

Notes:
[a] Refer to Tables 6-2 and 6-3 for COPC selection.
[b] Surface soil depth equal to 0 - 0 5 ft bgs.
[c] Subsurface soil depth equal to >0 5 - 10 ft bgs
COPC - Chemical of potential concern
HMX - Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetracine
SVOC - Semivolatile organic compounds
2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin
2,4,5-TP - 2,4,5-Trichloro(phenoxyacetic)propionic acid

TABLE 6-5

PRELIMINARY REMEDIATION GOALS (PRGs) FOR RISK SCREENING
SUBSITE FTIR-07/d
FORT IRWIN, CALIFORNIA

COPC	PRG (mg/kg) [a]	
	Cancer	Noncancer
Inorganics		
Arsenic	3.9E-01	2.2E+01
Barium	na	5.4E+03
Cadmium	9.0E+00	3.7E+01
Copper	na	2.9E+03
Lead [b]	na	na
Zinc	na	2.3E+04
SVOC		
Di-n-butyl phthlate	na	6.1E+03
Dioxins/Furans		
2,3,7,8-TCDD	3.9E-06	na
Herbicides		
2,4,5-TP	na	4.9E+02
Nitrosamines		
N-Nitrosodiphenylamine	9.9E+01	na
Explosives		
2,4-Dinitrotoluene	na	1.2E+02
HMX	na	3.1E+03
RDX	4.4E+00	1.8E+02

Notes:
[a] Source: Region 9 PRG Table Update 2000 (USEPA, 2000)
[b] Lead is evaluated using the California Lead Risk Assessment Spreadsheet (Bloodpb07.xls).
COPC - Chemical of potential concern.
HMX - Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetracine.
mg/kg - Milligrams per kilogram.
na - Not available
PRG - Preliminary remediation goal
SVOC - Semi-volatile organic compounds.
2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin.
2,4,5-TP - 2,4,5-Trichloro(phenoxyacetic)propionic acid

TABLE 6-6

SCREENING NONCANCER HAZARD FOR A FUTURE RESIDENT EXPOSED TO SURFACE SOILS [a]
SUBSITE FTIR-07/d
FORT IRWIN, CALIFORNIA

Constituent	Maximum Soil Concentration [b] (mg/kg)	Residential Soil PRG [c] (mg/kg)	Screening Noncancer Hazard [d]
Inorganics			
Copper	88.6	2,900	0.031
Zinc	170	23,000	0.007
		Hazard Index:	0.038

Notes:
[a] Surface soil depth equal to 0 - 0.5 ft bgs.
[b] Maximum detected concentration of original or duplicate soil samples (0 - 0.5 ft bgs).
[c] Source: Region 9 PRG Table 2000 Update (USEPA, 2000).
[d] Noncancer hazard is a unitless value corresponding to the likelihood of a noncarcinogenic effect.

mg/kg - Milligrams per kilogram.
PRG - Preliminary remediation goal.

TABLE 6-7

SCREENING CANCER RISK FOR A FUTURE RESIDENT EXPOSED TO SUBSURFACE SOILS [a]
SUBSITE FTIR-07/d
FORT IRWIN, CALIFORNIA

Constituent	Maximum Soil Concentration [b] (mg/kg)		Residential Soil PRG [c] (mg/kg)	Screening Cancer Risk [d]
Inorganics				
Arsenic	9.8	J	3.9E-01	2.5E-05
Cadmium	0.56		9.0E+00	6.2E-08
Dioxins and Furans				
TEQ (2,3,7,8-TCDD)	5.0E-08	J	3.9E-06	1.3E-08
Nitrosoamines				
N-Nitrosodiphenylamine	4.4		9.9E+01	4.4E-08
Explosives				
RDX	0.026	J	4.4E+00	5.9E-09
			Cumulative Risk:	2.5E-05

Notes:
[a] Subsurface soil depth equal to >0.5 - 10 ft bgs.
[b] Maximum detected concentration of original or duplicate soil samples (>0.5 - 10 ft bgs).
[c] Source: Region 9 PRG Table 2000 Update (USEPA, 2000).
[d] Cancer risk is a unitless value corresponding to the likelihood of a carcinogenic effect.

J - Estimated value.
mg/kg - Milligrams per kilogram.
PRG - Preliminary remediation goal.
TEQ (2,3,7,8-TCDD) - Total equivalents concentration based on 2,3,7,8-tetrachlorodibenzo-p-dioxin.

TABLE 6-8

SCREENING NONCANCER HAZARD FOR A FUTURE RESIDENT EXPOSED TO SUBSURFACE SOILS [a]
SUBSITE FTIR-07/d
FORT IRWIN, CALIFORNIA

Constituent	Maximum Soil Concentration [b] (mg/kg)		Residential Soil PRG [c] (mg/kg)	Screening Noncancer Hazard [d]
Inorganics				
Arsenic	9.8	J	22	0.45
Barium	203		5,400	0.038
Cadmium	0.56		37	0.015
Copper	236		2,900	0.081
Zinc	824		23,000	0.036
SVOC				
Di-n-butyl phthalate	35		6,100	0.0057
Herbicides				
2,4,5-TP (Silvex)	0.0012	J	490	0.0000024
Explosives				
2,4-Dinitrotoluene	45.0		120	0.38
HMX	0.150	J	3,100	0.000048
RDX	0.026	J	180	0.00014
			Hazard Index:	1.0

Notes:
[a] Subsurface soil depth equal to >0.5 - 10 ft bgs.
[b] Maximum detected concentration of original or duplicate soil samples (>0.5 - 10 ft bgs).
[c] Source: Region 9 PRG Table 2000 Update (USEPA, 2000).
[d] Noncancer hazard is a unitless value corresponding to the likelihood of a noncarcinogenic effect.

HMX - Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetracine.
J - Estimated value.
mg/kg - Milligrams per kilogram.
PRG - Preliminary remediation goal.
SVOC - Semi-volatile organic compounds.
2,4,5-TP - 2,4,5-Trichloro(phenoxyacetic)propionic acid.

TABLE 6-9

EXPOSURE POINT CONCENTRATION DETERMINATION FOR SUBSURFACE SOILS
SUBSITE FTIR-07/d
FORT IRWIN, CALIFORNIA

Constituent	Maximum Concentration (mg/kg		Minimum Concentration [a] (mg/kg)		95 % UCL Concentration [b] (mg/kg)	Exposure Point Concentration [c]
Inorganics						
Arsenic	9.8	J	3.5	J	8.3	8.3
Barium	203		24.9		110	110
Cadmium	0.56		0.255	(nd)	0.35	0.35
Copper	236		4.0		182	182
Lead	18.9		2.6	(nd)	9.0	9.0
Zinc	824		10.7		1200	824
SVOC						
Di-n-butyl phthalate	35.0	(nd)	0.33	(nd)	35.4	35.0
Dioxins/Furans						
1,2,3,4,6,7,8-HpCDD	0.000003		0.000003			
OCDD	0.000020		0.000020			
TEQ (2,3,7,8-TCDD)	5.00E-08		5.00E-08		nc	5.00E-08
Herbicides						
2,4,5-TP (Silvex)	0.0012	J	0.0012	J	5.6	0.0012
Nitrosamines						
N-Nitrosodiphenylamine	4.4		0.050	(nd)	2730	4.4

TABLE 6-9

EXPOSURE POINT CONCENTRATION DETERMINATION FOR SUBSURFACE SOILS
SUBSITE FTIR-07/d
FORT IRWIN, CALIFORNIA

Constituent	Maximum Concentration (mg/kg		Minimum Concentration [a] (mg/kg)		95 % UCL Concentration [b] (mg/kg)	Exposure Point Concentration [c]
Explosives						
2,4-Dinitrotoluene	45	(nd)	0.25	(nd)	1.41E+09	45
HMX	0.150	J	0.125	(nd)	nc	0.150
RDX	0.026	J	0.026	J	nc	0.026

Notes:
[a] For samples which were non-detect (nd), one-half the detection limit was assumed.
[b] The 95 percent upper confidence limit (95 % UCL) was calculated based on a log-normal distribution.
[c] The exposure point concentration (EPC) is equal to the 95 % UCL. However, when the 95 % UCL exceeded the maximum concentration detected, or the 95 % UCL could not be calculated, the maximum concentration was assumed as the EPC

HMX - Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetracine.
HpCDD - Heptachlorodibenzo-p-dioxin.
J - Estimated value.
mg/kg - Milligram per kilogram.
nc - Not calculated.
OCDD - Octachlorodibenzo-p-dioxin.
SVOC - Semi-volatile organic compounds.
2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin.
2,4,5-TP - 2,4,5-Trichloro(phenoxyacetic)propionic acid.

TABLE 6-10

EXPOSURE PARAMETERS AND ASSUMPTIONS FOR MILITARY PERSONNEL
ENGAGED IN FIELD TRAINING EXERCISES
SUBSITE FTIR-07/d
FORT IRWIN, CALIFORNIA

Exposure Parameter	Units	Exposure Assumptions: Normal Activity [a]	Exposure Assumptions: Moderate-High Activity [b]	Source
Air Concentration - C_a	ug/m^3	Chemical-specific	Chemical-specific	Not applicable
Soil Concentration - C_s	mg/kg	Chemical-specific	Chemical-specific	Not applicable
Body Weight - BW	kg	70	70	USEPA, 1995a
Soil Ingestion Rate - IR	mg/day	75 [c]	720 [d]	Parsons, 1995
Inhalation Rate - InhR	m^3/hr	0 83	2 5	USEPA, 1995a
Exposure Time - ET	hr/day	12 [e]	12 [e]	Parsons, 1995
Exposure Frequency - EF	day/yr	154 [f]	154 [f]	Parsons, 1995
Exposure Duration - ED	yr	4 [g]	4 [g]	Parsons, 1995
Dermal Surface Area - SA	cm^2/event	4,300 [h]	4,300 [h]	Parsons 1995
Skin Adherence Factor - AF	mg/cm^2	1	1	Parsons, 1995
Particulate Emission Factor - PEF	m^3/kg	1 6E+07 [i]	3 3E+06 [j]	Parsons, 1995
Averaging Time - AT	days			
Carcinogens		25,550	25,550	USEPA, 1989a
Noncarcinogens		1460 [k]	1460 [k]	Parsons, 1995

Sources:
Exposure Factors Handbook (USEPA, 1995a)
Project Workplan for the Site Inspection and Remedial Investigation of 31 Sites at the National Training Center Fort Irwin, California (Parsons ES, 1995)

Notes:
[a] Assumptions are based on a military worker engaged in light work or at rest
[b] Assumptions are based on a military worker engaged in moderate to heavy work while conducting military maneuvers
[c] Assumes an incidental soil ingestion rate of 6 25 mg/hr (50 mg/day / 8 hr) over a period of 12 hours
[d] Assumes an incidental soil ingestion rate of 60 mg/hr (480 mg/day / 8 hr) over a period of 12 hours
[e] Assumes a military worker is engaged in light work or at rest for 12 hours, and performing moderate to heavy work for 12 hours
[f] Assumes a military worker is engaged in field activities for 14 days per month for 11 months
[g] Assumes a military worker is stationed at Fort Irwin for a maximum of 4 years
[h] Assumes exposure of the head, arms and hands consistent with military attire
[i] Assumes the highest annual average respirable particulate concentration (61 ug/m^3) reported over the last 4 years for the Mojave Desert Air Quality Management District (in Victorville California)
[i] Assumes a respirable particulate concentration of 305 ug/m^3 for heavy vehicular traffic
[k] Assumption is based on a total exposure duratioin of 4 years (4 years x 365 days/yr = 1,460 days)

TABLE 6-11

EXPOSURE PARAMETERS AND ASSUMPTIONS FOR INDUSTRIAL WORKERS
SUBSITE FTIR-07/d
FORT IRWIN, CALIFORNIA

Exposure Parameter	Units	Exposure Assumptions	Source
Soil Concentration - C_s	mg/kg	Chemical-specific	Not applicable
Body Weight - BW	kg	70	USEPA, 1995a
Soil Ingestion Rate - IR	mg/day	50	USEPA, 1995a
Inhalation Rate - InhR	m^3/hr	2.5	USEPA, 1995a
Exposure Time - ET	hr/day	8	USEPA, 1995a
Exposure Frequency - EF	day/yr	250	USEPA, 1995a
Exposure Duration - ED	yr	25	USEPA, 1995a
Dermal Surface Area - SA	cm^2/event	5,700	USEPA, 1998b
Skin Adherence Factor - AF	mg/cm^2	0.08	USEPA, 1998b
Particulate Emission Factor - PEF	m^3/kg	1.32E+09	USEPA, 1998a
Averaging Time - AT	days		
Carcinogens		25,550	USEPA, 1989a
Noncarcinogens		9,125	USEPA, 1989a

Sources:
Risk Assessment Guidance for Superfund, Volume I: HHEM - Part A (USEPA, 1989a)
Exposure Factors Handbook (USEPA, 1995a).
Region IX Preliminary Remediation Goals (PRGs) 1998 (USEPA, 1998a)
Risk Assessment Guidance for Superfund, Volume I: HHEM - Supplemental Guidance Dermal Risk Assessment (USEPA 1998b)

Notes:
cm^2/event - Square centimeters per event
day/yr - Days per year
hr/day - Hours per day
kg - Kilograms
m^3/hr - Cubic meters per hour
m^3/kg - Cubic meters per kilogram
mg/cm^2 - Milligrams per square centimeter
mg/day - Milligrams per day
mg/kg - Milligrams per kilogram

TABLE 6-12

TOXICITY VALUES USED IN THE BASELINE HUMAN HEALTH RISK ASSESSMENT
SUBSITE FTIR-07/d
FORT IRWIN, CALIFORNIA

	Cancer Slope Factor - CSF $(mg/kg\text{-}d)^{-1}$				Reference Dose - RfD (mg/kg-d)			
Constituent	Oral		Inhalation		Oral		Inhalation	
Inorganics								
Arsenic	1.5E+00	I	1.5E+01	I	3.0E-04	I	3.0E-04	R
Barium	na		na		7.0E-02	I	1.4E-04	H
Cadmium	na		6.3E+00	I	5.0E-04	I	5.7E-05	X
Copper	na		na		3.7E-02	H	3.7E-02	R
Lead	na		na		na		na	
Zinc	na		na		3.0E-01	I	3.0E-01	R
SVOC								
Di-n-butylphthalate	na		na		1.0E-01	I	1.0E-01	R
Dioxins/Furans								
2,3,7,8-TCDD	1.5E+05	H	1.5E+05	H	na		na	
Herbicides								
2,4,5-TP	na		na		8.0E-03	I	8.0E-03	R
Nitrosamines								
N-Nitrosodiphenylamine	4.9E-03	I	4.9E-03	R	na		na	
Explosives								
2,4-Dinitrotoluene	na		na		2.0E-03	I	2.0E-03	R
HMX	na		na		5.0E-02	I	5.0E-02	R
RDX	1.0E-01	I	1.0E-01	R	3.0E-03	I	3.0E-03	R

Notes:
CSF - Cancer slope factor
HMX - Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetracine
mg/kg-d - Milligram per kilogram per day
na - Not available.
RfD - Reference dose
SVOC - Semivolatile organic compounds
2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin
2,4,5-TP - 2,4,5-Trichloro(phenoxyacetic)propionic acid

I IRIS Database (USEPA, 1998)
H HEAST (USEPA, 1995c)
N National Center for Environmental Assessment
R Route extrapolation
X Withdrawn

TABLE 6-13

CANCER RISK CALCULATIONS FOR CURRENT/FUTURE MILITARY PERSONNEL
SUBSITE FTIR-07/d - SUBSURFACE SOILS
FORT IRWIN, CALIFORNIA

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Cancer Slope Factor (mg/kg-d)$^{-1}$ Oral	Dermal	Inhalation	Pathway-Specific Cancer Risk Ingestion	Dermal	VOC Inhalation	Dust Inhalation	Chemical-Specific Risk
Inorganics													
Arsenic	8.3	2.27E-06	1.2E-07	Inc	2.8E-08	1.5E+00	1.5E+00	1.5E+01	3.4E-06	1.8E-07	Inc	4.2E-07	4.0E-06
Cadmium	0.35	9.58E-08	5.2E-09	Inc	1.2E-09	na	na	6.3E+00	0.0E+00	0.0E+00	Inc	7.4E-09	7.4E-09
Dioxins/Furans													
TEQ (2,3,7,8-TCDD)	5.00E-08	1.37E-14	7.4E-15	Inc	1.7E-16	1.5E+05	1.5E+05	1.5E+05	2.1E-09	1.1E-09	Inc	2.5E-11	3.2E-09
Nitrosamines													
N-Nitrosodiphenylamine	4.4	1.20E-06	6.5E-07	Inc	1.5E-08	4.9E-03	4.9E-03	4.9E-03	5.9E-09	3.2E-09	Inc	7.2E-11	9.2E-09
Explosives													
RDX	0.026	7.12E-09	3.9E-09	Inc	8.7E-11	1.1E-01	1.1E-01	1.1E-01	7.8E-10	4.2E-10	Inc	9.6E-12	1.2E-09
												ILCR:	**4.0E-06**

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and cancer risks shown only for carcinogenic chemicals with available toxicity values.

2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium

3) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor.

ILCR Incremental lifetime cancer risk.
Inc Incomplete pathway.
mg/kg Milligrams per kilogram.
mg/kg-d Milligrams per kilogram per day.
na Not available.
TEQ (2,3,7,8-TCDD) Toxicity equivalents quotient based on 2,3,7,8-tetrachlorodibenzo-p-dioxin.

TABLE 6-14

NONCANCER HAZARD CALCULATIONS FOR CURRENT/FUTURE MILITARY PERSONNEL
SUBSITE FTIR-07/d - SUBSURFACE SOILS
FORT IRWIN, CALIFORNIA

Constituent	Soil Concentration* (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Reference Dose (mg/kg-d)			Pathway-Specific Noncancer HI				Chemical-Specific HI
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Arsenic	8.3	3.98E-05	2.2E-06	Inc	4.9E-07	3.0E-04	3.0E-04	3.0E-04	1.3E-01	7.2E-03	Inc	1.6E-03	0.14
Barium	110	5.27E-04	2.9E-05	Inc	6.4E-06	7.0E-02	7.0E-02	1.4E-04	7.5E-03	4.1E-04	Inc	4.6E-02	0.054
Cadmium	0.35	1.68E-06	9.1E-08	Inc	2.0E-08	5.0E-04	5.0E-04	5.7E-05	3.4E-03	1.8E-04	Inc	3.6E-04	0.0039
Copper	182	8.72E-04	4.7E-05	Inc	1.1E-05	3.7E-02	3.7E-02	3.7E-02	2.4E-02	1.3E-03	Inc	2.9E-04	0.025
Zinc	824	3.95E-03	2.1E-04	Inc	4.8E-05	3.00E-01	3.00E-01	3.00E-01	1.3E-02	7.1E-04	Inc	1.6E-04	0.014
SVOC													
Di-n-butyl phthalate	35	1.68E-04	9.1E-05	Inc	2.0E-06	1.0E-01	1.0E-01	1.0E-01	1.7E-03	9.1E-04	Inc	2.0E-05	0.0026
Herbicides													
2,4,5-TP	0.0012	5.75E-09	3.1E-09	Inc	7.0E-11	8.0E-03	8.0E-03	8.0E-03	7.2E-07	3.9E-07	Inc	8.8E-09	0.0000011
Explosives													
2,4-Dinitrotoluene	45	2.16E-04	1.2E-04	Inc	2.6E-06	2.0E-03	2.0E-03	2.0E-03	1.1E-01	5.8E-02	Inc	1.3E-03	0.17
HMX	0.15	7.19E-07	3.9E-07	Inc	8.8E-09	5.0E-02	5.0E-02	5.0E-02	1.4E-05	7.8E-06	Inc	1.8E-07	0.000022
RDX	0.026	1.25E-07	6.7E-08	Inc	1.5E-09	3.0E-03	3.0E-03	3.0E-03	4.2E-05	2.2E-05	Inc	5.1E-07	0.000064
												Total HI:	0.41

Notes:

* Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.
2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium
3) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HI = Exposure Dose/Reference dose.

HI	Hazard index.
HMX	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetracine.
inc	Incomplete pathway.
mg/kg	Milligrams per kilogram.
mg/kg-d	Milligrams per kilogram per day.
2,4,5-TP	2,4,5-Trichloro(phenoxyacetic)propionic acid.
SVOC	Semivolatile organic compounds.

TABLE 6-15

CANCER RISK CALCULATIONS FOR A FUTURE INDUSTRIAL WORKER
SUBSITE FTIR-07/d - SUBSURFACE SOILS
FORT IRWIN, CALIFORNIA

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Cancer Slope Factor (mg/kg-d)$^{-1}$			Pathway-Specific Cancer Risk				Chemical-Specific Risk
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Arsenic	8.3	1.45E-06	1.3E-07	inc	4.4E-10	1.5E+00	1.5E+00	1.5E+01	2.2E-06	2.0E-07	Inc	6.6E-09	2.4E-06
Cadmium	0.35	6.12E-08	5.6E-09	inc	1.9E-11	na	na	6.3E+00	0.0E+00	0.0E+00	inc	1.2E-10	1.2E-10
Dioxins/Furans													
2,3,7,8-TEQ	5.00E-08	8.74E-15	8.0E-15	inc	2.7E-18	1.5E+05	1.5E+05	1.5E+05	1.3E-09	1.2E-09	inc	4.0E-13	2.5E-09
Nitrosamines													
N-Nitrosodiphenylamine	4.4	7.69E-07	7.0E-07	inc	2.3E-10	4.9E-03	4.9E-03	4.9E-03	3.8E-09	3.4E-09	inc	1.1E-12	7.2E-09
Explosives													
RDX	0.026	4.54E-09	4.1E-09	Inc	1.4E-12	1.1E-01	1.1E-01	1.1E-01	5.0E-10	4.6E-10	inc	1.5E-13	9.6E-10
												ILCR:	2.4E-06

Notes:
[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.
1) Doses and cancer risks shown only for carcinogenic chemicals with available toxicity values.
2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium
3) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor.

ILCR — Incremental lifetime cancer risk.
inc — Incomplete pathway.
mg/kg — Milligrams per kilogram.
mg/kg-d — Milligrams per kilogram per day.
na — Not available.
TEQ (2,3,7,8-TCDD) Toxicity equivalents quotient based on 2,3,7,8-tetrachlorodibenzo-p-dioxin.

TABLE 6-16

NONCANCER HAZARD CALCULATIONS FOR A FUTURE INDUSTRIAL WORKER
SUBSITE FTIR-07/d - SUBSURFACE SOILS
FORT IRWIN, CALIFORNIA

Constituent	Soil Concentration[a] (mg/kg)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Dose (mg/kg-d)	Dust Inhalation Dose (mg/kg-d)	Reference Dose (mg/kg-d)			Pathway-Specific Noncancer HI				Chemical-Specific HI
						Oral	Dermal	Inhalation	Ingestion	Dermal	VOC Inhalation	Dust Inhalation	
Inorganics													
Arsenic	8.3	4.06E-06	3.7E-07	Inc	1.2E-09	3.0E-04	3.0E-04	3.0E-04	1.4E-02	1.2E-03	Inc	4.1E-06	0.015
Barium	110	5.38E-05	4.9E-06	Inc	1.6E-08	7.0E-02	7.0E-02	1.4E-04	7.7E-04	7.0E-05	Inc	1.2E-04	0.00096
Cadmium	0.35	1.71E-07	1.6E-08	Inc	5.2E-11	5.0E-04	5.0E-04	5.7E-05	3.4E-04	3.1E-05	Inc	9.1E-07	0.00037
Copper	182	8.90E-05	8.1E-06	Inc	2.7E-08	3.7E-02	3.7E-02	3.7E-02	2.4E-03	2.2E-04	Inc	7.3E-07	0.0026
Zinc	824	4.03E-04	3.7E-05	Inc	1.2E-07	3.00E-01	3.00E-01	3.00E-01	1.3E-03	1.2E-04	Inc	4.1E-07	0.0015
SVOC													
Di-n-butylphthalate	35.0	1.71E-05	1.6E-05	Inc	5.2E-09	1.0E-01	1.0E-01	1.0E-01	1.7E-04	1.6E-04	Inc	5.2E-08	0.00033
Herbicides													
2,4,5-TP	0.0012	5.87E-10	5.4E-10	Inc	1.8E-13	8.0E-03	8.0E-03	8.0E-03	7.3E-08	6.7E-08	Inc	2.2E-11	0.00000014
Explosives													
2,4-Dinitrotoluene	45	2.20E-05	2.0E-05	Inc	6.7E-09	2.0E-03	2.0E-03	2.0E-03	1.1E-02	1.0E-02	Inc	3.3E-06	0.021
HMX	0.150	7.34E-08	6.7E-08	Inc	2.2E-11	5.0E-02	5.0E-02	5.0E-02	1.5E-06	1.3E-06	Inc	4.4E-10	0.0000028
RDX	0.026	1.27E-08	1.2E-08	Inc	3.9E-12	3.0E-03	3.0E-03	3.0E-03	4.2E-06	3.9E-06	Inc	1.3E-09	0.0000081
												Total HI	0.042

Notes:

[a] Based on the maximum or 95 percent upper confidence limit (95% UCL) on the mean concentration detected at the site.

1) Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.
2) Absorbed doses were calculated for dermal contact with the medium, and intakes were calculated for ingestion or inhalation of a medium
3) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HI = Exposure Dose/Reference dose.

HI	Hazard index.
HMX	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetracine.
Inc	Incomplete pathway.
mg/kg	Milligrams per kilogram.
mg/kg-d	Milligrams per kilogram per day.
2,4,5-TP	2,4,5-Trichloro(phenoxyacetic)propionic acid.
SVOC	Semivolatile organic compounds.

TABLE 7-1

PLANTS KNOWN TO OCCUR ON FORT IRWIN
FORT IRWIN, CALIFORNIA

Common Name	Scientific Name	Source
Family Adiantaceae		
goldenback fern	*Pentagramma triangularis*	2
Family Cupressaceae		
Utah juniper	*Juniperus osteosperma*	2
Family Ephedraceae		
California tea	*Ephedra californica*	2, 4
Clokey tea	*Ephedra fasciculata v. clokeyi*	2
Death Valley ephedra	*Ephedra funerea*	2, 3
Nevada tea	*Ephedra nevadensis*	2, 4
Green tea, squaw tea	*Ephedra viridis*	2, 4
DICOTS		
Family Amaranthaceae		
tumbling amaranth or pigweed	*Amaranthus albus*	2
spiny amaranth	*Amaranthus spinosus*	9
Arizona-sweet	*Tidestroemia oblongifolia*	2, 3
Family Apiaceae		
white flowered cymopterus	*Cymopterus aboriginum*	2, 3
veined cymopterus	*Cymopterus multinervatus*	11
Mojave wild parsley	*Lomatium mohavense*	2, 4
Parish's lomatium	*Lomatium nevadense v. parishii*	1, 10
Lomatium Nevada	*Lomatium nevadense v. pseudoorientale*	3
Family Asclepiadaceae		
desert milkweed	*Asclepias erosa*	1, 2, 4
broom milkweed	*Asclepias subulata*	2, 4
Utah cynanchum	*Cynanchum utahense*	11
climbing milkweed	*Sarcostemma hirtellum*	1, 4, 11
Family Asteraceae		
Goldenheads	*Acamptopappus sphaerocephalus*	1, 2, 4
Dyssodia	*Adenophyllum (Dyssodia) cooperi*	1, 2, 4
burweed, sand-bur	*Ambrosia acanthicarpa*	2, 4
burroweed	*Ambrosia dumosa*	1, 2, 4
burroweed	*Ambrosia dumosa X Hymenoclea salsola*	
chaff-bush	*Amphipappus fremontii s. fremontii*	1, 2, 4
scale-bud	*Anisocoma acaulis*	2
white western mugwort	*Artemisia ludoviciana s. albula*	2, 4
bud-sage	*Artemisia spinescens*	1, 2, 4
Great Basin sagebrush	*Artemisia tridentata*	4
gravel-ghost	*Atrichoseris platyphylla*	2, 4
short-leaved broom baccharis	*Baccharis brachyphylla*	2
Emory baccharis	*Baccharis emoryi*	1, 2, 3, 4
mulefat	*Baccharis salicifolia*	1, 4
desert broom	*Baccharis sarathroides*	1
squaw waterweed	*Baccharis sergiloides*	1, 2, 4
lax flower	*Baileya pauciradiata*	2
desert marigold	*Baileya pleniradiata*	2, 4
sweetbush	*Bebbia juncea v. aspera*	2, 4
spear-leaved brickellbush	*Brickellia arguta v. arguta*	1, 2, 4
desert brickelbush	*Brickellia desertorum*	2
woolly brickelbush	*Brickellia incana*	2, 4

TABLE 7-1

PLANTS KNOWN TO OCCUR ON FORT IRWIN
FORT IRWIN, CALIFORNIA

Common Name	Scientific Name	Source
little-leaf brickelbush	*Brickellia microphylla*	10
pinyon brickelbush	*Brickellia oblongifolia v. linifolia*	2
yellow tack-stem	*Calycoseris parryi*	2, 3, 4
pebble pincushion	*Chaenactis carphoclinia*	1, 2, 4
Fremont pincushion	*Chaenactis fremontii*	1, 2, 3, 4
Mojave pincushion	*Chaenactis macrantha*	2, 3, 4
desert pincushion	*Chaenactis stevioides*	1, 2
Xantu's pincushion	*Chaenactis xantiana*	1, 2
arid rubber rabbitbrush	*Chrysothamnus nauseosus s. leiospermus*	1, 2
black-stem rabbitbrush	*Chrysothamnus paniculatus*	1, 4
round-leaf rabbitbrush	*Chrysothamnus teretefolius*	1, 2, 4
sticky-leaf rabbitbrush	*Chrysothamnus viscidiflorus s. puberulus*	2
Mojave thistle	*Circium mohavense*	1, 4
desert thistle	*Circium neomexicana*	1, 2, 4
Bigelow tickseed	*Coreopsis bigelovii*	1, 2, 4
bugseed	*Dicoria canescens*	1
brittlebush	*Encelia farinosa v. farinosa*	1, 2, 4
rayless encelia	*Encelia frutescens v. frutescens*	1, 2+, 4
Acton daisy	*Encelia actonii*	1, 2, 4
Virgin River encelia	*Encelia virginensis*	2+
Cooper's goldenbush	*Ericameria cooperi*	1, 2, 4
cliff goldenbush	*Ericameria cuneata v. spathulata*	1, 4
interior goldenbush	*Ericameria linearifolia*	1, 2
boulder fleabane	*Erigeron breweri v. porphyeticus*	1, 2, 10
tidy fleabane	*Erigeron pumilus v. concinnoides*	1, 4
yellow frocks	*Eriophyllum ambiguum v. paleaceum*	1, 2, 3
Pringle woolly-sunflower	*Eriophyllum pringlei*	1, 2
Wallace's woolly-sunflower	*Eriophyllum wallacei*	1, 2, 4
Arizona filago	*Filago arizonica*	2
dwarf filago	*Filago depressa*	2
California gold, desert sunflower	*Geraea canescens*	1, 2, 4
keysia	*Glyptopleura marginata*	2
cudweed	*Gnaphalium palustre*	2
purple everlasting	*Gnaphalium purpureum*	9
snakeweed, small-flowered matchweed	*Gutierrezia microcephala*	1, 2, 4
annual sunflower	*Helianthus annuus*	2
cheesebush	*Hymenoclea salsola*	1, 4
alkali isocoma	*Isocoma acradenia v. eremophila*	1, 4
prickly lettuce	*Lactuca serriola*	1, 2, 4
autumn vinegarweed	*Lessingia lemmonii v. lemmonii*	2
Silver Lake aster	*Machaerantha arida*	1, 2, 3, 4
shrubby alkali aster	*Machaeranthera carnosa*	2
woolly dandelion	*Malacothrix californica*	1
snake's-head	*Malacothrix coulteri*	1, 2
desert dandelion	*Malacothrix glabrata*	1, 2, 4
Mojave desert stars	*Monoptilon bellidiforme*	2
desert stars	*Monoptilon bellioides*	1, 2, 4
hole-in-the-sand plant	*Nicolletia occidentalis*	1, 2, 4
Spanish needles	*Palafoxia arida v. arida*	1, 2, 4

TABLE 7-1

PLANTS KNOWN TO OCCUR ON FORT IRWIN
FORT IRWIN, CALIFORNIA

Common Name	Scientific Name	Source
cinch weed	*Pectis papposa*	1, 2
rock daisy	*Perityle emoryi*	1, 2, 3, 4
pygmy cedar	*Peucephyllum schottii*	1, 2, 4
arrowleaf	*Pleurocoronis pluriseta*	1, 2, 4
arrow-weed	*Pluchea (Tessaria) sericea*	1, 2, 4
odora	*Porophyllum gracile*	1, 2, 4
annual mitre	*Prenanthella exigua*	1, 2, 3
fan-leaf, turtlebacks	*Psathrotes annua*	1, 2, 4
velvet plant	*Psathrotes ramosissima*	1, 2, 4
California chicory	*Rafinesquia californica*	2
desert chicory	*Rafinesquea neomexicana*	1, 2
Mono grounsel	*Senecio flaccidus v. monoensis*	1, 2, 4
southern goldenrod	*Solidago confinis*	4
perennial sowthistle	*Sonchus arvensis*	4
sow-thistle	*Sonchus asper*	1, 2
common sow-thistle	*Sonchus oleraceus*	3, 4
annual milk-lettuce	*Stephanomeria exigua*	2, 4
rock pink	*Stephanomeria parryi*	2, 4
desert straw, wire-lettuce	*Stephanomeria pauciflora*	1, 2, 4
desert nest-straw	*Stylocline micropoides*	2
Peck nest-straw	*Stylocline psilocarphoides*	2
yellow xerasid, Fremont gold	*Syntrichopappus fremonti*	1, 2, 4
striped or silver cottonthorn	*Tetradymia argyraea**	2
cotton-thorn	*Tetradymia axillaris v. axillaris*	1, 4
felt-thorn	*Tetradymia stenolepis*	2, 4
silver puffs	*Uropappus lindleyi*	2, 11
net-leaf daisy, leather leaf	*Viguiera reticulata*	1, 2
Mojave aster	*Xylorhiza tortifolia*	1, 2, 4
Family Bignoniaceae		
desert-willow	*Chilopsis linearis v. arcuata*	1, 2, 4
Family Boraginaceae		
desert fiddleneck	*Amsinckia tessellata v. tessellata*	1, 2, 4
narrow-leaved forget-me-not	*Cryptantha angustifolia*	2, 4
bearded forget-me-not	*Cryptantha barbigera*	2, 4
capped forget-me-not	*Cryptantha circumcissa*	2, 4
Clokey forget-me-not	*Cryptantha clokeyi**	2
golden cryptantha	*Cryptantha confertiflora*	2
wire-stem forget-me-not	*Cryptantha dumetorum*	2
prickly forget-me-not	*Cryptantha echinella*	2
rough-stemmed forget-me-not	*Cryptantha holoptera**	2
white-haired forget-me-not	*Cryptanta maritima*	2, 4
red-root cryptantha	*Cryptantha micrantha*	3, 4
pointed forget-me-not	*Cryptantha muricata*	1, 3, 6
Nevada forget-me-not	*Cryptantha nevadensis*	2, 4
wing-seed forget-me-not	*Cryptantha pterocarya*	1, 2, 4
mounded cryptantha	*Cryptantha tumulosa**	2
scented forget-me-not	*Cryptantha utahensis*	1, 2, 4
annual heliotrope	*Heliotropium convovulaceum v. californicum*	2
chinese pusley	*Heliotropium curvassavicum v. oculatum*	1, 2, 3, 4

TABLE 7-1

PLANTS KNOWN TO OCCUR ON FORT IRWIN
FORT IRWIN, CALIFORNIA

Common Name	Scientific Name	Source
chuckwalla comb-bur	*Pectocarya heterocarpa*	2
coastal comb-bur	*Pectocarya linearis v. ferocula*	2
winged comb-bur	*Pectocarya penicillata*	2
broad-toothed comb bur	*Pectocarya platycarpa*	2
curve-fruited comb-bur	*Pectocarya recurvata*	2, 4
erect combbur	*Pectocarya setosa*	1, 2, 4
Jones popcorn flower	*Plagiobothrys jonesii*	4
annual coldenia	*Tiquilia nuttallii*	1, 4
pleated coldenia	*Tiquilia plicata*	1, 2, 3, 4
Family Brassicaceae		
blue-podded rock-cress	*Arabis glaucovalvula*	1, 11
arched rock-cress	*Arabis perennans*	1, 2, 11
showy rock-cress	*Arabis pulchra v. gracilis*	1, 3
Sahara mustard	*Brassica tournefortii*	2
Cooper's caulanthus	*Caulanthus cooperi*	2, 3
desert candle	*Caulanthus inflatus*	2
yellow tansy mustard	*Descurainia pinnata*	2, 4
tansy-mustard	*Descurainia sophia*	2, 4
spectacle-pod	*Dithyrea californica*	2, 4
desert wallflower	*Erysimum capitatum*	2
desert crucifer	*Guillenia lasiophylla*	2, 4
yellow peppergrass	*Lepidium flavum v. flavum*	1, 2, 4
desert alyssum	*Lepidium fremontii*	1, 2, 4
hairy-pod peppergrass	*Lepidium lasiocarpum v. lasiocarpum*	2, 3, 4
cliff sibara	*Sibara rosulata*	1
tumble-mustard	*Sisymbrium altissimum*	2, 6
london rocket	*Sisymbrium irio*	2, 3
hedge-mustard	*Sisymbrium orientale*	2
prince's plume	*Stanleya pinnata v. pinnata*	1, 2, 4
long-beaked twistflower	*Streptanthella longirostris*	2, 4
lace-pod	*Thysanocarpus curvipes*	2
fringe-pod	*Thysanocarpus laciniatus v. hitchockii*	1, 2, 4
Family Cactaceae		
cottontop cactus	*Echinocactus polycephalus v. polycephalus*	1, 2+, 4
hedgehog cactus	*Echinocereus engelmannii*	1, 2, 4
fishhook cactus	*Mamillaria tetrancistra*	2
beavertail	*Opuntia basilaris*	1, 4
silver or golden cholla	*Opuntia echinocarpa*	1, 4
Mojave prickly pear	*Opuntia erinacea*	1
pencil cholla	*Opuntia ramosissima*	1, 2, 4
Family Campanulaceae		
sticky threadstem	*Nemacladus glanduliferus v. orientalis*	2, 4
yellow-flowered threadstem	*Nemocladus rubescens*	2
Inyo threadstem	*Nemacladus sigmoideus*	2
parishella	*Parishella californica*	2
Family Capparidaceae		
Mojave stinkweed	*Cleomella obtusifolia*	1, 2, 3, 4
Family Caprifoliaceae		
fragrant snowberry	*Symphoricarpus longiflorus*	1, 3, 4

TABLE 7-1

PLANTS KNOWN TO OCCUR ON FORT IRWIN
FORT IRWIN, CALIFORNIA

Common Name	Scientific Name	Source
Family Caryophyllaceae		
Achyronychia cooperi	*frost-mat*	2, 3, 6
desert sandwort	*Arenaria macradenia v. macradenia*	1, 2, 4
saltmarsh sand-spurry	*Spergularia marina*	1
Family Chenopodiaceae		
iodine brush	*Allenrolfea occidentalis*	2, 4
four-wing saltbush	*Atriplex canescens*	1, 2, 4
shadscale	*Atriplex confertifolia*	1, 2, 4
wheelscale	*Atriplex elegans v. elegans*	2, 4
wheelscale	*Atriplex elegans v. fasciculata*	2, 3
desert holly	*Atriplex hymenelytra*	1, 2, 4
Nevada saltbush	*Atriplex lentiformis s. torreyi*	1, 2, 4
Parry saltbush	*Atriplex parryi*	1, 2, 4
arrowscale	*Atriplex phyllostegia*	2, 3, 4
allscale	*Atriplex polycarpa*	1, 2, 3, 4
spinescale	*Atriplex spinifera*	2
5-hook bassia	*Bassia hyssopifolia*	5
hoary goosefoot	*Chenopodium incanum*	2
lambsquarter, garden goosefoot	*Chenopodium murale*	1, 3
spiny hop-sage	*Grayia spinosa*	1, 2, 4
summer-cypress	*Kochia americana*	9
winter fat	*Krascheninnikovia lanata*	1, 2+, 4
patata	*Monolepis nuttalliana*	1, 2, 4
alkali-pink	*Nitrophila occidentalis*	2
barb-wire tumbleweed	*Salsola paulsenii*	2, 3, 4
tumbleweed, Russian thistle	*Salsola tragus (australis)*	1, 2, 4
greasewood	*Sarcobatus vermiculatus*	9
bush seepweed, inkweed	*Suaeda moquinii*	1, 2, 4
Family Convovulaceae		
alkali weed	*Cressa truxillensis v. vallicola*	1, 2, 3
dodder	*Cuscuta californica*	1, 2, 4
toothed dodder	*Cuscuta denticulata*	2
Family Cucurbitaceae		
coyote melon	*Cucurbita palmata*	1, 2, 4
Family Euphorbiaceae		
rattlesnake weed	*Chamaesyce albomarginata*	2, 4
desert annual spurge	*Chamaesyce micromeria*	1, 2
valley spurge	*Chamaesyce ocellata*	1, 2
Parish's spurge	*Chamaesyce parishii*	2
perennial spurge	*Chamaesyce polycarpa*	1, 2
Yuma spurge	*Chamaesyce setiloba*	3
Death Valley spurge	*Chamaesyce vallis-mortae*	1, 4
California croton	*Croton californica*	1, 2, 3, 4
turkey mullein, doveweed	*Eremocarpus setigerus*	1
toothleaf	*Stillingia paucidentata*	2, 4
spiny stillingia	*Stillingia spinulosa*	1, 2, 3, 4
Family Fabaceae		
keel beak	*Astragalus acutirostris*	2, 3
dwarf locoweed	*Astragalus didymocarpus didymocarpus*	2

TABLE 7-1

PLANTS KNOWN TO OCCUR ON FORT IRWIN
FORT IRWIN, CALIFORNIA

Common Name	Scientific Name	Source
2-seeded locoweed	*Astragalus didymocarpus v. dispermus*	4
Lane Mountain milkvetch	*Astragalus jaegerianus**	2+, 4
Catherine's milkvetch	*Astragalus layneae*	2, 4
Fremont rattleweed	*Astragalus lentiginosus v. fremontii*	2, 4
common rattleweed, dapplepod	*Astragalus lentiginosus v. variabilis*	2, 4
Mojave milkvetch	*Astragalus mohavensis v. hemigyrus*	3
Pursh's milkvetch	*Astragalus purshii v. tinctus*	1, 2, 3, 4
downy dalea	*Dalea mollisima*	1, 2, 4
short-podded lotus	*Lotus humistratus*	2, 4
Mojave rock-pea	*Lotus rigidus*	1, 2, 4
coast lotus	*Lotus salsuginosus v. brevivexillus*	4
stiff-haired lotus	*Lotus strigosus (tomentellus)*	1, 2, 4
Chilean lotus	*Lotus wrangelianus (subpinnatus)*	2+
Arizona lupine	*Lupinus arizonicus*	1
bajada lupine	*Lupinus concinnus v. orcuttiana*	2, 4
yellow-eyes	*Lupinus flavoculatus*	2
sunrise lupine	*Lupinus microcarpus v. horizontalis*	2, 4
royal lupine	*Lupinus odoratus*	2, 4
pale lupine	*Lupinus pallidus*	1
sand lupine	*Lupinus shockleyi*	2, 3, 4
honey mesquite	*Prosopis glandulosa v. torreyana*	1, 2, 3, 4
screwbean mesquite	*Prosopis pubescens*	1, 2, 3, 4
Mojave indigo bush	*Psorothamus arborescens v. arborescens**	2, 3, 4
Indigo bush	*Psorothamnus fremontii v. attenuata*	1, 4, 12
spotted dalea	*Psorothamnus polydenius v. polydenius*	1, 2, 4
desert senna	*Senna (Cassia) armata*	1, 2, 4
pinpoint clover	*Trifolium gracilentum v. gracentum*	2
Family Frankeniaceae		
alkali heath	*Frankenia salina (grandifolia v. campestris)*	1, 3
Family Geraniaceae		
red-stemmed filaree	*Erodium cicutarium*	1, 2+, 4
Texas filaree	*Erodium texanum*	1, 2, 4
Family Hydrophyllaceae		
whispering bells	*Emmenanthe penduliflora*	2, 3, 4
spotted eucrypta	*Eucrypta chrysanthemifolia v. bipinnatifida*	2, 3, 4
desert eucrypta	*Eucrypta micrantha*	2
purple mat	*Nama demissum v. covillei*	2
purple mat	*Nama demissum demissum*	2, 4
narrow-leaved nama	*Nama depressum*	2
hairy nama	*Nama hispidium v. spathulatum*	1, 2
small-leaved nama	*Nama pusillum*	2
wild heliotrope	*Phacelia crenulata v. ambigua*	2
Notch-leaf phacelia	*Phacelia crenulata v. crenulata*	4
limestone phacelia	*Phacelia cryptantha*	2, 3
blue-flowered heliotrope	*Phacelia distans*	2, 4
yellow throats	*Phacelia fremontii*	2, 4
weasel phacelia	*Phacelia mustelina*	2?
alkali phacelia	*Phacelia neglecta*	2
black tack phacelia	*Phacelia pachyphylla*	2, 3, 4

TABLE 7-1

PLANTS KNOWN TO OCCUR ON FORT IRWIN
FORT IRWIN, CALIFORNIA

Common Name	Scientific Name	Source
specter phacelia	*Phacelia pedicellata*	2, 4
round-leaved phacelia	*Phacelia rotundifolia*	2, 3, 4
California hyacinth	*Phacelia tanacetifolia*	1, 2, 4
Death Valley phacelia	*Phacelia vallis-mortae*	2, 4
fiesta flower	*Pholistoma membranaceum*	2, 4
Family Krameriaceae		
Pima ratany	*Krameria erecta (parvifolium v. imparata)*	1, 2, 4
Family Lamiaceae		
horehound	*Marrubium vulgare*	1, 4
spearmint	*Mentha spicata*	9
horsemint pennyroyal	*Monardella linoides s. linoides*	2
bladder sage	*Salazaria mexicana*	1, 2, 4
thistle sage	*Salvia carduacea*	1, 2, 4
chia sage	*Salvia columbariae*	1, 2, 4
Mojave sage	*Salvia mohavensis*	1, 2, 3, 4
showy sage	*Salvia pachyphylla*	2, 4
Family Lennoaceae		
scaly sandfood	*Pholistoma arenarium*	2, 4
Family Loasaceae		
rock-nettle	*Eucnide urens*	1, 2, 4
blazing-star	*Mentzelia affinis*	2
white-stem blazing star	*Mentzelia albicaulis*	2, 4
desert blazing star	*Mentzelia desertorum*	2
sand blazing star	*Mentzelia involucrata v. involucrata*	2, 4
obscure blazing star	*Mentzelia obscura*	2, 3
Inyo blazing star	*Menzelia oreophila*	2
wing-seeded blazing star	*Mentzelia pterosperma*	3
shiny-leaf sandpaper plant	*Petalonyx nitidus*	2
sandpaper plant	*Petalonyx thurberi s. thurberi*	1, 4
Family Lythraceae		
California loosestrife	*Lythrum californicum*	2
Family Malvaceae		
white mat mallow	*Eremalche exilis*	2, 4
desert five-spot	*Eremalche rotundifolia*	1, 2, 4
apricot mallow	*Sphaeralcea ambigua v. ambigua*	1, 2, 4
Family Nyctaginaceae		
desert sand-verbena	*Abronia villosa v. villosa*	1, 2, 4
windmills	*Allionia incarnata*	2, 4
ringstem	*Anulocaulis annulata*	2
wishbone plant	*Mirabilis bigelovii v. bigelovii*	2, 4
wishbone plant	*Mirabilis bigelovii v. retrorsa*	1, 2
Family Oleaceae		
desert olive	*Foresteria pubescens (neomexicana)*	1, 8
Family Onagraceae		
dwarf woody bottlewasher	*Camissonia boothii v. condensata*	2, 4
desert woody bottlewasher	*Camissonia boothii v. desertorum*	2, 3, 4
desert suncups	*Camissonia brevipes v. brevipes*	1, 4
field-primrose	*Camissonia campestris s. campestris*	1, 2, 4
brown-eyed evening primrose	*Camissonia claviformis v. claviformis*	1, 2, 3, 4

TABLE 7-1

PLANTS KNOWN TO OCCUR ON FORT IRWIN
FORT IRWIN, CALIFORNIA

Common Name	Scientific Name	Source
yellow flowered brown-eyed evening primrose	*Camissonia claviformis v piersonii*	4
gilman suncups	*Camissonia kernensis s gilmanii*	2
narrow-leaved evening-primrose	*Camissonia refracta*	2, 4
wavy-leaved evening-primrose	*Oenothera caespitosa s. crinita*	2
bird cage primrose, devils lantern	*Oenothera deltoides s deltoides*	1, 2, 3
yellow primrose	*Oenothera primaveris s primaveris*	2, 4
Family Orobanchaceae		
	Orobanche sp	4
Family Papaveraceae		
prickle poppy	*Argemone corymbosa*	2, 3, 4
Mojave gold poppy	*Eschscholzia glyptosperma*	1, 2, 3, 4
small-flowered gold poppy	*Eschscholzia minutiflora*	1, 2, 3, 4
Family Plantaginaceae		
woolly plantain	*Plantago ovata (insularis v. fastigiata)*	1, 2, 4
Patagonia plantain	*Plantago patagonica v. patagonica*	4
Family Polemoniaceae		
Mojave wooly star-flower	*Eriastrum densiflorum v mohavensis*	1
blue mantle	*Eriastrum diffusum*	2
sapphire flower	*Eriastrum eremicum*	1, 4
southern gilia	*Gilia australis*	3, 11
inyokern gilia	*Gilia brecciarum v. neglecta*	2, 4, 10
showy gilia	*Gilia cana v. speciformis*	1, 2, 4
Clokey's gilia	*Gilia clokeyi*	4
thread-stemmed gilia	*Gilia filiformis*	1, 2, 3, 4
broad-leaved gilia	*Gilia latifolia*	4
Great Basin gilia	*Gilia leptomeria*	2
dainty gilia	*Gilia micromeria*	2, 3
dwarf gilia	*Gilia minor*	2, 4
volcanic pale gilia	*Gilia ochroleuca v ochroleuca*	4
star gilia	*Gilia stellata*	1, 2, 3, 4
desert gilia	*Gilia transmontana*	1, 4, 10
spreading ipomopsis	*Ipomopsis polycladon*	1
desert calico	*Loeselliastrum matthewsii*	2, 3, 4
sunbonnets	*Loeselliastrum schottii*	2
dotted sunbonnets	*Langloisia setosissima s. punctata*	1, 2, 4
bristly sunbonnets	*Langloisia setosissima s. setosissima*	4
prickly phlox	*Leptodactylon pungens v. pungens*	2, 4
desert linanthus	*Linanthus demissus*	2, 4
evening snow	*Linanthus dichotomus*	2, 3, 4
jones linanthus	*Linanthus jonesii*	1, 2
Family Polygonaceae		
red triangles	*Centrostegia thurberi*	2
brittle spineflower	*Chorizanthe brevicornu*	1, 2, 4
badlands spineflower	*Chorizanthe corrugata*	1, 3
rigid spiny herb	*Chorizanthe rigida*	1, 2+, 4
Watson's spineflower	*Chorizanthe watsonii*	2
white skeletonweed	*Eriogonum baileyi*	2, 4
short-flowered skeletonweed	*Eriogonum brachyanthum*	2
tecopa skeletonweed	*Eriogonum brachypodum*	2

TABLE 7-1

PLANTS KNOWN TO OCCUR ON FORT IRWIN
FORT IRWIN, CALIFORNIA

Common Name	Scientific Name	Source
flat-topped skeletonweed	*Eriogonum deflexum v. deflexum*	2
Desert bush buckwheat	*Eriogonum fasciculatum v polifolium*	1, 2, 4
wild buckwheat	*Eriogonum gracile*	3
slender skeletonweed	*Eriogonum gracillimum*	1, 4
woolly heerman's buckwheat	*Eriogonum heermannii v. floccosum**	2, 4
desert trumpet	*Eriogonum inflatum*	1, 2, 4
spotted skeletonweed	*Eriogonum maculatum*	2
Great Basin Buckwheat	*Eriogonum cf. Microthecum v. ambiguum*	4, 6
bird's-nest skeletonweed	*Eriogonum nidularium*	1, 2, 4
palmers bird cage	*Eriogonum plamerianum*	2
turk's cap	*Eriogonum pusillum*	1, 2, 4
kidney-leaf skeletonweed	*Eriogonum reniforme*	1, 2, 4
thomas skeletonweed	*Eriogonum thomasii*	2, 4
little trumpets	*Eriogonum trichopes v trichopes*	1, 2, 4
sulfur buckwheat	*Eriogonum umbellatum v. ferrissii*	9
sulfur buckwheat	*Eriogonum umbellatum v. versicolor*	9
Wright's buckwheat	*Eriogonum wrightii*	2+
punctured bract	*Mucronea perfoliata*	2+
red saucers	*Oxytheca perfoliata*	1, 2, 4
knotweed	*Polygonum argyrocoleon*	2
wild rhubarb	*Rumex hymenosepalus*	1, 4
purple dock	*Rumex violascens*	2
Family Portulaceae		
pussypaws	*Calyptridium monandrum*	1
miner's lettuce	*Claytonia parviflora*	2, 3
Family Ranunculaceae		
desert larkspur	*Delphinium parishii*	1, 2, 4
Family Resedaceae		
oligomeris	*Oligomeris linifolius*	1, 2, 3, 4
Family Rhamnaceae		
Gray thorn	*Zizyphus cf. Obtusifolia v. canescens*	8
Family Rosaceae		
blackbrush	*Coleogyne ramosissima*	1, 2, 4
desert almond	*Prunus fasciculata*	2+, 4
bitterbrush	*Purshia mexicana v stansburyana*	8
Family Rubiaceae		
star bedstraw	*Galium stellatum s eremicum*	1, 2, 4
Family Rutaceae		
turpentine-broom	*Thamnosma montana*	1, 2, 4
Family Salicaceae		
Fremont cottonwood	*Populus fremontii*	1, 2, 3, 4
Narrow-leaved willow	*Salix exigua*	2
Goodding's black willow	*Salix gooddingii*	1, 2
Family Saururaceae		
yerba mansa	*Anemopsis californica*	1, 2, 3, 4
Family Scrophulariaceae		
twining snapdragon	*Antirrhinum filipes*	4
desert Indian paintbrush	*Castilleja angustifolia*	2, 3
purple owl's clover	*Castilleja exerta*	2

TABLE 7-1

PLANTS KNOWN TO OCCUR ON FORT IRWIN
FORT IRWIN, CALIFORNIA

Common Name	Scientific Name	Source
toad-flax paintbrush	*Castilleja linariifolia*	4
desert keckiella	*Keckiella antirrhinoides s. microphylla*	4
wash monkeyflower	*Mimulus bigelovii v. bigelovii*	1, 2, 4
common monkeyflower	*Mimulus guttatus*	2
lesser mohavea	*Mohavea breviflora*	2, 3
beardtongue	*Penstemon sp.*	2
Palmer's beardtongue	*Penstemon palmeri*	2
brookline	*Veronica cf. Anagallis-aquatica*	2+
Family Solanaceae		
Jimson weed	*Datura wrightii*	2
wolfberry	*Lycium andersonii*	1, 2, 4
peach-thorn	*Lycium cooperi*	1, 2, 4
rabbit-thorn	*Lycium pallidum v. oligospermum*	2
desert tobacco	*Nicotiana obtusifolia (trigonophylla)*	1, 2, 4
ground cherry	*Physalis crassifolia*	1, 2, 4
husk cherry	*Physalis hederifolia v. fendleri*	9
gray husk cherry	*Physalis pubescens v. grisea (pruinosa)*	4
white flowered nightshade	*Solanum americanum*	2
Family Tamaricaceae		
four-petaled salt cedar	*Tamarix parviflora*	2, 3
salt cedar	*Tamarix ramosissima*	1, 2, 4
Family Viscaceae		
desert mistletoe	*Phoradendron californicum*	1, 2, 4
Family Zygophyllaceae		
creosote bush	*Larrea tridentata*	1, 2, 4, 11
puncture vine	*Tribulus terrestris*	2
MONOCOTS		
Family Agavaceae		
Joshua tree	*Yucca brevifolia v. brevifolia*	1, 2+, 4
Mojave yucca	*Yucca schidigera*	1, 2+, 4
Family Cyperaceae		
spike rush	*Eleocharis macrostachya*	9
Mexican spike rush	*Eleocharis montevidensis*	2
Parish's spike rush	*Eleocharis parishii*	6, 9
hard stem bullrush	*Scirpus acutus*	2
bullrush	*Scirpus (olneyi) americanus*	2, 4
tri-square	*Scirpus pungens*	2
alkali bullrush	*Scirpus robustus*	4
Family Juncaceae		
wire grass	*Juncus balticus*	1, 3, 4
toad rush	*Juncus bufonius*	1, 3
Cooper's rush	*Juncus cooperi*	1, 3, 4
wire grass	*Juncus mexicanus*	1, 2
Family Liliaceae		
crested onion	*Allium atrorubens v. cristatum*	1, 3, 4
Kennedy mariposa lily	*Calochortus kennedyi*	2
alkali mariposa lily	*Calochortus striatus**	2
blue dycks	*Dichelostemma capitatum*	2, 4
desert lily	*Hesperocallis undulata*	3, 4

TABLE 7-1

PLANTS KNOWN TO OCCUR ON FORT IRWIN
FORT IRWIN, CALIFORNIA

Common Name	Scientific Name	Source
crowned onion	*Muilla coronata**	4
Family Poaceae		
Indian rice grass	*Achnatherum (Oryzopsis) hymenoides*	1, 2, 4
desert needle grass	*Achnatherum (Stipa) speciosa*	2, 4
six-week threeawn	*Aristida adscensionis*	1, 4
California threeawn	*Aristida californica*	2
purple three-awn	*Aristida purpurea v. nealleyi (A. glauca)*	2, 4
eyelash grass	*Bouteloua barbata*	2
ripgut brome	*Bromus diandrus*	2
red brome	*Bromus madritensis s. rubens*	1, 2+, 4
cheatgrass	*Bromus tectorum*	2, 4
Chilean chess	*Bromus trinii*	1, 2, 4
finger grass	*Chloris virgata*	9
Bermuda grass	*Cynodon dactylon*	9
saltgrass	*Distchlis spicata*	1, 2, 3, 4
barnyard grass	*Echinochloa crus-galli*	9
squirrel-tail grass	*Elymus elymoides (Sitanion hystrix)*	2, 4
fluff grass	*Erioneuron pulchellum*	1, 4
foxtail barley	*Hordeum murinum s. leporinum*	1, 2, 3, 4
Mexican sprangletop	*Leptochloa uninervia*	9
salina wildrye	*Leymus salinus*	2
annual ryegrass	*Lolium perenne*	2+
tall melic grass	*Melica frutescens*	1, 2, 4
deergrass	*Muhlenbergia rigens*	2, 4
canary grass	*Phalaris caroliniana*	2
common reed	*Phragmites australis*	1, 4
big galleta grass	*Pleuraphis (Hilaria) rigida*	1, 2, 4
rush-leaved blue grass	*Poa secunda s. juncifolia*	2, 3
Nevada blue grass	*Poa secunda s. secunda*	2, 4
rabbits foot grass	*Polypogon monspeliensis*	1, 2, 3, 4
Arabian grass	*Schismus arabicus*	2, 4
split grass	*Schismus barbatus*	2, 4, 6
alkali dropseed	*Sporobolus airoides*	2, 4
fescue grass	*Vulpia microstachys v. microstachys*	2
fescue grass	*Vulpia microstachys v. pauciflora*	2
six-weeks fescue	*Vulpia octoflora*	2, 4
Family Typhaceae		
southern cattail	*Typha domingensis*	2
broad-leaved cattail	*Typha latifolia*	4

Notes:
* - Sensitive Species occurring on Fort Irwin
s. - subspecies
v. - variety
cf - identification in doubt, based on sterile specimen or no voucher in existence
2+ - no vouchers made but based on positive identification.

TABLE 7-1

PLANTS KNOWN TO OCCUR ON FORT IRWIN
FORT IRWIN, CALIFORNIA

Sources:

1 Plant list compiled by Army Corps botanist Lois Goodman Plant species list, Fort Irwin National Training Center, San Bernardino County, California

2 Gibson, A , B Prigge, and K. Niessen. Floral Surveys at the Fort Irwin Training Center, San Bernardino County, California Includes vouchered specimens collections made at NTC and deposited at Rancho Santa Ana Botanic Gardens and U.C.L.A herbaria.

3 1970s Hendrickson, James. Field collections at Rancho Santa Ana Botanic Gardens and documented in Gibson et al

4 Lee and Ro Consulting Engineers compiled by Mark Bagley field work conducted with John Chestnut and Denise Labrouteux Endangered and sensitive species survey and deficiency tabulation for Fort Irwin National Training Center and Goldstone Space Communications Complex. Prepared for Directorate of Engineering and Housing, Fort Irwin National Training Center.

5 David Charlton field notes Floral survey of Garlic Springs, 1991.

6 AEHA observed 125 species at study plots

7 Brand, C ; W. Rickard, and N Cadoret. Vegetations Studies National Training Center, Fort Irwin, California.

8 Pratt, Gordon. Field work for 1995 butterfly surveys at Ft. Irwin. Per Comm. between Steve Ahmann and David Charlton, 1996.

9 LCTA, 1991-1994. Conducted by Colorado State University students.

10 Jaeger Edmund. Field collections stored at Rancho Santa Ana Botanic Gardens Biology instructor Riverside City College.

11 Wolfe, Carl, and Philip Munz Field collections by the horticulturalist and taxonomist at Rancho Santa Ana Botanic Gardens.

12 De Decker, Mary. Field collections housed at her herbarium at Independence with duplicates at Rancho Santa Ana Botanic Gardens

TABLE 7-2

REPTILES KNOWN TO OCCUR ON FORT IRWIN
FORT IRWIN, CALIFORNIA

Common Name	Scientific Name	Source
CLASS REPTILIA		
Testudinidae		
desert tortoise	*Gopherus agassizii**	1
Gekkonidae		
western banded gecko	*Coleonyx varigatus*	1, 4
Iguanidae		
desert iguana	*Dipsosaurus dorsalis*	1, 4
chuckwalla	*Sauromalus obesus**	1,4
Mojave fringe-toed lizard	*Uma scoparia**	11
zebra-tailed lizard	*Callisaurus draconoides*	1, 4
desert collared lizard	*Crotaphytus insularis*	1, 4
long-nosed leopard lizard	*Gambilia wislizenii*	1, 4
desert spiny lizard	*Sceloporus magister*	1, 4
western fence lizard	*Sceloporus occidentalis*	11
longed-tailed brush lizard	*Urosaurus graciosus*	11
side-blotched lizard	*Uta stansburiana*	1, 4
desert horned lizard	*Phrynosoma platyrhinos*	1, 4
Xantusidae		
desert night lizard	*Xantusia vigilis*	1, 4
Teiidae		
western whiptail	*Cnemidophorus tigris*	1, 4
Scincidae		
Gilbert skink	*Eumeces gilberti*	4
Leptotyphlopidae		
western blind snake	*Leptotyphlops humilis*	11
Boidae		
rosy boa	*Lichanura trivirgata*	1
Colubridae		
spotted leaf-nosed snake	*Phyllorhynchus decurtatus*	1, 4
coachwhip	*Masticophis flagellum*	1, 4
western patch-nosed snake	*Salvadora hexalepis*	1, 4
glossy snake	*Arizona elagans*	1, 4
gopher snake	*Pituaphis melanoleucus*	1, 4
common kingsnake	*Lampropeltis getulus*	1, 4
long-nosed snake	*Rhinocheilus lecontei*	1, 4
ground snake	*Sonora semiannulata*	11
western shovel-nosed snake	*Chionactis occipitalis*	1, 4
lyre snake	*Trimorphodon biscutatus*	1
night snake	*Hypsiglena torquata*	4
Viperidae		
speckled rattlesnake	*Crotalus mitchelii*	1, 4
sidewinder	*Crotalus cerastes*	1, 4
Mojave rattlesnake	*Crotalus scutulatus*	1, 4

Notes:
* - Indicates sensitive species status
+ - Unconfirmed sighting, personal communication from Fort Irwin Enviro Div personnel
(I) - Introduced species

TABLE 7-2

REPTILES KNOWN TO OCCUR ON FORT IRWIN
FORT IRWIN, CALIFORNIA

Sources:

1 Robert D Niehaus, Inc., 1995. Herpetological Survey and Physiological Studies on the Western Portion of Fort Irwin NTC.

2 Nagy, K A. and T L. Brown, 1994 Ecological and Impact Sensitivity of Reptiles at Fort Irwin

3 Robert D Niehaus, Inc., 1995. Small Mammal Survey of Selected Sites at NTC, Fort Irwin, CA.

4 Krzysik, A.J., 1991. Ecological Assessment of Military Training Effects on Threatened, Endangered, and Sensitive Animals and Plants at Fort Irwin, CA.

5 Forrest Shepard and Dr. Bob Rechtman, personal communication

6 Brydolf, Barbara, with Robert D Hiehaus, Inc 1996 Final Report, 1994 Avian Survey at the National Training Center, Fort Irwin, CA.

7 Brydolf, Barbara, 1995. Birds Found at Fort Irwin Sewage Treatment Ponds, 1994 and Spring 1995.

8 Giffith, Michele, 1993 1992 Land Condition - Trend Analysis, Fort Irwin, NTC, CA

9 Clark, Deborah J., 1992. 1991 Interim Report for the 1991 Land Condition - Trend Analysis, Wildlife Inventory, Fort Irwin NTC, CA.

10 Brown, Patricia E., 1994. Bat Survey of the NTC Fort Irwin, San Bernardino Co., CA

11 Morafka, David J, 1993. Amphibian and Reptile Study of 20 Sites at the NTC, Fort Irwin. (Draft Report)

12 McCalvin, Catherine and David Pereksta, 1994 Biological Inventory of the Hellwind Conyon Drainage System, Military Fort Irwin Reservation, San Bernardino Co. CA.

13 Steve Ahman, personal communication

TABLE 7-3

MAMMALS KNOWN TO OCCUR ON FORT IRWIN
FORT IRWIN, CALIFORNIA

Common Name	Scientific Name	Source
CLASS MAMMALIA		
Soricidae		
desert shrew	*Notiosorex crawfordi*	4
Vispertilionidae		
California myotis	*Myotis californicus*	10
western pipistrelle	*Pipistrellus hesperus*	10
big brown bat	*Eptesicus fuscus*	10
Townsend's big-eared bat	*Plecotus townsendii**	10
pallid bat	*Antrozous pallidus**	10
Molassidae		
Mexican free-tailed bat	*Tadarida brasiliensis*	10
western mastiff bat	*Eumops perotis californicus**	10
Bassariscidae		
ring-tailed cat	*Bassariscus astutus*	4+, 10
Mustelidae		
badger	*Taxidea taxus**	4
striped skunk	*Mephitis mephitis*	10
Canidae		
coyote	*Canis latrans*	4
kit fox	*Vulpes macrotis*	4
gray fox	*Urocyon cinereoargenteus*	5
Felidae		
mountain lion	*Felis concolor*	13
bobcat	*Lynx rufus*	4, 10
Sciuridae		
Mohave ground squirrel	*Spermophilus mohavensis**	3, 4
round-tailed ground squirrel	*Spermophilus tereticaudus*	3, 4
antelope ground squirrel	*Ammospermophilus leucurus*	3, 4
Geomydidae		
valley pocket gopher	*Thomomys bottae*	2
Heteromyidae		
little pocket mouse	*Perognathus longimembris*	3, 4
desert pocket mouse	*Perognathus penicillatus*	3, 4
long-tailed pocket mouse	*Chaetodipus formosus*	3, 4
Panamint kangaroo rat	*Dipodomys panamintinus*	3, 4
Great Basin kangaroo rat	*Dipodomys microps*	3, 4
desert kangaroo rat	*Dipodomys deserti*	3, 4
Merriam's kangaroo rat	*Dipodomys merriami*	3, 4
Cricetidae		
cactus mouse	*Peromyscus eremicus*	3, 4
canyon mouse	*Peromyscus crinitus*	3, 4
deer mouse	*Peromyscus maniculatus*	3, 4
brush mouse	*Peromyscus boylei*	3, 4
pinyon mouse	*Peromyscus truei*	3
southern grasshopper mouse	*Onychomys torridus*	2, 3, 4
desert woodrat	*Neotoma lepida*	3, 4
Leporidae		
black-tailed jack rabbit	*Lepus califonicus*	4

TABLE 7-3

MAMMALS KNOWN TO OCCUR ON FORT IRWIN
FORT IRWIN, CALIFORNIA

Common Name	Scientific Name	Source
desert cottontail	*Sylvilagus audubonii*	3, 4
Bovidae		
desert big horn sheep	*Ovis canadensis nelsoni**	4
Equidae		
wild burros	*Equus asinus*	4

Notes:
* - Indicates sensitive species status.
+ - Unconfirmed sighting, personal communication from Fort Irwin Enviro. Div. personnel
(I) - Introduced species

Sources:

1 Robert D. Niehaus, Inc , 1995. Herpetological Survey and Physiological Studies on the Western Portion of Fort Irwin NTC.

2 Nagy, K.A. and T.L. Brown, 1994. Ecological and Impact Sensitivity of Reptiles at Fort Irwin

3 Robert D. Niehaus, Inc., 1995. Small Mammal Survey of Selected Sites at NTC, Fort Irwin, CA.

4 Krzysik, A.J., 1991. Ecological Assessment of Military Training Effects on Threatened, Endangered, and Sensitive Animals and Plants at Fort Irwin, CA.

5 Forrest Shepard and Dr. Bob Rechtman, personal communication

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10 Brown, Patricia E., 1994. Bat Survey of the NTC Fort Irwin, San Bernardino Co , CA.

11 Morafka, David J , 1993. Amphibian and Reptile Study of 20 Sites at the NTC, Fort Irwin. (Draft Report)

12 McCalvin, Catherine and David Pereksta, 1994. Biological Inventory of the Hellwind Conyon Drainage System, Military Fort Irwin Reservation, San Bernardino Co. CA.

13 Steve Ahman, personal communication.

TABLE 7-4

BIRDS KNOWN TO OCCUR ON FORT IRWIN
FORT IRWIN, CALIFORNIA

Common Name	Scientific Name	Source
BIRDS	**CLASS AVES**	
Podicipedidae		
western grebe	*Aerchmophorus occidentalis**	6
horned grebe	*Podiceps auritus*	6, 7
eared grebe	*Podiceps nigricollis*	6, 7
pied-billed grebe	*Podilymbus podiceps*	6, 7
Ardeidae		
great egret	*Casmerodius albus**	6, 7, 4
snowy egret	*Egretta thula**	7, 4
cattle egret	*Bubulcus ibis*	6, 7
great blue heron	*Ardea herodias**	6
black-crowned night heron	*Nycticorax nycticorax**	4
American bittern	*Botaurus lentiginosus*	4
Threskiornithidae		
white-faced ibis	*Plegadis chihi**	7, 4
Anatidae		
Canada geese	*Branta canadensis*	4
greater white-fronted geese	*Anser fabalis*	4
mallard	*Anas platyrhynchos*	6, 7, 4
Gadwall	*Anas strepera*	6, 7
American widgeon	*Anas americana*	6, 7
northern shoveler	*Anas clypeata*	6, 7
blue-winged teal	*Anas discors*	6, 7
cinnamon teal	*Anas cyanoptera*	6, 7, 4
green-winged teal	*Anas crecca*	6, 7, 4
wood duck	*Aix sponsa*	6, 7
redhead	*Aythya americana*	6, 7
canvasback	*Aythya valisineria*	6, 7
ring-necked duck	*Aythya collaris*	6, 7
lesser scaup	*Aythya affinis*	6, 7
bufflehead	*Bucephala albeola*	6, 7
ruddy duck	*Oxyura jamaicensis*	6, 7, 4
Cathartidae		
turkey vulture	*Cathartes aura*	6,7
Accipitridae		
sharp-shinned hawk	*Accipiter striatus**	6, 7
Copper's hawk	*Accipiter cooperii**	6, 7, 4
northern goshawk	*Accipiter gentilis*	12
northern harrier	*Circus cyaneus**	6, 7, 4
red-tailed hawk	*Buteo jamaicensis*	6, 7, 4
Swainson's hawk	*Buteo swainsoni**	6
golden eagle	*Aquila chrysaetos**	6, 4
Falconidae		
prairie falcon	*Falco mexicanus**	6, 7, 4
American kestrel	*Falco sparverius*	6, 7, 4
Phasianidae		
Gambel's quail	*Callipepla gambelii*	6
chukar (I)	*Alectoris chukar*	6
Rallidae		

TABLE 7-4

BIRDS KNOWN TO OCCUR ON FORT IRWIN
FORT IRWIN, CALIFORNIA

Common Name	Scientific Name	Source
Virginia rail	*Rallus limicola*	6, 7
sora	*Porzana carolina*	6, 7
black rail	*Laterallus jamaicensis**	6, 7
American coot	*Fulica americana*	6, 7, 4
Charadriidae		
semipalmated plover	*Charadrius semipalmatus*	7
killdeer	*Charadrius vociferus*	6, 7
Recurvirostridae		
American avocet	*Recurvirostra americana*	6, 7
black-necked stilt	*Himantopus mexicanus*	6, 7
Scolopacidae		
long-billed curlew	*Numenius americanus**	6
greater yellow legs	*Tringa melanoleuca*	7
spotted sandpiper	*Actitus macularia*	6, 7
western sandpiper	*Calidris pusilla*	7
dunlin	*Calidris alpina*	7
long-billed dowitcher	*Limnodromus griseus*	7
Wilson's phalarope	*Phlaropus tricolor*	7
red-necked phalarope	*Phalaropus lobatus*	6, 7
common snipe	*Gallinago gallinago*	6, 7
Laridae		
California gull	*Larus californicus**	6, 7
ring-billed gull	*Larus delawarensis*	6, 7
Bonaparte's gull	*Larus philadelphia*	6, 7
yellow-footed gull	*Larus livens*	7
black tern	*Chlidonias niger**	7
Columbidae		
mourning dove	Zenaida macroura	6, 7
white-winged dove	Zenaida asiatica	12
ringed turtle-dove (I)	Streptopelia risoria	6
Cuculidae		
greater roadrunner	Geococcyx californianus	6, 7
Tytonidae		
barn owl	*Tyto alba*	6, 4
Strigidae		
western screech owl	*Otus kennicottii*	4
great horned owl	*Bubo virginianus*	6, 4
long-eared owl	*Asio otus**	6, 4
short-eared owl	*Asio flammeus**	12
burrowing owl	*Athene cunicularia**	6,4
Caprimulgidae		
common poorwill	*Phalaenoptilus nuttallii*	12
lesser nighthawk	*Chordeiles acutipennis*	6, 7
Apodidae		
Vaux's swift	*Chaetura vauxi**	6
white-throated swift	*Aeronautes saxatalis*	6, 7
Trochilidae		
black-chinned hummingbird	*Archilochus alexandri*	6
Anna's hummingbird	*Calypte anna*	12

TABLE 7-4

BIRDS KNOWN TO OCCUR ON FORT IRWIN
FORT IRWIN, CALIFORNIA

Common Name	Scientific Name	Source
Costa's hummingbird	*Calypte costae*	6
rufous hummingbird	*Selasphorus rufus*	6
Alcedinidae		
belted kingfisher	*Ceryle alcyon*	6, 7
Picidae		
northern flicker	*Colaptes auratus*	6, 7
ladder-backed woodpecker	*Picoides scalaris*	6
Tyrannidae		
Western kingbird	*Tyrannus verticalis*	6, 7, 4
Cassin's kingbird	*Tyrannus vociferans*	6
ash-throated flycatcher	*Myiarchus cinerascens*	6, 7
black phoebe	*Sayornis nigricans*	6, 7, 4
Say's phoebe	*Sayornis saya*	6, 7, 4
olive-sided flycatcher	*Contopus borealis*	12
western wood-pewee	*Contopus sordidulus*	6, 7
willow flycatcher	*Empidonax trailli*	12
Empidonax spp.	*Empidonax spp.*	6, 7
Alaudidae		
horned larks	*Eremophila alpestris**	6, 7, 4
Hirundinidae		
barn swallow	*Hirundo rustica*	6, 7
cliff swallow	*Hirundo pyrrhonota*	6, 7
violet-green swallow	*Tachycineta thalassina*	6, 7
tree swallow	*Tachycineta bicolor*	6
northern rough-winged swallow	*Stelgidopteryx serripennis*	6, 7
Corvidae		
common raven	*Corvus corax*	6, 7, 4
Remizidae		
verdin	*Auriparus flaviceps*	6, 4
Troglodytidae		
house wren	*Troglodytes aedon*	12
Bewick's wren	*Thryomanes bewickii*	6, 7
cactus wren	*Campylorhynchus brunneicapillus*	6, 4
rock wren	*Salpinctes obsoletus*	6, 4
canyon wren	*Catherpes mexicanus*	6
marsh wren	*Cistothorus palustris*	6, 7
Muscicapidae		
American robin	*Turdus migratorius*	6, 7
hermit thrush	*Catharus guttatus*	6, 7
mountain bluebird	*Sialia currucoides*	6, 7
blue-gray gnatcatcher	*Polioptila caerulea*	6
black-tailed gnatcatcher	*Polioptila nigriceps**	6
ruby-crowned kinglet	*Regulus calendula*	6, 7
Mimidae		
northern mockingbird	*Mimus polyglottos*	6, 7, 4
sage thrasher	*Oreoscoptes montanus*	13
Bendire's thrasher	*Toxostoma bendirei**	6
Le Conte's thrasher	*Toxostoma lecontei**	6, 4
crissal thrasher	*Toxostoma dorsale**	6

TABLE 7-4

BIRDS KNOWN TO OCCUR ON FORT IRWIN
FORT IRWIN, CALIFORNIA

Common Name	Scientific Name	Source
Motacillidae		
American pipit	*Anthus rubescens*	6, 7
Bombycillidae		
cedar waxwing	*Bombycilla cedrorum*	6
Ptilogonatidae		
phainopepla	*Phainopepla nitens*	6
Laniidae		
loggerhead shrike	*Lanius ludovicianus**	6, 7, 4
Sturnidae		
European starling (I)	*Sturnus vulgaris*	6, 7
Vireonidae		
gray vireo	*Vireo vicinior**	6
solitary vireo	*Vireo solitarius*	6, 7
Bell's vireo	*Vireo bellii*	6
least Bell's vireo	*Vireo bellii pusillus**	4
warbling vireo	*Vireo gilvus*	6, 7
Emberizidae		
orange-crowned warbler	*Vermivora celata*	6, 7
Tennessee warbler	*Vermivora peregrina*	8?
Nashville warbler	*Vermivora ruficapilla*	6
Virginia's warbler	*Vermivora virginiae**	6
yellow warbler	*Dendroica petechia**	6, 7
yellow-rumped warbler	*Dendroica coronata*	6, 7
black-throated gray warbler	*Dendroica nigrescens*	6
Townsend's warbler	*Dendroica townsendi*	6, 7
hermit warbler	*Dendroica occidentalis*	6
MacGillivray's warbler	*Oporornis tolmiei*	6, 7
common yellowthroat	*Geothlypis trichas*	6, 7
yellow-breasted chat	*Icteria virens**	6
Wilson's warbler	*Wilsonia pusilla*	6, 7
western tanager	*Piranga lodoviciana*	6, 7
black-headed grosbeak	*Pheucticus melanocephalus*	6, 7
indigo bunting	*Passerina cyanea*	7
lazuli bunting	*Passerina amoena*	6
green-tailed towhee	*Pipilo chlorurus*	6
rufous-sided towhee	*Pipilo erythrophthalmus*	12
American tree sparrow	*Spizella arborea*	6, 7
chipping sparrow	*Spizella passerina*	6, 7
Brewer's sparrow	*Spizella breweri*	6, 4
lark sparrow	*Chindestes grammacus*	6
black-throated sparrow	*Amphispiza bilineata*	6, 4
sage sparrow	*Amphispiza belli*	6, 4
Savannah sparrow	*Passerculus sandwichensis*	6, 7
song sparrow	*Melospiza melodia*	6, 7, 4
Lincoln's sparrow	*Melospiza lincolnii*	6
white-crowned sparrow	*Zonotrichia leucophrys*	6, 7, 4
dark-eyed junco	*Junco hyemalis*	6, 7
red-winged blackbird	*Agelaius phoeniceus*	6, 7
western meadow lark	*Sturnella neglecta*	6, 7

TABLE 7-4

BIRDS KNOWN TO OCCUR ON FORT IRWIN
FORT IRWIN, CALIFORNIA

Common Name	Scientific Name	Source
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	6, 7
rusty blackbird	*Euphagus carolinus*	6
Brewer's blackbird	*Euphagus cyanocephalus*	6, 7
brown-headed cowbird	*Molothrus ater*	6, 7
great-tailed grackle	*Quiscalus mexicanus*	6, 7
boat-tailed grackle	*Quiscalus major*	9
northern oriole	*Icterus galbula*	6
Scott's oriole	*Icterus parisorum*	6, 4
Fingillidae		
house finch	*Carpodacus mexicana*	6, 7
lesser goldfinch	*Carduelis psaltria*	6
Passeridae		
house sparrow (I)	*Passer domesticus*	6, 7

Notes:
* - Indicates sensitive species status.
+ - Unconfirmed sighting, personal communication from Fort Irwin Enviro Div personnel
(I) - Introduced species.

Sources:

1 Robert D. Niehaus, Inc , 1995. Herpetological Survey and Physiological Studies on the Western Portion of Fort Irwin NTC

2 Nagy, K.A. and T.L. Brown, 1994 Ecological and Impact Sensitivity of Reptiles at Fort Irwin.

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4 Krzysik, A.J., 1991. Ecological Assessment of Military Training Effects on Threatened, Endangered, and Sensitive Animals and Plants at Fort Irwin, CA.

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7 Brydolf, Barbara, 1995. Birds Found at Fort Irwin Sewage Treatment Ponds, 1994 and Spring 1995.

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10 Brown, Patricia E., 1994 Bat Survey of the NTC Fort Irwin, San Bernardino Co., CA

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12 McCalvin, Catherine and David Pereksta, 1994. Biological Inventory of the Hellwind Conyon Drainage System, Military Fort Irwin Reservation, San Bernardino Co. CA

13 Steve Ahman, personal communication.

TABLE 7-5

SELECTION OF CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN FOR SUFACE SOILS[a]
SUBSITE FTIR-07/d
FORT IRWIN, CALIFORNIA

Constituent	Soil Concentration (mg/kg) Maximum[b]		Minimum[c]		Mean[d]	Number of Samples[e]	Detections[f]	Detection Frequency	BUTL[g] (mg/kg)	COPEC[h]
Inorganics										
Aluminum	7240		4030		5820	3	3	100%	23,600	No
Arsenic	4.6	J	4.6	J	5.0	3	1	33%	9.14	No
Barium	58.4		45.0		55.5	3	3	100%	175	No
Beryllium	0.27		0.16	J	0.22	3	3	100%	1.17	No
Calcium	5070		1750		3000	3	3	100%	--	No[j]
Chromium	5.9		3.6		4.7	3	3	100%	27.7	No
Cobalt	3.5		1.9		2.7	3	3	100%	12.9	No
Copper	88.6		8.1		49.4	3	3	100%	28.7	Yes
Iron	8250		5930		7490	3	3	100%	--	No[j]
Lead	6.9		2.6[i]	nd	5.2	3	2	67%	7.33	No
Magnesium	2890		1890		2480	3	3	100%	na	No[j]
Manganese	183		149		171	3	3	100%	361	No
Nickel	4.8		2.7	J	4.0	3	3	100%	29.1	No
Potassium	1910		1350		1710	3	3	100%	--	No[j]
Sodium	141	J	53.1	J	88.5	3	3	100%	--	No[j]
Vanadium	13.2		9.0		11.8	3	3	100%	97	No
Zinc	170		24.6		103	3	3	100%	51	Yes

Notes:

[a] Surface soil depth equal to 0 - 0.5 ft bgs.

[b] Maximum detected concentration of original or duplicate soil samples (0 - 0.5 ft bgs).

[c] Minimum concentration of original or duplicate soil samples (0 - 0.5 feet).

[d] The arithmetic mean soil concentration for soil samples collected in the interval 0 - 0.5 ft bgs.

[e] Total number of soil samples collected in the 0 - 0.5 ft bgs (excludes duplicate samples).

[f] Total number of detections in soil samples collected in the interval 0 - 0.5 ft bgs (excludes duplicate samples).

[g] Background upper tolerance limit (BUTL) for Fort Irwin Soils. Source: Parsons Engineering Science, Inc., 1996.

[h] Constituent is considered a chemical of potential ecological concern (COPEC) if maximum concentration exceeds BUTL.

[i] Minimum concentration is a non-detect value and is assumed to be one-half the detection limit.

[j] Analyte eliminated as a COPEC based on its role as an essential dietary nutrient (refer to Section 7.3.4).

J - Estimated value.

mg/kg - Milligrams per kilogram.

-- - Not applicable.

nd - Not detected.

TABLE 7-6

SELECTION OF CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN FOR SUBSURFACE SOILS[a]
SUBSITE FTIR-07/d
FORT IRWIN, CALIFORNIA

(Page 1 of 2)

Constituent	Soil Concentration (mg/kg) Maximum[b]		Minimum[c]		Mean[d]	Number of Samples[e]	Detections[f]	Detection Frequency	BUTL[g] (mg/kg)	COPEC[h]
Inorganics										
Aluminum	7750		1380		4960	6	6	100%	23,600	No
Arsenic	9.8	J	3.8	J	6.7	6	5	83%	9.14	Yes
Barium	203		38.2		80.8	6	6	100%	175	Yes
Beryllium	0.410		0.043	J	0.209	6	6	100%	1.17	No
Cadmium	0.560		0.255[i]	nd	0.314	6	1	17%	0.416	Yes
Calcium	27700		3350		12000	6	6	100%	--	No[j]
Chromium	7.3		1.1		4.2	6	6	100%	27.7	No
Cobalt	4.2		0.5[i]	nd	2.4	6	5	83%	12.9	No
Copper	236		5.0		51.1	6	6	100%	28.7	Yes
Iron	14600		1770		6490	6	6	100%	--	No[j]
Lead	18.9		2.6[i]	nd	6.0	6	3	50%	7.33	Yes
Magnesium	5370		762		2660	6	6	100%	--	No[j]
Manganese	227		60.4		135	6	6	100%	361	No
Molybdenum	0.68	J	0.53	J	0.95	6	1	17%	4.58	No
Nickel	8.0		2.0[i]	nd	4.5	6	5	83%	29.1	No
Potassium	2100		405	J	1260	6	6	100%	--	No[j]
Sodium	449	J	40.4	J	202	6	6	100%	--	No[j]
Vanadium	15.0		3.4		9.6	6	6	100%	97	No
Zinc	824		11.8		182	6	6	100%	51	Yes
Semivolatile Organics										
Di-n-butyl phthalate	35.0		0.17[i]	nd	6.0	6	1	17%	--	Yes

TABLE 7-6

SELECTION OF CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN FOR SUBSURFACE SOILS[a]
SITE FTIR-07/d
FORT IRWIN, CALIFORNIA

Constituent	Soil Concentration (mg/kg) Maximum[b]		Minimum[c]		Mean[d]	Number of Samples[e]	Detections[f]	Detection Frequency	BUTL[g] (mg/kg)	COPEC[h]
Dioxins and Furans										
1,2,3,4,6,7,8-HpCDD	0.000003	J	0.000003	J	0.000003	1	1	100%		
OCDD	0.000020		0.000020		0.000020	1	1	100%		
TEQ (2,3,7,8-TCDD)	5.0E-08								--	Yes
Herbicides										
2,4,5-TP (Silvex)	0.0012	J	0.0012	J	0.0024	3	1	33%	--	Yes
Nitrosoamines										
N-Nitrosodiphenylamine	4.4		0.050[i]	nd	0.504	12	1	8%	--	Yes
Explosives										
2,4-Dinitrotoluene	45.0		0.17[i]	nd	7.65	6	1	14%	--	Yes

Notes:

[a] Subsurface soil depth equal to 2.5 - 5.0 ft bgs.

[b] Maximum detected concentration of original or duplicate soil samples (2.5 - 5.0 ft bgs).

[c] Minimum concentration of original or duplicate soil samples (2.5 - 5.0 feet).

[d] The arithmetic mean soil concentration for soil samples collected in the interval 2.5 - 5.0 ft bgs.

[e] Total number of soil samples collected in the 2.5 - 5.0 ft bgs (excludes duplicate samples).

[f] Total number of detections in soil samples collected in the interval 2.5 - 5.0 ft bgs (excludes duplicate samples).

[g] Background upper tolerance limit (BUTL) for Fort Irwin Soils. Source: Parsons Engineering Science, Inc., 1996.

[h] Constituent is considered a chemical of potential ecological concern (COPEC) if maximum concentration exceeds BUTL.

[i] Minimum concentration is a non-detect value and is assumed to be one-half the detection limit.

[j] Analyte eliminated as a COPEC based on its role as an essential dietary nutrient (refer to Section 7.3.4).

1,2,3,4,6,7,8-HpCDD - 1,2,3,4,6,7,8-Heptachlorodibynzo-p-dioxin

J - Estimated value.

mg/kg - Milligrams per kilogram.

-- - Not applicable.

nd - not detected.

OCDD-Octachlorodibenzo-p-dioxin

TEQ (2,3,7,8-TCDD) - 2,3,7,8-TCDD toxicity equivalent concentration.

2,4,5-TP - 2,4,5-Trichloro(phenoxyacetic) propionic acid

TABLE 7-7

SUMMARY OF CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN[a]
SUBSITE FTIR-07/d
FORT IRWIN, CALIFORNIA

Surface Soils[b]	Subsurface Soils[c]
Inorganics	**Inorganics**
Copper	Arsenic
Zinc	Barium
	Cadmium
	Copper
	Lead
	Zinc
	SVOCs
	Di-n-butyl phthalate
	Dioxins and Furans
	1,2,3,4,6,7,8-HpCDD
	OCDD
	Herbicides
	2,4,5-TP (Silvex)
	Nitrosoamines
	N-Nitrosodiphenylamine
	Explosives
	2,4-Dinitrotoluene

Notes:

[a] Refer to Tables 7-5 and 7-6 for COPEC selection

[b] Surface soil depth equal to 0 - 0.5 ft bgs.

[c] Subsurface soil depth equal to 2.5 - 5 ft bgs.

1,2,3,4,6,7,8-HpCDD - 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin

OCDD - Octachlorodibenzo-p-dioxin

SVOC - Semi-volatile organic compounds

2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin

2,4,5-TP - 2,4,5-Trichloro(phenoxyacetic)propionic acid

TABLE 7-8

EXPOSURE POINT CONCENTRATIONS FOR SUBSURFACE SOILS
SUBSITE FTIR-07/d
FORT IRWIN, CALIFORNIA

COPEC	Maximum Concentration (mg/kg)		Minimum Concentration [a] (mg/kg)		95 % UCL Concentration [b] (mg/kg)	Selected EPC (mg/kg) [c]
Inorganics						
Arsenic	9.8	J	3.8	J	8.6	8.6
Barium	203		38.2		184	184
Cadmium	0.56		0.255	(nd)	0.427	0.43
Copper	236		5.0		1970	236
Lead	18.9		2.6	(nd)	68.7	18.9
Zinc	824		11.8		55,200	824
SVOC						
Di-n-butyl phthalate	35.0	(nd)	0.17	(nd)	4,210	35.0
Dioxins/Furans						
1,2,3,4,6,7,8-HpCDD	0.000003		0.000003			
OCDD	0.000020		0.000020			
TEQ (2,3,7,8-TCDD)	0.000000050		0.000000050		nc	0.000000050
Herbicides						
2,4,5-TP (Silvex)	0.003	J	0.0012	J	nc	0.003
Nitrosamines						
N-Nitrosodiphenylamine	4.4		0.050	(nd)	173	4.4
Explosives						
2,4-Dinitrotoluene	45	(nd)	0.17	(nd)	1630	45

Notes:
[a] For samples which were non-detect (nd) one-half the detection limit was assumed.
[b] The 95 percent upper confidence limit (95 % UCL) was calculated based on a log-normal distribution.
[c] The exposure point concentration (EPC) is equal to the 95 % UCL. However, when the 95 % UCL exceeded the maximum concentration detected, or the 95 % UCL could not be calculated, the maximum concentration was assumed as the EPC.
HpCDD - Heptachlorodibenzo-p-dioxin.
ND - Not detected
OCDD - Octachlorodibenzo-p-dioxin.
SVOC - Semivolatile organic compounds.
2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin.
TEQ - Toxicity equivalent concentration
2,4,5-TP - 2,4,5-Trichloro(phenoxyacetic)propionic acid.
COPEC - Chemical of potential ecological concern.
EPC - Exposure point concentration.
J - Estimated value.
mg/kg - Milligrams per kilogram.
nc - Not calculated.

TABLE 7-9

TRANSFER COEFFICIENTS FOR ECOLOGICAL FOOD CHAIN MODELING[a]
SUBSITE FTIR-07/d
FORT IRWIN, CALIFORNIA

COPEC	Octanol/Water Partition Coefficient [b] (K_{ow})	Soil-To-Plant Transfer Coefficient (TC_{s-p})	Plant-To-Animal Transfer Coefficient (TC_{p-a})
Inorganics			
Arsenic	--	4.0E-02	2.0E-03
Barium	--	1.5E-01	1.5E-04
Cadmium	--	5.5E-01	6.5E-04
Copper	--	4.0E-01	1.0E-02
Lead	--	4.5E-02	3.0E-04
Zinc	--	1.5E+00	1.0E-01
SVOC			
Di-n-butylphthalate	3.7E+04	1.7E-02	7.5E-03
Dioxins/Furans			
2,3,7,8-TCDD	1.4E+06	2.1E-03	2.8E-01
Herbicides			
2,4,5-TP [c]	1.4E+03	1.2E-01	2.7E-04
Nitrosamines			
N-Nitrosodiphenylamine	1.4E+03	1.2E-01	2.7E-04
Explosives			
2,4-Dinitrotoluene [d]	2.6E+02	3.0E-01	5.3E-05

Notes:
[a] Refer to Section 7.4.5.1 for a description of transfer coefficient derivation
[b] Source: The Installation Restoration Program Toxicology Guide (ORNL, 1989).
[c] Based on 2,4,5-trichlorophenoxy acetic acid (2,4,5-T)
[d] Based on 2,6-dinitrotoluene.

-- - Not available
COPEC - Chemical of potential ecological concern.
SVOC - Semivolatile organic compounds.
2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin
2,4,5-TP - 2,4,5-Trichlorophenoxy propanoic acid

TABLE 7-10

EXPOSURE PARAMETERS FOR ECOLOGICAL INDICATOR RECEPTORS
SUBSITE FTIR-07/d
FORT IRWIN, CALIFORNIA

Exposure Parameter	Exposure Value: Mohave Ground Squirrel	Exposure Value: Golden Eagle
Body Weight (g)	108 [a]	3,750 [a]
	(85-130) [b]	(3,000-4,500) [b]
Diet Composition (%) [c]		
Plant Matter	100	0
Animal Matter	0	100
Food Ingestion Rate (g/d) [d]		
Plant Matter (IR_{Plant})	17.4	0
Animal Matter (IR_{Animal})	0	138
Soil Ingestion Rate (IR_{Soil})		
(%) [e]	2.4	<2
(g/d) [f]	0.4	2.8
Skin Surface Area (SSA) (cm^2)		
Total [g]	258	2,420
Exposed [h]	10.3	193.6
Home Range (HR) (acres) [i]	0.9	22,980
Exposure Area (EA) (acres) [j]		
FTIR-07/d	0.39	2.76
Site Utilization Factor (SUF) (unitless) [k]		
FTIR-07/d	0.43	1.7E-05
Exposure Duration (ED) (year) [l]	0.5	1.0

Notes:
[a] Average body weight for males and females combined (Whitaker 1977; 1996)
[b] Range of body weights for males and females (Whitaker, 1996).
[c] Source: Zeiner (1990).
[d] Calculated using Equations 3-9 (Mohave ground squirrel) and 3-3 (golden eagle) in USEPA (1993).
[e] Soil ingestion rates were derived from USEPA (1993); Mohave ground squirrel based on meadow vole soil ingestion rate, golden eagle based on soil ingestion rate for passerines
[f] Calculated as percent soil ingestion rates derived from USEPA (1993) multiplied by the food ingestion rate (g/d).
[g] Total skin surface area was calculated using Equation 3-22 (mammals) and 3-21 (birds) in USEPA (1993).
[h] Exposed skin surface area was calculated assuming the area of the feet (4% of total skin surface area) for the Mohave ground squirrel and the beak and legs (8% of total surface area) for the golden eagle
[i] Home range is equal to the area necessary to support the dietary and reproductive needs of each animal
[j] Exposure area based on the total area of each site.
[k] Site utilization factors are calculated as the exposure area divided by the home range
[l] Exposure duration (i.e., percent of year exposed) for the Mohave ground squirrel equal to 0.5 based on the fact that the species estivates and hibernates from August to March; and 1.0 for the golden eagle which is non-migratory and does not hibernate (Zeiner, 1990).

TABLE 7-11

ECOLOGICAL TOXICITY REFERENCE VALUES
FOR THE MOHAVE GROUND SQUIRREL -- ARMY VALUES
SUBSITE FTIR-07d
FORT IRWIN, CALIFORNIA

COPEC	Army Toxicity Benchmark [a] (mg/kg-d)	Benchmark Species	Benchmark Species Body Weight (kg)	Allometric Toxicity Reference Value - TRV_{Army} [b] (mg/kg-d)
Inorganics				
Arsenic	1.3E-01	mouse	0.030	9.1E-02
Barium	5.1E+00	rat	0.35	6.8E+00
Cadmium	1.0E+00	rat	0.35	1.3E+00
Copper	1.2E+01	mink	1.0	2.0E+01
Lead [c]	1.5E+00	various	--	1.5E+00
Zinc	1.6E+02	rat	0.35	2.1E+02
SVOC				
Di-n-butylphthalate	5.5E+02	mouse	0.030	4.0E+02
Dioxins/Furans				
2,3,7,8-TCDD	1.0E-06	rat	0.35	1.3E-06
Herbicides				
2,4,5-TP	1.0E+01	rat	0.35	1.3E+01
Nitrosamines				
N-Nitrosodiphenylamine	--	--	--	--
Explosives				
2,4-Dinitrotoluene	2.0E+01	rat	0.35	2.7E+01

Notes:
[a] Toxicity benchmarks were obtained from Sample et al. (1996), unless otherwise specified
[b] Mohave Ground Squirrel toxicity reference values are derived from body weight-based allometric conversion of the toxicity benchmark value using the following equation:

$$\text{Dose}_{\text{squirrel}} = \text{Dose}_{\text{test organism}} (\text{Body Weight}_{\text{test organism}} / \text{Body Weight}_{\text{squirrel}})^{0.25}$$

Where the body weight of the Mohave Ground Sqirrel is 0.108 kg.
[c] Army mammalian TRV for lead (USAEC, 2001)

COPEC - Chemical of potential ecological concern.
kg - Kilograms.
mg/kg-d - Milligrams per kilogram body weight per day.
-- Not Available or Not Applicable
2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin
2,4,5-TP - 2,4,5-Trichloro(phenoxyacetic)propionic acid
TRV - Toxicity reference value

TABLE 7-12

ECOLOGICAL TOXICITY REFERENCE VALUES
FOR THE MOHAVE GROUND SQUIRREL --
BIOLOGICAL TOXICITY ADVISORY GROUP (BTAG) VALUES
SUBSITE FTIR-07d
FORT IRWIN, CALIFORNIA

	BTAG--Low Toxicity Reference Value				BTAG--High Toxicity Reference Value			
COPEC	BTAG--Low Benchmark [a] (mg/kg-d)	Benchmark Species	Species Body Weight (kg)	Allometric BTAG TRV_{Low} (mg/kg-d) [b]	BTAG--High Benchmark [a] (mg/kg-d)	Benchmark Species	Species Body Weight (kg)	Allometric BTAG TRV_{High} (mg/kg-d) [b]
Inorganics								
Arsenic	3.2E-01	rat	0.33	4.2E-01	4.7E+00	rat	0.11	4.7E+00
Barium	--	--	--	--	--	--	--	--
Cadmium	6.0E-02	mouse	0.03	4.4E-02	2.6E+00	mouse	0.03	1.9E+00
Copper	2.7E+00	mouse	0.03	1.9E+00	6.3E+02	mouse	0.02	4.4E+02
Lead	1.5E-03	rat	0.21	1.8E-03	2.4E+02	mouse	0.02	1.6E+02
Zinc	9.6E+00	mouse	0.03	6.7E+00	4.1E+02	rat	0.18	4.6E+02

Notes:

[a] BTAG Low and High toxicity reference values and test organism weights were obtained from EFA, West (1998).

[b] Mohave Ground Squirrel toxicity reference values are derived from body weight-based allometric conversion of the toxicity benchmark value using the following equation:

$$\text{Dose}_{\text{squirrel}} = \text{Dose}_{\text{test organism}} (\text{Body Weight}_{\text{test organism}} / \text{Body Weight}_{\text{squirrel}})^{0.25}$$

Where the body weight of the Mohave Ground Squirrel is 0.108 kg.

COPEC - Chemical of potential ecological concern.
kg - Kilograms.
mg/kg-d - Milligrams per kilogram body weight per day.
-- Not Available or Not Applicable.
TRV - Toxicity reference value.

TABLE 7-13

ECOLOGICAL TOXICITY REFERENCE VALUES
FOR THE GOLDEN EAGLE -- ARMY VALUES
SUBSITE FTIR-07/d
FORT IRWIN, CALIFORNIA

COPEC	Army Toxicity Benchmark [a] (mg/kg-d)	Benchmark Species	Benchmark Species Body Weight (kg)	Allometric Toxicity Reference Value - TRV_{Army} [b] (mg/kg-d)
Inorganics				
Arsenic	5.1E+00	mallard	1	1.4E+00
Barium	2.1E+01	chicken	0.12	6.7E-01
Cadmium	1.5E+00	mallard	1.15	4.4E-01
Copper	4.7E+01	chicken	0.12	1.5E+00
Lead	3.9E+00	kestrel	0.13	1.3E-01
Zinc	1.5E+01	chicken	1.9	7.3E+00
SVOC				
Di-n-butylphthalate	1.1E-01	ring dove	0.16	4.7E-03
Dioxins/Furans				
2,3,7,8-TCDD	1.4E-05	ring-necked pheasant	1	3.7E-06
Herbicides				
2,4,5-TP	--	--	--	--
Nitrosamines				
N-Nitrosodiphenylamine	--	--	--	--
Explosives				
2,4-Dinitrotoluene	--	--	--	--

Notes:
[a] Toxicity benchmarks were obtained from Sample et al. (1996), unless otherwise specified
[b] Golden Eagle toxicity reference values are derived from body weight-based allometric conversion of the toxicity benchmark value using the following equation:

$$\text{Dose}_{\text{golden eagle}} = \text{Dose}_{\text{test organism}} (\text{Body Weight}_{\text{test organism}} / \text{Body Weight}_{\text{golden eagle}})$$

Where the body weight of the Golden Eagle is 3.75 kg

COPEC - Chemical of potential ecological concern
kg - Kilograms
mg/kg-d - Milligrams per kilogram body weight per day
-- Not Available or Not Applicable
2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin
2,4,5-TP - 2,4,5-Trichloro(phenoxyacetic)propionic acid
TRV - Toxicity reference value

TABLE 7-14

ECOLOGICAL TOXICITY REFERENCE VALUES
FOR THE GOLDEN EAGLE --
BIOLOGICAL TOXICITY ADVISORY GROUP (BTAG) VALUES
SUBSITE FTIR-07/d
FORT IRWIN, CALIFORNIA

	BTAG--Low Toxicity Reference Value				BTAG--High Toxicity Reference Value			
COPEC	BTAG--Low Benchmark [a] (mg/kg-d)	Benchmark Species	Species Body Weight (kg)	Allometric BTAG TRV_{Low} (mg/kg-d) [b]	BTAG--High Benchmark [a] (mg/kg-d)	Benchmark Species	Species Body Weight (kg)	Allometric BTAG TRV_{High} (mg/kg-d) [b]
Inorganics								
Arsenic	5.50E+00	mallard	1	1.5E+00	2.20E+01	mallard	1	5.9E+00
Barium	--	--	--	--	--	--	--	--
Cadmium	8.00E-02	mallard ducklings	0.782	1.7E-02	1.04E+01	japanese quail chicks	0.072	2.0E-01
Copper	2.30E+00	broiler chicks	0.121	7.4E-02	5.23E+01	broiler chicks	0.121	1.7E+00
Lead	1.40E-02	japanese quail chicks	0.072	2.7E-04	8.75E+00	chicken	0.12	2.8E-01
Zinc	1.72E+01	mallard ducklings	0.782	3.6E+00	1.72E+02	mallard	0.782	3.6E+01

Notes:

[a] BTAG Low and High Toxicity Reference Values and test organism weights were obtained from EFA, West (1998).

[b] Golden Eagle toxicity reference values are derived from body weight-based allometric conversion of the toxicity benchmark value using the following equation:

$$\text{Dose golden eagle} = \text{Dose}_{\text{test organism}} (\text{Body Weight}_{\text{test organism}} / \text{Body Weight}_{\text{golden eagle}})$$

Where the body weight of the Golden Eagle is 3.75 kg.

COPEC - Chemical of potential ecological concern.
kg - Kilograms.
mg/kg-d - Milligrams per kilogram body weight per day.
-- Not Available or Not Applicable.
TRV Toxicity reference value.

TABLE 7-15

MOHAVE GROUND SQUIRREL
DOSE AND HAZARD QUOTIENT CALCULATIONS USING ARMY TRVs
SUBSITE FTIR-07/d SURFACE SOILS
FORT IRWIN, CALIFORNIA

COPEC	Exposure Point Concentration (EPC) EPC_{Soil} [a] (mg/kg)	EPC_{Plant} [b] (mg/kg)	Food Ingestion $Dose_{food}$ (mg/kg-day)	Incidental Soil Ingestion $Dose_{soil}$ (mg/kg-day)	Dermal Exposure $Dose_{dermal}$ (mg/kg-day)	Total Exposure $Dose_{total}$ (mg/kg-day)	Army TRV_{Army} [c] (mg/kg)	Army HQ [d] (unitless)
Inorganics								
Copper	88.6	35	1.2E+00	7.1E-02	3.6E-06	1.3E+00	2.0E+01	0.064
Zinc	170	255	8.8E+00	1.4E-01	7.0E-06	9.0E+00	2.1E+02	0.042
							Hazard Index (HI):	0.1

Notes:

[a] Maximum detected concentration in original or duplicate soil samples (0 - 0.5 foot bgs).

[b] Dietary exposure point concentration is the estimated concentration in dietary items (plants), based on the soil - plant transfer coefficient.

[c] Refer to Table 7-11 for army toxicity reference values for the Mohave ground squirrel.

[d] Hazard quotient calculated as: HQ (unitless) = Total exposure dose (mg/kg-d) / Toxicity reference value (mg/kg-d).

COPEC - Chemical of potential ecological concern.
HQ - Hazard quotient.
HI - Hazard index.

mg/kg - Milligrams per kilogram.
mg/kg-d - Milligrams per kilogram body weight per day.
-- - Not available.
TRV - Toxicity reference value

TABLE 7-16

MOHAVE GROUND SQUIRREL
DOSE AND HAZARD QUOTIENT CALCULATIONS USING BTAG TRVs
SUBSITE FTIR-07/d SURFACE SOILS
FORT IRWIN, CALIFORNIA

COPEC	Exposure Point Concentration (EPC) EPC_{Soil} [a] (mg/kg)	EPC_{Plant} [b] (mg/kg)	Food Ingestion $Dose_{food}$ (mg/kg-day)	Incidental Soil Ingestion $Dose_{soil}$ (mg/kg-day)	Dermal Exposure $Dose_{dermal}$ (mg/kg-day)	Total Exposure $Dose_{total}$ (mg/kg-day)	BTAG TRV_{Low} [c] (mg/kg)	HQ [d] (unitless)	BTAG TRV_{High} [c] (mg/kg)	HQ [d] (unitless)
Inorganics										
Copper	88.6	35	1.2E+00	7.1E-02	3.6E-06	1.3E+00	1.9E+00	0.67	4.4E+02	0.0030
Zinc	170	255	8.8E+00	1.4E-01	7.0E-06	9.0E+00	6.7E+00	1.3	4.6E+02	0.019
							Hazard Index (HI):	2.0	Hazard Index (HI):	0.02

Notes:

[a] Maximum detected concentration in original or duplicate soil samples (0 - 0.5 foot bgs).

[b] Dietary exposure point concentration is the estimated concentration in dietary items (plants), based on the soil - plant transfer coefficient.

[c] Refer to Table 7-12 for BTAG toxicity reference values for the Mohave ground squirrel.

[d] Hazard quotient calculated as: HQ (unitless) = Total exposure dose (mg/kg-d) / Toxicity reference value (mg/kg-d).

COPEC - Chemical of potential ecological concern.
HQ - Hazard quotient.
HI - Hazard index.

mg/kg - Milligrams per kilogram.
mg/kg-d - Milligrams per kilogram body weight per day.
-- - Not available.
TRV - Toxicity reference value

TABLE 7-17

MOHAVE GROUND SQUIRREL
DOSE AND HAZARD QUOTIENT CALCULATIONS USING ARMY TRVs
SUBSITE FTIR-07/d SUBSURFACE SOILS
FORT IRWIN, CALIFORNIA

COPEC	Exposure Point Concentration (EPC) EPC_{Soil} [a] (mg/kg)	EPC_{Plant} [b] (mg/kg)	Food Ingestion $Dose_{food}$ [c] (mg/kg-day)	Incidental Soil Ingestion $Dose_{soil}$ [c] (mg/kg-day)	Dermal Exposure $Dose_{dermal}$ (mg/kg-day)	Total Exposure $Dose_{total}$ (mg/kg-day)	Army TRV_{Army} [d] (mg/kg)	HQ [e] (unitless)
Inorganics								
Arsenic	8.6	0.34	1.2E-02	6.8E-03	3.5E-07	1.9E-02	9.1E-02	0.21
Barium	184	27.6	9.6E-01	1.5E-01	7.5E-06	1.1E+00	6.8E+00	0.16
Cadmium	0.43	0.24	8.2E-03	3.4E-04	1.8E-08	8.5E-03	1.3E+00	0.0064
Copper	236	94	3.3E+00	1.9E-01	9.7E-06	3.5E+00	2.0E+01	0.17
Lead	19	0.85	5.9E-03	3.0E-03	7.8E-07	8.9E-03	1.5E+00	0.0059
Zinc	824	1236	4.3E+01	6.6E-01	3.4E-05	4.3E+01	2.1E+02	0.20
SVOC								
Di-n-butyl phthalate	35	0.60	2.1E-02	2.8E-02	1.4E-05	4.9E-02	4.0E+02	0.00
Dioxins/Furans								
TEQ (2,3,7,8-TCDD)	5.0E-08	1.0E-10	3.6E-12	4.0E-11	2.1E-14	4.3E-11	1.3E-06	0.00
Herbicides								
2,4,5-TP	0.0030	0.00035	1.2E-05	2.4E-06	1.2E-09	1.5E-05	1.3E+01	0.00
Nitrosamines								
N-Nitrosodiphenylamine	4.4	0.52	1.8E-02	3.5E-03	1.8E-06	2.1E-02	--	0.00
Explosives								
2,4-Dinitrotoluene	45	13.7	4.7E-01	3.6E-02	1.8E-05	5.1E-01	2.7E+01	0.019
							Hazard Index (HI):	0.8

Notes:

[a] Maximum or 95% UCL concentration in original or duplicate soil samples (2.5 - 5 feet bgs).

[b] Dietary exposure point concentration is the estimated concentration in dietary items (plants), based on the soil - plant transfer coefficient.

[c] A bioavailability factor of 0.2 was applied to lead values only.

[d] Refer to Table 7-11 for army toxicity reference values for the Mohave ground squirrel.

[e] Hazard quotient calculated as: HQ (unitless) = Total exposure dose (mg/kg-d) / Toxicity reference value (mg/kg-d).

COPEC - Chemical of potential ecological concern.
HQ - Hazard quotient.
HI - Hazard index.
SVOC - Semivolatile organic compounds.
2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin.
2,4,5-TP - 2,4,5-Trichloro(phenoxyacetic)propanoic acid.
mg/kg - Milligrams per kilogram.
mg/kg-d - Milligrams per kilogram body weight per day.
-- - Not available.

TABLE 7-18

MOHAVE GROUND SQUIRREL
DOSE AND HAZARD QUOTIENT CALCULATIONS USING BTAG TRVs
SUBSITE FTIR-07/d SUBSURFACE SOILS
FORT IRWIN, CALIFORNIA

COPEC	Exposure Point Concentration (EPC) EPC_{Soil} [a] (mg/kg)	EPC_{Plant} [b] (mg/kg)	Food Ingestion $Dose_{food}$ [c] (mg/kg-day)	Incidental Soil Ingestion $Dose_{soil}$ [c] (mg/kg-day)	Dermal Exposure $Dose_{dermal}$ (mg/kg-day)	Total Exposure $Dose_{total}$ (mg/kg-day)	BTAG TRV_{Low} [d] (mg/kg)	BTAG HQ [e] (unitless)	BTAG TRV_{High} [d] (mg/kg)	BTAG HQ [e] (unitless)
Inorganics										
Arsenic	8.6	0.34	1.2E-02	6.8E-03	3.5E-07	1.9E-02	4.2E-01	0.044	4.7E+00	0.0040
Barium	184	27.6	9.6E-01	1.5E-01	7.5E-06	1.1E+00	--	--	--	--
Cadmium	0.43	0.24	8.2E-03	3.4E-04	1.8E-08	8.5E-03	4.4E-02	0.19	1.9E+00	0.0044
Copper	236	94	3.3E+00	1.9E-01	9.7E-06	3.5E+00	1.9E+00	1.8	4.4E+02	0.0079
Lead	19	0.85	5.9E-03	3.0E-03	7.8E-07	8.9E-03	1.8E-03	5.0	1.6E+02	0.000057
Zinc	824	1,236	4.3E+01	6.6E-01	3.4E-05	4.3E+01	6.7E+00	6.5	4.6E+02	0.094
SVOC										
Di-n-butyl phthalate	35	0.60	2.1E-02	2.8E-02	1.4E-05	4.9E-02	--	--	--	--
Dioxins/Furans										
TEQ (2,3,7,8-TCDD)	5.0E-08	1.0E-10	3.6E-12	4.0E-11	2.1E-14	4.3E-11	--	--	--	--
Herbicides										
2,4,5-TP	0.0030	0.00035	1.2E-05	2.4E-06	1.2E-09	1.5E-05	--	--	--	--
Nitrosamines										
N-Nitrosodiphenylamine	4.4	0.52	1.8E-02	3.5E-03	1.8E-06	2.1E-02	--	--	--	--
Explosives										
2,4-Dinitrotoluene	45	13.7	4.7E-01	3.6E-02	1.8E-05	5.1E-01	--	--	--	--
							Hazard Index (HI):	14	Hazard Index (HI):	0.1

Notes:

[a] Maximum or 95% UCL concentration in original or duplicate soil samples (2.5 - 5 feet bgs).

[b] Dietary exposure point concentration is the estimated concentration in dietary items (plants), based on the soil - plant transfer c

[c] A bioavailabitity factor of 0.2 was applied to lead values only.

[d] Refer to Table 7-12 for BTAG toxicity reference values for the Mohave ground squirrel.

[e] Hazard quotient calculated as: HQ (unitless) = Total exposure dose (mg/kg-d) / Toxicity reference value (mg/kg-d).

COPEC - Chemical of potential ecological concern.
HQ - Hazard quotient.
HI - Hazard index.
SVOC - Semivolatile organic compounds.
2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin.
2,4,5-TP - 2,4,5-Trichloro(phenoxyacetic)propanoic acid.
mg/kg - Milligrams per kilogram.
mg/kg-d - Milligrams per kilogram body weight per day.
-- - Not available.

TABLE 7-19

GOLDEN EAGLE
DOSE AND HAZARD QUOTIENT CALCULATIONS USING ARMY TRVs
SUBSITE FTIR-07/d SURFACE SOILS
FORT IRWIN, CALIFORNIA

COPEC	Exposure Point Concentration (EPC) EPC_{Soil} [a] (mg/kg)	EPC_{Plant} [b] (mg/kg)	$EPC_{Small\ Mammal}$ [c] (mg/kg)	Food Ingestion $Dose_{food}$ (mg/kg-day)	Incidental Soil Ingestion $Dose_{soil}$ (mg/kg-day)	Dermal Exposure $Dose_{dermal}$ (mg/kg-day)	Total Exposure $Dose_{total}$ (mg/kg-day)	Army TRV_{Army} [d] (mg/kg)	HQ [e] (unitless)
Inorganics									
Copper	78.8	35	3.5E-01	2.2E-07	1.0E-06	9.2E-11	1.2E-06	1.5E+00	8.0E-07
Zinc	2310	255	2.6E+01	1.6E-05	2.9E-05	2.7E-09	4.5E-05	7.3E+00	6.2E-06
								Hazard Index (HI):	0.000007

Notes:

[a] Maximum detected concentration in original or duplicate soil samples (0 - 0.5 foot bgs).

[b] Dietary exposure point concentration is the estimated concentration in dietary items (plants), based on the soil - plant transfer coefficient.

[c] Small mammal exposure point concentration is the estimated concentration in dietary items (small mammals), based on the plant-to-small mammal transfer coefficient.

[d] Refer to Table 7-13 for army toxicity reference values for the golden eagle.

[e] Hazard quotient calculated as: HQ (unitless) = Total exposure dose (mg/kg-day) / Toxicity reference value (mg/kg-day).

COPEC - Chemical of potential ecological concern.
HI - Hazard index.
HQ - Hazard quotient.
mg/kg - Milligrams per kilogram.
mg/kg-day - Milligrams per kilogram per day.
-- - Not available.

TALBLE 7-20

GOLDEN EAGLE
DOSE AND HAZARD QUOTIENT CALCULATIONS USING BTAG TRVs
SUBSITE FTIR-07/d SURFACE SOILS
FORT IRWIN, CALIFORNIA

COPEC	Exposure Point Concentration (EPC) EPC_{Soil} [a] (mg/kg)	EPC_{Plant} [b] (mg/kg)	$EPC_{Small\ Mammal}$ [c] (mg/kg)	Food Ingestion $Dose_{food}$ (mg/kg-day)	Incidental Soil Ingestion $Dose_{soil}$ (mg/kg-day)	Dermal Exposure $Dose_{dermal}$ (mg/kg-day)	Total Exposure $Dose_{total}$ (mg/kg-day)	BTAG TRV_{Low} [d] (mg/kg)	BTAG HQ [e] (unitless)	BTAG TRV_{High} [d] (mg/kg)	BTAG HQ [e] (unitless)
Inorganics											
Copper	78.8	35	3.5E-01	2.2E-07	1.0E-06	9.2E-11	1.2E-06	7.4E-02	1.6E-05	1.7E+00	7.2E-07
Zinc	2310	255	2.6E+01	1.6E-05	2.9E-05	2.7E-09	4.5E-05	3.6E+00	1.3E-05	3.6E+01	1.3E-06
								Hazard Index (HI):	0.00002	Hazard Index (HI):	0.000001

Notes:

[a] Maximum detected concentration in original or duplicate soil samples (0 - 0.5 foot bgs).

[b] Dietary exposure point concentration is the estimated concentration in dietary items (plants), based on the soil - plant transfer coefficient.

[c] Small mammal exposure point concentration is the estimated concentration in dietary items (small mammals), based on the plant-to-small mammal transfer coefficient.

[d] Refer to Table 7-14 for BTAG toxicity reference values for the golden eagle.

[e] Hazard quotient calculated as: HQ (unitless) = Total exposure dose (mg/kg-day) / Toxicity reference value (mg/kg-day).

COPEC - Chemical of potential ecological concern.
HI - Hazard index.
HQ - Hazard quotient.

mg/kg - Milligrams per kilogram.
mg/kg-day - Milligrams per kilogram per day.
-- - Not available.
TRV - Toxicity reference value

TABLE 7-21

GOLDEN EAGLE
DOSE AND HAZARD QUOTIENT CALCULATIONS USING ARMY TRVs
SUBSITE FTIR-07/d SUBSURFACE SOILS
FORT IRWIN, CALIFORNIA

COPEC	Exposure Point Concentration (EPC) EPC_{Soil} [a] (mg/kg)	EPC_{Plant} [b] (mg/kg)	$EPC_{Small\ Mammal}$ [c] (mg/kg)	Food Ingestion $Dose_{food}$ [d] (mg/kg-day)	Incidental Soil Ingestion $Dose_{soil}$ [d] (mg/kg-day)	Dermal Exposure $Dose_{dermal}$ (mg/kg-day)	Total Exposure $Dose_{total}$ (mg/kg-day)	Army TRV_{Army} [e] (mg/kg)	Army HQ [f] (unitless)
Inorganics									
Arsenic	8.6	0.30	6.0E-04	3.8E-10	1.1E-07	1.0E-11	1.1E-07	1.4E+00	8.0E-08
Barium	184	27.6	4.1E-03	2.6E-09	2.3E-06	2.2E-10	2.3E-06	6.7E-01	3.5E-06
Cadmium	0.40	0.20	1.3E-04	8.1E-11	5.1E-09	4.7E-13	5.2E-09	4.4E-01	1.2E-08
Copper	236	94	9.4E-01	5.9E-07	3.0E-06	2.8E-10	3.6E-06	1.5E+00	2.4E-06
Lead	19	0.90	2.7E-04	3.4E-11	4.8E-08	2.2E-11	4.8E-08	1.3E-01	3.6E-07
Zinc	824	1236	1.2E+02	7.7E-05	1.0E-05	9.6E-10	8.8E-05	7.3E+00	1.2E-05
SVOC									
Di-n-butyl phthalate	35	1.0	7.5E-03	4.7E-09	4.4E-07	4.1E-10	4.5E-07	4.7E-03	9.5E-05
Dioxins/Furans									
TEQ (2,3,7,8-TCDD)	5.0E-08	1.0E-10	2.8E-11	1.8E-17	6.3E-16	5.8E-19	6.5E-16	3.7E-06	1.7E-10
Herbicides									
2,4,5-TP	0.0030	0.00036	9.8E-08	6.1E-14	3.8E-11	3.5E-14	3.8E-11	--	--
Nitrosamines									
N-Nitrosodiphenylamine	4.0	0.50	1.4E-04	8.5E-11	5.1E-08	4.7E-11	5.1E-08	--	--
Explosives									
2,4-Dinitrotoluene	45	1.1	5.8E-05	3.6E-11	5.7E-07	5.3E-10	5.7E-07	--	--

Hazard Index (HI): 0.0001

TABLE 7-21

GOLDEN EAGLE
DOSE AND HAZARD QUOTIENT CALCULATIONS USING ARMY TRVs
SUBSITE FTIR-07/d SUBSURFACE SOILS
FORT IRWIN, CALIFORNIA

Notes:

[a] Maximum or 95% UCL concentration in original or duplicate soil samples (2.5 - 5 feet bgs).

[b] Dietary exposure point concentration is the estimated concentration in dietary items (plants), based on the soil - plant transfer coefficient.

[c] Small mammal exposure point concentration is the estimated concentration in dietary items (small mammals), based on the plant-to-small mammal transfer coefficient.

[d] A bioavailabitity factor of 0.2 was applied to lead values only.

[e] Refer to Table 7-13 for army toxicity reference values for the golden eagle.

[f] Hazard quotient calculated as: HQ (unitless) = Total Exposure Dose (mg/kg-day) / Toxicity Reference Value (mg/kg-day).

COPEC - Chemical of potential ecological concern.

HI - Hazard index.

HQ - Hazard quotient.

SVOC - Semivolatile organic compounds.

2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioixin.

2,4,5-TP - 2,4,5-Trichlorophenoxy propanoic acid.

mg/kg - Milligrams per kilogram.

mg/kg-day - Milligrams per kilogram body weight per day.

na - Not available.

TABLE 7-22

GOLDEN EAGLE
DOSE AND HAZARD QUOTIENT CALCULATIONS BTAG TRVs
SUBSITE FTIR-07/d SUBSURFACE SOILS
FORT IRWIN, CALIFORNIA

COPEC	Exposure Point Concentration (EPC) EPC_{Soil} [a] (mg/kg)	EPC_{Plant} [b] (mg/kg)	$EPC_{Small\ Mammal}$ [c] (mg/kg)	Food Ingestion $Dose_{food}$ [d] (mg/kg-day)	Incidental Soil Ingestion $Dose_{soil}$ [d] (mg/kg-day)	Dermal Exposure $Dose_{dermal}$ (mg/kg-day)	Total Exposure $Dose_{total}$ (mg/kg-day)	BTAG TRV_{Low} [e] (mg/kg)	BTAG HQ [f] (Unitless)	BTAG TRV_{High} [e] (mg/kg)	BTAG HQ [i] (Unitless)
Inorganics											
Arsenic	8.6	0.30	6.0E-04	3.8E-10	1.1E-07	1.0E-11	1.1E-07	1.5E+00	7.5E-08	5.9E+00	1.9E-08
Barium	184	27.6	4.1E-03	2.6E-09	2.3E-06	2.2E-10	2.3E-06	--	--	--	--
Cadmium	0.40	0.20	1.3E-04	8.1E-11	5.1E-09	4.7E-13	5.2E-09	1.7E-02	3.1E-07	2.0E-01	2.6E-08
Copper	236	94	9.4E-01	5.9E-07	3.0E-06	2.8E-10	3.6E-06	7.4E-02	4.8E-05	1.7E+00	2.1E-06
Lead	19	0.90	2.7E-04	3.4E-11	4.8E-08	2.2E-11	4.8E-08	2.7E-04	1.8E-04	2.8E-01	1.7E-07
Zinc	824	1236	1.2E+02	7.7E-05	1.0E-05	9.6E-10	8.8E-05	3.6E+00	2.4E-05	3.6E+01	2.4E-06
SVOC											
Di-n-butyl phthalate	35	1.0	7.5E-03	4.7E-09	4.4E-07	4.1E-10	4.5E-07	--	--	--	--
Dioxins/Furans											
TEQ (2,3,7,8-TCDD)	5.0E-08	1.0E-10	2.8E-11	1.8E-17	6.3E-16	5.8E-19	6.5E-16	--	--	--	--
Herbicides											
2,4,5-TP	0.0030	0.00036	9.8E-08	6.1E-14	3.8E-11	3.5E-14	3.8E-11	--	--	--	--
Nitrosamines											
N-Nitrosodiphenylamin	4.0	0.50	1.4E-04	8.5E-11	5.1E-08	4.7E-11	5.1E-08	--	--	--	--
Explosives											
2,4-Dinitrotoluene	45	1.1	5.8E-05	3.6E-11	5.7E-07	5.3E-10	5.7E-07	--	--	--	--
								Hazard Index (HI):	0.0003	Hazard Index (HI):	0.000005

TABLE 7-22

GOLDEN EAGLE
DOSE AND HAZARD QUOTIENT CALCULATIONS BTAG TRVs
SUBSITE FTIR-07/d SUBSURFACE SOILS
FORT IRWIN, CALIFORNIA

Notes:

[a] Maximum or 95% UCL concentration in original or duplicate soil samples (2.5 - 5 feet bgs).

[b] Dietary exposure point concentration is the estimated concentration in dietary items (plants), based on the soil - plant transfer coefficient.

[c] Small mammal exposure point concentration is the estimated concentration in dietary items (small mammals), based on the plant-to-small mammal transfer coefficient.

[d] A bioavailabitity factor of 0.2 was applied to lead values only.

[e] Refer to Table 7-14 for BTAG toxicity reference values for the golden eagle.

[f] Hazard quotient calculated as: HQ (unitless) = Total exposure dose (mg/kg-day) / Toxicity reference value (mg/kg-day).

COPEC - Chemical of potential ecological concern.

HI - Hazard index.

HQ - Hazard quotient.

SVOC - Semivolatile organic compounds.

2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioixin.

2,4,5-TP - 2,4,5-Trichlorophenoxy propanoic acid.

mg/kg - Milligrams per kilogram.

mg/kg-day - Milligrams per kilogram body weight per day.

-- - Not available.

TABLE 7-23

SUMMARY OF ECOLOGICAL RISK CHARACTERIZATION RESULTS
BASED ON ARMY AND BTAG TRVs
SITE FTIR-07/d SOILS
FORT IRWIN, CALIFORNIA

Media/Receptor	Risk Driver	Army TRV		BTAG TRV_{Low}		BTAG TRV_{High}		Maximum Concentration (mg/kg)	BUTL (mg/kg)
		HI	HQ	HI	HQ	HI	HQ		
Surface Soil									
Mohave Ground Squirrel		<1		2.0		<1			
	Zinc				1.3			103	51
Golden Eagle		<1		<1		<1			
	none								
Subsurface Soil									
Mohave Ground Squirrel		<1		14		<1			
	Copper				1.8			236	28.7
	Lead				5.0			18.9	7.33
	Zinc				6.5			824	51
Golden Eagle		<1		<1		<1			
	none								

Notes:
BTAG - Biological Toxicological Advisory Group
BUTL - Background Upper Tolerance Limit
HI - Hazard index
HQ -Hazard quotient
TRV - Toxicity reference value

APPENDIX B

ANALYTICAL RESULTS

TABLE B-1

SUBSITE FTIR-07/d
TEST PIT 7d-2-Ts-1
SOIL SAMPLE RESULTS

Parameter	7d-2-Ts-1-0.5 06/27/98 Result	Qualifier	7d-2-Td-1-0.5 (Dup. Of 7d-2-Ts-1-0.5) 06/27/98 Result	Qualifier
DIOXINS/FURANS (pg/g)				
1,2,3,4,6,7,8-HpCDD	NA		NA	
1,2,3,4,6,7,8-HpCDF	NA		NA	
1,2,3,4,7,8,9-HpCDF	NA		NA	
1,2,3,4,7,8-HxCDD	NA		NA	
1,2,3,4,7,8-HxCDF	NA		NA	
1,2,3,6,7,8-HxCDD	NA		NA	
1,2,3,6,7,8-HxCDF	NA		NA	
1,2,3,7,8,9-HxCDD	NA		NA	
1,2,3,7,8,9-HxCDF	NA		NA	
1,2,3,7,8-PeCDD	NA		NA	
1,2,3,7,8-PeCDF	NA		NA	
2,3,4,6,7,8-HxCDF	NA		NA	
2,3,4,7,8-PeCDF	NA		NA	
2,3,7,8-TCDD	NA		NA	
2,3,7,8-TCDF	NA		NA	
OCDD	NA		NA	
OCDF	NA		NA	
EXPLOSIVE (mg/kg)				
1,3,5-Trinitrobenzene	NA		NA	
1,3-Dinitrobenzene	NA		NA	
2,4,6-Trinitrotoluene	NA		NA	
2,4-Dinitrotoluene	NA		NA	
2,6-Dinitrotoluene	NA		NA	
2- and 4-Nitrotoluene	NA		NA	
2-Am-DNT	NA		NA	
3-Nitrotoluene	NA		NA	
4-Am-DNT	NA		NA	
HMX	NA		NA	
Nitrobenzene	NA		NA	
Nitroglycerin	NA		NA	
PETN	NA		NA	
RDX	NA		NA	
Tetryl	NA		NA	
GENERAL CHEMISTRY				
Ammonia as N (mg/kg)	< 0.51		< 0.54	
Moisture (%)	2.6		10.4	
Nitrate + Nitrite (as N) (mg/kg)	0.35		0.18	J
Percent Water (%)	1.4		6.9	

"<" results are below laboratory Practical Quanitation Limits (PQL)

TABLE B-1

SUBSITE FTIR-07/d
TEST PIT 7d-2-Ts-1
SOIL SAMPLE RESULTS

Parameter	7d-2-Ts-1-0.5 06/27/98			7d-2-Td-1-0.5 (Dup. Of 7d-2-Ts-1-0.5) 06/27/98		
		Result	Qualifier		Result	Qualifier
pH (pH units)		8.6			8.8	
HERBICIDES (μg/kg)						
2,4,5-T	<	5.1	UJ	<	5.4	UJ
2,4,5-TP (Silvex)	<	5.1	UJ	<	5.4	UJ
2,4-D	<	25	UJ	<	27	UJ
2,4-DB	<	100	UJ	<	110	UJ
Dalapon	<	100	UJ	<	110	UJ
Dicamba	<	10	UJ	<	11	UJ
Dichlorprop	<	25	UJ	<	27	UJ
Dinoseb (DNBP)	<	25	UJ	<	27	UJ
MCPA	<	5100	UJ	<	5400	UJ
MCPP	<	5100	UJ	<	5400	UJ
METALS (mg/kg)						
Aluminum		5970			4030	
Antimony	<	6.1	UJ	<	6.4	
Arsenic	<	10.1		<	10.7	
Barium		58.4			45.0	
Beryllium		0.23			0.2	J
Cadmium	<	0.51		<	0.54	
Calcium		1810			1750	
Chromium		4.7			3.6	
Chromium, Hexavalent	<	0.05		<	0.05	
Cobalt		2.4			1.9	
Copper		8.1			88.6	
Iron		8240			5930	
Lead	<	5.1			5.2	J
Magnesium		2540			1890	
Manganese		180	J		149	
Molybdenum	<	2			1	J
Nickel		4.4			3.5	J
Potassium		1700			1350	
Selenium	<	20.3		<	21.5	
Silver	<	1		<	1.1	
Sodium		67.2	J		53.1	J
Thallium	<	7.3		<	7.7	
Vanadium		13.0			9.0	
Zinc		24.6			115	
NITROSAMINES (μg/kg)						

"<" results are below laboratory Practical Quanitation Limits (PQL)

TABLE B-1

SUBSITE FTIR-07/d
TEST PIT 7d-2-Ts-1
SOIL SAMPLE RESULTS

Parameter	7d-2-Ts-1-0.5 06/27/98			7d-2-Td-1-0.5 (Dup. Of 7d-2-Ts-1-0.5) 06/27/98		
		Result	Qualifier		Result	Qualifier
N-Nitrosodimethylamine	<	100		<	110	
N-Nitrosodiphenylamine	<	100		<	110	
OCBA (mg/kg)						
Orthochlorobenzaldehyde	<	0.005		<	0.005	
PESTICIDES (μg/kg)						
4,4'-DDD	<	1.7		<	1.8	
4,4'-DDE	<	1.7		<	1.8	
4,4'-DDT	<	1.7		<	1.8	
Aldrin	<	0.84		<	0.89	
Chlordane	<	8.4		<	8.9	
Dieldrin	<	1.7		<	1.8	
Endosulfan I	<	0.84		<	0.89	
Endosulfan II	<	1.7		<	1.8	
Endosulfan sulfate	<	1.7		<	1.8	
Endrin	<	1.7		<	1.8	
Endrin aldehyde	<	1.7	UJ	<	1.8	UJ
Heptachlor	<	0.84		<	0.89	
Heptachlor epoxide	<	0.84		<	0.89	
Methoxychlor	<	8.4		<	8.9	
Toxaphene	<	34		<	36	
alpha-BHC	<	0.84		<	0.89	
beta-BHC	<	0.84		<	0.89	
delta-BHC	<	0.84		<	0.89	
gamma-BHC (Lindane)	<	0.84		<	0.89	
PCBs (μg/kg)						
Aroclor 1016	<	34		<	36	
Aroclor 1221	<	34		<	36	
Aroclor 1232	<	34		<	36	
Aroclor 1242	<	34		<	36	
Aroclor 1248	<	34		<	36	
Aroclor 1254	<	34		<	36	
Aroclor 1260	<	34		<	36	
SEMIVOLATILE ORGANIC COMPOUNDS (μg/kg)						
1,2,4-Trichlorobenzene	<	330		<	350	
1,2-Dichlorobenzene	<	330		<	350	
1,3-Dichlorobenzene	<	330		<	350	
1,4-Dichlorobenzene	<	330		<	350	

"<" results are below laboratory Practical Quanitation Limits (PQL)

TABLE B-1

SUBSITE FTIR-07/d
TEST PIT 7d-2-Ts-1
SOIL SAMPLE RESULTS

Parameter	7d-2-Ts-1-0.5 06/27/98		7d-2-Td-1-0.5 (Dup Of 7d-2-Ts-1-0.5) 06/27/98	
	Result	Qualifier	Result	Qualifier
2,2'-Oxybis(1-chloropropane)	< 330		< 350	
2,4,5-Trichlorophenol	< 330		< 350	
2,4,6-Trichlorophenol	< 330		< 350	
2,4-Dichlorophenol	< 330		< 350	
2,4-Dimethylphenol	< 330		< 350	
2,4-Dinitrophenol	< 1600		< 1700	
2,4-Dinitrotoluene	< 330		< 350	
2,6-Dinitrotoluene	< 330		< 350	
2-Chloronaphthalene	< 330		< 350	
2-Chlorophenol	< 330		< 350	
2-Methylnaphthalene	< 330		< 350	
2-Methylphenol	< 330		< 350	
2-Nitroaniline	< 1600		< 1700	
2-Nitrophenol	< 330		< 350	
3,3'-Dichlorobenzidine	< 670		< 710	UJ
3-Nitroaniline	< 1600		< 1700	
4,6-Dinitro-2-methylphenol	< 1600		< 1700	
4-Bromophenyl phenyl ether	< 330		< 350	
4-Chloro-3-methylphenol	< 330		< 350	
4-Chloroaniline	< 330		< 350	
4-Chlorophenyl phenyl ether	< 330		< 350	
4-Methylphenol	< 330		< 350	
4-Nitroaniline	< 1600		< 1700	
4-Nitrophenol	< 1600		< 1700	
Acenaphthene	< 330		< 350	
Acenaphthylene	< 330		< 350	
Anthracene	< 330		< 350	
Benzo(a)anthracene	< 330		< 350	
Benzo(a)pyrene	< 330		< 350	
Benzo(b)fluoranthene	< 330		< 350	
Benzo(g,h,i)perylene	< 330		< 350	
Benzo(k)fluoranthene	< 330		< 350	
Benzoic acid	< 1600		< 1700	UJ
Benzyl alcohol	< 330		< 350	
Butyl benzyl phthalate	< 330		< 350	
Chrysene	< 330		< 350	
Di-n-butyl phthalate	< 330		< 350	
Di-n-octyl phthalate	< 330	UJ	< 350	
Dibenz(a,h)anthracene	< 330		< 350	
Dibenzofuran	< 330		< 350	
Diethyl phthalate	< 330		< 350	

"<" results are below laboratory Practical Quanitation Limits (PQL)

TABLE B-1

SUBSITE FTIR-07/d
TEST PIT 7d-2-Ts-1
SOIL SAMPLE RESULTS

Parameter	7d-2-Ts-1-0 5 06/27/98			7d-2-Td-1-0.5 (Dup. Of 7d-2-Ts-1-0.5) 06/27/98		
		Result	Qualifier		Result	Qualifier
Dimethyl phthalate	<	330		<	350	
Fluoranthene	<	330		<	350	
Fluorene	<	330		<	350	
Hexachlorobenzene	<	330		<	350	
Hexachlorobutadiene	<	330		<	350	
Hexachlorocyclopentadiene	<	330		<	350	
Hexachloroethane	<	330		<	350	
Indeno(1,2,3-cd)pyrene	<	330		<	350	
Isophorone	<	330		<	350	
N-Nitroso-di-n-propylamine	<	100		<	110	
Naphthalene	<	330		<	350	
Nitrobenzene	<	330		<	350	
Pentachlorophenol	<	1600		<	1700	
Phenanthrene	<	330		<	350	
Phenol	<	330		<	350	
Pyrene	<	330		<	350	
bis(2-Chloroethoxy)-methane	<	330		<	350	
bis(2-Chloroethyl)ether	<	330		<	350	
bis(2-Ethylhexyl)-phthalate	<	330	UJ	<	350	
TOTAL PETROLEUM HYDROCARBONS (mg/kg)						
Total Petroleum Hydrocarbons	<	10		<	11	

"<" results are below laboratory Practical Quanitation Limits (PQL)

TABLE B-1

SUBSITE FTIR-07/d
TEST PIT 7d-2-Ts-1
SOIL SAMPLE RESULTS

Parameter	7d-2-Ts-1-2.5 06/27/98 Result	Qualifier	7d-2-Ts-1-5 06/27/98 Result	Qualifier
DIOXINS/FURANS (pg/g)				
1,2,3,4,6,7,8-HpCDD	NA		NA	
1,2,3,4,6,7,8-HpCDF	NA		NA	
1,2,3,4,7,8,9-HpCDF	NA		NA	
1,2,3,4,7,8-HxCDD	NA		NA	
1,2,3,4,7,8-HxCDF	NA		NA	
1,2,3,6,7,8-HxCDD	NA		NA	
1,2,3,6,7,8-HxCDF	NA		NA	
1,2,3,7,8,9-HxCDD	NA		NA	
1,2,3,7,8,9-HxCDF	NA		NA	
1,2,3,7,8-PeCDD	NA		NA	
1,2,3,7,8-PeCDF	NA		NA	
2,3,4,6,7,8-HxCDF	NA		NA	
2,3,4,7,8-PeCDF	NA		NA	
2,3,7,8-TCDD	NA		NA	
2,3,7,8-TCDF	NA		NA	
OCDD	NA		NA	
OCDF	NA		NA	
EXPLOSIVE (mg/kg)				
1,3,5-Trinitrobenzene	< 0.25		NA	
1,3-Dinitrobenzene	< 0.25		NA	
2,4,6-Trinitrotoluene	< 0.25		NA	
2,4-Dinitrotoluene	< 0.25		NA	
2,6-Dinitrotoluene	< 0.25		NA	
2- and 4-Nitrotoluene	< 0.25		NA	
2-Am-DNT	< 0.25		NA	
3-Nitrotoluene	< 0.25	R	NA	
4-Am-DNT	< 0.25		NA	
HMX	< 0.25		NA	
Nitrobenzene	0.19	UJ	NA	
Nitroglycerin	< 0.5		NA	
PETN	< 0.5		NA	
RDX	< 0.25		NA	
Tetryl	< 0.25		NA	
GENERAL CHEMISTRY				
Ammonia as N (mg/kg)	< 0.51		< 0.53	
Moisture (%)	1.8		5.3	
Nitrate + Nitrite (as N) (mg/kg)	< 0.25		0.51	
Percent Water (%)	1.8		5.3	

"<" results are below laboratory Practical Quanitation Limits (PQL)

TABLE B-1

SUBSITE FTIR-07/d
TEST PIT 7d-2-Ts-1
SOIL SAMPLE RESULTS

Parameter	7d-2-Ts-1-2.5 06/27/98			7d-2-Ts-1-5 06/27/98		
		Result	Qualifier		Result	Qualifier
pH (pH units)		8.8			8.7	
HERBICIDES (μg/kg)						
2,4,5-T	<	5.1		<	5.3	R
2,4,5-TP (Silvex)	<	5.1		<	5.3	R
2,4-D	<	25		<	26	R
2,4-DB	<	100		<	110	R
Dalapon	<	100		<	110	R
Dicamba	<	10		<	11	R
Dichlorprop	<	25		<	26	R
Dinoseb (DNBP)	<	25		<	26	R
MCPA	<	5100		<	5300	R
MCPP	<	5100	UJ	<	5300	R
METALS (mg/kg)						
Aluminum		2380			3250	
Antimony	<	6.1		<	6.3	
Arsenic		5.4	J	<	10.6	
Barium		38.2			48.0	
Beryllium		0.091	J		0.15	J
Cadmium	<	0.51		<	0.53	
Calcium		4540			12400	
Chromium		2.2			2.7	
Chromium, Hexavalent		NA		<	0.05	
Cobalt		1.7			1.4	
Copper		6.9			5.0	
Iron		3460			4100	
Lead	<	5.1		<	5.3	
Magnesium		1190			2140	
Manganese		108			92.7	
Molybdenum	<	2		<	2.1	
Nickel		2.4	J		2.8	
Potassium		767			942	
Selenium	<	20.4		<	21.1	
Silver	<	1		<	1.1	
Sodium		40.4			62.3	
Thallium	<	7.3		<	7.6	
Vanadium		5.9			7.0	
Zinc		14.5			14.5	
NITROSAMINES (μg/kg)						

"<" results are below laboratory Practical Quanitation Limits (PQL)

TABLE B-1

SUBSITE FTIR-07/d
TEST PIT 7d-2-Ts-1
SOIL SAMPLE RESULTS

Parameter		7d-2-Ts-1-2.5 06/27/98 Result	Qualifier		7d-2-Ts-1-5 06/27/98 Result	Qualifier
N-Nitrosodimethylamine	<	100		<	110	
N-Nitrosodiphenylamine	<	100		<	110	
OCBA (mg/kg)						
Orthochlorobenzaldehyde	<	0.005		<	0 005	
PESTICIDES (µg/kg)						
4,4'-DDD	<	1.7		<	1.8	
4,4'-DDE	<	1.7		<	1.8	
4,4'-DDT	<	1.7		<	1 8	
Aldrin	<	0.85		<	0.88	
Chlordane	<	8.5		<	8.8	
Dieldrin	<	1.7		<	1.8	
Endosulfan I	<	0.85		<	0.88	
Endosulfan II	<	1.7		<	1.8	
Endosulfan sulfate	<	1.7		<	1.8	
Endrin	<	1.7		<	1.8	
Endrin aldehyde	<	1 7	UJ	<	1 8	UJ
Heptachlor	<	0.85		<	0.88	
Heptachlor epoxide	<	0.85		<	0.88	
Methoxychlor	<	8.5	UJ	<	8.8	UJ
Toxaphene	<	34		<	35	
alpha-BHC	<	0.85		<	0.88	
beta-BHC	<	0 85		<	0.88	
delta-BHC	<	0 85		<	0 88	
gamma-BHC (Lindane)	<	0.85		<	0.88	
PCBs (µg/kg)						
Aroclor 1016	<	34		<	35	
Aroclor 1221	<	34		<	35	
Aroclor 1232	<	34		<	35	
Aroclor 1242	<	34		<	35	
Aroclor 1248	<	34		<	35	
Aroclor 1254	<	34		<	35	
Aroclor 1260	<	34		<	35	
SEMIVOLATILE ORGANIC COMPOUNDS (µg/						
1,2,4-Trichlorobenzene	<	340		<	350	
1,2-Dichlorobenzene	<	340		<	350	
1,3-Dichlorobenzene	<	340		<	350	
1,4-Dichlorobenzene	<	340		<	350	

"<" results are below laboratory Practical Quanitation Limits (PQL)

TABLE B-1

SUBSITE FTIR-07/d
TEST PIT 7d-2-Ts-1
SOIL SAMPLE RESULTS

Parameter	7d-2-Ts-1-2.5 06/27/98			7d-2-Ts-1-5 06/27/98		
		Result	Qualifier		Result	Qualifier
2,2'-Oxybis(1-chloropropane)	<	340	UJ	<	350	UJ
2,4,5-Trichlorophenol	<	340		<	350	
2,4,6-Trichlorophenol	<	340		<	350	
2,4-Dichlorophenol	<	340		<	350	
2,4-Dimethylphenol	<	340		<	350	
2,4-Dinitrophenol	<	1600		<	1700	
2,4-Dinitrotoluene	<	340		<	350	
2,6-Dinitrotoluene	<	340		<	350	
2-Chloronaphthalene	<	340		<	350	
2-Chlorophenol	<	340		<	350	
2-Methylnaphthalene	<	340		<	350	
2-Methylphenol	<	340		<	350	
2-Nitroaniline	<	1600	UJ	<	1700	UJ
2-Nitrophenol	<	340		<	350	
3,3'-Dichlorobenzidine	<	670		<	700	
3-Nitroaniline	<	1600		<	1700	
4,6-Dinitro-2-methylphenol	<	1600		<	1700	
4-Bromophenyl phenyl ether	<	340		<	350	
4-Chloro-3-methylphenol	<	340		<	350	
4-Chloroaniline	<	340		<	350	
4-Chlorophenyl phenyl ether	<	340		<	350	
4-Methylphenol	<	340		<	350	
4-Nitroaniline	<	1600		<	1700	
4-Nitrophenol	<	1600	UJ	<	1700	UJ
Acenaphthene	<	340		<	350	
Acenaphthylene	<	340		<	350	
Anthracene	<	340		<	350	
Benzo(a)anthracene	<	340		<	350	
Benzo(a)pyrene	<	340		<	350	
Benzo(b)fluoranthene	<	340		<	350	
Benzo(g,h,i)perylene	<	340		<	350	
Benzo(k)fluoranthene	<	340		<	350	
Benzoic acid	<	1600	UJ	<	1700	UJ
Benzyl alcohol	<	340		<	350	
Butyl benzyl phthalate	<	340		<	350	
Chrysene	<	340		<	350	
Di-n-butyl phthalate	<	340		<	350	
Di-n-octyl phthalate	<	340		<	350	
Dibenz(a,h)anthracene	<	340		<	350	
Dibenzofuran	<	340		<	350	
Diethyl phthalate	<	340		<	350	

"<" results are below laboratory Practical Quanitation Limits (PQL)

TABLE B-1

SUBSITE FTIR-07/d
TEST PIT 7d-2-Ts-1
SOIL SAMPLE RESULTS

Parameter	7d-2-Ts-1-2.5 06/27/98			7d-2-Ts-1-5 06/27/98		
		Result	Qualifier		Result	Qualifier
Dimethyl phthalate	<	340		<	350	
Fluoranthene	<	340		<	350	
Fluorene	<	340		<	350	
Hexachlorobenzene	<	340		<	350	
Hexachlorobutadiene	<	340		<	350	
Hexachlorocyclopentadiene	<	340		<	350	
Hexachloroethane	<	340		<	350	
Indeno(1,2,3-cd)pyrene	<	340		<	350	
Isophorone	<	340		<	350	
N-Nitroso-di-n-propylamine	<	100		<	110	
Naphthalene	<	340		<	350	
Nitrobenzene	<	340	UJ	<	350	UJ
Pentachlorophenol	<	1600		<	1700	
Phenanthrene	<	340		<	350	
Phenol	<	340		<	350	
Pyrene	<	340		<	350	
bis(2-Chloroethoxy)-methane	<	340		<	350	
bis(2-Chloroethyl)ether	<	340		<	350	
bis(2-Ethylhexyl)-phthalate	<	340		<	350	
TOTAL PETROLEUM HYDROCARBONS (mg/l						
Total Petroleum Hydrocarbons	<	10		<	11	

"<" results are below laboratory Practical Quanitation Limits (PQL)

TABLE B-1

SUBSITE FTIR-07/d
TEST PIT 7d-2-Ts-1
SOIL SAMPLE RESULTS

Parameter		7d-2-Ts-1-10 06/27/98 Result	Qualifier
DIOXINS/FURANS (pg/g)			
1,2,3,4,6,7,8-HpCDD		NA	
1,2,3,4,6,7,8-HpCDF		NA	
1,2,3,4,7,8,9-HpCDF		NA	
1,2,3,4,7,8-HxCDD		NA	
1,2,3,4,7,8-HxCDF		NA	
1,2,3,6,7,8-HxCDD		NA	
1,2,3,6,7,8-HxCDF		NA	
1,2,3,7,8,9-HxCDD		NA	
1,2,3,7,8,9-HxCDF		NA	
1,2,3,7,8-PeCDD		NA	
1,2,3,7,8-PeCDF		NA	
2,3,4,6,7,8-HxCDF		NA	
2,3,4,7,8-PeCDF		NA	
2,3,7,8-TCDD		NA	
2,3,7,8-TCDF		NA	
OCDD		NA	
OCDF		NA	
EXPLOSIVE (mg/kg)			
1,3,5-Trinitrobenzene	<	0.25	UJ
1,3-Dinitrobenzene	<	0.25	UJ
2,4,6-Trinitrotoluene	<	0.25	UJ
2,4-Dinitrotoluene	<	0.25	UJ
2,6-Dinitrotoluene	<	0.25	UJ
2- and 4-Nitrotoluene	<	0.25	UJ
2-Am-DNT	<	0.25	UJ
3-Nitrotoluene	<	0.25	R
4-Am-DNT	<	0.25	UJ
HMX		0.15	J
Nitrobenzene		0.16	UJ
Nitroglycerin	<	0.5	UJ
PETN	<	0.5	UJ
RDX		0.026	J
Tetryl	<	0.25	UJ
GENERAL CHEMISTRY			
Ammonia as N (mg/kg)	<	0.51	
Moisture (%)		2.3	
Nitrate + Nitrite (as N) (mg/kg)		5.6	
Percent Water (%)		1.5	

"<" results are below laboratory Practical Quanitation Limits (PQL)

TABLE B-1

SUBSITE FTIR-07/d
TEST PIT 7d-2-Ts-1
SOIL SAMPLE RESULTS

Parameter		7d-2-Ts-1-10 06/27/98 Result	Qualifier
pH (pH units)		8.8	
HERBICIDES (µg/kg)			
2,4,5-T	<	5.1	
2,4,5-TP (Silvex)	<	5.1	
2,4-D	<	25	
2,4-DB	<	100	
Dalapon	<	100	
Dicamba	<	10	
Dichlorprop	<	25	
Dinoseb (DNBP)	<	25	
MCPA	<	5100	
MCPP	<	5100	UJ
METALS (mg/kg)			
Aluminum		1880	
Antimony	<	6.1	
Arsenic	<	10.2	
Barium		24.9	
Beryllium		0.12	J
Cadmium	<	0.51	
Calcium		878	
Chromium		1.7	
Chromium, Hexavalent		NA	
Cobalt		1.2	
Copper		4.0	
Iron		3340	
Lead	<	5.1	
Magnesium		812	
Manganese		115	
Molybdenum	<	2	
Nickel	<	4.1	
Potassium		606	
Selenium	<	20.3	
Silver	<	1	
Sodium		85.6	J
Thallium	<	7.3	
Vanadium		6.9	
Zinc		10.7	
NITROSAMINES (µg/kg)			

"<" results are below laboratory Practical Quanitation Limits (PQL)

TABLE B-1

SUBSITE FTIR-07/d
TEST PIT 7d-2-Ts-1
SOIL SAMPLE RESULTS

Parameter		7d-2-Ts-1-10 06/27/98 Result	Qualifier
N-Nitrosodimethylamine	<	100	
N-Nitrosodiphenylamine	<	100	
OCBA (mg/kg)			
Orthochlorobenzaldehyde	<	0.005	
PESTICIDES (µg/kg)			
4,4'-DDD	<	1.7	
4,4'-DDE	<	1.7	
4,4'-DDT	<	1.7	
Aldrin	<	0.84	
Chlordane	<	8.4	
Dieldrin	<	1.7	
Endosulfan I	<	0.84	
Endosulfan II	<	1.7	
Endosulfan sulfate	<	1.7	
Endrin	<	1.7	
Endrin aldehyde	<	1.7	UJ
Heptachlor	<	0.84	
Heptachlor epoxide	<	0.84	
Methoxychlor	<	8.4	UJ
Toxaphene	<	34	
alpha-BHC	<	0.84	
beta-BHC	<	0.84	
delta-BHC	<	0.84	
gamma-BHC (Lindane)	<	0.84	
PCBs (µg/kg)			
Aroclor 1016	<	34	
Aroclor 1221	<	34	
Aroclor 1232	<	34	
Aroclor 1242	<	34	
Aroclor 1248	<	34	
Aroclor 1254	<	34	
Aroclor 1260	<	34	
SEMIVOLATILE ORGANIC COMPOUNDS (µg/			
1,2,4-Trichlorobenzene	<	340	
1,2-Dichlorobenzene	<	340	
1,3-Dichlorobenzene	<	340	
1,4-Dichlorobenzene	<	340	

"<" results are below laboratory Practical Quanitation Limits (PQL)

TABLE B-1

SUBSITE FTIR-07/d
TEST PIT 7d-2-Ts-1
SOIL SAMPLE RESULTS

Parameter		7d-2-Ts-1-10 06/27/98 Result	Qualifier
2,2'-Oxybis(1-chloropropane)	<	340	UJ
2,4,5-Trichlorophenol	<	340	
2,4,6-Trichlorophenol	<	340	
2,4-Dichlorophenol	<	340	
2,4-Dimethylphenol	<	340	
2,4-Dinitrophenol	<	1600	
2,4-Dinitrotoluene	<	340	
2,6-Dinitrotoluene	<	340	
2-Chloronaphthalene	<	340	
2-Chlorophenol	<	340	
2-Methylnaphthalene	<	340	
2-Methylphenol	<	340	
2-Nitroaniline	<	1600	UJ
2-Nitrophenol	<	340	
3,3'-Dichlorobenzidine	<	670	
3-Nitroaniline	<	1600	
4,6-Dinitro-2-methylphenol	<	1600	
4-Bromophenyl phenyl ether	<	340	
4-Chloro-3-methylphenol	<	340	
4-Chloroaniline	<	340	
4-Chlorophenyl phenyl ether	<	340	
4-Methylphenol	<	340	
4-Nitroaniline	<	1600	
4-Nitrophenol	<	1600	UJ
Acenaphthene	<	340	
Acenaphthylene	<	340	
Anthracene	<	340	
Benzo(a)anthracene	<	340	
Benzo(a)pyrene	<	340	
Benzo(b)fluoranthene	<	340	
Benzo(g,h,i)perylene	<	340	
Benzo(k)fluoranthene	<	340	
Benzoic acid	<	1600	UJ
Benzyl alcohol	<	340	
Butyl benzyl phthalate	<	340	
Chrysene	<	340	
Di-n-butyl phthalate	<	340	
Di-n-octyl phthalate	<	340	
Dibenz(a,h)anthracene	<	340	
Dibenzofuran	<	340	
Diethyl phthalate	<	340	

"<" results are below laboratory Practical Quanitation Limits (PQL)

TABLE B-1

SUBSITE FTIR-07/d
TEST PIT 7d-2-Ts-1
SOIL SAMPLE RESULTS

Parameter		7d-2-Ts-1-10 06/27/98 Result	Qualifier
Dimethyl phthalate	<	340	
Fluoranthene	<	340	
Fluorene	<	340	
Hexachlorobenzene	<	340	
Hexachlorobutadiene	<	340	
Hexachlorocyclopentadiene	<	340	
Hexachloroethane	<	340	
Indeno(1,2,3-cd)pyrene	<	340	
Isophorone	<	340	
N-Nitroso-di-n-propylamine	<	100	
Naphthalene	<	340	
Nitrobenzene	<	340	UJ
Pentachlorophenol	<	1600	
Phenanthrene	<	340	
Phenol	<	340	
Pyrene	<	340	
bis(2-Chloroethoxy)-methane	<	340	
bis(2-Chloroethyl)ether	<	340	
bis(2-Ethylhexyl)-phthalate	<	340	
TOTAL PETROLEUM HYDROCARBONS (mg/l			
Total Petroleum Hydrocarbons	<	10	

"<" results are below laboratory Practical Quanitation Limits (PQL)

APPENDIX C

CHAIN OF CUSTODY FORMS

CHAIN-OF-CUSTODY

PROJECT NAME: FT. IRWIN	**QUANTERRA** ENVIRONMENTAL SERVICES	DUE: 18 JUL 98
PO NUMBER: CONTACT PM	880 Riverside Parkway	TO: Applied P & CH
PROJECT MANAGER: Jon Gildersleeve	West Sacramento, CA 95605	13760 Magnolia Avenue
	Phone #: (916) 374-4381	Chino, CA 91710

ANALYSES

SAMPLE DESCRIPTION	LAB ID	DATE	TIME	MATRIX	CONTAINERS	NITROSAMINES SW8070A									REMARKS/ SPCL INSTR
8.3c-1-Ts-1-0.5	300141-0001 SA	26 JUN 98	15:00	SOIL	125CGJ	X									
8.3c-1-Ts-1-2.5	300141-0002 SA	26 JUN 98	15:05	SOIL		X									
8.3c-1-Ts-1-5	300141-0003 SA	26 JUN 98	15:15	SOIL		X									
8.3c-1-Ts-1-5-MS	300141-0003 MS	26 JUN 98	15:15	SOIL	NO JAR	X									
8.3c-1-Ts-1-5-MSD	300141-0003 SD	26 JUN 98	15:15	SOIL	NO JAR	X									
8.3c-1-Ts-1-10	300141-0004 SA	26 JUN 98	15:30	SOIL		X									
8.3c-1-Ts-1-15	300141-0005 SA	26 JUN 98	15:45	SOIL		X									
8.3a-1-Ts-1-0.5	300141-0006 SA	26 JUN 98	12:30	SOIL		X									
8.3a-1-Ts-1-2.5	300141-0007 SA	26 JUN 98	12:50	SOIL		X									
8.3a-1-Ts-1-2.5-MS	300141-0007 MS	26 JUN 98	12:50	SOIL	NO JAR	X									
8.3a-1-Ts-1-2.5-MSD	300141-0007 SD	26 JUN 98	12:50	SOIL	NO JAR	X									
8.3a-1-Ts-1-5	300141-0008 SA	26 JUN 98	13:10	SOIL		X									
8.3a-1-Ts-1-10	300141-0009 SA	26 JUN 98	13:35	SOIL		X									
8.3a-1-Ts-1-15	300141-0010 SA	26 JUN 98	14:00	SOIL		X									
8.3c-1-Td-1-5	300141-0011 SA	26 JUN 98	14:45	SOIL		X									
8.3a-1-Td-1-2.5	300141-0012 SA	26 JUN 98	12:40	SOIL		X									
7d-1-Td-1-2.5	300141-0014 SA	27 JUN 98	10:10	SOIL		X									
7d-1-Tdd-1-2.5	300141-0015 SA	27 JUN 98	15:00	SOIL		X									

	SIGNATURE	PRINT NAME	COMPANY/TITLE	DATE	TIME
Relinquished by:	Jon Gildersleeve	Jon Gildersleeve	QES	7/1/98	16:30
Received by:	[illegible]	SAND CARIBI	APCL	7/2/98	1000
Relinquished by:					
Received by:					

Comments: LOG 4750

QA373 4/96 CMD

0000011

CHAIN-OF-CUSTODY

PROJECT NAME: FT. IRWIN

PO NUMBER: CONTACT PM

PROJECT MANAGER: Jon Gildersleeve

QUANTERRA *ENVIRONMENTAL SERVICES*
880 Riverside Parkway
West Sacramento, CA 95605

Phone #: (916) 374-4381

DUE: 18 JUL 98
TO: Applied P & CH
13760 Magnolia Avenue
Chino, CA 91710

SAMPLE DESCRIPTION	LAB ID	DATE	TIME	MATRIX	CONTAINERS	NITROSAMINES SW8070A									REMARKS/ SPCL INSTR
7d-2-Td-1-0.5	300141-0016 SA	27 JUN 98	10:00	SOIL	125CGJ	X									
8.1a-2-Ts-1-0.5	300141-0017 SA	27 JUN 98	07:00	SOIL		X									
8.1a-2-Ts-1-2.5	300141-0018 SA	27 JUN 98	07:10	SOIL		X									
8.1a-2-Ts-1-5	300141-0019 SA	27 JUN 98	07:30	SOIL		X									
8.1a-2-Ts-1-10	300141-0020 SA	27 JUN 98	07:50	SOIL		X									
8.1a-2-Td-1-5	300141-0021 SA	27 JUN 98	06:00	SOIL		X									
7d-1-Td-1-0.5	300141-0022 SA	27 JUN 98	12:20	SOIL		X									
7d-1-Td-1-2.5	300141-0023 SA	27 JUN 98	12:30	SOIL		X									
7d-1-Td-1-5	300141-0024 SA	27 JUN 98	12:45	SOIL		X									
7d-1-Td-1-10	300141-0025 SA	27 JUN 98	13:05	SOIL		X									
7d-1-Td-1-15	300141-0026 SA	27 JUN 98	13:30	SOIL		X									
7d-1-Tp-1-0.5	300141-0027 SA	27 JUN 98	13:50	SOIL		X									
7d-1-Tp-1-2.5	300141-0028 SA	27 JUN 98	14:00	SOIL		X									
7d-1-Tp-1-5	300141-0029 SA	27 JUN 98	14:15	SOIL		X									
7d-1-Tp-1-10	300141-0030 SA	27 JUN 98	14:20	SOIL		X									
7d-2-Ts-1-0.5	300141-0031 SA	27 JUN 98	11:15	SOIL		X									
7d-2-Ts-1-0.5-MS	300141-0031 MS	27 JUN 98	11:15	SOIL	NO JAR	X									
7d-2-Ts-1-0.5-MSD	300141-0031 SD	27 JUN 98	11:15	SOIL	NO JAR	X									

	SIGNATURE	PRINT NAME	COMPANY/TITLE	DATE	TIME
Relinquished by:	Jon Gildersleeve	Jon Gildersleeve	QES	7/1/98	16:30
Received by:	[illegible]	[illegible]	APCL	7/2/98	1000
Relinquished by:					
Received by:					

Comments: LOG 4750

QA373 4/96 CMD

0000012

CHAIN-OF-CUSTODY

PROJECT NAME: FT. IRWIN	**QUANTERRA** ENVIRONMENTAL SERVICES	DUE: 18 JUL 98
PO NUMBER: CONTACT PM	880 Riverside Parkway	TO: Applied P & CH
PROJECT MANAGER: Jon Gildersleeve	West Sacramento, CA 95605	13760 Magnolia Avenue
	Phone #: (916) 374-4381	Chino, CA 91710

SAMPLE DESCRIPTION	LAB ID	DATE	TIME	MATRIX	CONTAINERS	NITROSAMINES SW8070A									REMARKS/ SPCL INSTR
7d-2-Ts-1-2.5	300141-0032 SA	27 JUN 98	11:20	SOIL	125CGJ	X									
7d-2-Ts-1-5	300141-0033 SA	27 JUN 98	11:30	SOIL	↓	X									
7d-2-Ts-1-10	300141-0034 SA	27 JUN 98	11:45	SOIL	↓	X									

	SIGNATURE	PRINT NAME	COMPANY/TITLE	DATE	TIME
Relinquished by:	Jon Gildersleeve	Jon Gildersleeve	QES	7/1/98	16:30
Received by:	[illegible]	[illegible]	[illegible]	7/7/98	[illegible]
Relinquished by:					
Received by:					

Comments: LOG 4750

QA373 4/96 CMD

0000013

CHAIN-OF-CUSTODY

98E-03568

PROJECT NAME: FT IRWIN
PO NUMBER: CONTACT PM
PROJECT MANAGER: Jon Gildersleeve

QUANTERRA *ENVIRONMENTAL SERVICES*
880 Riverside Parkway
West Sacramento, CA 95605
Phone #: (916) 374-4381

DUE: 18 JUL 98
TO: DataChem Laboratories
960 West LeVoy Drive
Salt Lake City, UT 84123

SAMPLE DESCRIPTION	LAB ID	DATE	TIME	MATRIX	CONTAINERS	O-CHLOROBENZALD	~~EHYDE~~								REMARKS/ SPCL INSTR	
8.3c-1-Ts-1-0.5	300141-0001 SA	26 JUN 98	15:00	SOIL	125CGJ	X					98E03524				98E035	34
8.3c-1-Ts-1-2.5	300141-0002 SA	26 JUN 98	15:05	SOIL		X										35
8.3c-1-Ts-1-5	300141-0003 SA	26 JUN 98	15:15	SOIL		X							-		RUN MS/MSD	36
8.3c-1-Ts-1-5-MS	300141-0003 MS	26 JUN 98	15:15	SOIL	—	X									36MS	37
8.3c-1-Ts-1-5-MSD	300141-0003 SD	26 JUN 98	15:15	SOIL	—	X									36MSD	38
8.3c-1-Ts-1-10	300141-0004 SA	26 JUN 98	15:30	SOIL	125CGJ	X										39
8.3c-1-Ts-1-15	300141-0005 SA	26 JUN 98	15:45	SOIL		X									40 39MS	41
8.3a-1-Ts-1-0.5	300141-0006 SA	26 JUN 98	12:30	SOIL		X									41 39MSD	42
8.3a-1-Ts-1-2.5	300141-0007 SA	26 JUN 98	12:50	SOIL		X									RUN MS/MSD	42
8.3a-1-Ts-1-2.5-MS	300141-0007 MS	26 JUN 98	12:50	SOIL	—	X									42MS	43
8.3a-1-Ts-1-2.5-MSD	300141-0007 SD	26 JUN 98	12:50	SOIL	—	X									42MSD	44
8.3a-1-Ts-1-5	300141-0008 SA	26 JUN 98	13:10	SOIL	125CGJ	X										45
8.3a-1-Ts-1-10	300141-0009 SA	26 JUN 98	13:35	SOIL		X										46
8.3a-1-Ts-1-15	300141-0010 SA	26 JUN 98	14:00	SOIL		X										47
8.3c-1-Td-1-5	300141-0011 SA	26 JUN 98	14:45	SOIL		X										48
8.3a-1-Td-1-2.5	300141-0012 SA	26 JUN 98	12:40	SOIL		X										49
7d-1-Td-1-2.5	300141-0014 SA	27 JUN 98	10:10	SOIL		X										50
7d-1-Tdd-1-2.5	300141-0015 SA	27 JUN 98	15:00	SOIL		X										51

	SIGNATURE	PRINT NAME	COMPANY/TITLE	DATE	TIME
Relinquished by:	[signature]	Jon Gildersleeve	QES	7/7/98	10:30
Received by:	Thomas T. McKay	Thomas T. McKay	DCL	7/9/98	09:45
Relinquished by:					
Received by:					

Comments: PLEASE CONTACT JON GILDERSLEEVE IF YOU HAVE ANY QUESTIONS. LOG 4761

QA373 4/96 CMD

0000016

CHAIN-OF-CUSTODY

98E-0368

PROJECT NAME: FT IRWIN	QUANTERRA ENVIRONMENTAL SERVICES, 880 Riverside Parkway, West Sacramento, CA 95605
PO NUMBER: CONTACT PM	DUE: 18 JUL 98
PROJECT MANAGER: Jon Gildersleeve	TO: DataChem Laboratories, 960 West LeVoy Drive, Salt Lake City, UT 84123
	Phone #: (916) 374-4381

ANALYSES: O-CHLOROBENZALDEHYDE

SAMPLE DESCRIPTION	LAB ID	DATE	TIME	MATRIX	CONTAINERS	O-CHLOROBENZALDEHYDE	REMARKS/ SPCL INSTR
7d-2-Td-1-0.5	300141-0016 SA	27 JUN 98	10:00	SOIL	125CGJ	X	98E0355 52
8.1a-2-Ts-1-0.5	300141-0017 SA	27 JUN 98	07:00	SOIL		X	53
8.1a-2-Ts-1-2.5	300141-0018 SA	27 JUN 98	07:10	SOIL		X	54
8.1a-2-Ts-1-5	300141-0019 SA	27 JUN 98	07:30	SOIL		X	55
8.1a-2-Ts-1-10	300141-0020 SA	27 JUN 98	07:40	SOIL		X	56
8.1a-2-Td-1-5	300141-0021 SA	27 JUN 98	06:00	SOIL		X	57
7d-1-Ts-1-0.5	300141-0022 SA	27 JUN 98	12:20	SOIL		X	58
7d-1-Ts-1-2.5	300141-0023 SA	27 JUN 98	12:30	SOIL		X	59
7d-1-Ts-1-5	300141-0024 SA	27 JUN 98	12:45	SOIL		X	60
7d-1-Ts-1-10	300141-0025 SA	27 JUN 98	13:05	SOIL		X	61
7d-1-Ts-1-15	300141-0026 SA	27 JUN 98	13:30	SOIL		X	62
7d-1-Tp-1-0.5	300141-0027 SA	27 JUN 98	13:50	SOIL		X	63
7d-1-Tp-1-2.5	300141-0028 SA	27 JUN 98	14:00	SOIL		X	64
7d-1-Tp-1-5	300141-0029 SA	27 JUN 98	14:15	SOIL		X	65
7d-1-Tp-1-10	300141-0030 SA	27 JUN 98	14:20	SOIL		X	66
7d-2-Ts-1-0.5	300141-0031 SA	27 JUN 98	11:15	SOIL		X	RUN MS/MSD 67
7d-2-Ts-1-0.5-MS	300141-0031 MS	27 JUN 98	11:15	SOIL		X	67MS 68
7d-2-Ts-1-0.5-MSD	300141-0031 SD	27 JUN 98	11:15	SOIL		X	67MSD 69

	SIGNATURE	PRINT NAME	COMPANY/TITLE	DATE	TIME
Relinquished by:	Jon Gildersleeve	Jon Gildersleeve	QES	7/7/98	10:30
Received by:	Thomas T. McKay	Thomas T. McKay	DCL	7/9/98	09:45
Relinquished by:					
Received by:					

Comments: PLEASE CONTACT JON GILDERSLEEVE IF YOU HAVE ANY QUESTIONS. LOG 4761

QA373 4/96 CMD

0000017

CHAIN-OF-CUSTODY

98E-03568

PROJECT NAME: FT IRWIN
PO NUMBER: CONTACT PM
PROJECT MANAGER: Jon Gildersleeve

QUANTERRA ENVIRONMENTAL SERVICES
880 Riverside Parkway
West Sacramento, CA 95605
Phone #: (916) 374-4381

DUE: 18 JUL 98
TO: DataChem Laboratories
960 West LeVoy Drive
Salt Lake City, UT 84123

SAMPLE DESCRIPTION	LAB ID	DATE	TIME	MATRIX	CONTAINERS	O-CHLOROBENZALDEHYDE									REMARKS/ SPCL INSTR
7d-2-Ts-1-2.5	300141-0032 SA	27 JUN 98	11:20	SOIL	125CGJ	X									98E03570
~~7d-2-Ts-1-2.5~~	~~300141-0032 MS~~	~~27 JUN 98~~	~~11:20~~	~~SOIL~~		~~X~~	MCO 070798								
~~7d-2-Ts-1-2.5~~	~~300141-0032 SD~~	~~27 JUN 98~~	~~11:20~~	~~SOIL~~		~~X~~	MCO 070798								
7d-2-Ts-1-5	300141-0033 SA	27 JUN 98	11:30	SOIL	125CGJ	X									71
7d-2-Ts-1-10	300141-0034 SA	27 JUN 98	11:45	SOIL	↓	X									72

	SIGNATURE	PRINT NAME	COMPANY/TITLE	DATE	TIME
Relinquished by:	Jon Gildersleeve	Jon Gildersleeve	QES	7/9/98	10:30
Received by:	Thomas T. McKay	Thomas T McKay	DCL	7/9/98	09:45
Relinquished by:					
Received by:					

Comments: PLEASE CONTACT JON GILDERSLEEVE IF YOU HAVE ANY QUESTIONS. LOG 4761

QA373 4/96 CMD

0000018

MONTGOMERY WATSON
CHAIN OF CUSTODY RECORD

Cooler #2

Sampler(s) Printed Name and Signature:
Kristin A Shelton Kristin A Shelton
Wade Weston Absent

Fed Ex #: 804 7696 92290
Lab: Quanterra
MW Contact Person: Mary Privitera
Phone: 925 975 3486
Project Name: Ft. Irwin FTIR-07 and FTIR-08 Suppl. RI

Field Sample ID	Date	Time	Matrix	# of Containers	Metals (6010)	Hexavalent Chromium (7196)	SVOCs (8270)	organochlorine pesticides &PCBs (8080)	Chlorinated Herbicides (8150)	TRPH (418.1)	pH (9045)	Ammonia/Nitrogen (350.1)	Nitrate/Nitrite-Nitrogen (353.2)	o-chlorobenzaldehyde (CS hydrolysis product) DATACHEM	Nitrosamines (8070) DATACHEM	Moisture (ASTM D2216,D4643)	RDX/TNT Screening (colorimetric ENSYS)	Explosives(8321)	Dioxins/Furans (8290)	VOCs (8260)	Comments
8.1a-1-T3-1-0.5'	6/24/98	1645	Soil	3	X	X	X	X	X	X	X	X	X	X	X	X	X		X		
8.1a-1-T3-1-2.5'		1700		3	X		X	X	X	X	X	X	X	X	X	X	X		X	X	
8.1a-1-T3-1-5'		1715		3	X	X	X	X	X	X	X	X	X	X	X	X	X		X		
8.1a-1-T3-1-10'		1730		3	X		X	X	X	X	X	X	X	X	X	X	X		X		
8.1a-1-T3-1-15'		1745		3	X		X	X	X	X	X	X	X	X	X	X	X		X		
8.3b-1-T3-1-0.5		0930		3	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	
8.3b-1-T3-1-2.5'		1010		3	X		X	X	X	X	X	X	X	X	X	X	X		X	X	
8.3b-1-T3-1-5'		1020		3	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	
8.3b-1-T3-1-10'		1035		3	X		X	X	X	X	X	X	X	X	X	X	X		X		
8.3b-1-T3-1-15'		1110		3	X		X	X	X	X	X	X	X	X	X	X	X		X		
* TB062698		1200	water	2																X	

Sample Condition Upon Receipt at Laboratory:

Special Instructions/Comments:

Metals analysis includes: Aluminum, arsenic, barium, beryllium, cadmium, calcium, chromium(total), cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, phosphorous, selenium, silver, sodium, thallium, vanadium, zinc.

Nitroaromatics/Nitroamines and PETN/Nitroglycerin analysis conducted if positive for RDX or TNT screening.

* 2 vials w/ 3mm bubbles on 6-30-98

rec'd in good cond. 06-30-98

Released by (Sig):	Released by (Print):	Company Name	Date	Time
Kristin A Shelton	Kristin A Shelton	Montgomery Watson	6/29/98	1000
Received by (Sig):	**Received by (Print):**	**Company Name**	**Date**	**Time**
Cheryl Hytrek	Cheryl Hytrek	QES	6-30-98	1930
Released by (Sig):	**Released by (Print):**	**Company Name**	**Date**	**Time**
Received by (Sig):	**Received by (Print):**	**Company Name**	**Date**	**Time**

6000000

CHAIN OF-CUSTODY

PROJECT NAME: FT IRWIN

PO NUMBER: 300142

PROJECT MANAGER: Jon Gildersleeve

QUANTERRA ENVIRONMENTAL SERVICES
880 Riverside Parkway
West Sacramento, CA 95605

Phone #: (916) 374-4381

DUE: 18 JUL 98
TO: QES, SANTA ANA
1721 South Grand Avenue
Santa Ana, CA 92705

SAMPLE DESCRIPTION	LAB ID	DATE	TIME	MATRIX	CONTAINERS	ANALYSES: TPH-IR 418.1									REMARKS/ SPCL INSTR
8.1a-1-Ts-1-0.5	300142-0001 SA	26 JUN 98	16:45	SOIL	125LGJ	X									
8.1a-1-Ts-1-2.5	300142-0002 SA	26 JUN 98	17:00	SOIL		X									
8.1a-1-Ts-1-5	300142-0003 SA	26 JUN 98	17:15	SOIL		X									
8.1a-1-Ts-1-10	300142-0004 SA	26 JUN 98	17:30	SOIL		X									
8.1a-1-Ts-1-15	300142-0005 SA	26 JUN 98	17:45	SOIL		X									
8.3b-1-Ts-1-0.5	300142-0006 SA	26 JUN 98	09:30	SOIL		X									
8.3b-1-Ts-1-2.5	300142-0007 SA	26 JUN 98	10:10	SOIL		X									
8.3b-1-Ts-1-5	300142-0008 SA	26 JUN 98	10:20	SOIL		X									
8.3b-1-Ts-1-10	300142-0009 SA	26 JUN 98	10:35	SOIL		X									
8.3b-1-Ts-1-15	300142-0010 SA	26 JUN 98	11:10	SOIL		X									

	SIGNATURE	PRINT NAME	COMPANY/TITLE	DATE	TIME
Relinquished by:	[signature]	Jon Gildersleeve	QES	7/6/98	16:30
Received by:	[signature]	A. FEFITAC	QES	7/6/98	1000
Relinquished by:					
Received by:					

Comments: LOG 4751

QA373 4/96 CMD

0000010

CHAIN- -CUSTODY

PROJECT NAME: FT IRWIN	**QUANTERRA** ENVIRONMENTAL SERVICES 880 Riverside Parkway West Sacramento, CA 95605 Phone #: (916) 374-4381
PO NUMBER: CONTACT PM	DUE: 18 JUL 98 TO: Applied P & CH 13760 Magnolia Avenue Chino, CA 91710
PROJECT MANAGER: Jon Gildersleeve	

SAMPLE DESCRIPTION	LAB ID	DATE	TIME	MATRIX	CONTAINERS	ANALYSES: NITROSAMINES SW8070									REMARKS/ SPCL INSTR
8.1a-1-Ts-1-0.5	300142-0001 SA	26 JUN 98	16:45	SOIL	125CGJ	X									
8.1a-1-Ts-1-2.5	300142-0002 SA	26 JUN 98	17:00	SOIL		X									
8.1a-1-Ts-1-5	300142-0003 SA	26 JUN 98	17:15	SOIL		X									
8.1a-1-Ts-1-10	300142-0004 SA	26 JUN 98	17:30	SOIL		X									
8.1a-1-Ts-1-15	300142-0005 SA	26 JUN 98	17:45	SOIL		X									
8.3b-1-Ts-1-0.5	300142-0006 SA	26 JUN 98	09:30	SOIL		X									
8.3b-1-Ts-1-2.5	300142-0007 SA	26 JUN 98	10:10	SOIL		X									
8.3b-1-Ts-1-5	300142-0008 SA	26 JUN 98	10:20	SOIL		X									
8.3b-1-Ts-1-10	300142-0009 SA	26 JUN 98	10:35	SOIL		X									
8.3b-1-Ts-1-15	300142-0010 SA	26 JUN 98	11:10	SOIL		X									

	SIGNATURE	PRINT NAME	COMPANY/TITLE	DATE	TIME
Relinquished by:	Jon Gildersleeve	Jon Gildersleeve	QES	7/1/98	16:30
Received by:	[illegible]	[illegible]	APCL	7/2/98	1000
Relinquished by:					
Received by:					

Comments: LOG 4750

QA373 4/96 CMD

0000014

CHAIN-OF-CUSTODY

98E-0368

PROJECT NAME: FT IRWIN	**QUANTERRA** ENVIRONMENTAL SERVICES	DUE: 19 JUL 98
PO NUMBER: CONTACT PM	880 Riverside Parkway	TO: DataChem Laboratories, 960 West LeVoy Drive, Salt Lake City, UT 84123
PROJECT MANAGER: Jon Gildersleeve	West Sacramento, CA 95605	
	Phone #: (916) 374-4381	

SAMPLE DESCRIPTION	LAB ID	DATE	TIME	MATRIX	CONTAINERS	O-CHLOROBENZALD ~~EHYDE~~	ANALYSES	REMARKS/ SPCL INSTR	
8.1a-1-Ts-1-0.5	300142-0001 SA	26 JUN 98	16:45	SOIL	125CGJ	X		98E035	24
8.1a-1-Ts-1-2.5	300142-0002 SA	26 JUN 98	17:00	SOIL	↓	X			25
8.1a-1-Ts-1-5	300142-0003 SA	26 JUN 98	17:15	SOIL	↓	X			26
~~8.1a-1-Ts-1-5~~	~~300142-0003 MS~~	~~26 JUN 98~~	~~17:15~~	~~SOIL~~		~~X~~	MCD 070798		
~~8.1a-1-Ts-1-5~~	~~300142-0003 SD~~	~~26 JUN 98~~	~~17:15~~	~~SOIL~~		~~X~~	MCD 070798		
8.1a-1-Ts-1-10	300142-0004 SA	26 JUN 98	17:30	SOIL	125CGJ	X			27
8.1a-1-Ts-1-15	300142-0005 SA	26 JUN 98	17:45	SOIL	↓	X			28
8.3b-1-Ts-1-0.5	300142-0006 SA	26 JUN 98	09:30	SOIL	↓	X			29
~~8.3b-1-Ts-1-0.5~~	~~300142-0006 MS~~	~~26 JUN 98~~	~~09:30~~	~~SOIL~~		~~X~~	MCD 070798		
~~8.3b-1-Ts-1-0.5~~	~~300142-0006 SD~~	~~26 JUN 98~~	~~09:30~~	~~SOIL~~		~~X~~	MCD 070798		
8.3b-1-Ts-1-2.5	300142-0007 SA	26 JUN 98	10:10	SOIL	125CGJ	X			30
8.3b-1-Ts-1-5	300142-0008 SA	26 JUN 98	10:20	SOIL	↓	X			31
8.3b-1-Ts-1-10	300142-0009 SA	26 JUN 98	10:35	SOIL	↓	X			32
~~8.3b-1-Ts-1-10~~	~~300142-0009 MS~~	~~26 JUN 98~~	~~10:35~~	~~SOIL~~		~~X~~	MCD 070798		
~~8.3b-1-Ts-1-10~~	~~300142-0009 SD~~	~~26 JUN 98~~	~~10:35~~	~~SOIL~~		~~X~~	MCD 070798		
8.3b-1-Ts-1-15	300142-0010 SA	26 JUN 98	11:10	SOIL	125CGJ	X			33

	SIGNATURE	PRINT NAME	COMPANY/TITLE	DATE	TIME
Relinquished by:	[signature]	Jon Gildersleeve	QES	7/7/98	10:30
Received by:	Thomas T. McKay	Thomas T. McKay	DCL	7/9/98	09:45
Relinquished by:					
Received by:					

Comments: PLEASE CONTACT JON GILDERSLEEVE IF YOU HAVE ANY QUESTIONS. LOG 4761

QA373 4/96 CMD

0000015

10

APPENDIX D

DATA VALIDATION REPORTS

Fort Irwin
Data Validation Reports
LDC# 3103

Volatiles

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26 through June 27, 1998

LDC Report Date: September 15, 1998

Matrix: Soil/Water

Parameters: Volatiles

Validation Level: EPA Level III

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300141

Sample Identification

8 3a-1-Ts-1 0 5
8 3a-1-Ts-1-5
8 3a-1-Ts-1-10
8 3a-1-Td-1-2 5
TB062698
8 1a-2-Ts-1-0 5
8 3a-1-Ts-1 0 5MS
8 3a-1-Ts-1 0 5MSD

Introduction

This data review covers 7 soil samples and one water sample listed on the cover sheet including dilutions and reanalysis as applicable The analyses were per EPA SW 846 Method 8260 for Volatiles

This review follows a modified outline of the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (February 1994) as there are no current guidelines for the method stated above.

A table summarizing all data qualification is provided at the end of this report. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature

Blank results are summarized in Section V.

Field duplicates are summarized in Section XVI

Raw data were not reviewed for this SDG The review was based on QC data.

The following are definitions of the data qualifiers:

U Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.

J Indicates an estimated value.

R Quality control indicates the data is not usable.

N Presumptive evidence of presence of the constituent.

UJ Indicates the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

A Indicates the finding is based upon technical validation criteria.

P Indicates the finding is related to a protocol/contractual deviation.

None Indicates the data was not significantly impacted by the finding, therefore qualification was not required.

I. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures All cooler temperatures met validation criteria

II. GC/MS Instrument Performance Check

Instrument performance was checked at 12 hour intervals.

All ion abundance requirements were met

III. Initial Calibration

Initial calibration was performed using required standard concentrations

Percent relative standard deviations (%RSD) were less than or equal to 30.0% for selected compounds with the following exceptions:

Date	Compound	%RSD	Associated Samples	Flag	A or P
6/23/98	Acetone	34 689	All soil samples in SDG 300141	J (all detects) UJ (all non-detects)	A

A curve fit, based on the initial calibration, was established for quantitation for selected compounds with the following exceptions:

Date	Compound	r^2	Associated Samples	Flag	A or P
6/15/98	Vinyl acetate	0.97761	All water samples in SDG 300141	J (all detects) UJ (all non-detects)	A

Average relative response factors (RRF) for all volatile target compounds and system monitoring compounds were within validation criteria with the following exceptions:

Date	Compound	RRF (Limits)	Associated Samples	Flag	A or P
6/15/98	Acetone Vinyl acetate 2-Butanone	0 01487 (≥0.05) 0 04325 (≥0.05) 0 02649 (≥0 05)	All water samples in SDG 300141	J (all detects) R (all non-detects)	A
6/23/98	Acetone Vinyl acetate 2-Butanone	0 04814 (≥0.05) 0 04823 (≥0 05) 0 04622 (≥0 05)	All soil samples in SDG 300141	J (all detects) R (all non-detects)	A

IV. Continuing Calibration

Continuing calibration was performed at the required frequencies.

All of the continuing calibration percent differences (%D) between the initial calibration RRF and the continuing calibration RRF were less than or equal to 25.0% with the following exceptions:

Date	Compound	%D	Associated Samples	Flag	A or P
7/7/98	Chloroethane 2-Chloroethylvinyl ether	21 8 20 8	All water samples in SDG 300141	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	A
7/6/98	Dichlorodifluoromethane Bromomethane Acetone Carbon disulfide 2-Chloroethylvinyl ether 1 1 2,2-Tetrachloroethane	21 8 24 7 36 0 25 3 72 4 34 4	8 3a-1-Ts-1.0 5 8.3a-1-Ts-1-5 8 3a-1-Ts-1-10 8 1a-2-Ts-1-0 5 8 3a-1-Ts-1 0 5MS 8.3a-1-Ts-1.0 5MSD 07/06/98-MB	J (all detects) UJ (all non-detects)	A
7/7/98	Carbon tetrachloride 2-Chloroethylvinyl ether 1 1 2,2-Tetrachloroethane Trichlorofluoromethane 1 1 1-Trichloroethane	28 0 56.7 32.4 21 8 21 8	8.3a-1-Td-1-2.5 07/07/98-MB	J (all detects) UJ (all non-detects)	A

All of the continuing calibration RRF values were within validation criteria with the following exceptions:

Date	Compound	RRF (Limits)	Associated Samples	Flag	A or P
7/7/98	2-Chloroethylvinyl ether Acetone Vinyl acetate 2-Butanone	0 044 (≥0 05) 0.019 (≥0.05) 0 028 (≥0.05) 0 030 (≥0 05)	All water samples in SDG 300141	J (all detects) R (all non-detects)	A
7/6/98	Acetone Vinyl acetate 2-Butanone 2-Chloroethylvinyl ether	0 031 (≥0 05) 0 046 (≥0.05) 0 042 (≥0.05) 0 018 (≥0.05)	8.3a-1-Ts-1 0.5 8.3a-1-Ts-1-5 8 3a-1-Ts-1-10 8.1a-2-Ts-1-0.5 8 3a-1-Ts-1 0 5MS 8.3a-1-Ts-1.0 5MSD 07/06/98-MB	J (all detects) R (all non-detects)	A
7/7/98	Acetone 2-Butanone 2-Chloroethylvinyl ether	0.047 (≥0 05) 0 044 (≥0 05) 0 029 (≥0 05)	8.3a-1-Td-1-2.5 07/07/98-MB	J (all detects) R (all non-detects)	A

V. Blanks

Method blanks were reviewed for each matrix as applicable. No volatile contaminants were found in the method blanks with the following exceptions:

Method Blank ID	Analysis Date	Compound TIC (RT in minutes)	Concentration	Associated Samples
07/07/98-MB2	7/7/98	Carbon disulfide	0 45 ug/L	All water samples in SDG 300141
07/07/98-MB	7/7/98	Carbon disulfide	0 56 ug/Kg	8.3a-1-Td-1-2 5

Sample concentrations were compared to concentrations detected in the method blanks The sample concentrations were either not detected or were significantly greater (>10X for common contaminants >5X for other contaminants) than the concentrations found in the associated method blanks

Sample TB062698 was identified as a trip blank No volatile contaminants were found in this blank with the following exceptions:

Trip Blank ID	Sampling Date	Compound	Concentration	Associated Samples
TB062698	6/26/98	Chloromethane	0 58 ug/L	8.3a-1-Ts-1 0 5 8.3a-1-Ts-1-5 8.3a-1-Ts-1-10 8.3a-1-Td-1-2 5

Sample concentrations were compared to concentrations detected in the field blanks. The sample concentrations were either not detected or were significantly greater (>10X for common contaminants, >5X for other contaminants) than the concentrations found in the associated field blanks.

VI. Surrogate Spikes

Surrogates were added to all samples and blanks as required by the method All surrogate recoveries (%R) were within QC limits.

VII. Matrix Spike/Matrix Spike Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) samples were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits.

VIII. Laboratory Control Samples (LCS)

Laboratory control samples were reviewed for each matrix as applicable. Percent

recoveries (%R) and relative percent differences (RPD) were within QC limits.

IX. Regional Quality Assurance and Quality Control

Not applicable.

X. Internal Standards

All internal standard areas and retention times.

XI. Target Compound Identifications

Raw data were not reviewed for this SDG

XII. Compound Quantitation and CRQLs

The QAPP reporting limits were met with the following exceptions:

Sample	Compound	Finding	Criteria	Flag	A or P
All samples in SDG 300141	Dichlorodifluoromethane 2-Hexanone Trichlorofluoromethane Acetone 2-Butanone 4-Methyl-2-butanone Vinyl acetate	Laboratory reporting limit reported at 500 ug/Kg.	Reporting limit should be reported at 560 ug/Kg per the QAPP	None None None None None None None	P

Raw data were not reviewed for this SDG.

XIII. Tentatively Identified Compounds (TICs)

Raw data were not reviewed for this SDG

XIV. System Performance

Raw data were not reviewed for this SDG

XV. Overall Assessment of Data

Data flags have been summarized at the end of the report.

XVI. Field Duplicates

No field duplicates were identified in this SDG.

Fort Irwin
Volatiles - Data Qualification Summary - SDG 300141

SDG	Sample	Compound	Flag	A or P	Reason
300141	8.3a-1-Ts-1 0 5 8 3a-1-Ts-1-5 8.3a-1-Ts-1-10 8 3a-1-Td-1-2 5 8 1a-2-Ts-1-0.5	Acetone	J (all detects) UJ (all non-detects)	A	Initial calibration (%RSD)
300141	TB062698	Vinyl acetate	J (all detects) UJ (all non-detects)	A	Initial calibration (r^2)
300141	TB062698 8 3a-1-Ts-1 0 5 8.3a-1-Ts-1-5 8.3a-1-Ts-1-10 8.3a-1-Td-1-2 5 8.1a-2-Ts-1-0 5	Acetone Vinyl acetate 2-Butanone	J (all detects) R (all non-detects)	A	Initial calibration (RRF)
300141	TB062698	Chloroethane 2-Chloroethylvinyl ether	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	A	Continuing calibration (%D)
300141	8.3a-1-Ts-1 0 5 8.3a-1-Ts-1-5 8.3a-1-Ts-1-10 8.1a-2-Ts-1-0.5	Dichlorodifluoromethane Bromomethane Acetone Carbon disulfide 2-Chloroethylvinyl ether 1 1 2 2-Tetrachloroethane	J (all detects) UJ (all non-detects)	A	Continuing calibration (%D)
300141	8 3a-1-Td-1-2 5	Carbon tetrachloride 2-Chloroethylvinyl ether 1 1 2,2-Tetrachloroethane Trichlorofluoromethane 1 1 1-Trichloroethane	J (all detects) UJ (all non-detects)	A	Continuing calibration (%D)
300141	TB062698	2-Chloroethylvinyl ether Acetone Vinyl acetate 2-Butanone	J (all detects) R (all non-detects)	A	Continuing calibration (RRF)
300141	8.3a-1-Ts-1 0 5 8.3a-1-Ts-1-5 8.3a-1-Ts-1-10 8.1a-2-Ts-1-0.5	Acetone Vinyl acetate 2-Butanone 2-Chloroethylvinyl ether	J (all detects) R (all non-detects)	A	Continuing calibration (RRF)
300141	8.3a-1-Td-1-2 5	Acetone 2-Butanone 2-Chloroethylvinyl ether	J (all detects) R (all non-detects)	A	Continuing calibration (RRF)

SDG	Sample	Compound	Flag	A or P	Reason
300141	8 3a-1-Ts-1 0.5 8.3a-1-Ts-1-5 8 3a-1-Ts-1-10 8.3a-1-Td-1-2 5 TB062698 8 1a-2-Ts-1-0.5	Dichlorodifluoromethane 2-Hexanone Trichlorofluoromethane Acetone 2-Butanone 4-Methyl-2-butanone Vinyl acetate	None None None None None None None	P	Compound quantitation and CRQLs

Fort Irwin
Volatiles - Laboratory Blank Data Qualification Summary - SDG 300141

No Sample Data Qualified in this SDG

Fort Irwin
Volatiles - Field Blank Data Qualification Summary - SDG 300141

No Sample Data Qualified in this SDG

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26, 1998

LDC Report Date: September 9, 1998

Matrix: Soil/Water

Parameters: Volatiles

Validation Level: EPA Level IV

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300142

Sample Identification

8 1a-1-Ts-1-2 5
8 1a-1-Ts-1-2.5RE
8.3b-1-Ts-1-0 5
8.3b-1-Ts-1-2.5
8 3b-1-Ts-1-5
TB062698
8.3b-1-Ts-1-0.5MS
8.3b-1-Ts-1-0.5MSD

Introduction

This data review covers 7 soil samples and one water sample listed on the cover sheet including dilutions and reanalysis as applicable. The analyses were per EPA SW 846 Method 8260A for Volatiles.

This review follows a modified outline of the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (February 1994) as there are no current guidelines for the method stated above.

A table summarizing all data qualification is provided at the end of this report. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

Blank results are summarized in Section V.

Field duplicates are summarized in Section XVI.

The following are definitions of the data qualifiers:

U Indicates the compound or analyte was analyzed for but not detected at or above the stated limit

J Indicates an estimated value.

R Quality control indicates the data is not usable.

N Presumptive evidence of presence of the constituent.

UJ Indicates the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

A Indicates the finding is based upon technical validation criteria.

P Indicates the finding is related to a protocol/contractual deviation.

None Indicates the data was not significantly impacted by the finding, therefore qualification was not required.

I. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria.

II. GC/MS Instrument Performance Check

Instrument performance was checked at 12 hour intervals.

All ion abundance requirements were met.

III. Initial Calibration

Initial calibration was performed using required standard concentrations.

Percent relative standard deviations (%RSD) were less than or equal to 30.0% for selected compounds with the following exceptions:

Date	Compound	%RSD	Associated Samples	Flag	A or P
6/23/98	Acetone	34.689	8.1a-1-Ts-1-2.5 8.3b-1-Ts-1-0.5 8.3b-1-Ts-1-2.5 8.3b-1-Ts-1-5 8.3b-1-Ts-1-0.5MS 8.3b-1-Ts-1-0.5MSD 07JUL98-6A	J (all detects) UJ (all non-detects)	A

A curve fit, based on the initial calibration, was established for quantitation for selected compounds. The coefficient of determination (r^2) was greater than or equal to 0.990 with the following exceptions:

Date	Compound	r^2	Associated Samples	Flag	A or P
6/15/98	Bromomethane Vinyl acetate	0.95873 0.97761	All water samples in SDG 300142	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	A
7/10/98	Bromomethane Chloroethane	0.98772 0.94989	8.1a-1-Ts-1-2.5RE 13JUL98-1A	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	A

Average relative response factors (RRF) for all volatile target compounds and system monitoring compounds were within validation criteria with the following exceptions:

Date	Compound	RRF (Limits)	Associated Samples	Flag	A or P
6/15/98	Acetone Vinyl acetate 2-Butanone	0 01487 (≥0 05) 0 04325 (≥0 05) 0 02649 (≥0.05)	All water samples in SDG 300142	J (all detects) R (all non-detects)	A
6/23/98	Acetone Vinyl acetate 2-Butanone	0 04814 (≥0 05) 0 04823 (≥0.05) 0 04622 (≥0 05)	8 1a-1-Ts-1-2 5 8.3b-1-Ts-1-0 5 8.3b-1-Ts-1-2 5 8 3b-1-Ts-1-5 8 3b-1-Ts-1-0.5MS 8.3b-1-Ts-1-0.5MSD 07JUL98-6A	J (all detects) R (all non-detects)	A

IV. Continuing Calibration

Continuing calibration was performed at the required frequencies.

All of the continuing calibration percent differences (%D) between the initial calibration RRF and the continuing calibration RRF were less than or equal to 25 0% with the following exceptions:

Date	Compound	%D	Associated Samples	Flag	A or P
7/7/98 (V3310)	Chloroethane 2-Chloroethylvinyl ether	21 8 20 8	All water samples in SDG 300142	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	A
7/7/98 (V6305)	Trichlorofluoromethane 1 1 1-Trichloroethane Carbon tetrachloride 2-Chloroethylvinyl ether 1 1 2 2-Tetrachloroethane	21 8 21 8 28.0 56.7 32.4	8.1a-1-Ts-1-2 5 8.3b-1-Ts-1-0 5 8.3b-1-Ts-1-2 5 8.3b-1-Ts-1-5 8 3b-1-Ts-1-0 5MS 8.3b-1-Ts-1-0.5MSD 07JUL98-6A	J (all detects) UJ (all non-detects)	A
7/13/98	Chloroethane Vinyl acetate	46 0 34 1	8.1a-1-Ts-1-2.5RE 13JUL98-1A	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	A

All of the continuing calibration RRF values were within validation criteria with the following exceptions:

Date	Compound	RRF (Limits)	Associated Samples	Flag	A or P
7/7/98 (V3310)	2-Chloroethylvinyl ether Acetone Vinyl acetate 2-Butanone	0.044 (≥0.05) 0.019 (≥0.05) 0.028 (≥0.05) 0.030 (≥0.05)	All water samples in SDG 300142	J (all detects) R (all non-detects)	A
7/7/98 (V6305)	Acetone 2-Butanone 2-Chloroethylvinyl ether	0.047 (≥0.05) 0.044 (≥0.05) 0.029 (≥0.05)	8.1a-1-Ts-1-2.5 8.3b-1-Ts-1-0.5 8.3b-1-Ts-1-2.5 8.3b-1-Ts-1-5 8.3b-1-Ts-1-0.5MS 8.3b-1-Ts-1-0.5MSD 07JUL98-6A	J (all detects) R (all non-detects)	A

V. Blanks

Method blanks were reviewed for each matrix as applicable. No volatile contaminants were found in the method blanks with the following exceptions:

Method Blank ID	Analysis Date	Compound TIC (RT in minutes)	Concentration	Associated Samples
07JUL98-6A	7/7/98	Carbon disulfide	0.56 ug/Kg	8.1a-1-Ts-1-2.5 8.3b-1-Ts-1-0.5 8.3b-1-Ts-1-2.5 8.3b-1-Ts-1-5
07JUL98-3A	7/7/98	Carbon disulfide	0.45 ug/L	TB062698

Sample concentrations were compared to concentrations detected in the method blanks. The sample concentrations were either not detected or were significantly greater (>10X for common contaminants, >5X for other contaminants) than the concentrations found in the associated method blanks.

Sample TB062698 was identified as a trip blank. No volatile contaminants were found in this blank with the following exceptions:

Trip Blank ID	Sampling Date	Compound	Concentration	Associated Samples
TB062698	6/26/98	Chloromethane Xylenes (total)	0.43 ug/L 0.20 ug/L	All samples in SDG 300142

Sample concentrations were compared to concentrations detected in the field blanks. The sample concentrations were either not detected or were significantly greater (>10X for common contaminants, >5X for other contaminants) than the concentrations found in the associated field blanks.

VI. Surrogate Spikes

Surrogates were added to all samples and blanks as required by the method All surrogate recoveries (%R) were within QC limits with the following exceptions:

Sample	Surrogate	%R (Limits)	Compound	Flag	A or P
TB062698	Toluene-d8	78 (88-110)	All TCL compounds	J (all detects) UJ (all non-detects)	P

VII. Matrix Spike/Matrix Spike Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) samples were reviewed for each matrix as applicable Percent recoveries (%R) and relative percent differences (RPD) were within QC limits.

VIII. Laboratory Control Samples (LCS)

Laboratory control samples were reviewed for each matrix as applicable Percent recoveries (%R) and relative percent differences (RPD) were within QC limits

IX. Regional Quality Assurance and Quality Control

Not applicable

X. Internal Standards

All internal standard areas and retention times were within QC limits

XI. Target Compound Identifications

All target compound identifications were within validation criteria

XII. Compound Quantitation and CRQLs

All compound quantitation and CRQLs were within validation criteria.

The QAPP reporting limits were met with the following exceptions:

Sample	Compound	Finding	Criteria	Flag	A or P
All soil samples in SDG 300142	Dichlorodifluoromethane 2-Hexanone Trichlorofluoromethane Acetone 2-Butanone 4-Methyl-2-butanone Vinyl acetate	Laboratory reporting limit reported at 10 ug/Kg	Reporting limit should be reported at 5 0 ug/Kg per the QAPP	None None None None None None None	P

XIII. Tentatively Identified Compounds (TICs)

Tentatively identified compounds were not reported by the laboratory.

XIV. System Performance

The system performance was acceptable

XV. Overall Assessment of Data

Data flags have been summarized at the end of the report.

XVI. Field Duplicates

No field duplicates were identified in this SDG

Fort Irwin
Volatiles - Data Qualification Summary - SDG 300142

SDG	Sample	Compound	Flag	A or P	Reason
300142	8 1a-1-Ts-1-2.5 8 3b-1-Ts-1-0 5 8 3b-1-Ts-1-2 5 8.3b-1-Ts-1-5	Acetone	J (all detects) UJ (all non-detects)	A	Initial calibration (%RSD)
300142	TB062698	Bromomethane Vinyl acetate	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	A	Initial calibration (r^2)
300142	8 1a-1-Ts-1-2.5RE	Bromomethane Chloroethane	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	A	Initial calibration (r^2)
300142	TB062698 8.1a-1-Ts-1-2 5 8.3b-1-Ts-1-0.5 8 3b-1-Ts-1-2.5 8.3b-1-Ts-1-5	Acetone Vinyl acetate 2-Butanone	J (all detects) R (all non-detects)	A	Initial calibration (RRF)
300142	TB062698	Chloroethane 2-Chloroethylvinyl ether	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	A	Continuing calibration (%D)
300142	8 1a-1-Ts-1-2.5 8.3b-1-Ts-1-0 5 8 3b-1-Ts-1-2 5 8 3b-1-Ts-1-5	Trichlorofluoromethane 1 1 1-Trichloroethane Carbon tetrachloride 2-Chloroethylvinyl ether 1 1 2 2-Tetrachloroethane	J (all detects) UJ (all non-detects)	A	Continuing calibration (%D)
300142	8.1a-1-Ts-1-2.5RE	Chloroethane Vinyl acetate	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	A	Continuing calibration (%D)
300142	TB062698	2-Chloroethylvinyl ether Acetone Vinyl acetate 2-Butanone	J (all detects) R (all non-detects)	A	Continuing calibration (RRF)
300142	8.1a-1-Ts-1-2.5 8.3b-1-Ts-1-0.5 8.3b-1-Ts-1-2 5 8.3b-1-Ts-1-5	Acetone 2-Butanone 2-Chloroethylvinyl ether	J (all detects) R (all non-detects)	A	Continuing calibration (RRF)
300142	TB062698	All TCL compounds	J (all detects) UJ (all non-detects)	P	Surrogate spikes (%R)

SDG	Sample	Compound	Flag	A or P	Reason
300142	8.1a-1-Ts-1-2.5 8.1a-1-Ts-1-2.5RE 8.3b-1-Ts-1-0.5 8.3b-1-Ts-1-2.5 8.3b-1-Ts-1-5	Dichlorodifluoromethane 2-Hexanone Trichlorofluoromethane Acetone 2-Butanone 4-Methyl-2-butanone Vinyl acetate	None None None None None None None	P	Compound quantitation and CRQLs

Fort Irwin
Volatiles - Laboratory Blank Data Qualification Summary - SDG 300142

No Sample Data Qualified in this SDG

Fort Irwin
Volatiles - Field Blank Data Qualification Summary - SDG 300142

No Sample Data Qualified in this SDG

Fort Irwin
Data Validation Reports
LDC# 3103

Semivolatiles

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26 through June 27, 1998

LDC Report Date: September 15, 1998

Matrix: Soil

Parameters: Semivolatiles

Validation Level: EPA Level III

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300141

Sample Identification

8 3c-1-Ts-1-0 5	7d-1-Ts-1-0 5
8 3c-1-Ts-1-2.5	7d-1-Ts-1-2.5
8 3c-1-Ts-1-5	7d-1-Ts-1-5
8 3c-1-Ts-1-10	7d-1-Ts-1-10
8 3c-1-Ts-1-15	7d-1-Ts-1-15
8 3a-1-Ts-1 0.5	7d-1-Tp-1-0.5
8 3a-1-Ts-1-2.5	7d-1-Tp-1-2.5
8 3a-1-Ts-1-5	7d-1-Tp-1-5
8.3a-1-Ts-1-10	7d-1-Tp-1-10
8.3a-1-Ts-1-15	7d-2-Ts-1-0.5
8 3c-1-Td-1-5	7d-2-Ts-1-2 5
8 3a-1-Td-1-2.5	7d-2-Ts-1-5
7d-1Td-1-2.5	7d-2-Ts-1-10
7d-1-Tdd-1-2.5	8 3c-1-Ts-1-5MS
7d-2-Td-1-0.5	8 3c-1-Ts-1-5MSD
8 1a-2-Ts-1-0.5	8 3a-1-Ts-1-2.5MS
8 1a-2-Ts-1-2.5	8 3a-1-Ts-1-2.5MSD
8 1a-2-Ts-1-5	7d-2-Ts-1-0 5MS
8.1a-2-Ts-1-10	7d-2-Ts-1-0 5MSD
8 1a-2-Td-1-5	

Introduction

This data review covers 39 soil samples listed on the cover sheet including dilutions and reanalysis as applicable The analyses were per EPA SW 846 Method 8270 for Semivolatiles

This review follows a modified outline of the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (February 1994) as there are no current guidelines for the method stated above.

A table summarizing all data qualification is provided at the end of this report Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature

Blank results are summarized in Section V

Field duplicates are summarized in Section XVI

Raw data were not reviewed for this SDG The review was based on QC data

The following are definitions of the data qualifiers:

U Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.

J Indicates an estimated value.

R Quality control indicates the data is not usable.

N Presumptive evidence of presence of the constituent.

UJ Indicates the compound or analyte was analyzed for but not detected The sample detection limit is an estimated value

A Indicates the finding is based upon technical validation criteria.

P Indicates the finding is related to a protocol/contractual deviation.

None Indicates the data was not significantly impacted by the finding, therefore qualification was not required

I. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria.

II. GC/MS Instrument Performance Check

Instrument performance was checked at 12 hour intervals.

All ion abundance requirements were met.

III. Initial Calibration

Initial calibration was performed using required standard concentrations.

Percent relative standard deviations (%RSD) were less than or equal to 30.0% for all compounds.

Average relative response factors (RRF) for all semivolatile target compounds and system monitoring compounds were greater than or equal to 0.05 as required.

IV. Continuing Calibration

Continuing calibration was performed at the required frequencies.

All of the continuing calibration percent differences (%D) between the initial calibration RRF and the continuing calibration RRF were less than or equal to 20.0% with the following exceptions:

Date	Compound	%D	Associated Samples	Flag	A or P
7/20/98	Benzoic acid 3 3 -Dichlorobenzidine	46 8 24 1	8.3c-1-Ts-1-0 5 8.3c-1-Ts-1-2 5 8.3c-1-Ts-1-5 8.3c-1-Ts-1-10 8 3c-1-Ts-1-15 8.3a-1-Ts-1 0 5 8.3a-1-Ts-1-2 5 8.3a-1-Ts-1-5 8.3a-1-Ts-1-10 8.3a-1-Ts-1-15 8 3c-1-Td-1-5 8 3a-1-Td-1-2 5 7d-1Td-1-2 5 7d-1-Tdd-1-2.5 7d-2-Td-1-0 5 8 1a-2-Ts-1-0.5 8 3c-1-Ts-1-5MS 8 3c-1-Ts-1-5MSD 8 3a-1-Ts-1-2 5MS 8.3a-1-Ts-1-2.5MSD 07JUL98-115MB	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	A
7/21/98	Benzoic acid 4-Nitroaniline 3 3 -Dichlorobenzidine	46.5 22.6 38 1	8 1a-2-Ts-1-2 5	J (all detects) UJ (all non-detects)	A
7/22/98	Bis(2-ethylhexyl)phthalate Di-n-octylphthalate	21 9 30 2	8.1a-2-Ts-1-5 8.1a-2-Ts-1-10 8 1a-2-Td-1-5 7d-1-Ts-1-0 5 7d-1-Ts-1-2.5 7d-1-Ts-1-10 7d-1-Ts-1-15 7d-1-Tp-1-0 5 7d-1-Tp-1-2 5 7d-1-Ts-1-5 7d-2-Ts-1-0 5 7d-2-Ts-1-0.5MS 7d-2-Ts-1-0.5MSD 07JUL125MB	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	A
7/23/98	2 2'-Oxybis(1-chloropropane) Nitrobenzene Benzoic acid 2-Nitroaniline 4-Nitrophenol	22.2 20.4 37 4 21 5 22 4	7d-1-Tp-1-5 7d-1-Tp-1-10 7d-2-Ts-1-2.5 7d-2-Ts-1-5 7d-2-Ts-1-10	J (all detects) UJ (all non-detects)	A

All of the continuing calibration RRF values were greater than or equal to 0.05

V. Blanks

Method blanks were reviewed for each matrix as applicable. No semivolatile contaminants were found in the method blanks with the following exceptions:

Method Blank ID	Extraction Date	Compound TIC (RT in minutes)	Concentration	Associated Samples
07JUL98-11S	7/7/98	Benzo(a)anthracene Chrysene 3,3 'Dichlorobenzidine Fluoranthene 4-Nitrophenol Pyrene	70 ug/Kg 73 ug/Kg 49 ug/Kg 100 ug/Kg 110 ug/Kg 75 ug/Kg	8 3c-1-Ts-1-0 5 8 3c-1-Ts-1-2 5 8 3c-1-Ts-1-5 8 3c-1-Ts-1-10 8.3c-1-Ts-1-15 8 3a-1-Ts-1 0 5 8 3a-1-Ts-1-2 5 8.3a-1-Ts-1-5 8 3a-1-Ts-1-10 8 3a-1-Ts-1-15 8 3c-1-Td-1-5 8 3a-1-Td-1-2 5 7d-1Td-1-2 5 7d-1-Tdd-1-2.5 7d-2-Td-1-0 5 8.1a-2-Ts-1-0 5
07JUL98-12S	7/7/98	Benzo(a)anthracene Fluoranthene Pyrene	50 ug/Kg 110 ug/Kg 81 ug/Kg	8 1a-2-Ts-1-2 5 8 1a-2-Ts-1-5 8 1a-2-Ts-1-10 8.1a-2-Td-1-5 7d-1-Ts-1-0.5 7d-1-Ts-1-2 5 7d-1-Ts-1-5 7d-1-Ts-1-10 7d-1-Ts-1-15 7d-1-Tp-1-0.5 7d-1-Tp-1-2 5 7d-1-Tp-1-5 7d-1-Tp-1-10 7d-2-Ts-1-0.5 7d-2-Ts-1-2.5 7d-2-Ts-1-5 7d-2-Ts-1-10

Sample concentrations were compared to concentrations detected in the method blanks. The sample concentrations were either not detected or were significantly greater (>10X for common contaminants, >5X for other contaminants) than the concentrations found in the associated method blanks.

No field blanks were identified in this SDG.

VI. Surrogate Spikes

Surrogates were added to all samples and blanks as required by the method All surrogate recoveries (%R) were within QC limits.

VII. Matrix Spike/Matrix Spike Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) samples were reviewed for each matrix as applicable Percent recoveries (%R) and relative percent differences (RPD) were within QC limits with the following exceptions:

Spike ID (Associated Samples)	Compound	MS (%R) (Limits)	MSD (%R) (Limits)	RPD (Limits)	Flag	A or P
8.3a-1-Ts-1-2.5MS/MSD (8 3a-1-Ts-1-2 5)	Pyrene	-	-	43 (≤36)	J (all detects)	A

VIII. Laboratory Control Samples (LCS)

Laboratory control samples were reviewed for each matrix as applicable Percent recoveries (%R) were within QC limits with the following exceptions:

LCS ID	Compound	%R (Limits)	Associated Samples	Flag	A or P
07/07/98-11SLCS	1 2 4-Trichlorobenzene	108 (38-107)	8.3c-1-Ts-1-0.5 8.3c-1-Ts-1-2.5 8 3c-1-Ts-1-5 8 3c-1-Ts-1-10 8.3c-1-Ts-1-15 8 3a-1-Ts-1 0.5 8.3a-1-Ts-1-2 5 8 3a-1-Ts-1-5 8 3a-1-Ts-1-10 8.3a-1-Ts-1-15 8.3c-1-Td-1-5 8 3a-1-Td-1-2 5 7d-1Td-1-2.5 7d-1-Tdd-1-2.5 7d-2-Td-1-0.5 8.1a-2-Ts-1-0 5 07JUL98-11S	J (all detects)	A

IX. Regional Quality Assurance and Quality Control

Not applicable.

X. Internal Standards

Internal standard data were not provided and therefore not reviewed.

XI. Target Compound Identifications

Raw data were not reviewed for this SDG.

XII. Compound Quantitation and CRQLs

The QAPP reporting limits were met with the following exceptions:

Sample	Compound	Finding	Criteria	Flag	A or P
All samples in SDG 300141	3 3 -Dichlorobenzidine	Laboratory reporting limit reported at 660 ug/Kg.	Reporting limit should be reported at 330 ug/Kg per the QAPP	None	P
All samples in SDG 300141	Benzoic acid 4.6-Dinitro-2-methylphenol 2.4-Dinitrophenol 2-Nitroaniline 3-Nitroaniline 4-Nitroaniline 4-Nitrophenol Pentachlorophenol	Laboratory reporting limit reported at 1600 ug/Kg.	Reporting limit should be reported at 330 ug/Kg per the QAPP	None None None None None None None None	P

Raw data were not reviewed for this SDG

XIII. Tentatively Identified Compounds (TICs)

Raw data were not reviewed for this SDG.

XIV. System Performance

Raw data were not reviewed for this SDG.

XV. Overall Assessment

Data flags have been summarized at the end of the report.

XVI. Field Duplicates

Samples 7d-1Td-1-2 5 and 7d-1-Ts-1-2.5, samples 7d-2-Td-1-0 5 and 7d-2-Ts-1-0 5, samples 7d-1-Tdd-1-2 5 and 7d-1-Tp-1-2.5, samples 8.1a-2-Ts-1-5 and 8.1a-2-Td-1-5, samples 8.3a-1-Ts-1-2 5 and 8.3a-1-Td-1-2.5, and samples 8.3c-1-Ts-1-5 and 8.3c-1-Td-1-5 were identified as field duplicates. No semivolatiles were detected in any of the samples.

Fort Irwin
Semivolatiles - Data Qualification Summary - SDG 300141

SDG	Sample	Compound	Flag	A or P	Reason
300141	8 3c-1-Ts-1-0 5 8 3c-1-Ts-1-2 5 8 3c-1-Ts-1-5 8 3c-1-Ts-1-10 8 3c-1-Ts-1-15 8 3a-1-Ts-1 0.5 8.3a-1-Ts-1-2.5 8.3a-1-Ts-1-5 8.3a-1-Ts-1-10 8.3a-1-Ts-1-15 8.3c-1-Td-1-5 8 3a-1-Td-1-2 5 7d-1Td-1-2 5 7d-1-Tdd-1-2.5 7d-2-Td-1-0.5	Benzoic acid 3.3-Dichlorobenzidine	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	A	Continuing calibration (%D)
300141	8 1a-2-Ts-1-2 5	Benzoic acid 4-Nitroaniline 3.3-Dichlorobenzidine	J (all detects) UJ (all non-detects)	A	Continuing calibration (%D)
300141	8 1a-2-Ts-1-5 8 1a-2-Ts-1-10 8 1a-2-Td-1-5 7d-1-Ts-1-0 5 7d-1-Ts-1-2 5 7d-1-Ts-1-10 7d-1-Ts-1-15 7d-1-Tp-1-0 5 7d-1-Tp-1-2 5 7d-1-Ts-1-5 7d-2-Ts-1-0 5	Bis(2-ethylhexyl)phthalate Di-n-octylphthalate	J (all detects) UJ (all non-detects)	A	Continuing calibration (%D)
300141	7d-1-Tp-1-5 7d-1-Tp-1-10 7d-2-Ts-1-2 5 7d-2-Ts-1-5 7d-2-Ts-1-10	2,2'-Oxybis(1-chloropropane) Nitrobenzene Benzoic acid 2-Nitroaniline 4-Nitrophenol	J (all detects) UJ (all non-detects)	A	Continuing calibration (%D)
300141	8 3a-1-Ts-1-2.5	Pyrene	J (all detects)	A	Matrix spike/Matrix spike duplicates (RPD)

SDG	Sample	Compound	Flag	A or P	Reason
300141	8.3c-1-Ts-1-0.5 8.3c-1-Ts-1-2.5 8.3c-1-Ts-1-5 8.3c-1-Ts-1-10 8.3c-1-Ts-1-15 8.3a-1-Ts-1-0.5 8.3a-1-Ts-1-2.5 8.3a-1-Ts-1-5 8.3a-1-Ts-1-10 8.3a-1-Ts-1-15 8.3c-1-Td-1-5 8.3a-1-Td-1-2.5 7d-1Td-1-2.5 7d-1-Tdd-1-2.5 7d-2-Td-1-0.5 8.1a-2-Ts-1-0.5	1,2,4-Trichlorobenzene	J (all detects)	A	Laboratory control samples (%R)
300141	8.3c-1-Ts-1-0.5 8.3c-1-Ts-1-2.5 8.3c-1-Ts-1-5 8.3c-1-Ts-1-10 8.3c-1-Ts-1-15 8.3a-1-Ts-1-0.5 8.3a-1-Ts-1-2.5 8.3a-1-Ts-1-5 8.3a-1-Ts-1-10 8.3a-1-Ts-1-15 8.3c-1-Td-1-5 8.3a-1-Td-1-2.5 7d-1Td-1-2.5 7d-1-Tdd-1-2.5 7d-2-Td-1-0.5 8.1a-2-Ts-1-0.5 8.1a-2-Ts-1-2.5 8.1a-2-Ts-1-5 8.1a-2-Ts-1-10 8.1a-2-Td-1-5 7d-1-Ts-1-0.5 7d-1-Ts-1-2.5 7d-1-Ts-1-5 7d-1-Ts-1-10 7d-1-Ts-1-15 7d-1-Tp-1-0.5 7d-1-Tp-1-2.5 7d-1-Tp-1-5 7d-1-Tp-1-10 7d-2-Ts-1-0.5 7d-2-Ts-1-2.5 7d-2-Ts-1-5 7d-2-Ts-1-10	All TCL compounds	None	P	Compound quantitation and CRQLs

Fort Irwin
Semivolatiles - Laboratory Blank Data Qualification Summary - SDG 300141

No Sample Data Qualified in this SDG

Fort Irwin
Semivolatiles - Field Blank Data Qualification Summary - SDG 300141

No Sample Data Qualified in this SDG

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26, 1998

LDC Report Date: September 9, 1998

Matrix: Soil

Parameters: Semivolatiles

Validation Level: EPA Level IV

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300142

Sample Identification

8.1a-1-Ts-1-0.5
8.1a-1-Ts-1-2.5
8.1a-1-Ts-1-5
8.1a-1-Ts-1-10
8.1a-1-Ts-1-15
8.3b-1-Ts-1-0.5
8.3b-1-Ts-1-2.5
8.3b-1-Ts-1-5
8.3b-1-Ts-1-10
8.3b-1-Ts-1-15
8.3b-1-Ts-1-0.5MS
8.3b-1-Ts-1-0.5MSD

Introduction

This data review covers 12 soil samples listed on the cover sheet including dilutions and reanalysis as applicable The analyses were per EPA SW 846 Method 8270 for Semivolatiles.

This review follows a modified outline of the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (February 1994) as there are no current guidelines for the method stated above

A table summarizing all data qualification is provided at the end of this report. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

Blank results are summarized in Section V

Field duplicates are summarized in Section XVI.

The following are definitions of the data qualifiers:

U Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.

J Indicates an estimated value

R Quality control indicates the data is not usable.

N Presumptive evidence of presence of the constituent.

UJ Indicates the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value

A Indicates the finding is based upon technical validation criteria.

P Indicates the finding is related to a protocol/contractual deviation.

None Indicates the data was not significantly impacted by the finding, therefore qualification was not required.

I. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria.

II. GC/MS Instrument Performance Check

Instrument performance was checked at 12 hour intervals

All ion abundance requirements were met.

III. Initial Calibration

Initial calibration was performed using required standard concentrations

Percent relative standard deviations (%RSD) were less than or equal to 30.0% for all compounds.

Average relative response factors (RRF) for all semivolatile target compounds and system monitoring compounds were greater than or equal to 0.05 as required

IV. Continuing Calibration

Continuing calibration was performed at the required frequencies.

All of the continuing calibration percent differences (%D) between the initial calibration RRF and the continuing calibration RRF were less than or equal to 25.0% with the following exceptions:

Date	Compound	%D	Associated Samples	Flag	A or P
7/21/98	Benzyl alcohol 2-Methylphenol N-Nitroso-di-n-propylamine Benzoic acid	28.7 22.9 20.6 34.0	8.1a-1-Ts-1-2.5 8.1a-1-Ts-1-5 8.1a-1-Ts-1-10 8.1a-1-Ts-1-15 8.3b-1-Ts-1-0.5 8.3b-1-Ts-1-2.5 8.3b-1-Ts-1-5 8.3b-1-Ts-1-10 8.3b-1-Ts-1-15 8.3b-1-Ts-1-0.5MS 8.3b-1-Ts-1-0.5MSD 07JUL98-13S	J (all detects) UJ (all non-detects)	A
7/22/98	Bis(2-ethylhexyl)phthalate Di-n-octylphthalate	21.9 30.2	8.1a-1-Ts-1-0.5	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	P

All of the continuing calibration RRF values were greater than or equal to 0.05

V. Blanks

Method blanks were reviewed for each matrix as applicable. No semivolatile contaminants were found in the method blanks.

No field blanks were identified in this SDG.

VI. Surrogate Spikes

Surrogates were added to all samples and blanks as required by the method. All surrogate recoveries (%R) were within QC limits.

VII. Matrix Spike/Matrix Spike Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) samples were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits.

VIII. Laboratory Control Samples (LCS)

Laboratory control samples were reviewed for each matrix as applicable. Percent recoveries (%R) were within QC limits with the following exceptions:

LCS ID	Compound	%R (Limits)	Associated Samples	Flag	A or P
07JUL98-13S	2,4-Dinitrotoluene	99 (28-89)	All samples in SDG 300142	J (all detects)	A
07JUL98-13SD	2,4-Dinitrotoluene	93 (28-89)	All samples in SDG 300142	J (all detects)	A

IX. Regional Quality Assurance and Quality Control

Not applicable.

X. Internal Standards

All internal standard areas and retention times were within QC limits.

XI. Target Compound Identifications

All target compound identifications were within validation criteria.

XII. Compound Quantitation and CRQLs

All compound quantitation and CRQLs were within validation criteria.

The QAPP reporting limits were met with the following exceptions:

Sample	Compound	Finding	Criteria	Flag	A or P
All samples in SDG 300142	All TCL compounds	Laboratory reporting limit was higher than the QAPP	QAPP reporting limits should be used	None	P

XIII. Tentatively Identified Compounds (TICs)

Tentatively identified compounds were not reported by the laboratory.

XIV. System Performance

The system performance was acceptable

XV. Overall Assessment

Data flags have been summarized at the end of the report.

XVI. Field Duplicates

No field duplicates were identified in this SDG.

Fort Irwin
Semivolatiles - Data Qualification Summary - SDG 300142

SDG	Sample	Compound	Flag	A or P	Reason
300142	8.1a-1-Ts-1-2.5 8.1a-1-Ts-1-5 8.1a-1-Ts-1-10 8.1a-1-Ts-1-15 8.3b-1-Ts-1-0.5 8.3b-1-Ts-1-2.5 8.3b-1-Ts-1-5 8.3b-1-Ts-1-10 8.3b-1-Ts-1-15	Benzyl alcohol 2-Methylphenol N-Nitroso-di-n-propylamine Benzoic acid	J (all detects) UJ (all non-detects)	A	Continuing calibration (%D)
300142	8.1a-1-Ts-1-0.5	Bis(2-ethylhexyl)phthalate Di-n-octylphthalate	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	P	Continuing calibration (%D)
300142	8.1a-1-Ts-1-0.5 8.1a-1-Ts-1-2.5 8.1a-1-Ts-1-5 8.1a-1-Ts-1-10 8.1a-1-Ts-1-15 8.3b-1-Ts-1-0.5 8.3b-1-Ts-1-2.5 8.3b-1-Ts-1-5 8.3b-1-Ts-1-10 8.3b-1-Ts-1-15	2,4-Dinitrotoluene	J (all detects)	A	Laboratory control samples (%R)
300142	8.1a-1-Ts-1-0.5 8.1a-1-Ts-1-2.5 8.1a-1-Ts-1-5 8.1a-1-Ts-1-10 8.1a-1-Ts-1-15 8.3b-1-Ts-1-0.5 8.3b-1-Ts-1-2.5 8.3b-1-Ts-1-5 8.3b-1-Ts-1-10 8.3b-1-Ts-1-15	All TCL compounds	None	P	Compound quantitation and CRQLs

Fort Irwin
Semivolatiles - Laboratory Blank Data Qualification Summary - SDG 300142

No Sample Data Qualified in this SDG

Fort Irwin
Semivolatiles - Field Blank Data Qualification Summary - SDG 300142

No Sample Data Qualified in this SDG

LDC #: 3103B2a

VALIDATION COMPLETENESS WORKSHEET

SDG #: 300142 X AFCEE Level II __NFESC Level D

Laboratory: Quanterra Environmental Services

Date: 9/9/98
Page: 1 of 1
Reviewer:
2nd Reviewer:

METHOD: GC/MS Semivolatiles (EPA SW 846 Method 8270)

The samples listed below were reviewed for each of the following validation areas Validation findings are noted in attached validation findings worksheets.

	Validation Area		Comments
I.	Technical holding times	A	Sampling dates: 6/26/98
II.	GC/MS Instrument performance check	A	
III.	Initial calibration	A	
IV.	Continuing calibration	SW	
V.	Blanks	A	
VI.	Surrogate spikes	A	
VII.	Matrix spike/Matrix spike duplicates	A	
VIII.	Laboratory control samples	~~A~~ SW	LCS
IX.	Regional Quality Assurance and Quality Control	N	
X.	Internal standards	A	
XI.	Target compound identification	A	
XII.	Compound quantitation/CRQLs	A	
XIII	Tentatively identified compounds (TICs)	N	not reported, not required
XIV	System performance	A	
XV	Overall assessment of data	A	
XVI	Field duplicates	N	
XVII.	Field blanks	N	

Note: A = Acceptable
N = Not provided/applicable
SW = See worksheet

ND = No compounds detected
R = Rinsate
FB = Field blank

D = Duplicate
TB = Trip blank
EB = Equipment blank

Validated Samples:

all 1ab

1	8.1a-1-Ts-1-0.5	11	8.3b-1-Ts-1-0.5MS	21	
2	8.1a-1-Ts-1-2.5	12	8.3b-1-Ts-1-0.5MSD	22	
3	8.1a-1-Ts-1-5	13	~~98~~ 00 07JUL98-135	23	
4	8.1a-1-Ts-1-10	14		24	
5	8.1a-1-Ts-1-15	15		25	
6	8.3b-1-Ts-1-0.5	16		26	
7	8.3b-1-Ts-1-2.5	17		27	
8	8.3b-1-Ts-1-5	18		28	
9	8.3b-1-Ts-1-10	19		29	
10	8.3b-1-Ts-1-15	20		30	

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26 through June 27, 1998

LDC Report Date: October 15, 1998

Matrix: Soil

Parameters: Nitrosamines

Validation Level: EPA Level III

Laboratory: Applied P & Ch Laboratory

Sample Delivery Group (SDG): 300141

Sample Identification

8.3c-1-Ts-1-0.5
8.3c-1-Ts-1-2.5
8.3c-1-Ts-1-5
8.3c-1-Ts-1-10
8.3c-1-Ts-1-15
8.3a-1-Ts-1-0.5
8.3a-1-Ts-1-2.5
8.3a-1-Ts-1-5
8.3a-1-Ts-1-10
8.3a-1-Ts-1-15
8.3c-1-Td-1-5
8.3a-1-Td-1-2.5
7d-1Td-1-2.5
7d-1-Tdd-1-2.5
7d-2-Td-1-0.5
8.1a-2-Ts-1-0.5
8.1a-2-Ts-1-2.5
8.1a-2-Ts-1-5
8.1a-2-Ts-1-10
8.1a-2-Td-1-5
7d-1-Ts-1-0.5
7d-1-Ts-1-2.5
7d-1-Ts-1-5
7d-1-Ts-1-10
7d-1-Ts-1-15
7d-1-Tp-1-0.5
7d-1-Tp-1-2.5
7d-1-Tp-1-5
7d-1-Tp-1-10
7d-2-Ts-1-0.5
7d-2-Ts-1-2.5
7d-2-Ts-1-5
7d-2-Ts-1-10

Introduction

This data review covers 33 soil samples listed on the cover sheet including dilutions and reanalysis as applicable The analyses were per EPA SW 846 Method 8270 for Nitrosamines

This review follows a modified outline of the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (February 1994) as there are no current guidelines for the method stated above.

A table summarizing all data qualification is provided at the end of this report. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

Blank results are summarized in Section V.

Field duplicates are summarized in Section XVI

Raw data were not reviewed for this SDG. The review was based on QC data.

The following are definitions of the data qualifiers:

U Indicates the compound or analyte was analyzed for but not detected at or above the stated limit

J Indicates an estimated value.

R Quality control indicates the data is not usable

N Presumptive evidence of presence of the constituent

UJ Indicates the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

A Indicates the finding is based upon technical validation criteria.

P Indicates the finding is related to a protocol/contractual deviation.

None Indicates the data was not significantly impacted by the finding, therefore qualification was not required.

I. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria.

II. GC/MS Instrument Performance Check

Instrument performance was checked at 12 hour intervals.

All ion abundance requirements were met.

III. Initial Calibration

Initial calibration was performed using required standard concentrations.

Percent relative standard deviations (%RSD) were less than or equal to 30.0% for all compounds.

Average relative response factors (RRF) for all nitrosamine target compounds and system monitoring compounds were greater than or equal to 0.05 as required.

IV. Continuing Calibration

Continuing calibration was performed at the required frequencies.

All of the continuing calibration percent differences (%D) between the initial calibration RRF and the continuing calibration RRF were less than or equal to 20.0%.

All of the continuing calibration RRF values were greater than or equal to 0.05.

V. Blanks

Method blanks were reviewed for each matrix as applicable. No nitrosamine contaminants were found in the method blanks.

No field blanks were identified in this SDG.

VI. Surrogate Spikes

Surrogates were added to all samples and blanks as required by the method. All surrogate recoveries (%R) were within QC limits.

VII. Matrix Spike/Matrix Spike Duplicates

The laboratory has indicated that there was insufficient sample volume for analysis of the matrix spike and matrix spike duplicate.

VIII. Laboratory Control Samples (LCS)

Laboratory control samples were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits.

IX. Regional Quality Assurance and Quality Control

Not applicable.

X. Internal Standards

All internal standard areas and retention times were within QC limits.

XI. Target Compound Identifications

Raw data were not reviewed for this SDG.

XII. Compound Quantitation and CRQLs

Raw data were not reviewed for this SDG

XIII. Tentatively Identified Compounds (TICs)

Raw data were not reviewed for this SDG.

XIV. System Performance

Raw data were not reviewed for this SDG

XV. Overall Assessment

Data flags have been summarized at the end of the report.

XVI. Field Duplicates

Samples 7d-1Td-1-2.5 ad 7d-1-Ts-1-2.5, samples 7d-2-Td-1-0.5 and 7d-2Ts-1-0.5, samples 7d-1Tdd-1-2.5 and 7d-1-Tp-1-2.5, samples 8.1a-2-Ts-1-5 and 8.1a-2-Td-1-5, samples 8.3a-1-Ts-1-2.5 and 8.3a-1-Td-1-2.5, and samples 8.3c-1-Ts-1-5 and 8.3c-1-Td-1-5 were identified as field duplicates. No nitrosamines were detected in any of the samples.

Fort Irwin
Nitrosamines - Data Qualification Summary - SDG 300141

No Sample Data Qualified in this SDG

Fort Irwin
Nitrosamines - Laboratory Blank Data Qualification Summary - SDG 300141

No Sample Data Qualified in this SDG

Fort Irwin
Nitrosamines - Field Blank Data Qualification Summary - SDG 300141

No Sample Data Qualified in this SDG

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26, 1998

LDC Report Date: September 15, 1998

Matrix: Soil

Parameters: Nitrosamines

Validation Level: EPA Level IV

Laboratory: Applied P & Ch Laboratory

Sample Delivery Group (SDG): 300142

Sample Identification

8.1a-1-Ts-1-0.5
8.1a-1-Ts-1-2.5
8.1a-1-Ts-1-5
8.1a-1-Ts-1-10
8.1a-1-Ts-1-15
8.3b-1-Ts-1-0.5
8.3b-1-Ts-1-2.5
8.3b-1-Ts-1-5
8.3b-1-Ts-1-10
8.3b-1-Ts-1-15

Introduction

This data review covers 10 soil samples listed on the cover sheet including dilutions and reanalysis as applicable The analyses were per EPA SW 846 Method 8270 for Nitrosamines.

This review follows a modified outline of the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (February 1994) as there are no current guidelines for the method stated above

A table summarizing all data qualification is provided at the end of this report. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature

Blank results are summarized in Section V

Field duplicates are summarized in Section XVI

The following are definitions of the data qualifiers:

U Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.

J Indicates an estimated value

R Quality control indicates the data is not usable.

N Presumptive evidence of presence of the constituent.

UJ Indicates the compound or analyte was analyzed for but not detected The sample detection limit is an estimated value.

A Indicates the finding is based upon technical validation criteria.

P Indicates the finding is related to a protocol/contractual deviation

None Indicates the data was not significantly impacted by the finding, therefore qualification was not required

I. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria.

II. GC/MS Instrument Performance Check

Instrument performance was checked at 12 hour intervals.

All ion abundance requirements were met.

III. Initial Calibration

Initial calibration was performed using required standard concentrations.

Percent relative standard deviations (%RSD) were less than or equal to 30.0% for all compounds.

Average relative response factors (RRF) for all nitrosamine target compounds and system monitoring compounds were greater than or equal to 0.05 as required.

IV. Continuing Calibration

Continuing calibration was performed at the required frequencies.

All of the continuing calibration percent differences (%D) between the initial calibration RRF and the continuing calibration RRF were less than or equal to 20.0%.

All of the continuing calibration RRF values were greater than or equal to 0.05.

V. Blanks

Method blanks were reviewed for each matrix as applicable. No nitrosamine contaminants were found in the method blanks.

No field blanks were identified in this SDG.

VI. Surrogate Spikes

Surrogates were added to all samples and blanks as required by the method. All surrogate recoveries (%R) were within QC limits.

VII. Matrix Spike/Matrix Spike Duplicates

The laboratory has indicated that there was insufficient sample volume for analysis of the matrix spike and matrix spike duplicate.

VIII. Laboratory Control Samples (LCS)

Laboratory control samples were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits

IX. Regional Quality Assurance and Quality Control

Not applicable.

X. Internal Standards

All internal standard areas and retention times were within QC limits

XI. Target Compound Identifications

All target compound identifications were within validation criteria

XII. Compound Quantitation and CRQLs

All compound quantitation and CRQLs were within validation criteria.

XIII. Tentatively Identified Compounds (TICs)

Tentatively identified compounds were not reported by the laboratory.

XIV. System Performance

The system performance was acceptable

XV. Overall Assessment

Data flags have been summarized at the end of the report.

XVI. Field Duplicates

No field blanks were identified in this SDG.

Fort Irwin
Nitrosamines - Data Qualification Summary - SDG 300142

No Sample Data Qualified in this SDG

Fort Irwin
Nitrosamines - Laboratory Blank Data Qualification Summary - SDG 300142

No Sample Data Qualified in this SDG

Fort Irwin
Nitrosamines - Field Blank Data Qualification Summary - SDG 300142

No Sample Data Qualified in this SDG

Fort Irwin
Data Validation Reports
LDC# 3103

Chlorinated Pesticides & PCBs

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26 through June 27, 1998

LDC Report Date: September 15, 1998

Matrix: Soil

Parameters: Chlorinated Pesticides & PCBs

Validation Level: EPA Level III

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300141

Sample Identification

8.3c-1-Ts-1-0 5	7d-1-Ts-1-0.5
8.3c-1-Ts-1-2.5	7d-1-Ts-1-2.5
8 3c-1-Ts-1-5	7d-1-Ts-1-5
8 3c-1-Ts-1-10	7d-1-Ts-1-10
8.3c-1-Ts-1-15	7d-1-Ts-1-15
8 3a-1-Ts-1 0 5	7d-1-Tp-1-0.5
8 3a-1-Ts-1-2.5	7d-1-Tp-1-2.5
8.3a-1-Ts-1-5	7d-1-Tp-1-5
8 3a-1-Ts-1-10	7d-1-Tp-1-10
8 3a-1-Ts-1-15	7d-2-Ts-1-0.5
8.3c-1-Td-1-5	7d-2-Ts-1-2.5
8.3a-1-Td-1-2.5	7d-2-Ts-1-5
7d-1Td-1-2.5	7d-2-Ts-1-10
7d-1-Tdd-1-2 5	8.3c-1-Ts-1-5MS
7d-2-Td-1-0 5	8 3c-1-Ts-1-5MSD
8.1a-2-Ts-1-0 5	8 3a-1-Ts-1-2 5MS
8 1a-2-Ts-1-2 5	8 3a-1-Ts-1-2.5MSD
8 1a-2-Ts-1-5	7d-2-Ts-1-0.5MS
8.1a-2-Ts-1-10	7d-2-Ts-1-0 5MSD
8.1a-2-Td-1-5	

Introduction

This data review covers 39 soil samples listed on the cover sheet including dilutions and reanalysis as applicable. The analyses were per EPA SW 846 Method 8080 for Chlorinated Pesticides and PCBs

This review follows a modified outline of the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (February 1994) as there are no current guidelines for the method stated above

A table summarizing all data qualification flags is provided at the end of this report. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

Blank results are summarized in Section V

Field duplicates are summarized in Section XIV

Raw data were not reviewed for this SDG. The review was based on QC data.

The following are definitions of the data qualifiers:

U Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.

J Indicates an estimated value.

R Quality control indicates the data is not usable.

N Presumptive evidence of presence of the constituent.

UJ Indicates the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

A Indicates the finding is based upon technical validation criteria.

P Indicates the finding is related to a protocol/contractual deviation.

None Indicates the data was not significantly impacted by the finding, therefore qualification was not required.

I. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures All cooler temperatures met validation criteria.

II. GC/ECD Instrument Performance Check

Instrument performance was acceptable unless noted otherwise under initial calibration and continuing calibration sections.

III. Initial Calibration

Initial calibration of single and multicomponent compounds was performed for the primary (quantitation) column and confirmation column as required by this method

The percent relative standard deviations (%RSD) were less than or equal to 20.0% for all compounds.

IV. Continuing Calibration

Continuing calibration was performed at required frequencies.

The percent differences (%D) of calibration factors in continuing standard mixtures were within the 15 0% QC limits with the following exceptions:

Date	Standard	Column	Compound	%D	Associated Samples	Flag	A or P
7/16/98	INDB4X	DB-1701	Endrin aldehyde	37	8.3c-1-Ts-1-0.5 8.3c-1-Ts-1-2.5 8.3c-1-Ts-1-5 8.3c-1-Ts-1-10 8.3c-1-Ts-1-15 8.3a-1-Ts-1.0.5 8.3c-1-Ts-1-5MS 8.3c-1-Ts-1-5MSD 08JUL98-135	J (all detects) UJ (all non-detects)	P
7/17/98	INDB4X	DB-1701	Endrin aldehyde	46	7d-1-Ts-1-5 7d-1-Ts-1-10 7d-1-Ts-1-15 7d-1-Tp-1-0.5 7d-1-Tp-1-2.5 7d-1-Tp-1-5 7d-1-Tp-1-10 7d-2-Ts-1-0.5 7d-2-Ts-1-0.5MS 7d-2-Ts-1-0.5MSD	J (all detects) UJ (all non-detects)	P

Date	Standard	Column	Compound	%D	Associated Samples	Flag	A or P
7/16/98	INDB4X	DB-1701	Endrin aldehyde	43	8.3a-1-Ts-1-2.5 8.3a-1-Ts-1-5 8.3a-1-Ts-1-10 8.3a-1-Ts-1-15 8.3c-1-Td-1-5 8.3a-1-Td-1-2.5 7d-1Td-1-2.5 7d-1-Tdd-1-2.5 8.3a-1-Ts-1-2.5MS 8.3a-1-Ts-1-2.5MSD	J (all detects) UJ (all non-detects)	P
7/17/98	INDB4X	DB-1701	Endrin aldehyde	47	7d-2-Td-1-0.5 8.1a-2-Ts-1-0.5 8.1a-2-Ts-1-2.5 8.1a-2-Ts-1-5 8.1a-2-Ts-1-10 8.1a-2-Td-1-5 7d-1-Ts-1-0.5 7d-1-Ts-1-2.5 08JUL98-125	J (all detects) UJ (all non-detects)	P
7/17/98	INDB4X	DB-1701 DB-608	Endrin aldehyde Methoxychlor	39 21	7d-2-Ts-1-2.5 7d-2-Ts-1-5 7d-2-Ts-1-10	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	P

The individual 4,4'-DDT and Endrin breakdowns were less than 20.0%.

V. Blanks

Method blanks were reviewed for each matrix as applicable. No chlorinated pesticide or PCB contaminants were found in the method blanks.

No field blanks were identified in this SDG.

VI. Surrogate Spikes

Surrogates were added to all samples and blanks as required by the method. All surrogate recoveries (%R) were within QC limits with the following exceptions:

Sample	Column	Surrogate	%R (Limits)	Compound	Flag	A or P
8.3c-1-Ts-1-5	Not specified	Tetrachloro-m-xylene	60 (60-135)	All TCL compounds	J (all detects) UJ (all non-detects)	A
7d-1Td-1-2.5	Not specified	Tetrachloro-m-xylene	63 (65-135)	All TCL compounds	J (all detects) UJ (all non-detects)	A

Sample	Column	Surrogate	%R (Limits)	Compound	Flag	A or P
7d-1-Ts-1-0.5	Not specified	Tetrachloro-m-xylene	62 (65-135)	All TCL compounds	J (all detects) UJ (all non-detects)	A
7d-1-Ts-1-5	Not specified	Tetrachloro-m-xylene	1690 (65-135)	All TCL compounds	J (all detects)	A

VII. Matrix Spike/Matrix Spike Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) samples were reviewed for each matrix as applicable Percent recoveries (%R) and relative percent differences (RPD) were within QC limits

VIII. Laboratory Control Samples (LCS)

Laboratory control samples were reviewed for each matrix as applicable Percent recoveries (%R) were within QC limits.

IX. Regional Quality Assurance and Quality Control

Not applicable.

X. Pesticide Cleanup Checks

a. Florisil Cartridge Check

Florisil cleanup was not required and therefore not performed in this SDG

b. GPC Calibration

GPC cleanup was not required and therefore not performed in this SDG

XI. Target Compound Identification

Raw data were not reviewed for this SDG.

XII. Compound Quantitation and Reported CRQLs

The QAPP reporting limits were met with the following exceptions:

Sample	Compound	Finding	Criteria	Flag	A or P
All samples in SDG 300141	alpha-BHC beta-BHC delta-BHC gamma-BHC Heptachlor Aldrin Heptachlor epoxide Endosulfan I	Laboratory reporting limit reported at 0 83 ug/Kg	Reporting limit should be reported at 0 33 ug/Kg per the QAPP	None None None None None None None None	P
All samples in SDG 300141	Dieldrin 4 4 -DDE Endrin Endrin aldehyde Endosulfan II 4 4'-DDD Endosulfan sulfate 4 4 -DDT	Laboratory reporting limit reported at 1 7 ug/Kg	Reporting limit should be reported at 0 33 ug/Kg per the QAPP	None None None None None None None None	P
All samples in SDG 300141	Methoxychlor	Laboratory reporting limit reported at 8 3 ug/Kg	Reporting limit should be reported at 3 3 ug/Kg per the QAPP	None	P
All samples in SDG 300141	Aroclor 1016 Aroclor 1221 Aroclor 1232 Aroclor 1242 Aroclor 1248 Aroclor 1254 Aroclor 1260	Laboratory reporting limit reported at 1 7 ug/Kg	Reporting limit should be reported at 0 33 ug/Kg per the QAPP	None None None None None None None	P

Raw data were not reviewed for this SDG.

XIII. Overall Assessment of Data

Data flags are summarized at the end of this report.

XIV. Field Duplicates

Samples 7d-1Td-1-2 5 and 7d-1-Ts-1-2.5, samples 7d-2-Td-1-0 5 and 7d-2-Ts-1-0 5, samples 7d-1-Tdd-1-2 5 and 7d-1-Tp-1-2 5, samples 8 1a-2-Ts-1-5 and 8 1a-2-Td-1-5, samples 8 3a-1-Ts-1-2.5 and 8 3a-1-Td-1-2 5, samples 8 3c-1-Ts-1-5 and 8 3c-1-Td-1-5 were identified as field duplicates No chlorinated pesticides or PCBs were detected in any of the samples.

Fort Irwin
Chlorinated Pesticides & PCBs - Data Qualification Summary - SDG 300141

SDG	Sample	Compound	Flag	A or P	Reason
300141	8 3c-1-Ts-1-0 5 8 3c-1-Ts-1-2 5 8 3c-1-Ts-1-5 8 3c-1-Ts-1-10 8 3c-1-Ts-1-15 8 3a-1-Ts-1 0 5 7d-1-Ts-1-5 7d-1-Ts-1-10 7d-1-Ts-1-15 7d-1-Tp-1-0.5 7d-1-Tp-1-2.5 7d-1-Tp-1-5 7d-1-Tp-1-10 7d-2-Ts-1-0 5 8 3a-1-Ts-1-2 5 8 3a-1-Ts-1-5 8 3a-1-Ts-1-10 8 3a-1-Ts-1-15 8 3c-1-Td-1-5 8 3a-1-Td-1-2 5 7d-1Td-1-2 5 7d-1-Tdd-1-2.5 7d-2-Td-1-0 5 8 1a-2-Ts-1-0.5 8 1a-2-Ts-1-2.5 8 1a-2-Ts-1-5 8 1a-2-Ts-1-10 8 1a-2-Td-1-5 7d-1-Ts-1-0 5 7d-1-Ts-1-2 5	Endrin aldehyde	J (all detects) UJ (all non-detects)	P	Continuing calibration (%D)
300141	7d-2-Ts-1-2.5 7d-2-Ts-1-5 7d-2-Ts-1-10	Endrin aldehyde Methoxychlor	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	P	Continuing calibration (%D)
300141	8 3c-1-Ts-1-5 7d-1Td-1-2.5 7d-1-Ts-1-0 5	All TCL compounds	J (all detects) UJ (all non-detects)	A	Surrogate spikes (%R)
300141	7d-1-Ts-1-5	All TCL compounds	J (all detects)	A	Surrogate spikes (%R)

SDG	Sample	Compound	Flag	A or P	Reason
300141	8 3c-1-Ts-1-0 5	alpha-BHC	None	P	Compound quantitation and CRQLs
	8 3c-1-Ts-1-2.5	beta-BHC	None		
	8 3c-1-Ts-1-5	delta-BHC	None		
	8 3c-1-Ts-1-10	gamma-BHC	None		
	8.3c-1-Ts-1-15	Heptachlor	None		
	8 3a-1-Ts-1 0 5	Aldrin	None		
	8 3a-1-Ts-1-2 5	Heptachlor epoxide	None		
	8.3a-1-Ts-1-5	Endosulfan I	None		
	8 3a-1-Ts-1-10	Dieldrin	None		
	8.3a-1-Ts-1-15	4 4'-DDE	None		
	8.3c-1-Td-1-5	Endrin	None		
	8 3a-1-Td-1-2.5	Endrin aldehyde	None		
	7d-1Td-1-2.5	Endosulfan II	None		
	7d-1-Tdd-1-2.5	4 4'-DDD	None		
	7d-2-Td-1-0 5	Endosulfan sulfate	None		
	8 1a-2-Ts-1-0 5	4,4'-DDT	None		
	8 1a-2-Ts-1-2.5	Methoxychlor	None		
	8 1a-2-Ts-1-5	Aroclor 1016	None		
	8 1a-2-Ts-1-10	Aroclor 1221	None		
	8 1a-2-Td-1-5	Aroclor 1232	None		
	7d-1-Ts-1-0 5	Aroclor 1242	None		
	7d-1-Ts-1-2 5	Aroclor 1248	None		
	7d-1-Ts-1-5	Aroclor 1254	None		
	7d-1-Ts-1-10	Aroclor 1260	None		
	7d-1-Ts-1-15				
	7d-1-Tp-1-0 5				
	7d-1-Tp-1-2 5				
	7d-1-Tp-1-5				
	7d-1-Tp-1-10				
	7d-2-Ts-1-0 5				
	7d-2-Ts-1-2 5				
	7d-2-Ts-1-5				
	7d-2-Ts-1-10				

Fort Irwin
Chlorinated Pesticides & PCBs - Laboratory Blank Data Qualification Summary - SDG 300141

No Sample Data Qualified in this SDG

Fort Irwin
Chlorinated Pesticides & PCBs - Field Blank Data Qualification Summary - SDG 300141

No Sample Data Qualified in this SDG

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26, 1998

LDC Report Date: September 11, 1998

Matrix: Soil

Parameters: Chlorinated Pesticides & PCBs

Validation Level: EPA Level IV

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300142

Sample Identification

8 1a-1-Ts-1-0 5
8 1a-1-Ts-1-2 5
8 1a-1-Ts-1-5
8.1a-1-Ts-1-10
8.1a-1-Ts-1-15
8.3b-1-Ts-1-0.5
8.3b-1-Ts-1-2.5
8 3b-1-Ts-1-5
8.3b-1-Ts-1-10
8.3b-1-Ts-1-15
8.3b-1-Ts-1-0.5MS
8.3b-1-Ts-1-0.5MSD

Introduction

This data review covers 12 soil samples listed on the cover sheet including dilutions and reanalysis as applicable. The analyses were per EPA SW 846 Method 8080 for Chlorinated Pesticides and PCBs.

This review follows a modified outline of the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (February 1994) as there are no current guidelines for the method stated above.

A table summarizing all data qualification flags is provided at the end of this report. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

Blank results are summarized in Section V

Field duplicates are summarized in Section XIV

The following are definitions of the data qualifiers:

U Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.

J Indicates an estimated value.

R Quality control indicates the data is not usable

N Presumptive evidence of presence of the constituent.

UJ Indicates the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value

A Indicates the finding is based upon technical validation criteria.

P Indicates the finding is related to a protocol/contractual deviation

None Indicates the data was not significantly impacted by the finding, therefore qualification was not required.

I. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria.

II. GC/ECD Instrument Performance Check

Instrument performance was acceptable unless noted otherwise under initial calibration and continuing calibration sections.

III. Initial Calibration

Initial calibration of single and multicomponent compounds was performed for the primary (quantitation) column and confirmation column as required by this method.

The percent relative standard deviations (%RSD) were less than or equal to 20.0% for all compounds

Retention time windows were evaluated and considered technically acceptable.

IV. Continuing Calibration

Continuing calibration was performed at required frequencies.

The percent differences (%D) of calibration factors in continuing standard mixtures were within the 15.0% QC limits with the following exceptions:

Date	Standard	Column	Compound	%D	Associated Samples	Flag	A or P
7/23/98	INDA 4X	DB-608	4,4'-DDT Methoxychlor	16 20	8.1a-1-Ts-1-0.5 8.1a-1-Ts-1-2.5 8.1a-1-Ts-1-5 8.1a-1-Ts-1-10 8.1a-1-Ts-1-15 8.3b-1-Ts-1-0.5 8.3b-1-Ts-1-0.5MS 8.3b-1-Ts-1-0.5MSD	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	P
7/23/98	INDB 4X	DB-1701	Endrin aldehyde	33	8.1a-1-Ts-1-0.5 8.1a-1-Ts-1-2.5 8.1a-1-Ts-1-5 8.1a-1-Ts-1-10 8.1a-1-Ts-1-15 8.3b-1-Ts-1-0.5 8.3b-1-Ts-1-0.5MS 8.3b-1-Ts-1-0.5MSD	J (all detects) UJ (all non-detects)	P

Date	Standard	Column	Compound	%D	Associated Samples	Flag	A or P
7/23/98	INDA 4X	DB-608	Methoxychlor	16	8.3b-1-Ts-1-2.5 8.3b-1-Ts-1-5 8.3b-1-Ts-1-10 8.3b-1-Ts-1-15	J (all detects) UJ (all non-detects)	P
7/23/98	INDB 4X	DB-1701	Endrin aldehyde	28	8.3b-1-Ts-1-2.5 8.3b-1-Ts-1-5 8.3b-1-Ts-1-10 8.3b-1-Ts-1-15	J (all detects) UJ (all non-detects)	P

Retention times (RT) of all compounds in the calibration standards were within QC limits

The individual 4,4'-DDT and Endrin breakdowns were less than or equal to 15.0% with the following exceptions:

Date	Column	Compound	%Breakdown	Associated Samples	Affected Compounds	Flag	A or P
7/23/98	DB-608	Endrin	16	8.1a-1-Ts-1-0.5 8.1a-1-Ts-1-2.5 8.1a-1-Ts-1-5 8.1a-1-Ts-1-10 8.1a-1-Ts-1-15 8.3b-1-Ts-1-0.5 8.3b-1-Ts-1-0.5MS 8.3b-1-Ts-1-0.5MSD 08JUL98-11S	Endrin Endrin aldehyde	J (all detects) J (all detects)	P

V. Blanks

Method blanks were reviewed for each matrix as applicable. No chlorinated pesticide or PCB contaminants were found in the method blanks.

No field blanks were identified in this SDG.

VI. Surrogate Spikes

Surrogates were added to all samples and blanks as required by the method. All surrogate recoveries (%R) were within QC limits

VII. Matrix Spike/Matrix Spike Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) samples were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits.

VIII. Laboratory Control Samples (LCS)

Laboratory control samples were reviewed for each matrix as applicable Percent recoveries (%R) were within QC limits.

IX. Regional Quality Assurance and Quality Control

Not applicable.

X. Pesticide Cleanup Checks

a. Florisil Cartridge Check

Florisil cleanup was not required and therefore not performed in this SDG

b. GPC Calibration

GPC cleanup was not required and therefore not performed in this SDG

XI. Target Compound Identification

All target compound identifications were within validation criteria.

XII. Compound Quantitation and Reported CRQLs

All compound quantitation and CRQLs were within validation criteria.

The QAPP reporting limits were met with the following exceptions:

Sample	Compound	Finding	Criteria	Flag	A or P
All samples in SDG 300142	alpha-BHC beta-BHC delta-BHC gamma-BHC Heptachlor Aldrin Heptachlor epoxide Endosulfan I	Laboratory reporting limit reported at 0 83 ug/Kg.	Reporting limit should be reported at 0.33 ug/Kg per the QAPP	None None None None None None None None	P
All samples in SDG 300142	Dieldrin 4 4 -DDE Endrin Endrin aldehyde Endosulfan II 4,4'-DDD Endosulfan sulfate 4 4'-DDT	Laboratory reporting limit reported at 1 7 ug/Kg	Reporting limit should be reported at 0.33 ug/Kg per the QAPP	None None None None None None None None	P

Sample	Compound	Finding	Criteria	Flag	A or P
All samples in SDG 300142	Methoxychlor	Laboratory reporting limit reported at 8.3 ug/Kg.	Reporting limit should be reported at 3.3 ug/Kg per the QAPP	None	P
All samples in SDG 300142	Aroclor-1016 Aroclor-1221 Aroclor-1232 Aroclor-1242 Aroclor-1248 Aroclor-1254 Aroclor-1260	Laboratory reporting limit reported at 33 ug/Kg.	Reporting limit should be reported at 6.7 ug/Kg per the QAPP	None None None None None None None	P

XIII. Overall Assessment of Data

Data flags are summarized at the end of this report.

XIV. Field Duplicates

No field duplicates were identified in this SDG.

Fort Irwin
Chlorinated Pesticides & PCBs - Data Qualification Summary - SDG 300142

SDG	Sample	Compound	Flag	A or P	Reason
300142	8.1a-1-Ts-1-0.5 8.1a-1-Ts-1-2.5 8.1a-1-Ts-1-5 8.1a-1-Ts-1-10 8.1a-1-Ts-1-15 8.3b-1-Ts-1-0.5	4,4'-DDT Methoxychlor Endrin aldehyde	J (all detects) UJ (all non-detects)	P	Continuing calibration (%D)
300142	8.3b-1-Ts-1-2.5 8.3b-1-Ts-1-5 8.3b-1-Ts-1-10 8.3b-1-Ts-1-15	Methoxychlor Endrin aldehyde	J (all detects) UJ (all non-detects)	P	Continuing calibration (%D)
300142	8.1a-1-Ts-1-0.5 8.1a-1-Ts-1-2.5 8.1a-1-Ts-1-5 8.1a-1-Ts-1-10 8.1a-1-Ts-1-15 8.3b-1-Ts-1-0.5	Endrin Endrin aldehyde	J (all detects) J (all detects)	P	Continuing calibration (%breakdown)
300142	8.1a-1-Ts-1-0.5 8.1a-1-Ts-1-2.5 8.1a-1-Ts-1-5 8.1a-1-Ts-1-10 8.1a-1-Ts-1-15 8.3b-1-Ts-1-0.5 8.3b-1-Ts-1-2.5 8.3b-1-Ts-1-5 8.3b-1-Ts-1-10 8.3b-1-Ts-1-15	alpha-BHC beta-BHC delta-BHC gamma-BHC Heptachlor Aldrin Heptachlor epoxide Endosulfan I Dieldrin 4,4'-DDE Endrin Endrin aldehyde Endosulfan II 4,4'-DDD Endosulfan sulfate 4,4'-DDT Methoxychlor Aroclor-1016 Aroclor-1221 Aroclor-1232 Aroclor-1242 Aroclor-1248 Aroclor-1254 Aroclor-1260	None None None None None None None None None None None None None None None None None None None None None None None	P	Compound quantitation and CRQLs

Fort Irwin
Chlorinated Pesticides & PCBs - Laboratory Blank Data Qualification Summary - SDG 300142

No Sample Data Qualified in this SDG

Fort Irwin
Chlorinated Pesticides & PCBs - Field Blank Data Qualification Summary - SDG 300142

No Sample Data Qualified in this SDG

Fort Irwin
Data Validation Reports
LDC# 3103

Metals

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26 through June 27, 1998

LDC Report Date: September 10, 1998

Matrix: Soil

Parameters: Metals

Validation Level: EPA Level III

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300141

Sample Identification

8 3c-1-Ts-1-0.5	7d-1-Ts-1-0.5
8.3c-1-Ts-1-2.5	7d-1-Ts-1-2.5
8 3c-1-Ts-1-5	7d-1-Ts-1-5
8.3c-1-Ts-1-10	7d-1-Ts-1-10
8.3c-1-Ts-1-15	7d-1-Ts-1-15
8.3a-1-Ts-1.0.5	7d-1-Tp-1-0 5
8 3a-1-Ts-1-2.5	7d-1-Tp-1-2.5
8 3a-1-Ts-1-5	7d-1-Tp-1-5
8.3a-1-Ts-1-10	7d-1-Tp-1-10
8 3a-1-Ts-1-15	7d-2-Ts-1-0.5
8.3c-1-Td-1-5	7d-2-Ts-1-2.5
8 3a-1-Td-1-2.5	7d-2-Ts-1-5
7d-1Td-1-2.5	7d-2-Ts-1-10
7d-1-Tdd-1-2.5	8 3c-1-Ts-1-5MS
7d-2-Td-1-0.5	8.3c-1-Ts-1-5MSD
8.1a-2-Ts-1-0.5	8.3a-1-Ts-1-2.5MS
8.1a-2-Ts-1-2 5	8.3a-1-Ts-1-2 5MSD
8.1a-2-Ts-1-5	7d-2-Ts-1-0 5MS
8 1a-2-Ts-1-10	7d-2-Ts-1-0 5MSD
8.1a-2-Td-1-5	

Introduction

This data review covers 39 soil samples listed on the cover sheet including dilutions and reanalysis as applicable. The analyses were per EPA SW 846 Methods 6010 and 7000 for Metals. The metals analyzed were Aluminum, Antimony, Arsenic, Barium, Beryllium, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Magnesium, Manganese, Molybdenum, Nickel, Potassium, Selenium, Silver, Sodium, Thallium, Vanadium, and Zinc

The review follows a modified outline of the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (February 1994) as there are no current guidelines for the methods stated above.

A table summarizing all data qualification flags is provided at the end of this report. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from specified protocols or is of technical advisory nature.

Blanks are summarized in Section III.

Field duplicates are summarized in Section XIII

Raw data were not reviewed for this SDG. The review was based on QC data.

The following are definitions of the data qualifiers:

U Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.

J Indicates an estimated value

R Quality control indicates the data is not usable.

N Presumptive evidence of presence of the constituent.

UJ Indicates the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

A Indicates the finding is based upon technical validation criteria.

P Indicates the finding is related to a protocol/contractual deviation.

None Indicates the data was not significantly impacted by the finding, therefore qualification was not required.

I. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria.

II. Calibration

An initial calibration was performed.

The frequency and analysis criteria of the initial calibration verification (ICV) and continuing calibration verification (CCV) were met

III. Blanks

Method blanks were reviewed for each matrix as applicable.

Data qualification by the initial, continuing and preparation blanks (ICB/CCB/PBs) was based on the maximum contaminant concentration in the ICB/CCB/PBs in the analysis of each analyte. No contaminant concentrations were found above the reporting limit in the initial, continuing and preparation blanks with the following exceptions:

Method Blank ID	Analyte	Concentration	Associated Samples
PB1 (prep blank)	Barium Magnesium Sodium	0.064 mg/Kg 3.2 mg/Kg 3.4 mg/Kg	8.3c-1-Ts-1-0.5 8.3c-1-Ts-1-2.5 8.3c-1-Ts-1-5 8.3c-1-Ts-1-10 8.3c-1-Ts-1-15 8.3a-1-Ts-1-0.5 8.3a-1-Ts-1-2.5 8.3a-1-Ts-1-5 8.3a-1-Ts-1-10 8.3a-1-Ts-1-15 8.3c-1-Td-1-5 8.3a-1-Td-1-2.5 7d-1Td-1-2.5 7d-1-Tdd-1-2.5 7d-2-Td-1-0.5 8.1a-2-Ts-1-0.5 8.1a-2-Ts-1-2.5 8.1a-2-Ts-1-5 8.1a-2-Ts-1-10

Method Blank ID	Analyte	Concentration	Associated Samples
PB2 (prep blank)	Calcium Iron Magnesium	11.3 mg/Kg 1.4 mg/Kg 2.6 mg/Kg	8.1a-2-Td-1-5 7d-1-Ts-1-0.5 7d-1-Ts-1-2.5 7d-1-Ts-1-5 7d-1-Ts-1-10 7d-1-Ts-1-15 7d-1-Tp-1-0.5 7d-1-Tp-1-2.5 7d-1-Tp-1-5 7d-1-Tp-1-10 7d-2-Ts-1-0.5 7d-2-Ts-1-2.5 7d-2-Ts-1-5 7d-2-Ts-1-10

Sample concentrations were compared to concentrations detected in the ICB/CCB/PBs. The sample concentrations were either not detected or were significantly greater (>5X blank contaminants) than the concentrations found in the associated method blanks

No field blanks were identified in this SDG

IV. ICP Interference Check Sample (ICS) Analysis

The frequency of analysis was met.

The criteria for analysis were met.

V. Matrix Spike Analysis

Matrix spike (MS) and matrix spike duplicate (MSD) analyses were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits with the following exceptions:

Spike ID (Associated Samples)	Analyte	MS (%R) (Limits)	MSD (%R) (Limits)	RPD (Limits)	Flag	A or P
8.3c-1-Ts-1-5MS/MSD (All samples in SDG 300141)	Antimony	44 (75-125)	43 (75-125)	--	J (all detects) UJ (all non-detects)	A
8.3a-1-Ts-1-2.5MS/MSD (All samples in SDG 300141)	Antimony	56 (75-125)	51 (75-125)	--	J (all detects) UJ (all non-detects)	A
7d-2-Ts-1-0.5MS/MSD (All samples in SDG 300141)	Antimony Manganese	50 (75-125) 66 (75-125)	38 (75-125) --	-- --	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	A

VI. Duplicate Sample Analysis

Duplicate (DUP) sample analyses were reviewed for each matrix as applicable

VII. Laboratory Control Samples (LCS)

Laboratory control samples were reviewed for each matrix as applicable. Percent recoveries (%R) were within QC limits.

VIII. Internal Standard (ICP-MS)

ICP-MS was not utilized in this SDG.

IX. Furnace Atomic Absorption QC

Graphite furnace atomic absorption was not utilized in this SDG

X. ICP Serial Dilution

Not required by the method.

XI. Sample Result Verification

All sample result verifications met validation criteria.

The QAPP reporting limits were met with the following exceptions:

Sample	Analyte	Finding	Criteria	Flag	A or P
All samples in SDG 300141	Arsenic	Laboratory reporting limit reported at 10 mg/Kg.	Reporting limit should be reported at 1 mg/Kg per the QAPP.	None	P
All samples in SDG 300141	Calcium	Laboratory reporting limit reported at 50 mg/Kg.	Reporting limit should be reported at 15 mg/Kg per the QAPP	None	P
All samples in SDG 300141	Iron	Laboratory reporting limit reported at 10 mg/Kg.	Reporting limit should be reported at 8 mg/Kg per the QAPP	None	P
All samples in SDG 300141	Lead	Laboratory reporting limit reported at 5 mg/Kg.	Reporting limit should be reported at 1 mg/Kg per the QAPP.	None	P
All samples in SDG 300141	Magnesium	Laboratory reporting limit reported at 50 mg/Kg.	Reporting limit should be reported at 20 mg/Kg per the QAPP.	None	P

Sample	Analyte	Finding	Criteria	Flag	A or P
All samples in SDG 300141	Manganese	Laboratory reporting limit reported at 1 mg/Kg.	Reporting limit should be reported at 0.5 mg/Kg per the QAPP	None	P
All samples in SDG 300141	Potassium	Laboratory reporting limit reported at 500 mg/Kg.	Reporting limit should be reported at 300 mg/Kg per the QAPP	None	P
All samples in SDG 300141	Selenium	Laboratory reporting limit reported at 20 mg/Kg	Reporting limit should be reported at 1 mg/Kg per the QAPP	None	P
All samples in SDG 300141	Sodium	Laboratory reporting limit reported at 500 mg/Kg.	Reporting limit should be reported at 40 mg/Kg per the QAPP	None	P
All samples in SDG 300141	Thallium	Laboratory reporting limit reported at 200 mg/Kg	Reporting limit should be reported at 2 mg/Kg per the QAPP	None	P

XII. Overall Assessment of Data

Data flags have been summarized at the end of this report.

XIII. Field Duplicates

Samples 8.3c-1-Ts-1-5 and 8.3c-1-Td-1-5, samples 8.3a-1-Ts-1-2.5 and 8.3a-1-Td-1-2.5, samples 7d-1Td-1-2.5 and 7d-1-Ts-1-2.5, samples 7d-1-Tdd-1-2.5 and 7d-1-Tp-1-2.5, samples 7d-2-Td-1-0.5 and 7d-2-Ts-1-0.5, and samples 8.1a-2-Ts-1-5 and 8.1a-2-Td-1-5 were identified as field duplicates. No metals were detected in any of the samples with the following exceptions:

Analyte	Concentration (mg/Kg)		RPD (Limits)	Flag	A or P
	8.3c-1-Ts-1-5	8.3c-1-Td-1-5			
Aluminum	6300	9070	36 (≤70)	-	-
Barium	67.6	72.8	7 (≤70)	-	-
Beryllium	0.42	0.48	13 (≤70)	-	-
Calcium	6250	5940	5 (≤70)	-	-
Chromium	6.2	8.2	28 (≤70)	-	-
Cobalt	3.9	4.3	10 (≤70)	-	-

Analyte	Concentration (mg/Kg)		RPD (Limits)	Flag	A or P
	8.3c-1-Ts-1-5	8.3c-1-Td-1-5			
Copper	13 9	10.8	25 (≤70)	-	-
Iron	8710	10700	21 (≤70)	-	-
Lead	6 3	7 4	16 (≤70)	-	-
Magnesium	2550	2850	11 (≤70)	-	-
Manganese	261	279	7 (≤70)	-	-
Nickel	5 9	7 4	23 (≤70)	-	-
Potassium	1900	2280	18 (≤70)	-	-
Sodium	89 4	102	13 (≤70)	-	-
Vanadium	14 5	18 3	23 (≤70)	-	-
Zinc	30 9	32 0	3 (≤70)	-	-
Molybdenum	0 93	2 0U	73 (≤70)	-	-

Analyte	Concentration (mg/Kg)		RPD (Limits)	Flag	A or P
	8.3a-1-Ts-1-2.5	8.3a-1-Td-1-2.5			
Aluminum	2590	3130	19 (≤70)	-	-
Barium	31 1	37 3	18 (≤70)	-	-
Beryllium	0.18	0 21	15 (≤70)	-	-
Calcium	1900	2030	7 (≤70)	-	-
Chromium	2.3	3.2	33 (≤70)	-	-
Cobalt	1 4	1 9	30 (≤70)	-	-
Copper	30 9	10 6	98 (≤70)	-	-
Iron	3870	5170	29 (≤70)	-	-
Lead	5 7U	3 4	51 (≤70)	-	-

Analyte	Concentration (mg/Kg)		RPD (Limits)	Flag	A or P
	8.3a-1-Ts-1-2.5	8.3a-1-Td-1-2.5			
Magnesium	1000	1250	22 (≤70)	-	-
Manganese	138	147	6 (≤70)	-	-
Nickel	2 3	2 9	23 (≤70)	-	-
Potassium	874	1050	18 (≤70)	-	-
Sodium	284	342	19 (≤70)	-	-
Vanadium	5 9	7 9	29 (≤70)	-	-
Zinc	27 9	19 9	33 (≤70)	-	-
Molybdenum	0 70	2.1U	100 (≤70)	-	-

Analyte	Concentration (mg/Kg)		RPD (Limits)	Flag	A or P
	7d-1Td-1-2.5	7d-1-Ts-1-2.5			
Aluminum	5750	6300	9 (≤70)	-	-
Arsenic	10 6U	3 8	94 (≤70)		
Barium	65 9	65 8	0 2 (≤70)	-	-
Beryllium	0 32	0 22	37 (≤70)	-	-
Calcium	18500	5040	114 (≤70)	-	-
Chromium	4 6	5 1	10 (≤70)	-	-
Cobalt	2 9	3.2	10 (≤70)	-	-
Copper	16 7	11 8	34 (≤70)	-	-
Iron	6900	7080	3 (≤70)	-	-
Lead	4 8	3.5	31 (≤70)	-	-
Magnesium	3740	2630	35 (≤70)	-	-
Manganese	158	152	4 (≤70)	-	-

Analyte	Concentration (mg/Kg)		RPD (Limits)	Flag	A or P
	7d-1Td-1-2.5	7d-1-Ts-1-2.5			
Nickel	5 3	3 8	33 (≤70)	-	-
Potassium	1670	1610	4 (≤70)	-	-
Sodium	307	246	22 (≤70)	-	-
Vanadium	10 9	11 8	8 (≤70)	-	-
Zinc	29 0	24 3	18 (≤70)	-	-

Analyte	Concentration (mg/Kg)		RPD (Limits)	Flag	A or P
	7d-1-Tdd-1-2.5	7d-1-Tp-1-2.5			
Aluminum	7750	6550	17 (≤70)	-	-
Arsenic	7 1	5 6	24 (≤70)	-	-
Barium	203	51 0	120 (≤70)	-	-
Beryllium	0 41	0 29	34 (≤70)	-	-
Calcium	27700	13400	70 (≤70)	-	-
Chromium	6 5	5 0	26 (≤70)	-	-
Cobalt	3 1	2.6	18 (≤70)	-	-
Copper	236	9 5	184 (≤70)	-	-
Iron	7910	6910	1 (≤70)	-	-
Lead	4 8	4 2	13 (≤70)	-	-
Magnesium	5370	3520	42 (≤70)	-	-
Manganese	163	163	0 (≤70)	-	-
Nickel	6 5	5 1	24 (≤70)	-	-
Potassium	2100	1610	26 (≤70)	-	-
Sodium	449	307	38 (≤70)	-	-

Analyte	Concentration (mg/Kg)		RPD (Limits)	Flag	A or P
	7d-1-Tdd-1-2.5	7d-1-Tp-1-2.5			
Vanadium	14.5	12.4	16 (≤70)	..	..
Zinc	199	22.5	160 (≤70)	..	..
Molybdenum	0 68	2.1U	102 (≤70)	..	..

Analyte	Concentration (mg/Kg)		RPD (Limits)	Flag	A or P
	7d-2-Td-1-0.5	7d-2-Ts-1-0.5			
Aluminum	4030	5970	39 (≤70)	..	..
Barium	45 0	58 4	26 (≤70)	..	..
Beryllium	0 20	0 23	14 (≤70)	..	..
Calcium	1750	1810	3 (≤70)	..	..
Chromium	3.6	4 7	26 (≤70)	..	..
Cobalt	1 9	2 4	23 (≤70)	..	..
Copper	88 6	8.1	166 (≤70)	..	..
Iron	5930	8240	33 (≤70)	..	..
Lead	5 2	5 1U	2 (≤70)	..	..
Magnesium	1890	2540	29 (≤70)	..	..
Manganese	149	180	19 (≤70)	..	..
Nickel	3 5	4.4	23 (≤70)	..	..
Potassium	1350	1700	23 (≤70)	..	..
Sodium	53.1	67 2	23 (≤70)	..	..
Vanadium	9.0	13 0	36 (≤70)	..	..
Zinc	115	24 6	130 (≤70)	..	..
Molybdenum	1.0	2.0U	67 (≤70)	..	..

Analyte	Concentration (mg/Kg)		RPD (Limits)	Flag	A or P
	8.1a-2-Ts-1-5	8.1a-2-Td-1-5			
Aluminum	3640	4790	27 (≤70)	-	-
Barium	36.7	45.0	20 (≤70)	-	-
Beryllium	0.25	0.26	4 (≤70)	-	-
Calcium	612	754	21 (≤70)	-	-
Chromium	3.4	3.8	11 (≤70)	-	-
Cobalt	2.3	2.4	4 (≤70)	-	-
Copper	6.0	9.1	41 (≤70)	-	-
Iron	4440	5020	12 (≤70)	-	-
Lead	8.0	10.8	30 (≤70)	-	-
Magnesium	1550	1790	14 (≤70)	-	-
Manganese	155	170	9 (≤70)	-	-
Nickel	3.7	3.3	11 (≤70)	-	-
Potassium	1180	1280	8 (≤70)	-	-
Sodium	75.6	81.4	7 (≤70)	-	-
Vanadium	6.2	7.3	16 (≤70)	-	-
Zinc	22.5	40.1	56 (≤70)	-	-

Fort Irwin
Metals - Data Qualification Summary - SDG 300141

SDG	Sample	Analyte	Flag	A or P	Reason
300141	8 3c-1-Ts-1-0 5 8.3c-1-Ts-1-2 5 8.3c-1-Ts-1-5 8.3c-1-Ts-1-10 8.3c-1-Ts-1-15 8.3a-1-Ts-1 0 5 8.3a-1-Ts-1-2.5 8.3a-1-Ts-1-5 8.3a-1-Ts-1-10 8.3a-1-Ts-1-15 8.3c-1-Td-1-5 8.3a-1-Td-1-2.5 7d-1Td-1-2 5 7d-1-Tdd-1-2.5 7d-2-Td-1-0 5 8.1a-2-Ts-1-0.5 8.1a-2-Ts-1-2 5 8.1a-2-Ts-1-5 8.1a-2-Ts-1-10 8.1a-2-Td-1-5 7d-1-Ts-1-0.5 7d-1-Ts-1-2 5 7d-1-Ts-1-5 7d-1-Ts-1-10 7d-1-Ts-1-15 7d-1-Tp-1-0.5 7d-1-Tp-1-2.5 7d-1-Tp-1-5 7d-1-Tp-1-10 7d-2-Ts-1-0.5 7d-2-Ts-1-2 5 7d-2-Ts-1-5 7d-2-Ts-1-10	Antimony Manganese	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	A	Matrix spike/Matrix spike duplicates (%R)

SDG	Sample	Analyte	Flag	A or P	Reason
300141	8.3c-1-Ts-1-0.5	Arsenic	None	P	Sample result verification
	8.3c-1-Ts-1-2.5	Calcium	None		
	8.3c-1-Ts-1-5	Iron	None		RLs
	8.3c-1-Ts-1-10	Lead	None		
	8.3c-1-Ts-1-15	Magnesium	None		
	8.3a-1-Ts-1-0.5	Manganese	None		
	8.3a-1-Ts-1-2.5	Potassium	None		
	8.3a-1-Ts-1-5	Selenium	None		
	8.3a-1-Ts-1-10	Sodium	None		
	8.3a-1-Ts-1-15	Thallium	None		
	8.3c-1-Td-1-5				
	8.3a-1-Td-1-2.5				
	7d-1Td-1-2.5				
	7d-1-Tdd-1-2.5				
	7d-2-Td-1-0.5				
	8.1a-2-Ts-1-0.5				
	8.1a-2-Ts-1-2.5				
	8.1a-2-Ts-1-5				
	8.1a-2-Ts-1-10				
	8.1a-2-Td-1-5				
	7d-1-Ts-1-0.5				
	7d-1-Ts-1-2.5				
	7d-1-Ts-1-5				
	7d-1-Ts-1-10				
	7d-1-Ts-1-15				
	7d-1-Tp-1-0.5				
	7d-1-Tp-1-2.5				
	7d-1-Tp-1-5				
	7d-1-Tp-1-10				
	7d-2-Ts-1-0.5				
	7d-2-Ts-1-2.5				
	7d-2-Ts-1-5				
	7d-2-Ts-1-10				

Fort Irwin
Metals - Laboratory Blank Data Qualification Summary - SDG 300141

No Sample Data Qualified in this SDG

Fort Irwin
Metals - Field Blank Data Qualification Summary - SDG 300141

No Sample Data Qualified in this SDG

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26, 1998

LDC Report Date: September 10, 1998

Matrix: Soil

Parameters: Metals

Validation Level: EPA Level IV

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300142

Sample Identification

8 1a-1-Ts-1-0 5
8 1a-1-Ts-1-2.5
8.1a-1-Ts-1-5
8.1a-1-Ts-1-10
8.1a-1-Ts-1-15
8.3b-1-Ts-1-0.5
8.3b-1-Ts-1-2.5
8 3b-1-Ts-1-5
8 3b-1-Ts-1-10
8 3b-1-Ts-1-15
8 3b-1-Ts-1-0.5MS
8 3b-1-Ts-1-0 5MSD

Introduction

This data review covers 12 soil samples listed on the cover sheet including dilutions and reanalysis as applicable The analyses were per EPA SW 846 Methods 6010 and 7000 for Metals. The metals analyzed were Aluminum, Antimony, Arsenic, Barium, Beryllium, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Magnesium, Manganese, Molybdenum, Nickel, Potassium, Selenium, Silver, Sodium, Thallium, Vanadium, and Zinc.

The review follows a modified outline of the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (February 1994) as there are no current guidelines for the methods stated above.

A table summarizing all data qualification flags is provided at the end of this report. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from specified protocols or is of technical advisory nature.

Blanks are summarized in Section III.

Field duplicates are summarized in Section XIII

The following are definitions of the data qualifiers:

U Indicates the compound or analyte was analyzed for but not detected at or above the stated limit

J Indicates an estimated value

R Quality control indicates the data is not usable

N Presumptive evidence of presence of the constituent.

UJ Indicates the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

A Indicates the finding is based upon technical validation criteria.

P Indicates the finding is related to a protocol/contractual deviation.

None Indicates the data was not significantly impacted by the finding, therefore qualification was not required.

I. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria.

II. Calibration

An initial calibration was performed.

The frequency and analysis criteria of the initial calibration verification (ICV) and continuing calibration verification (CCV) were met.

III. Blanks

Method blanks were reviewed for each matrix as applicable.

Data qualification by the initial, continuing and preparation blanks (ICB/CCB/PBs) was based on the maximum contaminant concentration in the ICB/CCB/PBs in the analysis of each analyte. No contaminant concentrations were found above the reporting limit in the initial, continuing and preparation blanks with the following exceptions:

Method Blank ID	Analyte	Concentration	Associated Samples
PB (prep blank)	Aluminum Barium Calcium Chromium Iron Magnesium Sodium	3 4 mg/Kg 0.10 mg/Kg 11 2 mg/Kg 0 37 mg/Kg 1 6 mg/Kg 4 4 mg/Kg 5.2 mg/Kg	All samples in SDG 300142

Sample concentrations were compared to concentrations detected in the ICB/CCB/PBs. The sample concentrations were either not detected or were significantly greater (>5X blank contaminants) than the concentrations found in the associated method blanks.

No field blanks were identified in this SDG.

IV. ICP Interference Check Sample (ICS) Analysis

The frequency of analysis was met.

The criteria for analysis were met.

V. Matrix Spike Analysis

Matrix spike (MS) and matrix spike duplicate (MSD) analyses were reviewed for each

matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits with the following exceptions:

Spike ID (Associated Samples)	Analyte	MS (%R) (Limits)	MSD (%R) (Limits)	RPD (Limits)	Flag	A or P
8.3b-1-Ts-1-0.5MS/MSD (All samples in SDG 300142)	Chromium Manganese Antimony Zinc	74.4 (75-125) 47.1 (75-125) 37.4 (75-125) 69.8 (75-125)	- - 42.5 (75-125) 62.1 (75-125)	- - - -	J (all detects) UJ (all non-detects)	A

VI. Duplicate Sample Analysis

Duplicate (DUP) sample analyses were reviewed for each matrix as applicable.

VII. Laboratory Control Samples (LCS)

Laboratory control samples were reviewed for each matrix as applicable. Percent recoveries (%R) were within QC limits

VIII. Internal Standard (ICP-MS)

ICP-MS was not utilized in this SDG.

IX. Furnace Atomic Absorption QC

Graphite furnace atomic absorption was not utilized in this SDG.

X. ICP Serial Dilution

Not required by the method.

XI. Sample Result Verification

All sample result verifications met validation criteria.

The QAPP reporting limits were met with the following exceptions:

Sample	Analyte	Finding	Criteria	Flag	A or P
All samples in SDG 300142	Arsenic	Laboratory reporting limit reported at 10 mg/Kg.	Reporting limit should be reported at 1 mg/Kg per the QAPP	None	P
All samples in SDG 300142	Calcium	Laboratory reporting limit reported at 50 mg/Kg	Reporting limit should be reported at 15 mg/Kg per the QAPP	None	P

Sample	Analyte	Finding	Criteria	Flag	A or P
All samples in SDG 300142	Iron	Laboratory reporting limit reported at 10 mg/Kg.	Reporting limit should be reported at 8 mg/Kg per the QAPP	None	P
All samples in SDG 300142	Lead	Laboratory reporting limit reported at 5 mg/Kg.	Reporting limit should be reported at 1 mg/Kg per the QAPP	None	P
All samples in SDG 300142	Magnesium	Laboratory reporting limit reported at 50 mg/Kg.	Reporting limit should be reported at 20 mg/Kg per the QAPP	None	P
All samples in SDG 300142	Manganese	Laboratory reporting limit reported at 1 mg/Kg	Reporting limit should be reported at 0.5 mg/Kg per the QAPP	None	P
All samples in SDG 300142	Potassium	Laboratory reporting limit reported at 500 mg/Kg.	Reporting limit should be reported at 300 mg/Kg per the QAPP	None	P
All samples in SDG 300142	Selenium	Laboratory reporting limit reported at 20 mg/Kg.	Reporting limit should be reported at 1 mg/Kg per the QAPP	None	P
All samples in SDG 300142	Sodium	Laboratory reporting limit reported at 500 mg/Kg.	Reporting limit should be reported at 40 mg/Kg per the QAPP	None	P
All samples in SDG 300142	Thallium	Laboratory reporting limit reported at 200 mg/Kg.	Reporting limit should be reported at 2 mg/Kg per the QAPP	None	P

XII. Overall Assessment of Data

Data flags have been summarized at the end of this report.

XIII. Field Duplicates

No field duplicates were identified in this SDG

Fort Irwin
Metals - Data Qualification Summary - SDG 300142

SDG	Sample	Analyte	Flag	A or P	Reason
300142	8.1a-1-Ts-1-0.5 8.1a-1-Ts-1-2.5 8.1a-1-Ts-1-5 8.1a-1-Ts-1-10 8.1a-1-Ts-1-15 8.3b-1-Ts-1-0.5 8.3b-1-Ts-1-2.5 8.3b-1-Ts-1-5 8.3b-1-Ts-1-10 8.3b-1-Ts-1-15	Chromium Manganese Antimony Zinc	J (all detects) UJ (all non-detects)	A	Matrix spike/Matrix spike duplicates (%R)
300142	8.1a-1-Ts-1-0.5 8.1a-1-Ts-1-2.5 8.1a-1-Ts-1-5 8.1a-1-Ts-1-10 8.1a-1-Ts-1-15 8.3b-1-Ts-1-0.5 8.3b-1-Ts-1-2.5 8.3b-1-Ts-1-5 8.3b-1-Ts-1-10 8.3b-1-Ts-1-15	Arsenic Calcium Iron Lead Magnesium Manganese Potassium Selenium Sodium Thallium	None None None None None None None None None None	P	Sample result verification

Fort Irwin
Metals - Laboratory Blank Data Qualification Summary - SDG 300142

No Sample Data Qualified in this SDG

Fort Irwin
Metals - Field Blank Data Qualification Summary - SDG 300142

No Sample Data Qualified in this SDG

Fort Irwin
Data Validation Reports
LDC# 3103

Herbicides

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26 through June 27, 1998

LDC Report Date: September 15, 1998

Matrix: Soil

Parameters: Herbicides

Validation Level: EPA Level III

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300141

Sample Identification

8 3c-1-Ts-1-0 5	7d-1-Ts-1-0 5
8 3c-1-Ts-1-2.5	7d-1-Ts-1-2.5
8 3c-1-Ts-1-5	7d-1-Ts-1-5
8 3c-1-Ts-1-10	7d-1-Ts-1-10
8.3c-1-Ts-1-15	7d-1-Ts-1-15
8.3a-1-Ts-1 0.5	7d-1-Tp-1-0 5
8.3a-1-Ts-1-2 5	7d-1-Tp-1-2 5
8.3a-1-Ts-1-5	7d-1-Tp-1-5
8 3a-1-Ts-1-10	7d-1-Tp-1-10
8.3a-1-Ts-1-15	7d-2-Ts-1-0.5
8 3c-1-Td-1-5	7d-2-Ts-1-2.5
8.3a-1-Td-1-2.5	7d-2-Ts-1-5
7d-1Td-1-2.5	7d-2-Ts-1-10
7d-1-Tdd-1-2.5	8.3c-1-Ts-1-2 5MS
7d-2-Td-1-0.5	8 3c-1-Ts-1-2.5MSD
8 1a-2-Ts-1-0.5	8 3a-1-Ts-1 0.5MS
8 1a-2-Ts-1-2.5	8 3a-1-Ts-1.0.5MSD
8 1a-2-Ts-1-5	7d-1-Tp-1-10MS
8 1a-2-Ts-1-10	7d-1-Tp-1-10MSD
8.1a-2-Td-1-5	

Introduction

This data review covers 39 soil samples listed on the cover sheet including dilutions and reanalysis as applicable. The analyses were per EPA SW 846 Method 8150 for Herbicides

This review follows a modified outline of the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (February 1994) as there are no current guidelines for the method stated above

A table summarizing all data qualification flags is provided at the end of this report. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature

Blank results are summarized in Section III.

Field duplicates are summarized in Section IX.

Raw data were not reviewed for this SDG The review was based on QC data.

The following are definitions of the data qualifiers:

U Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.

J Indicates an estimated value

R Quality control indicates the data is not usable.

N Presumptive evidence of presence of the constituent.

UJ Indicates the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

A Indicates the finding is based upon technical validation criteria.

P Indicates the finding is related to a protocol/contractual deviation.

None Indicates the data was not significantly impacted by the finding, therefore qualification was not required.

I. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria.

II. Calibration

a. Initial Calibration

Initial calibration of compounds was performed for the primary (quantitation) column and confirmation column as required by this method.

The percent relative standard deviations (%RSD) were less than or equal to 20 0% for all compounds with the following exceptions:

Date	Column	Compound	%RSD	Associated Samples	Flag	A or P
6/27/98	DB-608	MCPP	33	All samples in SDG 300141	J (all detects) UJ (all non-detects)	P

b. Calibration Verification

Calibration verification was performed at the required frequencies.

The percent differences (%D) of calibration factors in continuing standard mixtures were within the 15 0% QC limits with the following exceptions:

Date	Standard	Column	Compound	%D	Associated Samples	Flag	A or P
7/11/98	CCV	DB-608	2 4-D 2 4-DB	17 16	8.3c-1-Ts-1-0.5 8.3c-1-Ts-1-2.5 8.3c-1-Ts-1-5 8.3c-1-Ts-1-10 8.3c-1-Ts-1-15 8.3a-1-Ts-1 0 5 8.3c-1-Ts-1-2.5MS 8.3c-1-Ts-1-2.5MSD 07JUL98-11M	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	P
7/14/98	CCV	DB-608	Dalapon 2 4-D 2 4-DB	16 17 17	7d-2-Td-1-0.5 8.1a-2-Ts-1-5 8 1a-2-Ts-1-10 8 1a-2-Td-1-5 7d-1-Ts-1-0.5 7d-1-Ts-1-2.5 10JOL98-12M	J (all detects) UJ (all non-detects)	P

Date	Standard	Column	Compound	%D	Associated Samples	Flag	A or P
7/15/98	CCV	DB-608	MCPP	20	7d-2-Ts-1-2.5 7d-2-Ts-1-5 7d-2-Ts-1-10	J (all detects) UJ (all non-detects)	P

III. Blanks

Method blanks were reviewed for each matrix as applicable No herbicide contaminants were found in the method blanks

No field blanks were identified in this SDG

IV. Accuracy and Precision Data

a. Surrogate Recovery

Surrogates were added to all samples and blanks as required by the method All surrogate recoveries (%R) were within QC limits with the following exceptions:

Sample	Column	Surrogate	%R (Limits)	Compound	Flag	A or P
8.3c-1-Ts-1-5	Not specified	DCAA	32 (65-135)	All TCL compounds	J (all detects) UJ (all non-detects)	A
8.3a-1-Ts-1 0 5	Not specified	DCAA	0 (65-135)	All TCL compounds	J (all detects) R (all non-detects)	A
8.3c-1-Td-1-5	Not specified	DCAA	0 (65-135)	All TCL compounds	J (all detects) R (all non-detects)	A
7d-2-Td-1-0 5	Not specified	DCAA	42 (65-135)	All TCL compounds	J (all detects) UJ (all non-detects)	A
8 1a-2-Ts-1-0.5	Not specified	DCAA	0 (65-135)	All TCL compounds	J (all detects) R (all non-detects)	A
8 1a-2-Ts-1-2.5	Not specified	DCAA	30 (65-135)	All TCL compounds	J (all detects) UJ (all non-detects)	A
8.1a-2-Ts-1-5	Not specified	DCAA	32 (65-135)	All TCL compounds	J (all detects) UJ (all non-detects)	A
8 1a-2-Ts-1-10	Not specified	DCAA	40 (65-135)	All TCL compounds	J (all detects) UJ (all non-detects)	A

Sample	Column	Surrogate	%R (Limits)	Compound	Flag	A or P
8.1a-2-Td-1-5	Not specified	DCAA	0 (65-135)	All TCL compounds	J (all detects) R (all non-detects)	A
7d-1-Ts-1-0.5	Not specified	DCAA	0 (65-135)	All TCL compounds	J (all detects) R (all non-detects)	A
7d-1-Ts-1-2.5	Not specified	DCAA	0 (65-135)	All TCL compounds	J (all detects) R (all non-detects)	A
7d-1-Ts-1-5	Not specified	DCAA	0 (65-135)	All TCL compounds	J (all detects) R (all non-detects)	A
7d-1-Ts-1-10	Not specified	DCAA	0 (65-135)	All TCL compounds	J (all detects) R (all non-detects)	A
7d-1-Ts-1-15	Not specified	DCAA	0 (65-135)	All TCL compounds	J (all detects) R (all non-detects)	A
7d-1-Tp-1-0.5	Not specified	DCAA	0 (65-135)	All TCL compounds	J (all detects) R (all non-detects)	A
7d-1-Tp-1-2.5	Not specified	DCAA	0 (65-135)	All TCL compounds	J (all detects) R (all non-detects)	A
7d-2-Ts-1-0.5	Not specified	DCAA	42 (65-135)	All TCL compounds	J (all detects) UJ (all non-detects)	A
7d-2-Ts-1-5	Not specified	DCAA	0 (65-135)	All TCL compounds	J (all detects) R (all non-detects)	A

b. Matrix Spike/(Matrix Spike) Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) samples were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits with the following exceptions:

Spike ID (Associated Samples)	Compound	MS (%R) (Limits)	MSD (%R) (Limits)	RPD (Limits)	Flag	A or P
8.3a-1-Ts-1 0.5MS/MSD (8.3a-1-Ts-1.0.5)	2 4-D	60 (65-135)	59 (65-135)	-	J (all detects) UJ (all non-detects)	A
	2.4 5-T	60 (65-135)	-	-	J (all detects) UJ (all non-detects)	

Introduction

This data review covers 45 soil samples listed on the cover sheet including dilutions and reanalysis as applicable. The analyses were per Data Chem Laboratories Method CSGAS for o-Chlorobenzaldehyde.

This review follows a modified outline of the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (February 1994) as there are no current guidelines for the method stated above.

A table summarizing all data qualification flags is provided at the end of this report. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature

Blank results are summarized in Section III

Field duplicates are summarized in Section IX

Raw data were not reviewed for this SDG. The review was based on QC data.

The following are definitions of the data qualifiers:

U Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.

J Indicates an estimated value

R Quality control indicates the data is not usable.

N Presumptive evidence of presence of the constituent.

UJ Indicates the compound or analyte was analyzed for but not detected The sample detection limit is an estimated value.

A Indicates the finding is based upon technical validation criteria.

P Indicates the finding is related to a protocol/contractual deviation.

None Indicates the data was not significantly impacted by the finding, therefore qualification was not required.

I. Technical Holding Times

All technical holding time requirements were met with the following exceptions:

Sample	Total Days From Sample Collection Until Extraction	Required Holding Time (in Days) From Sample Collection Until Extraction	Flag	A or P
8.3c-1-Ts-1-5REMS 8 3c-1-Ts-1-5REMSD 8 3a-1-Ts-1-2.5REMS 8 3a-1-Ts-1-2.5REMSD	24	14	J (all detects) UJ (all non-detects)	A
7d-2-Ts-1-0 5REMS 7d-2-Ts-1-0.5REMSD	23	14	J (all detects) UJ (all non-detects)	A

The chain-of-custodies were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria.

II. Calibration

a. Initial Calibration

Initial calibration of compounds was performed for the primary (quantitation) column and confirmation column as required by this method.

A curve fit, based on the initial calibration, was established for quantitation. The coefficient of determination (r^2) was greater than or equal to 0 990 .

Retention time windows were evaluated and considered technically acceptable.

b. Calibration Verification

Calibration verification was performed at the required frequencies.

The percent differences (%D) of calibration factors in continuing standard mixtures were within the 25.0% QC limits.

Retention times (RT) of all compounds in the calibration standards were within QC limits.

III. Blanks

Method blanks were reviewed for each matrix as applicable. No o-Chlorobenzaldehyde contaminants were found in the method blanks.

No field blanks were identified in this SDG.

IV. Accuracy and Precision Data

a. Surrogate Recovery

Surrogates were added to all samples and blanks as required by the method. All surrogate recoveries (%R) were within QC limits with the following exceptions:

Sample	Surrogate	%R (Limits)	Compound	Flag	A or P
7d-1-Tp-1-5	2 4-Dichlorobenzaldehyde	137 (65-135)	o-Chlorobenzaldehyde	J (all detects)	A
7d-1-Tp-1-10	2 4-Dichlorobenzaldehyde	138 (65-135)	o-Chlorobenzaldehyde	J (all detects)	A
7d-2-Ts-1-2 5	2 4-Dichlorobenzaldehyde	136 (65-135)	o-Chlorobenzaldehyde	J (all detects)	A
7d-2-Ts-1-5	2 4-Dichlorobenzaldehyde	136 (65-135)	o-Chlorobenzaldehyde	J (all detects)	A
BL-148903-1	2 4-Dichlorobenzaldehyde	144 (65-135)	o-Chlorobenzaldehyde	J (all detects)	A

b. Matrix Spike/(Matrix Spike) Duplicate

Matrix spike (MS) and matrix spike duplicate (MSD) samples were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits with the following exceptions:

Spike ID (Associated Samples)	Compound	MS (%R) (Limits)	MSD (%R) (Limits)	RPD (Limits)	Flag	A or P
8.3c-1-Ts-1-5MS/MSD (8.3c-1-Ts-1-5)	o-Chlorobenzaldehyde	0 (65-135)	0 (65-135)	-	J (all detects) R (all non-detects)	A
8 3a-1-Ts-1-2.5MS/MSD (8.3a-1-Ts-1-2.5)	o-Chlorobenzaldehyde	0 (65-135)	0 (65-135)	-	J (all detects) R (all non-detects)	A
7d-2-Ts-1-0.5MS/MSD (7d-2-Ts-1-0.5)	o-Chlorobenzaldehyde	0 (65-135)	0 (65-135)	-	J (all detects) R (all non-detects)	A

c. Laboratory Control Samples

Laboratory control samples were reviewed for each matrix as applicable. Percent recoveries (%R) were within QC limits with the following exceptions:

LCS ID	Compound	%R (Limits)	Associated Samples	Flag	A or P
QC-148901-1	o-Chlorobenzaldehyde	0 (70-130)	8.3c-1-Ts-1-0.5 8.3c-1-Ts-1-2.5 8.3c-1-Ts-1-5 8.3c-1-Ts-1-10 8.3c-1-Ts-1-15 8.3a-1-Ts-1.0.5 BL-148901-1	J (all detects) R (all non-detects)	A
QC-148902-1	o-Chlorobenzaldehyde	0 (70-130)	8.3a-1-Ts-1-2.5 8.3a-1-Ts-1-5 8.3a-1-Ts-1-10 8.3a-1-Ts-1-15 8.3c-1-Td-1-5 8.3a-1-Td-1-2.5 7d-1Td-1-2.5 7d-1-Tdd-1-2.5 7d-2-Td-1-0.5 8.1a-2-Ts-1-0.5 8.1a-2-Ts-1-2.5 8.1a-2-Ts-1-5 8.1a-2-Ts-1-10 8.1a-2-Td-1-5 7d-1-Ts-1-0.5 7d-1-Ts-1-2.5 7d-1-Ts-1-5 7d-1-Ts-1-10 BL-148902-1	J (all detects) R (all non-detects)	A
QC-148903-1	o-Chlorobenzaldehyde	0 (70-130)	7d-1-Ts-1-15 7d-1-Tp-1-0.5 7d-1-Tp-1-2.5 7d-1-Tp-1-5 7d-1-Tp-1-10 7d-2-Ts-1-0.5 7d-2-Ts-1-2.5 7d-2-Ts-1-5 7d-2-Ts-1-10 BL-148903-1	J (all detects) R (all non-detects)	A

V. Target Compound Identification

Raw data were not reviewed for this SDG.

VI. Compound Quantitation and CRQLs

Raw data were not reviewed for this SDG

Sample results were reported on a wet weight basis.

VII. System Performance

Raw data were not reviewed for this SDG.

VIII. Overall Assessment of Data

Data flags are summarized at the end of this report.

IX. Field Duplicates

Samples 8.3c-1-Ts-1-5 and 8.3c-1-Td-1-5, samples 8.3a-1-Ts-1-2.5 and 3a-1-Td-1-2.5, samples 7d-1Td-1-2.5 and 7d-1-Ts-1-2.5, samples 7d-1-Tdd-1-2.5 and 7d-1-Tp-1-2.5, samples 7d-2-Td-1-0.5 and 7d-2-Ts-1-0.5, and samples 8.1a-2-Ts-1-5 and 8.1a-2-Td-1-5 were identified as field duplicates. No o-Chlorobenzaldehyde was detected in any of the samples.

Fort Irwin
o-Chlorobenzaldehyde - Data Qualification Summary - SDG 300141

SDG	Sample	Compound	Flag	A or P	Reason
300141	7d-1-Tp-1-5 7d-1-Tp-1-10 7d-2-Ts-1-2.5 7d-2-Ts-1-5	o-Chlorobenzaldehyde	J (all detects)	A	Surrogate recovery (%R)
300141	8.3c-1-Ts-1-5 8.3a-1-Ts-1-2.5 7d-2-Ts-1-0.5	o-Chlorobenzaldehyde	J (all detects) R (all non-detects)	A	Matrix spike/Matrix spike duplicates (%R)
300141	8.3c-1-Ts-1-0.5 8.3c-1-Ts-1-2.5 8.3c-1-Ts-1-5 8.3c-1-Ts-1-10 8.3c-1-Ts-1-15 8.3a-1-Ts-1-0.5 8.3a-1-Ts-1-2.5 8.3a-1-Ts-1-5 8.3a-1-Ts-1-10 8.3a-1-Ts-1-15 8.3c-1-Td-1-5 8.3a-1-Td-1-2.5 7d-1Td-1-2.5 7d-1-Tdd-1-2.5 7d-2-Td-1-0.5 8.1a-2-Ts-1-0.5 8.1a-2-Ts-1-2.5 8.1a-2-Ts-1-5 8.1a-2-Ts-1-10 8.1a-2-Td-1-5 7d-1-Ts-1-0.5 7d-1-Ts-1-2.5 7d-1-Ts-1-5 7d-1-Ts-1-10 7d-1-Ts-1-15 7d-1-Tp-1-0.5 7d-1-Tp-1-2.5 7d-1-Tp-1-5 7d-1-Tp-1-10 7d-2-Ts-1-0.5 7d-2-Ts-1-2.5 7d-2-Ts-1-5 7d-2-Ts-1-10	o-Chlorobenzaldehyde	J (all detects) R (all non-detects)	A	Laboratory control samples (%R)

Fort Irwin
o-Chlorobenzaldehyde - Laboratory Blank Data Qualification Summary - SDG 300141

No Sample Data Qualified in this SDG

Fort Irwin
o-Chlorobenzaldehyde - Field Blank Data Qualification Summary - SDG 300141

No Sample Data Qualified in this SDG

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26, 1998

LDC Report Date: September 14, 1998

Matrix: Soil

Parameters: o-Chlorobenzaldehyde

Validation Level: EPA Level IV

Laboratory: Data Chem Laboratories

Sample Delivery Group (SDG): 300142

Sample Identification

8.1a-1-Ts-1-0.5
8.1a-1-Ts-1-2.5
8.1a-1-Ts-1-5
8.1a-1-Ts-1-10
8.1a-1-Ts-1-15
8.3b-1-Ts-1-0.5
8.3b-1-Ts-1-2.5
8.3b-1-Ts-1-5
8.3b-1-Ts-1-10
8.3b-1-Ts-1-15

Introduction

This data review covers 10 soil samples listed on the cover sheet including dilutions and reanalysis as applicable. The analyses were per Data Chem Laboratories Method CSGAS for o-Chlorobenzaldehyde.

This review follows a modified outline of the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (February 1994) as there are no current guidelines for the method stated above.

A table summarizing all data qualification flags is provided at the end of this report. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

Blank results are summarized in Section III.

Field duplicates are summarized in Section IX.

The following are definitions of the data qualifiers:

U Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.

J Indicates an estimated value.

R Quality control indicates the data is not usable

N Presumptive evidence of presence of the constituent.

UJ Indicates the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

A Indicates the finding is based upon technical validation criteria.

P Indicates the finding is related to a protocol/contractual deviation.

None Indicates the data was not significantly impacted by the finding, therefore qualification was not required.

I. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria.

II. Calibration

a. Initial Calibration

Initial calibration of compounds was performed for the primary (quantitation) column and confirmation column as required by this method.

A curve fit, based on the initial calibration, was established for quantitation. The coefficient of determination (r^2) was greater than or equal to 0.990.

Retention time windows were evaluated and considered technically acceptable.

b. Calibration Verification

Calibration verification was performed at the required frequencies.

The percent differences (%D) of calibration factors in continuing standard mixtures were within the 25.0% QC limits.

Retention times (RT) of all compounds in the calibration standards were within QC limits.

III. Blanks

Method blanks were reviewed for each matrix as applicable. No o-Chlorobenzaldehyde contaminants were found in the method blanks.

No field blanks were identified in this SDG.

IV. Accuracy and Precision Data

a. Surrogate Recovery

Surrogates were added to all samples and blanks as required by the method. All surrogate recoveries (%R) were within QC limits.

b. Matrix Spike/(Matrix Spike) Duplicate

Matrix spike (MS) and matrix spike duplicate (MSD) samples were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits.

c. Laboratory Control Samples

Laboratory control samples were reviewed for each matrix as applicable Percent recoveries (%R) were within QC limits with the following exceptions:

LCS ID	Compound	%R (Limits)	Associated Samples	Flag	A or P
QC-148901-1	o-Chlorobenzaldehyde	0 (70-130)	All samples in SDG 300142	J (all detects) R (all non-detects)	A

V. Target Compound Identification

All target compound identifications were within validation criteria.

VI. Compound Quantitation and CRQLs

All compound quantitation and CRQLs were within validation criteria.

Sample results were reported on a wet weight basis.

VII. System Performance

The system performance was acceptable

VIII. Overall Assessment of Data

Data flags are summarized at the end of this report.

IX. Field Duplicates

No field duplicates were identified in this SDG.

Fort Irwin
o-Chlorobenzaldehyde - Data Qualification Summary - SDG 300142

SDG	Sample	Compound	Flag	A or P	Reason
300142	8.1a-1-Ts-1-0.5 8.1a-1-Ts-1-2.5 8.1a-1-Ts-1-5 8.1a-1-Ts-1-10 8.1a-1-Ts-1-15 8.3b-1-Ts-1-0.5 8.3b-1-Ts-1-2.5 8.3b-1-Ts-1-5 8.3b-1-Ts-1-10 8.3b-1-Ts-1-15	o-Chlorobenzaldehyde	J (all detects) R (all non-detects)	A	Laboratory control samples (%R)

Fort Irwin
o-Chlorobenzaldehyde - Laboratory Blank Data Qualification Summary - SDG 300142

No Sample Data Qualified in this SDG

Fort Irwin
o-Chlorobenzaldehyde - Field Blank Data Qualification Summary - SDG 300142

No Sample Data Qualified in this SDG

Fort Irwin
Data Validation Reports
LDC# 3103

Wet Chemistry

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26 through June 27, 1998

LDC Report Date: September 15, 1998

Matrix: Soil

Parameters: Wet Chemistry

Validation Level: EPA Level III

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300141

Sample Identification

8 3c-1-Ts-1-0 5	7d-1-Ts-1-0.5	8 3c-1-Ts-1-5DUP
8.3c-1-Ts-1-2.5	7d-1-Ts-1-2 5	7d-2-Ts-1-0 5DUP
8 3c-1-Ts-1-5	7d-1-Ts-1-5	
8.3c-1-Ts-1-10	7d-1-Ts-1-10	
8 3c-1-Ts-1-15	7d-1-Ts-1-15	
8 3a-1-Ts-1.0 5	7d-1-Tp-1-0 5	
8.3a-1-Ts-1-2.5	7d-1-Tp-1-2 5	
8.3a-1-Ts-1-5	7d-1-Tp-1-5	
8.3a-1-Ts-1-10	7d-1-Tp-1-10	
8.3a-1-Ts-1-15	7d-2-Ts-1-0.5	
8 3c-1-Td-1-5	7d-2-Ts-1-2.5	
8.3a-1-Td-1-2.5	7d-2-Ts-1-5	
7d-1Td-1-2.5	7d-2-Ts-1-10	
7d-1-Tdd-1-2.5	8 3a-1-Ts-1-2.5MS	
7d-2-Td-1-0 5	8 3a-1-Ts-1-2.5MSD	
8.1a-2-Ts-1-0.5	8.3c-1-Ts-1-5MS	
8 1a-2-Ts-1-2.5	8.3c-1-Ts-1-5MSD	
8.1a-2-Ts-1-5	7d-2-Ts-1-0 5MS	
8.1a-2-Ts-1-10	7d-2-Ts-1-0 5MSD	
8 1a-2-Td-1-5	8.3a-1-Ts-1-2 5DUP	

Introduction

This data review covers 42 soil samples on the cover sheet. The analyses were per EPA Method 350.1 for Ammonia, EPA Method 353.2 for Nitrate + Nitrite as Nitrogen, and EPA SW 846 Method 9045B for pH.

The review follows a modified outline of the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (February 1994) as there are no current guidelines for the methods stated above.

A table summarizing all data qualification is provided at the end of this report. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

Blank results are summarized in Section III.

Field duplicates are summarized in Section VII

Raw data were not reviewed for this SDG. The review was based on QC data.

The following are definitions of the data qualifiers:

U Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.

J Indicates an estimated value.

R Quality control indicates the data is not usable.

N Presumptive evidence of presence of the constituent.

UJ Indicates the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

A Indicates the finding is based upon technical validation criteria.

P Indicates the finding is related to a protocol/contractual deviation.

None Indicates the data was not significantly impacted by the finding, therefore qualification was not required.

I. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures All cooler temperatures met validation criteria

II. Calibration

a. Initial Calibration

All criteria for the initial calibration of each method were met.

b. Calibration Verification

Calibration verification frequency and analysis criteria were met for each method when applicable.

III. Blanks

Method blanks were reviewed for each matrix as applicable No contaminant concentrations were found in the method blanks.

No field blanks were identified in this SDG.

IV. Accuracy and Precision Data

a. Matrix Spike/(Matrix Spike) Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) analyses were reviewed for each matrix as applicable Percent recoveries (%R) and relative percent differences (RPD) were within QC limits.

Duplicate (DUP) sample analyses were reviewed for each matrix as applicable. Relative percent differences (RPD) were within QC limits.

b. Laboratory Control Samples

Laboratory control samples were reviewed for each matrix as applicable Percent recoveries (%R) were within QC limits.

V. Sample Result Verification

All sample result verifications were within validation criteria.

The QAPP reporting limits were met with the following exceptions:

Sample	Compound	Finding	Criteria	Flag	A or P
All samples in SDG 300141	Nitrate/Nitrite as N	Laboratory reporting limit reported at 0.25 mg/Kg.	Reporting limit should be reported at 0.10 mg/Kg per the QAPP	None	P

VI. Overall Assessment of Data

Data flags are summarized at the end of this report

VII. Field Duplicates

Samples 8.3c-1-Ts-1-5 and 8.3c-1-Td-1-5, samples 8 3a-1-Ts-1-2.5 and 8.3a-1-Td-1-2.5, samples 7d-1Td-1-2.5 and 7d-1-Ts-1-2.5, samples 7d-1-Tdd-1-2 5 and 7d-1-Tp-1-2 5, samples 7d-2-Td-1-0.5 and 7d-2-Ts-1-0 5, and samples 8.1a-2-Ts-1-5 and 8 1a-2-Td-1-5 were identified as field duplicates. No contaminant concentrations were detected in any of the samples with the following exceptions:

Analyte	Concentration mg/Kg		RPD (Limits)	Flag	A or P
	8.3c-1-Ts-1-5	8.3c-1-Td-1-5			
Ammonia	0 16 mg/Kg	0 15 mg/Kg	6 (≤70)	-	-
pH	8 4 units	8 5 units	1 (≤70)	-	-
Nitrate/Nitrite as N	2.9 mg/Kg	0.91 mg/Kg	104 (≤70)	-	-

Analyte	Concentration		RPD (Limits)	Flag	A or P
	8.3a-1-Ts-1-2.5	8.3a-1-Td-1-2.5			
Ammonia	0.26 mg/Kg	0.19 mg/Kg	31 (≤70)	-	-
pH	9 7 units	9.7 units	0 (≤70)	-	-
Nitrate/Nitrite as N	0.38 mg/Kg	0.30 mg/Kg	24 (≤70)	-	-

Analyte	Concentration		RPD (Limits)	Flag	A or P
	7d-1Td-1-2.5	7d-1-Ts-1-2.5			
Ammonia	0.49 mg/Kg	0.052 mg/Kg	162 (≤70)	-	-
pH	9.2 units	9 0 units	2 (≤70)	-	-

Analyte	Concentration		RPD (Limits)	Flag	A or P
	7d-1Td-1-2.5	7d-1-Ts-1-2.5			
Nitrate/Nitrite as N	3 9 mg/Kg	4 1 mg/Kg	5 (≤70)	-	-

Analyte	Concentration		RPD (Limits)	Flag	A or P
	7d-1-Tdd-1-2.5	7d-1-Tp-1-2.5			
Ammonia	0.16 mg/Kg	0 15 mg/Kg	6 (≤70)	-	-
pH	9 1 units	9 1 units	0 (≤70)	-	-
Nitrate/Nitrite as N	0 69 mg/Kg	1 3 mg/Kg	61 (≤70)	-	-

Analyte	Concentration		RPD (Limits)	Flag	A or P
	7d-2-Td-1-0.5	7d-2-Ts-1-0.5			
pH	8.8 units	8.6 units	2 (≤70)	-	-
Nitrate/Nitrite as N	0.18 mg/Kg	0 35 mg/Kg	64 (≤70)	-	-

Analyte	Concentration		RPD (Limits)	Flag	A or P
	8 1a-2-Ts-1-5	8 1a-2-Td-1-5			
pH	8 3 units	7 7 units	8 (≤70)	-	-
Nitrate/Nitrite as N	2 9 mg/Kg	1 5 mg/Kg	64 (≤70)	-	-

Fort Irwin
Wet Chemistry - Data Qualification Summary - SDG 300141

SDG	Sample	Analyte	Flag	A or P	Reason
300141	8.3c-1-Ts-1-0.5 8.3c-1-Ts-1-2.5 8.3c-1-Ts-1-5 8.3c-1-Ts-1-10 8.3c-1-Ts-1-15 8.3a-1-Ts-1-0.5 8.3a-1-Ts-1-2.5 8.3a-1-Ts-1-5 8.3a-1-Ts-1-10 8.3a-1-Ts-1-15 8.3c-1-Td-1-5 8.3a-1-Td-1-2.5 7d-1Td-1-2.5 7d-1-Tdd-1-2.5 7d-2-Td-1-0.5 8.1a-2-Ts-1-0.5 8.1a-2-Ts-1-2.5 8.1a-2-Ts-1-5 8.1a-2-Ts-1-10 8.1a-2-Td-1-5 7d-1-Ts-1-0.5 7d-1-Ts-1-2.5 7d-1-Ts-1-5 7d-1-Ts-1-10 7d-1-Ts-1-15 7d-1-Tp-1-0.5 7d-1-Tp-1-2.5 7d-1-Tp-1-5 7d-1-Tp-1-10 7d-2-Ts-1-0.5 7d-2-Ts-1-2.5 7d-2-Ts-1-5 7d-2-Ts-1-10	Nitrate/Nitrite as N	None	P	Sample result verification RLS

Fort Irwin
Wet Chemistry - Laboratory Blank Data Qualification Summary - SDG 300141

No Sample Data Qualified in this SDG

Fort Irwin
Wet Chemistry - Field Blank Data Qualification Summary - SDG 300141

No Sample Data Qualified in this SDG

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26, 1998

LDC Report Date: September 11, 1998

Matrix: Soil

Parameters: Wet Chemistry

Validation Level: EPA Level IV

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300142

Sample Identification

8.1a-1-Ts-1-0.5
8.1a-1-Ts-1-2.5
8.1a-1-Ts-1-5
8.1a-1-Ts-1-10
8.1a-1-Ts-1-15
8.3b-1-Ts-1-0.5
8.3b-1-Ts-1-2.5
8.3b-1-Ts-1-5
8.3b-1-Ts-1-10
8.3b-1-Ts-1-15
8.3b-1-Ts-1-0.5MS
8.3b-1-Ts-1-0.5MSD
8.3b-1-Ts-1-15DUP

Introduction

This data review covers 13 soil samples on the cover sheet. The analyses were per EPA Method 350.1 for Ammonia. EPA Method 353.2 for Nitrate + Nitrite as Nitrogen, and EPA SW 846 Method 9045B for pH.

The review follows a modified outline of the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (February 1994) as there are no current guidelines for the methods stated above.

A table summarizing all data qualification is provided at the end of this report. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature

Blank results are summarized in Section III.

Field duplicates are summarized in Section VII

The following are definitions of the data qualifiers:

U Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.

J Indicates an estimated value.

R Quality control indicates the data is not usable.

N Presumptive evidence of presence of the constituent.

UJ Indicates the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

A Indicates the finding is based upon technical validation criteria.

P Indicates the finding is related to a protocol/contractual deviation

None Indicates the data was not significantly impacted by the finding, therefore qualification was not required.

I. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria.

II. Calibration

a. Initial Calibration

All criteria for the initial calibration of each method were met.

b. Calibration Verification

Calibration verification frequency and analysis criteria were met for each method when applicable.

III. Blanks

Method blanks were reviewed for each matrix as applicable. No contaminant concentrations were found in the method blanks.

No field blanks were identified in this SDG.

IV. Accuracy and Precision Data

a. Matrix Spike/(Matrix Spike) Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) analyses were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits.

Duplicate (DUP) sample analyses were reviewed for each matrix as applicable. Relative percent differences (RPD) were within QC limits.

b. Laboratory Control Samples

Laboratory control samples were reviewed for each matrix as applicable. Percent recoveries (%R) were within QC limits.

V. Sample Result Verification

All sample result verifications were within validation criteria.

The QAPP reporting limits were met with the following exceptions:

Sample	Compound	Finding	Criteria	Flag	A or P
All samples in SDG 300142	Ammonia	Laboratory reporting limit reported at 0 25 mg/Kg.	Reporting limit should be reported at 0.1 mg/Kg per the QAPP	None	P

VI. Overall Assessment of Data

Data flags are summarized at the end of this report.

VII. Field Duplicates

No field duplicates were identified in this SDG

Fort Irwin
Wet Chemistry - Data Qualification Summary - SDG 300142

SDG	Sample	Analyte	Flag	A or P	Reason
300142	8 1a-1-Ts-1-0.5 8 1a-1-Ts-1-2.5 8.1a-1-Ts-1-5 8.1a-1-Ts-1-10 8.1a-1-Ts-1-15 8.3b-1-Ts-1-0.5 8.3b-1-Ts-1-2 5 8.3b-1-Ts-1-5 8.3b-1-Ts-1-10 8.3b-1-Ts-1-15	Ammonia	None	P	Sample result verification

Fort Irwin
Wet Chemistry - Laboratory Blank Data Qualification Summary - SDG 300142

No Sample Data Qualified in this SDG

Fort Irwin
Wet Chemistry - Field Blank Data Qualification Summary - SDG 300142

No Sample Data Qualified in this SDG

Fort Irwin
Data Validation Reports
LDC# 3103

Total Recoverable Petroleum Hydrocarbons

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26 through June 27, 1998

LDC Report Date: September 11, 1998

Matrix: Soil

Parameters: Total Recoverable Petroleum Hydrocarbons

Validation Level: EPA Level III

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300141

Sample Identification

8.3c-1-Ts-1-0.5	7d-1-Ts-1-0.5
8.3c-1-Ts-1-2.5	7d-1-Ts-1-2.5
8.3c-1-Ts-1-5	7d-1-Ts-1-5
8.3c-1-Ts-1-10	7d-1-Ts-1-10
8.3c-1-Ts-1-15	7d-1-Ts-1-15
8.3a-1-Ts-1-0.5	7d-1-Tp-1-0.5
8.3a-1-Ts-1-2.5	7d-1-Tp-1-2.5
8.3a-1-Ts-1-5	7d-1-Tp-1-5
8.3a-1-Ts-1-10	7d-1-Tp-1-10
8.3a-1-Ts-1-15	7d-2-Ts-1-0.5
8.3c-1-Td-1-5	7d-2-Ts-1-2.5
8.3a-1-Td-1-2.5	7d-2-Ts-1-5
7d-1Td-1-2.5	7d-2-Ts-1-10
7d-1-Tdd-1-2.5	8.3c-1-Ts-1-5MS
7d-2-Td-1-0.5	8.3c-1-Ts-1-5MSD
8.1a-2-Ts-1-0.5	8.3a-1-Ts-1-2.5MS
8.1a-2-Ts-1-2.5	8.3a-1-Ts-1-2.5MSD
8.1a-2-Ts-1-5	7d-2-Ts-1-0.5MS
8.1a-2-Ts-1-10	7d-2-Ts-1-0.5MSD
8.1a-2-Td-1-5	

Introduction

This data review covers 39 soil samples listed on the cover sheet including dilutions and reanalysis as applicable. The analyses were per EPA Method 418.1 for Total Recoverable Petroleum Hydrocarbons (TRPH).

The review follows a modified outline of the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (February 1994) as there are no current guidelines for the method stated above.

A table summarizing all data qualification flags is provided at the end of this report. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

Blanks results are summarized in Section III.

Field duplicates are summarized in Section VII.

Raw data were not reviewed for this SDG. The review was based on QC data.

The following are definitions of the data qualifiers:

U Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.

J Indicates an estimated value.

R Quality control indicates the data is not usable.

N Presumptive evidence of presence of the constituent.

UJ Indicates the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

A Indicates the finding is based upon technical validation criteria.

P Indicates the finding is related to a protocol/contractual deviation.

None Indicates the data was not significantly impacted by the finding, therefore qualification was not required

I. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria.

II. Calibration

a. Initial Calibration

All criteria for the initial calibration were met.

b. Calibration Verification

Calibration verification frequency and analysis criteria were met.

III. Blanks

Method blanks were reviewed for each matrix as applicable. No total recoverable petroleum hydrocarbon contaminants were found in the method blanks

No field blanks were identified in this SDG.

IV. Accuracy and Precision Data

a. Matrix Spike/(Matrix Spike) Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) analyses were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits.

b. Laboratory Control Samples

Laboratory control samples were reviewed for each matrix as applicable. Percent recoveries (%R) were within QC limits

V. Sample Result Verification

Raw data were not reviewed for this SDG.

VI. Overall Assessment of Data

Data flags have been summarized at the end of this report.

VII. Field Duplicates

Samples 8.3a-1-Ts-1-2.5 and 8.3a-1-Td-1-2.5, samples 8.3c-1-Ts-1-5 and 8.3c-1-Td-1-5,

samples 8.1a-2-Ts-1-5 and 8 1a-2-Td-1-5 samples 7d-1-Tdd-1-2.5 and 7d-1-Tp-1-2.5, samples 7d-2-Td-1-0.5 and 7d-2-Ts-1-0 5, and samples 7d-1Td-1-2.5 and 7d-1-Ts-1-2.5 were identified as field duplicates. No total recoverable petroleum hydrocarbons were detected in any of the samples with the following exceptions:

Analyte	Concentration (mg/Kg)		RPD (Limits)	Flag	A or P
	8.3a-1-Ts-1-2.5	8.3a-1-Td-1-2.5			
Total recoverable petroleum hydrocarbons	11U	160	174 (≤70)	-	-

Fort Irwin
Total Recoverable Petroleum Hydrocarbons - Data Qualification Summary - SDG 300141

No Sample Data Qualified in this SDG

Fort Irwin
Total Recoverable Petroleum Hydrocarbons - Laboratory Blank Data Qualification Summary - SDG 300141

No Sample Data Qualified in this SDG

Fort Irwin
Total Recoverable Petroleum Hydrocarbons - Field Blank Data Qualification Summary - SDG 300141

No Sample Data Qualified in this SDG

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26, 1998

LDC Report Date: September 11, 1998

Matrix: Soil

Parameters: Total Recoverable Petroleum Hydrocarbons

Validation Level: EPA Level IV

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300142

Sample Identification

8.1a-1-Ts-1-0.5
8.1a-1-Ts-1-2.5
8.1a-1-Ts-1-5
8.1a-1-Ts-1-10
8.1a-1-Ts-1-15
8.3b-1-Ts-1-0.5
8.3b-1-Ts-1-2.5
8.3b-1-Ts-1-5
8.3b-1-Ts-1-10
8.3b-1-Ts-1-15

Introduction

This data review covers 10 soil samples listed on the cover sheet including dilutions and reanalysis as applicable. The analyses were per EPA Method 418 1 for Total Recoverable Petroleum Hydrocarbons (TRPH)

The review follows a modified outline of the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (February 1994) as there are no current guidelines for the method stated above.

A table summarizing all data qualification flags is provided at the end of this report. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

Blanks results are summarized in Section III

Field duplicates are summarized in Section VII.

The following are definitions of the data qualifiers:

U Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.

J Indicates an estimated value.

R Quality control indicates the data is not usable.

N Presumptive evidence of presence of the constituent.

UJ Indicates the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

A Indicates the finding is based upon technical validation criteria

P Indicates the finding is related to a protocol/contractual deviation

None Indicates the data was not significantly impacted by the finding, therefore qualification was not required

I. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria.

II. Calibration

a. Initial Calibration

All criteria for the initial calibration were met.

b. Calibration Verification

Calibration verification frequency and analysis criteria were met

III. Blanks

Method blanks were reviewed for each matrix as applicable No total recoverable petroleum hydrocarbon contaminants were found in the method blanks

No field blanks were identified in this SDG.

IV. Accuracy and Precision Data

a. Matrix Spike/(Matrix Spike) Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) analyses were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits.

b. Laboratory Control Samples

Laboratory control samples were reviewed for each matrix as applicable Percent recoveries (%R) were within QC limits.

V. Sample Result Verification

All sample result verifications were within validation criteria.

VI. Overall Assessment of Data

Data flags have been summarized at the end of this report.

VII. Field Duplicates

No field duplicates were identified in this SDG.

Fort Irwin
Total Recoverable Petroleum Hydrocarbons - Data Qualification Summary - SDG 300142

No Sample Data Qualified in this SDG

Fort Irwin
Total Recoverable Petroleum Hydrocarbons - Laboratory Blank Data Qualification Summary - SDG 300142

No Sample Data Qualified in this SDG

Fort Irwin
Total Recoverable Petroleum Hydrocarbons - Field Blank Data Qualification Summary - SDG 300142

No Sample Data Qualified in this SDG

LDC #: 3103B11 **VALIDATION COMPLETENESS WORKSHEET** Date: 9/[illegible]8

SDG #: 300142 X ~~AFCEE Level~~ II ___NFESC Level D Page: 1 of 1

Laboratory: Quanterra Environmental Services EPA LEVEL IV Reviewer: MK

2nd Reviewer: A

METHOD: Total Recoverable Petroleum Hydrocarbons (EPA Method 418 1)

The samples listed below were reviewed for each of the following validation areas. Validation findings are noted in attached validation findings worksheets.

	Validation Area		Comments
I.	Technical holding times	A	Sampling dates: 4/26/98
IIa.	Initial calibration	A	
IIb.	Calibration verification	A	
III.	Blanks	A	
IVa.	Matrix Spike/(Matrix Spike) Duplicates	A	MS/MSD from SDG 300141
IVb.	Laboratory control samples	A	LCS
V.	Sample result verification	A	
VI.	Overall assessment of data	A	
VII.	Field duplicates	N	
VIII.	Field blanks	N	

Note: A = Acceptable; N = Not provided/applicable; SW = See worksheet; ND = No compounds detected; R = Rinsate; FB = Field blank; D = Duplicate; TB = Trip blank; EB = Equipment blank

Validated Samples:

1	8.1a-1-Ts-1-0.5 soil	11		21	
2	8.1a-1-Ts-1-2.5	12		22	
3	8.1a-1-Ts-1-5	13		23	
4	8.1a-1-Ts-1-10	14		24	
5	8.1a-1-Ts-1-15	15		25	
6	8.3b-1-Ts-1-0.5	16		26	
7	8.3b-1-Ts-1-2.5	17		27	
8	8.3b-1-Ts-1-5	18		28	
9	8.3b-1-Ts-1-10	19		29	
10	8.3b-1-Ts-1-15	20		30	

Notes:

Fort Irwin
Data Validation Reports
LDC# 3103

Dioxins & Dibenzofurans

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 27, 1998

LDC Report Date: September 10, 1998

Matrix: Soil

Parameters: Dioxins/Dibenzofurans

Validation Level: EPA Level III

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300141

Sample Identification

7d-1-Ts-1-5

Introduction

This data review covers one soil sample listed on the cover sheet including dilutions and reanalysis as applicable. The analyses were per EPA SW 846 Method 8290 for Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans.

This review follows a modified outline of the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (February 1994) as there are no current guidelines for the method stated above.

A table summarizing all data qualification is provided at the end of this report. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

Blank results are summarized in Section V

Field duplicates are summarized in Section XIV

Raw data were not reviewed for this SDG. The review was based on QC data.

The following are definitions of the data qualifiers:

U Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.

J Indicates an estimated value.

R Quality control indicates the data is not usable.

N Presumptive evidence of presence of the constituent.

UJ Indicates the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

A Indicates the finding is based upon technical validation criteria.

P Indicates the finding is related to a protocol/contractual deviation

None Indicates the data was not significantly impacted by the finding, therefore qualification was not required.

I. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria.

II. GC/MS Instrument Performance Check

Instrument performance was checked at the required daily frequency.

Retention time windows were established for all homologues. The chromatographic resolution between 2,3,7,8-TCDD and peaks representing any other unlabeled TCDD isomer was less than or equal to 25%.

III. Initial Calibration

A five point initial calibration was performed as required by the method.

Percent relative standard deviations (%RSD) were less than or equal to 20.0% for unlabeled compounds and less than or equal to 30.0% for labeled compounds.

The ion abundance ratios for all PCDDs and PCDFs were within validation criteria.

IV. Routine Calibration (Continuing)

Routine calibration was performed at the required frequencies.

All of the routine calibration percent differences (%D) between the initial calibration RRF and the routine calibration RRF were less than or equal to 20.0% for unlabeled compounds and less than or equal to 30.0% for labeled compounds with the following exceptions:

Date	Compound	%D	Associated Samples	Flag	A or P
7/30/98	1,2,3,6,7,8-HxCDF	29 (≤20)	All samples in SDG 300141	J	A

The ion abundance ratios for all PCDDs and PCDFs were within validation criteria.

V. Blanks

Method blanks were reviewed for each matrix as applicable. No polychlorinated dioxin/dibenzofuran contaminants were found in the method blanks.

No field blanks were identified in this SDG.

VI. Matrix Spike/Matrix Spike Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) samples were reviewed for each matrix as applicable with the following exceptions:

Sample	Compound	Finding	Criteria	Flag	A or P
7d-1-Ts-1-5	All TCL compounds	No MS/MSD associated with these samples.	MS/MSD required	None	P

VII. Laboratory Control Samples (LCS)

Laboratory control samples were reviewed for each matrix as applicable. The percent recoveries (%R) were within the QC limits.

VIII. Regional Quality Assurance and Quality Control

Not applicable

IX. Internal Standards

All internal standard recoveries were within QC limits.

X. Target Compound Identifications

Raw data were not reviewed for this SDG.

XI. Compound Quantitation and CRQLs

Raw data were not reviewed for this SDG.

XII. System Performance

Raw data were not reviewed for this SDG.

XIII. Overall Assessment of Data

Data flags have been summarized at the end of the report.

XIV. Field Duplicates

No field duplicates were identified in this SDG

Fort Irwin
Dioxins/Dibenzofurans - Data Qualification Summary - SDG 300141

SDG	Sample	Compound	Flag	A or P	Reason
300141	7d-1-Ts-1-5	All TCL compounds	None	P	Matrix spike/Matrix spike duplicates

Fort Irwin
Dioxins/Dibenzofurans - Laboratory Blank Data Qualification Summary - SDG 300141

No Sample Data Qualified in this SDG

Fort Irwin
Dioxins/Dibenzofurans - Field Blank Data Qualification Summary - SDG 300141

No Sample Data Qualified in this SDG

Fort Irwin
Data Validation Reports
LDC# 3103

Hexavalent Chromium

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26 through June 27, 1998

LDC Report Date: September 11, 1998

Matrix: Soil

Parameters: Hexavalent Chromium

Validation Level: EPA Level III

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300141

Sample Identification

8.3c-1-Ts-1-0.5
8.3c-1-Ts-1-5
8.3a-1-Ts-1-0.5
8.3a-1-Ts-1-5
8.3c-1-Td-1-5
7d-2-Td-1-0.5
8.1a-2-Ts-1-0.5
8.1a-2-Ts-1-5
8.1a-2-Td-1-5
7d-1-Ts-1-0.5
7d-1-Ts-1-5
7d-2-Ts-1-0.5
7d-2-Ts-1-5
8.3a-1-Ts-1-5MS
8.3a-1-Ts-1-5MSD
7d-1-Ts-1-0.5MS
7d-1-Ts-1-0.5MSD

Introduction

This data review covers 17 soil samples listed on the cover sheet. The analyses were per EPA SW 846 Method 7196 for Hexavalent Chromium.

The review follows a modified outline of the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (February 1994) as there are no current guidelines for the method stated above.

A table summarizing all data qualification is provided at the end of this report. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature

Blank results are summarized in Section III

Field duplicates are summarized in Section VII.

Raw data were not reviewed for this SDG. The review was based on QC data.

The following are definitions of the data qualifiers:

U Indicates the compound or analyte was analyzed for but not detected at or above the stated limit

J Indicates an estimated value

R Quality control indicates the data is not usable

N Presumptive evidence of presence of the constituent.

UJ Indicates the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

A Indicates the finding is based upon technical validation criteria

P Indicates the finding is related to a protocol/contractual deviation.

None Indicates the data was not significantly impacted by the finding, therefore qualification was not required

I. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures All cooler temperatures met validation criteria

II. Calibration

a. Initial Calibration

All criteria for the initial calibration were met

b. Calibration verification

Calibration verification frequency and analysis criteria were met.

III. Blanks

Method blanks were reviewed for each matrix as applicable No hexavalent chromium contaminants were found in the method blanks

No field blanks were identified in this SDG.

IV. Accuracy and Precision Data

a. Matrix Spike/(Matrix Spike) Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) samples were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits

b. Laboratory Control Samples

Laboratory control samples were reviewed for each matrix as applicable. Percent recoveries (%R) were within QC limits

V. Sample Result Verification

Raw data were not reviewed for this SDG.

VI. Overall Assessment of Data

Data flags are summarized at the end of this report.

VII. Field Duplicates

Samples 8.3c-1-Ts-1-5 and 8.3c-1-Td-1-5, samples 7d-2-Td-1-0 5 and 7d-2-Ts-1-0.5, and samples 8.1a-2-Ts-1-5 and 8.1a-2-Td-1-5 were identified as field duplicates No hexavalent chromium was detected in any of the samples

Fort Irwin
Hexavalent Chromium - Data Qualification Summary - SDG 300141

No Sample Data Qualified in this SDG

Fort Irwin
Hexavalent Chromium - Laboratory Blank Data Qualification Summary - SDG 300141

No Sample Data Qualified in this SDG

Fort Irwin
Hexavalent Chromium - Field Blank Data Qualification Summary - SDG 300141

No Sample Data Qualified in this SDG

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26, 1998

LDC Report Date: September 11, 1998

Matrix Soil

Parameters: Hexavalent Chromium

Validation Level: EPA Level III

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300142

Sample Identification

8.1a-1-Ts-1-0.5
8.1a-1-Ts-1-5
8.3b-1-Ts-1-0.5
8.3b-1-Ts-1-5
8.3b-1-Ts-1-0.5MS
8.3b-1-Ts-1-0.5MSD

Introduction

This data review covers 6 soil samples listed on the cover sheet. The analyses were per EPA SW 846 Method 7196 for Hexavalent Chromium.

The review follows a modified outline of the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (February 1994) as there are no current guidelines for the method stated above.

A table summarizing all data qualification is provided at the end of this report. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

Blank results are summarized in Section III.

Field duplicates are summarized in Section VII

The following are definitions of the data qualifiers:

U Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.

J Indicates an estimated value.

R Quality control indicates the data is not usable.

N Presumptive evidence of presence of the constituent.

UJ Indicates the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value

A Indicates the finding is based upon technical validation criteria.

P Indicates the finding is related to a protocol/contractual deviation.

None Indicates the data was not significantly impacted by the finding, therefore qualification was not required.

I. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria.

II. Calibration

a. Initial Calibration

All criteria for the initial calibration were met.

b. Calibration verification

Calibration verification frequency and analysis criteria were met

III. Blanks

Method blanks were reviewed for each matrix as applicable No hexavalent chromium contaminants were found in the method blanks.

No field blanks were identified in this SDG.

IV. Accuracy and Precision Data

a. Matrix Spike/(Matrix Spike) Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) samples were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits.

b. Laboratory Control Samples

Laboratory control samples were reviewed for each matrix as applicable Percent recoveries (%R) were within QC limits

V. Sample Result Verification

All sample result verifications were within validation criteria.

VI. Overall Assessment of Data

Data flags are summarized at the end of this report.

VII. Field Duplicates

No field duplicates were identified in this SDG.

Fort Irwin
Hexavalent Chromium - Data Qualification Summary - SDG 300142

No Sample Data Qualified in this SDG

Fort Irwin
Hexavalent Chromium - Laboratory Blank Data Qualification Summary - SDG 300142

No Sample Data Qualified in this SDG

Fort Irwin
Hexavalent Chromium - Field Blank Data Qualification Summary - SDG 300142

No Sample Data Qualified in this SDG

Fort Irwin
Data Validation Reports
LDC# 3103

Nitroaromatics & Nitramines

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 27, 1998

LDC Report Date: September 14, 1998

Matrix: Soil

Parameters: Nitroaromatics and Nitramines

Validation Level: EPA Level III

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300141

Sample Identification

8.3a-1-Ts-1-10
8.3a-1-Td-1-2.5
8.1a-2-Ts-1-5
7d-1-Ts-1-15
7d-1-Tp-1-0.5
7d-2-Ts-1-2.5
7d-2-Ts-1-10
7d-2-Ts-1-2.5MS
7d-2-Ts-1-2.5MSD
7d-2-Ts-1-10MS
7d-2-Ts-1-10MSD

Introduction

This data review covers 11 soil samples listed on the cover sheet including dilutions and reanalysis as applicable. The analyses were per EPA SW 846 Method 8321 for Nitroaromatics and Nitramines

This review follows a modified outline of the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (February 1994) as there are no current guidelines for the method stated above.

A table summarizing all data qualification flags is provided at the end of this report. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

Blank results are summarized in Section III.

Field duplicates are summarized in Section X.

Raw data were not reviewed for this SDG. The review was based on QC data.

The following are definitions of the data qualifiers:

U Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.

J Indicates an estimated value.

R Quality control indicates the data is not usable.

N Presumptive evidence of presence of the constituent.

UJ Indicates the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

A Indicates the finding is based upon technical validation criteria.

P Indicates the finding is related to a protocol/contractual deviation.

None Indicates the data was not significantly impacted by the finding, therefore qualification was not required.

I. Technical Holding Times

All technical holding time requirements were met with the following exceptions:

Sample	Total Days From Sample Collection Until Extraction	Required Holding Time (in Days) From Sample Collection Until Extraction	Flag	A or P
8.1a-2-Ts-1-5 7d-2-Ts-1-10 7d-2-Ts-1-10MS 7d-2-Ts-1-10MSD	16	14	J (all detects) UJ (all non-detects)	A

The chain-of-custodies were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria

II. Calibration

a. Initial Calibration

Initial calibration was performed using required standard concentrations.

Percent relative standard deviations (%RSD) were less than or equal to 30.0% for all compounds with the following exceptions:

Date	Compound	%RSD	Associated Samples	Flag	A or P
7/21/98	Nitrobenzene	30.5	All samples in SDG 300141	J (all detects) UJ (all non-detects)	A

Average relative response factors (RRF) for all target compounds and system monitoring compounds were within validation criteria with the following exceptions:

Date	Compound	RRF (Limits)	Associated Samples	Flag	A or P
/21/98	3-Nitrotoluene	0.0404 (≥0.05)	All samples in SDG 300141	J (all detects) R (all non-detects)	A

b. Calibration Verification

Continuing calibration was performed at the required frequencies.

The percent recoveries (%R) of amounts in continuing standard mixtures were within the 70-130% QC limits with the following exceptions:

Date	Compound	%R	Associated Samples	Flag	A or P
7/22/98	1 3 5-Trinitrobenzene	160 33	7d-2-Ts-1-10MSD	J (all detects) UJ (all non-detects)	A

III. Blanks

Method blanks were reviewed for each matrix as applicable. No nitroaromatic or nitramine contaminants were found in the method blanks with the following exceptions:

Method Blank ID	Extraction Date	Compound	Concentration	Associated Samples
09JUL98-7A	7/9/98	Nitrobenzene	0 17 ug/Kg	8 3a-1-Ts-1-10 8 3a-1-Td-1-2.5 7d-1-Ts-1-15 7d-1-Tp-1-0 5 7d-2-Ts-1-2 5
13JUL98-7A	7/13/98	Nitrobenzene	0 12 ug/Kg	8 1a-2-Ts-1-5 7d-2-Ts-1-10

Sample concentrations were compared to concentrations detected in the method blanks The sample concentrations were either not detected or were significantly greater (>5X blank contaminants) than the concentrations found in the associated method blanks with the following exceptions:

Sample	Compound	Reported Concentration	Modified Final Concentration
8 3a-1-Ts-1-10	Nitrobenzene	0 17 ug/Kg	0 25U ug/Kg
8 3a-1-Td-1-2 5	Nitrobenzene	0 25 ug/Kg	0 25U ug/Kg
7d-1-Ts-1-15	Nitrobenzene	0 25 ug/Kg	0.25U ug/Kg
7d-1-Tp-1-0 5	Nitrobenzene	0 25 ug/Kg	0 25U ug/Kg
7d-2-Ts-1-2 5	Nitrobenzene	0 19 ug/Kg	0 25U ug/Kg
8 1a-2-Ts-1-5	Nitrobenzene	0 14 ug/Kg	0 25U ug/Kg
7d-2-Ts-1-10	Nitrobenzene	0 16 ug/Kg	0 25U ug/Kg

No field blanks were identified in this SDG.

IV. Accuracy and Precision Data

a. Surrogate Recovery

Surrogates were added to all samples and blanks as required by the method. All surrogate recoveries (%R) were within QC limits

b. Matrix Spike/(Matrix Spike) Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) samples were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits with the following exceptions:

Spike ID (Associated Samples)	Compound	MS (%R) (Limits)	MSD (%R) (Limits)	RPD (Limits)	Flag	A or P
7d-2-Ts-1-10MS/MSD (7d-2-Ts-1-10)	2 4 6-Trinitrotoluene	137 (65-135)	143 (65-135)	-	J (all detects)	A

c. Laboratory Control Samples

Laboratory control samples were reviewed for each matrix as applicable. Percent recoveries (%R) were within QC limits.

V. Internal Standards

Internal standard data were not provided and therefore not reviewed.

VI. Target Compound Identification

Raw data were not reviewed for this SDG.

VII. Compound Quantitation and CRQLs

Raw data were not reviewed for this SDG

VIII. System Performance

Raw data were not reviewed for this SDG.

IX. Overall Assessment of Data

Data flags are summarized at the end of this report.

X. Field Duplicates

No field duplicates were identified in this SDG.

Fort Irwin
Nitroaromatics and Nitramines - Data Qualification Summary - SDG 300141

SDG	Sample	Compound	Flag	A or P	Reason
300141	8.1a-2-Ts-1-5 7d-2-Ts-1-10	All TCL compounds	J (all detects) UJ (all non-detects)	A	Technical holding times
300141	8.3a-1-Ts-1-10 8.3a-1-Td-1-2.5 8.1a-2-Ts-1-5 7d-1-Ts-1-15 7d-1-Tp-1-0.5 7d-2-Ts-1-2.5 7d-2-Ts-1-10	Nitrobenzene	J (all detects) UJ (all non-detects)	A	Initial calibration (%RSD)
300141	8.3a-1-Ts-1-10 8.3a-1-Td-1-2.5 8.1a-2-Ts-1-5 7d-1-Ts-1-15 7d-1-Tp-1-0.5 7d-2-Ts-1-2.5 7d-2-Ts-1-10	3-Nitrotoluene	J (all detects) R (all non-detects)	A	Initial calibration (RRF)
300141	7d-2-Ts-1-10	2,4,6-Trinitrotoluene	J (all detects)	A	Matrix spike/Matrix spike duplicates (%R)

Fort Irwin
Nitroaromatics and Nitramines - Laboratory Blank Data Qualification Summary - SDG 300141

SDG	Sample	Compound	Modified Final Concentration	A or P
300141	8.3a-1-Ts-1-10	Nitrobenzene	0.25U ug/Kg	A
300141	8.3a-1-Td-1-2.5	Nitrobenzene	0.25U ug/Kg	A
300141	7d-1-Ts-1-15	Nitrobenzene	0.25U ug/Kg	A
300141	7d-1-Tp-1-0.5	Nitrobenzene	0.25U ug/Kg	A
300141	7d-2-Ts-1-2.5	Nitrobenzene	0.25U ug/Kg	A
300141	8.1a-2-Ts-1-5	Nitrobenzene	0.25U ug/Kg	A
300141	7d-2-Ts-1-10	Nitrobenzene	0.25U ug/Kg	A

Fort Irwin
Nitroaromatics and Nitramines - Field Blank Data Qualification Summary - SDG 300141

No Sample Data Qualified in this SDG

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26, 1998

LDC Report Date: September 14, 1998

Matrix: Soil

Parameters: Nitroaromatics and Nitramines

Validation Level: EPA Level IV

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300142

Sample Identification

8.1a-1-Ts-1-10
8.1a-1-Ts-1-15
8.3b-1-Ts-1-2 5
8.3b-1-Ts-1-5
8 3b-1-Ts-1-10
8 3b-1-Ts-1-10MS
8 3b-1-Ts-1-10MSD

Introduction

This data review covers 7 soil samples listed on the cover sheet including dilutions and reanalysis as applicable. The analyses were per EPA SW 846 Method 8321 for Nitroaromatics and Nitramines.

This review follows a modified outline of the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (February 1994) as there are no current guidelines for the method stated above.

A table summarizing all data qualification flags is provided at the end of this report. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

Blank results are summarized in Section III.

Field duplicates are summarized in Section X

The following are definitions of the data qualifiers:

U Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.

J Indicates an estimated value

R Quality control indicates the data is not usable.

N Presumptive evidence of presence of the constituent.

UJ Indicates the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

A Indicates the finding is based upon technical validation criteria.

P Indicates the finding is related to a protocol/contractual deviation

None Indicates the data was not significantly impacted by the finding, therefore qualification was not required.

I. Technical Holding Times

All technical holding time requirements were met with the following exceptions:

Sample	Total Days From Sample Collection Until Extraction	Required Holding Time (in Days) From Sample Collection Until Extraction	Flag	A or P
8.3b-1-Ts-1-2.5	17	14	J (all detects) UJ (all non-detects)	A

The chain-of-custodies were reviewed for documentation of cooler temperatures All cooler temperatures met validation criteria.

II. Calibration

a. Initial Calibration

Initial calibration was performed using required standard concentrations.

Percent relative standard deviations (%RSD) were less than or equal to 30.0% for all compounds with the following exceptions:

Date	Compound	%RSD	Associated Samples	Flag	A or P
7/21/98	Nitrobenzene	30.5	All samples in SDG 300142	J (all detects) UJ (all non-detects)	A

Average relative response factors (RRF) for all target compounds and system monitoring compounds were within validation criteria with the following exceptions:

Date	Compound	RRF (Limits)	Associated Samples	Flag	A or P
7/21/98	3-Nitrotoluene	0.0404 (≥0.05)	All samples in SDG 300142	J (all detects) R (all non-detects)	A

b. Calibration Verification

Continuing calibration was performed at the required frequencies.

The percent recoveries (%R) of amounts in continuing standard mixtures were within the 70-130% QC limits with the following exceptions:

Date	Compound	%R	Associated Samples	Flag	A or P
7/22/98	1 3 5-Trinitrobenzene	160.33	8.3b-1-Ts-1-2.5	J (all detects) UJ (all non-detects)	A

III. Blanks

Method blanks were reviewed for each matrix as applicable. No nitroaromatic or nitramine contaminants were found in the method blanks with the following exceptions:

Method Blank ID	Extraction Date	Compound	Concentration	Associated Samples
09JUL98-7A	7/9/98	Nitrobenzene	0.17 ug/Kg	8 1a-1-Ts-1-10 8 1a-1-Ts-1-15 8 3b-1-Ts-1-5 8 3b-1-Ts-1-10
13JUL98-7A	7/13/98	Nitrobenzene	0 12 ug/Kg	8 3b-1-Ts-1-2.5

Sample concentrations were compared to concentrations detected in the method blanks. The sample concentrations were either not detected or were significantly greater (>5X blank contaminants) than the concentrations found in the associated method blanks with the following exceptions:

Sample	Compound	Reported Concentration	Modified Final Concentration
8 1a-1-Ts-1-10	Nitrobenzene	0 29 ug/Kg	0.29U ug/Kg
8.1a-1-Ts-1-15	Nitrobenzene	0 33 ug/Kg	0.33U ug/Kg
8.3b-1-Ts-1-5	Nitrobenzene	0 31 ug/Kg	0.31U ug/Kg
8 3b-1-Ts-1-10	Nitrobenzene	0 15 ug/Kg	0 25U ug/Kg
8.3b-1-Ts-1-2 5	Nitrobenzene	0 17 ug/Kg	0.25U ug/Kg

No field blanks were identified in this SDG.

IV. Accuracy and Precision Data

a. Surrogate Recovery

Surrogates were added to all samples and blanks as required by the method. All surrogate recoveries (%R) were within QC limits with the following exceptions:

Sample	Surrogate	%R (Limits)	Compound	Flag	A or P
8 1a-1-Ts-1-15	Nitrobenzene-d5	137 (65-135)	All TCL compounds	J (all detects)	A

b. Matrix Spike/(Matrix Spike) Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) samples were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits with the following exceptions:

Spike ID (Associated Samples)	Compound	MS (%R) (Limits)	MSD (%R) (Limits)	RPD (Limits)	Flag	A or P
8.3b-1-Ts-1-10MS/MSD (8 3b-1-Ts-1-10)	HMX	154 (65-135)	138 (65-135)	-	J (all detects)	A
	1 3 5-Trinitrobenzene	-	137 (65-135)	-	J (all detects)	
	2 4 6-Trinitrotoluene	-	136 (65-135)	-	J (all detects)	
	Tetryl	138 (65-135)	142 (65-135)	-	J (all detects)	
	Nitroglycerin	-	136 (65-135)	-	J (all detects)	
	PETN	146 (65-135)	-	-	J (all detects)	

c. Laboratory Control Samples

Laboratory control samples were reviewed for each matrix as applicable Percent recoveries (%R) were within QC limits.

V. Internal Standards

All internal standard areas and retention times were within QC limits with the following exceptions:

Sample	Internal Standards	Area (Limits)	Compound	Flag	A or P
8.3b-1-Ts-1-5	13C-RDX	405724 (435057-1740228)	HMX	J (all detects)	P
	2,6-Dinitrotoluene-d3	1368284 (1472042-5888168)	RDX	UJ (all non-detects)	
	15N-Nitroglycerin	78115 (112539-450156)	Tetryl		
			Nitrobenzene		
			2 4-Dinitrotoluene		
			2-Am-DNT		
			2 6-Dinitrotoluene		
			4-Am-DNT		
			2-and 4-Nitrotoluene		
			3-Nitrotoluene		
			Nitroglycerin		
			PETN		

Sample	Internal Standards	Area (Limits)	Compound	Flag	A or P
8.1a-1-Ts-1-10	1 3-Dinitrobenzene-d4 2,6-Dinitrotoluene-d3 15N-Nitroglycerin	695326 (1254765-5019060) 1623091 (3425631-13702526) 107084 (152802-611210)	1.3 5-Trinitrobenzene 1.3-Dinitrobenzene 2.4 6-Trinitrotoluene Tetryl Nitrobenzene 2.4-Dinitrotoluene 2-Am-DNT 2.6-Dinitrotoluene 4-Am-DNT 2-and 4-Nitrotoluene 3-Nitrotoluene Nitroglycerin PETN	J (all detects) UJ (all non-detects)	P
8.3b-1-Ts-1-10	13C-RDX	412798 (435057-1740228)	HMX RDX	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	P
13JUL98-7A	2 6-Dinitrotoluene	6202292 (1472042-5888168)	Tetryl Nitrobenzene 2 4-Dinitrotoluene 2-Am-DNT 2 6-Dinitrotoluene 4-Am-DNT 2-and 4-Nitrotoluene 3-Nitrotoluene	J (all detects)	A

VI. Target Compound Identification

All target compound identifications were within validation criteria.

VII. Compound Quantitation and CRQLs

All compound quantitation and CRQLs were within validation criteria.

Sample results were reported on a wet weight basis.

VIII. System Performance

The system performance was acceptable.

IX. Overall Assessment of Data

Data flags are summarized at the end of this report.

X. Field Duplicates

No field duplicates were identified in this SDG.

Fort Irwin
Nitroaromatics and Nitramines - Data Qualification Summary - SDG 300142

SDG	Sample	Compound	Flag	A or P	Reason
300142	8 3b-1-Ts-1-2 5	All TCL compounds	J (all detects) UJ (all non-detects)	A	Technical holding times
300142	8.1a-1-Ts-1-10 8 1a-1-Ts-1-15 8.3b-1-Ts-1-2.5 8 3b-1-Ts-1-5 8 3b-1-Ts-1-10	Nitrobenzene	J (all detects) UJ (all non-detects)	A	Initial calibration (%RSD)
300142	8.1a-1-Ts-1-10 8.1a-1-Ts-1-15 8.3b-1-Ts-1-2 5 8 3b-1-Ts-1-5 8.3b-1-Ts-1-10	3-Nitrotoluene	J (all detects) R (all non-detects)	A	Initial calibration (RRF)
300142	8 3b-1-Ts-1-2.5	1 3 5-Trinitrobenzene	J (all detects) UJ (all non-detects)	A	Calibration verification (%R)
300142	8.1a-1-Ts-1-15	All TCL compounds	J (all detects)	A	Surrogate recovery (%R)
300142	8.3b-1-Ts-1-10	HMX 1 3 5-Trinitrobenzene 2.4 6-Trinitrotoluene Tetryl Nitroglycerin PETN	J (all detects) J (all detects) J (all detects) J (all detects) J (all detects) J (all detects)	A	Matrix spike/Matrix spike duplicates (%R)
300142	8 3b-1-Ts-1-5	HMX RDX Tetryl Nitrobenzene 2 4-Dinitrotoluene 2-Am-DNT 2 6-Dinitrotoluene 4-Am-DNT 2-and 4-Nitrotoluene 3-Nitrotoluene Nitroglycerin PETN	J (all detects) UJ (all non-detects)	P	Internal standards (area)

SDG	Sample	Compound	Flag	A or P	Reason
300142	8.1a-1-Ts-1-10	1 3.5-Trinitrobenzene 1 3-Dinitrobenzene 2 4 6-Trinitrotoluene Tetryl Nitrobenzene 2 4-Dinitrotoluene 2-Am-DNT 2 6-Dinitrotoluene 4-Am-DNT 2-and 4-Nitrotoluene 3-Nitrotoluene Nitroglycerin PETN	J (all detects) UJ (all non-detects)	P	Internal standards (area)
300142	8.3b-1-Ts-1-10	HMX RDX	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	P	Internal standards (area)

Fort Irwin
Nitroaromatics and Nitramines - Laboratory Blank Data Qualification Summary - SDG 300142

SDG	Sample	Compound	Modified Final Concentration	A or P
300142	8 1a-1-Ts-1-10	Nitrobenzene	0.29U ug/Kg	A
300142	8.1a-1-Ts-1-15	Nitrobenzene	0 33U ug/Kg	A
300142	8.3b-1-Ts-1-5	Nitrobenzene	0.31U ug/Kg	A
300142	8 3b-1-Ts-1-10	Nitrobenzene	0.25U ug/Kg	A
300142	8.3b-1-Ts-1-2.5	Nitrobenzene	0 25U ug/Kg	A

Fort Irwin
Nitroaromatics and Nitramines - Field Blank Data Qualification Summary - SDG 300142

No Sample Data Qualified in this SDG

APPENDIX E

CHEMICAL QUALITY ASSURANCE REPORT

CESPK-ED-EH
MEMORANDUM

03 December 1999

FOR: Curtis Payton, Project Manager
FROM: Mark Imhoff, Laboratory Data Consultants, Inc.

SUBJECT: Chemical Quality Assurance Report (CQAR), FTIR-07 & FTIR-08, National Training Center (NTC), Fort Irwin, CA
Contract No : DACA05-97-D-0026, DO – 27

The attached document is the CQAR for the samples collected on 26 and 27 June 1998 for this project. Five soil quality assurance (QA) split samples were collected for this effort. The samples were analyzed for semivolatile organic compounds (SVOCs) by EPA Method 8270B, organochlorine pesticides (OCPest) and polychlorinated biphenyls (PCBs) by EPA Method 8080, organochlorine herbicides (OCHerb) by EPA Method 8151A, total recoverable petroleum hydrocarbons by EPA Method 418.1, metals by EPA Method 6010A, mercury by EPA Method 7471, hexavalent chromium by EPA Method 7196, pH by EPA Method 9045, ammonia-nitrogen by EPA Method 350.3, nitrate and nitrite by EPA Method 300.0. The primary laboratory was Quanterra Environmental Services (Quanterra). The QA laboratory was Curtis & Tompkins, Ltd. (C&T). The QA laboratory subcontracted the nitrate and nitrite analysis to Clayton Laboratory Services (Clayton) and the OCHerb to Agriculture and Priority Pollutants Laboratories, Inc. (APPL). The QA split data were considered acceptable for the intended purposes.

Details regarding the data review are described in the attached report. For further information please consult with the USACE Sacramento District Chemist or the Project Chemist.

The point of contact for this report is Mr. Mark Imhoff, Senior Chemist, Laboratory Data Consultants, Inc. (LDC), at 650 University Avenue, Suite 117, Sacramento, CA 95825, (916) 649-8740

cc: Pam Wehrmann, District Chemist, USACE
Nicole Ortega, Project Chemist, USACE
Julia Halsne, Senior Scientist, LDC

CHEMICAL QUALITY ASSURANCE REPORT
FTIR-07 & FTIR-08
NATIONAL TRAINING CENTER
FORT IRWIN, CALIFORNIA

DECEMEBER 1999

Prepared for:

U.S. Army Corps of Engineers-Sacramento District (USACE)
Environmental Engineering Section
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Contract Number: DACA05-97-D-0026
Delivery Order Number: 0027

Mark Imhoff, Senior Chemist
Laboratory Data Consultants, Inc.

TABLE OF CONTENTS

Section		Page
ES	EXECUTIVE SUMMARY	6
1.0	PROJECT DESCRIPTION	8
2.0	SUMMARY OF DATA QUALITY OBJECTIVES	11
3.0	QUALITY ASSURANCE SAMPLE HANDLING	12
4.0	DATA REVIEW SUMMARY	13
5.0	DATA QUALITY ASSESSMENT	15
6.0	DATA COMPARISON SUMMARY	21
7.0	REFERENCES	24

APPENDICES

A QUALITY ASSURANCE SPLIT SAMPLE RESULTS

LIST OF TABLES

1-1 SAMPLE CROSS REFERENCE SUMMARY

1-2 PRACTICAL QUANTITATION LIMIT COMPARISON

6-1 DATA RESULTS COMPARISON SUMMARY

6-2 CRITERIA FOR COMPARING PRIMARY AND QA SPLIT SAMPLE RESULTS

LIST OF ACRONYMS

APPL	Agriculture and Priority Pollutants Laboratory, Inc.
ARMY	U.S. Department of the Army
CA	California
C&T	Curtis & Tompkins, Ltd.
CDAP	Chemical Data Acquisition Plan
COPC	Chemicals of Potential Concern
CQAR	Chemical Quality Assurance Report
DERP	Defense Environmental Restoration Program
DOD	Department of Defense
DUP	Duplicate
FS	Feasibility Study
IRP	Installation Restoration Program
LCS	Laboratory Control Sample
LDC	Laboratory Data Consultants, Inc.
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NA	Not Applicable
NCP	National Contingency Plan
PARSONS	Parsons Engineering Science, Inc.
PARCC	Precision, Accuracy, Representativeness, Comparability, and Completeness
PQL	Practical Quantitation Limit
QA	Quality Assurance
RPD	Relative Percent Difference
SDG	Sample Delivery Group
SVOCs	Semivolatile Organic Compounds
TRPH	Total Recoverable Petroleum Hydrocarbons
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
ug/L	Micrograms per Liter
mg/L	Milligrams per Liter

EXECUTIVE SUMMARY

This Chemical Quality Assurance Report (CQAR) has been prepared by Laboratory Data Consultants, Inc. (LDC) for the U.S. Corps of Engineers-Sacramento District (USACE) for the investigation FTIR-07 & FTIR-08 at the National Training Center, Fort Irwin California (CA). The purpose of this CQAR is to provide the data user with a comparison of results from a third party, independent laboratory against primary laboratory results. This review is achieved through the inspection and analysis of quality assurance (QA) split sample results, and through an examination of the corresponding project sample data

The primary project laboratory was Quanterra Environmental Services (Quanterra), located in Sacramento, CA. The QA laboratory was Curtis & Tompkins, Ltd (C&T) located in Berkeley, CA. The QA laboratory subcontracted the nitrate/nitrite analyses to Clayton Laboratory Services located in Pleasanton, CA. The QA laboratory subcontracted the organochlorine herbicide analyses to Agriculture and Priority Pollutants Laboratories, Inc (APPL) located in Fresno, CA. The contractor for this project was Montgomery Watson located in Walnut Creek, CA

This CQAR follows the USACE guidance provided in "Chemical Quality Assurance for HTRW Projects", EM 200-1-6 (USACE, 1997). Data were reviewed based on the "Chemical Data Acquisition Plan for the Site Inspection of 31 Sites at the National Training Center, Fort Irwin (CDAP) (Parsons, 1995), "National Functional Guidelines for

Organic Data Review" (EPA, 1994a), "National Functional Guidelines for Inorganic Data Review" (EPA, 1994b), and the appropriate method references (EPA, 1986).

The data were considered acceptable for intended purposes. The data quality evaluation is presented in Section 5.0. Minor qualifications were required for the OCPest and metals analyses. However, the data quality objectives (summarized in Section 2.0) were met.

1.0 PROJECT DESCRIPTION

The USACE is performing investigations related to Fort Irwin under the authority of the U.S. Department of the Army (Army) Installation Restoration Program (IRP). The purpose of the IRP is to assess past hazardous waste disposal and spill sites on Army installations and to develop remedial action plans which are consistent with the National Contingency Plan (NCP) for those sites which pose a threat to human health or the environment.

The primary laboratory was Quanterra Environmental Services (Quanterra), located in Sacramento, CA. The QA laboratory was Curtis & Tompkins, Ltd. (C&T) located in Berkeley, CA. The QA laboratory subcontracted the nitrate and nitrite analyses to Clayton Laboratory Services (Clayton) located in Pleasanton, CA. The QA laboratory subcontracted the organochlorine herbicide (OCHerb) analyses to Agriculture and Priority Pollutants Laboratories, Inc. (APPL) located in Fresno, CA. The contractor for this project was Montgomery Watson located in Walnut Creek, CA.

The CQAR covers the five soil QA split samples collected on 26 and 27 June 1998. The QA split samples were analyzed for semivolatile organic compounds (SVOCs) by EPA Method 8270B, organochlorine pesticides and polychlorinated biphenyls (OCPest/PCBs) by EPA Method 8080, OCHerbs by EPA Method 8151A, total recoverable petroleum hydrocarbons (TRPH) by EPA Method 418.1, metals by EPA Method 6010A, mercury by EPA Method 7471, hexavalent chromium by EPA Method 7196, pH by EPA Method

9045, ammonia-nitrogen by EPA Method 350.3, nitrate by EPA Method 300.0 & nitrite by EPA Method 300.0. The sample list is presented in Table 1-1. The PQLs are presented in Table 1-2. The data comparison is presented in Table 6-1. Section 2.0, Summary of Data Quality Objectives, summarizes the data quality objectives for this project event; Section 3.0, Quality Assurance Sample Handling, summarizes the QA sample handling activities for this project event; Section 4.0, Data Review Summary, summarizes the overall data review process and results; Section 5.0, Data Quality Assessment, presents details regarding the data quality review results by method; Section 6.0, Data Comparison Summary; presents the results of the comparison between primary and QA split sample results by method, Section 7.0, References, presents the list of reference documents used to generate this CQAR.

This CQAR follows the USACE guidance provided in "Chemical Quality Assurance for HTRW Projects", EM 200-1-6 (USACE, 1997). Data were reviewed based on the "Chemical Data Acquisition Plan for the Site Inspection of 31 Sites at the National Training Center, Fort Irwin (CDAP) (Parsons, 1995), "National Functional Guidelines for Organic Data Review" (EPA, 1994a), "National Functional Guidelines for Inorganic Data Review" (EPA, 1994b), and the appropriate method references. In addition to these guidelines, the data reviewer also used professional judgement regarding evaluation of primary and QA split samples results and confirmation of the detectable concentrations, as described in Section 6.0.

There were no restrictions placed on the data generated for this field effort.

2.0 SUMMARY OF DATA QUALITY OBJECTIVES

The main objective of the investigation was to assess past hazardous waste disposal and spill sites on Army installations and to develop remedial action plans, which are consistent with the NCP for those sites which pose a threat to human health or the environment

The DQOs, as described in the CDAP (Parsons 1995) are as follows:

- Confirm or deny the presence of contamination at each site or sub-site.
- Identify and characterize maximum concentrations of contaminants to support human and ecological risk assessment screenings
- Evaluate the potential for past, present, or future migration of detected contaminants to groundwater.
- For sites where remediation is indicated, assess whether contamination is of limited extent and easily defined.
- For sites where remediation may be necessary and contamination is extensive and/or difficult to define, provide sufficient data to support baseline risk assessment.
- For sites where remediation is necessary, provide data to support Feasibility Studies (FSs).

3.0 QUALITY ASSURANCE SAMPLE HANDLING

The QA split samples were separate field duplicate samples that were submitted to the QA laboratory. QA split samples were collected as five percent of the total sampling effort by matrix. Generally, QA samples are collected for the first sample and every twentieth sample, thereafter. If information was available regarding areas of particular interest at a site is available, the distribution of the QA samples was placed at the discretion of the field personnel with concurrence of the USACE.

The sample chain-of-custody, packaging, and transportation procedures were outlined in Section 6.0 of the CDAP (Parsons, 1995). There were no nonconformances noted with QA sampling activities for this field effort.

The preservation and holding time requirements were specified in Table 6.1.1-1 of the CDAP (Parsons, 1995). The laboratories provide information regarding holding time, sample condition upon receipt, and sample storage requirement compliance in the case narratives and support documentation provided in the data packages. There were no nonconformances identified with the QA sample packaging, transportation, storage, or holding times.

4.0 DATA REVIEW SUMMARY

Through the data review process, the QA split data were evaluated for acceptable quality and frequency of collection, based on the parameters of precision, accuracy, representativeness, completeness, and comparability (PARCC). The achievement of these parameters is discussed in detail in Section 5.0 of this CQAR.

Table 1-1 presents a cross-reference summary of the primary samples, QA split samples, and analytical methods performed.

Based on the QA split sample QC review presented in Section 5.0, the results for the QA split samples were considered acceptable for the intended purposes. The QA split sample results confirmed the primary sample results with the exception of total recoverable petroleum hydrocarbons as described in Section 6.0.

There were no non-routine occurrences with regard to the QA split sampling or analysis during execution of this effort with the exceptions noted above. Details regarding QC nonconformances are described in Section 5.0. Details regarding QA split and primary samples results comparison are provided in Section 6.0.

No corrective actions were necessary with regard to the QA split sampling or analysis during the execution of this project with the following exceptions (described in detail in Section 5.0):

- The QA laboratory performed sample extraction two and three days past holding time for SVOC (EPA Method 8270B) and OCPest/PCBs (EPA Method 8080).
- The QA laboratory did not perform the corrective action required based on QC nonconformances for OCPest/PCB analyses.
- The QA laboratory did not meet all the CDAP-specified PQLs for SVOCs, OCPest/PCBs, OCHerbs, and wet chemistry parameters.
- Primary sample 8.3a-1-Td-1-2.5 analysis included VOCs by EPA Method 8260, and nitroaromatics & nitramines by EPA Method 8321. The QA split was not analyzed for these parameters. The QA sample chain-of-custody forms did not indicate that these analyses were required.
- All primary sample analysis included CS gas analysis (orthochlorobenzaldehyde). The QA split samples were not analyzed for this parameter. The QA sample chain-of-custody forms did not indicate that these analyses were required.
- The QA laboratory (Clayton) performed nitrate and nitrite analysis by method 300.0. The primary laboratory analyzed the samples for nitrate plus nitrite as N according to the CDAP by EPA Method 353.2.

These nonconformances should be addressed with the QA laboratory prior to initiation of any new work for this project.

5.0 DATA QUALITY ASSESSMENT

The QA laboratory reported QA split sample data in one sample delivery group (SDG) The samples consisted of five soil samples for SVOCs by EPA Method 8270B, OCPest/PCBs by EPA Method 8080, OCHerb by EPA Method 8151A, TRPH by EPA Method 418.1, metals by EPA Method 6010A, mercury by EPA Method 7471, hexavalent chromium by EPA Method 7196, pH by EPA Method 9045, ammonia by EPA Method 350.3, and nitrate and nitrite by EPA Method 300.0

The overall data review is discussed in Section 4.0. Section 5.0 summarizes the data quality assessment by method. The QA split sample analytical data reports are presented in Appendix A. The data were reviewed based on the "Chemical Data Acquisition Plan for the Site Inspection of 31 Sites at the National Training Center, Fort Irwin (Parsons, 1995), "National Functional Guidelines for Organic Data Review" (EPA, 1994a), "National Functional Guidelines for Inorganic Data Review" (EPA, 1994b), and the appropriate method references Based on the review presented in the subsections below, the results for the QA split samples were considered acceptable for the intended purposes. The QA split sample results confirmed the primary sample results with the exceptions noted below and in Section 6.0.

As indicated in Section 4.0, the primary laboratory analyzed the samples for VOCs by EPA Method 8260, explosives by EPA Method 8321, and CS gas Because the QA

laboratory did not perform these analyses, there is no data evaluation presented in this Section.

5.1 SVOCs

All SVOC data were assessed to be valid; however, the data were qualified based on holding time nonconformances, as described below.

All calibration standard results met the criteria. The associated method blank did not contain contamination.

Holding times were not met for the extraction and analysis of the QA split samples. The samples were extracted outside of holding time by two and three days for all analyses. There were no detectable concentrations of SVOCs reported. All SVOC results were qualified as estimated (UJ). This was a contract compliance nonconformance.

There were no surrogate recoveries outside the control limits for this analysis. Matrix spike/matrix spike duplicates (MS/MSDs) were analyzed with every batch of samples. Recoveries and relative percent difference (RPDs) were within acceptance limits. LCS recoveries met the specified acceptance criteria.

The data are considered usable for the intended purposes for SVOCs analysis.

5.2 Organochlorine Pesticides and PCBs

All OCPest/PCB data were assessed to be valid; however, the data were qualified based on extraction holding times, continuing calibration, and matrix spike nonconformances, as described below.

Holding times were not met for the extraction and analysis of the QA split samples. The samples were extracted outside of holding time by two and three days for all analyses. There were no detectable concentrations for OCPest/PCBs reported. All OCPest/PCB results were qualified as estimated (UJ). This was a contract compliance nonconformance.

All calibration standard results met the criteria with the following exception:

- Percent differences (%Ds) were outside of QC limits for heptachlor, heptachlor epoxide A, endosulfan I, dieldrin, 4,4'-DDT and aroclor 1016 in the continuing calibration. All sample results were non-detects and were qualified as estimated (UJ).
- Re-extraction and re-analysis was not performed as per the CDAP corrective action procedures prescribed for this nonconformance. This was a contract compliance nonconformance.

The associated method blank did not contain contamination. There were no surrogate recoveries outside the control limits for this analysis.

Matrix spike/matrix spike duplicates (MS/MSDs) were analyzed with every batch of samples. Recoveries and relative percent difference (RPDs) were within acceptance limits with the following exception:

- The percent recovery of 4,4'DDT (63%, 59%) in the Sample 8.3A-1-Td-1-2.5MS/MSD was below QC limit (65-135%). The non-detect result for 4,4'-DDT for sample 8.3A-1-Td-1-2.5 was qualified as estimated (UJ). The MS/MSD was not re-prepared and re-analyzed as per the CDAP corrective action procedures prescribed for this nonconformance. This was a contract compliance nonconformance.

LCS recoveries met the specified acceptance criteria.

The data are considered usable for the intended purposes for OCPest/PCBs analysis.

5.3 Organochlorine Herbicides

All OCHerb data were assessed to be valid, no data qualifications were necessary.

All calibration standard results met the criteria. The associated method blank did not contain contamination. Holding times were met for the analysis of the sample. The MS/MSDs were analyzed with every batch of samples. Recoveries and RPDs were within acceptance limits. LCS recoveries and RPDs met the specified acceptance criteria.

The data are considered usable for the intended purposes for OCHerbs analysis.

5.4 Metals

All metals data were assessed to be valid with limited data qualified based on QC nonconformances. The data were qualified based on serial dilution recoveries, as described below. The results were considered acceptable with the qualifications described below.

All calibration standard results met the criteria. The associated method blank did not contain contamination. Holding times were met for the analysis of the sample. The MS/laboratory duplicates (DUPs) were analyzed with every batch of samples. Recoveries and RPDs were within acceptance limits.

The serial dilution recoveries were within acceptance limits with the following exceptions:

- In the serial dilution of sample 7d-1-Tdd-2.5, the recoveries of arsenic, chromium, copper, lead, thallium, zinc, iron, manganese and sodium were outside of acceptance criteria. No analytical spike was performed. All results for these analytes were qualified as estimated (UJ/J).

LCS recoveries and RPDs met the specified acceptance criteria.

The data are considered usable for the intended purposes for metals analysis.

5.5 Wet Chemistry

All ammonia-nitrogen, hexavalent chromium, TRPH, nitrate-N, and nitrite-N data were assessed to be valid.

All calibration standard results met the criteria. The associated method blanks did not contain contamination. Holding times were met for the analysis of the sample. The MS/MSDs were analyzed with every batch of samples. Recoveries and RPDs were within acceptance limits. LCS recoveries and RPDs met the specified acceptance criteria.

The data are considered usable for the intended purposes for wet chemistry analyses.

6.0 DATA COMPARISON SUMMARY

The data generated met the contract specifications outlined in the CDAP (Parsons 1995) and described in Sections 4.0 and 5.0

Table 6-1 presents a summary of the detectable analytical results for primary samples and the associated QA split samples with the resulting precision. The USACE guidance "Chemical Quality Assurance for HTRW Projects" (USACE, 1997) and the USACE Cold Regions & Environmental Research Laboratory "Comparison Criteria for Environmental Chemical Analyses of Split Samples Sent to Different Laboratories – Corps of Engineers Archived Data" (USACE, 1996) assessment logic were used to evaluate the QA split and primary sample precision results. The USACE guidance (USACE 1996) specifies the procedures for comparison of QA and primary data. Table 6-2 outlines the USACE criteria used for comparing field QC and QA sample data.

Data were not qualified based on QA split results; however, care should be taken when using results that indicated results greater than assessment criteria

The results of the comparison between primary and QA split sample results are provided below: The comparison results are separated into minor and major disagreements as defined in the USACE guidance (USACE, 1996). Where there is a disagreement involving the QA data, both sets of data were evaluated to ascertain if either had weaknesses in its supporting laboratory QC data (i.e., missing or out-of-control data). If

the QA laboratory QC data was in control, then the QA sample data was considered the "more correct", regardless of the status of the primary laboratory QC data There is also a possibility that the differences between the QA and primary data could be due to sample heterogeneity. This explanation was used as a last resort or when supporting information was available. The major disagreements occurred for metals and the wet chemistry parameters. Table 6-1 summarizes the comparison of the QA and primary data results

For SVOCs, OCPest/PCBs, and OCHerbs all compounds were non-detect; therefore, comparison of results was not evaluated for the QA and primary samples.

For Metals the majority of detected analytes indicated acceptable comparison results

- Sample 8.3a-1-Td-1-2.5, 8.3c-1-Td-1-5, and 8.1a-2-Td-1-5 indicated major disagreements for the arsenic and thallium between the QA and primary samples. The primary sample had high level reporting limits for these analytes (10 times the reporting limit for the QA split sample) The results for the QA split samples for these analytes were considered more accurate.
- Sample 7d-2Td-1-0.5 indicated major disagreements for the copper, thallium, and zinc between the QA and primary samples The primary result for copper was 17 times and zinc was 6 times the concentration in the QA sample. The reporting limit for thallium for the primary samples was 86 times the amount reported in the QA sample. The results for zinc in the primary sample were 6.1 times the concentration detected in the QA split sample. The results for the QA split samples for these analytes were considered more accurate

- Sample 7d-1-Tdd-1-2.5 indicated major disagreements for thallium and zinc between the QA and primary samples. The reporting limit for thallium for the primary samples was 79 times the amount reported in the QA sample. The results for zinc in the primary sample were 7.4 times the concentration detected in the QA split sample. The results for the QA split samples for these analytes were considered more accurate.

The wet chemistry analyses indicated agreement between the primary and QA split results with two exceptions.

- One TRPH sample (8.3a-1-Td-1-2.5) indicated a major disagreement between results of six times difference. The result for TRPH was 160 mg/kg and <26 mg/kg for the primary and QA split samples, respectively. This discrepancy was attributed to the heterogeneity of the sample. For conservative purposes, the primary sample result was considered more accurate. However, this analysis for should be monitored for further performance issues.
- Ammonia indicated a major disagreement between the primary and QA split results in three samples (8.3a-1-Td-1-2.5, 8.3c-1-Td-1-5, and 7d-1-Tdd-1-2.5). The ammonia results for the primary samples were considered estimated because they were below the PQL. Because the QA laboratory did not report values below the PQL (0.19, 0.15, and 0.16 mg/kg). All the results for the QA samples were nondetect with PQLs of 11, 10, and 11 mg/kg. The primary sample results were considered acceptable.
- The primary laboratory analyzed nitrate plus nitrite by EPA Method 353.1 and the QA laboratory analyzed samples for nitrate and nitrite by EPA Method 300.0. The results

for nitrate and nitrite were added to provide a comparison of these analyses The results indicated acceptable comparability between the primary and QA laboratories

The primary and QA laboratory PQLs for some analytes did not meet the CDAP required PQLs, as indicated in Table 1-2. The results for SVOCs, OCPest/PCBs, OCHerbs were all nondetect for the primary and QA laboratories; however, the PQLs were considerably higher than the CDAP PQLs (two- to 10-fold). Out of 25 metals, 10 for the primary laboratory and two for the QA laboratory were greater than the PQLs in the CDAP. These nonconformances should be assessed against the data quality objectives to insure that adequate sensitivity was achieved for this project.

7.0 REFERENCES

USACE, 1997 Chemical Quality Assurance Reports for HTRW Projects, EM 200-1-6, USACE, October 1997.

USACE, 1996 CRREL Special Report No. 96-9, "Comparison Criteria for Environmental Chemical Analyses of Split Samples Sent to Different Laboratories – Corps of Engineers Archived Data", Grant, C G., Jenkins, T F., and Mudambi, A R., USACE Cold Regions & Environmental Research Laboratory, Hanover NH, May 1996.

USEPA, 1986 Test Methods for Evaluating Solid Waste, SW-846, Physical and Chemical Methods, Update I, II, and III, US EPA December 1998.

USEPA, 1994a National Functional Guidelines for Organic Data Review, USEPA, February 1994.

USEPA, 1994b National Functional Guidelines for Inorganic Data Review, USEPA, February 1994.

Parsons, 1995 Chemical Data Acquisition Plan for the Site Inspection and Remedial Investigation of 31 Sites at the National Training Center, Fort Irwin, California.

TABLE 1-1
SAMPLE IDENTIFICATION CROSS REFERENCE SUMMARY
U.S. ARMY
NATIONAL TRAINING CENTER (FTIR07 08)
FORT IRWIN, CALIFORNIA

Field Identification	Date Collected	Primary Laboratory Identification	QA Laboratory Identification
8.3a-Td-1-2.5	06/26/1999	300141-0012	134393-001
8.3c-1-Td-1-5	06/26/1999	300141-0011	134393-002
8.1a-2-Td-1-5	06/27/1999	300141-0021	134393-003
7d-2-Td-1-0.5	06/27/1999	300141-0016	134393-004
7d-1-Tdd-1-2.5	06/27/1999	300141-0015	134393-005

QA: Quality Assurance

TABLE 1-2
PRACTICAL QUANTITATION LIMIT COMPARISON
NATIONAL TRAINING CENTER (FTIR07 08)
FORT IRWIN, CALIFORNIA

Parameter	CDAP PQL	Primary Laboratory PQL	QA Laboratory PQL
SVOC (ug/kg)			
All analytes	170	**340 - 1600**	**330 - 1700**
OCPest/PCB (ug/kg)			
All analytes	0.33 - 6.7	**0.85 - 34**	**3.0 - 30**
OCHerbicides (ug/kg)			
2,4-D	10	**25**	**200**
2,4,5-DB	10	**100**	**400**
2,4,5-T	5	5.1	**40**
2,4,5-TP (Silvex)	5	5.1	**40**
Dalapon	NA	100	2000
Diacamba	1	**10**	**40**
Dichlorprop	2	**25**	**200**
Dinoseb	2	**25**	**100**
MCPA	500	**5100**	**40000**
MCPP	500	**5100**	**40000**
Wet Chemistry (mg/kg)			
Ammonia	0.5	0.5	**10**
Nitrate plus Nitrite	0.1	**0.25**	**NA**
Nitrate	NA	NA	**1**
Nitrite	NA	NA	**0.5**
Hexavalent Chromium	1.0	0.05	0.05
TRPH	100	10	26
Metals (mg/kg)			
Aluminum	30	10	10
Antimony	20	6	3
Arsenic	1	**10**	0.25
Barium	1	1	0.5
Beryllium	0.3	0.2	0.1
Cadmium	0.8	0.5	0.25
Calcium	15	**50**	**25**
Chromium	3	1	0.5
Cobalt	4	1	1
Copper	2	2	0.5
Iron	8	**10**	5

TABLE 1-2
PRACTICAL QUANTITATION LIMIT COMPARISON
NATIONAL TRAINING CENTER (FTIR07 08)
FORT IRWIN, CALIFORNIA

Parameter	CDAP PQL	Primary Laboratory PQL	QA Laboratory PQL
Lead	1	**5**	0.15
Magnesium	20	**50**	**25**
Manganese	0.5	**1**	0.5
Molybdenum	8	2	1
Mercury	0.1	NA	0.04
Nickel	8	4	1
Potassium	300	**500**	25
Phosphorous	40	NA	5
Selenium	1	**20**	0.25
Silver	5	1	0.5
Sodium	40	**500**	25
Thallium	2	**200**	0.25
Vanadium	1.5	1	0.5
Zinc	7	2	1

CDAP: Chemical Data Acquisition Plan
NA: Not Analyzed
PQL: Practical Quantitation Limit
QA: Quality Assurance

Notes:
Bold = PQL greater than the CDAP PQL
The PQLs presented in this table are a subset of the entire list in the CDAP.
Ranges are presented for SVOCs and OCPest/PCBs because these analytes were all nondetect.

TABLE 6-1
PRECISION RESULTS FOR PRIMARY AND QA SPLIT SAMPLES
NATIONAL TRAINING CENTER (FTIR07 08),
FORT IRWIN

Sample Parameter	8 3a-1-Td-1-2.5 Primary	QA Split	Difference Factor	Comparison Results	8 3c-1-Td-1-5 Primary	QA Split	Difference Factor	Comparison Results
VOCs (ug/kg)								
All Analytes	ND	NA	NA	NA	NA	NA	NA	NA
OCPesticides (ug/kg)								
All Analytes	ND	ND	NA	NA	ND	ND	NA	NA
OCHerbicides (ug/kg)								
All Analytes	ND	ND	NA	NA	ND	ND	NA	NA
Explosives (ug/kg)								
All Analytes	ND	NA	NA	NA	NA	NA	NA	NA
SVOCs (ug/kg)								
All Analytes	ND	ND	NA	NA	ND	ND	NA	NA
General Inorganics (mg/kg)								
Ammonia as N	0 19 J	<11	58	Major	0.15 J	<10	67	Major
pH	9.7	7 8	1.2	Acceptable	8 5	7.9	1 1	Acceptable
Nitrate+Nitrite as N (a)	0.3	<0 5	1.7	Acceptable	0.91	2 0	2 2	Acceptable
Hexavalent Chromium	NA	NA	NA	NA	<0.05	<0 052	NA	NA
TRPH	160	<26	6.2	Major	<10	<26	NA	NA
Metals (mg/kg)								
Aluminum	3130	3700	1.2	Acceptable	9070	6300	1 4	Acceptable
Antimony	<6 3	<3 1	NA	NA	<6.1	<3 1	NA	NA
Arsenic	<10 5	1.3	8.1	Major	<10 2	2 2	4 6	Major
Barium	37.3	36	1 0	Acceptable	72 8	57	1 3	Acceptable
Beryllium	0 21	0 23	1 1	Acceptable	0.48	0 35	1 4	Acceptable
Cadmium	<0.53	<0 25	NA	NA	<0.51	<0 26	NA	NA
Calcium	2,030	2600	1 3	Acceptable	5,940	4100	1 4	Acceptable
Chromium	3 2	2 9	1.1	Acceptable	8 2	5 4	1 5	Acceptable
Cobalt	1.9	2 2	1 2	Acceptable	4 3	3.6	1 2	Acceptable
Copper	10.6	10	1.1	Acceptable	10 8	8 8	1 2	Acceptable
Iron	5170	4000	1 3	Acceptable	10700	7300	1 5	Acceptable
Lead	3 4 J	2.5	1 4	Acceptable	7.4	3 7	2 0	Acceptable
Magnesium	1,250	1,400	1 1	Acceptable	2,850	2,300	1 2	Acceptable
Manganese	147	140	1 1	Acceptable	279	210	1 3	Acceptable
Molybdenum	<2 1	<1 0	NA	NA	<2.0	<1 0	NA	NA
Nickel	2.9 J	3 0	1.0	Acceptable	7.4	4 6	1 6	Acceptable
Potassium	1,050	1,100	1 0	Acceptable	2,280	1,700	1 3	Acceptable
Selenium	<21 1	<0 25	NA	NA	<20 4	<0 26	NA	NA
Silver	<1 1	<0 51	NA	NA	<1.0	<0 51	NA	NA
Sodium	342 J	440	1 3	Acceptable	102 J	71	1 4	Acceptable
Thallium	<211	2 5	84	Major	<204	4 9	42	Major
Vanadium	7.9	6 7	1.2	Acceptable	18 3	14	1 3	Acceptable
Zinc	19.9	19	1.0	Acceptable	32	26	1 2	Acceptable

(a) The detected QA split results are for nitrate only by EPA Method 300 0. The non-detect reporting limit is for nitrite by EPA Method 300 0.
NA: Not Analyzed
QA: Quality Assurance
TRPH: Total Recoverable Petroleum Hydrocarbons
VOCs: Volatile Organic Compounds

TABLE 6-1
PRECISION RESULTS FOR PRIMARY AND QA SPLIT SAMPLES
NATIONAL TRAINING CENTER (FTIR07 08),
FORT IRWIN

Sample Parameter	8 1a-2-Td-1-5 Primary	QA Split	Difference Factor	Comparison Results	7d-2-Td-1-0 5 Primary	QA Split	Difference Factor	Comparison Results
VOCs (ug/kg)								
All Analytes	NA	NA	NA	NA	ND	NA	NA	NA
OCPesticides (ug/kg)								
All Analytes	ND	ND	NA	NA	ND	ND	NA	NA
OCHerbicides (ug/kg)								
All Analytes	ND	ND	NA	NA	ND	ND	NA	NA
Explosives (ug/kg)								
All Analytes	NA	NA	NA	NA	NA	NA	NA	NA
SVOCs (ug/kg)								
All Analytes	ND	ND	NA	NA	ND	ND	NA	NA
General Inorganics (mg/kg)								
Ammonia as N	<0 53	<10	NA	NA	<0 54	<11	NA	NA
pH	7 7	7.8	1 0	Acceptable	8.8	7.0	1 3	Acceptable
Nitrate+Nitrite as N (a)	1.5	3	2 0	Acceptable	0 18 J	<0 5	2 8	Acceptable
Hexavalent Chromium	<0 05	<0 052	NA	NA	<0 05	<0.054	NA	NA
TRPH	<11	<26	NA	NA	<11	<27	NA	NA
Metals (mg/kg)								
Aluminum	4790	4800	1 0	Acceptable	4030	3900	1 0	Acceptable
Antimony	<6 3	<3 0	NA	NA	<6.4	<3 3	NA	NA
Arsenic	<10 6	1 2	8 8	Major	<10.7	<1.1	NA	NA
Barium	45	75	1 7	Acceptable	45	43	1 0	Acceptable
Beryllium	0 26	0.3	1 2	Acceptable	0 2 J	0 18	1 1	Acceptable
Cadmium	<0.53	<0.25	NA	NA	<0 54	<0 27	NA	NA
Calcium	754	760	1 0	Acceptable	1,750	1300	1 3	Acceptable
Chromium	3 8	7 3	1 9	Acceptable	3 6	2 9	1 2	Acceptable
Cobalt	2 4	2.4	1.0	Acceptable	1 9	2.4	0 8	Acceptable
Copper	9 1	6 3	1 4	Acceptable	88.6	5.2	17.0	Major
Iron	5,020	4,300	1 2	Acceptable	5930	4400	1.3	Acceptable
Lead	10.8	4.4	2.5	Disagree	5.2 J	1.9	2 7	Disagree
Magnesium	1,790	1,800	1 0	Acceptable	1,890	1,800	1 1	Acceptable
Manganese	170	160	1.1	Acceptable	149	140	1.1	Acceptable
Molybdenum	<2 1	0 99	2 1	Disagree	1 0 J	<1 1	1.0	Acceptable
Nickel	3 3 J	3.7	0 9	Acceptable	3 5 J	2.8	1 3	Acceptable
Potassium	1,280	1,200	1 1	Acceptable	1,350	1,300	1 0	Acceptable
Selenium	<21 1	<0.25	NA	NA	<21 5	<0 27	NA	NA
Silver	<1 1	<0.5	NA	NA	<1.1	<0 54	NA	NA
Sodium	81.4 J	80	1 0	Acceptable	53 J	41	1 3	Acceptable
Thallium	<211	3.6	59 0	Major	<215	2 5	86	Major
Vanadium	7 3	6.5	1.1	Acceptable	9	7 2	1 3	Acceptable
Zinc	40.1	24	1.7	Acceptable	115	19	6 1	Major

(a) The detected QA split results are fo
NA: Not Analyzed
QA: Quality Assurance
TRPH: Total Recoverable Petroleum H
VOCs: Volatile Organic Compounds

TABLE 6-1
PRECISION RESULTS FOR PRIMARY AND QA SPLIT SAMPLES
NATIONAL TRAINING CENTER (FTIR07 08),
FORT IRWIN

Sample Parameter	7d-1-Tdd-1-2 5 Primary	QA Split	Difference Factor	Comparison Results
VOCs (ug/kg)				
All Analytes	NA	NA	NA	NA
OCPesticides (ug/kg)				
All Analytes	ND	ND	NA	NA
OCHerbicides (ug/kg)				
All Analytes	ND	ND	NA	NA
Explosives (ug/kg)				
All Analytes	NA	NA	NA	NA
SVOCs (ug/kg)				
All Analytes	ND	ND	NA	NA
General Inorganics (mg/kg)				
Ammonia as N	0 16 J	<11	69	Major
pH	9.1	7.3	1 2	Acceptable
Nitrate+Nitrite as N (a)	0 69	<0 5	1 4	Acceptable
Hexavalent Chromium	NA	NA	NA	NA
TRPH	<11	<27	NA	NA
Metals (mg/kg)				
Aluminum	7750	8700	1.1	Acceptable
Antimony	<6 8	<3.1	NA	NA
Arsenic	7.1 J	2 9	2.4	Disagree
Barium	203	100	2.0	Acceptable
Beryllium	0.41	<0 37	1 1	Acceptable
Cadmium	<0 57	<0.26	NA	NA
Calcium	27,700	21000	1 3	Acceptable
Chromium	6 5	6	1.1	Acceptable
Cobalt	3 1	3 4	1.1	Acceptable
Copper	236	12	19 7	Major
Iron	7910	7000	1 1	Acceptable
Lead	4.8	3 1	1 5	Acceptable
Magnesium	5,370	5,000	1 1	Acceptable
Manganese	163	140	1 2	Acceptable
Molybdenum	0.68 J	<1.0	1 5	Acceptable
Nickel	6 5	5 3	1 2	Acceptable
Potassium	2,100	2,100	1 0	Acceptable
Selenium	<22 8	<0 26	NA	NA
Silver	<1 1	<0 52	NA	NA
Sodium	449 J	370	1 2	Acceptable
Thallium	<228	2.9	79 0	Major
Vanadium	14.5	15	1 0	Acceptable
Zinc	199	27	7.4	Major

(a) The detected QA split results are fo
NA: Not Analyzed
QA: Quality Assurance
TRPH: Total Recoverable Petroleum H
VOCs: Volatile Organic Compounds

TABLE 6-2
CRITERIA FOR COMPARING PRIMARY AND QUALITY ASSURANCE SPLIT SAMPLE RESULTS
NATIONAL TRAINING CENTER (FTIR07 08)
FORT IRWIN, CALIFORNIA

Matrix	Parameter	Disagreement	Major Disagreement
All	All	>5X difference when one result is <DL	>10X difference when one result is <DL
All	All	>3X difference when one results is <RL	>5X difference when one results is <RL
Soil	All except metals and TRPH	>4X difference	>5X difference
Soil	Metals	>2X difference	>3X difference
Soil	TRPH	Arbitrary (suggest >3X difference)	Arbitrary (suggest >5X difference)

Reference: USACE, 1996
DL: detection limit
RL: reporting limit
TPH: total petroleum hydrocarbons

APPENDIX F

FIELD DUPLICATE SUMMARY

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26 through June 27, 1998

LDC Report Date: September 15, 1998

Matrix: Soil/Water

Parameters: Volatiles

Validation Level: EPA Level III

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300141

Sample Identification

8 3a-1-Ts-1 0.5
8 3a-1-Ts-1-5
8 3a-1-Ts-1-10
8 3a-1-Td-1-2.5
TB062698
8 1a-2-Ts-1-0.5
8 3a-1-Ts-1 0.5MS
8 3a-1-Ts-1 0.5MSD

recoveries (%R) and relative percent differences (RPD) were within QC limits

IX. Regional Quality Assurance and Quality Control

Not applicable.

X. Internal Standards

All internal standard areas and retention times.

XI. Target Compound Identifications

Raw data were not reviewed for this SDG.

XII. Compound Quantitation and CRQLs

The QAPP reporting limits were met with the following exceptions:

Sample	Compound	Finding	Criteria	Flag	A or P
All samples in SDG 300141	Dichlorodifluoromethane 2-Hexanone Trichlorofluoromethane Acetone 2-Butanone 4-Methyl-2-butanone Vinyl acetate	Laboratory reporting limit reported at 500 ug/Kg.	Reporting limit should be reported at 560 ug/Kg per the QAPP	None None None None None None None	P

Raw data were not reviewed for this SDG

XIII. Tentatively Identified Compounds (TICs)

Raw data were not reviewed for this SDG

XIV. System Performance

Raw data were not reviewed for this SDG.

XV. Overall Assessment of Data

Data flags have been summarized at the end of the report.

XVI. Field Duplicates

No field duplicates were identified in this SDG.

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26, 1998

LDC Report Date: September 9, 1998

Matrix: Soil/Water

Parameters: Volatiles

Validation Level: EPA Level IV

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300142

Sample Identification

8.1a-1-Ts-1-2.5
8.1a-1-Ts-1-2.5RE
8.3b-1-Ts-1-0.5
8.3b-1-Ts-1-2.5
8.3b-1-Ts-1-5
TB062698
8.3b-1-Ts-1-0.5MS
8.3b-1-Ts-1-0.5MSD

Sample	Compound	Finding	Criteria	Flag	A or P
All soil samples in SDG 300142	Dichlorodifluoromethane 2-Hexanone Trichlorofluoromethane Acetone 2-Butanone 4-Methyl-2-butanone Vinyl acetate	Laboratory reporting limit reported at 10 ug/Kg	Reporting limit should be reported at 5 0 ug/Kg per the QAPP	None None None None None None None	P

XIII. Tentatively Identified Compounds (TICs)

Tentatively identified compounds were not reported by the laboratory

XIV. System Performance

The system performance was acceptable.

XV. Overall Assessment of Data

Data flags have been summarized at the end of the report.

XVI. Field Duplicates

No field duplicates were identified in this SDG

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26 through June 27, 1998

LDC Report Date: September 15, 1998

Matrix: Soil

Parameters: Semivolatiles

Validation Level: EPA Level III

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300141

Sample Identification

8 3c-1-Ts-1-0 5	7d-1-Ts-1-0 5
8 3c-1-Ts-1-2 5	7d-1-Ts-1-2 5
8 3c-1-Ts-1-5	7d-1-Ts-1-5
8 3c-1-Ts-1-10	7d-1-Ts-1-10
8 3c-1-Ts-1-15	7d-1-Ts-1-15
8.3a-1-Ts-1 0 5	7d-1-Tp-1-0 5
8.3a-1-Ts-1-2 5	7d-1-Tp-1-2.5
8.3a-1-Ts-1-5	7d-1-Tp-1-5
8.3a-1-Ts-1-10	7d-1-Tp-1-10
8.3a-1-Ts-1-15	7d-2-Ts-1-0 5
8.3c-1-Td-1-5	7d-2-Ts-1-2 5
8 3a-1-Td-1-2.5	7d-2-Ts-1-5
7d-1Td-1-2.5	7d-2-Ts-1-10
7d-1-Tdd-1-2.5	8.3c-1-Ts-1-5MS
7d-2-Td-1-0.5	8.3c-1-Ts-1-5MSD
8.1a-2-Ts-1-0 5	8.3a-1-Ts-1-2.5MS
8.1a-2-Ts-1-2 5	8 3a-1-Ts-1-2.5MSD
8 1a-2-Ts-1-5	7d-2-Ts-1-0 5MS
8 1a-2-Ts-1-10	7d-2-Ts-1-0.5MSD
8 1a-2-Td-1-5	

Sample	Compound	Finding	Criteria	Flag	A or P
All samples in SDG 300141	3 3 -Dichlorobenzidine	Laboratory reporting limit reported at 660 ug/Kg	Reporting limit should be reported at 330 ug/Kg per the QAPP	None	P
All samples in SDG 300141	Benzoic acid 4 6-Dinitro-2-methylphenol 2 4-Dinitrophenol 2-Nitroaniline 3-Nitroaniline 4-Nitroaniline 4-Nitrophenol Pentachlorophenol	Laboratory reporting limit reported at 1600 ug/Kg	Reporting limit should be reported at 330 ug/Kg per the QAPP	None None None None None None None None	P

Raw data were not reviewed for this SDG

XIII. Tentatively Identified Compounds (TICs)

Raw data were not reviewed for this SDG.

XIV. System Performance

Raw data were not reviewed for this SDG.

XV. Overall Assessment

Data flags have been summarized at the end of the report.

XVI. Field Duplicates

Samples 7d-1Td-1-2.5 and 7d-1-Ts-1-2.5, samples 7d-2-Td-1-0 5 and 7d-2-Ts-1-0 5, samples 7d-1-Tdd-1-2 5 and 7d-1-Tp-1-2 5, samples 8.1a-2-Ts-1-5 and 8.1a-2-Td-1-5, samples 8 3a-1-Ts-1-2.5 and 8.3a-1-Td-1-2.5, and samples 8 3c-1-Ts-1-5 and 8.3c-1-Td-1-5 were identified as field duplicates. No semivolatiles were detected in any of the samples

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26, 1998

LDC Report Date: September 9, 1998

Matrix: Soil

Parameters: Semivolatiles

Validation Level: EPA Level IV

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300142

Sample Identification

8 1a-1-Ts-1-0.5
8 1a-1-Ts-1-2 5
8.1a-1-Ts-1-5
8.1a-1-Ts-1-10
8 1a-1-Ts-1-15
8 3b-1-Ts-1-0 5
8.3b-1-Ts-1-2.5
8.3b-1-Ts-1-5
8.3b-1-Ts-1-10
8.3b-1-Ts-1-15
8.3b-1-Ts-1-0 5MS
8.3b-1-Ts-1-0 5MSD

XII. Compound Quantitation and CRQLs

All compound quantitation and CRQLs were within validation criteria.

The QAPP reporting limits were met with the following exceptions:

Sample	Compound	Finding	Criteria	Flag	A or P
All samples in SDG 300142	All TCL compounds	Laboratory reporting limit was higher than the QAPP	QAPP reporting limits should be used.	None	P

XIII. Tentatively Identified Compounds (TICs)

Tentatively identified compounds were not reported by the laboratory.

XIV. System Performance

The system performance was acceptable.

XV. Overall Assessment

Data flags have been summarized at the end of the report

XVI. Field Duplicates

No field duplicates were identified in this SDG.

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26 through June 27, 1998

LDC Report Date: October 15, 1998

Matrix: Soil

Parameters: Nitrosamines

Validation Level: EPA Level III

Laboratory: Applied P & Ch Laboratory

Sample Delivery Group (SDG): 300141

Sample Identification

8.3c-1-Ts-1-0.5
8.3c-1-Ts-1-2.5
8.3c-1-Ts-1-5
8.3c-1-Ts-1-10
8.3c-1-Ts-1-15
8.3a-1-Ts-1-0.5
8.3a-1-Ts-1-2.5
8.3a-1-Ts-1-5
8.3a-1-Ts-1-10
8.3a-1-Ts-1-15
8.3c-1-Td-1-5
8.3a-1-Td-1-2.5
7d-1Td-1-2.5
7d-1-Tdd-1-2.5
7d-2-Td-1-0.5
8.1a-2-Ts-1-0.5
8.1a-2-Ts-1-2.5
8.1a-2-Ts-1-5
8.1a-2-Ts-1-10
8.1a-2-Td-1-5
7d-1-Ts-1-0.5
7d-1-Ts-1-2.5
7d-1-Ts-1-5
7d-1-Ts-1-10
7d-1-Ts-1-15
7d-1-Tp-1-0.5
7d-1-Tp-1-2.5
7d-1-Tp-1-5
7d-1-Tp-1-10
7d-2-Ts-1-0.5
7d-2-Ts-1-2.5
7d-2-Ts-1-5
7d-2-Ts-1-10

VIII. Laboratory Control Samples (LCS)

Laboratory control samples were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits.

IX. Regional Quality Assurance and Quality Control

Not applicable.

X. Internal Standards

All internal standard areas and retention times were within QC limits

XI. Target Compound Identifications

Raw data were not reviewed for this SDG

XII. Compound Quantitation and CRQLs

Raw data were not reviewed for this SDG.

XIII. Tentatively Identified Compounds (TICs)

Raw data were not reviewed for this SDG.

XIV. System Performance

Raw data were not reviewed for this SDG.

XV. Overall Assessment

Data flags have been summarized at the end of the report.

XVI. Field Duplicates

Samples 7d-1Td-1-2.5 ad 7d-1-Ts-1-2.5, samples 7d-2-Td-1-0.5 and 7d-2Ts-1-0.5, samples 7d-1Tdd-1-2.5 and 7d-1-Tp-1-2.5, samples 8.1a-2-Ts-1-5 and 8.1a-2-Td-1-5, samples 8.3a-1-Ts-1-2.5 and 8.3a-1-Td-1-2.5, and samples 8.3c-1-Ts-1-5 and 8.3c-1-Td-1-5 were identified as field duplicates. No nitrosamines were detected in any of the samples

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26, 1998

LDC Report Date: September 15, 1998

Matrix: Soil

Parameters: Nitrosamines

Validation Level: EPA Level IV

Laboratory: Applied P & Ch Laboratory

Sample Delivery Group (SDG): 300142

Sample Identification

8.1a-1-Ts-1-0.5
8.1a-1-Ts-1-2.5
8.1a-1-Ts-1-5
8.1a-1-Ts-1-10
8.1a-1-Ts-1-15
8.3b-1-Ts-1-0.5
8.3b-1-Ts-1-2.5
8.3b-1-Ts-1-5
8.3b-1-Ts-1-10
8.3b-1-Ts-1-15

VIII. Laboratory Control Samples (LCS)

Laboratory control samples were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits.

IX. Regional Quality Assurance and Quality Control

Not applicable.

X. Internal Standards

All internal standard areas and retention times were within QC limits.

XI. Target Compound Identifications

All target compound identifications were within validation criteria

XII. Compound Quantitation and CRQLs

All compound quantitation and CRQLs were within validation criteria

XIII. Tentatively Identified Compounds (TICs)

Tentatively identified compounds were not reported by the laboratory.

XIV. System Performance

The system performance was acceptable.

XV. Overall Assessment

Data flags have been summarized at the end of the report

XVI. Field Duplicates

No field blanks were identified in this SDG

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26 through June 27, 1998

LDC Report Date: September 15, 1998

Matrix: Soil

Parameters: Chlorinated Pesticides & PCBs

Validation Level: EPA Level III

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300141

Sample Identification

8 3c-1-Ts-1-0 5	7d-1-Ts-1-0.5
8 3c-1-Ts-1-2.5	7d-1-Ts-1-2.5
8 3c-1-Ts-1-5	7d-1-Ts-1-5
8.3c-1-Ts-1-10	7d-1-Ts-1-10
8 3c-1-Ts-1-15	7d-1-Ts-1-15
8 3a-1-Ts-1 0 5	7d-1-Tp-1-0 5
8 3a-1-Ts-1-2 5	7d-1-Tp-1-2 5
8 3a-1-Ts-1-5	7d-1-Tp-1-5
8 3a-1-Ts-1-10	7d-1-Tp-1-10
8 3a-1-Ts-1-15	7d-2-Ts-1-0.5
8.3c-1-Td-1-5	7d-2-Ts-1-2 5
8 3a-1-Td-1-2.5	7d-2-Ts-1-5
7d-1Td-1-2.5	7d-2-Ts-1-10
7d-1-Tdd-1-2.5	8 3c-1-Ts-1-5MS
7d-2-Td-1-0.5	8 3c-1-Ts-1-5MSD
8.1a-2-Ts-1-0 5	8 3a-1-Ts-1-2.5MS
8 1a-2-Ts-1-2 5	8.3a-1-Ts-1-2.5MSD
8.1a-2-Ts-1-5	7d-2-Ts-1-0.5MS
8.1a-2-Ts-1-10	7d-2-Ts-1-0.5MSD
8.1a-2-Td-1-5	

Sample	Compound	Finding	Criteria	Flag	A or P
All samples in SDG 300141	alpha-BHC beta-BHC delta-BHC gamma-BHC Heptachlor Aldrin Heptachlor epoxide Endosulfan I	Laboratory reporting limit reported at 0.83 ug/Kg	Reporting limit should be reported at 0 33 ug/Kg per the QAPP	None None None None None None None None	P
All samples in SDG 300141	Dieldrin 4 4 -DDE Endrin Endrin aldehyde Endosulfan II 4 4'-DDD Endosulfan sulfate 4 4'-DDT	Laboratory reporting limit reported at 1 7 ug/Kg	Reporting limit should be reported at 0.33 ug/Kg per the QAPP	None None None None None None None None	P
All samples in SDG 300141	Methoxychlor	Laboratory reporting limit reported at 8.3 ug/Kg	Reporting limit should be reported at 3 3 ug/Kg per the QAPP	None	P
All samples in SDG 300141	Aroclor 1016 Aroclor 1221 Aroclor 1232 Aroclor 1242 Aroclor 1248 Aroclor 1254 Aroclor 1260	Laboratory reporting limit reported at 1 7 ug/Kg	Reporting limit should be reported at 0 33 ug/Kg per the QAPP	None None None None None None None	P

Raw data were not reviewed for this SDG.

XIII. Overall Assessment of Data

Data flags are summarized at the end of this report.

XIV. Field Duplicates

Samples 7d-1Td-1-2.5 and 7d-1-Ts-1-2.5, samples 7d-2-Td-1-0.5 and 7d-2-Ts-1-0 5, samples 7d-1-Tdd-1-2 5 and 7d-1-Tp-1-2.5, samples 8 1a-2-Ts-1-5 and 8.1a-2-Td-1-5, samples 8 3a-1-Ts-1-2 5 and 8.3a-1-Td-1-2 5, samples 8.3c-1-Ts-1-5 and 8 3c-1-Td-1-5 were identified as field duplicates. No chlorinated pesticides or PCBs were detected in any of the samples

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26, 1998

LDC Report Date: September 11, 1998

Matrix: Soil

Parameters: Chlorinated Pesticides & PCBs

Validation Level: EPA Level IV

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300142

Sample Identification

8 1a-1-Ts-1-0 5
8 1a-1-Ts-1-2 5
8.1a-1-Ts-1-5
8.1a-1-Ts-1-10
8.1a-1-Ts-1-15
8 3b-1-Ts-1-0.5
8 3b-1-Ts-1-2 5
8 3b-1-Ts-1-5
8.3b-1-Ts-1-10
8 3b-1-Ts-1-15
8.3b-1-Ts-1-0.5MS
8.3b-1-Ts-1-0.5MSD

Sample	Compound	Finding	Criteria	Flag	A or P
All samples in SDG 300142	Methoxychlor	Laboratory reporting limit reported at 8.3 ug/Kg	Reporting limit should be reported at 3.3 ug/Kg per the QAPP	None	P
All samples in SDG 300142	Aroclor-1016 Aroclor-1221 Aroclor-1232 Aroclor-1242 Aroclor-1248 Aroclor-1254 Aroclor-1260	Laboratory reporting limit reported at 33 ug/Kg.	Reporting limit should be reported at 6.7 ug/Kg per the QAPP	None None None None None None None	P

XIII. Overall Assessment of Data

Data flags are summarized at the end of this report.

XIV. Field Duplicates

No field duplicates were identified in this SDG.

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26 through June 27, 1998

LDC Report Date: September 10, 1998

Matrix: Soil

Parameters: Metals

Validation Level: EPA Level III

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300141

Sample Identification

8.3c-1-Ts-1-0.5	7d-1-Ts-1-0 5
8.3c-1-Ts-1-2.5	7d-1-Ts-1-2 5
8.3c-1-Ts-1-5	7d-1-Ts-1-5
8.3c-1-Ts-1-10	7d-1-Ts-1-10
8 3c-1-Ts-1-15	7d-1-Ts-1-15
8 3a-1-Ts-1.0.5	7d-1-Tp-1-0 5
8 3a-1-Ts-1-2.5	7d-1-Tp-1-2.5
8 3a-1-Ts-1-5	7d-1-Tp-1-5
8 3a-1-Ts-1-10	7d-1-Tp-1-10
8 3a-1-Ts-1-15	7d-2-Ts-1-0.5
8 3c-1-Td-1-5	7d-2-Ts-1-2.5
8 3a-1-Td-1-2.5	7d-2-Ts-1-5
7d-1Td-1-2.5	7d-2-Ts-1-10
7d-1-Tdd-1-2.5	8.3c-1-Ts-1-5MS
7d-2-Td-1-0.5	8 3c-1-Ts-1-5MSD
8 1a-2-Ts-1-0 5	8 3a-1-Ts-1-2 5MS
8.1a-2-Ts-1-2 5	8.3a-1-Ts-1-2.5MSD
8.1a-2-Ts-1-5	7d-2-Ts-1-0.5MS
8.1a-2-Ts-1-10	7d-2-Ts-1-0 5MSD
8.1a-2-Td-1-5	

Sample	Analyte	Finding	Criteria	Flag	A or P
All samples in SDG 300141	Manganese	Laboratory reporting limit reported at 1 mg/Kg.	Reporting limit should be reported at 0.5 mg/Kg per the QAPP.	None	P
All samples in SDG 300141	Potassium	Laboratory reporting limit reported at 500 mg/Kg.	Reporting limit should be reported at 300 mg/Kg per the QAPP	None	P
All samples in SDG 300141	Selenium	Laboratory reporting limit reported at 20 mg/Kg	Reporting limit should be reported at 1 mg/Kg per the QAPP	None	P
All samples in SDG 300141	Sodium	Laboratory reporting limit reported at 500 mg/Kg	Reporting limit should be reported at 40 mg/Kg per the QAPP.	None	P
All samples in SDG 300141	Thallium	Laboratory reporting limit reported at 200 mg/Kg	Reporting limit should be reported at 2 mg/Kg per the QAPP	None	P

XII. Overall Assessment of Data

Data flags have been summarized at the end of this report.

XIII. Field Duplicates

Samples 8.3c-1-Ts-1-5 and 8.3c-1-Td-1-5, samples 8.3a-1-Ts-1-2.5 and 8.3a-1-Td-1-2.5, samples 7d-1Td-1-2.5 and 7d-1-Ts-1-2.5, samples 7d-1-Tdd-1-2.5 and 7d-1-Tp-1-2.5, samples 7d-2-Td-1-0.5 and 7d-2-Ts-1-0.5 and samples 8.1a-2-Ts-1-5 and 8.1a-2-Td-1-5 were identified as field duplicates. No metals were detected in any of the samples with the following exceptions:

Analyte	Concentration (mg/Kg)		RPD (Limits)	Flag	A or P
	8.3c-1-Ts-1-5	8.3c-1-Td-1-5			
Aluminum	6300	9070	36 (≤70)	-	-
Barium	67.6	72.8	7 (≤70)	-	-
Beryllium	0.42	0.48	13 (≤70)	-	-
Calcium	6250	5940	5 (≤70)	-	-
Chromium	6.2	8.2	28 (≤70)	-	-
Cobalt	3.9	4.3	10 (≤70)	-	-

Analyte	Concentration (mg/Kg)		RPD (Limits)	Flag	A or P
	8.3c-1-Ts-1-5	8.3c-1-Td-1-5			
Copper	13.9	10.8	25 (≤70)	-	-
Iron	8710	10700	21 (≤70)	-	-
Lead	6.3	7.4	16 (≤70)	-	-
Magnesium	2550	2850	11 (≤70)	-	-
Manganese	261	279	7 (≤70)	-	-
Nickel	5.9	7.4	23 (≤70)	-	-
Potassium	1900	2280	18 (≤70)	-	-
Sodium	89.4	102	13 (≤70)	-	-
Vanadium	14.5	18.3	23 (≤70)	-	-
Zinc	30.9	32.0	3 (≤70)	-	-
Molybdenum	0.93	2.0U	73 (≤70)	-	-

Analyte	Concentration (mg/Kg)		RPD (Limits)	Flag	A or P
	8.3a-1-Ts-1-2.5	8.3a-1-Td-1-2.5			
Aluminum	2590	3130	19 (≤70)	-	-
Barium	31.1	37.3	18 (≤70)	-	-
Beryllium	0.18	0.21	15 (≤70)	-	-
Calcium	1900	2030	7 (≤70)	-	-
Chromium	2.3	3.2	33 (≤70)	-	-
Cobalt	1.4	1.9	30 (≤70)	-	-
Copper	30.9	10.6	98 (≤70)	-	-
Iron	3870	5170	29 (≤70)	-	-
Lead	5.7U	3.4	51 (≤70)	-	-

Analyte	Concentration (mg/Kg)		RPD (Limits)	Flag	A or P
	8.3a-1-Ts-1-2.5	8.3a-1-Td-1-2.5			
Magnesium	1000	1250	22 (≤70)	-	-
Manganese	138	147	6 (≤70)	-	-
Nickel	2 3	2 9	23 (≤70)	-	-
Potassium	874	1050	18 (≤70)	-	-
Sodium	284	342	19 (≤70)	-	-
Vanadium	5 9	7 9	29 (≤70)	-	-
Zinc	27 9	19 9	33 (≤70)	-	-
Molybdenum	0 70	2 1U	100 (≤70)	-	-

Analyte	Concentration (mg/Kg)		RPD (Limits)	Flag	A or P
	7d-1Td-1-2.5	7d-1-Ts-1-2.5			
Aluminum	5750	6300	9 (≤70)	-	-
Arsenic	10 6U	3 8	94 (≤70)		
Barium	65 9	65 8	0 2 (≤70)	-	-
Beryllium	0 32	0 22	37 (≤70)	-	-
Calcium	18500	5040	114 (≤70)	-	-
Chromium	4 6	5 1	10 (≤70)	-	-
Cobalt	2 9	3 2	10 (≤70)	-	-
Copper	16 7	11 8	34 (≤70)	-	-
Iron	6900	7080	3 (≤70)	-	-
Lead	4 8	3 5	31 (≤70)	-	-
Magnesium	3740	2630	35 (≤70)	-	-
Manganese	158	152	4 (≤70)	-	-

Analyte	Concentration (mg/Kg)		RPD (Limits)	Flag	A or P
	7d-1Td-1-2.5	7d-1-Ts-1-2.5			
Nickel	5 3	3 8	33 (≤70)	-	-
Potassium	1670	1610	4 (≤70)	-	-
Sodium	307	246	22 (≤70)	-	-
Vanadium	10 9	11 8	8 (≤70)	-	-
Zinc	29 0	24 3	18 (≤70)	-	-

Analyte	Concentration (mg/Kg)		RPD (Limits)	Flag	A or P
	7d-1-Tdd-1-2.5	7d-1-Tp-1-2.5			
Aluminum	7750	6550	17 (≤70)	-	-
Arsenic	7 1	5 6	24 (≤70)	-	-
Barium	203	51 0	120 (≤70)	-	-
Beryllium	0 41	0 29	34 (≤70)	-	-
Calcium	27700	13400	70 (≤70)	-	-
Chromium	6 5	5 0	26 (≤70)	-	-
Cobalt	3 1	2 6	18 (≤70)	-	-
Copper	236	9 5	184 (≤70)	-	-
Iron	7910	6910	1 (≤70)	-	-
Lead	4 8	4 2	13 (≤70)	-	-
Magnesium	5370	3520	42 (≤70)	-	-
Manganese	163	163	0 (≤70)	-	-
Nickel	6 5	5 1	24 (≤70)	-	-
Potassium	2100	1610	26 (≤70)	-	-
Sodium	449	307	38 (≤70)	-	-

Analyte	Concentration (mg/Kg)		RPD (Limits)	Flag	A or P
	7d-1-Tdd-1-2.5	7d-1-Tp-1-2.5			
Vanadium	14 5	12.4	16 (≤70)	-	-
Zinc	199	22 5	160 (≤70)	-	-
Molybdenum	0.68	2 1U	102 (≤70)	-	-

Analyte	Concentration (mg/Kg)		RPD (Limits)	Flag	A or P
	7d-2-Td-1-0.5	7d-2-Ts-1-0.5			
Aluminum	4030	5970	39 (≤70)	-	-
Barium	45 0	58 4	26 (≤70)	-	-
Beryllium	0 20	0 23	14 (≤70)	-	-
Calcium	1750	1810	3 (≤70)	-	-
Chromium	3 6	4 7	26 (≤70)	-	-
Cobalt	1 9	2.4	23 (≤70)	-	-
Copper	88 6	8 1	166 (≤70)	-	-
Iron	5930	8240	33 (≤70)	-	-
Lead	5 2	5 1U	2 (≤70)	-	-
Magnesium	1890	2540	29 (≤70)	-	-
Manganese	149	180	19 (≤70)	-	-
Nickel	3 5	4.4	23 (≤70)	-	-
Potassium	1350	1700	23 (≤70)	-	-
Sodium	53 1	67 2	23 (≤70)	-	-
Vanadium	9 0	13 0	36 (≤70)	-	-
Zinc	115	24 6	130 (≤70)	-	-
Molybdenum	1 0	2 0U	67 (≤70)	-	-

Analyte	Concentration (mg/Kg)		RPD (Limits)	Flag	A or P
	8.1a-2-Ts-1-5	8.1a-2-Td-1-5			
Aluminum	3640	4790	27 (≤70)	-	-
Barium	36.7	45 0	20 (≤70)	-	-
Beryllium	0 25	0.26	4 (≤70)	-	-
Calcium	612	754	21 (≤70)	-	-
Chromium	3.4	3 8	11 (≤70)	-	-
Cobalt	2.3	2.4	4 (≤70)	-	-
Copper	6 0	9 1	41 (≤70)	-	-
Iron	4440	5020	12 (≤70)	-	-
Lead	8 0	10 8	30 (≤70)	-	-
Magnesium	1550	1790	14 (≤70)	-	-
Manganese	155	170	9 (≤70)	-	-
Nickel	3.7	3 3	11 (≤70)	-	-
Potassium	1180	1280	8 (≤70)	-	-
Sodium	75 6	81.4	7 (≤70)	-	-
Vanadium	6 2	7 3	16 (≤70)	-	-
Zinc	22.5	40.1	56 (≤70)	-	-

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26, 1998

LDC Report Date: September 10, 1998

Matrix: Soil

Parameters: Metals

Validation Level: EPA Level IV

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300142

Sample Identification

8 1a-1-Ts-1-0 5
8 1a-1-Ts-1-2 5
8 1a-1-Ts-1-5
8 1a-1-Ts-1-10
8 1a-1-Ts-1-15
8 3b-1-Ts-1-0 5
8 3b-1-Ts-1-2 5
8 3b-1-Ts-1-5
8 3b-1-Ts-1-10
8 3b-1-Ts-1-15
8 3b-1-Ts-1-0 5MS
8 3b-1-Ts-1-0 5MSD

Sample	Analyte	Finding	Criteria	Flag	A or P
All samples in SDG 300142	Iron	Laboratory reporting limit reported at 10 mg/Kg.	Reporting limit should be reported at 8 mg/Kg per the QAPP	None	P
All samples in SDG 300142	Lead	Laboratory reporting limit reported at 5 mg/Kg.	Reporting limit should be reported at 1 mg/Kg per the QAPP	None	P
All samples in SDG 300142	Magnesium	Laboratory reporting limit reported at 50 mg/Kg	Reporting limit should be reported at 20 mg/Kg per the QAPP	None	P
All samples in SDG 300142	Manganese	Laboratory reporting limit reported at 1 mg/Kg.	Reporting limit should be reported at 0.5 mg/Kg per the QAPP	None	P
All samples in SDG 300142	Potassium	Laboratory reporting limit reported at 500 mg/Kg	Reporting limit should be reported at 300 mg/Kg per the QAPP	None	P
All samples in SDG 300142	Selenium	Laboratory reporting limit reported at 20 mg/Kg.	Reporting limit should be reported at 1 mg/Kg per the QAPP	None	P
All samples in SDG 300142	Sodium	Laboratory reporting limit reported at 500 mg/Kg.	Reporting limit should be reported at 40 mg/Kg per the QAPP	None	P
All samples in SDG 300142	Thallium	Laboratory reporting limit reported at 200 mg/Kg.	Reporting limit should be reported at 2 mg/Kg per the QAPP	None	P

XII. Overall Assessment of Data

Data flags have been summarized at the end of this report.

XIII. Field Duplicates

No field duplicates were identified in this SDG.

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26 through June 27, 1998

LDC Report Date: September 15, 1998

Matrix: Soil

Parameters: Herbicides

Validation Level: EPA Level III

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300141

Sample Identification

8 3c-1-Ts-1-0 5	7d-1-Ts-1-0 5
8 3c-1-Ts-1-2 5	7d-1-Ts-1-2.5
8 3c-1-Ts-1-5	7d-1-Ts-1-5
8 3c-1-Ts-1-10	7d-1-Ts-1-10
8 3c-1-Ts-1-15	7d-1-Ts-1-15
8 3a-1-Ts-1 0 5	7d-1-Tp-1-0 5
8 3a-1-Ts-1-2 5	7d-1-Tp-1-2 5
8 3a-1-Ts-1-5	7d-1-Tp-1-5
8 3a-1-Ts-1-10	7d-1-Tp-1-10
8 3a-1-Ts-1-15	7d-2-Ts-1-0 5
8.3c-1-Td-1-5	7d-2-Ts-1-2.5
8 3a-1-Td-1-2.5	7d-2-Ts-1-5
7d-1Td-1-2.5	7d-2-Ts-1-10
7d-1-Tdd-1-2 5	8.3c-1-Ts-1-2 5MS
7d-2-Td-1-0 5	8.3c-1-Ts-1-2 5MSD
8.1a-2-Ts-1-0.5	8.3a-1-Ts-1 0.5MS
8.1a-2-Ts-1-2.5	8.3a-1-Ts-1 0.5MSD
8.1a-2-Ts-1-5	7d-1-Tp-1-10MS
8.1a-2-Ts-1-10	7d-1-Tp-1-10MSD
8.1a-2-Td-1-5	

VII. System Performance

Raw data were not reviewed for this SDG.

VIII. Overall Assessment of Data

Data flags are summarized at the end of this report.

IX. Field Duplicates

Samples 7d-1Td-1-2.5 and 7d-1-Ts-1-2 5, samples 7d-2-Td-1-0 5 and 7d-2-Ts-1-0.5, samples 7d-1-Tdd-1-2 5 and 7d-1-Tp-1-2.5, samples 8.1a-2-Ts-1-5 and 8.1a-2-Td-1-5, samples 8.3a-1-Ts-1-2.5 and 8 3a-1-Td-1-2.5, and samples 8.3c-1-Ts-1-5 and 8 3c-1-Td-1-5 were identified as field duplicates No herbicides were detected in any of the samples with the following exceptions:

Compound	Concentration (ug/Kg)		RPD (Limits)	Flag	A or P
	7d-1-Tdd-1-2.5	7d-1-Tp-1-2.5			
2 4 5-TP	5 7U	1 2	130 (≤50)	J (all detects) UJ (all non-detects)	A

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26, 1998

LDC Report Date: September 15, 1998

Matrix: Soil

Parameters: Herbicides

Validation Level: EPA Level IV

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300142

Sample Identification

8.1a-1-Ts-1-0.5
8.1a-1-Ts-1-2.5
8 1a-1-Ts-1-5
8 1a-1-Ts-1-10
8.1a-1-Ts-1-15
8 3b-1-Ts-1-0 5
8 3b-1-Ts-1-2 5
8 3b-1-Ts-1-5
8 3b-1-Ts-1-10
8.3b-1-Ts-1-15
8 1a-1-Ts-1-5MS
8.1a-1-Ts-1-5MSD

Sample	Compound	Finding	Criteria	Flag	A or P
All samples in SDG 300142	2 4-D	Laboratory reporting limit reported at 25 ug/Kg	Reporting limit should be reported at 10 ug/Kg per the QAPP	None	P
All samples in SDG 300142	2 4-DB	Laboratory reporting limit reported at 100 ug/Kg	Reporting limit should be reported at 10 ug/Kg per the QAPP	None	P
All samples in SDG 300142	MCPA MCPP	Laboratory reporting limit reported at 5000 ug/Kg.	Reporting limit should be reported at 500 ug/Kg per the QAPP	None None	P
All samples in SDG 300142	Dinoseb Dichlorprop	Laboratory reporting limit reported at 25 ug/Kg	Reporting limit should be reported at 2 ug/Kg per the QAPP	None None	P
All samples in SDG 300142	Dicamba	Laboratory reporting limit reported at 10 ug/Kg.	Reporting limit should be reported at 1 ug/Kg per the QAPP	None	P

VII. System Performance

The system performance was acceptable.

VIII. Overall Assessment of Data

Data flags are summarized at the end of this report.

IX. Field Duplicates

No field duplicates were identified in this SDG.

VIII. Overall Assessment of Data

Data flags are summarized at the end of this report.

IX. Field Duplicates

Samples 8.3c-1-Ts-1-5 and 8.3c-1-Td-1-5, samples 8.3a-1-Ts-1-2.5 and 3a-1-Td-1-2.5, samples 7d-1Td-1-2.5 and 7d-1-Ts-1-2.5, samples 7d-1-Tdd-1-2.5 and 7d-1-Tp-1-2.5, samples 7d-2-Td-1-0.5 and 7d-2-Ts-1-0.5, and samples 8.1a-2-Ts-1-5 and 8.1a-2-Td-1-5 were identified as field duplicates. No o-Chlorobenzaldehyde was detected in any of the samples.

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26 through June 27, 1998

LDC Report Date: September 14, 1998

Matrix: Soil

Parameters: o-Chlorobenzaldehyde

Validation Level: EPA Level III

Laboratory: Data Chem Laboratories

Sample Delivery Group (SDG): 300141

Sample Identification

8 3c-1-Ts-1-0 5
8.3c-1-Ts-1-2 5
8 3c-1-Ts-1-5
8 3c-1-Ts-1-10
8 3c-1-Ts-1-15
8.3a-1-Ts-1.0 5
8 3a-1-Ts-1-2.5
8.3a-1-Ts-1-5
8 3a-1-Ts-1-10
8 3a-1-Ts-1-15
8.3c-1-Td-1-5
8.3a-1-Td-1-2.5
7d-1Td-1-2.5
7d-1-Tdd-1-2.5
7d-2-Td-1-0.5
8.1a-2-Ts-1-0.5
8.1a-2-Ts-1-2 5
8 1a-2-Ts-1-5
8 1a-2-Ts-1-10
8.1a-2-Td-1-5
7d-1-Ts-1-0 5
7d-1-Ts-1-2 5
7d-1-Ts-1-5
7d-1-Ts-1-10
7d-1-Ts-1-15
7d-1-Tp-1-0 5
7d-1-Tp-1-2.5
7d-1-Tp-1-5
7d-1-Tp-1-10
7d-2-Ts-1-0.5
7d-2-Ts-1-2 5
7d-2-Ts-1-5
7d-2-Ts-1-10
8 3c-1-Ts-1-5MS
8.3c-1-Ts-1-5MSD
8.3a-1-Ts-1-2.5MS
8.3a-1-Ts-1-2.5MSD
7d-2-Ts-1-0.5MS
7d-2-Ts-1-0 5MSD
8 3c-1-Ts-1-5REMS
8.3c-1-Ts-1-5REMSD
8.3a-1-Ts-1-2 5REMS
8 3a-1-Ts-1-2.5REMSD
7d-2-Ts-1-0 5REMS
7d-2-Ts-1-0.5REMSD

c. Laboratory Control Samples

Laboratory control samples were reviewed for each matrix as applicable. Percent recoveries (%R) were within QC limits with the following exceptions:

LCS ID	Compound	%R (Limits)	Associated Samples	Flag	A or P
QC-148901-1	o-Chlorobenzaldehyde	0 (70-130)	All samples in SDG 300142	J (all detects) R (all non-detects)	A

V. Target Compound Identification

All target compound identifications were within validation criteria.

VI. Compound Quantitation and CRQLs

All compound quantitation and CRQLs were within validation criteria.

Sample results were reported on a wet weight basis.

VII. System Performance

The system performance was acceptable.

VIII. Overall Assessment of Data

Data flags are summarized at the end of this report

IX. Field Duplicates

No field duplicates were identified in this SDG.

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26, 1998

LDC Report Date: September 14, 1998

Matrix: Soil

Parameters: o-Chlorobenzaldehyde

Validation Level: EPA Level IV

Laboratory: Data Chem Laboratories

Sample Delivery Group (SDG): 300142

Sample Identification

8.1a-1-Ts-1-0.5
8.1a-1-Ts-1-2.5
8.1a-1-Ts-1-5
8.1a-1-Ts-1-10
8.1a-1-Ts-1-15
8.3b-1-Ts-1-0.5
8.3b-1-Ts-1-2.5
8.3b-1-Ts-1-5
8.3b-1-Ts-1-10
8.3b-1-Ts-1-15

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26 through June 27, 1998

LDC Report Date: September 15, 1998

Matrix: Soil

Parameters: Wet Chemistry

Validation Level: EPA Level III

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300141

Sample Identification

8.3c-1-Ts-1-0.5	7d-1-Ts-1-0.5	8.3c-1-Ts-1-5DUP
8.3c-1-Ts-1-2.5	7d-1-Ts-1-2.5	7d-2-Ts-1-0.5DUP
8.3c-1-Ts-1-5	7d-1-Ts-1-5	
8.3c-1-Ts-1-10	7d-1-Ts-1-10	
8.3c-1-Ts-1-15	7d-1-Ts-1-15	
8.3a-1-Ts-1-0.5	7d-1-Tp-1-0.5	
8.3a-1-Ts-1-2.5	7d-1-Tp-1-2.5	
8.3a-1-Ts-1-5	7d-1-Tp-1-5	
8.3a-1-Ts-1-10	7d-1-Tp-1-10	
8.3a-1-Ts-1-15	7d-2-Ts-1-0.5	
8.3c-1-Td-1-5	7d-2-Ts-1-2.5	
8.3a-1-Td-1-2.5	7d-2-Ts-1-5	
7d-1Td-1-2.5	7d-2-Ts-1-10	
7d-1-Tdd-1-2.5	8.3a-1-Ts-1-2.5MS	
7d-2-Td-1-0.5	8.3a-1-Ts-1-2.5MSD	
8.1a-2-Ts-1-0.5	8.3c-1-Ts-1-5MS	
8.1a-2-Ts-1-2.5	8.3c-1-Ts-1-5MSD	
8.1a-2-Ts-1-5	7d-2-Ts-1-0.5MS	
8.1a-2-Ts-1-10	7d-2-Ts-1-0.5MSD	
8.1a-2-Td-1-5	8.3a-1-Ts-1-2.5DUP	

Sample	Compound	Finding	Criteria	Flag	A or P
All samples in SDG 300141	Nitrate/Nitrite as N	Laboratory reporting limit reported at 0 25 mg/Kg	Reporting limit should be reported at 0.10 mg/Kg per the QAPP	None	P

VI. Overall Assessment of Data

Data flags are summarized at the end of this report.

VII. Field Duplicates

Samples 8 3c-1-Ts-1-5 and 8 3c-1-Td-1-5, samples 8 3a-1-Ts-1-2 5 and 8.3a-1-Td-1-2.5, samples 7d-1Td-1-2.5 and 7d-1-Ts-1-2 5, samples 7d-1-Tdd-1-2 5 and 7d-1-Tp-1-2.5, samples 7d-2-Td-1-0.5 and 7d-2-Ts-1-0.5, and samples 8.1a-2-Ts-1-5 and 8.1a-2-Td-1-5 were identified as field duplicates. No contaminant concentrations were detected in any of the samples with the following exceptions:

Analyte	Concentration mg/Kg		RPD (Limits)	Flag	A or P
	8.3c-1-Ts-1-5	8.3c-1-Td-1-5			
Ammonia	0 16 mg/Kg	0 15 mg/Kg	6 (≤70)	-	-
pH	8 4 units	8 5 units	1 (≤70)	-	-
Nitrate/Nitrite as N	2.9 mg/Kg	0 91 mg/Kg	104 (≤70)	-	-

Analyte	Concentration		RPD (Limits)	Flag	A or P
	8.3a-1-Ts-1-2.5	8.3a-1-Td-1-2.5			
Ammonia	0 26 mg/Kg	0.19 mg/Kg	31 (≤70)	-	-
pH	9 7 units	9 7 units	0 (≤70)	-	-
Nitrate/Nitrite as N	0 38 mg/Kg	0.30 mg/Kg	24 (≤70)	-	-

Analyte	Concentration		RPD (Limits)	Flag	A or P
	7d-1Td-1-2.5	7d-1-Ts-1-2.5			
Ammonia	0.49 mg/Kg	0 052 mg/Kg	162 (≤70)	-	-
pH	9 2 units	9 0 units	2 (≤70)	-	-

Analyte	Concentration		RPD (Limits)	Flag	A or P
	7d-1Td-1-2 5	7d-1-Ts-1-2.5			
Nitrate/Nitrite as N	3 9 mg/Kg	4 1 mg/Kg	5 (≤70)	-	-

Analyte	Concentration		RPD (Limits)	Flag	A or P
	7d-1-Tdd-1-2.5	7d-1-Tp-1-2.5			
Ammonia	0 16 mg/Kg	0 15 mg/Kg	6 (≤70)	-	-
pH	9 1 units	9 1 units	0 (≤70)	-	-
Nitrate/Nitrite as N	0 69 mg/Kg	1 3 mg/Kg	61 (≤70)	-	-

Analyte	Concentration		RPD (Limits)	Flag	A or P
	7d-2-Td-1-0.5	7d-2-Ts-1-0 5			
pH	8 8 units	8 6 units	2 (≤70)	-	-
Nitrate/Nitrite as N	0 18 mg/Kg	0 35 mg/Kg	64 (≤70)	-	-

Analyte	Concentration		RPD (Limits)	Flag	A or P
	8.1a-2-Ts-1-5	8.1a-2-Td-1-5			
pH	8 3 units	7 7 units	8 (≤70)	-	-
Nitrate/Nitrite as N	2 9 mg/Kg	1 5 mg/Kg	64 (≤70)	-	-

Sample	Compound	Finding	Criteria	Flag	A or P
All samples in SDG 300142	Ammonia	Laboratory reporting limit reported at 0 25 mg/Kg.	Reporting limit should be reported at 0.1 mg/Kg per the QAPP	None	P

VI. Overall Assessment of Data

Data flags are summarized at the end of this report

VII. Field Duplicates

No field duplicates were identified in this SDG.

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26, 1998

LDC Report Date: September 11, 1998

Matrix: Soil

Parameters: Wet Chemistry

Validation Level: EPA Level IV

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300142

Sample Identification

8.1a-1-Ts-1-0.5
8.1a-1-Ts-1-2.5
8.1a-1-Ts-1-5
8.1a-1-Ts-1-10
8.1a-1-Ts-1-15
8.3b-1-Ts-1-0.5
8.3b-1-Ts-1-2.5
8.3b-1-Ts-1-5
8.3b-1-Ts-1-10
8.3b-1-Ts-1-15
8.3b-1-Ts-1-0.5MS
8.3b-1-Ts-1-0.5MSD
8.3b-1-Ts-1-15DUP

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26 through June 27, 1998

LDC Report Date: September 11, 1998

Matrix: Soil

Parameters: Total Recoverable Petroleum Hydrocarbons

Validation Level: EPA Level III

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300141

Sample Identification

8.3c-1-Ts-1-0.5	7d-1-Ts-1-0 5
8.3c-1-Ts-1-2 5	7d-1-Ts-1-2.5
8 3c-1-Ts-1-5	7d-1-Ts-1-5
8.3c-1-Ts-1-10	7d-1-Ts-1-10
8.3c-1-Ts-1-15	7d-1-Ts-1-15
8.3a-1-Ts-1-0 5	7d-1-Tp-1-0 5
8 3a-1-Ts-1-2 5	7d-1-Tp-1-2.5
8.3a-1-Ts-1-5	7d-1-Tp-1-5
8.3a-1-Ts-1-10	7d-1-Tp-1-10
8.3a-1-Ts-1-15	7d-2-Ts-1-0 5
8 3c-1-Td-1-5	7d-2-Ts-1-2.5
8.3a-1-Td-1-2.5	7d-2-Ts-1-5
7d-1Td-1-2.5	7d-2-Ts-1-10
7d-1-Tdd-1-2.5	8.3c-1-Ts-1-5MS
7d-2-Td-1-0.5	8.3c-1-Ts-1-5MSD
8 1a-2-Ts-1-0 5	8 3a-1-Ts-1-2.5MS
8.1a-2-Ts-1-2.5	8.3a-1-Ts-1-2 5MSD
8.1a-2-Ts-1-5	7d-2-Ts-1-0.5MS
8.1a-2-Ts-1-10	7d-2-Ts-1-0 5MSD
8 1a-2-Td-1-5	

I. Technical Holding Times

All technical holding time requirements were met.

The chain-of-custodies were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria.

II. Calibration

a. Initial Calibration

All criteria for the initial calibration were met.

b. Calibration Verification

Calibration verification frequency and analysis criteria were met.

III. Blanks

Method blanks were reviewed for each matrix as applicable. No total recoverable petroleum hydrocarbon contaminants were found in the method blanks.

No field blanks were identified in this SDG.

IV. Accuracy and Precision Data

a. Matrix Spike/(Matrix Spike) Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) analyses were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits.

b. Laboratory Control Samples

Laboratory control samples were reviewed for each matrix as applicable. Percent recoveries (%R) were within QC limits.

V. Sample Result Verification

Raw data were not reviewed for this SDG.

VI. Overall Assessment of Data

Data flags have been summarized at the end of this report.

VII. Field Duplicates

Samples 8.3a-1-Ts-1-2.5 and 8.3a-1-Td-1-2.5, samples 8.3c-1-Ts-1-5 and 8.3c-1-Td-1-5,

samples 8.1a-2-Ts-1-5 and 8 1a-2-Td-1-5 samples 7d-1-Tdd-1-2.5 and 7d-1-Tp-1-2.5, samples 7d-2-Td-1-0.5 and 7d-2-Ts-1-0 5. and samples 7d-1Td-1-2.5 and 7d-1-Ts-1-2.5 were identified as field duplicates No total recoverable petroleum hydrocarbons were detected in any of the samples with the following exceptions:

Analyte	Concentration (mg/Kg)		RPD (Limits)	Flag	A or P
	8.3a-1-Ts-1-2.5	8.3a-1-Td-1-2.5			
Total recoverable petroleum hydrocarbons	11U	160	174 (≤70)	-	-

I. Technical Holding Times

All technical holding time requirements were met

The chain-of-custodies were reviewed for documentation of cooler temperatures. All cooler temperatures met validation criteria

II. Calibration

a. Initial Calibration

All criteria for the initial calibration were met.

b. Calibration Verification

Calibration verification frequency and analysis criteria were met

III. Blanks

Method blanks were reviewed for each matrix as applicable No total recoverable petroleum hydrocarbon contaminants were found in the method blanks

No field blanks were identified in this SDG.

IV. Accuracy and Precision Data

a. Matrix Spike/(Matrix Spike) Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) analyses were reviewed for each matrix as applicable. Percent recoveries (%R) and relative percent differences (RPD) were within QC limits

b. Laboratory Control Samples

Laboratory control samples were reviewed for each matrix as applicable Percent recoveries (%R) were within QC limits.

V. Sample Result Verification

All sample result verifications were within validation criteria.

VI. Overall Assessment of Data

Data flags have been summarized at the end of this report.

VII. Field Duplicates

No field duplicates were identified in this SDG.

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26, 1998

LDC Report Date: September 11, 1998

Matrix: Soil

Parameters: Total Recoverable Petroleum Hydrocarbons

Validation Level: EPA Level IV

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300142

Sample Identification

8 1a-1-Ts-1-0 5
8 1a-1-Ts-1-2 5
8 1a-1-Ts-1-5
8 1a-1-Ts-1-10
8 1a-1-Ts-1-15
8 3b-1-Ts-1-0 5
8 3b-1-Ts-1-2 5
8 3b-1-Ts-1-5
8 3b-1-Ts-1-10
8 3b-1-Ts-1-15

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 27, 1998

LDC Report Date: September 10, 1998

Matrix: Soil

Parameters: Dioxins/Dibenzofurans

Validation Level: EPA Level III

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300141

Sample Identification

7d-1-Ts-1-5

VI. Matrix Spike/Matrix Spike Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) samples were reviewed for each matrix as applicable with the following exceptions:

Sample	Compound	Finding	Criteria	Flag	A or P
7d-1-Ts-1-5	All TCL compounds	No MS/MSD associated with these samples.	MS/MSD required.	None	P

VII. Laboratory Control Samples (LCS)

Laboratory control samples were reviewed for each matrix as applicable. The percent recoveries (%R) were within the QC limits.

VIII. Regional Quality Assurance and Quality Control

Not applicable

IX. Internal Standards

All internal standard recoveries were within QC limits.

X. Target Compound Identifications

Raw data were not reviewed for this SDG.

XI. Compound Quantitation and CRQLs

Raw data were not reviewed for this SDG

XII. System Performance

Raw data were not reviewed for this SDG.

XIII. Overall Assessment of Data

Data flags have been summarized at the end of the report.

XIV. Field Duplicates

No field duplicates were identified in this SDG

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26 through June 27, 1998

LDC Report Date: September 11, 1998

Matrix: Soil

Parameters: Hexavalent Chromium

Validation Level: EPA Level III

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300141

Sample Identification

8.3c-1-Ts-1-0.5
8.3c-1-Ts-1-5
8.3a-1-Ts-1-0.5
8.3a-1-Ts-1-5
8.3c-1-Td-1-5
7d-2-Td-1-0.5
8.1a-2-Ts-1-0.5
8.1a-2-Ts-1-5
8.1a-2-Td-1-5
7d-1-Ts-1-0.5
7d-1-Ts-1-5
7d-2-Ts-1-0.5
7d-2-Ts-1-5
8.3a-1-Ts-1-5MS
8.3a-1-Ts-1-5MSD
7d-1-Ts-1-0.5MS
7d-1-Ts-1-0.5MSD

VII. Field Duplicates

Samples 8 3c-1-Ts-1-5 and 8 3c-1-Td-1-5, samples 7d-2-Td-1-0 5 and 7d-2-Ts-1-0 5, and samples 8.1a-2-Ts-1-5 and 8.1a-2-Td-1-5 were identified as field duplicates. No hexavalent chromium was detected in any of the samples

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26, 1998

LDC Report Date: September 11, 1998

Matrix: Soil

Parameters: Hexavalent Chromium

Validation Level: EPA Level III

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300142

Sample Identification

8.1a-1-Ts-1-0.5
8.1a-1-Ts-1-5
8.3b-1-Ts-1-0.5
8.3b-1-Ts-1-5
8.3b-1-Ts-1-0.5MS
8.3b-1-Ts-1-0.5MSD

I. Technical Holding Times

All technical holding time requirements were met

The chain-of-custodies were reviewed for documentation of cooler temperatures All cooler temperatures met validation criteria.

II. Calibration

a. Initial Calibration

All criteria for the initial calibration were met.

b. Calibration verification

Calibration verification frequency and analysis criteria were met

III. Blanks

Method blanks were reviewed for each matrix as applicable. No hexavalent chromium contaminants were found in the method blanks.

No field blanks were identified in this SDG.

IV. Accuracy and Precision Data

a. Matrix Spike/(Matrix Spike) Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) samples were reviewed for each matrix as applicable Percent recoveries (%R) and relative percent differences (RPD) were within QC limits.

b. Laboratory Control Samples

Laboratory control samples were reviewed for each matrix as applicable. Percent recoveries (%R) were within QC limits

V. Sample Result Verification

All sample result verifications were within validation criteria.

VI. Overall Assessment of Data

Data flags are summarized at the end of this report.

VII. Field Duplicates

No field duplicates were identified in this SDG.

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 27, 1998

LDC Report Date: September 14, 1998

Matrix: Soil

Parameters: Nitroaromatics and Nitramines

Validation Level: EPA Level III

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300141

Sample Identification

8.3a-1-Ts-1-10
8 3a-1-Td-1-2 5
8 1a-2-Ts-1-5
7d-1-Ts-1-15
7d-1-Tp-1-0 5
7d-2-Ts-1-2.5
7d-2-Ts-1-10
7d-2-Ts-1-2.5MS
7d-2-Ts-1-2.5MSD
7d-2-Ts-1-10MS
7d-2-Ts-1-10MSD

IV. Accuracy and Precision Data

a. Surrogate Recovery

Surrogates were added to all samples and blanks as required by the method All surrogate recoveries (%R) were within QC limits.

b. Matrix Spike/(Matrix Spike) Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) samples were reviewed for each matrix as applicable Percent recoveries (%R) and relative percent differences (RPD) were within QC limits with the following exceptions:

Spike ID (Associated Samples)	Compound	MS (%R) (Limits)	MSD (%R) (Limits)	RPD (Limits)	Flag	A or P
7d-2-Ts-1-10MS/MSD (7d-2-Ts-1-10)	2 4 6-Trinitrotoluene	137 (65-135)	143 (65-135)	-	J (all detects)	A

c. Laboratory Control Samples

Laboratory control samples were reviewed for each matrix as applicable. Percent recoveries (%R) were within QC limits.

V. Internal Standards

Internal standard data were not provided and therefore not reviewed.

VI. Target Compound Identification

Raw data were not reviewed for this SDG.

VII. Compound Quantitation and CRQLs

Raw data were not reviewed for this SDG

VIII. System Performance

Raw data were not reviewed for this SDG.

IX. Overall Assessment of Data

Data flags are summarized at the end of this report.

X. Field Duplicates

No field duplicates were identified in this SDG

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Fort Irwin

Collection Date: June 26, 1998

LDC Report Date: September 14, 1998

Matrix: Soil

Parameters: Nitroaromatics and Nitramines

Validation Level: EPA Level IV

Laboratory: Quanterra Environmental Services

Sample Delivery Group (SDG): 300142

Sample Identification

8 1a-1-Ts-1-10
8 1a-1-Ts-1-15
8 3b-1-Ts-1-2.5
8 3b-1-Ts-1-5
8 3b-1-Ts-1-10
8 3b-1-Ts-1-10MS
8 3b-1-Ts-1-10MSD

Sample	Internal Standards	Area (Limits)	Compound	Flag	A or P
8 1a-1-Ts-1-10	1 3-Dinitrobenzene-d4 2,6-Dinitrotoluene-d3 15N-Nitroglycerin	695326 (1254765-5019060) 1623091 (3425631-13702526) 107084 (152802-611210)	1 3 5-Trinitrobenzene 1 3-Dinitrobenzene 2 4 6-Trinitrotoluene Tetryl Nitrobenzene 2 4-Dinitrotoluene 2-Am-DNT 2,6-Dinitrotoluene 4-Am-DNT 2-and 4-Nitrotoluene 3-Nitrotoluene Nitroglycerin PETN	J (all detects) UJ (all non-detects)	P
8 3b-1-Ts-1-10	13C-RDX	412798 (435057-1740228)	HMX RDX	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	P
13JUL98-7A	2 6-Dinitrotoluene	6202292 (1472042-5888168)	Tetryl Nitrobenzene 2 4-Dinitrotoluene 2-Am-DNT 2 6-Dinitrotoluene 4-Am-DNT 2-and 4-Nitrotoluene 3-Nitrotoluene	J (all detects)	A

VI. Target Compound Identification

All target compound identifications were within validation criteria.

VII. Compound Quantitation and CRQLs

All compound quantitation and CRQLs were within validation criteria.

Sample results were reported on a wet weight basis

VIII. System Performance

The system performance was acceptable.

IX. Overall Assessment of Data

Data flags are summarized at the end of this report.

X. Field Duplicates

No field duplicates were identified in this SDG.

APPENDIX G

LETTER TO DTSC REGARDING MECURY DATA

MONTGOMERY WATSON

November 24, 1998

Omo Patrick
Department of Toxic Substances Control
245 W. Broadway, Suite 425
Long Beach, CA 90802-4444

Subject: Supplemental Remedial Investigation at Sites FTIR-07 & FTIR-08, Fort Irwin National Training Center

Dear Mr. Patrick:

Montgomery Watson is submitting this letter addendum to the Project Workplan for the Site Inspection and Remedial Investigation of 31 Sites at the National Training Center, Fort Irwin, California (Parsons ES, 1995). This addendum is in reference to the analysis of mercury in the Supplemental Remedial Investigation (RI) for Sites FTIR-07 and FTIR-08.

Due to a laboratory error no mercury samples were analyzed at the subsites investigated during this Supplemental RI. The subsites under investigation include Site FTIR-07/d, FTIR-08/1a, FTIR-08/3a, FTIR-08/3b, and FTIR-08/3c. Based on information presented in this letter, it is Montgomery Watson's conclusion that mercury data is not critical to the evaluation of risks at Sites FTIR-07 and FTIR-08. Therefore, it is our proposal that preparation of the Supplemental RI Report and Baseline Risk Assessments continue as scheduled without this data. The following discussion provides information on the occurrence and sources of mercury at military facilities; detections of mercury from previous investigations at Sites FTIR-07 and FTIR-08; and the relative risk of mercury to human and ecological receptors.

OCCURRENCE AND SOURCES OF MERCURY AT MILITARY FACILITIES

Mercury fulminate is the most commonly used form of mercury at military facilities. This compound has historically been used in fuses and blasting caps. It is an extremely sensitive trigger source and is only used in small amounts. Fuses are designed to operate in series. Small amounts of the most sensitive chemicals trigger larger amounts of the less sensitive chemicals and so on until the largest amount of the least sensitive chemical is used to trigger the explosion. Since mercury fulminate is one of the most sensitive trigger sources, only minute amounts of mercury are used in fuses. Due to its extreme sensitivity, mercury fulminate is no longer used in fuses. Unexploded ordnance (UXO) specialists explain that mercury fulminate is so explosive that it would most likely be entirely volatilized during the explosion.

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MERCURY DETECTIONS FROM PREVIOUS INVESTIGATIONS

Mercury was not detected at concentrations greater than 0.4 mg/kg in samples collected from similar subsites at Sites FTIR-07 and FTIR-08 investigated by Parsons ES in 1997. In addition, mercury was not detected at concentrations above the background level of 0.20 mg/kg in any soil samples collected at Site FTIR-07. Two samples from separate test pits at Site FTIR-08 Subsite 2a contained concentrations of mercury. Mercury was detected at depths of 4 and 5 feet at concentrations of 0.466 and 0.413 mg/kg, respectively. These test pits contained evidence of burned soil, rusted metal, white-ash material, and 30-caliber cartridges. Subsite FTIR-08/2a is located approximately 500 feet from the nearest subsite in this investigation. Although numerous samples were collected in the subsites surrounding Sites FTIR-07 and FTIR-08, the above mentioned samples were the only detections above the established background concentrations.

The highest concentration of mercury detected at other Fort Irwin IRP sites investigated by Montgomery Watson was 7.6 mg/kg. This concentration was found at Site FTIR-40 in a surface soil sample located on top of a large disposal pit containing glass, metal, tar, and wood.

RELATIVE RISK OF MERCURY

An evaluation was conducted by Montgomery Watson to determine what concentrations of mercury might trigger a human health or ecological risk. Mercury concentrations detected at range sites similar to Sites FTIR-07 and FTIR-08 are much lower than that necessary to trigger a risk, based on the following evaluations:

Human Health (USEPA, Region IX PRG, August 1998):
- Residential PRG = 22 mg/kg
- Industrial Worker = 560 mg/kg

Ecological Risk (Calculated from previous risk assessment evaluations):
- Mojave Ground Squirrel (HQ of 1) = 116 mg/kg

Therefore, the highest concentration of mercury observed at Fort Irwin is less than half the level necessary to trigger a human health residential risk, approximately 1 percent of the level necessary for a risk to an industrial worker, and 6 percent of the level to trigger a risk to a Mojave ground squirrel.

SUMMARY

Mercury is primarily used in the form of mercury fulminate as a trigger source. It is an extremely sensitive compound that is most likely volatilized during the explosion. Mercury has been detected at concentrations above background levels at Site FTIR-08/2a

located approximately 500 feet from the nearest subsite in this investigation. However, the concentrations of mercury detected were not high enough to trigger a human health or ecological risk. In addition, the highest concentration detected at Fort Irwin during a previous investigation is also not high enough to trigger a risk.

It is our conclusion that the analysis of mercury is not critical to the risk evaluation at sites FTIR-07 and FTIR-08. We are requesting your approval to continue with the preparation of the Supplemental RI at Sites FTIR-07 and FTIR-08 without the mercury data so that further schedule delays may be avoided. Your comments on this addendum would be appreciated.

Please do not hesitate to call me with any questions at 916-921-3553.

Sincerely,

Karen Kramer

Karen Kramer
Project Manager

cc: Curtis Payton (USACE – Sacramento District)
Tiffany Gates-Tull (Fort Irwin – DPW)
John Christopher (DTSC)
Jay Cass (RWQCB – Lahonton Region)
Steve Crane (Montgomery Watson)

APPENDIX H

TOXICOLOGY PROFILES

TOXICOLOGY PROFILES

ARSENIC

(CAS RN 7440-38-2)

Arsenic is a naturally occurring element in the earth's crust usually found combined with one or more other elements. It is especially prevalent in ores that contain copper or lead. When combined with oxygen, chlorine, or sulfur it is referred to as inorganic arsenic, and when combined with carbon and hydrogen it is referred to as organic arsenic. This is an important distinction since inorganic forms are more prevalent in the environment than organic forms, and because inorganic forms are more toxic than organic forms. Both forms are released to the environment by human activities such as fossil fuel consumption, pesticide use and copper smelting, and via natural processes such as volcanic emissions, weathering of arsenic-containing minerals and ores, and forest fires (ATSDR, 1992). Soil usually contains about 5,000 μg/kg arsenic; food contains about 20 to 140 μg/kg; waste contains about 2 μg/L; and air contains about 0.02 to 0.10 $\mu g/m^3$.

Absorption/Distribution/Metabolism/Excretion

Water soluble inorganic arsenic compounds are substantially absorbed (more than 90 percent) from the GI tract of humans and laboratory animals. Estimates of absorption following oral exposure of humans to water soluble, inorganic arsenic compounds range from 54 to 95 percent (Bettley and O'Shea, 1975 cited in ATSDR, 1992). Less water soluble forms are absorbed to a smaller degree. For example, only 30 to 40 percent of an oral dose of arsenic trioxide, which has limited water solubility, is absorbed by laboratory animals (Marafante and Vahter, 1987 cited in ATSDR, 1992). Water soluble, inorganic arsenic compounds are also rapidly and substantially absorbed via inhalation in both animals and humans. Studies have indicated that 75 to 85 percent of deposited arsenic is absorbed from the lungs within 4 days (Holland et al., 1959 cited in ATSDR, 1992). Less soluble arsenic compounds (e.g., lead arsenate, gallium arsenide) are less

completely absorbed (about 55 percent of an administered dose absorbed in 3 days) (Marafante and Vahter, 1987 cited in ATSDR, 1992). There is little quantitative information on the dermal absorption of arsenic compounds in humans or in animals. However, one study has indicated that arsenic initially binds to the skin and is then slowly taken up into blood (Dutkiewicz, 1977 cited in ATSDR, 1992).

Once absorbed, arsenic is rapidly cleared from the blood in humans and animals (except in rats where it is bound to red blood cells) and distributed to the liver, kidney, lung, spleen, aorta, skin, hair and upper GI tract (Rhodes and Sanders, 1985; Liebscher and Smith, 1968 cited in ATSDR, 1992). These tissues are then cleared rapidly except for skin and hair, where arsenic tends to accumulate. Most absorbed arsenic is metabolized in the liver to methylated products and excreted in the urine (ATSDR, 1992). Since methyl derivatives of arsenic appear to be less toxic than inorganic arsenic, and since methylation results in less tissue retention of inorganic arsenic, methylation is viewed as a detoxification process.

Acute Toxicity

Oral doses of about 50 to 300 mg inorganic arsenic may be fatal to adults, and subchronic oral exposure to about 3 mg/day can be fatal to infants exposed via contaminated milk. On the basis of these observations, the minimum acute and subacute oral lethal dose in humans is estimated to be about 1 to 3 mg/kg/day (ATSDR, 1992). Inhalation or dermal exposure has not been associated with acute lethality in humans.

Acute or subacute oral exposures to high nonlethal, oral doses of arsenic ranging from about 0.04 to 3 mg/kg/day via drinking water or other types of ingestion (e.g., herbal preparation) produces a range of GI signs, with nausea, vomiting, and thirst being common. Very high oral doses may also produce acute encephalopathy (any degenerative disease of the brain), and injury to the liver consisting of necrosis (cell death) and fatty infiltration.

Animals are less sensitive to the toxic effects of arsenic than are humans. For example, reported lethal doses in animals (10 to 300 mg/kg) are significantly higher than lethal doses reported in humans (0.6 to 2 mg/kg).

Target Organ Toxicity

The EPA has published a chronic oral RfD of 3.0E-04 mg/kg-day for arsenic (IRIS, 6/95). This value is based on observations of keratosis, hyperpigmentation, and possible vascular complications in humans exposed to arsenic in their drinking water. The purpose of the UF of 3 associated with this RfD is to account for the lack of data to preclude reproductive toxicity as a critical effect and to account for some uncertainty over whether the NOAEL of the critical study accounts for all senstive individuals. It should be noted that there was not a clear consensus among the Agency scientists on this RfD. risk managers should realize the flexibility afforded them in making regulatory decisions when uncertainty and lack of clear consensus are taken into account.

Developmental Toxicity

There is only suggestive evidence that exposure to arsenic results in developmental toxicity in humans (ATSDR, 1992). Studies in animals, however, do support the view that arsenic is a developmental toxicant, causing reduced birth weight, a variety of fetal malformations (both skeletal and soft tissue), and increased fetal mortality. These effects have been noted following inhalation exposure of mice (Nagymajtenyi et al. 1985), oral exposure of mice and hamsters (Baxley et al., 1981; Hood and Harrison, 1982; Hood et al., 1978 cited in ATSDR 1992), and intraperitoneal or intravenous injection of rats, mice, and hamsters (Beaudoin, 1974; Carpenter, 1987; Ferm and Carpenter, 1968; Ferm et al., 1971; Hanlong and Ferm, 1986c; Hood and Bishop, 1972; Mason et al., 1989; Willhite, 1981 cited in ATSDR, 1992). However, in all these cases the doses required to cause effects were high and often resulted in significant maternal toxicity or even lethality. It thus appears that although inorganic arsenic is a developmental toxicant, the developing fetus is not especially susceptible, and teratogenicity or fetotoxicity are

unlikely to be of concern except at doses that are also toxic to the pregnant female (ATSDR, 1992).

Genotoxicity

The results of tests for genotoxicity of arsenic are mixed, but in general the inorganic arsenicals appear to be either inactive or weak mutagens (Jacobson-Kram and Montalbano, 1985 cited in ATSDR, 1992) that are able to produce chromosomal effects (aberrations, sister chromatid exchange) in most systems. Studies of humans have detected higher than average incidence of chromosomal aberrations in peripheral lymphocytes, both after inhalation exposure (Beckman et al., 1977; Nordenson et al., 1978 cited in ATSDR, 1992) and oral exposure (Burgdorf et al., 1977; Nordenson et al. 1979 cited in ATSDR, 1992).

Cardiotoxicity. Chronic oral exposure to arsenic is also associated with cardiological and vascular effects. Injury and abnormal function of cardiac tissue have been reported in children ingesting water containing as little as 0.6 to 0.8 mg/L arsenic. Peripheral vascular disease leading to gangrene of the toes and feet ("Blackfoot disease") has been reported in a Taiwanese population ingesting drinking water containing 0.4 to 0.6 mg/L arsenic (Chen et al., 1988b; Chi and Blackwell, 1968; Tseng et al., 1968 cited in ATSDR, 1992). Similar peripheral vascular lesions have been reported in vintners exposed to arsenical pesticides, in persons in Chili consuming water containing about 0.8 mg/L arsenic, and in patients from a region in Mexico where arsenic toxicity is endemic (ATSDR, 1992). (It should be noted that some investigators have questioned the role of arsenic in Blackfoot disease and have suggested that the causative factor may be a fluorescent arsenic-containing compound of unknown structure which is present in water where "Blackfoot disease" is endemic.)

Carcinogenicity

There is evidence that chronic oral exposure to elevated levels of arsenic increases the risk of skin cancer in humans. The largest study of arsenic-induced skin cancer has been described by

Tseng (1968 cited in ATSDR, 1992)). This study focused on a large population in Taiwan where arsenic levels in deep wells used for drinking water ranged from 0.001 to 1.82 mg/L, with average levels of around 0.4 to 0.6 mg/L. Based on examination of over 40,000 exposed people the excess skin cancer rate was found to be 10.6/1000 (or about 1 x 10^{-2}). On the basis of these and other (Wv et al., 1989; Zaldiver, 1974 cited in ATSDR, 1992) the EPA cautions that the design of this study limits its usefulness in risk estimation. Arsenic-induced skin cancer has also been attributed to water supplies in Chile, Argentina and Mexico (Borgono and Greiber, 1972; Bergoglio, 1964; Cebrian et al. 1983 cited in ATSDR, 1992).

The EPA has concluded that the Tseng (1977) study is the most appropriate basis for the derivation of an oral unit risk and slope factor for arsenic, although because of its study design considerable uncertainty in dose response should be recognized. Based on this study, a unit risk of 5E-05 $(ug/L)^{-1}$ has been published (IRIS, 3/94). The associated slope factor is calculated to be 1.8E+00 $(mg/kg\text{-}day)^{-1}$. IRIS (3/94) notes that a recent memorandum by the Administrator of the EPA, while recommending that the above slope factor be adopted, also notes that the "uncertainties associated with ingested inorganic arsenic are such that estimates could be modified downwards as much as an order of magnitude, relative to risk estimates associated with most other carcinogens. In such instances, the management document must clearly articulate this fact and state the factors that influenced such a decision." (This seems to imply that a unit risk of 5.0E-06 for arsenic may be appropriate, and that an associated slope factor of 1.8E-01 $(mg/kg\text{-}day)^{-1}$ may be acceptable.)

The ATSDR toxicological profile for arsenic notes that several types of internal tumors have also been associated with oral arsenic exposure (ATSDR, 1992). For example, hepatic angiosarcoma, a rare tumor in the general population, occurs at increased frequency in persons exposed to Fowler's solution (potassium arsenite), or to arsenical pesticides. Also, exposure to arsenic through ingestion of water containing 0.4 to 1.1 mg/L arsenic has been associated with increased occurrence of bladder, lung and liver cancer. Limited observations suggest arsenic might be associated with several other types of cancer as well, including cancer of the mammary gland, cancer of the lymphatic tissues, leukemia, and renal adenocarcinoma (Kasper et al., 1984; Lender

et al., 1975; Regelson et al., 1968, Roth, 1957; Sommers and McManus, 1953; Chen et al., 1985, 1986, 1988a, 1988b, 1988c; Chiang et al., 1988; Wu et al., 1989 cited in ATSDR, 1992).

Chronic exposure to arsenic via inhalation results in an elevated risk of lung cancer in humans. Studies of smelter workers in the United States, Sweden, and Japan have all found an association between occupational arsenic exposure and lung cancer mortality (Enterline and Marsh, 1982; Lee-Feldstein, 1983; Axelson et al., 1978; Tokudome and Kuratsune, 1976; Rencher et al., 1977 cited in ATSDR, 1992) Studies of pesticide manufacturing workers, of arsenical pesticide applicators, and of a population located near a pesticide manufacturing plant have also revealed an excess of lung cancer deaths among exposed persons (Ott et al., 1974; Mabuchi et al., 1979; Matanoski et al., 1981; Roth, 1958, as cited in ATSDR, 1992).

The EPA has derived geometric means of unit risks from different data sets obtained from workers occupationally exposed at two different smelters in the United States. The final estimate of an inhalation unit risk is the geometric mean of these two values and is 4.3E-03†$(\mu g/m^3)^{-1}$ from which an inhalation slope factor of 1.5E+01 $(mg/kg/day)^{-1}$ has been derived (IRIS, 7/92). An inhalation slope factor of 50 mg/kg-day has been reported in HEAST (1994).

It is interesting to note that in laboratory animals oral exposure to arsenic does not result in cancer; and, there is only suggestive evidence that exposure to arsenic via inhalation induces lung cancer.

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Agency for Toxic Substances and Disease Registry. Draft, 1992. Toxicological Profile for Arsenic. Update.

U.S. Environmental Protection Agency (EPA). Health Effects Assessment Summary Tables (HEAST). 1994.

U.S. Environmental Protection Agency (EPA). Integrated Risk Information System (IRIS). 1994.

BARIUM

(CAS RN 7440-39-3)

Barium is a yellowish-white, slightly lustrous metal with a body-centered cubic structure (Merck, 1983, as cited in HSDB, 1995). It is used in paints, soap, paper, and rubber, and in the manufacture of ceramics and glass (Doull, et al., 1986, as cited in HSDB, 1995). It is also used as a component in various proprietary nodularizing and deoxidizing alloys, in the manufacture of alloys for such products as nickel barium parts used in ignition equipment for automobiles, and in the manufacture of lithopone and television picture tubes (Venugopal, et al., 1978, as cited in HSDB, 1995). Barium is soluble in alcohol but insoluble in benzene; it has a boiling point of 1640°C and a melting point of 725°C (Weast, 1989, as cited in HSDB, 1995). Naturally occurring barium is a mixture of seven stable isotopes; thirteen other radioactive isotopes are known to exist (Weast, 1989, as cited in HSDB, 1995).

Absorption/Distribution/Metabolism/Excretion

Absorption of barium following inhalation exposure by humans has not been widely studied; however, results of studies with experimental animals suggest that the rate and extent of absorption of barium from the respiratory tract depends on the exposure level, and the solubility of the particular form of barium that was administered (ATSDR, 1991). As with other metals, barium is probably very poorly absorbed from the GI tract; the International Commission for Radiation Protection (ICRP) estimates that the GI absorption of barium is less than 5% (ICRP, 1973, as cited in ATSDR, 1991). Barium is not lexpected to cross intact skin because of the high polarity of the forms in which it is most commonly encountered (ATSDR, 1991); therefore, dermal absorption of barium is not likely.

Studies in humans indicate that barium distributes predominantly to the skeleton and teeth. The route of exposure is presumed to be mostly oral (ATSDR, 1991). Barium occurs mostly in the bones and teeth of humans. Very little is found in blood plasma or soft tissues; but, when it is

detected in the organs, it is found in the eyes, lungs, skin, and adipose tissue in humans (Schroeder et al., 1972, as cited in ATSDR, 1991).

Since barium is an element, it is not metabolized in the body, but it may be metabolically transported or incorporated into complexes or tissues (ATSDR, 1991).

Barium taken by mouth is poorly absorbed, therefore, most of the dose is excreted in the feces (Tipton et al., 1966, as cited in ATSDR, 1991). Dogs that received barium by gavage excreted most of the dose within a few days and less then 3% of the initial body burden remained in the body after two weeks (Cuddihy and Griffith, 1972, as cited in ATSDR, 1991).

Acute Toxicity

No studies were available regarding death in humans or animals after inhalation or dermal exposure to barium. However, mortality has been reported to occur in a number of cases where humans have been acutely exposed to barium through accidental or intentional ingestion (ATSDR, 1991). These observations are supported by findings from acute studies with rodents that indicate barium is toxic by the oral route (Borzelleca et al., 1988, as cited in ATSDR, 1991). Reduced life span also has been observed in chronic oral studies with mice. These results from human case studies and acute and chronic studies with rodents suggest that humans who are exposed orally to high levels of barium may be at increased risk for mortality (ATSDR, 1991).

Target Organ Toxicity

Barium has been associated with a number of adverse health effects in both humans and experimental animals. Both human and animal evidence suggests that the cardiovascular system may be one of the primary targets of barium toxicity (ATSDR, 1991).

The US EPA has calculated an oral RfD of 7.0E-02 mg/kg/day based on increased blood pressure observed in subchronic to chronic human drinking water studies (IRIS, 1995). The UF of 3 is

used to account for sensitive individuals. A chronic RfC of 5.0E-4 mg/m^3 is listed in HEAST (1994). An inhalation RfD of 1.4E-04 mg/kg/day can be derived from this RfC. This would only apply to inhalation of barium from soil, sand, or dust. The RfC is based on fetotoxicity and has a UF of 1000.

Respiratory Effects. Benign pneumoconiosis has been observed in workers exposed occupationally by inhalation to barium (Doig et al., 1976, as cited in ATSDR, 1991). Acute intravasation of barium sulfate into the circulatory system of an adult female following a barium enema caused the compound to be deposited in blood cells throughout the body, including the lungs, and resulted in respiratory failure (Cove et al., 1974, as cited in ATSDR, 1991).

Developmental Toxicity

Results of a study which evaluated the correlation between barium concentrations in drinking water and human congenital malformation rates of the CNS indicated there was no correlation. However, another study suggested that exposure to barium may potentially be associated with adverse developmental effects. Reduced survival, underdevelopment, lowered body weight, decreased ability of the peripheral nervous system, and various blood disorders were reportedly noted in the offspring of rats following inhalation to barium for an intermediate exposure period. In the same study, increased mortality, increased leukocyte count, disturbances in liver function, and increased urinary excretion of hippuric acid were noted in the offspring of rats treated orally to barium during conception and pregnancy (Tarasenko et al., 1977, as cited in ATSDR, 1991)

Reproductive Toxicity

There are no studies regarding the reproductive effects of barium in humans (ATSDR, 1991). However, two animal studies have provided limited information suggesting that humans exposed to barium may be at increased risk for developing reproductive effects. Decreased ovary weight and decreased ovary/brain weight ratio have been noted in rats following acute oral exposure to barium. Intermediate inhalation exposure to barium has been associated in rats in one limited

study with disturbances in spermatogenesis, shortened estrous cycle, and alterations in the morphological structure of the ovaries and testes (Tarasenko et al., 1980, as cited in ATSDR, 1991).

Genotoxicity

Available data relating to the genotoxic effects of barium are derived from in vitro studies only; there were no available data regarding the genotoxicity of barium in vivo. A single recombination assay in which Bacillus subtilis was exposed to barium was negative for mutagenicity. Results of a test evaluating the fidelity of DNA synthesis in an avian myeloblastosis virus DNA polymerase system indicate that barium did not affect the accuracy of DNA replication (Nishioka, 1975 as cited in ATSDR, 1991)

Carcinogenicity

Two chronic oral studies which examined the incidence of tumors in rats and mice exposed to barium acetate in drinking water for lifetime were negative for carcinogenicity; however, they were inadequate for evaluating carcinogenic effects because insufficient numbers of animals were used, a complete histological examination was not performed, and only one exposure dose was evaluated (Schroeder and Mitchener 1975, as cited in ATSDR, 1991). Precancerous lesions were reported in one study in which a woman was treated on the cervix with a barium chloride solution; however, the relevance of this limited observation cannot be determined because only one subject was treated and because the vehicle solution was not specified (Ayre, 1966, as cited in ATSDR, 1991). Barium has not been evaluated by EPA for human carcinogenic potential (IRIS, 1995).

REFERENCES

Agency for Toxicological Substances and Disease Registry (ATSDR). Draft Toxicological Profile for Barium, February 15, 1991.

U.S. Environmental Protection Agency (EPA). Hazardous Substances Database (HSDB). 1995.

U.S. Environmental Protection Agency (EPA). Health Effects Assessment Summary Tables (HEAST). 1994.

U.S. Environmental Protection Agency (EPA). Integrated Risk Information System (IRIS). 1995.

CADMIUM

(CAS RN 7440-43-9)

Cadmium occurs naturally in the earth's crust, and low levels of cadmium are found in most waters. It is most often encountered in combination with other elements such as oxygen, chlorine, or sulfur. The largest anthropogenic source of cadmium in the general environment is the burning of fossil fuels (such as coal or oil) or the incineration of municipal waste materials. It may also escape into the air from zinc, lead, or copper smelters. Smoke from cigarettes also contains cadmium and most people who smoke have about twice as much cadmium in their bodies as nonsmokers.

Absorption/Distribution/Metabolism/Excretion

Cadmium is poorly absorbed from the GI tract. An average of only 3 to 6 percent of an oral dose of cadmium chloride has been reported to be retained by humans, with individual values ranging from about 1 to 7 percent. In animals, 0.5 to about 3 percent of an oral dose is retained

Absorption via inhalation is considerably greater than via ingestion, although this is limited to cadmium adsorbed to particulates of 0.1 mm or smaller which tend to be deposited in alveoli. For example, about 60 to 70 percent of a dose of cadmium instilled in rat lungs has been reported to be absorbed No direct measurements of alveolar absorption in humans are available, but calculations based on the increased body burden in smokers compared to that in nonsmokers suggest that respiratory absorption in man is probably about 30 to 60 percent. Small quantities of cadmium may also be absorbed through the skin.

Once absorbed, cadmium is widely distributed in the body with the major portion going to the liver and to the renal cortex of the kidney, where it accumulates. Cadmium is not known to undergo any direct metabolic conversions. It does, however, induce increased synthesis of the protein metallothionen, to which it is bound. When present in plasma the cadmium-metallothionen complex is readily diffusible and filterable at the glomerulus and is effectively

reabsorbed from the glomerular filtrate. This process effectively prevents efficient excretion of cadmium in the urine and contributes to the accumulation of cadmium in the kidney and liver.

Acute Toxicity

Acute oral exposure to 1,500 to 8,900 mg (20 to 130 mg/kg) cadmium or acute inhalation exposure to 40 to 50 mg/m^3 cadmium for 1 hour or to 9 mg/m^3 cadmium for 5 hours has been reported to cause death in humans. High oral exposures result in severe irritation of the GI tract including vomiting, diarrhea and abdominal pain. The concentration of cadmium in water that will induce vomiting is approximately 15 mg/L. High inhalation exposures are intensely irritating to respiratory tissues. Typical acute respiratory effects include severe tracheobronchitis (inflammation of the trachea and bronchi), pneumonitis (inflammation of the lung), and pulmonary edema (retention of fluid in the lung).

Acute oral LD_{50} values for cadmium in laboratory animals range from 50 to 350 mg/kg. Acute inhalation LD_{50} values range from 500 to 15,000 mg/m^3-minute.

Acute parenteral exposure of male rats to 2.2 mg/kg cadmium has resulted in marked necrosis and atrophy of the testes. Very large acute oral doses (100 mg/kg) have also been reported to cause similar testicular damage. Acute injections of cadmium also result in massive ovarian hemorrhage in female rats given subcutaneous injections of 2.3 to 4.6 mg/kg. Similar effects have been observed in mice. Hemorrhage and necrosis of the placenta of rats has also been observed following subcutaneous injection of 4.5 mg/kg cadmium on days 17 to 21 of gestation.

Target Organ Toxicity

The most commonly observed effects associated with chronic cadmium exposure are related to the accumulation of cadmium in the kidney, which occurs regardless of the route of exposure. It has been estimated that when accumulation of cadmium in the renal cortex reaches 200 µg/L wet weight renal cortex, the types of renal dysfunction described below will result.

Cadmium is unusual in relation to most of the substances for which an oral RfD has been determined in that a vast quantity of both human and animal toxicity data are available. The RfD is based on the highest level of cadmium in the human renal cortex not associated with significant proteinuria, which is 200 µg cadmium/gm wet weight human renal cortex. A toxicokinetic model was used to determine the level of chronic oral exposure that would result in this level of cadmium accumulation in the kidney (EPA, 1985 cited in ATSDR, 1989). Assuming that 2.5 percent of cadmium in food and 5 percent of cadmium in water is absorbed, and that 0.01 percent of the body burden of cadmium is eliminated each day, the model estimates that a daily dose of 0.005 mg/kg-day cadmium in water, or 0.01 mg/kg-day cadmium in food would result in a concentration of 200 µg Cd/gm wet weight renal cortex. These values are thus considered No Observed Adverse Effect Levels (NOAELs). When these values are adjusted to account for the possibility that some humans may be especially sensitive to cadmium-induced renal disease they become 0.0005 mg/kg-day for water and 0.001 mg/kg-day for food.

The EPA has derived an oral RfD of 0.0005 mg/kg-day for cadmium in water and 0.001 mg/kg-day for cadmium in food based on the occurrence of proteinuria in humans (IRIS, 7/92). EPA has not yet derived an inhalation RfC or RfD.

Renal Toxicity. Proximal tubular damage in the kidney as indicated by the presence of beta$_2$-microglobulin (microglobulinuria), lysozyme, ribonuclease, immunoglobulin light chains and retinol-binding protein in the urine occurs in workers exposed to cadmium via inhalation. This may be accompanied by depressed tubular reabsorption of other solutes, as well, such as enzymes, amino acids, glucose, calcium and inorganic phosphate. Microglobulinuria has also been reported in males in cadmium-polluted areas of Japan and Belgium.

These effects typically occur only after relatively long exposures to cadmium, or if cadmium levels have been acutely elevated. Following acute exposures, the relatively slow development of toxicity may represent the time required for cadmium to be redistributed in the body and the time required to reach a critical level in the renal cortex. Several estimates have indicated that

chronic exposures to 200 to 352 µg/day (about 0.003 to 0.005 mg/kg-day) cadmium over a period of 45 to 50 years would result in a critical level of cadmium in the renal cortex, and subsequent tubular proteinuria in at least 10 percent of an exposed population. A dose of 50 µg/day (about 0.0007 mg/kg-day) was estimated to cause tubular proteinuria in about 1 percent of an exposed population after 45 years. Via inhalation, it has been estimated that 10 percent of a worker population exposed to a concentration of 50 mg/m^3 would develop proteinuria in 10 years and that 1 percent would be affected at an exposure level of 16 µg/m^3. Exposures to 2.2 and 0.7 µg/m^3 cadmium for 50 years would result in similar renal dysfunction in 10 percent and 1 percent of the exposed population, respectively.

The renal response to cadmium exposure in laboratory animals appears to be similar to humans. In cadmium exposed rabbits, enzymuria occurred when the cadmium level in renal cortex reached 117 µg/L (dose not provided); aminoaciduria was observed at about 200†µg/L; and, low molecular weight proteinuria occurred when the renal cortex cadmium concentration was about 300 µg/L.

Musculo-Sketetal Toxicity. Painful bone disorders, including osteomalacia (softening of the bones), osteoporosis (bone thinning) and spontaneous bone fracture, have been observed in some humans chronically exposed to high levels of cadmium. These symptoms have been most thoroughly studied in postmenopausal women living in a cadmium-contaminated area in Japan where the affliction is called Itai-Itai disease. Osteomalacia has also been observed in some occupationally exposed workers. These effects on bone are generally considered to be indirect, arising as a consequence of cadmium-induced renal disease. (It should be noted that the role of cadmium as a direct cause of Itai-Itai disease is disputed. Some investigators argue that a nutritional deficiency plays the most important role and that cadmium exposure may simply enhance the incidence or severity of the disease through its effects on the kidney.)

Hematotoxicity. Some other effects reported to be associated with chronic occupational cadmium exposure are lowered hemoglobin concentrations and decreased packed cell volumes, and malabsorption of iron and various other solutes. Dyspnea (difficult breathing), emphysema,

decreased forced vital capacity, and increased mortality from respiratory disease have also been reported among populations chronically exposed to cadmium via inhalation. A positive correlation between increased mean renal cadmium concentrations in humans and the incidence of death from hypertensive disease has been reported by several laboratories. However, the incidence of hypertension is not known to be increased in human populations known to have been exposed to cadmium. A link between cadmium and hypertensive disease is therefore not certain.

Long-term oral cadmium administration has also been associated with anemia in mice and rats, and with increased passive avoidance behavior and neurobehavioral changes in rats.

Hepatotoxicity. Chronic oral exposure of rabbits to about 13 μg/kg/day cadmium in their drinking water, and of rats to 17 mg/L cadmium has been associated with structural changes in the liver. Changes in carbohydrate and ATP metabolism in the livers of rats have been reported following exposure to 25 ppm cadmium in their food.

Cardiotoxicity. A number of studies indicate that function of both the heart and the vascular system of laboratory animals may be impaired by cadmium exposure. Characteristic effects in the heart include decreased speed and strength of contractions. The effects in vascular smooth muscle may be either vasodilation or vasoconstriction, depending on conditions. Chronic exposure of rats to about 0.5 mg/kg-day cadmium in their drinking water resulted in small but significant increases in average systolic blood pressure. Changes were also observed in electrocardiograms of exposed rats. This hypertensive effect appears to be biphasic, reaching a maximum effect at doses around 0.1 mg/kg-day, but having no effect at exposure levels of 5 to 10† mg/kg-day.

Respiratory System Toxicity. Emphysema in rabbits and pulmonary fibrotic lesions in rats have been observed following chronic inhalation exposure to cadmium. Decreased calcium content in bone accompanied by marked rental tubular injury and increased urinary excretion of calcium have also been reported to follow chronic cadmium exposure of rats via inhalation.

Immunotoxicity. Relatively low doses of cadmium have been reported to alter the immune response in experimental animals. For example, decreased levels of spleen plaque-forming cells have been observed in mice exposed to 0.6 mg/kg-day for 10 weeks. Mice exposed to 5 to 50 mg/L cadmium in drinking water for 3 weeks exhibited immune suppression. Cadmium concentrations in the renal cortex of affected mice in these experiments was only 0.3 to 6.0 µg/L, which is considerably lower than the suggested critical level of cadmium in human renal cortex (200 µg/L) associated with toxicity.

Developmental and Reproductive Toxicity

As noted above acute parenteral exposure of rats to 2.2 mg/g or acute exposure to high oral doses, results in marked necrosis and atrophy of the testes. Single injections of 2.3 to 4.3 mg/kg cadmium to female rats or mice causes massive ovarian hemorrhage. Other reproductive effects include severely depressed testosterone levels and no viable sperm in male rats injected with doses of 1.8 mg/kg of cadmium chloride 14 days previously. Similarly, a marked reduction in sperm count of male rats injected with 1 mg/kg of cadmium chloride 15 days previously has been reported, although no decrease in fertility was observed until the dose reached 5 mg/kg.

Single injections (intravenous or subcutaneous) of high doses of cadmium during gestation result in teratogenicity and increased fetal mortality in hamsters (effective dose: 2 mg/kg) and mice (effective dose: 0.63 mg/kg). When exposure is via ingestion (about 10 to 15 mg/kg-day) the most common finding is decreased weight of offspring, usually without significant teratogenic or developmental effects. Congenital tail malformation was observed in a three generation study of rats exposed to 10 mg/L of cadmium chloride in drinking water (about 1 mg/kg-day) and sirenomelia (fused legs) was observed in offspring of rats dosed by gavage with cadmium chloride (40 mg/kg) on days 7 to 16 of gestation. Impaired neurobehavioral development in rats has been reported following exposure of female rats via gavage (0.4 or 4.0 mg/kg, given for 5 weeks preceding and continuing through gestation), via drinking water (60 mg/L given during

gestation), or via inhalation (0.02 or 0.16 mg/m^3, for 5 months preceding and continuing through gestation.

Exposure to airborne concentrations of 0.2 to 0.6 mg/m^3 during gestation results in a reduction of both maternal and fetal weight gain but no significant teratogenicity. Similarly, decreased pup weight and elevated perinatal mortality was observed in rats exposed to cadmium by inhalation to 3 mg/m^3, but no teratogenic or developmental effects were noted.

It should be noted that cadmium has not been observed to cause teratogenic or other developmental or reproductive effects in exposed humans.

Genotoxicity

Available data suggest that cadmium is mutagenic in mammalian cell culture assay systems. It is also mutagenic in both the mouse lymphoma assay and the Chinese hamster cell assay.

Conflicting results have been reported for chromosomal aberration studies using human lymphocytes from exposed workers, and using human and animal cell lines treated with cadmium in vitro. Chromosomal aberrations have been reported in hamster cells treated with cadmium sulfate or cadmium chloride and in human lymphocytes treated with cadmium acetate and cadmium sulfide. However, human lymphocytes treated with cadmium chloride in vitro showed no chromosomal aberrations. Lymphocytes taken from humans with above average cadmium exposure have produced both positive and negative responses.

Carcinogenicity

Epidemiological studies in humans exposed to cadmium provide limited evidence that inhaled cadmium is a human lung carcinogen. Thun et al. (1985 cited in ATSDR, 1989) reported that mortality from respiratory cancer tended to increase in a dose-dependent fashion in workers with cumulative levels of less than 585, between 585 -2,920 and greater than 2,920 mg cadmium/m^3-

days, although the increase was statistically significant only in the high dose group. These exposures correspond to time-weighted daily average levels of 168, 727 and 2,522†μg/m^3 cadmium, respectively. This observation is complicated by the fact that workers may have been exposed to other carcinogenic chemicals, including arsenic; and, exposure levels to both cadmium and arsenic were higher in previous years than in more recent years. Although some researchers have concluded that the observed excess in lung cancer is more likely to be due to arsenic than cadmium exposure (White 1985, Lamm 1987 cited in ATSDR, 1989), Thun et al. (1985) considered possible confounding by arsenic and concluded that arsenic exposure could not explain the observed excess in lung cancer.

An excess lung cancer risk has also been observed in three other studies but the EPA has concluded interpretation of the results of these studies is compromised by the presence of other carcinogens (arsenic, smoking) in the exposure, or by a small study population (Varner 1983; Sorahan and Waterhouse 1983; Armstrong and Kazantzis, 1983 cited in ATSDR, 1989).

Four studies of workers exposed to cadmium dust or fumes have provided evidence of a statistically significant association with prostate cancer (Kipling and Waterhouse, 1967; Lemen et al , 1976; Holden, 1980; Sorahan and Waterhouse, 1983 cited in ATSDR, 1989), but the total number of cases was small in each study.

Studies in animals have demonstrated that chronic inhalation exposure to cadmium chloride is associated with increased frequency of lung tumors. Takenaka et al. (1983 cited in ATSDR, 1989) exposed rats to aerosols of cadmium chloride at concentrations of 0, 12.5, 25 or 50†μg/m^3 for 18 months and observed a dose related increase in primary lung carcinoma frequency of 0, 15, 53 and 71 percent respectively. Mammary tumors in female rats, and tumors at multiple sites in male rats have been reported to follow intrathecal instillation of cadmium oxide (Sanders and Mahaffey, 1984 cited in ATSDR, 1989).

EPA has calculated unit risk values of lung cancer associated with lifetime exposure to a concentration of 1 μg/m^3 from both animal data (Takenaka et al., 1983 cited in ATSDR, 1989)

and human data (Thun et al., 1985 cited in ATSDR, 1989). The resulting values are 9.2×10^{-2} and 1.8×10^{-3} respectively. The California EPA (Cal EPA) has established an inhalation slope factor of 15 (Cal EPA, 1992).

There is no evidence to suggest cadmium is carcinogenic to either animals or humans via oral exposure.

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COPPER

(CAS RN 7440-50-8)

Copper is a reddish metal that occurs naturally in rock, soil, water, sediment, and air. Its average concentration in the earth's crust is about 50 parts per million. It is insoluble in hot and cold water but soluble in nitric acid or hot sulfuric acid (Weast, 1983, as cited in HSDB, 1995). Copper also occurs naturally in plants and animals. It is an essential element for all known living organisms including humans and other animals (ATSDR, 1990). Copper can be easily molded or shaped. Its reddish color is most commonly seen in the United States penny, electrical wiring, and some water pipes (ATSDR, 1990). Copper is used as a metal for electrical and electronic products (e.g., wire), building construction (e.g., plumbing pipes), industrial machinery, and equipment. In the transportation industry it is used in automobiles (HSDB, 1995). Copper has a boiling point of 2595°C, and a melting point of 1083°C (The Merck Index, 1983, as cited in HSDB, 1995).

Absorption/Distribution/Metabolism/Excretion

Copper oxide was observed in alveolar capillaries three hours after rats were exposed to a welding dust aerosol generated from pure copper wires (Batsura, 1969, as cited in ATSDR, 1990). Copper is absorbed in the stomach and small intestine. The site of maximal copper absorption is not known for humans, but it is assumed to be the stomach and upper intestine because of the rapid appearance of ^{64}Cu in the plasma after oral administration (Bearn and Kunkel, 1955, as cited in ATSDR, 1990).

Copper is absorbed from the GI tract as ionic copper, or is bound to amino acids (Crampton et al., 1965 as cited in ATSDR, 1990). Numerous factors may affect copper absorption. These factors include: (1) competition with other metals, including zinc and cadmium (Davies and Campbell, 1977, as cited in ATSDR, 1990); (2) the amount of copper in the stomach (Farrer and Mistilis, 1967, as cited in ATSDR, 1990); (3) certain dietary components; and (4) form of copper.

The absorption of copper appears to be inversely related to the amount of copper in the GI tract (Strickland et al., 1972, as cited in ATSDR, 1990).

Absorbed copper loosely binds to plasma albumin and amino acids in the portal blood, and is taken to the liver (Marceau et al., 1970, as cited in ATSDR, 1990). In the liver, copper is incorporated into ceruloplasmin and released into the plasma. Radioactive copper does not accumulate in extrahepatic organs until after the emergence of ceruloplasmin-^{64}Cu, suggesting that ceruloplasmin is a copper donor for the tissues (Owen, 1965, as cited in ATSDR, 1990).

The metabolism of copper consists mainly of its transfer to and from various organic ligands, most notably sulfhydryls and imidazole groups on amino acids and proteins. Several specific binding proteins for copper have been identified that are important in the uptake, storage, and release of copper from tissues. In the liver and other tissues, copper is stored bound to metallothionein and amino acids and in association with copper-dependent enzymes. Several studies have shown that copper exposure induces metallothionein synthesis (Mercer et al., 1981, as cited in ATSDR, 1990).

Bile is the major pathway for the excretion of copper. After the oral administration of radioactive copper as copper acetate in healthy humans, 72% was excreted in the feces (Bush et al., 1955, as cited in ATSDR, 1990). Normally, 0.5 - 3.0 percent of daily copper intake is excreted into the urine (Cartwright and Wintrobe, 1964, as cited in ATSDR, 1990). Biliary excretion of copper does not increase proportionally with dosage, suggesting that the hepatobiliary transport of copper is saturable (Gregus and Klaassen, 1986, as cited in ATSDR, 1990). Thus, at high copper intakes, urinary copper excretion increases (Gitlan et al., 1960, as cited in ATSDR, 1990).

Acute Toxicity

The only significant example of copper toxicity in humans is Wilsonís disease (Hepatolenticular degeneration), an autosomal recessive disorder that affects normal copper homeostasis. The disease is characterized by excessive retention of hepatic copper, decreased concentration of

plasma ceruloplasmin, impaired biliary copper excretion, and hypercupruria. The systemic manifestations of Wilsonís disease are hepatic and renal lesions and hemolytic anemia (Schroeder et al., 1966, as cited in ATSDR, 1990).

There are several reports of humans dying as a result of copper poisoning. Most of these involve the ingestion of large amounts of copper. Chuttani et al. (1965, as cited in ATSDR, 1990) attributed these deaths to extensive hepatic centrilobular necrosis. Deaths in animals given >250 mg Cu/kg/day in the diet have also been attributed to extensive hepatic centrilobular necrosis.

Target Organ Toxicity

The primary toxicological effects of consuming high levels of copper in humans is GI irritation, manifested as vomiting, nausea, diarrhea, and anorexia. Centrilobular necrosis of the liver and necrosis and sloughing of tubular cells in the kidney have been observed in individuals dying from copper poisoning (Chuttani et al., 1965, as cited in ATSDR, 1990).

The US EPA has listed a drinking water standard for copper of 1.3 mg/L (HEAST, 1994) from which an oral RfD of 3.7E-2 mg/kg/day can be derived.

Immunological Effects. Dermal exposure to copper results in contact allergic dermatitis in some individuals (Barranco, 1972, as cited in ATSDR, 1990). Inhalation studies in mice confirm the finding of impaired immune function after exposure to copper (Drummond et al., 1986, as cited in ATSDR, 1990).

Neurological Effects. Neurological effects have not been observed in healthy humans exposed to high levels of copper in drinking water. However, a clinical manifestation of Wilsonís disease is CNS degenerative changes. Symptoms include poor coordination, psychological impairment, tremor, disturbed gait, and rigidity (Strickland and Leu, 1975, as cited in ATSDR, 1990). Although neurotoxicity has not been observed in animals exposed to high levels of copper,

increased concentration of copper in the brain has been observed in rats given high levels of copper orally or intraperitoneally (DeVries et al., 1986, as cited in ATSDR, 1990).

Developmental Toxicity

Increased fetal mortality and developmental abnormalities have been observed in mice, mink, and hamsters either injected with copper or fed a diet high in copper (Aulerich et al., 1982, as cited in ATSDR, 1990). Developmental effects have been observed in minks administered doses 50 times lower than those given to mice and hamsters. Furthermore, distinct developmental effects in minks have resulted from dietary levels of copper that were well below the levels that would have been expected to cause maternal toxicity. Although developmental effects have not been reported in humans, there is a possibility that there may be an increased incidence of spontaneous abortion and miscarriage in women exposed to high levels of copper (ATSDR, 1990).

Reproductive Toxicity

Although reproductive performance was not adversely affected in minks fed a diet high in copper (Aulerich et al., 1982, as cited in ATSDR, 1990), the insertion of copper wires into the vas deferens or uterus prior to conception or at gestational day 3 resulted in decreased fertility or decreased number of implantation sites in monkeys, rats, hamsters, and rabbits (Chang and Tatum, 1970, as cited in ATSDR, 1990).

Genotoxicity

Several in vitro studies have examined genotoxic effects of copper in nonhuman systems. The results of tests using prokaryotic organisms are equivocal. However, positive results have been observed in vitro and in vivo in mammalian systems. At low levels (0.01 - 0.1 mM Cu as copper sulfate), DNA strand breaks were not observed in rat hepatocytes; however strand breaks did occur at high concentrations (0.04 mM Cu as copper sulfate) (Sina et al., 1983, as cited in

ATSDR, 1990). Although there are no data on the mutagenicity of copper in humans, in vivo studies and mammalian system in vitro studies suggest that copper is a potential human mutagen.

Carcinogenicity

An elevated incidence of cancer has not been observed in humans or animals exposed to copper via inhalation, oral, or dermal routes of exposure. The US EPA classifies copper as a Class D carcinogen (not classified) based on the fact that there are no human data, inadequate animal data from assays of copper compounds, and equivocal mutagenicity data (IRIS, 1995).

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2,4-DINITROTOLUENE and 2,6-DINITROTOLUENE
(CAS RN 121-14-2)

Isomers of dinitrotoluene (DNT) are yellow crystals at 20• C and 1 atm. Isomers of DNT are produced by the nitration of toluene. The major use of DNT is in the production of toluene diisocyanate which is, in turn, used to produce polyurethane foams. Six hundred million pounds of DNT were converted to flexible polyurethane foams in 1980 (Hartter, in press). The composition of DNT which is generally used in commercial applications is approximately 80 percent 2,4-DNT and 20 percent 2,6-DNT. Three separate oncogenicity assays have been completed, the dinitrotoluenes and their putative metabolites have been subjected to a wide range of short term tests for potential carcinogenicity, the compounds have been extensively tested for reproductive effects in animals and humans, and the metabolism and disposition of each of the six possible isomers have been studied in varying degrees of detail.

Absorption/Distribution/Metabolism/Excretion

In Vitro Metabolism. Incubation of DNT with hepatic postmitochondrial supernatant fraction or microsomes under anaerobic conditions yielded primarily aminonitrotoluenes, regardless of the species used. It has been suggested that at least a part of the reduction of 2,4-DNT to aminonitrotoluenes under anaerobic conditions was dependent upon cytochrome P-450 in postmitrochondrial supernatant fractions of rat liver. The females of each species (including mouse, rat, rabbit, dog, and monkey) produced markedly less aminonitrotoluenes than did males The sex differences largely disappeared if the incubations were performed under air and the total amounts of aminonitrotoluenes formed decreased as well.

In summary, the metabolism of dinitrotoluenes in vitro suggests that both hepatic and microfloral enzymes can effect reduction of the parent compounds to corresponding aminonitrotoluenes through potentially toxic nitroso and hydroxylamino compounds. It is clear that microorganisms

can accomplish this under physiologic conditions. It is not clear whether hepatic enzymes accomplish reduction under physiologic conditions.

In Vivo Metabolism. The literature suggests that there may be marked species and strain differences in the excretion of dinitrotoluene isomers. Female CD rats given doses of 2,3-, 2,4-, 2,5-, 2,6-, or 3,4-DNT ranging from 62 to 190 mg/kg (doses were 0.1 the LD and, thus, varied with the isomer) excreted 60 to 80 percent of the dose in the urine in 24 hr. Fecal excretion was less important and accounted for 9 to 32 percent of the dose in 24 hr. Urine was also the major route of excretion of 2,4- and 2,6-DNT by male and female Fischer-344 rats (15 to 30 percent excreted in feces and 55 to 90 percent excreted in the urine in 72 hr) when doses of 10 to 100 mg/kg were given.

A variety of urinary metabolites of the dinitrotoluenes have been identified. The following metabolites were identified in male Wistar rat urine during and following six consecutive daily doses of 2,4-DNT (25 mg/kg/day): 2-amino-4-nitrotoluene, 4-amino-2-nitrotoluene, 2,4-diaminotoluene, 2,4-dinitrobenzyl alcohol, 2-amino-4-nitrobenzyl alcohol, 4-amino-nitrobenzyl alcohol, 4-acetylamino-2-nitrotoluene, 4-acetylamino-2-aminotoluene, and 4-acetylamino-2-aminobenzoic acid.

Although there appear to be substantial strain and species differences in the metabolism of the dinitrotoluenes excreted, it is clear that the dinitrotoluene molecule undergoes both oxidation at the methyl group and reduction at one or more of the nitro groups.

Dinitrotoluene is absorbed from the GI tract and is converted in the liver first to dinitrobenzyl alcohol and then to dinitrobenzyl alcohol glucuronide. In male rats the glucuronide is preferentially excreted in the bile, but in female rats it is returned to the general circulation. Once in the bile, the glucuronide is transported to the small intestine where it is poorly reabsorbed.

Preliminary data have demonstrated that workers exposed to DNT excrete 2,6-DNT as 2,6-dinitrobenzoic acid and 2,6-dinitrobenzyl alcohol glucuronide. These metabolites are similar to those excreted by Fischer-344 rats and indicate that humans and rats may metabolize 2,4-DNT by similar routes.

Acute Toxicity

The toxic signs of acute DNT intoxication include CNS depression, respiratory depression, and ataxia. The lethal doses of the various DNT isomers in rats and mice have been reported (Ellis et al., 1979) and range from 216 mg/kg for 3,5-DNT in female rats to 1954 mg/kg for 2,4-DNT in male mice. 3,5-DNT consistently had the greatest toxic effect in both sexes of both species when compared to the other isomers. The individual isomers were generally less toxic in mice than in rats. The lethal dose of 2,4-DNT was much lower for cats (27 mg/kg) than for rodents.

The local irritation effect of DNT has been determined for the skin and eye in rabbits (Ellis et al., 1979). 2,5-DNT was moderately irritating while 2,3- and 3,4-DNT were mildly irritating to the skin; 2,4-, 2,6-, and 3,5-DNT were nonirritating to the skin. All six isomers were found to be nonirritating in the eye. Dermal sensitivity studies in guinea pigs indicated that 2,6-DNT gave a mild response. In contrast, the five isomers of DNT had no sensitizing activity.

In several chronic feeding studies, DNT reduced the rate of weight gain in both sexes of rats and mice (Anon, 1978) (Anon, 1979) (Ellis et al., 1979) (Kozukay et al., 1979). In these relatively recent studies, the animals were fed standard commercially available laboratory animal diets. Older literature indicated that both reduction of body weight gain and lethality can be at least partially blocked by high dietary fat content and increased caloric intake in rats and mice (Clayton and Baumann, 1948) (Clayton and Baumann, 1944) (Goldwater and Shils, 1949) (Shils and Goldwater, 1953).

Target Organ Toxicity

Toxic effects of DNT have been described for several different organ systems. In general, the hematologic results indicated a low-grade regenerative anemia in rats fed either 2,4-DNT at a constant dietary concentration 0.07 percent (Ellis et al., 1979) or fed technical grade DNT (75.8 percent, 19.5 percent 2,6-DNT, 4.7 percent other isomers) at a constant daily intake (35 mg/kg/day) (Anon, 1979). Confusion from this study resulted because the anemia and subsequent response produced alterations in erythrocyte counts, hemoglobin concentration, corpuscular volume, and reticulocyte numbers that were borderline statistically significant (Ellis et al., 1979). Therefore the response was no always consistent when a single hematologic parameter was simply evaluated on the basis of a statistical difference from the control group.

Methemoglobinemia has been reported in the cat after intraperitoneal injection of DNT (Kiese, 1974). A one-month recovery after either 12 or 24 months of 2,4-DNT treatment in rats and dogs resulted in the return of hematologic parameters to normal.

Neuromuscular effects of 2,4-DNT were noted in dogs based on clinical observations and histologic examination of tissues (Ellis et al., 1979; Ellis, Hong, and Lee, 1979) although the response among individual animals was extremely variable. The first neurological signs were noted in a male dog receiving 10 mg/kg/day of 2,4-DNT for 8 weeks and consisted of tremors followed by extensor rigidity. When the rigidity progressed to include the neck muscles, the animal was killed for necropsy. Histologic brain lesions, including encephalomalacia, enlarged astrocytes, and hypertrophy and mitosis of endothelial cells were noted in the cerebellum. Perivascular hemorrhage was found in the cerebellum and brain stem of two dogs which died, but such lesions were not identified in the animals killed at scheduled times.

Hepatotoxic effects of DNT have also been demonstrated. In rats fed tDNT (14 or 35 mg/kg/day), degenerative and proliferative alterations of the hepatocytes and bile duct epithelium were noted as early as 26 weeks (Anon, 1979). In general, lesions were more severe in male than in female rats, were dose dependent within a single sex group, and tended to progress throughout the 24-month feeding period. In dogs 2,4-DNT (10 mg/kg/day) fed for three months resulted in

hyperplasia of the biliary and gall bladder epithelium (Ellis et al., 1979). No hepatocellular alterations were reported.

The EPA has established an oral RfD of 2.0E-03 for 2,4-Dinitrotoluene (IRIS, 1994).

Reproductive Toxicology

2,6-DNT administered to beagle dogs at up to 100 mg/kg/day for 13 weeks caused degeneration of the testes and depression of spermatogenesis (Lee et al., 1976). CD rats fed up to 155 mg/kg/day of 2,6-DNT for 13 weeks had similar testicular atrophy and aspermatogenesis. Market aspermatogenesis was seen in Swiss mice fed up to 289 mg/kg/day of 2,6-DNT for 4 weeks (Lee et al., 1976).

Beagle dogs administered up to 5 mg/kg/day of 2,4-DNT for 13 weeks had a decrease in spermatogenesis (Lee et al., 1976). CD rats fed up to 265 mg/kg/day 2,4-DNT for 13 weeks had severe atrophy of the testes with no germ cells in any stage of spermatogenesis (Lee et al., 1976). In contrast, Swiss mice fed up to 468 mg/kg/day of 2,4-DNT for 13 weeks had no testicular lesions (Lee et al., 1976). No testicular lesions were noted in the beagle dogs administered up to 10 mg/kg/day 2,4-DNT for 2 years (Ellis et al., 1979), which is inconsistent with the results reported in the subchronic study cited above from the same laboratory (Lee et al., 1976). Swiss mice fed up to 900 mg/kg/day for 2 years had atrophy of the testes and nonfunctioning follicles in females as determined by lack of corpora lutea (Ellis et al., 1979).

Because of the observed adverse effects on the male and female reproductive systems, a comprehensive three-generation reproduction study was performed in CD rats. Even though body weights in the treated F0 and F1 animals were only 75 percent that of controls, no treatment effects on the fertility of the males or females were apparent. AT the highest dose there was lowered viability of the F1 generation and no F2 generation survived to mating age, but this was due to maternal neglect during parturition and not to 2,4-DNT administration. No treatment-related effects were seen on liveborn index, weight at birth, litter size, weight at weaning, or sex

ratio (Ellis et al., 1979). The lack of effect on reproductive performance by 2,4-DNT in this rigorous study is most interesting when compared with the adverse histological effects on germ cell producing organs by 2,4-DNT at higher doses.

A NIOSH study of 30 workers exposed to DNT and diaminotoluene (TDA) in a chemical plant reported a decrease in sperm counts relative to controls, a slight change in one category of abnormal sperm, and a small, but statistically insignificant, increase in spontaneous abortions for the wives of those exposed (Ahrenholtz, 1980). No difference between exposed and nonexposed workers was reported in renal or hepatic blood chemistry profiles. In another study, 579 employees of three U.S. chemical plants involved in DNT manufacture responded to questionnaires designed to assess fertility. No statistically significant differences were found when fertility was compared in persons at risk from exposure to DNT and in those with no such expected exposure (Levine et al., in press). The authors calculated that, in general, their method would have detected a true reduction of 50 percent in fertility 90 percent of the time.

Genetic Toxicology

The most thorough and quantitative analysis of the mutagenic potential of the dinitrotoluenes (Couch et al., 1981) showed all isomers of DNT and tDNT to be weakly mutagenic in at least one of the base pair substitution or frame shift strains in the *Salmonella*/microsome plate incorporation assay, with less activity in the presence of an S9 liver homogenate activation system. Similar studies showed that 2,4-DNT and 2,6-DNT were without activity in TA98 while both isomers exhibited modest activity in TA100 (Spangoord et al., 1982; Tokiwa et al., 1981). Based on their results Spanggord et al. presented a detailed discussion of potency and mechanism of action. Their conclusions, however, are limited because the assay used was not quantitative and the active mutagenic species was unknown. Hodgson et al. (Hodgson et al., 1976) reported a positive result with 2,4-DNT in strain TA 1535 contrary to two studies discussed above.

DNT isomers often exhibited high cytotoxicity such that concentration versus mutagenesis activity curves showed a sharp peak of activity within a narrow concentration range. 2,4-DNT

produced a dose-related response reaching only five-fold over control frequencies at 500 mg/mL with no difference upon addition of liver postmitochondrial supernatant (PMS) (Couch et al., 1981). 2,6-DNT produced an almost identical response. 3,5-DNT was approximately an order of magnitude more potent than any of the other isomers, again with or without a PMS.

Studies have confirmed that products of both oxidative and reductive metabolism are somewhat more mutagenic in bacteria than the parent DNT compounds. Because the ultimate carcinogen in vivo has not yet been identified, it remains unclear how important the activity due to any one of these metabolites may be.

The bacterial mutagenesis assays failed to predict the carcinogenicity of tDNT, failed to predict the large differences in carcinogenic potency between the 2,6-DNT and the 2,4-DNT isomers, and could not address questions regarding reasons for differences in carcinogenic potency of tDNT between male and female rats.

The recessive spot test is designed to detect induced mutations at a specific coat color loci in selected strains of mice (Russell and Major, 1957). The target cells at the time of exposure are embryonic neural crest cells when the pregnant female is treated at day 10.25 following conception. No response was seen in the recessive spot test in mice from mothers treated intraperitoneally with 100 mg/kg tDNT (Soares and Lock, 1980).

Carcinogenicity

Three independent chronic bioassays of DNT have been completed with dramatically different results. The variation can be partially explained based on differences in the conditions of the three bioassays. A 2-year feeding study sponsored by the Chemical Industry Institute of Toxicology (CIIT) indicated that tDNT was hepatocarcinogenic in Fischer-344 rats (Anon, 1979). Two high-dose males (35 mg/kg/day) had developed hepatocellular carcinomas as early as 26 weeks. After 1 year of feeding, 100 percent of the high-dose male rats had developed hepatocellular carcinomas while 50 percent of the high-dose females had developed

hepatocellular carcinomas 952-week and 55-week data combined). Nearly all the high-dose female animals without hepatocellular carcinomas had neoplastic nodules after 1 year A bioassay sponsored by the National Cancer Institute (NCI) (Anon, 1978) used 96 percent pure 2,4-DNT in contract to the technical grade DNT used in the CIIT bioassay. Fischer-344 rats were fed a constant dietary level of 0.008 percent (low dose) and 0.02 percent (high dose) for 78 weeks followed by 26 weeks on control diet. B6C3F1 mice were fed constant dietary levels of 0.008 percent (low dose) and 0.04 percent (high dose) for 78 weeks followed by 13 weeks of control diet. Both the low- and high-dose male rats had an increased incidence of fibromas in the skin and subcutaneous tissue, while the high-dose females had an increased incidence of fibroadenoma of the mammary glands. Neither six of Fischer-344 rats used in this study had a statistically significant increase in hepatic neoplasms. The DNT-fed mice did not have an increased incidence of any neoplasms compared to the control animals.

In a third carcinogenicity study, funded by the U.S. Army and conducted at Midwest Research Institute, Sprague-Dawley rats and Swiss mice were fed diets containing 15, 100, or 700 ppm of a mixture containing 98 percent 2,4-DNT and 2 percent 2,6-DNT for up to 2 years (Ellis et al., 1979). These diets provided an average intake of 2,4-DNT of 0.575, 3.92, or 34.5 mg/kg/day for the male rats and 0.706, 5.14, or 45.3 mg/kg/day for female rats. Hepatocellular carcinomas were significantly elevated in the high-dose females only (18/34 high-dose females compared to 0/23 for control females). High-dose males had an increase in hepatocellular carcinomas (6/29), but the elevation was not statistically significant when compared to control males (1/25).

In summary, the carcinogenicity of DNT has been demonstrated in three independent bioassays, but the site of tumor formation and the potency of DNT varied substantially among the studies. The hepatocarcinogenicity of tDNT demonstrated in the CIIT study contrasted to the lack of hepatocarcinogenicity for the 95 percent pure 2,4-DNT in the NCI study suggested that some isomer other than 2,4-DNT must have a major role in the hepatocarcinogenicity of tDNT. Therefore, the role of the individual isomers in the hepatocarcinogenicity of tDNT was extensively explored.

The ability of DNT to act as a promoter was determined by feeding tDNT or the purified isomers to male, Fischer-344 rats for up to 12 weeks after diethylnitrosamine initiation. tDNT, 2,4-DNT, and 2,6-DNT possessed demonstrable foci-enhancing activity (Leonard et al., 1982; Leonard and Popp, 1982). Of these, 2,6-DNT was the most active.

The initiating and promoting activity demonstrated in short-term in vivo assays strongly suggested that 2,6-DNT should be hepatocarcinogenic. This hypothesis was recently tested in a series of 1-year feeding studies of tDNT, 2,4-DNT (99.9 percent purity), and 2,6-DNT (99.9 percent purity) (Popp and Leonard, 1983). 2,6-DNT (14 or 7 mg/kg/day) was hepatocarcinogenic while 2,4-DNT (27 mg/kg/day) was not. This result helps to explain the different results obtained in the NCI and CIIT bioassays. Apparently, the hepatocarcinogenicity of tDNT is predominantly the result of the 2,6 isomer. The absence of hepatocarcinogenicity of 2,4-DNT in the NCI bioassay may have been due to the lack of initiated sites.

The EPA has established an oral slope factor of 6.8E-01 mg/kg/day for 2,4-dinitrotoluene (IRIS, 1994). Cal EPA has established an inhalation slope factor of 3.1E-01 for 2,4-dinitrotoluene (Cal EPA, 1992).

Summary

While the acute toxicity of DNT in experimental animals is not remarkable, various mixtures of DNT isomers produced positive results in three different oncogenicity assays. In the face of these positive results, DNT isomers exhibited only weak activity in the *Salmonella*/microsome assay and no activity at all in various mammalian cell culture genotoxicity assays, including DNA repair assays in primary rat hepatocyte cultures. Furthermore, each oncogenicity assay produced different conclusions regarding the potency of DNT as a carcinogen, the site at which DNT produced tumors, and the relative tumorigenicity of DNT in male and female rats. The results of this research have shown that, of the two isomers which comprise the majority of the commercially important mixture, only 2,6-DNT has carcinogenic effects in Fischer-344 rats.

The work on DNT has thus provided both a basis for future basic research into the mechanisms of carcinogenicity and a basis from which to work toward a rational assessment of risk for exposed humans. Because nitroaromatic compounds, in general, are important as environmental contaminants and as chemical intermediates, understanding the disposition of one group of these compounds may aid in the assessment of risk from the others as well.

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DIOXIN/FURAN

No data were located regarding the pharmacokinetics of the polychlorinated dibenzo-p-dioxins (PCDDs) or (PCDFs) of concern; however, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) has been used as a surrogate for other structurally similar members of these chemical classes.

Absorption/Distribution/Metabolism/Excretion

Estimates of the GI absorption of TCDD ranged from 50 to 86 percent of the administered dose in rats; comparable data were obtained for rats and hamsters. In rats treated dermally with 26 ng TCDD in methanol dermal absorption after 24 hours approximated 40 percent of that absorbed by the GI tract after an equivalent dose in ethanol. Dermal absorption from vaseline or polyethylene glycol vehicles was substantially less than from methanol, but quantitative estimates cannot be made from the available data.

Target Organ Toxicity

In rodents given single oral or intraperitoneal doses, or treated for two years with TCDD in the diet, the highest concentrations and greatest tissue depots occurred in the liver, followed closely by adipose tissue. Concentrations in other tissues were considerably lower than those in fat. Mouse liver continued to sequester TCDD more efficiently with prolonged exposure. In nonhuman primates and guinea pigs, however, greater TCDD concentrations and tissue depots occurred in the adipose tissue than in the liver. Data obtained at necropsy from one woman potentially exposed to TCDD, showed concentrations in adipose tissue about an order of magnitude higher than levels in the liver. Radioactivity from intravenous dosing with [^{14}C]2,3,7,8-TCDD has been shown to cross the placenta of rats and mice; concentrations of fetal tissues were lower than in maternal tissues.

In rodents and guinea pigs, TCDD was metabolized by microsomal mixed-function oxidase enzymes to hydroxylated derivatives that were conjugated with glucuronide or sulfate for

excretion via the bile or urine, respectively. The hydroxylation of several different PCDDs in the rat was postulated to involve formation of arene oxide intermediates (EPA, 1985). In rats, the metabolism of TCDD was inducible but relatively slow, about four orders of magnitude slower than the metabolism of benzo(a)pyrene. There was considerable species variation in the rate of metabolism of TCDD.

Studies with [^{14}C]2,3,7,8-TCDD showed that fecal excretion accounted for 39 to 99 percent of the total (fecal and urinary) excretion of radioactivity (EPA, 1985). Elimination half-lives (assuming first order kinetics) ranged from 11 to 30 days, inversely correlated with species sensitivity to TCDD. There was considerable interspecies variation in the relative importance of fecal versus urinary excretion and in the elimination half-lives.

The only effect in humans clearly attributable to TCDD was chloracne (ATSDR, 1989). The available data, however, also associated exposure to TCDD with hepatotoxicity and neurotoxicity in humans. In animals, TCDD toxicity is most commonly manifested as a wasting syndrome with thymic atrophy terminating in death, with a large number of organ systems showing nonspecific effects. Chronic treatment of animals with TCDD or a mixture of two isomers of hexachlorodibenzo-p-dioxin resulted in liver damage. Immunologic effects may be among the more sensitive endpoints of exposure to the PCDDs in animals. TCDD is a developmental and reproductive toxicant in animal models. California DTSC has established an oral RfD of 1×10^{-9}

Carcinogenicity

The EPA (1992) has verified dibenzofuran as a cancer weight-of-evidence Group D compound (not classifiable as to carcinogenicity to humans), based on a lack of cancer data in humans or animals. Data regarding human carcinogenicity of TCDD obtained from epidemiologic studies of workers exposed to pesticides or to other chlorinated chemicals known to be contaminated with TCDD, are conflicting (ATSDR, 1989). The interpretation of these studies is clouded, because exposure to TCDD was not quantified, multiple routes of exposure (dermal, inhalation, oral) were involved, and the workers were exposed to other potentially carcinogenic compounds.

TCDD, however, is clearly carcinogenic in animal models, inducing thyroid, lung, and live tumors in orally treated rats and mice (EPA, 1985). Similarly, oral treatment with a mixture of two hexachlorodibenzo-p-dioxin isomers induced liver tumors in rats and mice. On the basis of the animal data, TCDD and the hexachlorodibenzo-p-dioxins were assigned to EPA cancer weight-of-evidence Group B2 (probably human carcinogen). Although the PCDDs and PCDFs of concern were not classified, they are treated as probable human carcinogens, for which slope factors are derived.

The EPA (1993) has presented provisional oral and inhalation slope factors for TCDD of 150,000†mg/kg/day, based on the incidence of liver and lung tumors in an oral study in rats. In the absence of satisfactory congener-specific cancer data, the EPA (1989) derived toxicity equivalency factors (TEFs) for the other PCDDs and PCDFs, by assuming that all manifestations of toxicity for all members of these classes are mediated by a common mechanism (i.e., binding to the intraculluar AH receptor of target cells).

Considerable uncertainty surrounds the carcinogenic potential of the PCDDs and PCDFs of concern. Although TCDD is classified as a weight-of-evidence Group B2 substance, the homologues of concern are not classified. The appropriateness of estimating cancer potency of (i.e., regulating as carcinogens) compounds not assigned to a cancer weight-of-evidence group is questionable (EPA, 1986).

There is uncertainty about the slope factor for TCDD. Additional uncertainty is introduced by the use of the TEFs themselves, most of which were derived not from cancer data, but from in vitro data such as enzyme induction, which is only hypothetically related to a carcinogenic role. For example, the TEF of 0.001 for octachlorodibenzo-p-dioxins (OCDDs) and octachlorodibenzofurans (OCDFs) is based on the appearance of "dioxin-like" effects and detectable levels of OCDD late in a 13-week study of male rats treated with OCDD (Couture et al., 1988) and on in vitro evidence of enzyme induction (EPA, 1989). Before the Couture et al. (1988) paper was available, the TEF for these homologues, based on limited in vivo and in vitro data was 0.0.

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HMX

(CAS RN 2691-41-0)

Noncarcinogenic Effects

In humans, HMX (octahydro-1,3,5,7-tetranitro-1,3,5,7-tetracine) has been reported to cause skin irritation by direct application, but no other adverse effects were observed during possible occupational exposure (USEPA 1988). HMX is poorly absorbed from the gastrointestinal tract of laboratory animals (USEPA 1988); about 70% of the original dose is recovered unmetabolized in the feces. The AFo for HMX is assumed to be 0.30. Toxic effects are observed only at relatively high doses; the oral LD50 values range from 2,300 mg/kg in rats to 6,300 mg/kg in mice (USEPA 1988).

Adverse effects to the liver and kidneys were observed in rats and central nervous system effects and increased mortality were reported in mice following subchronic oral exposure to HMX (USEPA 1988b). Central nervous system effects (hyperkinesia and excitability) were observed in mice given doses as low as 100 mg/kg-day in the diet for 14 days (Greenough and McDonald 1985) and increased mortality was reported at higher doses.

It appears that the target organ response of rats to HMX is sex-specific. Everett et al. (1985) reported liver lesions in male rats and kidney lesions in female rats following administration of HMX in the diet for 13 weeks at doses of 450 to 4,000 mg/kg-day. No adverse effects were reported in males given 50 mg/kg-day or in females given 115 mg/kg-day. Based on the NOAEL of 50 mg/kg-day in male rats and 115 mg/kg-day for female rats (IRIS 1994), the USEPA calculated a chronic oral RfD of 5E-2 mg/kg-day. The confidence rating of the RfD is low, since interpretation of some data from the principal study was difficult, some endpoints were not evaluated at lower doses and no long-term studies or studies on reproductive effects or developmental toxicity were available. USEPA did not consider available data adequate to calculate an inhalation RfD (IRIS 1998).

USEPA has not derived a subchronic RfD for HMX. However, the chronic oral RfD was derived from the 13-week study of Everett et al. (1985), with an uncertainty factor that included a factor of 10 for extrapolation from subchronic to chronic duration (IRIS 1998). On this basis, to evaluate subchronic effects of HMX at the site, a subchronic RfD of 5E-1 mg/kg-day will be used.

Carcinogenic Effects

No studies were located on the carcinogenicity of HMX to any species by any route of exposure. HMX was found not to be mutagenic in several microbial systems (USEPA 1988). Gene mutation assays in several strains of Salmonella typhimurium were negative (Simmon et al 1977, Stilwell et al., 1977, Whong et al. 1980) and a mitotic gene conversion assay in Saccharomyces cerevisiae was also negative (Simmon et al. 1977). However, these results are considered inconclusive because of the low concentrations assayed or the lack of data in the reports (USEPA 1988). Based on the lack of epidemiological studies or cancer bioassays, the USEPA has classified HMX in Group D (not classifiable as to human carcinogenicity) (IRIS 1998).

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LEAD

(CAS RN 7439-92-1)

Lead is a naturally occurring bluish-grey metal found in small amounts in the earth's crust. It is found in plants and animals, air, drinking water, rivers, lakes, oceans, dust, and soil. Lead remains in soil for many years. Mixed ores or recycled scrap are the source of lead to industry. Its main use is in the manufacture of storage batteries followed by production of chemicals including paints, gasoline additives, various metal products, and ammunition.

The largest source of lead in air is from vehicle exhaust. Other sources include emissions from iron and steel production, smelting operations, municipal waste incinerators, and lead-acid-battery manufacturers. Lead is also present in tobacco smoke. The main sources of lead released to water are lead plumbing and solder in buildings; lead-containing dust and soil carried into water by rain and wind; and wastewater from industries using lead.

Exposure to lead may occur via breathing air, drinking water, and eating soil or foods that contain lead. Another source, for children, is from swallowing non-food items such as chips of lead-containing paint (i.e., pica).

Absorption/Distribution/Metabolism/Excretion

The rate and degree of lead absorption are largely related to its solubility in body tissues and fluids, among other factors. Upon inhalation, some fraction of inhaled airborne and orally ingested lead is deposited in the respiratory tract. The rate of deposition in adult humans is approximately 30 percent to 50 percent. Upon deposition in the lower respiratory tract, all chemical forms of lead are almost completely absorbed. Approximately 20 percent of inhaled lead was absorbed within 1 hour, and 70 percent was absorbed within 10 hours in humans breathing lead-containing engine exhausts or lead oxide and lead nitrate aerosols at 2 to 10†$\mu g/m^3$ lead (Chamberlain et al., 1978 cited in ATSDR, 1986). Inhaled lead is absorbed extensively and rapidly in animals as well. Morgan and Holmes (1978 cited in ATSDR, 1986)

estimated absorption rates of 50 percent within 1 hour and 98 percent within 7 days in adult rats breathing the equivalent of 6 mg/m^3 lead.

The primary site of lead absorption in children is the GI tract (approximately 50 percent) upon oral exposure, compared to 8 percent in adults (Hammond, 1982 cited in ATSDR, 1986) or 15 percent (Chamberlain et al., 1978 cited in ATSDR, 1986). Absorption may be as high as 45 percent in fasting adults (Chamberlain et al., 1978 cited in ATSDR, 1986). GI absorption in children (from nonfood sources) is estimated to be approximately 30 percent from dirt/dust and 17 percent from paint chips (Drill et al., 1979 cited in ATSDR, 1986). Absorption values are similar in animals (i.e., 1 percent to 15 percent in adults). The extent of GI absorption is age dependent (i.e., younger animals absorb 40 to 50 times more lead via the diet than do adults). GI absorption is enhanced by milk products, low calcium and vitamin D levels, fasting, or iron deficiencies. Dermal absorption is much less significant due to a greatly reduced dermal absorption rate. In humans, approximately 0 percent to 0.3 percent absorption has been measured (ATSDR, 1986).

Once in the body, lead is dispersed primarily to the bone, blood, and soft tissue pools regardless of the route of absorption. The half-life of lead in blood is approximately 36 days, in soft-tissue is 40 days and in bone is 10^4 days. Greater than 99 percent of blood lead is associated with the red blood cells. Over 50 percent of this blood pool is bound to hemoglobin, with lesser amounts bound to other proteins. Fetal hemoglobin has a greater affinity for lead than does adult hemoglobin. The biological half-life of lead in the blood of 2 year-old children is approximately 10 months.

In human adults approximately 95 percent of the total lead body burden is present in the bones. In children, this value is 73 percent. Bone lead levels increase with age. In most soft tissue, lead does not appear to accumulate as a function of age in humans over 20 years old.

Any dietary lead not absorbed by the GI tract is eliminated in the feces of both humans and animals. Rosen (1985 cited in ATSDR, 1986) demonstrated that 50 percent to 60 percent of the

absorbed fraction of lead was excreted on a short-term basis. Chamberlain et al. (1978 cited in ATSDR, 1986) found this half-life to be 19 days. Infants have been shown to retain 34 percent of the total amount of absorbed lead whereas adults demonstrate a 1 percent retention rate. In animals (rats) initial excretion occurs in the urine followed by greater excretion in the feces. In rats excretion occurs in two phases. The initial phase half-life is 21 hours followed by a slower 280 hour second phase (Morgan et al., 1977 cited in ATSDR, 1986).

Acute Toxicity

Human Toxicity. Mortality for workers was studied by Cooper et al. (1986 cited in ATSDR, 1986) in a cohort study of employees at lead-producing facilities. Two cohorts, all of whom had been employed for at least 1 year during 1946 through 1970 were studied for mortality from 1947 through 1980. Mean blood lead levels were 63 µg/dL for 1,326 of the 4,519 battery workers and 80 µg/dL for 537 of 2,300 lead production workers from 1947 through 1972. The number of observed deaths of both groups was significantly greater (P less than 0.01) than expected. Increased mortality resulted in a large part from malignant neoplasms; chronic renal disease; and "ill-defined" causes.

In children, lead intoxication leading to encephalopathy and death may result from oral exposure. The range of blood lead levels associated with encephalopathy is approximately 90 to 700 or 800 µg/dL and the range associated with death is approximately 125 to 750 µg/dL. The mortality rate of untreated lead encephalopathy (a severe neurological effect) in children was estimated by the EPA to be 65 percent prior to the introduction of chelation therapy. Shortly after therapy is started, mortality decreases for 25 to 33 percent. An absence of signs or symptoms has been observed in some children at blood lead levels of 60 to 300 µg/dL. Acute lead poisoning symptoms other than signs of encephalopathy have been observed at blood lead levels of approximately 60 to 450 µg/dL. Rummo (1974 cited in ATSDR, 1986) and Rummo et al. (1979 cited in ATSDR, 1986) observed hyperactivity and a decrease of 16 IQ points on the McCarthy General Cognitive Index (GCI) among children who previously had encephalopathy and whose mean blood lead levels at the time of encephalopathy were 88 µg/dL.

compounds. Impairment of heme synthesis results in disruption of a variety of important physiological processes including reduced hemoglobin synthesis, reduction of hemoproteins, renal endocrine effects, and hepatic effects.

Studies in animals have shown delays in reflex development in rats during early postnatal life at greater than 59 µg/dL (Kishi et al., 1983 cited in ATSDR, 1986). Decreased visual acuity in young rats have been observed in several studies at mean blood lead levels of 65 µg/dL. Blood lead levels as low as 15 to 20 µg/dL were associated with slower learning and higher rates of inappropriate responses (Cory - Slechta et al., 1985; Schlipkoter and Winneke, 1980 cited in ATSDR, 1986).

Exposure of male rats had an effect on cardiovascular function at levels of 50 ppm lead. Lead acetate was given in drinking water for 160 days with results of markedly increased blood pressure (182/138) as compared to 129/98 in controls (Iannaccone et al., 1981 cited in ATSDR, 1986). The mean blood lead level in the treated group was 38.4 µg/dL.

Animal studies provide evidence of nephropathy similar to that in humans, particularly after acute exposures. Lead appears to affect vitamin D metabolism in renal tubule cells such that circulating levels of the vitamin D hormone, 1,25 - dihydroxyvitamin D, are reduced (Smith et al., 1981 cited in ATSDR, 1986). High calcium diets protected against this effect. In vitro studies with rat pituitary cells showed that lead inhibited the thyrotropin-releasing hormone (TRH) and stimulated release of thyrotropin-stimulating hormone (TSH) in a dose-related manner (Huseman et al., 1987 cited in ATSDR, 1986). This supports the conclusions drawn from human data.

Developmental and Reproductive Toxicity

The EPA has concluded, based on a review of several studies, that a definitive association between prenatal lead exposure in humans and the occurrence of congenital anomalies has not been demonstrated. Various studies have reported decreased birth weights, still births, and

Lead interferes with heme biosynthesis by altering the activity of several key enzymes. A marked interference results in a reduction of the hemoglobin concentration in blood. Decreased hemoglobin production, coupled with an increase in erythrocyte destruction, results in anemia.

In adults, early symptoms of lead encephalopathy may develop within weeks of initial exposure. These symptoms include dullness, irritability, poor attention span, headache, muscular tremor, loss of memory, and hallucinations. The condition may then worsen to delirium, convulsions, paralysis, coma, and death. Severe lead encephalopathy is not observed except at blood lead levels well in excess of 120 µg/dL (Kehoe, 1961a, b, c cited in ATSDR, 1986). Smith et al. (1938 cited in ATSDR, 1986) suggested that acute lead poisoning in adults can occur at blood lead levels of approximately 100 µg/dL. Increased central and peripheral nervous system and GI symptoms were noted in 25 lead workers with maximum blood lead levels of 50 to 69 µg/dL (Haenninen et al., 1979 cited in ATSDR, 1986). Decreases in nerve conduction velocity have been observed in workers with blood lead levels of 30 to 48 µg/dL (Seppalainen et al., 1983 cited in ATSDR, 1986). Robinson et al. (1985 cited in ATSDR, 1986) cited evidence of a lead-related decrease in hearing acurity of children at maximum blood lead levels of 6.2 to 56.0 µg/dL. Lead neuropathy in children may be associated with the incidence of sickle cell disease in children.

Evidence from occupational, clinical, and general population studies indicates that lead affects the cardiovascular system in humans, resulting in cardiac lesions, electrocardiographic abnormalities, and increases in blood pressure. Renal toxicity (early or acute nephropathy) has also been associated with lead exposure but appears to be reversible. Chronic lead nephropathy associated with blood lead levels of 40 to greater than 100 µg/dL is irreversible.

Animal Toxicity. High rates of mortality were observed in rats exposed to tetramethyl lead (organic lead) for 7 h/day, 5 days/week at 63 mg/m^3 for 10 days, 49 mg/m^3 for 18 days, and 22 mg/m^3 for 35 days (Davis et al., 1963 cited in ATSDR, 1986). Several studies in animals also indicate that the effects of lead on heme synthesis occur in many tissues. The formation of heme-containing cytochromes is inhibited in animals treated intraperitoneally or orally with lead

placental weight. However, as noted by EPA, the majority of these studies did not account for possible confounding variables (i.e., socioeconomic status and concurrent exposures). Therefore, the above conclusion has been made. It has been noted, however, that gestational age may be reduced as prenatal lead exposure increases, even at blood lead levels below 15 µg/dL. Several studies have indicated negative correlations between maternal or cord blood lead levels and gestational age.

In one prospective study of the effects of pre- and postnatal lead exposure on child development McMichael et al. (1986 cited in ATSDR, 1986) studied 831 pregnant women and followed 774 pregnancies to completion in a lead smelter town. Blood lead levels were significantly higher in women who lived in the town compared to those residing outside the town (11.2 µg/dL versus 7.5 µg/dL). No association between lead exposure and congenital anomalies was noted when factors such as smoking and alcohol consumption were reviewed. Also observed was a greater incidence of low-birth weight (less than 2,500 g at gestational age greater than or equal to 37 weeks) in the town. More miscarriages and stillbirths occurred in the Port Pirie mothers compared to others. Neurobehavioral development, therefore, appears to be deleteriously affected by prenatal lead exposures. Transplacental transfer of lead in humans has been demonstrated in a number of studies. Fetal uptake of lead occurs by the 12th week of development and increases throughout development (Barltrop, 1969; Horiuchi et al., 1959 cited in ATSDR, 1986). Highest lead levels were measured in fetal bone, kidney, and liver tissue and lesser amounts in the brain and heart.

Teratogenicity studies in rats and mice provide no evidence that lead compounds (acetate or nitrate) are teratogenic when exposure occurs by natural routes. Intravenous or intraperitoneal injection of lead compounds into pregnant rats, mice or hamsters, however, has produced malformations in several studies. There are indications, as well, that lead accumulates in the placenta in times of fetal stress.

Severe occupational exposure (primarily via inhalation) to lead has been shown to be associated with a high likelihood of spontaneous abortions. The EPA has concluded that reproduction

effects on the sperm or testes of men chronically exposed at blood lead levels of 40 to 50 µg/dL may occur. Lancranjan et al. (1975 cited in ATSDR, 1986) studied 150 men with long-term lead exposure, categorized as follows: lead-poisoned (mean blood lead level 74.5 µg/dL); moderately poisoned (mean: 52.8 µg/dL); slightly poisoned (mean: 41 µg/dL); or physiologically poisoned (mean: 23 µg/dL). The lead-poisoned and moderately exposed groups had decreases in fertility. The effects were thought to be directly on the testes.

Chowdhury et al. (1984) found testicular atrophy and cellular degeneration in male rats given lead acetate in drinking water at 1 g/L (1,000 ppm) for 60 days. Blood lead levels averaged 142.6 µg/dL.

Genotoxicity

Results of in vitro studies with human lymphocyte cultures performed with lead acetate have been nearly divided between positive and negative. Results of in vivo studies are also contradictory, although the weight of evidence does suggest that lead has an effect on chromosomes. The status of calcium nutrition may be important in the expression of lead-induced clastogenicity in both in vitro and in vivo tests. Studies in mice (DeKnudt and Gerber, 1979 cited in ATSDR, 1986) and monkeys (DeKnudt et al., 1977 cited in ATSDR, 1986) indicated that calcium deficiency may enhance the genotoxicity of lead.

Carcinogenicity

The EPA has concluded that current human data are inadequate to refute or demonstrate the potential carcinogenicity of lead exposure to humans. Animal data, however, were deemed sufficient (particularly soluble lead salts).

An extensive series of reports of a large number of workers at six domestic lead production plants (smelter and recycling plants) and ten battery plants exists. Increased incidences of total malignant neoplasms were observed for both categories of lead workers. In a more recent

evaluation of a more select subset from the original study increases in total malignancies in both groups of workers attributed to digestive and respiratory cancers was reported (Cooper and Gaffey, 1975; Cooper, 1976 cited in ATSDR, 1986.

The most comprehensive set of studies of carcinogenicity resulting from oral exposure to lead was performed by Azar et al. (1973 cited in ATSDR, 1986). Lead acetate was given to rats at 0, 10, 50, 100, 500, 1,000, or 2,000 ppm lead in the diet for 2 years. Fifty rats per sex were exposed. After the study was in progress, groups of 20 rats per sex were also fed 0, 1,000 or 2,000 ppm lead in diet. Blood lead levels measured at 24 months were 12.7, 11.0, 18.5, 35.2 and 77.8 μg/dL in the 0-, 10-, 50-, 100-, and 500- ppm groups. Levels of 16.4, 98.6, and 98.4 μg/dL were observed in the 0-, 1,000-, and 2,000- ppm groups. Renal tumors occurred in 5/50 male rats at 500 ppm, in 10/20 males at 1,000 ppm, and in 16/20 males and 7/20 females at 2,000 ppm.

The EPA has classified lead in Class B2 - Probable Human Carcinogen. However, the agency is currently reviewing both the toxicity and carcinogenicity of lead for further evidence. Cancer slope factors and unit risk factors are not available.

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PHTHALATES

Di-n-octyl phthalate (DOP), bis (2-ethyl hexyl), phthalate (BEHP), and di-n-butyl phthalate (DBP), are members of the phthalate and phthalate esters family. Because of the lack of compound-specific information and the similarity of toxicity of the group of compounds, the general toxicity of the family of compounds with specific examples of various phthalate compounds will be presented.

Phthalate esters are used as plasticizers in almost every product category. They are used in construction, household products, toys, packaging, apparel, and medical products (Klaassen, et al., 1986).

Phthalates do not dissolve easily in water nor do they evaporate easily. However small amounts can enter the air as a gas. Phthalates once in the air generally break down within a few days. In soil, phthalates are broken down by the bacteria present which can take anywhere from a day up to a month depending on what types of bacteria are present and the temperature of the soil (Johnson, et al., 1977).

Phthalates appear to have relatively low toxicity. What animal data are available indicate that it takes consumption of large amounts to produce adverse effects, which are primarily reproductive.

Acute Effects

Acute lethality studies in animals indicate low acute toxicity of DOP, BEHP, and DBP. Study findings as observed by Smith (1953), Hardin, et al. (1987), and White, et al (1983) include single lethal doses of 8000 mg/kg up to more than 20,000 mg/kg.

Systemic Effects

An oral reference dose (RfD) of 2E-2 mg/kg/day for BEHP based on no observed effects as to relative liver weight is reported by the EPA (HEAST, 1991; IRIS, 1991). An oral RfD of 1E-1 mg/kg/day is reported by the EPA for DBP. The BEHP value is derived from a study conducted by Carpenter, et al. (1953) in which rats and guinea pigs were exposed to BEHP at 20-195 g/kg day. A lowest-observed-adverse-effects level (LOAEL) was identified and converted to 19 mg/kg/day of BEHP.

Carcinogenic Effects

Sittig (1985) reports that no studies on the carcinogenic potential of DOP are available. BEHP however has been classified as B2 (probable human carcinogen), by the EPA on the basis of dose related increases in liver tumor responses in rats and mice, both male and female (IRIS, 1990; HEAST, 1990). One group of 100 rats and one of 100 mice each were fed 0, 6000, and 12,000 ppm BEHP for 103 weeks. The increase in hepatocellular carcinoma and combined incidence of carcinoma and adenoma were significant (NTP, 1982). These findings are supported by data by Ganning, et al. (1984) that has shown BEHP to be a potent inducer of hepatic peroxisomal enzyme activity. The oral slope factor for BEHP is 1.4E-2 (mg/kg/day)-1 which is equivalent to an oral carcinogenic unit risk of 4E-7 (µg/l)-1 (IRIS, 1990; HEAST, 1990).

Teratogenicity, Embryotoxicity, And Reproductive Effects

Intraperitoneal injection of DOP in pregnant rats has caused teratogenic effects, increased resorptions and fetal toxicity (EPA, 1980). DBP has been shown to be toxic to the fetus (IRIS, 1990). BEHP has been observed to be fetotoxic and teratogenic also (Shiot and Nishimura, 1982).

The phthalates have also been associated with reproductive effects including seminiferous tubule damage and testicular damage (Shiota and Nichimura, 1982; Singhe, 1972; IRIS, 1990).

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RDX

(CAS RN 121-82-4)

Noncarcinogenic Effects

Occupational exposure (primarily by inhalation) to RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine) is associated with central nervous system effects, including insomnia, irritability, amnesia, headache, nausea, convulsions and unconsciousness. Accidental ingestion of RDX by humans has caused similar central nervous system effects (USEPA 1988).

Adverse effects following subchronic and chronic oral administration of RDX to laboratory animals include central nervous system symptoms, increased mortality, weight loss, anemia, hepatotoxicity, renal toxicity, testicular degeneration and inflammation of the prostate (USEPA 1988). Cholakis et al. (1980) reported anemia in male mice and rats following oral administration of RDX at doses of 160 mg/kg-day and 28 mg/kg-day, respectively, for 90 days. Increased liver weights were reported in both species at higher doses. Vomiting and central nervous system disturbances were reported in monkeys given oral doses of RDX of 10 mg/kg-day for 90 days (Martin and Hart, 1974).

In a chronic study in mice, Lish et al. (1984) observed testicular degeneration at a dose of 35 mg/kg-day, increased liver weights at 100 mg/kg-day and increased mortality at 175 mg/kg-day. Developmental toxicity resulting from RDX ingestion has also been reported in rats and rabbits at doses of 16 mg/kg-day and 20 mg/kg-day, respectively (USEPA, 1988).

Levine et al. (1983a) administered RDX in the diet to Fisher 344 rats at doses of 0.3, 1.5, 8.0 or 40 mg/kg-day for two years. They observed anemia, increased mortality, liver enlargement and kidney enlargement accompanied by histologic changes at the 40 mg/kg-day dose level. Inflammation of the prostate was reported at a dose of 1.5 mg/kg-day. No adverse effects were observed at the lowest dose level (0.3 mg/kg-day). Based on the NOAEL of 0.3 mg/kg-day from this study, USEPA calculated chronic and subchronic oral RfDs of 3E-3 mg/kg-day (USEPA

1994). The confidence level of the RfDs is rated high, based on a well-executed, long-term study with a clear NOEL and LOAEL and an extensive supporting database (USEPA 1994). USEPA did not consider available data adequate to calculate an inhalation RfC (USEPA 1994).

Carcinogenic Effects

RDX was not found to be carcinogenic to two strains of rats following oral administration of up to 10 mg/kg-day and 40 mg/kg-day for two years (Hart 1977, Levine et al. 1983a). However, statistically significant increases of hepatocellular carcinomas and adenomas (combined) were reported in female mice fed RDX at doses of 7 mg/kg-day and greater for two years (Lish et al. 1984). A nonsignificant increase in alveolar and bronchiolar carcinomas and a slight increase in malignant lymphoma of the kidney were also observed. Based on these studies, the USEPA has classified RDX in Group C (possible human carcinogen) by inhalation and oral routes of exposure (USEPA 1988), and calculated an oral slope factor (SF) of 1.1E-1 (mg/kg-day)-1 based on the incidence of liver tumors in mice (USEPA 1994). USEPA did not consider available data adequate to calculate an inhalation SF (USEPA 1994).

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ZINC

(CAS RN 7440-66-6)

Metallic zinc and various zinc salts are used extensively in the metal plating industry. Zinc is used in galvanizing, electroplating, dry cells, alloying, soldering fluxes, smoke generators, and zinc oxide is used as a pigment for paints and cosmetics. The toxicity of zinc depends on the particular form and salt of zinc and on the route of administration. Zinc is an essential nutrient and is found in a number of metalloenzymes including carbonic anhydrase, carboxypeptidase, alcohol dehydrodgenase, lactic dehydrogenase and alkaline phosphatase (Klaassen et al., 1986).

Zinc salts are used therapeutically as topical astringents, antiseptics, and emetics. Zinc undecylenate is commonly used in athlete's foot preparations and zinc pyridinethione is a common ingredient in antidandruff shampoos. Zinc is often used as a carrier salt for insulin preparations and bactericides.

Acute Effects

Acute exposure to zinc salts via ingestion results in nausea and gastrointestinal irritation. The most common form of acute zinc intoxication is in the inhalation of metal fumes. Zinc fume intoxication results in ocular, mucous membrane, and dermal irritation, malaise, fatigue, headache, blurred vision, and muscle cramping with pulmonary edema at very high concentrations. Upper respiratory tract irritation and sore throat are common symptoms of fume exposures. Acute, lethal exposure results in severe pulmonary edema followed by cyanosis, coma and death (Proctor, 1989).

Chronic Effects

In brass foundry workers, zinc oxide was found to produce zinc fume fevers due to inhalation of fumes during manufacturing processes. Clinical recovery is usually complete in 24 to 48 hours.

Chronic exposure to fumes has not shown adverse effects (NIOSH, 1986). Chronic exposure often results in bronchial pneumonia.

A fine salt of strong mineral acids can be corrosive to the skin and irritating to the gastrointestinal tract. However, the use of zinc oxide in many topical dermatologic preparations has demonstrated a low potential for skin irritation. An occupational dermatitis "Oxidepox" was reported in alloy workers exposed to zinc oxide particulates (ATSDR, 1989). It was concluded that zinc oxide particulates and lack of personal hygiene contributed to the minor eruptions. These were reversible with the institution of good hygiene practices (Clayton, 1981).

Gastrointestinal disturbances with peptic-ulcer-like symptoms have been supported in workers employed for years in brass foundries (Clayton, 1981). Clinically latent liver dysfunction has been reported in workers exposed to high levels of zinc oxide. Evidence of peptic ulcers was felt to be indicative of gastrointestinal tract damage (NIOSH, 1986).

Zinc is a nutritionally essential metal and deficiency results in several health consequences. Excessive exposure to zinc is relatively uncommon and requires very heavy exposure

Carcinogenic And Other Health Effects

There are no reports of zinc or zinc salts possessing carcinogenic activity. Zinc has been reported to inhibit tumor initiation but the mechanism is unknown. Zinc is cytotoxic to cells in culture and can cause chromosomal abnormalities to mammalian cells in culture.

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APPENDIX I

RESPONSES TO COMMENTS

REVIEW COMMENTS ON:
DRAFT SUPPLEMENTAL REMEDIAL INVESTIGATION
FOR LUCKY FUSE SITES FTIR-07 AND FTIR-08
NATIONAL TRAINING CENTER, FORT IRWIN

From: Department of Toxic Substances Control (DTSC)

Comments from Omoruyi Patrick, DTSC, Dated 6 May 1999.

GENERAL COMMENTS

Comment No. 1: *DTSC will defer its decision on the ecological risk assessment recommendation for no further action at Avawatz Valley Disposal Site-08 subsites: 08/1a, 08/3a, 08/3b, and 08/3c pending the re-evaluation of the ecological risk using the U.S. EPA recommended TRVs values. Enclosed is the DTSC, Human and Ecological Risk Division (HERD) comments on the above-referenced document.*

MW Response: Agreed. Ecological risks calculated using the USEPA Region IX Biological Technical Advisory Group (BTAG) toxicity reference values (TRVs) have been presented in Section 7.0 in the Final Supplemental RI Reports for Sites FTIR-07 and FTIR-08. Risk estimates calculated using the BTAG TRV-Low and TRV-High have also been presented.

REVIEW COMMENTS ON:
DRAFT SUPPLEMENTAL REMEDIAL INVESTIGATION
FOR LUCKY FUSE SITE FTIR-07/D
NATIONAL TRAINING CENTER, FORT IRWIN

From: Department of Toxic Substances Control (DTSC)

Comments from John P. Christopher, DTSC, Dated 30 April 1999.

GENERAL COMMENTS

Comment No. 1: *The human health risk assessment presented for Subsite FTIR-07/d is well done and can be made acceptable with minor corrections. The ecological risk assessment contains a major flaw. The Army should use toxicity reference values (TRV) recommended by USEPA Region IX Biological Technical Assistance Group (BTAG). Use of TRV-Low and TRV-High recommended by the BTAG will necessitate recalculation of hazard quotients (HQ) and re-evaluation of risk characterization for the two indicator species*

MW Response: The Army has presented ecological risks calculated using the BTAG TRV-Low and TRV-High in the Final Supplemental RI Report for Site FTIR-07. Please also refer to our responses to Specific Comments No. 7 and 8 below.

SPECIFIC COMMENTS

Comment No. 1: *Background Concentration, Table 4-1: Please label the concentrations of metals in the first column as 95% upper tolerance limits (95UTL) of the ambient distributions. In addition, the "Guidance Values" for silver and selenium in soil at concentrations of 9,400 mg/kg are Preliminary Remediation Goals (PRG) from USEPA Region IX. These cannot be used for selection of chemicals of potential concern (COPC). Therefore, their juxta-postion to background values in Table 4-1 might be misleading. If the Army chooses to quote PRGs, please show values for all the metals and state whether the values are for a residential or industrial setting.*

MW Response: The Background Concentrations in Table 4-1 have been corrected to indicate 95% upper tolerance limits of the ambient distributions. The PRGs for all the metals have been added to the table and the indication of industrial setting has been indicated.

Comment No. 2: *<u>Elevated Detection Limits, Table 4-2:</u> We noted high sample quantitation limits for selenium (>20 mg/kg) in all samples and for arsenic (~10 mg/kg) for sample 7d-1-Tp-1-0.5'. The elevated value for selenium had no impact on the ecological risk assessment, because no aquatic receptors are present at this desert site. The 95% upper tolerance limit on ambient concentrations of arsenic was 9.14 mg/kg and the highest value detected was 9.8 mg/kg, so the failure to detect arsenic at 10 mg/kg had no significant impact on the assessment.*

MW Response: Comment noted.

USACE Response: We will watch for this in the future, and please comment on this during the planning phases for upcoming projects to ensure we use appropriate quantitation limits.

Comment No. 3: *<u>Anomaly 1, Sample 7d-1-Ts-1-5, Table 4-2.</u> We concur that a hot spot exists at the 5 ft depth at Anomaly 1, with notable concentrations of 2, 4-dinitrotoluene, di-n-butyl phthalate, N-nitrosodiphenylamine, arsenic, cadmium, copper, lead, and zinc. These contaminants are consistent with open disposal/open burning (OB/OD) or ordnance.*

MW Response: Comment noted.

Comment No. 4: *<u>Guidance Documents, Sec. 6.1.1, p.6-3:</u> Please list two more guidance documents from this Department.*

> *"Supplemental Guidance for Human Health Multimedia Risk Assessments for Hazardous Waste Sites and Permitted Facilities", July 1992.*
>
> *"Selecting Inorganic Constituents as Chemical of Potential Concern in Risk Assessments at Hazardous Waste Sites and Permitted Facilities", February 1997, <u>http://www/cwo.com/~her1/downset.htm</u>.*

In addition, the reference for USEPA's "Exposure Factors Handbook" is obsolete. The correct references are:

> *"Exposure Factors Handbook, Volume I, General Factors", USEPA Office of Research and Development, August 1997, USEPA Publication No. EPA/600/P-95/002/Fa, NTIS Document No. PB98-124225.*
>
> *"Exposure Factors Handbook, Volume II, Food Ingestion Factors", USEPA Office of Research and Development,*

August 1997, USEPA Publication No. EPA/600/P-95/002/Fb, NTIS Document No. PB98-124233.

"Exposure Factors Handbook, Volume III, Activity Factors", USEPA Office of Research and Development, August 1997, USEPA Publication No. EPA/600/P-95/002/Fc, NTIS Document No. PB98-124241.

MW Response: Agreed. The text in Section 6.1.1 and the 'References' section have been revised to include the recommended citations.

Comment No. 5: *<u>Section 6.2.5, p. 6-11:</u> The spelling of the chemical name for 2,4,5-TP has either one too many parentheses or one too few. Please fix.*

MW Response: Comment noted. The spelling of the chemical name for 2,4,5-TP has been corrected

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Comment No. 6: *<u>Risk Characterization for Hypothetical Future Human Residents, Sec. 6.4.3.2, pp. 6-30 ff.:</u> We concur that surface soils present no significant risks or hazards to human receptors. We agree that 99% of the screening estimate of cancer risk is subsurface soil is due to arsenic (Table 6-7), but concentrations of arsenic at the site exceed ambient concentrations by only a few percent, if at all. The Hazard Index for total non-cancer hazard in subsurface soils is 1.2 (Table 6-8). Arsenic and 2,4-dinitrotoluene each contribute about 0.4 to the total of 1.2, but these two chemicals affect different target organs. Therefore, the no significant non-cancer hazard is present in subsurface soil for humans. The maximum concentration of lead observed does not give risk to an estimate of blood lead above 10 µg/dL.*

MW Response: Concur. Please also note that the HI estimate of 1.2 represents a screening risk estimate for residential receptors based on maximum concentrations of chemicals in subsurface soil. The HI values estimated in the baseline human health risk assessment were below 1.0 for all evaluated receptors

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Comment No. 7: *<u>TRVs, Table 7-11:</u> We recommend that the Army calculate HQs using the TRV-Low and TRV-High recommended by the USEPA Region IX BTAG. These values have been available for over one year and we have recommended their use to the Army on several prior occasions. For the COPC for which BTAG has not recommended a value, the Army may use the values shown in Table 7-11. The values recommended by BTAG are shown below. Complete literature citations may be obtained from our office.*

Chemical	TRV-Low mg/kg-day	TRV-High Mg/kg-day	Test Species	Body Weight (g)	Reference
Arsenic	0.32	-	Rat	332	Schroeder et al , 1968
	-	4.7	Rat	110	Brown et al , 1976
	5.5	22.0	Mallard	1,172	Stanley, et al., 1994
Cadmium	0.06	-	Mouse	32.2	Webster, 1988
	-	2.64	Mouse	31.4	Schroeder & Mitchener, 1971
	0.08	-	Mallard	798.5	Cain et al., 1983
	-	10.4	Mallard	84	Richardson et al., 1974
Copper	2.67	-	Mouse	30	Pocino et al., 1991
	-	632	Mouse	24.7	Herbert et al., 1993
	2.3	-	Chicken	639	Norvell et al., 1975
	-	52.3	Chicken	409	Jensen & Maurice, 1978
Lead	0.0015	-	Rat	208	Krasovskii et al , 1979
	-	241	Mouse	18.7	Wise, 1981
	0.014	-	Quail	84	Edens et al, 1967
	-	8.75	Chicken	800	Edens & Garlich, 1983
Zinc	9.60	-	Mouse	25.5	Aughey et al, 1977
	-	411	Rat	175	Schlicker & Cox, 1968
	17.2	172	Mallard	955	Gasaway & Buss, 1972

MW Response: Fort Irwin wishes to pursue regulatory closure of Site FTIR-07 and has included the USEPA Region IX BTAG TRVs in the evaluation of ecological risks for this site. In the Final Supplemental RI Report for Site FTIR-07, the Army has presented ecological risk estimates calculated using the USEPA Region IX BTAG TRVs. Please also note that the Army has re-visited and refined the assumptions used in modeling exposures for ecological indicator receptors.

Comment No. 8: *<u>Hazard Quotients, Sec. 7.6.1, pp. 7-29 ff.:</u> The Army's methods for calculation of exposure dose are acceptable, including the calculation of trophic transfer factors for COPCs. Therefore, the numerators of the Hazard Quotients (HQ) are acceptable. However, the denominators should be calculated based on TRV-Low and TRV-High, as shown in the table above. TRVs should be converted allometrically from rodents for the Mojave ground squirrel and from avian species for the golden eagle. Many*

of the TRVs recommended above are quite different from the values shown in Table 7-11. Therefore, the Army will need to re-calculate HQs and re-evaluate risk characterization for both indicator species.

MW Response: Agreed. Ecological risks for the Mojave ground squirrel and golden eagle have been re-evaluated using the USEPA Region IX BTAG TRVs. The Army has presented ecological risk estimates calculated using the USEPA Region IX BTAG TRVs in the Final Supplemental RI Report for Site FTIR-07. In addition, the Army has re-visited and refined the exposure assessments for the Mojave ground squirrel and golden eagle.

REVIEW COMMENTS ON:
DRAFT SUPPLEMENTAL REMEDIAL INVESTIGATION
FOR LUCKY FUSE SITE FTIR-07 AND FTIR-08
NATIONAL TRAINING CENTER, FORT IRWIN

From: United States Environmental Protection Agency (USEPA)

Comments from Richard P. Underwood, USEPA, Dated 3 March 1999.

SPECIFIC COMMENTS

Comment No. 1: *Page 1-3, Section 1.3: The Parson's report was finalized in September 1998.*

MW Response: Comment noted. The text has been changed to reflect the September 1998 date.

Comment No. 2: *Figure 1-2: Please label each lake as 'Dry Lake', such as Goldstone Dry Lake.*

MW Response: Comment noted. The figure has been changed to indicate 'dry lake.'

REVIEW COMMENTS ON:
DRAFT SUPPLEMENTAL REMEDIAL INVESTIGATION
FOR LUCKY FUSE SITE FTIR-07
NATIONAL TRAINING CENTER, FORT IRWIN

From: United States Environmental Protection Agency (USEPA)

Comments from Curtis Payton, USACE, Dated 27 September 1999.

SPECIFIC COMMENTS

Comment No. 1: *Page Vi, Abbreviations and Acronyms: Revise text to keep abbreviations and acronyms consistent throughout the document.*

1. *Differentiate between Cal EPA and DTSC Make changes throughout text.*
2. *Define ES*
3. *Define FTIR*
4. *MDRA – Missouri River Division no longer exists please change to the CX – Center of Expertise. Revise text as necessary.*
5. *PCDD – change "diotins' to "dioxins".*
6. *PEF – change "particolate" to "particulate".*
7. *PRG – define as "Region IX" Preliminary Remediation Goals.*
8. *TM – Change to PM, Project Manager.*
9. *USEPA – spell our "US" as "United States".*

MW Response: Comment noted The abbreviations and acronyms have been corrected.

Comment No. 2: *Section 1.3, Page 1-3, last paragraph, last sentence. Revise When reporting results omit the "J". This is a qualifier placed by the data validator and is used to assist the data user It should be noted that the acetone and 2-butanone results were estimated and explain the bias to those results i.e. may indicate false positive or negative.*

MW Response: Comment noted The text has been modified.

Comment No. 3. *Section 2.2, Page 2-2, Decontamination of bucket. Inquiry. Why did decontamination procedure not include methanol? Since PCBs and Pesticides were among the constituents of concern, what measures were taken to make sure contamination did not spread? Note. The Pesticide results indicate non-detect, there are no PCB results*

MW Response: Decontamination was performed in accordance with the workplan prepared by Parsons ES and approved by the regulatory agencies.

Comment No. 4: *<u>Section 2.1, Page 2-2, first paragraph, second sentence:</u> Revise. ". test <u>pits and the analytical results are</u> described in Section 4.0, ..."*

MW Response: Comment noted. The sentence "The analytical results are presented in Section 4.0" has been added at the end of Section 2.2, page 2-3.

Comment No. 5: *<u>Section 2.4, Page 2-4, first paragraph, fourth sentence:</u> Revise. See comment 1 note 4. These laboratories are USACE validated. The CX performs the validation process.*

MW Response: Comment noted. The text has been changed to reflect that the laboratories were USACE validated and the CX performs the validation.

Comment No. 6: *<u>Section 2.4, Page 2-4, second paragraph, last sentence:</u> Revise. Change USACE "technical manager (TM)" to "Project Manager (PM)".*

MW Response: Comment noted. The USACE Technical Manager has been changed to Project Manager.

Comment No. 7: *<u>Section 2.4.1, Page 2-4, first paragraph, first sentence:</u> Revise. Indicate how many of the total 16 samples collected were soil, QC (trip blanks, MS/MSD, field duplicate, equipment blank), QA.*

MW Response: Comment noted. The text has been revised to reflect the number of soil samples and field duplicate samples collected.

Comment No. 8: *<u>Section 2.4.1, Page 2-4, & App. B:</u> Inquiry. Do the "<" indicate that the results were below the project specific PQLs or the Laboratory PQLs? Note, both of these should have been the same. Revise. Make a note on the tables to define the "<".*

MW Response: Comment noted. An explanation of < values has been added to tables in Appendix B.

Comment No. 9: *<u>Section 2.4.1, Page 2-4, & App. C.</u> Revise. The chain-of-custody forms provided are for a different site. The sample identifications do not meet those of the project.*

MW Response: Field work was performed at Sites FTIR-07 and FTIR-08 concurrently. The COCs contain samples from both sites.

Comment No. 10: *<u>Section 2.4.1, Page 2-4, 4th bullet:</u> Revise. SW-846 Update III separate the Organochlorine pesticides and polychlorinated biphenyls. List these as two different analyses.*

MW Response: Comment noted. The text has been revised.

Comment No. 11: *<u>Section 2.4.1, Page 2-4, 6th bullet.</u> Inquiry. Why was Method 418.1 used as opposed to DHS 8015m for purgeables and extractables?*

MW Response: The workplan prepared by Parsons ES specified this method. Also, the SOW prepared by the Corps specified this method.

Comment No. 12: *<u>Section 2.4.1, Page 2-5, 1st paragraph, 1st sentence.</u> Inquiry. Were EnCore samples collected? Note, this has been an USACE requirement since 3/98.*

MW Response: Comment noted. Encore samples were not required for this project. The field work was conducted in accordance with the approved Parsons ES Workplan for investigation at Fort Irwin IRP sites.

Comment No. 13: *<u>Section 2.4.2, Page 2-7, 1st paragraph, 1st sentence:</u> Define Level 3 (definitive data with QC summaries) and 4 (raw data packages). Industry is trying to steer away from this terminology.*

MW Response: Comment noted. Text has been added to define Level 3 and Level 4 data packages.

Comment No 14: *<u>Section 2.4.2, Page 2-7:</u> For qualifier flags, indicate the associated bias.*

MW Response: Data validation was conducted using qualifiers outlined in the Parsons Workplan and did not include bias with the qualifier flags. No further action will be taken.

Comment No 15: *<u>Section 2.4.3.3, Page 2-12:</u> For the explanation of the mercury analysis, it is stated that it was not critical to the risk evaluation, so then, why was it requested in the first place?*

MW Response: Comment noted. The Parsons ES Workplan required the analysis of mercury in soil sample investigations. However, following evaluation of past mercury results and risk calculations it was determined that mercury does not play a significant role in the risk evaluation.

Comment No. 16: *<u>Section 2.4.4, Page 2-14:</u> The usability of the data should be explained here in non-chemistry terms. Since the purpose of the data was to assist the risk assessment, then the usability of that data to perform the assessment should be addressed.*

MW Response: Comment noted. The text has been revised.

Comment No. 17: *<u>Section 4.0, Page 4-1, last sentence:</u> Interpretation of ambient inorganic levels should be consistent with the DTSC guidance.*

MW Response: The text in this section is referring to geophysical anomalies detected during an electromagnetic field survey; therefore, DTSC guidance levels would not apply.

Comment No. 18: *<u>Section 4.2, Page 4-2:</u> General When referring to the detected concentration values, do not place the laboratory qualifiers or notes with the value. These notes are to the data interpreter only and only leads to confusion to the average reader. Delete these qualifiers or notes i.e. "J" or "B" (refer to comment 2).*

MW Response: Comment noted. The text has been revised.

Comment No. 19: *<u>Table 2-1:</u> Separate OCP and PCBs. These are separate analyses. Make this consistent throughout the report.*

MW Response: Comment noted. The text has been revised.

Comment No. 20: *<u>Table 4-1:</u> List the guidance levels for metals.*

MW Response: The PRGs for all the metals have been added to Table 4-1 and the indication of industrial setting has been indicated.

Comment No. 21: *<u>Table 4-2:</u> Explain the < values. Are these values associated with the laboratory PQL or the project specific PQLs (refer to No. 8)? Also, any qualifiers should be data validation qualifiers only, not those placed by the lab as footnotes (refer to No. 2). Also, if there is any bias associated to the qualifiers, they should be noted.*

MW Response: Comment noted. A footnote explaining < values has been added and the qualifiers have been revised as necessary.