



DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 49TH WING (ACC)
HOLLOMAN AIR FORCE BASE, NEW MEXICO



ENTERED

FEB 13 2012

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Dear New Mexico Environment Department

Holloman Air Force Base is pleased to submit the RCRA Facility Investigation Report Chemical Agent Disposal Site (DP-64) for your review.

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

If you have any questions, please contact Mr. David Scruggs of our Asset Management Flight at (575) 572-5395.

Sincerely

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FINAL

**RCRA FACILITY INVESTIGATION REPORT
CHEMICAL AGENT DISPOSAL SITE (DP-64)
HOLLOMAN AFB, NEW MEXICO**

Subcontract No.: 5020S.01

Under Prime Contract No.: W9128F-04-D-0017

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Prepared for:

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FINAL
RCRA FACILITY INVESTIGATION REPORT
CHEMICAL AGENT DISPOSAL SITE (DP-64)
HOLLOMAN AFB, NEW MEXICO
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- B Soil Boring Logs and Monitoring Well Construction Diagrams
- C Field Sampling Documentation
- D Analytical Data Packages (Provided on Enclosed CD)
- E Data Validation Reports

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LIST OF ACRONYMS

AAF	Army Air Field
AFB	Air Force Base
AF FM	Air Force Form
amsl	Above mean sea level
AOC	Area of Concern
bgs	Below ground surface
Bhate	Bhate Environmental Associates, Inc.
°C	Degrees Celsius
CAIS	Chemical Agent Identification Sets
cm/sec	Centimeters per second
CME	Central Mining Equipment
COPC	Chemical of potential concern
CSS	Chemical Safety Submission
DQO	Data quality objective
ECBC	Edgewood Chemical Biological Center
EM	Electromagnetic
EOD	Explosive Ordnance Disposal
ERP	Environmental Restoration Program
°F	Degrees Fahrenheit
ft	Feet
FWENC	Foster Wheeler Environmental Corporation
GPS	Global Positioning System
HAFB	Holloman Air Force Base
HHMSSL	Human Health Medium Specific Screening Level
IDW	Investigation Derived Waste
IRP	Installation Restoration Program
J	Laboratory or Validating Chemist Qualifier (denotes an estimated value)
LCS	Laboratory Control Sample
LTM	Long-Term Monitoring
MCL	Maximum Contaminant Level
MDL	Method detection limit
MEC	Munitions and Explosives of Concern
MS/MSD	Matrix Spike/Matrix Spike Duplicate
µg/kg	Micrograms per kilogram
µg/L	Micrograms per liter
mg/L	Milligrams per liter
mg/kg	Milligrams per kilogram
MTADS	Multiple Towed Array Detection System
NAD	North American Datum
NFA	No Further Action
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMWQCC	New Mexico Water Quality Control Commission

LIST OF ACRONYMS (CONTINUED)

NMWRRS	New Mexico Water Rights Reporting System
NWI	North Wind, Inc.
%	Percent
pH	Potential of hydrogen
PID	Photoionization Detector
PRG	Preliminary Remediation Goal
PVC	Polyvinyl chloride
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
%R	Percent recovery
RBC	Risk Based Concentration
RCRA	Resource Conservation Recovery Act
RCWM	Recovered Chemical Warfare Material
RFI	RCRA Facility Investigation
RI	Remedial Investigation
RL	Reporting Limit
RPD	Relative Percent Difference
RSL	Regional Screening Level
SCS	Soil Conservation Service
SOP	Standard Operating Procedure
SSFR	Site Specific Final Report
SSLs	Soil Screening Levels
SVOC	Semi-volatile organic compound
SWMU	Solid Waste Management Unit
SWRI	Southwest Research Institute
TDS	Total dissolved solids
UJ	Validating Chemist Qualifier (denotes an estimated non-detect value)
USACE	United States Army Corps of Engineers
USAESCH	United States Army Engineering Support Center, Huntsville
USCS	Unified Soil Classification System
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
UTL	Upper tolerance limit
UXO	Unexploded Ordnance
VOC	Volatile organic compound
WRCC	Western Regional Climate Center
Zapata	Zapata Engineering

1 INTRODUCTION

Bhate Environmental Associates, Inc. (Bhate) is working under Subcontract No. 5020S.01 to North Wind, Inc. (NWI), who has been retained by the U.S. Army Corps of Engineers (USACE), under contract W9128F-04-D-0017, to conduct a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI), at the Chemical Agent Disposal Site (DP-64), Holloman Air Force Base (HAFB), New Mexico. The primary objective of this investigation was to fill data gaps that existed from previous investigations in regards to soil and groundwater. RFI data collection activities were completed in October 2008 to support closure of the site based on guidance from the New Mexico Environment Department (NMED). This RFI Report has been prepared in accordance with the State of New Mexico requirements and following the guidelines set forth under HAFB's RCRA *Hazardous Waste Permit No. NM6572124422*; Appendix 4-B, RFI Outline, dated February 2004 (NMED, 2004a). The preparation and submittal of this RFI Report was delayed at the request of the NMED until the background concentrations of metals at HAFB could be finalized (NMED, 2011).

1.1 Objectives

The objectives of the RFI at Site DP-64 were to review available information and to collect soil and groundwater data to fulfill the data gap requirements identified by the NMED. The objectives of the DP-64 RFI were outlined in correspondence dated April 14, 2006, and January 30, 2008, from the NMED to HAFB (Attachment A) and are summarized as follows:

1. Advance soil borings in the 5 main areas of concern (anomalies 104, 105, 109, 112, and 137) and collect soil samples to determine the presence of contamination, if any.
2. Install groundwater monitoring wells to determine the nature and extent of groundwater contamination, if any.
3. Analyze soil and groundwater samples for Volatile Organic Compounds (VOCs), Semi-Volatile Organic Compounds (SVOCs), RCRA metals, Explosives, Nitrate/Nitrite (water only), and total dissolved solids (TDS) (water only).
4. Collect the proper data to support closure of the site based on guidance from the NMED.

The primary objective of this RFI is to determine whether the current soil and/or groundwater concentrations of VOCs, SVOCs, RCRA metals, Explosives, Nitrate/Nitrite, and TDS exceed any NMED Soil Screening Levels (SSLs) or applicable groundwater target levels. During this process, required data were collected to support the closure of the site based on guidance from the NMED. The ultimate objective is to achieve No Further Action (NFA) approval for site closure from NMED.

1.2 Purpose of the RCRA Facility Investigation

The primary purpose of the RFI is to comply with the requirements of RCRA Permit number NM6572124422 by completing the sampling program identified in the *RCRA Facility Investigation Work Plan, Chemical Agent Disposal Site (DP-64), Holloman Air Force Base, New Mexico* (Bhate, 2008) and applying the data quality objectives identified in the *Basewide Quality Assurance Project Plan (QAPP)* (Bhate, 2003). The data quality objectives include:

- Generate data to characterize contaminant sources; and
- Determine the nature and extent of contamination in the site media.

1.3 Scope of Work

The following summary of the work performed under this RFI is detailed in the *RCRA Facility Investigation Work Plan, Chemical Agent Disposal Site (DP-64), Holloman Air Force Base, New Mexico* (Bhate, 2008) and included:

- Review existing information about the site;
- Conduct a site reconnaissance;
- Identify potential receptors; and
- Evaluate all information collected.

To meet the RFI project objectives, the following activities were performed by Bhate in late October 2008:

- Five soil borings (DP64-SB04 through DP64-SB08) were drilled.
- Fifteen subsurface soil samples were collected for chemical analysis (3 samples per borehole).
- Four monitoring wells (DP64-MW01 through DP64-MW04) were installed in additional soil borings which were logged for lithology and headspace readings, but not sampled for chemical analysis.
- Groundwater samples were collected from new monitoring wells DP64-MW01 through DP64-MW04 along with one previously installed downgradient monitoring well (LF01-1W1). The samples were analyzed for the following parameters:
 - VOCs using U.S. Environmental Protection Agency (USEPA) Method 8260B (soil and groundwater);
 - SVOCs using USEPA Method 8270C (soil and groundwater);
 - RCRA Metals using USEPA Methods 6010B and 7471A/7470A (soil and groundwater);
 - Explosives using USEPA Method 8330A (soil and groundwater);
 - Nitrate/Nitrite using USEPA Method 300/9056 (groundwater only);
 - Percent Solids using USEPA Method 2540B (soil only); and
 - TDS using USEPA Method 2540C (groundwater only).

1.4 Document Organization

This RFI Report has been modeled after the format suggested in the RFI Report Requirements found in the HAFB RCRA Permit NM6572124422 (Appendix 4-B of the Permit; NMED, 2004a). The document contains the following eight sections:

- Section 1 – Introduction
- Section 2 – Site Background
- Section 3 – Environmental Setting
- Section 4 – Field Activities
- Section 5 – Laboratory Analysis and Data Validation Summary
- Section 6 – Nature and Extent of Contamination
- Section 7 – Conclusions and Recommendations
- Section 8 – References

The tables and figures referenced throughout this RFI Report are included following the text (after Section 8). Attachment A contains correspondence from the NMED regarding this site.

This report also includes the following five appendices:

- Appendix A – Historical Data from Previous Investigations
- Appendix B – Soil Boring Logs and Monitoring Well Construction Diagrams
- Appendix C – Field Sampling Documentation
- Appendix D – Analytical Data Packages (Provided on Enclosed CD)
- Appendix E – Data Validation Reports

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2 SITE BACKGROUND

2.1 HAFB Site Description

HAFB is located in southeastern New Mexico in Otero County, New Mexico, approximately 100 miles north-northeast of El Paso, Texas and six miles west of Alamogordo, New Mexico (Figure 2-1). HAFB was first established in 1942 as Alamogordo Army Air Field (AAF). From 1942 through 1945, Alamogordo AAF served as the training grounds for over 20 different flight groups, flying primarily B-17s, B-24s, and B-29s. After World War II, most operations had ceased at the base. In 1947, Air Material Command announced the air field would be its primary site for the testing and development of un-manned aircraft, guided missiles, and other research programs. On January 13, 1948, the Alamogordo installation was renamed Holloman Air Force Base, in honor of the late Col. George V. Holloman; a pioneer in guided missile research. In 1968, the 49th Tactical Fighter Wing arrived at HAFB and has remained since. Today, a portion of HAFB also serves as the training center for the German Air Force's Tactical Training Center.

2.2 Chemical Agent Disposal Site (DP-64) Site Description

Site DP-64 is located in the northeastern portion of HAFB on the north side and adjacent to the former Main Base Landfill (LF-01) (Figure 2-2). DP-64 is also listed as Area of Concern (AOC)-1 in Appendix 4-A of the HAFB RCRA *Hazardous Waste Permit No. NM6572124422*, revised November 29, 2005 (NMED, 2005). The total area of the DP-64 site is approximately 5.5 acres and is partially surrounded by a chain-link fence. Figure 2-3 shows the location of DP-64 in relation to the former Main Base Landfill (LF-01). DP-64 consists of gently rolling terrain with sparse desert vegetation.

During the 1950s, the Chemical Test Squadron from Edgewood Maryland flew missions to HAFB, although, no documentation has been found to indicate that testing of any chemical agents occurred at DP-64. However, M4 sulfur mustard vapor detection kits and detonation chemical agent identification sets (CAIS) were historically used at HAFB. CAIS kits were widely used by the Army for training purposes. The 1996 *Survey and Analysis Report, Second Edition* (U.S. Army Program Manager for Chemical Demilitarization, 1996) identified Alamogordo Army Air Base as a location where CAIS were recovered.

2.3 Applicable Screening Criteria

Analytical data obtained from previous investigations and the data collected during this RFI investigation will be evaluated against the applicable regulatory screening criteria that are specified in Appendix 4-F *Action Levels and Cleanup Levels* of the Holloman AFB Hazardous Waste Permit No. NM6572124422 (NMED, 2004b). The soil and groundwater data evaluation will consist of a direct comparison to the applicable action level screening criteria. The applicable screening criteria are presented in the RFI analytical data summary tables for the analytes and media of concern. The following sections present the regulatory criteria that were used to evaluate the analytical data.

2.3.1 Soils - VOCs, SVOCs, Explosives, and RCRA Metals

The residential SSLs established in *NMED Technical Background Document for Development of Soil Screening Levels Revision 5.0* (NMED, 2009) will be used as the primary action levels for VOCs, SVOCs, Explosives, and RCRA metals. As per the HAFB Permit, Appendix 4-F V.1 (NMED, 2004b) if a NMED soil cleanup level has not been established for a particular chemical of potential concern (COPC) (e.g. 2-methylnaphthalene), that constituent will be compared to the USEPA Region 6 Human Health Medium Specific Screening Level (HHMSSL). It should be noted that, under an Interagency Agreement as an update of the USEPA Region 3 Risk Based Concentration (RBC) Table, Region 6 HHMSSL Table, and the Region 9 Preliminary Remediation Goal (PRG) Table; the Region 6 HHMSSLs have been combined into the Regional Screening Level (RSL) Table (USEPA, 2011). Additionally, all detected RCRA metals will be compared to their respective NMED approved HAFB Background Levels (NMED, 2011).

2.3.2 Groundwater

2.3.2.1 VOCs, SVOCs, Explosives, and RCRA Metals

There are two applicable standards for groundwater: the New Mexico Water Quality Control Commission (NMWQCC) groundwater standards for contaminants (New Mexico Administrative Code [NMAC], 20.6.2.3103) and the USEPA's *National Primary Drinking Water Regulations* (USEPA, 2009) Maximum Contaminant Levels (MCLs). The lower of the two standards will be used as action levels for VOCs, SVOCs, Explosives, and RCRA metals detected in groundwater. Additionally, all detected RCRA metals will be compared to their respective NMED approved HAFB Background Levels (NMED, 2011).

2.3.2.2 Nitrate, Nitrite, and Total Dissolved Solids

There are three applicable standards for Nitrate, Nitrite, and TDS detected in groundwater: NMWQCC groundwater standards for contaminants (NMAC 20.6.2.3103) (Nitrate and TDS), the USEPA's *National Priority Drinking Water Regulations* MCLs (USEPA, 2009) (Nitrate and Nitrite), and the USEPA Secondary Drinking Water Standard (USEPA, 2009) (TDS only). The lowest of the three standards is used as the action levels for Nitrate, Nitrite, and TDS. Additionally, nitrate and nitrite will be compared to their respective NMED approved HAFB Background Levels (NMED, 2011).

2.4 Historical Data Review

This section presents an overview of the previous investigations conducted at Site DP-64. Prior to 2000, DP-64 was unknown as an area of potential contamination. The site was discovered in 2000 by a pedestrian walking in the area, and has undergone clearance, investigation, and removal activities since 2004. This section provides a historical overview and chronology of the previous activities conducted at Site DP-64 from 2000 through 2008.

2.4.1 DP-64 Ordnance Discovery

On February 9, 2000, several broken vials and two intact vials containing a clear to yellowish liquid were discovered by a pedestrian walking north of the closed Main Base Landfill (LF-01) site. During a re-vegetation project at LF-01, the topsoil associated with the landfill had been turned and the pedestrian reported their findings to the 49th Environmental Flight. The 49th Environmental Flight in conjunction with Foster Wheeler Environmental Corporation (FWENC) responded by locating, recovering, and transporting the two intact vials to Brooks Air Force Base (AFB), Texas, for analysis by the Southwest Research Institute (SWRI). The vials were analyzed for chemical warfare agents and three industrial chemical agents. The results of the analysis indicated that one vial contained 5 percent of the chemical warfare agent Lewisite in chloroform (Zapata Engineering [Zapata], 2005).

2.4.2 DP-64 Ordnance and Explosives Removal Action

FWENC prepared a Chemical Safety Submission (CSS) (FWENC, 2003) for the USACE in October 2003, which was then supplemented by the *Ordnance and Explosive Recovered Chemical Warfare Material Removal Action Final Work Plan* (Zapata, 2004) and the *Final Site Specific Final Report [SSFR] for Ordnance and Explosive Removal Action at Holloman Air Force Base New Mexico* (Zapata, 2005). The Final SSFR field activities included a detailed surface search and debris removal action, a subsurface geophysical survey to locate subsurface anomalies, and excavation of the identified subsurface anomalies.

The initial surface search conducted by unexploded ordnance (UXO) specialists with Zapata in May 2004, resulted in the discovery of one intact glass ampoule and several broken shards of glass from CAIS kits. The glass was removed from the site by the U.S. Army Engineering Support Center, Huntsville (USAESCH) and sent to an onsite interim holding facility for storage prior to disposal. Two soil samples (DP6401 and DP6402) were collected from under the intact ampoule and under the area where the broken ampoule was identified (Figure 2-4). The soil samples were shipped to the Edgewood Chemical Biological Center (ECBC) for chemical analysis. The analytical results (Appendix A) from the soil samples indicated negative results for chemical agents and agent breakdown products (Zapata, 2005). The total surface search at DP-64 included, 24 grids, each 100 feet (ft) by 100 ft in area. Figures B-4 and B-5 (Zapata, 2005), depict the results of the surface investigation, and are included in Appendix A of this RFI Report.

On June 8, 2004, Zapata subcontracted Blackhawk GeoServices to conduct a subsurface geophysical investigation at DP-64. The investigation encompassed an area of 400 ft by 600 ft (5.5 acres). Geophysical data were collected using the Multiple Towed Array Detection System (MTADS) EM [Electromagnetic]-61 (Zapata, 2005). Appendix A of this RFI Report includes a color grid control map of the survey area. The geophysical survey identified 123 subsurface anomalies that would require further intrusive investigation.

Intrusive activities began at site DP-64 on June 14, 2004. Each subsurface anomaly identified from the geophysical survey was excavated. A Geophysical Dig Sheet and Target History summary table, from Appendix E of the Final SSFR, is included in Appendix A of this RFI

Report. As a result of the investigation, 121 of the anomalies, were identified as scrap metal, and were attributed to debris related to the former Main Base Landfill, LF-01. The remainder of the anomalies were excavated and removed by the HAFB Explosive Ordnance Disposal (EOD) personnel for disposal.

On June 24, 2004, a 10 ft by 60 ft trench was excavated in the area where the ampoules were recovered (Figure 2-4). Additional glass ampoules were located during the excavation operations. Three subsurface soil samples were collected (DP6403 through DP6405) from soil adjacent to the recovered ampoules (Figure 2-4) and were sent offsite to ECBC for chemical analysis. In addition, a sixth soil sample (DP6406), included in the analytical report, was submitted by Zapata, but it is unknown where this sample was collected. The analytical results from the soil samples collected indicated negative results for chemical agents and agent breakdown products (Zapata, 2005). Complete analytical data packages for all 5 soil samples (including DP6401 and DP6402 collected during the surface investigation) are also included in Appendix A of this RFI Report.

According to the Final SSFR, a total of 15 CAIS kit components were recovered, packaged, and stored during this field effort. Seventeen electric blasting caps, seven M3 grenade igniters, and seven complete and partial M69 incendiary bomblets were also recovered by HAFB EOD personnel for disposal during the surface and subsurface investigations. Scrap Management Forms or manifests for the DP-64 debris are also included in Appendix A of this RFI Report.

The Zapata investigation concluded that a widespread threat of Munitions and Explosives of Concern (MEC) or Recovered Chemical Warfare Material (RCWM) in the area surrounding DP-64 was unlikely. Due to the fact that the surrounding acreage had been disturbed in the past by the construction of roads and a capped landfill adjacent to the site, this conclusion is logical.

A Notice of Deficiency letter to the Final SSFR (Zapata, 2005), provided by the NMED, dated April 14, 2006 (Attachment A), requested additional sampling to be conducted at DP-64. NMED requested additional soil sampling at five geophysical anomalies (104, 105, 109, 112, and 137) associated with previous "burn pit" locations (Figure 2-5).

The *RFI Work Plan, Chemical Agent Disposal Site (DP-64), Holloman Air Force Base, New Mexico* (Bhate, 2008) was designed based on the 2006 Notice of Deficiency letter. A Notice of Disapproval letter to the DP-64 RFI Work Plan (Bhate, 2008), provided by the NMED, dated January 30, 2008 (Attachment A), requested a minimum of three groundwater monitoring wells be installed at the DP-64 site and sampled for VOCs, SVOCs, RCRA Metals, Explosives, Nitrates/Nitrites, and TDS. This Notice of Disapproval Letter also requested that metals detected in the DP-64 soil samples be compared to the NMED SSLs (NMED, 2009) and the NMED approved background levels (NMED, 2011).

3 ENVIRONMENTAL SETTING

The following subsections present the environmental setting. This information was obtained primarily from the *Draft Final Remedial Investigation [RI] Report, Investigation, Study and Recommendation for 29 Waste Sites, Holloman Air Force Base, New Mexico Volume I* (Radian, 1992), unless cited otherwise.

3.1 Physiography and Topography

HAFB is located within the Sacramento Mountains Physiographic Province. HAFB is approximately 59,600 acres in area, and is located at a mean elevation of 4,093 feet above mean sea level (amsl). The region is characterized by high tablelands with rolling summit plains; cuesta-formed mountains dipping eastward and of west-facing escarpments with the wide bracketed basin forming the basin and range complex. The Base is located within the Tularosa Basin, which is part of a 170 mile long structural depression. The basin is bounded on the south by a low topographic divide near the Texas state line; on the west (about 30 miles) by the uplifted Organ, San Andes and Oscura Mountains; on the north by Chupadera Mesa; and on the east (about 10 miles) by the uplifted Jicarilla and Sacramento Mountains. The surrounding mountains rise abruptly to altitudes of 7,000 to 12,000 feet amsl. At its widest, the basin is about 60 miles east to west and stretches approximately 150 miles north to south.

The Tularosa Basin is a closed basin that contains all of the surface flow within its boundaries. Surface runoff from the surrounding mountains has deposited alluvial fans on the interior of the plain. Around the base, the ground surface is undulating comprised of alluvial fan deposits, eolian dunes, and flat bottomed playas (pan shaped depressions carved by wind erosion). To the west of the Base lie the gypsum sand dune fields of the White Sands National Monument. A topographic map of the base is provided in Figure 3-1 of this report.

3.2 Surface Water and Hydrology

Within the boundaries of the Base, surface water runoff is controlled by several arroyos that trend to the southwest (see Figure 3-2 of this report). The nearest inflow of surface waters to the Base comes from the Lost River, located in the north-central region of the Base. HAFB is dissected by several other southwest trending arroyos that control the surface drainage. Hay Draw arroyo is located in the far north. Malone and Rita's Draw, which drain into the Lost River, and Dillard Draw arroyos are located along the eastern perimeter of the Base. Approximately 10,000 years ago, indications are of a much wetter climate. The present day Lake Otero encompassed a much larger area, possibly upwards of several hundred square miles. Its remains are the Alkali Flat and Lake Lucero. Lake Lucero is a temporary feature of merely a few inches in depth during the rainy season.

Ancient lakes and streams deposited water bearing deposits over the older bedrock basement material. Fractures, cracks, and fissures in the Permian and Pennsylvanian bedrock yield small quantities of relatively good quality water in the deeper peripheral. Potable water is only found from a handful of wells near the edges of the basin with more saline water towards the center.

Two of the principal sources of potable water are a long narrow north-south trending area east of Tularosa and Alamogordo and in the far southwestern part of the basin. Alamogordo's water, as well as the Base's, is supplied from Lake Bonito (which is in the Pecos River Basin).

3.3 Regional Geology and Soils

3.3.1 Geology

The Tularosa Basin is the easternmost extension of the Basin and Range Province of the western United States. The Basin and Range was created by Cenozoic extensional (normal) faulting of Precambrian- through Tertiary-age sedimentary and igneous rocks. The basin is a graben, or downthrown block, bounded by the upthrown fault blocks of the San Andres and Sacramento Mountains.

During the Permian period of the Paleozoic era (approximately 270 million years ago), southern New Mexico was covered by a shallow sea. Limestone and sandstone were deposited, forming thick sedimentary units. Toward the end of the Mesozoic era (approximately 70 million years ago), the major mountain building activities that formed the Rocky Mountains took place. During these events, southern New Mexico emerged from the ocean as the earth's crust warped gently in this region. During the Cenozoic era (beginning approximately 70 million years ago), basin and range formation was initiated in what is now the southwestern United States. Approximately 10 million years ago, Cenozoic faulting formed the graben structure known as the Tularosa Basin. During this process, arched portions of rock collapsed between large-scale, north-south trending faults. The Tularosa Basin is a central downthrown area, bounded on the east and west by fault block mountains. Bedded Permian strata can be seen along the faces of the Sacramento and San Andres Mountains. Permian limestones also occur west of HAFB in a low bedrock outcrop near Hurtz Spring. In the millions of years following, rainfall, snowmelt, and wind eroded the mountain sediments depositing them in the valley (i.e. Tularosa Basin). Water carrying eroded limestone, dolomite, gravel, and other matter continue to flow into the basin. A generalized cross-section of the Tularosa Basin is shown in Figure 3-3 of this report.

As the Tularosa Basin is a bolson, which is a basin with no surface drainage outlet, sediments carried by surface water into a closed basin are bolson deposits. The overlying alluvium generally consists of unconsolidated gravels, sands, and clays. The bolson sediments within the Tularosa Basin are derived from the adjacent ranges as erosional deposits of limestone, dolomite, and gypsum. Coarser material is deposited at the base of the mountains while finer material is carried to the basin's interior. The bolson fill deposits thin out from Alamogordo to less than 100 feet near Hurtz Spring. Bolson fill deposits are 8,000 feet thick or more in the central portion of the Tularosa Basin.

Near-surface geologic conditions at HAFB have been established during this and numerous other Environmental Restoration Program (ERP) investigations. The near-surface bolson deposits at HAFB consist of sediments that are alluvial, eolian, and lacustrine in origin. The alluvial fan deposits are laterally discontinuous units of interbedded sand, silt, and clay while the eolian deposits consist primarily of gypsum sands. The eolian and alluvial deposits are usually

indistinguishable because the wind simultaneously reworks alluvial fan sediments and deposits gypsum sands resulting in an intermingling of the two sediment types. The playa, or lacustrine deposits, consist of medium to high plastic clay containing gypsum crystals and are contiguous with the alluvial fan and eolian deposits throughout HAFB. There has been the identification of stiff caliche layers, varying in thickness, at different areas of the Base. A generalized near surface cross-section for HAFB is shown in Figure 3-4 of this report.

3.3.2 Soils

The United States Department of Agriculture (USDA) Soil Conservation Service (SCS) has identified two soil associations in the vicinity of HAFB; the Holloman-Gypsum Land-Yesum complex, and the Mead silty clay loam. The permeability of these horizons ranges from 4×10^{-4} to 1×10^{-3} centimeters per second (cm/sec). The distribution of soils in the vicinity of HAFB is depicted on Figure 3-5 of this report (USDA, 1981).

The Holloman-Gypsum land-Yesum complex, 0 to 5 percent slopes soil consists of large areas of shallow and deep, well drained soils and areas of exposed gypsum. The Holloman soil makes up about 35 percent of the complex. Typically, the surface layer is light brown very fine sandy loam about 3 inches thick. The upper 13 inches of the substratum is pink very fine sandy loam that is very high in gypsum. Below that, the substratum is white gypsum to a depth of more than 60 inches. This soil is calcareous and mildly alkaline to moderately alkaline throughout. Permeability is moderate, and available water capacity is very low.

Gypsum land makes up about 30 percent of the Holloman-Gypsum land-Yesum complex, 0 to 5 percent slopes. Typically, less than 1 inch of very fine sandy loam overlies soft to hard, white gypsum. The deep Yesum very fine sandy loam makes up about 20 percent of the complex. Typically, the surface layer is light brown very fine sandy loam about 3 inches thick. The upper 9 inches of the substratum is light brown fine sandy loam that is very high in gypsum. Below that, the substratum is pink very fine sandy loam to a depth of more than 60 inches. The soil is calcareous throughout and is mildly alkaline. Permeability is moderate, and available water capacity is moderate. Many fine gypsum crystals are found throughout the profile.

The soil type located across the main drainage area for the installation is Mead silty clay loam, 0 to 1 percent slopes. This deep, poorly drained, nearly level soil is on outer fringes of alluvial fans. This soil formed in fine textured alluvium over lacustrine lake sediment. It is very high in salt content because of periodic flooding and poor drainage. Slopes are smooth and concave. Typically, the surface layer is reddish brown silty clay loam and clay loam about 5 inches thick. The substratum, to a depth of 48 inches, is light reddish brown clay that has a high content of salts. Below that, the substratum is lacustrine material of variable texture and color to a depth of more than 60 inches. Included with this soil are areas of Holloman soils and Gypsum land along the margins of the unit of steep, short gully sides and knolls. These inclusions make up about 15 percent of the map unit for this soil type. Individual areas are generally smaller than 10 acres. This soil is moderately calcareous throughout and is moderately to strongly alkaline. It has a layer of salt that is more soluble than gypsum. Permeability is very slow, and available water capacity is low.

3.4 Regional Hydrogeology

Groundwater occurs as an unconfined aquifer in the unconsolidated deposits of the central basin, with the primary source of recharge as rainfall percolation and minor amounts of stream run-off along the western edge of the Sacramento Mountains. Surface water/rainfall migrates downward into the alluvial sediments at the edge of the shallow aquifer near the ranges, and flows downgradient through progressively finer-grained sediments towards the central basin. Because the Tularosa Basin is a closed system, water that enters the area only leaves either through evaporation or percolation. This elevated amount of percolation results in a fairly high water table. Beneath HAFB, groundwater ranges from 5 to 50 feet bgs. Flow for the Base is generally towards the southwest with localized influences from the variations in the topography of the Base. In the northern and western portions of the Base, groundwater flows more to the west toward the Ritas Draw, Malone Draw, and Lost River drainages. Groundwater flow is affected by local topography in areas immediately adjacent to arroyos, where groundwater flows directly toward the drainages regardless of the regional flow pattern.

Figure 3-6 of this report shows the basewide groundwater flow direction obtained from water level measurements collected during the 2002 Long Term Monitoring (LTM) groundwater sampling event (FWENC, 2002). Groundwater quality in the Tularosa Basin is of potable quality at the recharge areas in close proximity to the Sacramento Mountains and becomes increasingly mineralized toward the central portion of the basin and discharge areas (Radian, 1992). The majority (over 70 %) of the ERP Sites/Solid Waste Management Units (SWMUs) located across HAFB have groundwater monitoring wells containing water with an average TDS concentration greater than 10,000 milligrams per liter (mg/L). This TDS data supports the hypothesis that TDS concentrations below 10,000 mg/L at HAFB are caused by dilution of natural groundwater from leaking water lines and surface irrigation from the domestic water supply. TDS concentrations greater than 10,000 mg/L exceed the NMWQCC limit as potable water and thus, the groundwater beneath HAFB has been designated as unfit for human consumption. Additionally, based on the USEPA document, *Final Draft Guidelines for Ground-Water Classification Under the EPA Ground-Water Protection Strategy* (USEPA, 1986), the groundwater can be classified as III B. Class III B groundwater is characterized by having a TDS concentration greater than 10,000 mg/L, and a low degree of interconnection to adjacent surface waters or groundwater of a higher class. Because the Tularosa is a closed basin, its groundwater does not discharge or connect to any adjacent aquifer. Adjacent surface waters include groundwater surfacing in Lake Holloman. TDS in Lake Holloman ranges from a winter low of 12,400 mg/L to a summer high of 17,000 mg/L (Cole, et al., 1981); therefore, groundwater at HAFB is not interconnected with surface water of a higher class.

There are no potable water wells on HAFB. Potable water for the Base (Boles, Douglas, and San Andres well fields) and the city of Alamogordo is derived from the foot of the nearby Sacramento Mountains, just south of Alamogordo. According to a groundwater well inventory (Table 3-1) prepared by the New Mexico Office of the State Engineer, there are approximately 25 domestic, 15 commercial, 7 irrigation, and 3 livestock wells located within a 4-mile radius of HAFB (New Mexico Water Rights Reporting System [NMWRRS] database, 2009). As shown on Figure 3-7, these wells are located along HAFB's northern and eastern boundaries (upgradient

and cross gradient respectively).

3.5 DP-64 Geology and Hydrogeology

The description of the Chemical Agent Disposal Site (DP-64) geology is based on the excavation activity completed by Zapata Engineering in 2004 along with the nine soil borings completed during this RFI by Bhate in October 2008. These two investigations defined subsurface conditions at DP-64 via direct sampling and observation of excavation and drilling operations. Drilling logs for this RFI are included in Appendix B of this report.

DP-64 consists of gently rolling terrain with sparse desert vegetation, well-drained soils, and exposed gypsum at the surface (Zapata, 2005). The DP-64 lithology consists primarily of silty sands, white gypsum sands, and clayey sands. The first 10 to 13 feet are primarily pale brown to reddish brown unconsolidated silty sands. Fine grained, silty sand with medium to coarse grained gypsum crystal inclusions is interbedded with fine grained white gypsum sand, and pale brown silty sand from depths of approximately 13 to 25 ft below ground surface (bgs). From 25 to 35 ft bgs an interbedded, plastic, clayey sand and silty sand occur in two to three foot intervals. At approximately 36 ft bgs a medium to coarse grained, well sorted, brown, saturated sand is encountered and continues to a depth of roughly 42 ft bgs. Underlying this sandy, water bearing unit, to a depth of 44 ft bgs is moist, stiff, non-plastic, silty clay.

Groundwater at DP-64 occurs in well sorted sands in a shallow unconfined aquifer from approximately 36 to 44 ft bgs. At DP-64 there are four monitoring wells (DP64-MW01 through DP64-MW04) installed by Bhate in October 2008 that are screened from approximately 32 to 44 ft bgs. In the southwest corner of Site DP-64 there is an existing monitoring well associated with the Former Main Base Landfill (LF-01). Monitoring well, LF01-1W1, was installed by Dames & Moore in September 1984 (Dames & Moore, 1987) and is screened from approximately 34 to 59 ft bgs. In October 2008, depth to groundwater measurements at these five monitoring wells ranged from 34.17 to 36.62 ft below the top of the polyvinyl chloride (PVC) casing and groundwater elevations ranged from 4,085.79 to 4,086.58 ft amsl. Tables 3-2 and 3-3 of this report present the monitoring well construction details and the groundwater elevation data respectively. A potentiometric surface map (Figure 3-8) was prepared using the data collected in October 2008. Groundwater flows south to southwest towards the main base area and the hydraulic gradient is approximately 1.73×10^{-3} .

Dillard Draw is an arroyo that runs north to south east of DP-64, along the HAFB boundary. Dillard Draw very slightly influences groundwater flow at this site, away from the typical west to southwest flow direction seen elsewhere around the main base area.

3.6 Climate

As a whole, New Mexico has a mild, arid to semi-arid continental climate characterized by light precipitation totals, abundant sunshine, relatively low humidity, and relatively large annual and diurnal temperature range (Western Regional Climate Center [WRCC], 2003). The climate of the Central Closed Basins varies with elevation. The Base is found in the low areas and is characterized by warm temperatures and dry air. Daytime temperatures often exceed 100

degrees Fahrenheit (°F) in the summer months and are in the middle 50s in the winter. A preponderance of clear skies and relatively low humidity permits rapid night time cooling resulting in average diurnal temperature ranges of 25 to 35°F. Potential evapotranspiration, at 67 inches per year, significantly exceeds annual precipitation, usually less than 10 inches. The very low rainfall amounts resulting in the arid conditions, which with the topographically induced wind patterns combining with the sparse vegetation, tend to cause localized “dust devils”. The annual rainfall for Alamogordo is 12 inches per year¹. Much of the precipitation falls during the mid-summer monsoonal period (July and August) as brief, yet frequent, intense thunderstorms culminating to 30 – 40% of the annual total rainfall.

3.7 Current and Future Land Use

The land surrounding HAFB consists of residential areas to the east and northeast (City of Alamogordo), rangeland to the south, the White Sands National Monument to the west, and areas where military activities are conducted to the north. The desert terrain of the area immediately surrounding HAFB has limited development, and there are no agricultural operations, residential communities, or large industrial operations located adjacent to the Base. HAFB is an active military installation and is expected to remain active for the foreseeable future. No transfer of military property to the public is anticipated, and public access to the Base is restricted.

Residential development on the Base is limited by environmental and operational constraints imposed by the 100-year floodplain, historic sites, and areas identified under the Installation Restoration Program (IRP). Safety and noise zones also limit residential development on HAFB. Future plans for residential development on the Base include renovation of existing structures, replacement of inefficient buildings, and expansion into open areas in the southeast corner of the Base (HAFB, 2000). Future land use is not expected to differ significantly from current land use practices.

3.8 Current and Future Water Use

At present, the primary fresh water resource for the City of Alamogordo and HAFB is Lake Bonita, 60 miles northeast of the Tularosa Basin. Currently, there are no potable supplies of groundwater or surface water located on the Base. HAFB obtains its water supply from the City of Alamogordo and the HAFB wells in the Boles, San Andres, and Douglas well fields at the base of the Sacramento Mountains. No water supply wells are located on or near the Base because of poor groundwater quality (TDS greater than 10,000 mg/L). The nearest production well downgradient from HAFB is a livestock well located 11 miles southwest of the Base. There are no potable or irrigation wells near to or immediately downgradient of the Base.

¹ <http://countrystudies.us/united-states/weather/new-mexico/>

4 FIELD ACTIVITIES

The objective of the investigation activities at the site was to fill data gaps identified by NMED (Attachment A). To meet the RFI objectives, the following activities were performed:

- Installed four new monitoring wells (DP64-MW01 through DP64-MW04);
- Advanced five soil borings (DP64-SB04 through DP64-SB08) and collected 15 soil samples (3 per borehole) to characterize soil conditions at geophysical anomalies 104, 105, 109, 112, and 137;
- Collected a groundwater sample from one existing down-gradient monitoring well to the south of DP-64 (LF01-1W1);
- Collected groundwater samples from the four new monitoring wells (DP64-MW01 through DP64-MW04);
- Analyzed soil samples for VOCs, SVOCs, RCRA metals, and Explosives; and
- Analyzed groundwater samples for VOCs, SVOCs, RCRA metals, Explosives, Nitrate/Nitrite, and TDS.

Prior to sampling activities, an Air Force Form, AF FM 332, and dig permit were submitted to the proper HAFB utility offices. All sampling activities were completed following the *Final RCRA Facility Investigation Work Plan Chemical Agent Disposal Site (DP-64) Holloman Air Force Base, New Mexico* (Bhate, 2008) and standard industry practices. A copy of the field logbook for this investigation is included in Appendix C of this RFI Report.

4.1 Soil Boring Sampling

In October 2008, five soil borings (DP64-SB04 through DP64-SB08) were advanced at Site DP-64 (Figure 4-1) in accordance with HAFB Standard Operating Procedures (SOPs) provided in the Basewide QAPP (Bhate, 2003). The soil borings were advanced using a Central Mining Equipment (CME) 85 hollow stem auger drill rig, a five foot stainless steel core barrel, and associated tooling. These soil borings were sampled continuously to a depth of approximately 40 feet bgs. Three soil samples for chemical analysis were collected from each borehole (DP64-SB04 through DP64-SB08). At the completion of sampling activities, borings DP64-SB04 through DP64-SB08 were abandoned with hydrated bentonite chips. Table 4-1 summarizes the soil boring locations, northing and easting coordinates, the sample intervals and the types of chemical analyses performed by the offsite laboratory. In addition, soils were continuously cored, lithology logged, and soil sample headspace readings were taken in the boreholes converted into monitoring wells although no soil samples were submitted for chemical analysis from these boreholes.

Soils were visually classified in the field by a geologist according to the Unified Soil Classification System (USCS). Soils were screened with a Mini Rae 2000 photoionization detector (PID), using soil-headspace screening techniques to aid in selecting samples for laboratory chemical analysis. Three soil samples were collected from each of the five soil borings (DP64-SB04 through DP64-SB08) for laboratory chemical analysis. Due to the absence of elevated PID readings, one sample was collected from approximately 2 ft bgs, one sample

above the capillary fringe, and a third soil sample from a location halfway between the capillary fringe and ground surface. Soil samples were placed in the appropriate containers, packed on ice at 4 degrees Celsius (°C), and delivered under strict chain-of-custody to Accutest Laboratories in Orlando, Florida. The soil boring logs for this investigation are included in Appendix B of this RFI Report.

4.2 Monitoring Well Installation

To determine the nature and extent of potential groundwater contamination at DP-64 four permanent monitoring wells (DP64-MW01 through DP64-MW04) were installed, in October 2008 by Bhate (Figure 4-2), as proposed in the *RCRA Facility Investigation Work Plan, Chemical Agent Disposal Site (DP-64), Holloman Air Force Base, New Mexico* (Bhate, 2008). DP64-MW01 was installed to serve as an upgradient well in the northeast corner of the site. DP64-MW02 was installed downgradient of anomaly 109, DP64-MW03 was installed downgradient of anomalies 104 and 105, and DP64-MW04 was installed downgradient of anomaly 137. Furthermore, existing monitoring well LF01-1W1 was used as an additional downgradient monitoring well at the site.

The newly installed permanent monitoring wells (DP64-MW01 through DP64-MW04) were constructed according to the *New Mexico Environment Department Groundwater Discharge Permit Monitoring Well Construction and Abandonment Guidelines*, Revision 1.0 (NMED, July 2008). The groundwater monitoring wells were constructed of 2-inch inner diameter PVC. Each well was screened with 10 ft of 0.010-inch factory slotted PVC. All connections between screen and riser sections were flush-threaded. The annular space surrounding the screen was backfilled with 10/20 silica sand to provide filter pack for each well. The sand was capped with a minimum 2-ft layer of granular bentonite and then the borehole was grouted, with a mixture of neat Portland cement and water, to the surface. Monitoring well surface completions were constructed as 8-inch flush mount well covers set within a twelve inch circular concrete pad. Appendix B contains the well construction diagrams for each of the four new monitoring wells.

4.3 Monitoring Well Development

Each monitoring well was developed using a combination of surging and pumping in order to promote hydraulic communication with the aquifer and to remove fines prior to sampling. Prior to well development, a water-level measurement was taken at each well using an electronic water-level probe. This information, in addition to well depth, and well diameter, was used to calculate the volume of water in each well. Each newly installed monitoring well was surged in 4-to-5 foot intervals from the bottom of the screened interval to agitate and remove the fine grained sediment from the filter pack. At the completion of surging, the groundwater was removed using a ProActive™ Mini-Monsoon stainless-steel submersible pump attached to 1/2-inch polyethylene tubing. Development was performed by over-pumping the well until at least five well volumes had been removed. A Horiba® U-52 water quality meter and Hanna® turbidity meter monitored groundwater parameters (temperature, potential of hydrogen [pH], conductivity, dissolved oxygen, and turbidity) during development until the parameters stabilized (+/- 10

percent [%]) for at least three consecutive readings. Groundwater parameters were logged into Monitoring Well Development Forms which are included in Appendix C of this report.

4.4 Groundwater Sampling

In October 2008, groundwater samples were collected from the four new wells (DP64-MW01 through DP64-MW04) along with one existing well (LF01-1W1) illustrated on Figure 4-2. Prior to sampling the four new monitoring wells, each well was developed by surging the well and removing at least five well volumes. Once the turbidity, pH, temperature, specific conductivity, dissolved oxygen, and oxidation reduction potential had stabilized by +/- 10 percent for at least three consecutive readings with a multi-parameter groundwater monitor, the monitoring well was considered developed. Appendix C includes the Monitoring Well Development Forms for the four new monitoring wells installed at DP-64.

Prior to sampling, groundwater levels were measured for each monitoring well and then it was purged. Monitoring well purging and sampling was completed with low flow techniques using a ProActive™ Mini-Monsoon, stainless steel submersible pump and disposable polyethylene tubing placed at mid-screen. Each of the wells was pumped at an average rate of less than 1 liter per minute. Appendix C includes the Monitoring Well Sample Collection Forms.

Groundwater samples were placed in the appropriate containers, packed on ice at 4 °C, and delivered under strict chain-of-custody to Accutest Laboratories located in Orlando, Florida.

4.5 Surveying

Sample locations were surveyed, by using a survey grade Trimble® Geometrics Pro XR global positioning system (GPS), in accordance with methods described in the Basewide QAPP (Bhate, 2003). The locations, referenced with horizontal coordinates, and top of casing elevations were obtained for each monitoring well. All elevations are referenced to the North American Datum (NAD) 1983. All horizontal coordinates are referenced to the State Plane Coordinate System, New Mexico Central. Elevations and coordinates are surveyed to the closest 0.001 foot. Tables 3-2 and 4-1 include the survey data for the 4 monitoring wells and 5 soil borings installed during this investigation.

4.6 Equipment Decontamination

All reusable equipment associated with soil sampling was decontaminated in accordance with the HAFB SOPs provided in the Basewide QAPP (Bhate, 2003).

4.7 Waste Handling

All investigation derived waste (IDW) produced during the investigation process was handled in accordance with the HAFB SOPs provided in the Basewide QAPP (Bhate, 2003).

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5 LABORATORY ANALYSIS AND DATA VALIDATION SUMMARY

The analysis of soil and groundwater samples collected during this investigation followed the proposed methodologies presented in the *Final RCRA Facility Investigation Work Plan, Chemical Agent Disposal Site (DP-64), Holloman Air Force Base, New Mexico* (Bhate, 2008). All analytical procedures followed the USEPA SW846 protocol with the groundwater and soil samples being analyzed in various combinations for the following:

- VOCs by USEPA Method 8260B
- SVOCs by USEPA Method 8270C
- RCRA Metals by USEPA Method 6010B/7470A/7471A
- Explosives by USEPA Method 8330A

The groundwater samples also included the following wet chemistry analysis:

- Nitrate/Nitrite by USEPA Method E300/9056
- TDS by Method 2540C

All of the laboratory data generated as part of this project was validated by the project chemist. Field Quality Assurance (QA)/Quality Control (QC) samples, including trip blanks, equipment blank, and matrix spike/matrix spike duplicates (MS/MSDs) were collected to document field and laboratory QA/QC. The analytical data is provided in Appendix D of this report. The Data Validation Reports are provided in Appendix E. Accutest Laboratories in Orlando, Florida performed the analysis of all samples collected.

Overall, only minor QC issues were identified during the data validation of the laboratory results and the laboratory took all necessary corrective actions. All of the data were determined to be usable with only minor qualifications. Information regarding the precision, accuracy, representativeness, and completeness is provided in the validation reports (Appendix E) with the following section providing a synopsis of each analyte group.

5.1 Volatile Organic Compounds

The Encore samples for DP64-SB07-2, DP64-SB07-2-a, DP64-SB04-2, DP64-SB04-18, DP64-SB04-36, and DP64-SB07-16 were not preserved within method specific hold times. The detected volatile compounds were qualified as estimated, "J", and the non-detected compounds were qualified as estimated, non-detected, "UJ".

Methylene chloride was detected in multiple soil method and/or trip blanks. The sample concentration in DP64-SB07-2, DP64-SB04-2, DP64-SB08-2, DP64-SB08-34, DP64-SB08-17, DP64-SB05-2, DP64-SB05-18, DP64-SB05-36, DP64-SB06-2, DP64-SB06-17, DP64-SB06-17-a, and DP64-SB06-35 was less than 10 times the blank concentration and qualified as estimated, "J". The compound 1,1-dichloroethylene was detected in the trip blank associated with DP64-SB06-2, DP64-SB06-17, DP64-SB06-17-a, and DP64-SB06-35. Sample DP64-SB06-35 was the only sample to yield a positive result and was qualified as estimated, "J".

The aqueous laboratory control sample (LCS) percent recovery (%R) for 1,2,3-trichloropropane was below QC limits associated with LF01-IW1. Samples DP64-MW01 and DP64-MW02 yielded LCS %Rs for acrolein (along with MS and/or MSD %R discrepancies) and 1,1-dichloroethylene below QC limits. These non-detected compounds were qualified as estimated non-detected, "UJ".

The soil LCS %Rs for acrolein, benzyl chloride, and propionitrile (along with MS and/or MSD %R discrepancies) were below QC limits associated with samples DP64-SB08-2, DP64-SB08-34, DP64-SB08-17, DP64-SB05-2, DP64-SB05-18, DP64-SB05-36, DP64-SB06-2, DP64-SB06-17, and DP64-SB06-17-a. These non-detected compounds were qualified as estimated non-detected, "UJ".

The relative percent difference (RPD) between the sample (DP64-SB06-17) and duplicate (DP64-SB06-17-a) was exceeded for methylene chloride and was qualified as estimated, "J", in both samples.

5.2 Semi-volatile Organic Compounds

The confirmation run for DP64-SB04-36 was run one day beyond hold time. All compounds yielded no detections and were qualified as estimated, non-detected, "UJ".

5.3 RCRA Metals

The MS and/or MSD and/or RPD for cadmium, chromium, lead, selenium, and silver were outside QC limits in various soil samples. Due to sample non-homogeneity all positive results were qualified as estimated, "J", and all non-detected results were qualified as estimated, non-detected "UJ". The exception being the high MSD recovery for silver (>125%) associated with samples DP64-SB08-2, DP64-SB08-34, DP64-SB08-17, DP64-SB05-2, DP64-SB05-18, DP64-SB05-36, DP64-SB06-2, DP64-SB06-17, DP64-SB06-17-a, and DP64-SB06-35 which yielded no detections; therefore silver was not qualified in the aforementioned samples.

The RPD between the sample (DP64-SB07-2) and duplicate (DP64-SB07-2-a) was exceeded for cadmium and was qualified as estimated, "J", in both samples.

The aqueous RPD for the laboratory duplicate of arsenic was outside QC limits associated with samples DP64-MW01, DP64-MW02, DP64-MW03, DP64-MW03-a, and DP64-MW04. This non-detected metal was qualified as estimated, non-detected, "UJ".

The soil RPD for the laboratory duplicate was outside QC limits for multiple metals. However, due to sample non-homogeneity, cadmium, chromium, and lead in samples DP64-SB07-2, DP64-SB07-2-a, DP64-SB08-2, DP64-SB08-34, DP64-SB08-17, DP64-SB05-2, DP64-SB05-18, DP64-SB05-36, DP64-SB06-2, DP64-SB06-17, DP64-SB06-17-a, and DP64-SB06-35 and lead only in samples DP64-SB04-2, DP64-SB04-18, DP64-SB04-36, DP64-SB07-16, and DP64-SB07-33 were qualified as estimated "J" (if greater than the method detection limit [MDL]) or as estimated, non-detected, "UJ" (if less than the MDL).

The serial dilution percent difference for multiple metals was outside control limits. Only the concentration for barium was greater than 50 times the MDL in samples DP64-SB07-2, DP64-SB07-2-a, DP64-SB04-2, DP64-SB04-18, DP64-SB04-36, DP64-SB07-16, DP64-SB07-33, DP64-SB08-2, DP64-SB08-17, DP64-SB05-2, DP64-SB05-18, DP64-SB05-36, DP64-SB06-2, DP64-SB06-17, DP64-SB06-17-a, and DP64-SB06-35 and for chromium in samples DP64-SB07-2, DP64-SB04-18, DP64-SB04-36, DP64-SB08-2, DP64-SB08-17, DP64-SB05-18, DP64-SB05-36, DP64-SB06-17-a, and DP64-SB06-35 and therefore were qualified as estimated, "J".

For all samples, arsenic, lead, and selenium required a dilution due to matrix interference. Elevated reporting limits (RLs) were reported.

5.4 Explosives

The LCS %R for tetryl was outside QC limits associated with sample LF01-IW1. There was insufficient sample volume to re-extract therefore, it was qualified as estimated, non-detected, "UJ".

5.5 Wet Chemistry

In all aqueous samples, the nitrite analysis was analyzed beyond the required hold time. This ion was not detected in all samples and was qualified as estimated, non-detected, "UJ". All nitrite analysis required a dilution due to matrix interference and elevated RLs were reported.

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6 NATURE AND EXTENT OF CONTAMINATION

This section presents the soil and groundwater analytical results from the RFI field activities completed at Site DP-64 by Bhate in October 2008. This section also presents the current nature and extent of contamination found in the soil and groundwater during this investigation. The soil and groundwater sampling locations from this investigation are shown on Figures 4-1 and 4-2.

The objectives of the RFI at DP-64 were to: 1) determine if any soil, and/or groundwater contamination exist at the site, 2) delineate the current horizontal and vertical extent of the potential contamination, and 3) collect the proper data meeting the data quality objectives (DQOs) to support closure of the site. The ultimate objective is to achieve approval for site closure from NMED. Soil and groundwater analytical results are summarized in Tables 6-1 and 6-2 respectively. Duplicate soil samples were collected in soil borings DP64-SB06 (17 feet bgs) and DP64-SB07 (2 feet bgs), and a duplicate groundwater sample was collected from monitoring well DP64-MW03.

6.1 Soil Analytical Results

The 17 soil samples (including 2 duplicates) collected from soil borings DP64-SB04 through DP64-SB08 were analyzed for VOCs, SVOCs, explosives, and RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver). The subsurface soil samples were collected from depths ranging between 2 and 36 feet bgs. The last two digits of the sample identification number indicate the bottom of the sample interval. The soil analytical results are summarized in Table 6-1 and the soil boring locations are shown on Figure 4-1 of this RFI report.

Three VOCs were detected above the method detection limit (MDL) in the 17 soil samples collected. An estimated result (less than the RL [J]) of 1,1-dichloroethylene was detected in soil sample DP64-SB06-35 at 2.1 J micrograms per kilogram ($\mu\text{g}/\text{kg}$). Toluene was also detected less than the RL in soil sample DP64-SB07-2 at 2.3 J $\mu\text{g}/\text{kg}$. Both VOCs were detected well below their respective NMED SSLs (NMED, 2009). Methylene chloride (a common laboratory contaminant) was also detected in the majority of the 17 soil samples submitted for analysis. All the detections of methylene chloride were qualified with a "J" by the validating chemist due to the presence of methylene chloride in the associated method blanks. Additionally, all SVOCs were not detected in any of the soil samples collected during this RFI field effort.

One explosive was detected above the MDL in 1 of the 17 soil samples collected. 2,6 - Dinitrotoluene was detected in soil sample DP64-SB06-17-a at 63.7 J $\mu\text{g}/\text{kg}$. This estimated detection of 2,6-dinitrotoluene was well below the NMED SSL of 61,200 $\mu\text{g}/\text{kg}$ (NMED, 2009).

Each of the eight RCRA metals was detected above the MDL. The maximum detections of arsenic (3.3 milligrams per kilogram [mg/kg]), barium (90.1 J mg/kg), cadmium (1.6 J mg/kg), chromium (9.7 J mg/kg), lead (5.2 J mg/kg), mercury (0.038 J mg/kg), selenium (3.5 J mg/kg), and silver (0.15 J mg/kg) were well below their respective NMED SSLs (NMED, 2009). As shown on Table 6-1, two metals (cadmium and selenium) exceeded their respective NMED approved background levels (NMED, 2011).

6.2 Groundwater Analytical Results

The six groundwater samples (including 1 duplicate) collected from monitoring wells LF01-1W1 and DP64-MW01 through DP64-MW04 were analyzed for VOCs, SVOCs, explosives, RCRA metals, nitrite, nitrate, and TDS. The analytical results are presented in Table 6-2 and the monitoring well locations are shown on Figure 4-2.

Sec-butylbenzene (0.30 J micrograms per liter [$\mu\text{g/L}$]) was the only VOC detected above the MDL in the groundwater samples collected during this RFI field effort. The detection of sec-butylbenzene does not exceed any applicable USEPA MCLs or NMWQCC standards (NMAC 20.6.2.3103). No SVOCs or explosives were detected in any of the groundwater samples collected.

Three RCRA metals were detected above their respective MDLs in the groundwater samples collected at site DP-64. Maximum concentrations of barium (50.6 J $\mu\text{g/L}$) and selenium (16.5 J $\mu\text{g/L}$) were detected well below their respective USEPA MCLs and NMWQCC Standards. Arsenic, detected in monitoring well LF01-1W1 at 12 J $\mu\text{g/L}$, was an estimated detection below the RL (RL was elevated due to matrix interference). Arsenic exceeded the USEPA MCL (10 $\mu\text{g/L}$) and the NMED approved background level for filtered constituents in groundwater (10 $\mu\text{g/L}$) (NMED, 2011). However, it should be noted that dissolved arsenic detections in groundwater samples collected from 24 wells across the base ranged from 4.5 $\mu\text{g/L}$ to 25 $\mu\text{g/L}$, with a calculated UTL of 28.53 $\mu\text{g/L}$ in the Basewide Background Study (NationView/Bhate JV III, 2011). Because this estimated concentration of arsenic at LF01-1W1 falls within this range it most likely represents the natural variability of groundwater geochemistry occurring across the base.

The six groundwater samples collected were also analyzed for nitrite, nitrate, and TDS. Nitrite was not detected above the MDL in any of the groundwater samples collected. Nitrate was detected in all the monitoring wells. However, the maximum nitrate concentration, detected in the duplicate sample collected from monitoring well DP64-MW03 (2.8 mg/L), was below the USEPA MCL (10 mg/L) and the NMWQCC Standard (10 mg/L). TDS values ranged from 15,500 mg/L (DP64-MW01) to 17,800 mg/L (LF01-1W1) with an average TDS concentration of 16,900 mg/L, and exceeded the NMWQCC standard of 1,000 mg/L in each well. Groundwater with TDS greater than 10,000 mg/L is classified by the USEPA as Class III B (USEPA, 1986), which is designated unfit for human consumption.

7 CONCLUSIONS AND RECOMMENDATIONS

As documented by Zapata (described in Section 2 of this report) all debris associated with the Chemical Agent Disposal Site DP-64, was characterized and removed in 2004. Furthermore, analytical results from the 17 soil samples collected during the RFI, at 5 geophysical anomalies requiring additional investigation, did not contain VOCs, SVOCs, explosives, or RCRA metals above NMED SSLs (NMED, 2009). With the exception of a singular estimated arsenic detection, in the groundwater sample collected from monitoring well LF01-1W1, VOCs, SVOCs, explosives, nitrate, nitrite, or RCRA metals did not exceed the USEPA MCLs or NMWQCC standards, in any of the groundwater samples. Although this estimated detection of arsenic (12 J $\mu\text{g/L}$) exceeded the USEPA MCL (10 $\mu\text{g/L}$), it is below the calculated UTL (28.53 $\mu\text{g/L}$), and most likely represents the natural variability of groundwater geochemistry across the base. Furthermore, TDS values were well above 10,000 mg/L in all 5 wells sampled, making the groundwater unfit for human consumption.

Therefore, HAFB will submit a Statement of Basis requesting No Further Action for Site DP-64 (AOC-1) based upon Criterion #5 listed in Appendix 4-B of the HAFB Hazardous Waste Permit (NMED, 2004) which states:

“The site was characterized or remediated in accordance with applicable state and/or federal regulations, and the available data indicate that contaminants pose an acceptable level of risk under current and projected future land use.”

This criterion was accomplished by conducting additional characterization activities (soil and groundwater sampling). It was determined by the RFI that a source area above the current NMED SSLs was not detected at the site. Therefore, excavation of contaminated soil is not required for site closure.

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FIGURES