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

RECEIVED

FEB 27 2008

MEMORANDUM FOR NEW MEXICO ENVIRONMENT DEPARTMENT
Attn: Mr. James Bearzi
Hazardous Waste Bureau
2905 Rodeo Park Drive East
Santa Fe NM 87105-6303

FEB 22 2008

FROM: 49 CES/CD
550 Tabosa Ave
Holloman AFB NM 88330-8458

Subject: Basewide Background Study Work Plan, Holloman AFB

1. The subject work plan is hereby submitted to NMED for review and approval.

2. I certify penalty under 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.

3. If you have any questions, please feel free to contact Ms. Deborah Hartell at (575) 572-3931.

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Deputy Base Civil Engineer

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BASEWIDE BACKGROUND STUDY WORK PLAN HOLLOMAN AIR FORCE BASE, NEW MEXICO

Prepared for:

49 CES/CEV
Holloman Air Force Base
New Mexico

Under Contract To:

U.S. Army Corps of Engineers
Omaha District
Omaha, Nebraska

Contract No. DACA45-03-D-0023
Task Order No. 021

February 2008

Prepared by:

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Bhate Project No. 9050361.01.02

BASEWIDE BACKGROUND STUDY WORK PLAN HOLLOMAN AIR FORCE BASE, NEW MEXICO

REVIEW SHEET

This Work Plan has been reviewed and approved by:

	[signature]	2-22-08
Katherine Thompson Geologist/Bhate Field Manager	Signature	Date
	[signature]	2-22-08
J. Mark Stapleton, Ph.D., P.E., AEE Technical Director	Signature	Date
	[signature]	2-22-08
Frank Gardner, P.G. Program Manager	Signature	Date

BASEWIDE BACKGROUND STUDY WORK PLAN HOLLOMAN AIR FORCE BASE, NEW MEXICO

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ACRONYMS AND ABBREVIATIONS

AEE	Associate to the American Academy of Environmental Engineering
AAF	Army Air Field
AF Fm	Air Force Form
amsl	Above mean sea level
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
bgs	Below ground surface
Bhate	Bhate Environmental Associates, Inc.
BWBG	Basewide background
CES/CEV	Civil Engineering Squadron/Environmental Flight
COC	Chain-of-custody
COPCs	Chemicals of potential concern
CV	Coefficient of Variation
DL	Detection Limit
DO	Dissolved oxygen
DQO	Data quality objective
EDD	Electronic data deliverable
ERP	Environmental Restoration Program
ERPIMS	Environmental Restoration Program Information Management System
°F	Degrees Fahrenheit
FID	Flame ionization detector
ft	Feet
FWENC	Foster Wheeler Environmental Corporation
GPS	Global positioning system
HAFB	Holloman Air Force Base
HASP	Health and Safety Plan
IDLs	Instrument detection limits
IDW	Investigation-Derived Waste
LCS	Laboratory control samples
LCSD	Laboratory control sample duplicates
MDL	Method Detection Limit
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
MS	Matrix spike
MSD	Matrix spike duplicate
NAD	North American Datum
NAP	Natural attenuation parameter
NMED	New Mexico Environment Department
NMWQCC	New Mexico Water Quality Control Commission
ORP	Oxidation reduction potential
OSHA	Occupational Safety and Health Administration
OVA	Organic vapor analyzer
P.E.	Professional Engineer

1 INTRODUCTION

Bhate Environmental Associates, Inc., (Bhate) has been retained by the United States Army Corps of Engineers (USACE), under contract DACA45-03-D-0023, Task Order No. 021, to conduct a Basewide Background Study at Holloman Air Force Base (HAFB), New Mexico. On August 24, 2007, the New Mexico Environment Department (NMED) notified the 49th Civil Engineering Squadron/Environmental Flight (CES/CEV) at HAFB that it had completed its review of the document entitled *Base-wide Background Study, Sewage Lagoons and Lakes Investigation,* submitted in December 1993 by Radian Corporation (hereinafter referred to as the "Background Study") and disapproved the Background Study for several technical reasons. NMED indicated that the Background Study was inadequate from a technical and statistical perspective and indicated that it must be completely redone. A copy of the NMED Disapproval letter is provided as Attachment 1.

1.1 Objectives

The primary objective of this Work Plan is to serve as the primary working document for the collection of soil and groundwater data to fulfill the requirements identified by the NMED in order to establish background values for the occurrence of certain naturally occurring inorganic constituents.

1.1.1 Purpose of the Basewide Background Study

The purpose of this study is to establish background values for the occurrence of certain naturally occurring inorganic constituents.

1.1.2 Scope of Work

The following list is a summary of the work to be performed in order to complete the Basewide Background Study.

- Prepare and submit a work plan
- Implement the work plan which includes the following:
  - identification of clean background soil boring locations (42)
  - identification of existing wells appropriate for background study (30)
  - development of statistical methodology
  - collection and analysis of surface soil, subsurface soil, and saturated subsurface soil samples from 42 soil borings located across HAFB
  - collection of groundwater samples from 30 existing monitoring wells quarterly for a period of one year
  - perform statistical evaluation of sampling data to establish background values
- Prepare and submit Basewide Background Study Report

- ***Chapter 6 – Health and Safety Requirements.*** This chapter provides the health and safety requirements associated with the investigation activities for this Basewide Background Study Work Plan.
- ***Chapter 7 – Organization and Schedule.*** This chapter provides key personnel and the schedule for the implementation of this Basewide Background Study Work Plan.
- ***Chapter 8 – References.*** This chapter provides references used in this Basewide Background Study Work Plan.

The ***Tables*** and ***Figures*** referenced throughout this Basewide Background Study Work Plan are included following the text (after Chapter 8).

- ***Attachment 1*** – NMED Disapproval Letter dated August 24, 2007
- ***Appendix A*** – Site-Specific Addendum to the Basewide Health and Safety Plan
- ***Appendix B*** – Site-Specific Addendum to the Basewide Quality Assurance Project Plan
- ***Appendix C*** – Historical Data

2 ENVIRONMENTAL SETTING

2.1 Physiography and Topography

HAFB is located within the Sacramento Mountains Physiographic Province on the western edge of the Sacramento Mountains (Figure 1-1). 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 in the Tularosa Sub-basin which is part of the Central Closed Basins. The bordering mountains rise abruptly to altitudes of 7,000 to 12,000 feet amsl. The San Andres Mountains bound the basin to the west (about 30 miles) with the Sacramento Mountains approximately 10 miles to the east. At its widest, the basin is about 60 miles east to west and stretches approximately 150 miles north to south.

2.2 Surface Water and Hydrology

The Tularosa Basin contains all of the surface flow in its boundaries. The nearest inflow of surface waters to the Base comes from the Lost River, located in the north-central region of the Base. The upper reaches of the Three Rivers and the Sacramento River are perennial in the basin. HAFB is dissected by several 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).

2.3 Regional Geology and Soils

2.3.1 Geology

The sedimentary rocks which make up the adjacent mountain ranges are between 500 and 250 million years old (WSMR, 2003a). During the period when the area was submerged under the 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.

2.4 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. A general groundwater contour map is provided as Figure 2-2.

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. The majority (over 70 %) of the Environmental Restoration Program (ERP) Sites/Solid Waste Management Units (SWMUs) located across HAFB, have groundwater monitoring wells containing water with an average total dissolved solids (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 New Mexico Water

Restoration Program. 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 (Foster Wheeler, 2002).

2.7 Current and Future Water Use

At present, the primary fresh water resource for the City of Alamogordo and Holloman AFB 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. Holloman AFB 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 13 miles southwest of DP-63. There are no potable or irrigation wells near to or immediately downgradient of the Base (Foster Wheeler, 2002).

3 TECHNICAL APPROACH

The following technical approach is to provide HAFB environmental restoration project teams and NMED with details on how data that will be obtained in the new background study will be graphically and statistical analyzed.

A scientific approach will be used to determine the type, quantity, and quality of environmental data needed to support establishing background values at HAFB. This will provide the scientific foundation for defensible decision-making by helping to assure that representative field samples are collected at appropriate locations and times, that appropriate graphical and statistical analyses of the resulting data are conducted, and that appropriate interpretations of the data and statistical analyses are made.

3.1 Sample Location Selection

Background sampling locations were selected using aerial photographs and historical basemaps to identify areas which have been undisturbed. These locations were selected to encompass the entire base including the range and industrial areas.

3.2 Determination of Number of Samples

Based on the soil (described in section 2.3.2), these soils have the same parent materials, the same history, and very similar pedologic and mineralogic properties. Accordingly, HAFB plans to sample throughout the area, treating the entire installation as a single population for statistical purposes. Based on a study of the soils and lithology involved, it appears appropriate to collect a discrete sample from the surface (0 to 2 feet below ground surface [bgs] to a maximum of 0 to 5 feet bgs), a composite sample from the subsurface above the saturated zone (depths will vary based upon depth to groundwater), and a discrete sample from the subsurface within the saturated zone.

Any sampling plan requires a known or estimated population distribution in order to establish the number of samples needed to achieve a given reliability goal. Information available from previous investigations were used to estimate statistical parameters to 'size' the study. Previous data may or may not be representative of background, but no attempt has been made to qualify earlier data for use in calculation of background. However, the distribution of data from previous investigations provides the best available estimate of the statistical parameters involved.

HAFB will determine the number of samples required to reliably determine background by carrying out the following analysis, using the t-statistic, the calculated standard deviation, s, of observations of arsenic concentrations from previous investigations and asserting that the desire is to know, at the 95% confidence level ($\alpha = 0.05$), the mean of the concentration in the surface soils to within 0.5 milligrams per kilogram (mg/kg).

probability distribution of the measurements, as well as the number of non-detects and possible outliers that are present. This information is needed to help determine the quality of the data sets and how the data should be statistically analyzed.

Based on USEPA, 2000a, HAFB will conduct the following statistical evaluation of the background inorganic concentrations data set. A preliminary data review will be conducted to include basic statistical quantities (summary statistics). The summary statistics to be developed and presented will include the mean, median, range, standard deviation, type of distribution (normal, log normal, or other), coefficient of variation, and 95% Upper Confidence Level (UCL) of the mean of the data set. These summary statistics will be computed using the USEPA-endorsed program, ProUCL, that was distributed with the document *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites* (OSWER 9285.6-10) (USEPA, 2002).

3.4.1 Data Sets with No Non-Detects

The number of measurements in a data set is denoted by n. The n measurements are denoted by x1, x2,..., xn. The descriptive summary statistics that should be computed for the background data sets are: Arithmetic Mean (x), Median (when n is an odd integer), Median (when n is an even integer), pth sample percentile, Range, Interquartile range, Sample Standard Deviation (SD), Sample Variance, and the Coefficient of Variation (CV)

3.4.2 Data Sets That Contain Non-Detects

Non-detects are measurements that the analytical laboratory reports are below some quantitative upper limits such as the detection limit or the limit of quantitation. Data sets that contain non-detects are said to be censored data sets.

The methods used to compute descriptive statistics when non-detects are present should be selected based on the number of non-detects and the total number of measurements, n (detects plus non-detects). If n is large (say, $n > 25$) and less than 15% of the data set are non-detects, the general guidance in *Guidance for the Data Quality Assessment, Practical Methods for Data Analysis, EPA QA/G-9, QA97 Update, EPA/600/R-96/084* (USEPA, 1996) is to replace the non-detects with the Detection Limit (DL), DL/2, or a very small value. The descriptive summary statistics may then be computed using the (now) full data set, although some of the resulting statistics will be biased to some degree. (The median, pth sample percentile, and the interquartile range may not be biased if the number of non-detects is sufficiently small.) The biases may be large, even though less than 15% of the measurements are non-detects, particularly if n is small, say $n < 25$.

If 15% to 50% of the data set are non-detects, the guidance offered in the *Guidance for the Data Quality Assessment, Practical Methods for Data Analysis, EPA QA/G-9, QA96 Update, EPA/600/R-96/084* (USEPA, 1996) and *Guidance for the Data Quality Assessment, Practical Methods for Data Analysis, EPA QA/G-9, QA97 Update, EPA/600/R-96/084* (USEPA, 1997) is

- conduct exploratory data analyses to develop hypotheses about possible differences in the means, variances, and shapes for the background measurement distributions
- visually depict and communicate differences in the distribution parameters (means, variances, and shapes) for the background measurement distributions
- graphically evaluate if the background data have a normal, lognormal, or some other distribution
- evaluate, illuminate, and communicate the results obtained using formal statistical tests for COPCs

The following graphical plots will be considered: boxplots, quantile plots, and probability plots.

The boxplot, sometimes called a *box-and-whisker* plot, simultaneously displays the full range of the data, as well as key summary statistics. The boxplot provides a visual picture of the symmetry or asymmetry of the data set. If the data set distribution is symmetric, the central box will be divided into two equal halves by the median, the mean will be approximately equal to the median, the whiskers will be approximately the same length, and approximately the same number of extreme data points (if any exist) will occur at either end of the plot.

The quantile plot shows each data value plotted versus the fraction (f) of the entire data set that is less than that value. The plot derives its name from the fact that the quantiles of the data set can be read directly from the y-axis of the plot. A quantile is the same as a percentile except that it is expressed as a fraction rather than a percentage. The shape of the plotted points on the quantile plot can be used to assess whether the data set is symmetric or skewed. The plotted curve for a data set that is skewed to the *right* has a steeper slope at the top right than at the bottom left. The plotted curve for a data set that is skewed to the *left* has a steeper slope near the bottom left of the graph. If the data set has a symmetric shape, the top portion of the graph will stretch to the upper right corner in the same way the bottom portion of the graph stretches to the lower left, creating an S-shape curve.

A probability plot is a graph of data plotted versus the quantiles of a user-specified distribution. Usually, the goal of constructing a probability plot is to visually (subjectively) evaluate the null hypothesis that the data are well fit (modeled) by the specified distribution. Frequently, the null hypothesis is the data set has a normal or lognormal distribution, although other distributions such as the Weibull and Gamma distributions (Gilbert 1987, page 157) are sometimes used. If the graph of plotted points in a probability plot appears linear to the eye with little scatter or deviation about the line, one would conclude the data appear to be well fit by the specified distribution. If the plotted points do not approximate a straight line, the type of departures from linearity provide information about how the actual data distribution deviates from the hypothesized distribution. Probability plots should always be used in conjunction with one of the formal statistical tests for evaluating what the best fitting distribution for the data set may be.

of background measurements, the true concentrations in relatively small areas at the ERP site are elevated relative to the true background concentrations, in which case only a small portion of the distribution of ERP site measurements would be expected to be shifted to higher concentrations than the distribution of background measurements.

For the case of a simple shift, the two-sample t-test, the Satterthwaite t-test, and the Wilcoxon Rank Sum (WRS) test are the preferred tests. However, the Slippage test, Quantile test, and the two-sample test for proportion are better suited to identify metals that have elevated concentrations in only small areas..

All tests require that background measurements be independent (not spatially or temporally correlated) and representative of the underlying area and background populations. This assumption requires (1) an appropriate probability-based sampling design strategy be used to determine the location of soil samples to be collected, and (2) the soil samples are far enough apart in space and time that spatial and temporal correlations among concentrations at different locations are not present. Also, to help guard against the tests having power that is too low to reliably detect a COPC, the number of samples (data values) and data sets for all the statistical tests should be at least 10 and, hopefully, more than 20.

3.5.1 The Threshold Comparison Method

A method that has been proposed for identifying COPC is the *threshold comparison method.*

The threshold comparison method consists of comparing the highest concentration (measurement) detected at an ERP site with a concentration that represents the upper range of ambient (local background) conditions.

The following 6-step procedure has been proposed by NMED.

1. If possible, expand the background data set.
2. Use a statistical test, such as the Shapiro-Wilk W-test, to test the background data set for normality and lognormality.
3. Compute descriptive statistics for the background data set.
4. Construct a normal or lognormal probability plot of the data (the threshold comparison method refers to these plots as cumulative probability plots).
5. Use the probability plot to identify possible outliers, as well as the set of data points nearest the origin that represents ambient conditions.
6. Select the background threshold value as the value that represents the upper range of ambient conditions. The selection of the threshold value is if the number of background measurements, m, is small, the threshold value may be the mean or an upper confidence limit on the mean. If m is large, the threshold value may be an upper percentile, such as the 95th percentile or even the 99th percentile.

4 INVESTIGATION ACTIVITIES

The purpose of this section is to describe investigation activities associated with soil and groundwater data collection in order to establish background values for the occurrence of certain naturally occurring inorganic constituents.

4.1 Pre-investigation Requirements

Before site-specific activities can begin, there are several pre-investigation documents and approval requirements to be met, including Air Force Form (AF Fm) 332 approval, Base dig permit(s) with utility clearances, site security measures, and facility manager notification of the intended operations. Bhate will coordinate project requests for Base installation support services through the 49th CES/CEV. Pertinent to the start of activities, a pre-construction meeting and site walk-through will be conducted with the USACE Resident Engineer, HAFB personnel, and Bhate Site Manager, to inspect site-specific conditions for equipment access, equipment staging, and decontamination area(s), potential site hazards, and emergency evacuation routes. Also reviewed at this time will be project procedures in accordance with the schedule and planned activities.

4.1.1 AF Form 332

Prior to initiating the confirmatory sampling activities, a completed and approved AF Fm 332 will be obtained. This form authorizes construction work at HAFB and is required for the initiation of any construction work. This work order describes what activities will take place at the location.

4.1.2 Dig Permit/Utility Clearances

Prior to the submittal of the dig permit(s) (AF Fm 103), the drilling locations will be clearly delineated with marker flags, stakes, or paint, as appropriate to the surface material. Utility clearance approvals will be completed by the appropriate HAFB utility office (e.g., telephone, sewer, water, natural gas etc.). Upon receipt of the approved dig permit (AF Form 103) with the utility clearances, the Bhate Site Manager or other authorized project personnel will complete a site walk-through confirming the dig permit authorizations and make any required changes.

4.1.3 Site Security

Site security is concerned with safety at the sampling locations during all drilling and sampling activities and will be addressed as outlined in the *Basewide Health and Safety Plan* (HASP) (Bhate, 2003b). At a minimum the exclusion zone at each sampling location will be secured with caution tape, and traffic cones surrounding the perimeter of the location. The size of each exclusion zone will be determined by the size of the drilling and support equipment, and the prevailing sampling location conditions. Open boreholes will not be left unattended without first

4.2.2.1 Laboratory Analyses for Soil Sampling

The analysis of soil samples collected for the Basewide Background Study will follow the USEPA SW-846 protocol. A summary of the soil sampling scheme is provided in Tables 4-1 and 4-2. The soil samples will be analyzed as follows:

- Target Analyte List (TAL) Metals by USEPA Methods 6010B and 7471A
- Radionuclides by USEPA Methods E900/E903.0/E904.0/E905.0 Modified/E907.0

Samples submitted for laboratory analysis will be labeled, handled, and prepared for shipment in accordance with HAFB SOP-1. The samples will be placed on ice and shipped under strict chain-of-custody to TestAmerica Laboratories, Inc., in Denver, Colorado and St. Louis, Missouri.

4.2.2.2 Quality Control Samples

Field duplicate samples will be collected at a frequency of 10 percent and matrix spike and matrix spike duplicate (MS/MSD) samples will be collected at a frequency of 5 percent. A minimum of 13 field duplicate samples and 6 MS/MSD samples will be collected.

The detection reporting limits for all analytical parameters and the quality assurance sampling requirements (duplicate and MS/MSD) are summarized in the QAPP Addendum provided in Appendix B of this Work Plan.

4.2.2.3 Sampling Depths

At each boring location, one discrete near surface soil sample will be collected from a depth of no greater than 5 feet bgs. Subsurface soil samples will be collected from below a depth of no less than 2 feet. These subsurface soil samples will be a composite of each sample interval, with the exception of the surface soil sample, above the saturated zone. Once groundwater is encountered, one additional discrete sample will be collected from the saturated zone. Depths of each sample location will be dependent upon the localized water table.

4.2.2.4 Soil Description and Classification

Each boring will be visually classified and lithology described in the field according to HAFB SOP - 7 and the Unified Soil Classification System (USCS) (American Society for Testing and Materials [ASTM] D 2487-06 and ASTM D 2488-06) by a qualified geologist. Soil boring logs will be completed in the field and presented in the Basewide Background Study report in order to determine if the sampling locations demonstrate mineralogical uniformity across the base. In addition, the following information will be recorded in a bound field logbook for each sample collected:

- Date and time of collection,
- Sample location,

accuracy of +/- 1.0 foot. Vertical elevations will be referenced to North American Datum (NAD) 1983 coordinates.

4.2.3 Groundwater Sampling

Groundwater samples will be collected from 30 existing monitoring wells located across the base and are shown on Figure 4-2.

4.2.3.1 Laboratory Analyses for Groundwater Sampling

The analysis of groundwater samples collected for the Basewide Background Study will follow the USEPA SW-846 protocol. A summary of the groundwater sampling scheme is provided in Tables 4-3 and 4-4. The groundwater samples will be analyzed as follows:

- TAL Metals by USEPA Method 6010B/6020B and 7470A (filtered and unfiltered)
- Radionuclides by USEPA Methods E900/E903.0/E904.0/E905.0 Modified/E907.0
- Natural Attenuation Parameters (NAPs) by USEPA Methods 310.1/SW2320B (alkalinity), 325.2 (chloride), 353.2 (nitrate and nitrite), 4500S-F (sulfide), 9056 (sulfate), and E350.1 (ammonia)
- TDS by USEPA Method 160.1

It should be noted that alkalinity results will not speciate between carbonate or bicarbonate, however, based on the historical data provided in Appendix C, the most likely phase encountered at HAFB will be bicarbonate. The previous sampling indicates the presence of carbonate and is substantiated based on the pH range (6-10) on base and its location on the carbonate phase diagram.

Samples submitted for laboratory analysis will be labeled, handled, and prepared for shipment in accordance with HAFB SOP-1. The samples will be placed on ice and shipped under strict chain-of-custody to TestAmerica Laboratories, Inc., in Denver, Colorado and St. Louis, Missouri.

4.2.3.2 Quality Control Samples

Field duplicate samples will be collected at a frequency of 10 percent and MS/MSD samples will be collected at a frequency of 5 percent. A minimum of 3 field duplicate samples and 2 MS/MSD samples will be collected.

The detection reporting limits for all analytical parameters and the quality assurance sampling requirements (duplicates and MS/MSD) are summarized in the QAPP Addendum provided in Appendix B of this Work Plan.

4.2.3.6 Sampling Frequency

Four quarterly groundwater monitoring events will occur over the period of one year. During each event, groundwater samples will be collected from 30 existing monitoring wells presented on Figure 4-2. Table 4-3 provides a sampling summary for each of the four events.

4.3 Investigation-Derived Waste Management

IDW will be managed and characterized according to HAFB SOP-9. Whenever possible, waste minimization techniques will be used to reduce the amount of IDW. The soil sampling locations and the groundwater monitoring wells were chosen based on previous investigations, therefore, these locations are not considered to be contaminated. All waste generated while drilling will be used to backfill the borehole and/or spread on the ground at the boring. Purge water be containerized in either a 55-gallon drum or holding tank, sampled, transported, and disposed of through the HAFB Wastewater Treatment Plant (WWTP). Personal protective equipment (PPE) and other site non-hazardous debris/waste shall be disposed of in standard trash receptacles.

4.4 General Decontamination Procedures

Small equipment, such as sampling tools, will be decontaminated in accordance with HAFB SOP-2. Heavy equipment will be decontaminated by steam cleaning at a temporary decontamination pad. The containers and decontamination pad will be managed in a secure area and the decontamination water will be allowed to evaporate or discharged to the HAFB WWTP. Sediment remaining in the decontamination pad area after the water has either evaporated or been discharged to the WWTP, will be spread on the ground.

4.5 Site Restoration

Upon completion of the investigation activities, the sampling locations will be restored to their original condition. Soil sampling locations will be backfilled or grouted to the surface. The areas will be canvassed for trash, debris, etc.

5 PROJECT QUALITY ASSURANCE

5.1 Data Quality Objectives Process

To support the overall investigation objectives, DQOs have been established. The DQOs are qualitative and quantitative statements that specify the quality of data required to meet the goals of site characterizations, risk assessments, and remedial design. Data developed during the investigation will be used to support site-specific studies of potential solid waste management units in the area.

DQOs will be used to:

- Ensure data comparability through the use of standard methods and controlled systems to collect and analyze samples;
- Provide analytical results of known and acceptable precision and accuracy; and to provide a minimum of 95 percent data completeness for analytical results representing each matrix-method combination.

The level of analytical support to meet these goals will be both screening and definitive data. As part of the analytical reporting requirements for the definitive data, both reporting laboratories will provide the following data, in addition to the data deliverables as described in the *Quality Assurance Project Plan Addendum, Basewide Background Study, Holloman AFB, New Mexico* found in Appendix B of this Work Plan:

- Sample identification numbers cross-referenced with laboratory identification numbers and QC sample numbers,
- Problems with arriving samples noted on chain-of-custody,
- Each analyte reported as an actual value or less than a specified detection limit, and
- Dilution factors, preparation dates, and analysis dates.

QC sample results for laboratory blanks, surrogate spikes, matrix spikes (MS), laboratory control samples (LCS), field duplicates, and trip blanks will be used to evaluate the reliability of the data. The data developed during the investigation will meet the chosen objectives for precision, accuracy, representativeness, completeness, comparability, and sensitivity.

5.1.1 Precision

Precision is a measure of the degree of reproducibility of an analytical value and is used as a check on the quality of the sampling and analytical procedures. Laboratory replicates, field duplicates, and duplicate analysis (such as MS/MSD and LCS/LCS duplicates [LCSD]) are used to quantify precision. Laboratory replicates measure the analytical precision, whereas field duplicate analysis provides a precision measurement that includes the sampling and the potential variability of the sample matrix.

- Comparing actual sampling procedures and chain of custody forms to those described in the work plan,
- Identifying and eliminating non-representative data in site characterization activities, and
- Evaluating holding times and condition of samples on arrival at the laboratory.

The objective of this element is to eliminate all non-representative data.

5.1.5 Comparability

Comparability is a qualitative measure of the confidence with which one data set can be compared to another. These data sets include data generated by different laboratories, data generated by laboratories in previous investigative phases, data generated by the same laboratory over a period of several years, or data obtained using differing sampling techniques or analytical protocols. The measurement comparability objective of this work plan is to generate consistent data using standard test methods, standard field data sheets, and uniform concentration units. These data are intended to be accepted and used by other investigators who are considering specific sites within the HAFB.

5.1.6 Sensitivity

Sensitivity is a general term referring to the calibration sensitivity and the analytical sensitivity of a piece of equipment, used to establish detection/quantitation/reporting limits. Several limits have been established to describe sensitivity requirements (i.e. instrument detection limits [IDLs], method detection limits [MDLs], practical quantitation limits [PQLs], reporting limits [RLs]). Since IDLs and MDLs are normally based on a reagent water matrix or a purified soil matrix, published IDLs and MDLs are presumed not to be consistently achievable for environmental samples. It is because of this inconsistency and the goal to promote the generation of comparable data that the following definitions shall be used to meet the project DQOs:

- IDL – The IDL references the absolute limit of detection for a compound or analyte in a media that is free from matrix interferences at a level greater than two times the noise level of the instrument. Certain programs require the laboratory to publish IDLs on an annual basis; however, achievement of these detection levels generally cannot be met during routine analyses.
- MDL – The MDL is the minimum concentration of an analyte that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero, and is determined from the analysis of sample in a given matrix containing the analyte. The laboratory is required to perform an MDL study during the initial setup of the analytical procedure and annually thereafter. An MDL study is also performed whenever the basic chemistry of the procedure is changed. When MDLs are reported with analytical data, they should be adjusted for sample weight, moisture content, and volumetric dilution on a per-sample basis. The project specific MDLs are presented in Tables 4-2 and 4-4.

the *Basewide QAPP*. Sample labeling procedures will adhere to the format provided in the *Basewide QAPP*.

5.4 Project Documentation

The field operations documentation will provide consistent procedures and formats for documentation and management of field records and collected samples.

5.4.1 Sample Documentation

Sample documentation, identification, and tracking will adhere to the prescribed methods found in the *Basewide QAPP*. All sampling activities will include documentation of significant activities, potential environmental influences during sampling, field variances, and sample identification information. At a minimum, field logbooks will be utilized to record dates and times, sampling protocols, project numbers, and sampler's name. Other pertinent information will include COC numbers and air-bill tracking number. Chain-of-custody forms will be completed and included with each sample shipment; one COC per cooler.

At a minimum, the following sample collection information will be logged in the field logbook:

- Date and time
- Sample identification number
- Project number
- Sampler name
- Preservative (if any)
- Analysis
- Map or schematic of sampling location (provided in this Work Plan)

5.4.2 Field Logbook

Personnel will use only bound field logbooks for the maintenance of field records. The Project Manager will ensure that all field notes can be efficiently traced, filed, and retrieved. All entries will be recorded in indelible, waterproof ink. If errors are made, corrections will be made by crossing a single line through the error, correcting the information, and initialing and dating the correction. Entries in the field logbook will be made as described below.

Documentation and reporting of events and activities will be made in chronological order on the right page of an open logbook. All entries will be dated and time of entry recorded. At the beginning of each day, the first two entries will be "personnel/contractors on site" and "weather". At the end of each day's entry, the personnel will draw a diagonal line originating from the bottom left corner of the page to the conclusion of the entry and sign along the line indicating the conclusion of the entry or the day's activity. Once completed, the field logbooks become accountable documents and will be maintained as part of the project files.

6 HEALTH AND SAFETY REQUIREMENTS

Project Health and Safety practices will adhere to the *Basewide Health and Safety Plan* (Bhate, December 2003b) and the Site Specific Addendum to the *Basewide HASP*, as included in Appendix A of this Work Plan. It is anticipated that no greater than modified level D PPE will be required to complete the investigation activities. This includes: Occupational Safety and Health Administration (OSHA) approved safety shoes, American National Standards Institute (ANSI) approved safety glasses (Z87.1) and hard hat (Z89.1-1997: Type I), sleeved shirt and long pants, and as required, hearing protection, leather work gloves, and nitrile gloves during sampling.

7 ORGANIZATION AND SCHEDULE

Ms. Katherine Thompson, will serve as the Bhate Field Manager during the sampling activities and will also ensure that required project documents, permits, contractual agreements, and other program tasks are completed. In addition, Ms. Thompson will serve as the Bhate Geologist and Site Safety and Health Officer. Key project personnel are listed in Table 7-1. The initial field activities are anticipated to begin in the Summer of 2008. A proposed schedule of activities is provided as Figure 7-1. This schedule will be updated based upon approval of this Work Plan by NMED.

8 REFERENCES

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ATTACHMENT 1

NMED CORRESPONDENCE

NEW MEXICO
ENVIRONMENT DEPARTMENT

Hazardous Waste Bureau

2905 Rodeo Park Drive East, Building 1
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BILL RICHARDSON
Governor

DIANE DENISH
Lieutenant Governor

RON CURRY
Secretary

CINDY PADILLA
Deputy Secretary

CERTIFIED MAIL – RETURN RECEIPT REQUESTED

August 24, 2007

Debbie Hartell, Chief
Environmental Flight
49th CES/CEV
550 Tabosa Avenue
Holloman AFB, NM 88330-8458

**RE: DISAPPROVAL: REPORT ON BASE-WIDE BACKGROUND STUDY, DECEMBER 1993
HOLLOMAN AIR FORCE BASE, EPA ID# NM6572124422
HWB-HAFB-MISC**

Dear Ms. Hartell:

The New Mexico Environment Department (NMED) has reviewed the U. S. Department of Defense (Permittee) Holloman Air Force Base's (HAFB) document entitled *Base-wide Background Study, Sewage Lagoons and Lakes Investigation,* dated December 1993 (hereinafter referred to as the "Background Study"). NMED cannot find any documentation in the administrative record that the U. S. Environmental Protection Agency (EPA) has reviewed this report which was completed at a time when EPA had lead authority for corrective action under RCRA in New Mexico. Regardless, the NMED hereby disapproves the Background Study for several technical reasons that are discussed below.

As you are aware, information on the background levels of naturally occurring constituents is required to fully implement corrective action at any Solid Waste Management Unit (SWMU) or Area of Concern (AOC) where hazardous constituents (for example, metals) associated with a SWMU or AOC may also be naturally occurring. This is the case at some SWMUs and AOCs at HAFB. Background information is needed to determine if certain contaminants found naturally in the environment are at levels representative of contamination.

NMED disapproves the subject HAFB Background Study for the following reasons:

1. The sample size is much too small to ensure that there are adequate estimates of the mean and variance for any given constituent. This is true for both the groundwater and soil data sets.
2. Sampling locations are poorly described and do not provide confidence that the samples were collected at locations that are representative of natural conditions. For example, according to Figure 1-2, some of the monitoring wells used for the Background Study may be located in areas affected by Facility operations. Also, total depths of the wells vary from 16 to 54 feet, so it is not clear if the wells are monitoring the same hydrostratigraphic unit or aquifer.
3. Some of the statistical descriptors are reported as negative values (for example, the minimum, mean, and median for antimony, as well as many other values listed in Table 2-1). Given that these values cannot be less than zero, they are indicative of a fundamental misunderstanding on how to apply statistics to determine background concentrations. NMED does not have confidence that any of the statistics reported can be relied upon to make decisions.
4. Described as a *key* element of the HAFB Background Study was the common practice of using analytical results for *laboratory blanks* to augment background data (see page 14 of the Background Study). This is absolutely an unacceptable practice which again demonstrates a fundamental misunderstanding of the application of statistical methods to data sets. You cannot legitimately mix the data of different populations and claim that the pooled data are representative of one of the populations. Background data should be augmented with background data representative of the same population.
5. Although the report correctly indicates that there may be temporal or spatial variations in groundwater quality, and spatial variations in the concentrations of constituents in soil, the Permittee did not assess these potential variations and whether different populations of soil and groundwater exist and therefore should be studied separately. At a minimum, the Permittee should have evaluated and reported on the geologic and hydrogeologic conditions that influence constituent populations for soil and groundwater, as well as any temporal variations in water quality.
6. Apparently there are cases where certain unspecified data were "shifted upward by a fixed amount" (see page 31). Although NMED does not believe that there was any illicit intent by the Permittee to deceive the Department, this does represent a poor technical decision on how to deal with problematic data. Regardless, such fabricated results are not something the NMED can trust to make decisions.

Because the Background Study is inadequate, and the NMED has absolutely no confidence in its results, it cannot be used to determine if inorganic constituents at HAFB are representative of natural or contaminated conditions. Therefore, the requirement to determine the nature and extent of contamination can not be met for some SWMUs and AOCs. Unfortunately, the Background Study is so grossly inadequate that it must be completely redone. Thus, the Permittee must submit to the NMED for approval, within 90 days of receipt of this letter, a work plan to conduct an appropriate background study for the HAFB Facility. The work plan shall specify what naturally occurring constituents will be evaluated (including field parameters for groundwater such as pH, Eh, specific conductance, dissolve oxygen and parameters for determining redox conditions). The work plan must also include a schedule for completing the new background study, and a description of the geologic and hydrogeologic settings of HAFB, sample locations, analytical methods, detection limits, field and laboratory quality control, quality control targets for each analyte, how population distributions will be determined, the statistical descriptors that will be determined and how they will be determined, the methods for handling outliers and non-detect data, and how all of the data and results of the study will be reported to the NMED.

Please contact Mr. William Moats of my staff at 505-222-9551 if you have any questions concerning this matter.

Sincerely,

James P. Bearzi
Chief
Hazardous Waste Bureau

JPB:wpm

cc: J. Kieling, NMED HWB
W. Moats, NMED HWB
C. Amindyas, NMED HWB
D. Strasser, NMED HWB
L. King, EPA Region 6 (6PD-F)
File: HAFB 2007 and Reading

TABLES

Table 4-1
Soil Sampling Scheme
Basewide Background Study Work Plan
Holloman Air Force Base, New Mexico

Soil Boring Identification Number	Number of Samples Per Boring[1]	TAL Metals Analysis (6010B/7471A)	Radionuclides Analysis (900/E903.0/E904.0/ E905.0 Mod./E907.0)
BWBG-SB01	3	3	3
BWBG-SB02	3	3	3
BWBG-SB03	3	3	3
BWBG-SB04	3	3	3
BWBG-SB05	3	3	3
BWBG-SB06	3	3	3
BWBG-SB07	3	3	3
BWBG-SB08	3	3	3
BWBG-SB09	3	3	3
BWBG-SB10	3	3	3
BWBG-SB11	3	3	3
BWBG-SB12	3	3	3
BWBG-SB13	3	3	3
BWBG-SB14	3	3	3
BWBG-SB15	3	3	3
BWBG-SB16	3	3	3
BWBG-SB17	3	3	3
BWBG-SB18	3	3	3
BWBG-SB19	3	3	3
BWBG-SB20	3	3	3
BWBG-SB21	3	3	3
BWBG-SB22	3	3	3
BWBG-SB23	3	3	3
BWBG-SB24	3	3	3
BWBG-SB25	3	3	3
BWBG-SB26	3	3	3
BWBG-SB27	3	3	3
BWBG-SB28	3	3	3
BWBG-SB29	3	3	3
BWBG-SB30	3	3	3
BWBG-SB31	3	3	3
BWBG-SB32	3	3	3
BWBG-SB33	3	3	3
BWBG-SB34	3	3	3
BWBG-SB35	3	3	3
BWBG-SB36	3	3	3
BWBG-SB37	3	3	3
BWBG-SB38	3	3	3
BWBG-SB39	3	3	3
BWBG-SB40	3	3	3
BWBG-SB41	3	3	3
BWBG-SB42	3	3	3
Subtotal	126	126	126
Quality Assurance/Quality Control Samples Required			
Field Duplicates	NA	13	13
Matrix Spike (MS)	NA	6	6
Matrix Spike Duplicate (MSD)	NA	6	6
Total Number of Samples	**NA**	**151**	**151**

Notes:
NA = Not Applicable
TAL = Target Analyte List
(6010B/7471A) = Method Number

[1] Three soil samples will be collected from each boring. One surface soil sample will be collected from a depth ranging from 0 to 2 feet below ground surface (bgs) to a maximum of 0 to 5 feet bgs. The second sample will be a composite sample collected from the subsurface soil above the saturated zone (depths will vary based upon the depth to groundwater). The third sample will be collected from within the saturated zone (depths will vary based upon the depth to groundwater).

Table 4-2
Soil Analytical Method Information
Basewide Background Study Work Plan
Holloman Air Force Base, New Mexico

Analyte	Method	MDL	RL	1/2 Life
TAL Metals		mg/kg	mg/kg	Years
Aluminum	SW6010B	4.9	10	NA
Antimony	SW6010B	0.38	1.5	NA
Arsenic	SW6010B	0.66	2	NA
Barium	SW6010B	0.24	1	NA
Beryllium	SW6010B	0.15	0.5	NA
Cadmium	SW6010B	0.041	0.5	NA
Calcium	SW6010B	14.1	50	NA
Chromium (total)	SW6010B	0.4	1.5	NA
Cobalt	SW6010B	0.1	1	NA
Copper	SW6010B	0.56	2	NA
Iron	SW6010B	3.8	15	NA
Lead	SW6010B	0.27	0.8	NA
Magnesium	SW6010B	3.7	20	NA
Manganese	SW6010B	0.1	1	NA
Mercury (total)	SW7471A	0.0088	0.033	NA
Nickel	SW6010B	0.24	4	NA
Potassium	SW6010B	41	300	NA
Selenium	SW6010B	0.86	1.3	NA
Silver	SW6010B	0.16	1	NA
Sodium	SW6010B	59	500	NA
Thallium	SW6010B	0.65	1.2	NA
Tin	SW6010B	1.9	10	NA
Vanadium	SW6010B	0.62	2	NA
Zinc	SW6010B	1	3	NA
Radionuclides		pCi/g[1]	pCi/g[2]	Years
Lead (^{210}Pb)	E905.0 Mod.	NV	NV	22.6
Radium (^{226}Ra)	E903.0	NV	0.01	1,600
Radium (^{228}Ra)	E904.0	NV	0.02	5.75
Isotopic Thorium (^{228}Th, ^{230}Th, ^{232}Th)	E907.0	NV	0.05	1.9 / 75,000 / 14,000,000,000
Isotopic Uranium (^{234}U, ^{235}U, ^{238}U)	E907.0	NV	NV	240,000/704,000,000/4,500,000,000
Carbon 14 (^{14}C)	E900	NV	5	5,720

Notes:
MDL = Method Detection Limit
RL = Reporting Limit
TAL = Target Analyte List
mg/kg = milligrams per kilogram
NA = Not Applicable
pCi/g = picocuries per gram
NV = No Value
[1] MDL is replaced by the MDC (minimum detectable concetration) and is sample specific
[2]RL is dependent upon sample volume and count time

Table 4-3
Groundwater Sampling Scheme
Basewide Background Study Work Plan
Holloman Air Force Base, New Mexico

Monitoring Well Identification Number	TAL Metals Analysis (6010B/6020B/ 7470A) - FILTERED[1]	TAL Metals Analysis (6010B/6020B/ 7470A) - UNFILTERED[1]	Radionuclides Analysis (900/E903.0/E904.0/ E905.0 Mod./E907.0)	NAPS[2] (310.1/SW2320B/325.2/ 353.2/4500S-F/9056/ E350.1)	TDS (160.1)
MW3903	1	1	1	1	1
SS61-MW01	1	1	1	1	1
SS61-MW11	1	1	1	1	1
MW-19-03	1	1	1	1	1
MW-21-04	1	1	1	1	1
MW-29-01	1	1	1	1	1
MW30&33-01	1	1	1	1	1
MW30&33-02	1	1	1	1	1
TDS-MW01	1	1	1	1	1
TDS-MW02	1	1	1	1	1
TDS-MW03	1	1	1	1	1
TDS-MW04	1	1	1	1	1
MW-23-01	1	1	1	1	1
MW-23-04	1	1	1	1	1
S10-MW4	1	1	1	1	1
S1-MW1	1	1	1	1	1
S1-MW2	1	1	1	1	1
S1-MW5	1	1	1	1	1
MW-BG-04	1	1	1	1	1
MW-01	1	1	1	1	1
MW-06	1	1	1	1	1
MW-13	1	1	1	1	1
MW58-03	1	1	1	1	1
MW37-06	1	1	1	1	1
MW04-01	1	1	1	1	1
MW38-01	1	1	1	1	1
MW24-05	1	1	1	1	1
MW24-03	1	1	1	1	1
MW24-01	1	1	1	1	1
MW41-04	1	1	1	1	1
Subtotal	30	30	30	30	30
QA/QC Samples Required					
Field Duplicates	3	3	3	3	3
Matrix Spike (MS)	2	2	2	2	0
Matrix Spike Duplicate (MSD)	2	2	2	2	0
Total Number of Samples Per Event[3]	**37**	**37**	**37**	**37**	**33**
Total Number of Samples x 4 events	**148**	**148**	**148**	**148**	**132**

Notes:
TAL = Target Analyte List
(6010B/7470A) = Method Number
NAPs = Natural Attenuation Parameters
TDS = Total Dissolved Solids
QA/QC = Quality Assurance/Quality Control
[1] Two separate samples will be collected for TAL metals; one will be unfiltered, and one will be collected through a 0.45 micron filter.
[2] NAP analysis includes: Alkalinity, Ammonia, Chloride, Nitrate, Nitrite, Sulfate, and Sulfide.
[3] All 30 wells will sampled for each of the 4 sampling events.

Table 4-4
Groundwater Analytical Method Information
Basewide Background Study Work Plan
Holloman Air Force Base, New Mexico

Analyte	Method	MDL	RL	1/2 Life
TAL Metals[1]		mg/L	mg/L	
Aluminum	SW6010B	0.018	0.1	NA
Antimony	SW6010B	0.00314	0.01	NA
Arsenic	SW6010B	0.00441	0.015	NA
Barium	SW6010B	0.00104	0.01	NA
Beryllium	SW6010B	0.000474	0.001	NA
Calcium	SW6010B	0.0345	0.2	NA
Cadmium	SW6010B	0.000452	0.005	NA
Cobalt	SW6010B	0.00123	0.01	NA
Chromium (total)	SW6010B	0.00256	0.01	NA
Copper	SW6010B	0.00449	0.015	NA
Iron	SW6010B	0.022	0.1	NA
Lead	SW6010B	0.00261	0.009	NA
Magnesium	SW6010B	0.0428	0.2	NA
Manganese	SW6010B	0.00179	0.01	NA
Mercury (total)	SW7470A	0.0000272	0.0002	NA
Nickel	SW6010B	0.00778	0.04	NA
Potassium	SW6010B	0.237	3	NA
Selenium	SW6010B	0.00486	0.015	NA
Silver	SW6010B	0.00278	0.01	NA
Sodium	SW6010B	0.0916	1	NA
Thallium	SW6020B	0.02	1	NA
Tin	SW6010B	0.00583	0.1	NA
Vanadium	SW6010B	0.00247	0.01	NA
Zinc	SW6010B	0.00453	0.02	NA
General Chemistry				
Alkalinity	310.1[2] / SW2320B	1.07	5	NA
Ammonia	E350.1	0.0225	0.1	NA
Chloride	4500-CL-C	0.576	3	NA
Nitrate	E353.2	0.0191	0.1	NA
Nitrite	4500 NO2-B	0.0043	0.015	NA
Sulfate	9056	0.232	5	NA
Sulfide	4500S-F	0.495	1	NA
Total Dissolved Solids	2540C	4.7	10	NA
Radionuclides		pCi/L[3]	pCi/L[4]	Years
Lead (^{210}Pb)	E905.0 Mod.	NV	1	22.6
Radium (^{226}Ra)	E903.0	NV	0.2	1,600
Radium (^{228}Ra)	E904.0	NV	1	5.75
Isotopic Thorium (^{228}Th, ^{230}Th, ^{232}Th)	E907.0	NV	0.2	1.9 / 75,000 / 14,000,000,000
Isotopic Uranium (^{234}U, ^{235}U, ^{238}U)	E907.0	NV	0.2	240,000/704,000,000/4,500,000,000
Carbon 14 (^{14}C)	E900	NV	20	5,720
Field Parameters				
Conductivity	2510B	NA	NA	NA
Dissolved Oxygen (DO)	ASTM D888	NA	NA	NA
Oxidation Reduction Potential (ORP)	2580	NA	NA	NA
pH	150.1	NA	NA	NA
Temperature	NA	NA	NA	NA
Turbidity	NA	NA	NA	NA

Notes:

MDL = Method Detection Limit
RL = Reporting Limit
TAL = Target Analyte List
mg/L = milligrams per liter

NA = Not Applicable
pCi/L = picocuries per liter
NV = No Value

[1] Samples submitted for TAL Metals analysis will be both filtered and unfiltered.

[2] Results of the 310.1 Alkalinity analysis are reported as $CaCO_3$ (calcium carbonate). There is no speciation between CO_3 (carbonate) or HCO_3 (bicarbonate), however, based on historical pH data for Holloman Air Force Base, HCO_3 is most likely to be encountered. Historical data is provided in Appendix C of this Work Plan.

[3] MDL is replaced by the MDC (minimum detectable concetration) and is sample specific

[4] RL is dependent upon sample volume and count time

Table 7-1
Key Personnel and Responsibilities
Basewide Background Study Work Plan
Holloman Air Force Base, New Mexico

Name	Project Title/Assigned Role	Phone Numbers
Ms. Katherine Thompson	Field Team Leader/Field Geologist/ Site Manager/SSHO	Work: (205) 910-3882
Mr. Frank Gardner, P.G.	Bhate Program Manager	Work: (303) 386-6454
J. Mark Stapleton, Ph.D., P.E., AEE	Technical Director	Work: (205) 999-7657
Mr. Brian Muller, CIH, CHMM, CSP	Health and Safety Specialist	Work: (205) 918-4000

Notes:
P.G. = Professional Geologist
P.E. = Professional Engineer
AEE = Associate to the American Academy of Environmental Engineering
SSHO = Site Safety and Health Officer
CIH = Certified Industrial Hygienist
CHMM = Certified Hazardous Materials
CSP = Certified Safety Professional

FIGURES