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HOLLOMAN AIR FORCE BASE NEW MEXICO

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SEP 4
Hazardous Waste Bureau

28 August 2014

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Mr. John E. Kieling
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SUBJECT: Transmittal of Final Interim Measures Work Plan, Group 3 Former Underground Storage Tank Sites: AOC-UST-221 (TU503), AOC-UST-298 (TU508), AOC-UST-901 (TU506) and AOC-UST-7003 (TU518)

Dear Mr. Kieling,

We received your 06 August 2014 approval letter for the subject document. Attached is the Final Interim Measures Work Plan.

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 regarding this submittal, please contact me at (575) 572-3931.

Sincerely,

DEANNA ROTHHAUPT, GS-12, DAFC

Attachment(s): Final Interim Measures Work Plan, Group 3 Former Underground Storage Tank Sites: AOC-UST-221 (TU503), AOC-UST-298 (TU508), AOC-UST-901 (TU506) and AOC-UST-7003 (TU518). Hard copy and CD.

cc: Mr. Brian Salem, NMED HWB (Hard copy and CD)
Mr. Will Moats, NMED HWB (letter only)
C. Hendrickson, EPA, Region 6 (letter only)

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FINAL
INTERIM MEASURES WORK PLAN

Group 3 Former Underground Storage Tank Sites:

AOC-UST-221 (TU503), AOC-UST-298 (TU508), AOC-UST-901 (TU506), and AOC-UST-7003 (TU518)

Holloman Air Force Base, New Mexico

Prepared for
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Contract No.: FA8903-13-C-0008

URS Group, Inc.
Denver, Colorado

11 August 2014

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LIST OF ACRONYMS AND ABBREVIATIONS

°F	degree Fahrenheit
AFB	Air Force Base
AFCEC	Air Force Civil Engineer Center
AOC	Area of Concern
bgs	below ground surface
CAC	Corrective Action Complete
CFR	Code of Federal Regulations
COC	Contaminant of Concern
CY	cubic yard
DERA	Defense Environmental Restoration Account
DOT	Department of Transportation
DPT	direct-push technology
DRO	diesel range organics
FPM	FPM Remediations, LLC
ft	foot/feet
GIS	geographic information system
GRO	gasoline range organics
HSA	hollow stem auger
HASP	Health and Safety Plan
HWA	Hazardous Waste Act
HWB	Hazardous Waste Bureau
IDW	investigation derived waste
IM	Interim Measure
IRP	Installation Restoration Program
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
NM	New Mexico
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMWQCC	New Mexico Water Quality Control Commission
NRCS	Natural Resources Conservation Service
NTU	nephelometric turbidity unit
ORO	oil range organics
PAH	polynuclear aromatic hydrocarbon
PBR	Performance Based Remediation
PID	photoionization detector
PPE	personal protective equipment
ppm	parts per million
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act

RFI	RCRA Facility Investigation
RSL	Regional Screening Level
Shaw	Shaw Environmental & Infrastructure, Inc.
SOP	Standard Operating Procedure
sq ft	square foot/feet
SSL	soil screening levels
SVOC	semivolatile organic compound
TAL	Target Analyte List
TAT	turn-around time
TCLP	Toxicity Characterization Leachate Procedure
TDS	total dissolved solids
TPH	total petroleum hydrocarbons
URS	URS Group, Inc.
USAF	United States Air Force
U.S. Census	United States Census Bureau
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	underground storage tank
VCM	Voluntary Corrective Measures
VOC	volatile organic compound
WMSR	White Sands Missile Range

1.0 INTRODUCTION

This Interim Measures (IM) Work Plan addresses four Group 3 Underground Storage Tank (UST) Areas of Concern (AOCs) located at Holloman Air Force Base (AFB) near Alamogordo, New Mexico (NM)(**Figure 1-1**). The AOCs consist of former UST sites, where the USTs have been removed, but elevated concentrations of petroleum hydrocarbons (e.g., diesel fuel) have been documented in soil, groundwater, or both media. These sites include:

- AOC-UST-221 (TU503, formerly TU/US-C503),
- AOC-UST-901 (TU506, formerly TU/US-C506),
- AOC-UST-298 (TU508, formerly TU/US-C508), and
- AOC-UST-7003 (TU518, formerly TU/US-C518).

This IM Work Plan has been prepared by FPM Remediations, LLC (FPM)/URS Group, Inc. (URS) on behalf of the United States Air Force Civil Engineer Center (AFCEC), under Contract Number FA8903-12-R-0050, in accordance with Holloman AFB's Resource Conservation and Recovery Act (RCRA) Permit (Permit Number - NM6572124422) (NMED 2004) and Notice to Approve a Class 3 Permit Modifications (NMED 2012a), which added the sites to the RCRA Permit.

As part of a Defense Environmental Restoration Account (DERA) study for AFCEC, these sites were evaluated to determine eligibility for cleanup funding under DERA. The DERA Evaluation Report evaluated historical site information and recommended that these sites be further investigated (URS 2009).

The sites were partially investigated and some petroleum-impacted soil was removed by Shaw Environmental & Infrastructure, Inc. (Shaw) under the Voluntary Corrective Measures (VCM) program. The VCM Request (Shaw 2012) was prepared by Shaw, on behalf of AFCEC under the Midwest Performance Based Remediation (PBR) Contract (Contract Number FA8903-09-D-8580) and submitted to the New Mexico Environment Department (NMED) for review by the United States Air Force (USAF) on 29 February 2012.

Based on URS' review of the preliminary data collected under the VCM, additional investigative and remedial work is necessary at these sites to achieve Corrective Actions Complete (CAC). This work can most effectively be accomplished through the use of IM because the sites are relatively small, the nature of the petroleum hydrocarbons is well understood, and the technologies to remove and/or destroy the hydrocarbons are well-proven.

1.1 Interim Measures Purpose

The purpose of these IM is to facilitate a timely corrective measure which will minimize or prevent the further migration of contaminants and limit actual or potential human and environmental exposure to contaminants. The ultimate goal of this project is to bring each of these four sites to CAC status, with no requirement for further land use controls. The IM approach for the TU sites was discussed with NMED during a meeting on 16 December 2013 between NMED, Holloman AFB, and URS.

1.2 Interim Measures Objectives

The primary objectives of the IM are to:

- Clearly delineate the nature and extent of petroleum hydrocarbons in subsurface soil and groundwater,
- Remove and/or destroy petroleum hydrocarbons present in the soil and/or groundwater and concentrations above applicable screening values,
- Provide confirmatory sampling data to demonstrate that each site has achieved regulatory cleanup levels, and
- Provide the necessary data to support a CAC proposal to NMED to delist the sites from the RCRA Permit.

These IM objectives will be achieved in part through the following field activities, which are described in this Work Plan:

- utility clearance;
- soil and/or groundwater reconnaissance sampling for contaminants of concern (COCs);
- excavation and disposal of contaminated soil;
- temporary well point and/or monitoring well installation;
- subsurface injection of bioremediation augmentation substrates;
- confirmation sampling of soil and/or groundwater;
- surveying; and
- site restoration.

1.3 Regulatory Setting

Pursuant to the RCRA Permit, IM activities conducted at Holloman AFB are performed under the New Mexico Hazardous Waste Act (HWA), the New Mexico Hazardous Waste Management Regulations, and RCRA. The NMED Hazardous Waste Bureau (HWB) has regulatory enforcement authority for the State of New Mexico.

The media of concern for the UST sites referenced in this document include subsurface soil and groundwater. Pursuant to the RCRA Permit, and with guidance provided by NMED, cleanup levels for impacted soil under these IM will be to the latest revision of NMED and EPA documents at the time of work plan approval and/or execution of the fieldwork. Currently, these levels include the residential soil screening levels (SSLs) presented in the *Risk Assessment Guidance for Site Investigations and Remediation* (NMED 2012b), or the United States Environmental Protection Agency's (USEPA) *Regional Screening Levels (RSLs)* for residential soil (USEPA 2013), if no SSL has been identified for a specific compound. Additionally, the RCRA Permit requires groundwater cleanup levels (latest revision as of work plan approval) to be set at the more conservative of those specified by either the New Mexico Water Quality Control Commission (NMWQCC) as protective of human health (20.6.2.3103 New Mexico

Annotated Code [NMAC]), or by USEPA's Maximum Contaminant Levels (MCLs) (USEPA 2013).

In addition to the prescribed regulatory guidance, the *Final Background Study Report; Holloman AFB, New Mexico, Revision 3* (NationView 2011) provides reference data for comparison to metals concentrations in soils and groundwater under these IM. The background levels of metals in soil and groundwater published in that report have been accepted by NMED (NMED 2011) and will be used as secondary screening data to determine whether soil or groundwater have been impacted by metals at the former UST sites. In the event that there are detected metals in excess of established background concentrations, it may be appropriate to further evaluate the data and propose a weight-of-evidence argument for selected values if it appears as though they may be naturally occurring.

1.4 Interim Measures Work Plan Organization

This IM Work Plan is divided into six sections and includes three appendices. The sections of this Work Plan include:

- Section 1 - Introduction, Purpose, Objectives, and Regulatory Setting
- Section 2 - Previous Investigations and Background Information;
- Section 3 - The technical approach for implementing IM at the sites, including general procedures and typical methods and materials that may be used;
- Section 4 - A brief discussion of the IM Report structure and contents;
- Section 5 - An estimated project schedule for IM implementation and reporting; and
- Section 6 - A list of documents referenced in this Work Plan.

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2.0 PREVIOUS INVESTIGATIONS AND BACKGROUND INFORMATION

2.1 Previous Investigations

As stated in Section 1.0, initial investigative work was performed and documented in the DERA Evaluation Report (URS 2009). This work mostly involved a review of historical records with a resulting recommendation for further investigation based on the potential presence of contaminants. Subsequent environmental investigation and remediation was conducted under both the USAF's Installation Restoration Program (IRP) and the RCRA Corrective Action Program.

The following sections provide brief descriptions of work performed under the 2012 VCM Request. Shaw performed the VCM along with investigative work with the intention of concurrently conducting a RCRA Facility Investigation (RFI). However, the corresponding RFI Work Plan and Report were not reviewed by NMED. Data obtained from these activities were compiled in a Sample Completion Report, Group 3 – Nine Former UST Sites (Shaw 2013), which has not been reviewed or commented on by NMED as of the time of preparation of this IM Work Plan (January 2014). There is no indication that the results of the work previously performed will be submitted for review by NMED as a standalone document. The analytical data reported in the Sample Completion Report (Shaw 2013) will be re-evaluated within the context of the data generated under these IM, and a determination on its appropriateness as either a screening or compliance/confirmation tool will be made at that time. The 2012 investigation data will be submitted for review within the IM Report prepared in accordance with this Work Plan regardless of whether it is used for screening or confirmation purposes. References to the sample locations and results are discussed below, but will be formally presented in the IM Report.

2.1.1 TU503

Records for former UST site TU503 (**Figure 2-1**) indicate that this UST associated with Building 221 was removed in 1991 (Shaw 2012). Closure records report that the UST was a steel tank with a capacity of 300 gallons (URS 2009). The tank had been in service for an estimated 5 years and had been used for diesel fuel storage prior to closure. There was no known internal or external tank protection, and the associated piping was bare steel. The records show that soil directly beneath the tank had a total petroleum hydrocarbon (TPH) concentration of 1,470 milligrams per kilogram (mg/kg) prior to soil removal. As part of the UST removal effort, soil directly beneath the tank was also removed. The analytical results for the soil left in place indicated that the TPH concentration was 141.35 mg/kg (i.e., below the NMED screening level of 1,000 mg/kg). However, in a November 1992 letter to Holloman AFB, NMED indicated that it would still be necessary to determine the lateral extent of contaminated soils.

During the 2012 VCM, approximately 42 cubic yards (CY) of soil were excavated from the site between 7 and 11 feet below ground surface (bgs). Additionally a 2 foot (ft) wide, 24 ft long, 11 ft deep trench was excavated to delineate the contamination based on visual evidence. The contamination extended 18 ft laterally, which was confirmed by soil samples. A total of 13 soil samples were collected from various depth intervals down to the water table (approximately 9 ft bgs) at locations surrounding the former UST at Building 221. Screening criteria for TPH-gasoline range organics (GRO) were exceeded in 11 of 13 samples, including samples from the

wall and floor of the excavation. Delineation of TPH- diesel range organics (DRO) contamination was not completed to the east, west, and south. Benzo(a)pyrene was detected above screening levels at a depth of 9-10 ft bgs 12 ft west of the former UST location.

Three monitoring wells were installed as part of the VCM, one upgradient and two downgradient. Groundwater samples were collected from only two of the three wells. Downgradient well USTC503-MW01 did not yield sufficient groundwater for sampling. Upgradient monitoring well USTC503-MW02 had a total dissolved solids (TDS) value greater than 10,000 milligrams per liter (mg/L), and therefore, no further analyses were performed since NMWQCC standards are for aquifers with TDS concentrations less than or equal to 10,000 mg/L (20.6.2 NMAC). Sample results for downgradient well USTC503-MW03 were compared to the NMWQCC water quality standards, but none of the parameters analyzed exceeded those groundwater standards.

2.1.2 TU506

Records for former UST site TU506 at Building 901 (**Figure 2-2**) indicate that the associated UST was closed in 1991. Closure records report the UST was a bare steel tank with a capacity of 250 gallons. The tank had been in service for 31 years, was used for diesel fuel or used oil storage, and was in poor condition exhibiting severe corrosion at the time of closure. There was no known internal or external tank protection, and the associated piping was bare steel. Soil contamination was noted during closure; a soil sample taken below the tank had a TPH concentration of 14,000 mg/kg. There are no records to show that soil remediation was performed at that time.

During the 2012 VCM, 13 soil samples were collected from varying depths down to the water table, at locations surrounding the former UST north of Holloman AFB Building 901. No parameters were detected that exceeded New Mexico residential SSLs. Likewise, TPH was not detected above the 1,000 mg/kg SSL in any of the soil samples, and no additional removal actions were conducted.

Three monitoring wells were installed and sampled during the VCM. Iron, manganese, TPH-GRO, and TPH-DRO were detected in downgradient well USTC506-MW01 above NMWQCC criteria. The former UST was used to store petroleum products, most recently diesel fuel and used oil, as noted in the Tank Closure Report (URS 2009). There is no reason to expect that the iron or manganese detected in USTC506-MW02 is associated with the former Building 901 UST.

2.1.3 TU508

Records for former UST site TU508 at Building 298 (**Figure 2-3**) indicate that three USTs were removed in 1996. Closure records report that the three USTs were each constructed of fiberglass reinforced plastic (URS 2009). Two of the tanks had a capacity of 5,000 gallons each; one held jet fuel (JP4/8) and the other held gasoline. A third tank had a capacity of 3,000 gallons and held diesel fuel. There was no internal or external tank protection, and the associated piping was also fiberglass reinforced plastic. The tanks were removed by excavation, cut up into 3 ft by 5 ft pieces, and transported off site for disposal. The records also show that soil samples were collected from the walls and floor of the excavation, and from the resultant soil stockpile following soil removal. Analytical results for the soil samples indicated the presence of TPH-

DRO in excess of 1,000 mg/kg from a depth of 4.5 to 6.0 ft bgs and from within the soil stockpile. An additional total of 600 CYs of soil was excavated from the former UST pit, resulting in soil concentrations of TPH-DRO below 1,000 mg/kg in the remaining soils.

During the 2012 VCM, a total of 11 soil samples were collected from various depth intervals down to the water table (approximately 5 ft bgs) at locations surrounding the former USTs at Building 298. Five soil samples were collected from the base of the former UST pit. TPH results showed no exceedances of the NMED residential SSLs in soil samples collected from the former UST area. In addition, soil samples collected from the three well borings placed in the vicinity of the former UST area yielded similar TPH results. Concentrations of arsenic and cobalt exceeded NMED residential SSLs in some soil samples. A background value for arsenic of 3.7 mg/kg has been established for Holloman AFB (NationView 2011). The arsenic results in soil at Building 298, ranging from 3.9 mg/kg to 4.6 mg/kg, slightly exceed the background value, but do not exceed the range of background concentrations. The cobalt result of 68.7 mg/kg is an order of magnitude above the background value of 7.7 mg/kg for Holloman AFB. The value for cobalt in soil is anomalously high, and was outside of the range of background concentrations.

Results of the geochemical evaluation indicate that arsenic detected in soil samples at Building 298 was within the range of background samples and was likely naturally occurring. The study also concluded that the cobalt concentration in the sample collected from a depth of 0 to 2 ft bgs in fill material at downgradient well boring USTC508-MW01 cannot be explained by natural processes, and therefore, contamination is suspected. However, it is unlikely that this single detection of cobalt is associated with the former USTs at Building 298.

Three monitoring wells were installed and sampled during the VCM. Additionally, four existing monitoring wells located in the vicinity of Building 298 were sampled once the analytical results from the three installed wells revealed the presence of chlorinated solvents. The existing wells were added to the program to further investigate the local groundwater since chlorinated solvents are not normally associated with petroleum hydrocarbon (i.e., gasoline, diesel fuel, and JP 4/8) USTs. The analytical results for the four existing monitoring wells sampled during that investigation revealed the presence of various chlorinated Volatile Organic Compounds (VOCs) both upgradient (SS18-MW08) and further downgradient of the site of the Building 298 former USTs. For these wells, a number of chlorinated VOCs were present in the groundwater above screening levels.

2.1.4 TU518

Records for former UST site TU518 at Building 7003 (**Figure2-4**) indicate that the associated UST was removed from the National Radar Testing Facility in 2008 (URS 2009). During excavation, contamination was evident from the top of the excavation down toward the UST, indicating that the contamination was due to repeated overfills. Sample results showed TPH contamination of 21,000 mg/kg in the soil. According to Base personnel, NMED was on site and verified that the tank was in sound condition and that the contamination was due to overfilling. The removal project was not funded for remediation; therefore, the excavation was filled with clean soil without removing all contamination.

During the 2012 VCM, soil excavation was performed to remove polynuclear aromatic hydrocarbons (PAH) impacted soil, but it also exposed petroleum hydrocarbon impacted soil. Approximately 45.5 CYs of soil were removed for off-site disposal from an excavation 16 ft

long, 13 ft wide, and 7 to 9 ft deep. Confirmation soil samples were collected from the excavation walls and floor. Petroleum-related contaminants were detected in the soil samples, but not at concentrations that exceeded residential SSLs. Therefore, the TPH-DRO impacted soil at concentrations exceeding the residential SSL has been horizontally delineated, and the TPH-DRO impacted soil is delineated vertically to groundwater. Benzo(a)pyrene was detected at a concentration above the SSL in one confirmation sample. However, a second confirmation soil sample collected from the same depth interval did not detect benzo(a)pyrene, indicating that the result was likely an anomalous detection.

Although groundwater was not investigated due to direct push technology (DPT) refusal, historical analytical results indicate that TDS concentrations are likely in excess of 10,000 mg/L and therefore the groundwater would be considered non-potable as indicated in 20.6.2 NMAC. However, additional actions may be necessary under such conditions if the potential exists for risk from vapor intrusion or to ecological receptors.

2.2 General Background Information

2.2.1 Physical Setting

Holloman AFB is situated in south central New Mexico, in the northwest central part of Otero County, approximately 75 miles north–northeast of El Paso, Texas (USAF 2013). Holloman AFB has a population of 3,054 (U.S. Census 2010) and occupies approximately 59,639 acres in the northeast quarter of Section 1, Township 17 South, Range 8 East. The White Sands Missile Range (WSMR) testing facilities occupy additional land extending northward from the Base. Privately and publicly owned lands border the remainder of Holloman AFB. The major highway servicing Holloman AFB is Highway 70, which runs southwest from the town of Alamogordo, New Mexico, and separates Holloman AFB from publicly owned lands to the south. Alamogordo, which has a population of 30,401 according to (U.S. Census 2010), is located approximately 7 miles east of the Base.

2.2.2 Holloman AFB History

Holloman AFB was first established in 1942 as Alamogordo Army Air Field. From 1942 through 1945, Alamogordo Army Air Field 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 that the air field would be its primary site for the testing and development of unmanned aircraft, guided missiles, and other research programs (USAF 2013). On 13 January 1948, the Alamogordo installation was renamed in honor of the late Colonel George V. Holloman, a pioneer in guided missile research. In 1968, the 49th Tactical Fighter Wing arrived at Holloman AFB and has remained since. Today, Holloman AFB also serves as the training center for the German Air Force's Tactical Training Center.

2.2.3 Physiography and Topography

Holloman AFB is located within the Basin and Range Province physiographic province in the Sacramento Section on the western edge of the Sacramento Mountains at a mean elevation of 4,093 ft above mean sea level (USGS 2003). The region is characterized by high tablelands with

rolling summit plains, cuesta-formed mountains dipping eastward, and west-facing escarpments with the wide bracketed basin forming the basin and range complex. Holloman AFB is within the Tularosa Basin, which is part of the Central Closed Basins (NMED 2004). The bordering mountains rise abruptly to altitudes of 7,000 to 12,000 ft above mean sea level. The San Andres Mountains approximately 30 miles to the west bound the basin to the west, with the Sacramento Mountains approximately 10 miles to the east (**Figure 1-1**). At its widest, the basin is approximately 60 miles east to west and stretches approximately 150 miles north to south.

2.2.4 Climate

As a whole, New Mexico has a mild, arid to semiarid continental climate characterized by light precipitation totals, abundant sunshine, relatively low humidity, and relatively large annual and diurnal temperature ranges (Western Regional Climate Center 2013). The climate of the Central Closed Basins varies with elevation. The Base is located in the lower elevation areas, characterized by warm temperatures and dry air. Daytime temperatures often exceed 100 degrees Fahrenheit (°F) in the summer months and are in the middle 50-degree range in the winter. A preponderance of clear skies and relatively low humidity permits rapid cooling resulting in average diurnal temperature ranges of 25° to 35°F. Potential evapotranspiration, at 73 inches per year, significantly exceeds annual precipitation, usually less than 10 inches. Arid conditions resulting from very low rainfall amounts, coupled with topographically induced wind patterns and combined with sparse vegetation, tend to cause localized “dust devils.” The annual rainfall for Alamogordo is 12 inches per year. Much of the precipitation falls during the mid-summer monsoonal period (July and August) from brief, yet frequent, intense thunderstorms culminating in 30 to 40 percent of the total annual rainfall.

2.2.5 Regional Geology and Soils

2.2.5.1 Regional Geology

The sedimentary rocks, which make up the adjacent mountain ranges, are between 500 and 250 million years old (Weir, Jr. 1965). During the period when the area was submerged beneath the shallow intracontinental sea, the layers of limestone, shale, gypsum, and sandstone were deposited. In time, these layers were pushed upward through various tectonic forces, forming a large bulge on the surface. Approximately 10 million years ago, the center began to subside, resulting in a vertical drop of thousands of feet leaving the edges still standing (the present-day Sacramento and San Andres mountain ranges). 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 materials continued to flow into the basin.

As the Tularosa Basin is a bolson-type basin, 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. Soils in the basin are derived from the adjacent ranges as erosional deposits of limestone, dolomite, and gypsum. A fining sequence from the ranges towards the basin’s center characterizes the area with the near surface soils being alluvial, eolian, and lacustrine deposits. 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 due to the

reworking of the alluvial sediment by eolian processes. The playa, or lacustrine deposits, consist of clay containing gypsum and are contiguous with the alluvial fan and eolian deposits throughout the Base. Stiff caliche layers, varying in thickness, have been identified at different areas of the Base.

2.2.5.2 Soils

The United States Natural Resources Conservation Service (NRCS) (formerly Soil Conservation Service) has identified two soil associations in the vicinity of Holloman AFB—the Holloman-Gypsum Land-Yesum Complex and the Mead silty clay loam (Derr 1981)(**Figure 2-5**). The hydraulic conductivity of these horizons ranges from 4×10^{-4} to 1×10^{-3} centimeters per second.

The Holloman-Gypsum Land-Yesum Complex (0 to 5 percent slopes) consists of larger 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 approximately 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 approximately 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 deeper Yesum horizon consists of very fine sandy loam that makes up approximately 20 percent of the complex. Typically, the surface layer is light brown, very fine sandy loam approximately 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 found across the main drainage area for the Base is Mead silty clay loam (0 to 1 percent slopes). This deep, poorly drained, nearly level soil occurs 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 approximately 5 inches thick. The substratum, to a depth of 48 inches, is light reddish-brown clay that has a high salt content. Below that, the substratum is lacustrine material of variable texture and color to a depth of more than 60 inches. Included within 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 approximately 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 low, and available water capacity is low (URS 2009).

2.2.5.3 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 runoff

along the western edge of the Sacramento Mountains (Basabilvazo, Myers, and Nickerson 1994). 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 leaves either through evaporation or percolation. This elevated amount of percolation results in a fairly high water table. Beneath Holloman AFB, groundwater ranges from 5 to 50 ft bgs. Flow for the Base is generally towards the southwest with localized influences from variations in topography (**Figure 2-6**). In the northern and western portions of the Base, groundwater flows more to the west towards 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.

Groundwater 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 percent) of the Environmental Restoration Program sites located across Holloman AFB have groundwater monitoring wells containing water with an average TDS concentration greater than 10,000 mg/L. These TDS data support the hypothesis that TDS concentrations below 10,000 mg/L at Holloman AFB are caused by dilution of natural groundwater quality from leaking water lines and surface irrigation from the domestic water supply. TDS concentrations greater than 10,000 mg/L exceed the NMWQCC limit for potable water, and therefore, the groundwater beneath Holloman AFB has been designated as unfit for human consumption. Likewise, the USEPA guidelines have identified the groundwater as a Class IIIB water source, characterized by TDS concentrations exceeding 10,000 mg/L and a low degree of interconnection with adjacent surface water or groundwater of a higher class. Groundwater at Holloman AFB does not discharge or connect to any adjacent aquifers because the Tularosa Basin is a closed basin. Adjacent surface waters include Lost River and Lake Holloman, which also have high concentrations of TDS and are not considered potential drinking water sources.

2.2.5.4 Surface Water Hydrology

The Tularosa Basin contains all of the surface flow in its boundaries (NMWQCC 2006). 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 Sacramento River are perennial in the basin. Holloman AFB is dissected by several southwest-trending arroyos that control surface drainage. Hay Draw arroyo is located in the far north. Malone and Ritas draws, which drain into the Lost River and Dillard Draw arroyos, are located along the eastern perimeter of the Base. Indications are that the climate was much wetter approximately 10,000 years ago. The present-day Lake Otero formerly 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 merely a few inches deep during the rainy season. Ancient lakes and streams deposited water-bearing deposits over older bedrock basement materials. Fractures, cracks, and fissures in the Permian and Pennsylvanian bedrock yield small quantities of relatively good quality water in the deeper periphery. Potable water is only found in wells near the edges of the basin with more saline water found towards the center. Two of the principal sources of potable water are a long narrow area on the upslope sides of Tularosa and Alamogordo and another area

in the far southwestern part of the basin. A portion of the city of Alamogordo's water, as well as the Holloman AFB's water, is supplied from Bonito Lake (which is in the Pecos River Basin).

2.2.5.5 Current and Future Land Use

The land surrounding Holloman AFB consists of residential areas to the east and northeast (city of Alamogordo), rangeland to the south, White Sands National Monument to the west, and areas where military activities are conducted to the north. The desert terrain immediately surrounding Holloman AFB has limited development, Mesa Verde Ranch operates along the eastern border, and there are no residential communities, or large industrial operations located adjacent to the Base. Holloman AFB 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 (Foster Wheeler 2002). Future land use is not expected to differ significantly from current land use practices (Foster Wheeler 2002).

2.2.5.6 Current and Future Water Use

Currently, there are no potable supplies of groundwater or surface water located on the Base (Foster Wheeler 2002). Holloman AFB obtains its water supply from the city of Alamogordo and Holloman AFB 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 with TDS concentrations greater than 10,000 mg/L. There are no potable or irrigation wells near or immediately downgradient of the Base.

3.0 PROCEDURES FOR IMPLEMENTATION

This section includes general procedures for implementing the delineation and remedial action activities to be undertaken. Several supporting project-related plans have also been prepared, and are included in this Work Plan as the following appendices:

- A site-specific Quality Assurance Project Plan (QAPP) is provided as **Appendix A**, and establishes the overarching analytical and data collection protocols and documentation requirements so that data are generated, reviewed, and analyzed in a consistent manner, for the investigation and remediation activities performed in the scope of work presented in this Work Plan.
- A site-specific Health and Safety Plan (HASP) is provided in **Appendix B**, and defines the health and safety guidelines developed to protect URS personnel, subcontractors, and government personnel involved in the IM.
- URS Standard Operating Procedures (SOPs) are provided in **Appendix C**, and outline the general procedures used to conduct various activities associated with IM implementation.

The following specific tasks will be applied to each of the former UST sites subject to IM under this Work Plan:

- Pre-mobilization activities;
- Mobilization/site setup;
- Exploratory soil and groundwater sampling;
- Excavation/soil removal;
- Confirmation soil sampling;
- Subsurface injection;
- Monitoring well installation and development;
- Confirmation groundwater sampling;
- Waste management;
- Site restoration;
- Site surveying; and
- Reporting.

URS has evaluated the VCM approach proposed by Shaw and reviewed by NMED, and prepared this IM Work Plan with recognition of the existing VCM Request, but with proposed changes to more effectively achieve the goals of IM. The primary changes between the previously submitted VCM Request (Shaw 2012) and this IM Work Plan are:

- Removal of the 40 CY excavation limit contained within the VCM Request, which was a contractual limitation for that work. Impacted soil with COC concentrations above the applicable cleanup levels will be removed (or otherwise remediated), whenever feasible, with no fixed limit on the volume of excavation at a given site.

- Modification of the previous monitoring well installation plan which stipulated only three wells per site. Instead, additional monitoring wells and/or temporary well points will be installed as necessary to achieve objectives of the IM including delineation of the nature and extent of contamination. At each site, at least three monitoring wells will be properly constructed to perform site delineation, remediation performance monitoring, and/or compliance monitoring.
- Pursuant to Part 4, Section F of the Holloman AFB RCRA Permit, planned IM activities at the former UST sites are not limited to remediation of impacted soil. IM will be implemented to "mitigate any current or potential threat(s) to human health or the environment and [are] consistent with and integrated into any long-term solution at the facility" (NMED 2004), including the remediation of impacted groundwater. Following identification of the nature and extent of contamination at the individual sites, soil removal and bioremediation will be utilized to remediate contaminated soil and groundwater, if necessary.

3.1 Applicable Regulations and Standards

Federal and state regulations and standards that may be applicable to these IM include the following:

- Holloman AFB RCRA Permit No. NM6572124422, February 2004 (NMED 2004).
- RCRA Permit No. NM6572124422 Modification, October 2009 (NMED 2009).
- NMED residential SSLs (NMED 2012).
- USEPA residential RSLs (USEPA 2013).
- NMWQCC groundwater cleanup levels protective of human health (20.6.2.3103 NMAC).
- USEPA MCLs (USEPA 2013).
- New Mexico HWA (NMSA 1978, §74-4-1).
- New Mexico Hazardous Waste Management Regulations, (20.4.1.100 NMAC).
- RCRA, 40 Code of Federal Regulations (CFR) 260-268, Management of Hazardous Waste. In the event that investigation derived waste (IDW) sampling and analysis indicate the presence of constituents of potential concern at concentrations rendering them hazardous, storage and disposal protocols will be followed in accordance with RCRA hazardous waste regulations, as adopted by NMED.
- United States Department of Transportation (DOT) 49 CFR 172, 173, and 178: Applies to packaging IDW for removal off site and addresses hazard-class diamond labeling.

The latest revision of NMED and EPA documents at the time of work plan approval and/or execution of the fieldwork will be used.

3.2 Pre-mobilization Activities

Prior to mobilization of equipment, subcontractors (e.g., drilling subcontractor, New Mexico-licensed surveyor, and approved analytical laboratory) will be procured. All necessary permits (e.g., digging permits) will be initiated. All site activities will be coordinated with appropriate Holloman AFB personnel.

Prior to initiating intrusive activities, a completed and approved Air Force Form 332 will be obtained for authorization of construction work at Holloman AFB. A request for locating underground utilities in the area will be submitted to the local one-call utility notification center, as applicable. Additionally, Air Force Form 103 will be submitted to request that the location of underground utilities be marked at the specific sites. Drilling and excavation locations will be identified with paint, flags, or stakes, as appropriate to the surface material. Utility clearance approvals will be completed by the appropriate Holloman AFB utility office (e.g., telephone, sewer, water, natural gas, etc.).

3.3 Mobilization Setup

Personnel, equipment, and resources necessary to implement this IM Work Plan will be mobilized to the sites. Site setup will occur at each of the applicable former UST sites. Warning signs and safety fencing may be used, where necessary, to indicate the danger of entering a work zone and to keep the work area clear of obstructions such as facility-worker vehicles. Setup will also include establishing a location for material storage and other equipment staging areas.

3.4 Exploratory Soil and Groundwater Sampling

Exploratory (pre-remediation) soil and groundwater sampling are intended to be utilized as a screening tool; therefore, the protocols for exploratory delineation sampling may differ from the more stringent requirements of confirmatory and compliance sampling that will be conducted following remedial activities. The sample collection and preparation procedures utilized during delineation will be implemented to provide guidance for excavation and subsurface injection, and will not provide analytical data to be relied upon as a boundary condition or to achieve site closure directly. The results of exploratory sampling may also be used to determine placement of more formal confirmation and compliance sample locations. As opposed to confirmatory sampling, exploratory samples may be analyzed in the field by a screening test or in a setting other than a fully-accredited laboratory and will not be required to adhere to criteria specified in the QAPP or SOPs.

The main types of sampling that will be conducted during implementation of this IM Work Plan include:

- Pre-remediation delineation soil and groundwater sampling for chemical contamination;
- Performance monitoring sampling, as warranted, during any ongoing remedial actions; and
- Post-remediation confirmation sampling for contaminated soil and groundwater.

The more formal confirmatory sampling activities are described in greater detail in **Section 3.6** (Confirmation Soil Sampling) and **Section 3.9** (Confirmation Groundwater Sampling).

Exploratory samples will be clearly identified as exploratory, delineation, or with similar wording to avoid confusion with confirmation samples.

To differentiate exploratory from confirmatory samples, an exploratory sample is defined as a field-screening tool to be used for determining more precise application of the IM, whereas a confirmation sample is defined as a representative sample that has been collected, analyzed, and validated in accordance with the QAPP and applicable SOPs, and is subsequently used to document that the concentrations of COCs in soil or groundwater are below the applicable cleanup levels. Pre-excavation exploratory sample data will not be validated; however, the data will be included in the IM Report for reference.

At each former UST site, exploratory sampling will be conducted using DPT, trenching, or other appropriate methods. In addition to standard vertical DPT drilling methods, angled and/or horizontal soil borings may be utilized to access otherwise obstructed areas such as beneath building foundations. Subsurface investigation will be conducted to determine the horizontal and vertical extent of soil and groundwater contamination, as required. During trenching or DPT drilling, soil screening will be conducted using a photoionization detector (PID), visual and olfactory observations, and collection of screening samples (as described above) to guide the exploration and identify the extent of soil contamination.

The maximum extent of accessible soil contamination will be determined based on field observation, site conditions, and physical restrictions. Visual observation of stained soil; field and/or laboratory soil screening; and proximity of existing underground utilities, surface structures, and building foundations may also define the limits of accessible contamination.

Exploratory samples will be analyzed for TPH-GRO, -DRO, and -oil range organics (ORO) using Modified USEPA Method 8015. Target Analyte List (TAL) metals, semi-volatile organic compounds (SVOCs), and VOCs will also be analyzed. The QAPP (**Appendix A**) indicates the sampling and analytical method requirements for confirmation soil and groundwater samples; however, not all elements of the QAPP are applicable to exploratory sample collection and analysis. The SOPs (**Appendix C**) describe the general methods and equipment to be used in the collection and handling of environmental samples; exploratory sampling for soil and groundwater will be in general accordance with the applicable SOPs.

3.5 Excavation/Soil Removal

Once contamination in site soil has been delineated, removal of contaminated soil may be performed using a backhoe or hydraulic excavator. Should the soil removal require access to areas completed in concrete or asphalt, the surface covering will be removed prior to excavation and replaced following backfill and compaction.

If contaminated soil appears to extend past the expected excavation limits, excavation will continue until soil is no longer considered to be potentially contaminated, based on visual evidence, field- or laboratory-screening, or other appropriate screening methods. However, excavation may be limited by the presence of buildings and/or utilities. Once the screening inspection indicates that soil is not potentially contaminated, confirmation samples will be collected in accordance with the QAPP and SOPs (**Appendices A and C**). Confirmation samples will be collected at a frequency of one from each side wall of the excavation per 20 linear feet along the area of contamination within the excavation. This applies to excavations with less than 50,000 CYs of soil. For excavations greater than 50,000 CYs, the frequency of sampling will be

every 50 linear feet. A minimum of one excavation floor sample will be collected and for larger excavations floor samples will be collected at intervals of approximately 500 square feet (sq ft). Excavation activities and subsequent sampling and analysis will continue until confirmation sampling and analysis indicate that concentrations of COCs do not exceed the applicable NMED residential SSLs (NMED 2012b).

Following removal of contaminated soil and confirmation sampling, the excavations will be backfilled with clean fill material and compacted with a vibratory compactor, backhoe, or other appropriate methods. There is no pre-defined limit to the volume, depth, or horizontal extent of excavation.

The excavated soil will be placed in appropriate roll-off containers (lined and covered, if necessary) for off-site disposal, or on 20-millimeter plastic sheeting for temporary stockpiling. Waste characterization samples may be collected to facilitate off-site transport and disposal of IDW at an appropriate permitted disposal facility or on-Base land farm. Management of IDW is further described in **Section 3.10**.

Open trenches will be lined with plastic sheeting to prevent contact between rainwater and contaminated soil. When necessary, soil berms or other appropriate methods may be used to control storm water. Rainwater may be pumped out of open trenches to the ground surface or to the storm water drainage system. Groundwater encountered in an excavation will be pumped from the excavation and contained as IDW for treatment/disposal prior to backfilling.

3.6 Confirmation Soil Sampling

Following discussion with NMED, confirmation soil samples will be analyzed for TPH-GRO, -DRO, and -ORO using Modified USEPA Method 8015. TAL metals, SVOCs, and VOCs will also be analyzed. The QAPP (**Appendix A**) indicates the sampling and analytical method requirements for confirmation soil samples.

Pursuant to the Holloman AFB RCRA Permit, soil analytical results will be compared with the corresponding NMED residential SSLs (NMED 2012b), or USEPA RSLs (USEPA 2013) if no SSL has been designated. Excavation activities and subsequent sampling and analysis will continue until confirmation sampling and analysis indicate that COC concentrations do not exceed the applicable cleanup levels.

If a confirmation soil sample result exceeds the applicable screening levels, then an additional amount of excavation wall or floor material will be excavated, and one additional confirmation soil sample (wall or floor) will be collected. This process will continue until the confirmation soil samples indicate concentrations are below applicable cleanup levels.

All samples will be collected and delivered to the laboratory under chain-of-custody protocol with request for expedited turn-around time (TAT) for analytical results. These samples will be collected, handled, and analyzed according to the QAPP and SOPs (**Appendices A and C**).

Quality Assurance (QA)/Quality Control (QC) samples will be collected for the appropriate COCs so that sample results can be properly validated and eventually used as confirmation samples. The QA/QC samples will be collected at the following frequencies, per matrix, as detailed in the QAPP (**Appendix A**):

- Field Duplicates: one for every 20 field samples;

- Matrix Spike, Matrix Spike Duplicate pairs: one for every 20 field samples; and
- Rinsate (Equipment) Blanks: one for every 20 field samples collected with non-disposable/non-dedicated equipment.

3.7 Subsurface Injection

Due to the relatively small size of the individual sites, the generally straightforward nature of hydrocarbon remediation, and the established effectiveness of bioremediation for petroleum hydrocarbons, selected bioremediation augmentation substrates will be injected into the subsurface at sites where COC concentrations in the vadose zone or groundwater exceed the applicable screening levels following any remedial excavation. The injection locations will be spaced at appropriate horizontal and vertical intervals, and are anticipated to be set on approximate 10- to 20-ft centers, with injection depths ranging from approximately 5 to 20 ft bgs, with specific injection details to be determined in the field.

The optimum method to deliver bioremediation augmentation substrates into the subsurface is to inject the material through direct push rods using hydraulic mixing and pumping equipment. This approach increases the spreading and mixing of substrates into the aquifer. Upon completion of injection, each direct-push hole will be properly sealed to the surface.

The quantity of substrate dosing required at each site will be based on the results of exploratory soil and groundwater sample analysis, and consultation with the selected substrate manufacturer, among other pertinent factors.

Bioremediation augmentation substrates under consideration for these IM (i.e., BOS 200® and ORC Advanced®) are non-toxic and proven remediation technologies that have been used successfully by both URS and the USAF at multiple sites.

3.8 Monitoring Well Installation and Development

3.8.1 Monitoring Well Installation

Additional monitoring wells may be installed in the vicinity of each of the former UST locations to determine the impact to groundwater. As discussed in Section 1.0, most sites already have multiple monitoring wells in place. Additional monitoring wells will be installed as necessary to fulfill the objectives of the IM. At least three properly constructed monitoring wells will be utilized at each site to perform compliance monitoring.

Well-drilling activities will be performed by an individual with a current and valid well driller license issued by the State of New Mexico. Monitoring wells will be installed using the hollow-stem auger (HSA) drilling technique in accordance with NMED Ground Water Quality Bureau Monitoring Well Construction and Abandonment Guidelines (NMED 2011b). The boreholes will be advanced into the water table using HSAs such that the borehole diameter will be at least 4 inches larger than the outside diameter of the well casing to allow for proper placement of the filter pack and sealant. Care will be taken so that the completed monitoring wells are sufficiently straight and plumb to allow passage of measuring and sampling devices.

During drilling, a URS Geologist will document the following information for each boring:

- Boring or well identification (this identification will be unique, and ensure it has not been used previously at the Base);
- Purpose of the boring (e.g., soil sampling, monitoring well);
- Location in relation to an easily identifiable landmark;
- Names of drilling subcontractor and logger;
- Start and finish dates and times;
- Drilling method;
- Diameters of surface casing, casing type, and methods of installation;
- Depth at which saturated conditions were first encountered;
- Lithologic descriptions and depths of lithologic boundaries;
- Sampling-interval depths; and
- Other pertinent field observations.

Field forms including soil boring logs for documentation of field activities are provided in **Appendix C**. Well installation equipment will be decontaminated according to the specifications of the Decontamination SOP (**Appendix C**).

Approximately two to three soil samples will be collected from split-spoons during the advancement of each well boring at the 0 to 2 ft interval and the interval with the highest PID field screen result, or the interval immediately above groundwater if no elevated PID readings are observed. Soil samples collected from the well borings will be analyzed for the same parameters as the exploratory soil samples described in **Section 3.4**; however, well boring soil samples will be treated as confirmatory/compliance samples, and will be subject to the protocols established in the QAPP and SOPs (**Appendices A and C**).

Well borings will be advanced approximately 8 ft into the water table and completed such that the well screen intersects the water table. The wells will be constructed of 2-inch diameter Schedule 40 polyvinyl chloride (PVC) riser and screen. The screened section of the wells will consist of 10 ft of 0.010-inch slotted screen (or other field determined slot size). A silica sand filter pack will be placed around the screen to approximately 2 ft above the top of the screen. A 2-ft thick bentonite seal will be placed above the filter pack. The remaining annular space will be grouted with neat cement.

For wells that will be finished aboveground ("stick-up"), the casing will extend from the top of the screen to approximately 2 to 3 ft above ground surface. The top of the casing will be fitted with a removable cap, and the exposed casing will be protected by a locking steel protective casing. The protective casing will be large enough in diameter to allow easy access for removal of the cap. A concrete pad (2-ft minimum radius, 4-inch minimum thickness) will be installed around the protective casing and wellhead. The concrete and surrounding soil will be sloped to direct rainfall and runoff away from the wellhead. Protective steel posts (bollards) will be installed around the wells, where needed, to protect the wellhead from damage by vehicles or equipment.

Monitoring wells that are completed as "flush-mounted" will be constructed with water-tight well vaults that are rated to withstand traffic loads and fitted with locking, expandable well plugs. Concrete pads (2-ft minimum radius, 4-inch minimum thickness) will be poured around the well vaults. Vault covers will be secured with bolts. Additionally, the vault cover will indicate that the wellhead of a monitoring well is contained within the vault. The concrete and surrounding soil must be sloped to direct rainfall and runoff away from the well vault.

To document specific details of the monitoring well installations, the URS Geologist will prepare drilling logs and as-built well construction diagrams in the field as the activity is taking place. Specific procedures and example forms for installing monitoring wells are provided in SOPs (**Appendix C**). The monitoring wells will be constructed in accordance with NMED guidance (NMED 2011b).

3.8.2 Monitoring Well Development

The newly installed monitoring wells will be developed to create an effective filter pack around the well screen, remove fine particles from the formation near the borehole, and assist in restoring the natural water quality of the aquifer in the vicinity of the well. All newly installed monitoring wells will be developed no sooner than 48 hours after installation to allow for grout curing.

Monitoring wells will be developed using surge blocks, bailers, or pumps to achieve effective well development.

During well development, documentation of the activity will take place in accordance with SOPs (**Appendix C**) and will include recording of water level and depth-to-bottom measurements, water quality parameters, discharge water color, water volume, and time period.

Well development will continue until the following criteria are met:

- Water that has been removed from the well is visually clear, and the turbidity measures less than or equal to 10 nephelometric turbidity units (NTUs); and
- The pH, temperature, and specific conductance parameters have stabilized (less than 10 percent variation for three successive readings).

In the event that fine-grained deposits are present in the subsurface, it may be difficult to achieve a turbidity of 10 NTUs during well development. This is primarily a concern when a well has been screened in a formation that contains a high level of fine material (silt and clay). Silt and clay can occasionally travel through filter packs on properly constructed wells, resulting in turbid water. While selection of proper filter pack and screen materials minimizes turbidity, fine-grained particles may still flow through. Proper well construction and development procedures will be followed to reduce measured turbidity in monitoring wells. If turbidity remains greater than 10 NTUs after 4 hours of continuous well development, well development will cease. If the well is pumped dry, it will be allowed to recharge and be re-pumped as much as practical within the 4-hour time limit.

3.9 Confirmation Groundwater Monitoring

Following remedial actions taken at the individual sites, confirmation groundwater samples will be collected based on recommendations in the IM Report. It is estimated that quarterly sampling for a period of 1 year will be required.

Following discussion with NMED, confirmation groundwater samples will be analyzed for TPH-GRO, -DRO, and -ORO using Modified USEPA Method 8015. TAL metals, SVOCs, and VOCs will also be analyzed. The QAPP (**Appendix A**) indicates the sampling and analytical method requirements for confirmation soil samples.

Groundwater samples will be collected from site monitoring wells in accordance with the procedures provided in QAPP and SOPs (**Appendices A and C**). If groundwater at the site exceeds NMED water quality standards, the TDS levels from nearby monitoring wells will be used to develop a TDS survey to determine if the present-day groundwater in the immediate vicinity of the site is above the NMED 10,000-mg/L TDS potable water threshold. The Groundwater Bureau does not regulate groundwater that has a TDS over this threshold, and analytical results may then be compared to USEPA MCLs to determine if contaminant concentrations exceed regulatory thresholds. It may also be necessary to assess potential risks associated with vapor intrusion and/or ecological receptors.

Groundwater sampling will occur no sooner than 2 days following monitoring well development at any monitoring well. Groundwater monitoring wells will be purged and samples will be collected using low-flow sampling techniques in accordance with the QAPP and SOPs (**Appendices A and C**). Field parameters (e.g., temperature, conductivity, pH, and turbidity) will be measured during well purging. Groundwater samples will be collected when the field parameters stabilize with minor fluctuation between consecutive readings. Groundwater samples collected from monitoring wells will be analyzed for the same parameters as the exploratory groundwater samples described in **Section 3.4**; however, monitoring well boring groundwater samples will be treated as confirmatory/compliance samples, and will be subject to the protocols established in the QAPP and SOPs (**Appendices A and C**). Groundwater samples for metals analysis will be field filtered prior to submittal to the analytical laboratory.

3.10 Waste Management

Waste management options in order of preference are reuse, recycling, treatment, and disposal. Waste may be classified as non-investigative waste or investigative waste:

- Non-investigative waste, such as trash and office garbage, will be collected on an as-needed basis to maintain the site in a clean and orderly manner. This waste will be accumulated in plastic garbage bags and transported to a designated sanitary landfill or collection bin.
- IDW generated during these IM will be segregated into the following categories:
    - Suspected contaminated soil
    - Concrete or asphalt rubble
    - Decontamination, well development, seepage water in excavations, and purge water

- Personnel protective equipment (PPE), sampling debris, and plastic sheeting

The IDW will be properly containerized and temporarily stored at a location specified by Holloman AFB prior to disposal. Depending on the COCs, fencing or other special marking may be required. Acceptable waste containers include sealed, DOT-approved, steel 55-gallon drums; small dumping bins with lids; or roll-off boxes with liners and covers. The containers will be transported in such a manner as to prevent spillage or particulate loss to the atmosphere. When required, sampling of drums or roll-off boxes will be done in accordance with SOPs (**Appendix C**).

The IDW will be segregated at the site according to the specified categories. Each waste container will be properly labeled with site identification, matrix, date of generation, and other pertinent information for handling.

3.11 Site Restoration

Following delineation and remedial action activities at the former UST sites, site conditions will be restored to similar states as initial conditions. Direct-push boreholes will be filled with appropriate materials, and the surfaces will be finished to match the surrounding area (e.g., soil, asphalt cold patch, concrete, etc.). Excavations will be backfilled with clean fill and compacted with a vibratory compactor, backhoe, or other appropriate methods. The area will be graded to maintain positive drainage to conform to site conditions. The ground covering will then be restored to surrounding site conditions or other covering as directed by Holloman AFB.

3.12 Surveying

Surveying of the locations (northing, easting, and elevation coordinates) of excavations, confirmation soil sampling locations, new and existing monitoring well locations, and other pertinent site features will be conducted by a State of New Mexico-licensed surveyor. Elevation data for monitoring wells will include the top of the PVC riser and ground surface elevation at the well locations. Surveying data will be provided in a spreadsheet format for import into the geographic information system (GIS), and the data will also be incorporated into the report figures.

Horizontal coordinates will be referenced to the New Mexico Central State Plane Coordinate System, and surveyed to an accuracy of ±1.0 ft. Vertical elevations will be referenced to North American Datum 1983 coordinate system to an accuracy of ±0.01 ft.

Geospatial information will also be submitted as a separate deliverable to the USAF. All applicable federal, U.S. Department of Defense, and USAF geospatial data standards will be followed. Spatial data will be compliant with the Spatial Data Standards for Facilities, Infrastructure, and Environment v2.6.

Each geospatial data set will be accompanied by metadata that conforms to the Spatial Data Facilities, Infrastructure, and Environment standards. The horizontal accuracy of any geospatial data created will be tested and reported in accordance with the National Standard for Spatial Data Accuracy, and the results will be recorded in the metadata.

3.13 Reporting

The details of reporting related to this IM Work Plan are discussed in **Section 4.0** (Interim Measures Report).

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4.0 INTERIM MEASURES REPORT

Documentation of the project will be maintained, including field notes/forms, photographs, analytical, and survey data. An IM Report detailing the delineation and remedial action activities will be prepared and submitted to NMED for review. The IM Report will include the following elements:

- A description of IM implemented, including:
  - Purpose of the IM;
  - A summary of the delineation and remedial action activities conducted at each site as part of the overall IM;
  - Descriptions of field operations, including quantity of soil removed, quantity of soil backfilled, number of soil borings or monitoring wells installed, quantities of materials injected into the subsurface, and quantity of wastes generated;
  - Documentation of disposal volumes, manifests, and bills of lading;
  - Maps with surveyed excavation footprints and locations of surveyed confirmation samples, including monitoring wells; and
  - Photographs showing site conditions and/or typical operations.
- Summaries of results, including:
  - A discussion of the chemical sampling efforts, including the results of all delineation sampling, and associated maps and tables; and
  - Explanation of data validation efforts.
- Summaries of problems encountered, including:
  - Explanation and description of any modifications to the IM Work Plan, and why the modification was necessary.
- Summaries of accomplishments and/or effectiveness of IMs, including:
  - A discussion of the confirmation/compliance sample analytical results; and
  - Recommendations, as appropriate, for disposition of the site(s) under the Holloman AFB RCRA Part B Permit.
- Copies of relevant laboratory/monitoring data, etc., including:
  - Pertinent field data, sampling sheets, and laboratory results in appendices.

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5.0 PROJECT SCHEDULE

A preliminary project schedule for the overall anticipated sequence of IM activities is presented in **Figure 5-1**. The schedule is dependent on many independent factors including, but not limited to, USAF and NMED review and comment, subcontractor availability, weather, and site conditions.

USAF and NMED will be notified 30 days prior to the start of IM field activities. Additionally, during IM implementation, brief daily status reports may be submitted to Environmental representatives at Holloman AFB by electronic mail. These reports will summarize the previous day's activities, the planned activities for the following day, and other pertinent information.

As a general rule, IM will proceed quickly from site delineation to remediation within the same mobilization, if feasible. The IM implementation schedule will allow for evaluation of screening-level data collected during delineation to formulate a more detailed remedial approach specific to each site. Following implementation of the site-specific IM remedy, compliance and confirmation sample collection will begin. Post-remedy groundwater sample collection (e.g., monthly or quarterly) may be conducted to monitor IM effectiveness at the individual sites and augment the implemented remedial actions with additional remediation if deemed necessary to achieve the IM objectives.

Upon successful completion of the IM, the IM Report will be submitted for review and approval of CAC without controls status.

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6.0 REFERENCES

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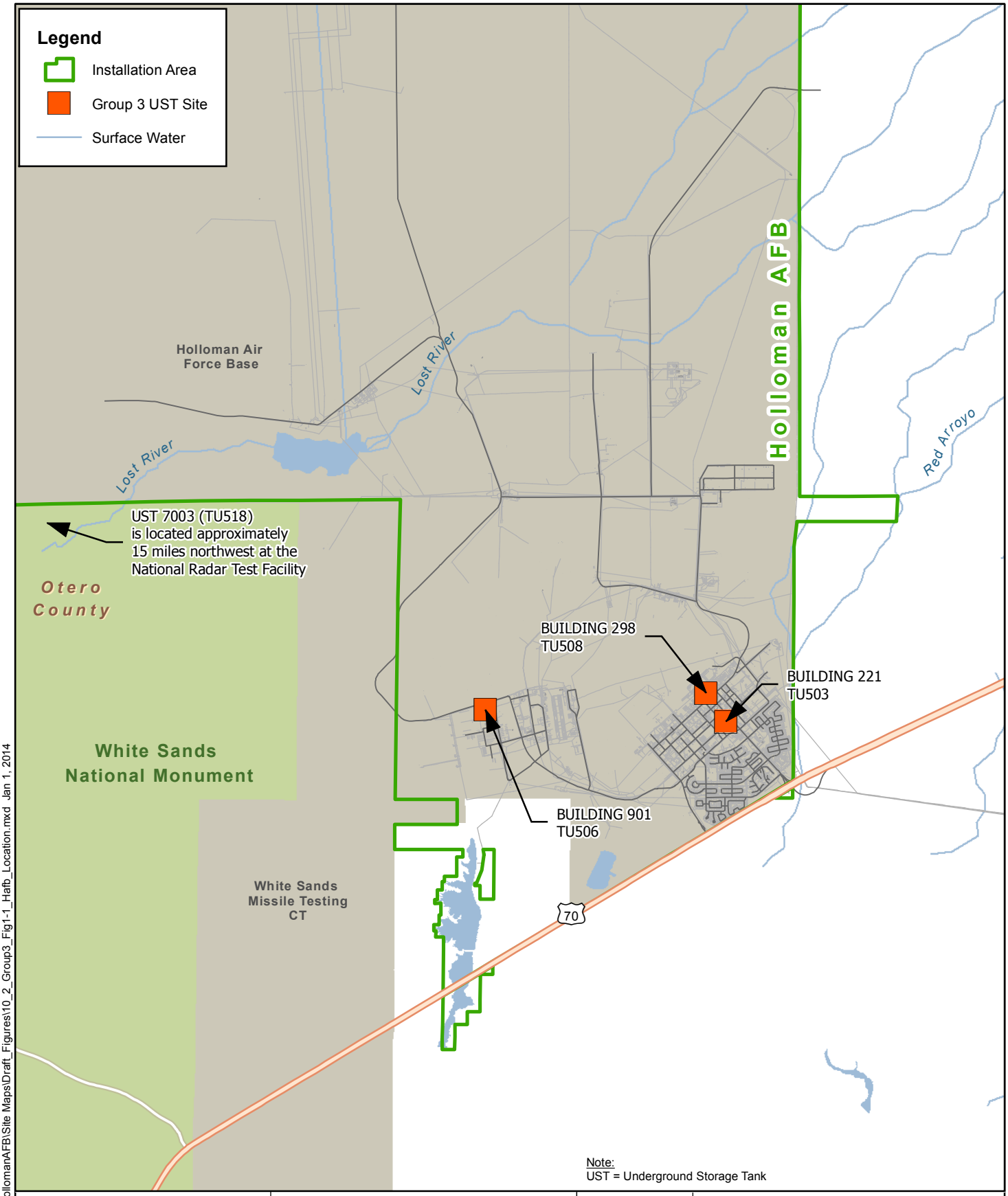

Note:
UST = Underground Storage Tank

N
W E
S

0 3,500 7,000 10,500
Scale in Feet
1 inch = 7,000 feet

URS

Coordinate System:
NAD 1983 State Plane, New Mexico Central Zone, Feet

Designed	JDM
Drawn	LED
Checked	DAE
Peer Review	DAE
Project Manager	BGP
Project Number	23446543

Figure 1-1

Location Map

Holloman Air Force Base
USAF

Jan 9, 2014

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Legend

- Existing Structure
- Road Centerline
- Concrete
- Excavation
- Trench
- Storm Sewer Line
- Wastewater Line
- Water Line
- Electrical Cable Line
- Natural Gas Line
- Fuel Line

Coordinate System:
NAD 1983 State Plane, New Mexico
Central Zone, Feet

N W E S

0 20 40 80
Scale in Feet
1 inch = 40 feet

URS

Designed	JDM
Drawn	LED
Checked	DAE
Peer Review	DAE
Project Manager	BGP
Project Number	23446543

Figure 2-1
Building 221
TU503
Site Map

Holloman Air Force Base

USAF

Jan 9, 2014

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Legend

- Existing Structure
- Storm Sewer Line
- Wastewater Line
- Water Line
- Electrical Cable Line
- Natural Gas Line

Coordinate System:
NAD 1983 State Plane, New Mexico
Central Zone, Feet

N
W E
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0 20 40 80
Scale in Feet
1 inch = 40 feet

URS

Designed	JDM
Drawn	LED
Checked	DAE
Peer Review	DAE
Project Manager	BGP
Project Number	23446543

Figure 2-2
Building 901
TU506
Site Map

Holloman Air Force Base
USAF

Jan 9, 2014

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Legend

- Existing Structure
- Road Centerline
- Storm Sewer Line
- Wastewater Line
- Water Line
- Electrical Cable Line
- Natural Gas Line

Coordinate System:
NAD 1983 State Plane, New Mexico
Central Zone, Feet

N W E S

0 20 40 80
Scale in Feet
1 inch = 40 feet

URS

Designed	JDM
Drawn	LED
Checked	DAE
Peer Review	DAE
Project Manager	BGP
Project Number	23446543

Figure 2-3
Building 298
TU508
Site Map

Holloman Air Force Base
USAF

Jan 9, 2014

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Legend

- Building
- Road Centerline
- Excavation
- Tank Pit
- Trench

Note:
Excavation, trench, and tank pit locations are approximate.

Coordinate System:
NAD 1983 State Plane, New Mexico
Central Zone, Feet

N W E S

0 20 40 80
Scale in Feet
1 inch = 40 feet

URS

Designed	JDM
Drawn	LED
Checked	DAE
Peer Review	DAE
Project Manager	BGP
Project Number	23446543

Figure 2-4
UST 7003
TU518
Site Map

Holloman Air Force Base
USAF

Jan 9, 2014

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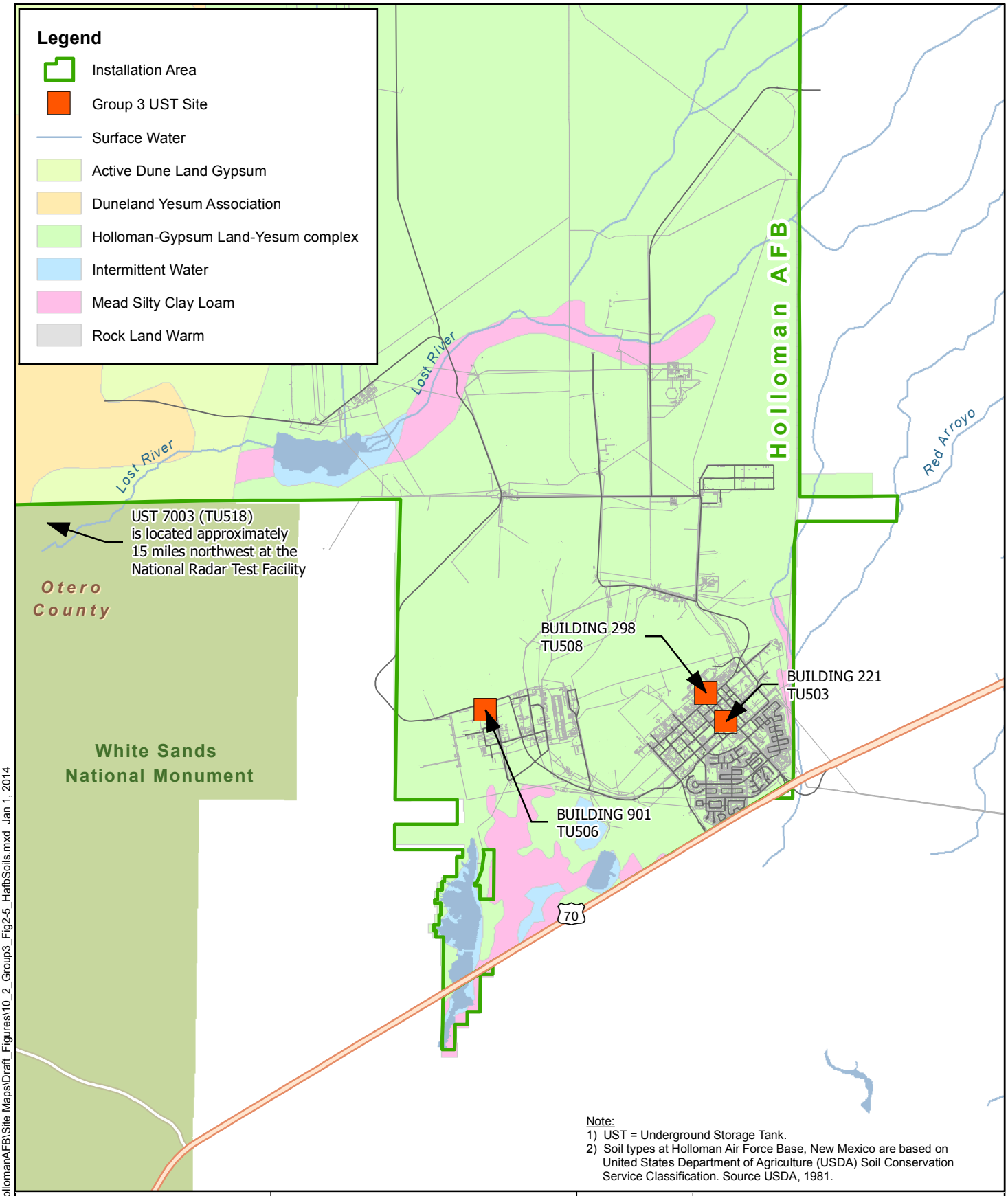

Note:
1) UST = Underground Storage Tank.
2) Soil types at Holloman Air Force Base, New Mexico are based on United States Department of Agriculture (USDA) Soil Conservation Service Classification. Source USDA, 1981.

N
W E
S

0 3,500 7,000 10,500
Scale in Feet
1 inch = 7,000 feet

URS

Coordinate System:
NAD 1983 State Plane, New Mexico Central Zone, Feet

Designed	JDM
Drawn	LED
Checked	DAE
Peer Review	DAE
Project Manager	BGP
Project Number	23446543

Figure 2-5

Regional Soils

Holloman Air Force Base
USAF

Jan 9, 2014

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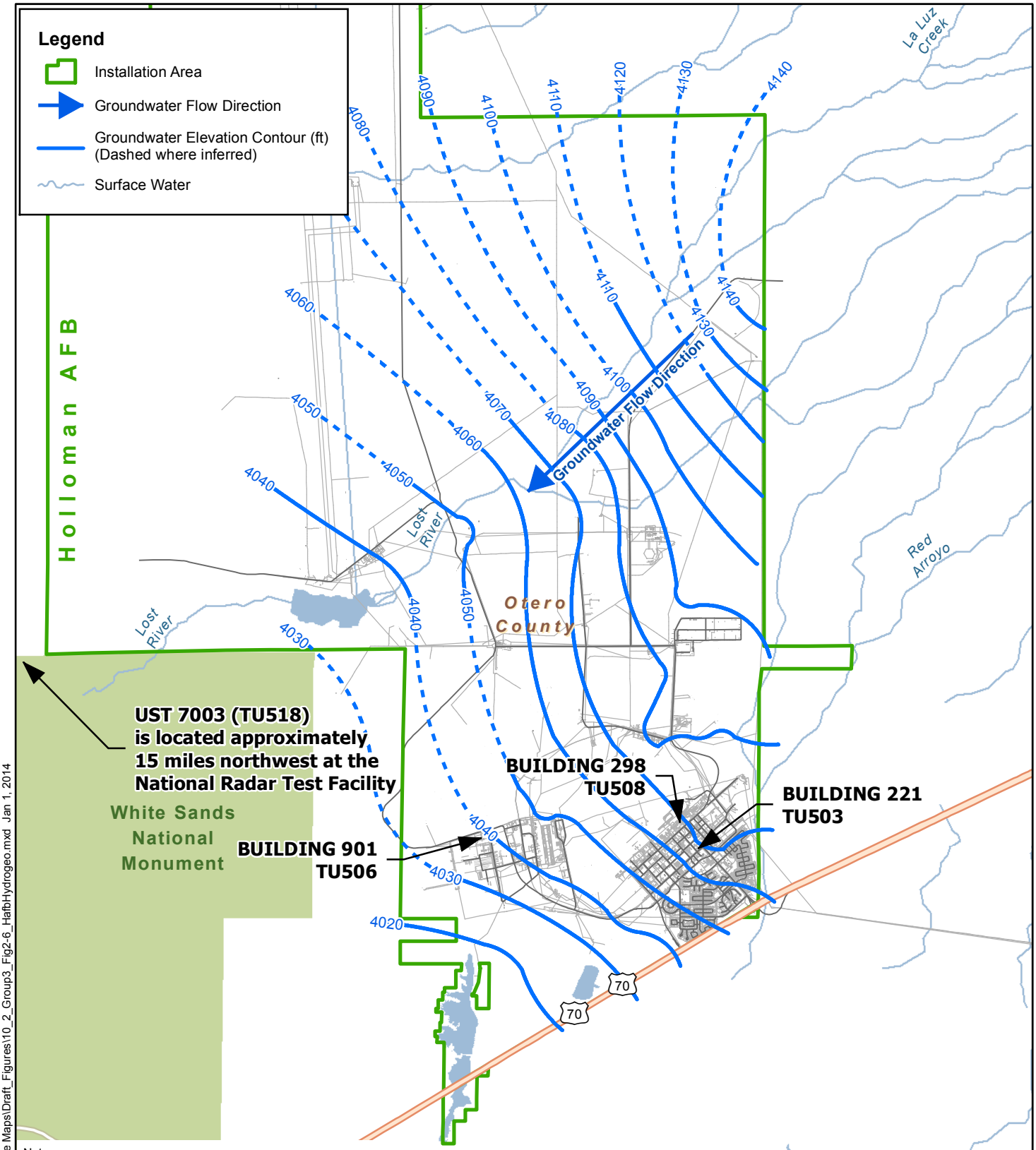

Note:
1) Groundwater contour map showing groundwater elevation contours across Holloman Air Force Base, New Mexico, are based on 2002 measurements taken from the shallow aquifer.
2) Source: Holloman AFB GIS, 2002 LTM.

N
W E
S

0 4,000 8,000 12,000
Scale in Feet
1 inch = 8,000 feet

URS

Coordinate System:
NAD 1983 State Plane, New Mexico Central Zone, Feet

Designed	JDM
Drawn	LED
Checked	DAE
Peer Review	DAE
Project Manager	BGP
Project Number	23446543

Figure 2-6

Regional Hydrogeology

Holloman Air Force Base
USAF

Mar 11, 2014

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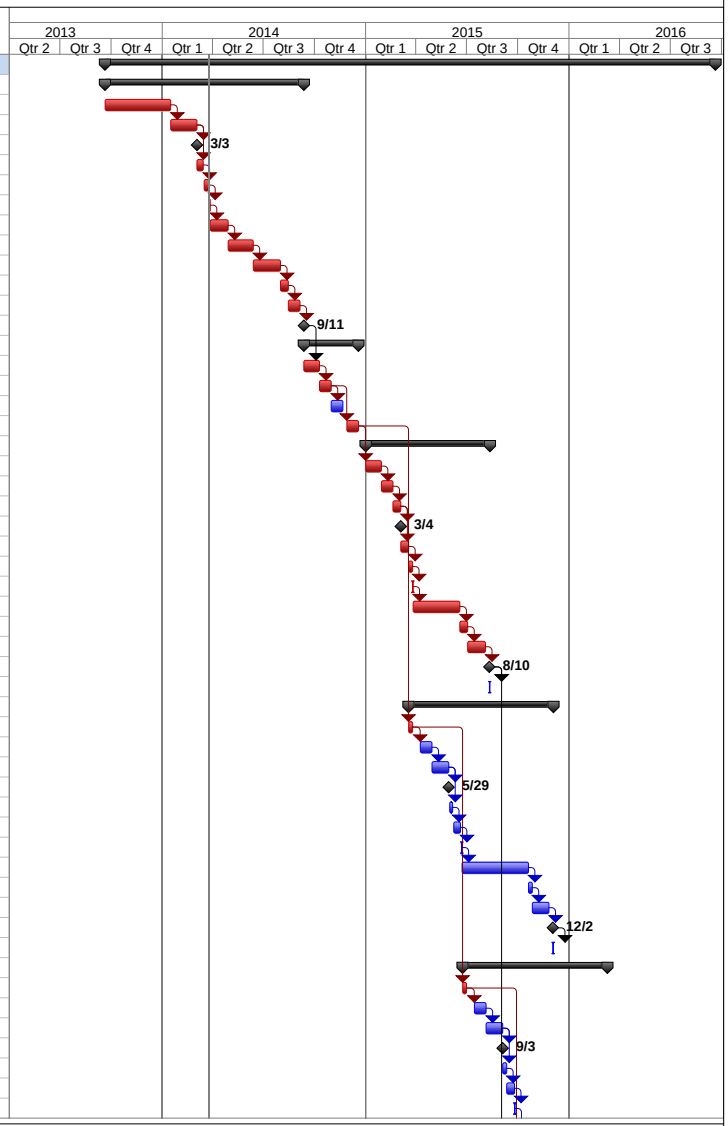
FA8903-12-R-0050

Proposed Schedule for Interim Measures - Group 3 UST Sites
New Mexico-Arizona Group
Holloman AFB, New Mexico
Performance Based Remediation

URS

ID	Name	Duration	Start	Finish	Predecessors
1	**TU503, TU506, TU508 and TU518**	**782 days**	**Fri 9/20/13**	**Mon 9/19/16**	
2	**IM Work Plan**	**255 days**	**Fri 9/20/13**	**Thu 9/11/14**	
3	Prepare & Submit Draft IM Work Plan to AF	84 days	Fri 9/20/13	Wed 1/15/14	
4	Air Force Review of Draft / Provide Comments	33 days	Thu 1/16/14	Mon 3/3/14	3
5	AF Approval of Draft IM Work Plan Milestone	0 days	Mon 3/3/14	Mon 3/3/14	4
6	Respond to Comments (AF) / Prepare & Submit Draft Final to AF	9 days	Tue 3/4/14	Fri 3/14/14	4
7	AF Review & Approval of Draft Final IM Work Plan	6 days	Mon 3/17/14	Mon 3/24/14	6
8	Submit Draft Final IM Work Plan for Regulator Review	3 days	Tue 3/25/14	Thu 3/27/14	7
9	NMED Request Fee	22 days	Fri 3/28/14	Mon 4/28/14	8
10	AF Pay NMED Fee	33 days	Tue 4/29/14	Thu 6/12/14	9
11	Regulator Review of Draft Final / Provide Comments	35 days	Fri 6/13/14	Thu 7/31/14	10
12	Respond to Comments (Regulator) / Prepare & Submit Final	10 days	Fri 8/1/14	Thu 8/14/14	11
13	AF and Regulator Review of Final IM Work Plan	15 days	Fri 8/15/14	Thu 9/4/14	12
14	AF and Regulator Approval of Final IM Work Plan Milestone	0 days	Thu 9/11/14	Thu 9/11/14	13FS+5 days
15	**IM Field Work**	**70 days**	**Fri 9/12/14**	**Thu 12/18/14**	
16	Dig Permits & Utility Clearance	20 days	Fri 9/12/14	Thu 10/9/14	14
17	Supplemental Characterization Field Work	15 days	Fri 10/10/14	Thu 10/30/14	16
18	Excavation, Confirmatory Sampling, and Site Restoration	15 days	Fri 10/31/14	Thu 11/20/14	17
19	Groundwater Remediation (injection)	15 days	Fri 11/28/14	Thu 12/18/14	17FS+20 days
20	**IM Report**	**159 days**	**Thu 1/1/15**	**Tue 8/11/15**	
21	Prepare & Submit Draft IM Report	20 days	Thu 1/1/15	Wed 1/28/15	19
22	Air Force Review of Draft / Provide Comments	15 days	Thu 1/29/15	Wed 2/18/15	21
23	Respond to Comments	10 days	Thu 2/19/15	Wed 3/4/15	22
24	Air Force Approval of Draft IM Report Milestone	0 days	Wed 3/4/15	Wed 3/4/15	23
25	Prepare & Submit Draft Final to AF	10 days	Thu 3/5/15	Wed 3/18/15	23
26	AF Review & Approval of Draft Final / Revise as needed	5 days	Thu 3/19/15	Wed 3/25/15	25
27	Submit Draft Final IM Report for Regulatory Review	1 day	Thu 3/26/15	Thu 3/26/15	26
28	Regulator Review of Draft Final / Provide Comments	60 days	Fri 3/27/15	Thu 6/18/15	27
29	Respond to Regulator Comments on Draft Final and Prepare Final	10 days	Fri 6/19/15	Thu 7/2/15	28
30	AF and Regulator Review of Final / Revise as needed	22 days	Fri 7/3/15	Mon 8/3/15	29
31	Regulatory and AF Approval of Final IM Report Milestone	0 days	Mon 8/10/15	Mon 8/10/15	30FS+5 days
32	ERPIMS Submission	1 day	Tue 8/11/15	Tue 8/11/15	31
33	**1Q Groundwater Monitoring Report**	**186 days**	**Thu 3/19/15**	**Thu 12/3/15**	
34	Groundwater Monitoring Field Work	5 days	Thu 3/19/15	Wed 3/25/15	19FS+90 edays
35	Prepare & Submit Draft to AF 1Q 2015 Groundwater Monitoring Report	15 days	Thu 4/9/15	Wed 4/29/15	34FS+10 days
36	Air Force Review of Draft / Provide Comments	22 days	Thu 4/30/15	Fri 5/29/15	35
37	AF Approval of Draft 1Q 2015 Groundwater Monitoring Report Milestone	0 days	Fri 5/29/15	Fri 5/29/15	36
38	Respond to Comments (AF) / Prepare & Submit Draft Final to AF	5 days	Mon 6/1/15	Fri 6/5/15	36
39	AF Review & Approval of Draft Final 1Q 2015 Groundwater Monitoring Report	10 days	Mon 6/8/15	Fri 6/19/15	38
40	Submit Draft Final for Regulator Review	1 day	Mon 6/22/15	Mon 6/22/15	39
41	Regulator Review of Draft Final / Provide Comments	85 days	Tue 6/23/15	Mon 10/19/15	40
42	Respond to Comments (Regulator) / Prepare & Submit Final	5 days	Tue 10/20/15	Mon 10/26/15	41
43	AF and Regulator Review of Final 1Q 2015 Groundwater Monitoring Report	22 days	Tue 10/27/15	Wed 11/25/15	42
44	AF and Regulator Approval of Final 1Q 2015 Groundwater Monitoring Report Milestone	0 days	Wed 12/2/15	Wed 12/2/15	43FS+5 days
45	ERPIMS Submission	1 day	Thu 12/3/15	Thu 12/3/15	44
46	**2Q Groundwater Monitoring Report**	**186 days**	**Wed 6/24/15**	**Wed 3/9/16**	
47	Groundwater Monitoring Field Work	5 days	Wed 6/24/15	Tue 6/30/15	34FS+90 edays
48	Prepare & Submit Draft to AF 2Q 2015 Groundwater Monitoring Report	15 days	Wed 7/15/15	Tue 8/4/15	47FS+10 days
49	Air Force Review of Draft / Provide Comments	22 days	Wed 8/5/15	Thu 9/3/15	48
50	AF Approval of Draft 2Q 2015 Groundwater Monitoring Report Milestone	0 days	Thu 9/3/15	Thu 9/3/15	49
51	Respond to Comments (AF) / Prepare & Submit Draft Final to AF	5 days	Fri 9/4/15	Thu 9/10/15	49
52	AF Review & Approval of Draft Final 2Q 2015 Groundwater Monitoring Report	10 days	Fri 9/11/15	Thu 9/24/15	51
53	Submit Draft Final for Regulator Review	1 day	Fri 9/25/15	Fri 9/25/15	52



Project: Group 3 UST Sites IM
Date: Wed 3/26/14
File: Figure 5-1 Preliminary Project Sc

Task		Project Summary		Inactive Milestone		Manual Summary Rollup		Critical	
Split		External Tasks		Inactive Summary		Manual Summary		Critical Split	
Milestone		External Milestone		Manual Task		Start-only		Progress	
Summary		Inactive Task		Duration-only		Finish-only		Deadline	

March 26, 2014

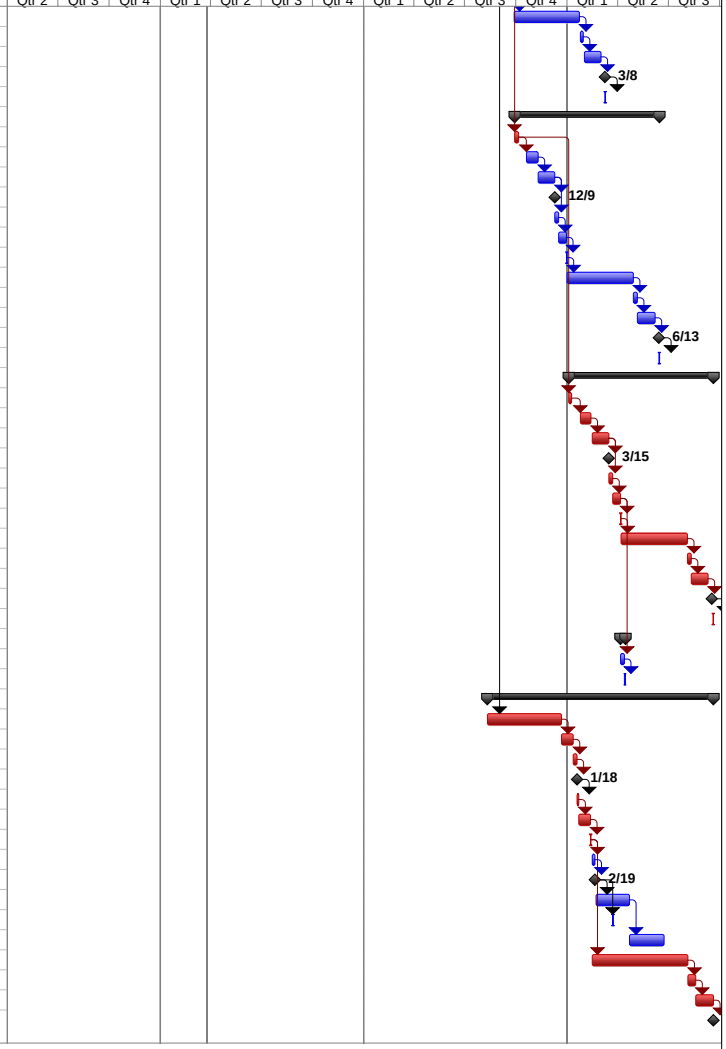
Figure 5-1. Preliminary Project Schedule

FA8903-12-R-0050

Proposed Schedule for Interim Measures - Group 3 UST Sites
New Mexico-Arizona Group
Holloman AFB, New Mexico
Performance Based Remediation

URS

ID	Name	Duration	Start	Finish	Predecessors
54	Regulator Review of Draft Final / Provide Comments	85 days	Mon 9/28/15	Fri 1/22/16	53
55	Respond to Comments (Regulator) / Prepare & Submit Final	5 days	Mon 1/25/16	Fri 1/29/16	54
56	AF and Regulator Review of Final 2Q 2015 Groundwater Monitoring Report	22 days	Mon 2/1/16	Tue 3/1/16	55
57	AF and Regulator Approval of Final 2Q 2015 Groundwater Monitoring Report Milestone	0 days	Tue 3/8/16	Tue 3/8/16	56FS+5 days
58	ERPIMS Submission	1 day	Wed 3/9/16	Wed 3/9/16	57
59	**3Q Groundwater Monitoring Report**	**186 days**	**Tue 9/29/15**	**Tue 6/14/16**	
60	Groundwater Monitoring Field Work	5 days	Tue 9/29/15	Mon 10/5/15	47FS+90 edays
61	Prepare & Submit Draft to AF 3Q 2015 Groundwater Monitoring Report	15 days	Tue 10/20/15	Mon 11/9/15	60FS+10 days
62	Air Force Review of Draft / Provide Comments	22 days	Tue 11/10/15	Wed 12/9/15	61
63	AF Approval of Draft 3Q 2015 Groundwater Monitoring Report Milestone	0 days	Wed 12/9/15	Wed 12/9/15	62
64	Respond to Comments (AF) / Prepare & Submit Draft Final to AF	5 days	Thu 12/10/15	Wed 12/16/15	62
65	AF Review & Approval of Draft Final 3Q 2015 Groundwater Monitoring Report	10 days	Thu 12/17/15	Wed 12/30/15	64
66	Submit Draft Final for Regulator Review	1 day	Thu 12/31/15	Thu 12/31/15	65
67	Regulator Review of Draft Final / Provide Comments	85 days	Fri 1/1/16	Thu 4/28/16	66
68	Respond to Comments (Regulator) / Prepare & Submit Final	5 days	Fri 4/29/16	Thu 5/5/16	67
69	AF and Regulator Review of Final 3Q 2015 Groundwater Monitoring Report	22 days	Fri 5/6/16	Mon 6/6/16	68
70	AF and Regulator Approval of Final 3Q 2015 Groundwater Monitoring Report Milestone	0 days	Mon 6/13/16	Mon 6/13/16	69FS+5 days
71	ERPIMS Submission	1 day	Tue 6/14/16	Tue 6/14/16	70
72	**4Q Groundwater Monitoring Report**	**186 days**	**Mon 1/4/16**	**Mon 9/19/16**	
73	Groundwater Monitoring Field Work	5 days	Mon 1/4/16	Fri 1/8/16	60FS+90 edays
74	Prepare & Submit Draft to AF 4Q 2015 Groundwater Monitoring Report	15 days	Mon 1/25/16	Fri 2/12/16	73FS+10 days
75	Air Force Review of Draft / Provide Comments	22 days	Mon 2/15/16	Tue 3/15/16	74
76	AF Approval of Draft 4Q 2015 Groundwater Monitoring Report Milestone	0 days	Tue 3/15/16	Tue 3/15/16	75
77	Respond to Comments (AF) / Prepare & Submit Draft Final to AF	5 days	Wed 3/16/16	Tue 3/22/16	75
78	AF Review & Approval of Draft Final 4Q 2015 Groundwater Monitoring Report	10 days	Wed 3/23/16	Tue 4/5/16	77
79	Submit Draft Final for Regulator Review	1 day	Wed 4/6/16	Wed 4/6/16	78
80	Regulator Review of Draft Final / Provide Comments	85 days	Thu 4/7/16	Wed 8/3/16	79
81	Respond to Comments (Regulator) / Prepare & Submit Final	5 days	Thu 8/4/16	Wed 8/10/16	80
82	AF and Regulator Review of Final 4Q 2015 Groundwater Monitoring Report	22 days	Thu 8/11/16	Fri 9/9/16	81
83	AF and Regulator Approval of Final 4Q 2015 Groundwater Monitoring Report Milestone	0 days	Fri 9/16/16	Fri 9/16/16	82FS+5 days
84	ERPIMS Submission	1 day	Mon 9/19/16	Mon 9/19/16	83
85	**Well Abandonment Field Work**	**7 days**	**Wed 4/6/16**	**Thu 4/14/16**	
86	Dig Permits & Utility Clearance (if applicable)	5 days	Wed 4/6/16	Tue 4/12/16	78
87	Well Abandonment	2 days	Wed 4/13/16	Thu 4/14/16	86
88	**Corrective Action Complete (CAC) Proposal**	**290 days**	**Tue 8/11/15**	**Mon 9/19/16**	
89	Prepare and Submit Draft CAC Proposal	95 days	Tue 8/11/15	Mon 12/21/15	31
90	Air Force Review of Draft/Provide Comments	15 days	Tue 12/22/15	Mon 1/11/16	89
91	Respond to Comments	5 days	Tue 1/12/16	Mon 1/18/16	90
92	Air Force Approval Draft CAC Proposal	0 days	Mon 1/18/16	Mon 1/18/16	91
93	Prepare and Submit Draft Final CAC Proposal	3 days	Tue 1/19/16	Thu 1/21/16	92
94	Air Force and MSG Review of Draft Final/Revise as Needed	15 days	Fri 1/22/16	Thu 2/11/16	93
95	Submit Draft Final for Regulatory Review	1 day	Fri 2/12/16	Fri 2/12/16	94
96	Prepare Newspaper Notice	5 days	Mon 2/15/16	Fri 2/19/16	95
97	Publish Approved Newspaper Notice and Submit it to Stakeholders and NMED	0 days	Fri 2/19/16	Fri 2/19/16	96
98	Public Comment Period	44 days	Mon 2/22/16	Thu 4/21/16	97
99	Public Meeting	1 day	Wed 3/23/16	Wed 3/23/16	97FS+22 days
100	Assist with Responses to Public Comment (if any)	44 days	Fri 4/22/16	Wed 6/22/16	98
101	Regulator Review of Draft Final / Provide Comments	124 days	Mon 2/15/16	Thu 8/4/16	95
102	Respond to Regulator Comments on Draft Final (if necessary) and Prepare Final CAC Proposal	10 days	Fri 8/5/16	Thu 8/18/16	101
103	Air Force and Regulator Review of Final CAC Proposal/Revise as needed	22 days	Fri 8/19/16	Mon 9/19/16	102
104	Regulatory Approval of Final CAC Proposal (Administratively Completeness Letter) and Achieve SC (finished with all AF requirements to Permit Mod)	0 days	Mon 9/19/16	Mon 9/19/16	103



Project: Group 3 UST Sites IM
Date: Wed 3/26/14
File: Figure 5-1 Preliminary Project Sc

Task		Project Summary		Inactive Milestone		Manual Summary Rollup		Critical	
Split		External Tasks		Inactive Summary		Manual Summary		Critical Split	
Milestone		External Milestone		Manual Task		Start-only		Progress	
Summary		Inactive Task		Duration-only		Finish-only		Deadline	

March 26, 2014

Figure 5-1. Preliminary Project Schedule

Appendix A
Sampling and Analysis Plan/Quality Assurance Project Plan (QAPP)

DRAFT FINAL
INTERIM MEASURES WORKPLAN

Appendix A
Sampling and Analysis Plan/Quality Assurance Project Plan

Group 3 Former Underground Storage Tank Sites:

AOC-UST-221 (TU503), AOC-UST-298 (TU508), AOC-UST-901 (TU506), and AOC-UST-7003 (TU518)

Holloman Air Force Base, New Mexico

Prepared for
Air Force Civil Engineer Center
2261 Hughes Ave
Joint Base San Antonio Lackland, Texas 78236-9853

Contract No.: FA8903-13-C-00080
SubCLINs: 0055AA, 0056AA, 0057AA, 0054AA, and 0058AA

URS Group, Inc.
Denver, Colorado

March 2014

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LIST OF ACRONYMS

%	percent
%R	percent recovery
<	less than
>	greater than
±	plus or minus
≤	less than or equal to
≥	greater than or equal to
°C	degrees Celsius
µg/L	micrograms per liter
A	analytical
AFB	Air Force Base
AFCEC	United States Air Force Civil Engineer Center
AL	action limit
AOC	area of concern
B.A.	Bachelor of Arts
B.S.	Bachelor of Science
CA	corrective action
CD	compact disc (electronic copy)
CFR	Code of Federal Regulations
COC	chain-of-custody
COPC	chemicals of potential concern
COR	contracting officer representative
CVAA	cold vapor atomic absorption
DI	de-ionized
DL	detection limit
DO	dissolved oxygen
DoD	Department of Defense
DQI	data quality indicator
DRO	diesel range organics
EB	equipment blank
ELAP	environmental laboratory accreditation program
ESC	ESC Lab Sciences of Mount Juliet, Tennessee
FB	field blank
FPM	FPM Remediations, Inc.
g	gram
GC	gas chromatography
GC/MS	gas chromatography/mass spectrometer
GFAA	graphite furnace atomic absorption
GPS	global positioning system
GRO	gasoline range organics
HC	hard copy
HCl	hydrochloric acid
HNO_3	nitric acid

HWB	Hazardous Waste Bureau
ICP	inductively couple plasma
ICP-AES	inductively coupled plasma-atomic emission spectrometry
ID	identification
IDW	investigation-derived waste
IM	Interim Measure
L	liter
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LD	laboratory duplicate
LOD	limit of detection
LOQ	limit of quantitation
MDL	method detection limit
MEK	Methyl ethyl ketone
mg/Kg	milligrams per kilogram
mg/L	milligrams per liter
mL	milliliter
mS/cm	milliSiemens per centimeter
M.S.	Master of Science
MS	mass spectrometer
MS/MSD	matrix spike/matrix spike duplicate
MTBE	Methyl tert-butyl ether
NA	not applicable
NELAP	National Environmental Laboratory Accreditation Program
NM	New Mexico
NMED	New Mexico Environment Department
No.	number
ORO	oil range organics
ORP	oxygen reduction potential
oz	ounce
PAH	polynuclear aromatic hydrocarbons
PCE	Tetrachloroethylene
PDS	post-digestion spike
Ph.D	Doctorate
PID	photoionization detector
PQO	project quality objectives
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
QSM	Quality Systems Manual
RCRA	Resource Conservation and Recovery Act of 1976
RL	reporting limit
RPD	relative percent difference
RSL	regional screening level
S	sampling

SAP	sampling and analysis plan
SARA	Superfund Amendments and Reauthorization Act of 1986
SIM	selected ion monitoring
SM	Standard Methods
SOP	standard operating procedure
SSHP	site safety and health plan
SVOC	semivolatile organic compound
TB	trip blank
TBD	to be determined
TCE	Trichloroethylene
TCLP	Toxicity Characteristic Leaching Procedure
TDS	total dissolved solids
TPH	total petroleum hydrocarbons
U.S.	United States
UFP-QAPP	Uniform Federal Policy for Quality Assurance Project Plans
URS	URS Group, Inc.
USEPA	U.S. Environmental Protection Agency
UST	underground storage tank
VOC	volatile organic compound
YSI	YSI Incorporated

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UNIFORM FEDERAL POLICY FOR QUALITY ASSURANCE PROJECT PLANS
Holloman Air Force Base

EXECUTIVE SUMMARY

This Sampling and Analysis Plan (SAP)/Quality Assurance Project Plan (QAPP) for the Interim Measures (IM) Work Plan details the corrective measures planned for four former underground storage tank (UST) sites at Holloman Air Force Base (AFB) near Alamogordo, New Mexico. This SAP/QAPP has been prepared by URS Group, Inc. (URS)), as a subcontractor to FPM Remediations, Inc. (FPM) and is addressed under the New Mexico-Arizona Group Performance-Based Remediation (PBR) Contract on behalf of the United States Air Force Civil Engineer Center (AFCEC).

The former Group 3 UST sites are located at the following Holloman AFB Areas of Concern (AOCs): AOC-UST-221 (TU503, formerly TU/US-C503), AOC-UST-901 (TU506, formerly TU/US-C506), AOC-UST-298 (TU508, formerly TU/US-C508), and AOC-UST-7003 (TU518, formerly TU/US-C518). The proposed IM will minimize or prevent the further migration of contaminants and limit actual or potential human and environmental exposure to contaminants. The IM Work Plan and this SAP/QAPP have been prepared pursuant to the requirements of the Holloman AFB Hazardous Waste Facility Permit No. NM6572124422 (the Permit) issued and enforced by New Mexico Environment Department (NMED) (NMED, 2004).

In accordance with the Holloman AFB RCRA Permit, the primary objectives of this IM are to facilitate a timely corrective measure which will mitigate any current or potential threat(s) to human health or the environment and is consistent with, and integrated into, any long-term solution at the facility. The ultimate goal of this project is to bring each of these four (4) sites to Corrective Action Complete (CAC) status, with no requirement for further land use controls.

This compilation of worksheets meets the requirements of the SAP and QAPP, and supplements the IM Work Plan. Each worksheet addresses specific requirements of the UFP-QAPP. The ultimate success of an environmental program or project depends on the quality of the environmental data collected and used in decision-making, and this depends significantly on the adequacy of the QAPP and its effective implementation.

The tasks described in this project technical plan will be performed in accordance with the Site Safety and Health Plan (SSHP) which describes the health and safety guidelines developed by URS to protect URS personnel, subcontractors, and government personnel involved in the project at Holloman AFB. The Uniform Federal Policy (UFP)– SAP/QAPP was prepared in accordance with the *Uniform Federal Policy (UFP) for Quality Assurance Project Plans (QAPPs): Evaluating, Assessing, and Documenting Environmental Collection and Use Programs Part 2A: UFP-QAPP Workbook* (Intergovernmental Data Quality Task Force, 2005) and will be utilized to establish the overarching analytical and data collection protocols and documentation requirements such that data are generated, reviewed, and analyzed in a consistent manner.

The IM Work Plan presents the technical rationale for the proposed IM approach and describes planned activities, including:

- Advancing and sampling soil borings to evaluate the nature and extent of contamination, if any, in soil.
- Installing and sampling temporary groundwater monitoring wells to evaluate the nature and extent of contamination, if any, in groundwater.
- Focused excavation and/or subsurface injection of bioremediation augmentation substrates to address areas where contaminants of concern exceed applicable screening levels.
- Confirmation sampling to demonstrate the efficacy of any focused excavation and or subsurface injection of bioremediation augmentation substrates.

More details associated with the site background, history, current and future land use and previous site investigations are presented in the IM Work Plan.

ESC Lab Sciences of Mount Juliet, Tennessee (ESC) was selected to provide the analytical support for this project and is a Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) and New Mexico National Environmental Laboratory Accreditation Program (NELAP) certified laboratory.

QAPP Worksheet #1 – Title and Approval Page
(UFP-QAPP Manual Section 2.1)

DRAFT FINAL
Site-Specific Sampling and Analysis Plan/Quality Assurance Project Plan

Interim Measures Work Plan

Group 3 Former Underground Storage Tank Sites:

AOC-UST-221 (TU503), AOC-UST-298 (TU508), AOC-UST-901 (TU506), and AOC-UST-7003 (TU518)

Holloman Air Force Base, New Mexico

March 2014

Prepared for:
United States Air Force Civil Engineer Center
2261 Hughes Ave
Joint Base San Antonio-Lackland, Texas

Prepared by:
URS Group, Inc.
8181 East Tufts Avenue
Denver, CO 80237
(303) 740-2600

Prepared under:
Contract No. FA8903-13-C-0008

Review Signatures:

Brian Powers/URS Project Manager/**Date**

Larry Brook/URS Project Chemist/**Date**

Approval Signatures:

Stephanie Ramon, Air Force Civil Engineer Center Contracting Officer's Representative/**Date**

David Rizzuto, Holloman Environmental/**Date**

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QAPP Worksheet #2 – QAPP Identifying Information
(UFP-QAPP Manual Section 2.2.4)

Site Name/Project Name: Holloman AFB/Four Former UST Sites

Title: Interim Measures

Site Location: Holloman AFB, Otero County, New Mexico

Revision Number: 0

Site Number/Code: Four Group 3 USTs

Revision Date: NA

Areas of Concern: AOC-UST-221 (TU503, formerly TU/US-C503), AOC-UST-901 (TU506, formerly TU/US-C506), AOC-UST-298 (TU508, formerly TU/US-C508), and AOC-UST-7003 (TU518, formerly TU/US-C518)

Contractor Name: URS Group, Inc.

Contract Number: FA8903-13-C-0008

Contract Title: New Mexico-Arizona Group Performance-Based Remediation (PBR) Contract with the Air Force Civil Engineer Center (AFCEC)

Work Assignment Number: URS Project Number 23446543

1. Identify regulatory program: Following the Resource Conservation and Recovery Act (RCRA) process as administered by the New Mexico Environment Department (NMED). Tasks will be performed in accordance with the Holloman AFB, RCRA Permit NM6572124422-2, prepared and administered by the NMED, Hazardous Waste Bureau (HWB), Santa Fe, New Mexico (NM).

   This Site-Specific Sampling and Analysis Plan (SAP)/Quality Assurance Project Plan (QAPP) was prepared using guidance from the following documents:

   - *Uniform Federal Policy (UFP) for Quality Assurance Project Plans (QAPPs): Evaluating,*
   - *Assessing, and Documenting Environmental Collection and Use Programs Part 2A: UFP-QAPP Workbook* (Intergovernmental Data Quality Task Force, 2005)
   - *Guidance on Systematic Planning Using the Data Quality Objectives Process, U.S. Environmental Protection Agency (EPA) QA/G-4* (EPA, 2006)
   - *U.S. Department of Defense (DOD) Quality Systems Manual (QSM) for Environmental Laboratories, Version 4.2* (DOD, 2010)
   - *EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5,* (EPA, 2002)
   - *EPA Requirements for Quality Assurance Project Plans,* EPA QA/R-5, (EPA, 2001)

2. Identify approval entity: Approvals will be provided by the Air Force Civil Engineer Center (AFCEC) and Holloman Air Force Base (AFB).

3. The QAPP is (select one): ☐Generic ☒Project Specific

4. List dates of scoping sessions that were held: A project kick-of meeting took place in Albuquerque, New Mexico on December 16, 2013.

5. List dates and titles of QAPP documents written for previous site work, if applicable:

Title	Approval Date
Site Specific Sampling and Analysis Plan/Quality Assurance Project Plan for the Voluntary Corrective Measure Request, Group 3 Former Underground Storage Tank Sites at Holloman, AFB, New Mexico. (Shaw Environmental and Infrastructure, February 2012).	Draft documents not submitted for NMED approval

6. List organizational partners (stakeholders) and connection with lead organization:
AFCEC, Lead Organization; NMED HWB, regulator; FPM, prime contractor; URS, subcontractor; and Holloman AFB, property owners.

7. List data users:
AFCEC, Holloman AFB, NMED HWB

QAPP Worksheet #2 – Identifying Information

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Crosswalk to this UFP QAPP and Related Documents
Project Management and Objectives		
2.1 Title and Approval Page	– Title and Approval Page	Site-Specific SAP/QAPP Worksheet #1
2.2 Document Format and Table of Contents 2.2.1 Document Control Format 2.2.2 Document Control Numbering System 2.2.3 Table of Contents 2.2.4 QAPP Identifying Information	– Table of Contents – QAPP Identifying Information	Site-Specific SAP/QAPP Worksheet #2
2.3 Distribution List and Project Personnel Sign-Off Sheet 2.3.1 Distribution List 2.3.2 Project Personnel Sign-Off Sheet	– Distribution List – Project Personnel Sign-Off Sheet	Site-Specific SAP/QAPP Worksheets #3 and #4
2.4 Project Organization 2.4.1 Project Organizational Chart 2.4.2 Communication Pathways 2.4.3 Personnel Responsibilities and Qualifications 2.4.4 Special Training Requirements and Certification	– Project Organizational Chart – Communication Pathways – Personnel Responsibilities and Qualifications Table – Special Personnel Training Requirements Table	Site-Specific SAP/QAPP Worksheets #5 through #8
2.5 Project Planning/Problem Definition 2.5.1 Project Planning (Scoping) 2.5.2 Problem Definition, Site History, and Background	– Project Planning Session Documentation (including Data Needs tables) – Project Scoping Session Participants Sheet – Problem Definition, Site History, and Background – Site Maps (historical and present)	Site-Specific SAP/QAPP Worksheets #9 and #10 IM Work Plan Section 1
2.6 Project Quality Objectives and Measurement Performance Criteria 2.6.1 Development of Project Quality Objectives Using the Systematic Planning Process 2.6.2 Measurement Performance Criteria	– Site-Specific Project Quality Objectives (PQOs) – Measurement Performance Criteria Table – Reference Limits and Evaluation Table	Site-Specific SAP/QAPP Worksheets #11, #12, and 15 IM Work Plan Sections 1 and 3
2.7 Secondary Data Evaluation	– Sources of Secondary Data and Information – Secondary Data Criteria and Limitations Table	Site-Specific SAP/QAPP Worksheet #13
2.8 Project Overview and Schedule 2.8.1 Project Overview 2.8.2 Project Schedule	– Summary of Project Tasks – Project Schedule/Timeline Table	Site-Specific SAP/QAPP Worksheets #14 and #16 IM Work Plan Sections 1 and 5

QAPP Worksheet #2 – Identifying Information

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Crosswalk to this UFP QAPP and Related Documents
Measurement/Data Acquisition		
3.1 Sampling Tasks 3.1.1 Sampling Process Design and Rationale 3.1.2 Sampling Procedures and Requirements 3.1.2.1 Sampling Collection Procedures 3.1.2.2 Sample Containers, Volume, and Preservation 3.1.2.3 Equipment/Sample Containers Cleaning and Decontamination Procedures 3.1.2.4 Field Equipment Calibration, Maintenance, Testing, and Inspection Procedures 3.1.2.5 Supply Inspection and Acceptance Procedures 3.1.2.6 Field Documentation Procedures	– Sampling Design and Rationale – Sampling Locations and Methods/SOP Requirements Table – Sample Container Identification – Analytical Methods Requirements Table – Field Quality Control (QC) Sample Summary Table – Sampling SOPs – Project Sampling SOP References Table – Field Equipment Calibration, Maintenance, Testing, and Inspection Table	Site-Specific SAP/QAPP Worksheets #17 through #22 IM Work Plan Section 3
3.2 Analytical Tasks 3.2.1 Analytical SOPs 3.2.2 Analytical Instrument Calibration Procedures 3.2.3 Analytical Instrument and Equipment Maintenance, Testing, and Inspection Procedures 3.2.4 Analytical Supply Inspection and Acceptance Procedures	– ESC Analytical SOPs – ESC Analytical SOP References Table – Analytical Instrument Calibration Table – Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	Site-Specific SAP/QAPP Worksheets #23 through #25
3.3 Sample Collection Documentation, Handling, Tracking, and Custody Procedures 3.3.1 Sample Collection Documentation 3.3.2 Sample Handling and Tracking System 3.3.3 Sample Custody	– Sample Collection, Packaging, Shipment, Receipt, Archival and Disposal – Sample Chain-of-Custody and Sample Custody	Site-Specific SAP/QAPP Worksheets #26 and #27
3.4 Quality Control Samples 3.4.1 Sampling Quality Control Samples 3.4.2 Analytical Quality Control Samples	– Sampling and Analytical QC Samples Table	Site-Specific SAP/QAPP Worksheet #28
3.5 Data Management Tasks 3.5.1 Project Documentation and Records 3.5.2 Data Package Deliverables 3.5.3 Data Reporting Formats 3.5.4 Data Handling and Management 3.5.5 Data Tracking and Control	– Project Documents and Records Table – Analytical Services Table – Data Management SOPs	Site-Specific SAP/QAPP Worksheets #29 and #30

QAPP Worksheet #2 – Identifying Information

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Crosswalk to this UFP QAPP and Related Documents
Assessment/Oversight		
4.1 Assessments and Response Actions 4.1.1 Planned Assessments 4.1.2 Assessment Findings and Corrective Action Responses	– Planned Project Assessments Table – Assessment Findings and Corrective Action Responses Table	Site-Specific SAP/QAPP Worksheets #31 and #32
4.2 QA Management Reports	– QA Management Reports Table	Site-Specific SAP/QAPP Worksheet #33
4.3 Final Project Report	– Report Summarizing Activities, Results and Conclusions	IM Work Plan Section 4
Data Review		
5.1 Overview		
5.2 Data Review Steps 5.2.1 Step I: Verification 5.2.2 Step II: Validation 5.2.2.1 Step IIa Validation Activities 5.2.2.2 Step IIb Validation Activities 5.2.3 Step III: Usability Assessment 5.2.3.1 Data Limitations and Actions from Usability Assessment 5.2.3.2 Activities	– Verification (Step I) Process Table – Validation (Steps IIa and IIb) Process Table – Validation (Steps IIa and IIb) Summary Table – Usability Assessment	Site-Specific SAP/QAPP Worksheets #34 through #37
5.3 Streamlining Data Review 5.3.1 Data Review Steps To Be Streamlined 5.3.2 Criteria for Streamlining Data Review 5.3.3 Amounts and Types of Data Appropriate for Streamlining		Site-Specific SAP/QAPP Worksheets #31 and #32

QAPP Worksheet #3 – Distribution List
(UFP-QAPP Manual Section 2.3.1)

Document Distribution List for IM Work Plan and IM Report

Document Description	Agency/Contact					
	AFCEC Attn: Stephanie Ramon	AFCEC Attn: Layi Oyelowo	Holloman AFB Attn: DeAnna Rothhaupt	NMED HWB Attn: David Strasser	ESC Lab Sciences Attn: Daphne Richards [(a)]	Holloman AFB Information Repository
Draft	0 HC 1 CD	0 HC 1 CD	0 HC 2 CD	0 HC 0 CD	0 HC 1 CD	0 HC 0 CD
Draft Final	0 HC 1 CD	0 HC 1 CD	4 HC 4 CD	2 HC 2 CD	1 HC 1 CD	0 HC 0 CD
Final	0 HC 1 CD	0 HC 1 CD	4 HC 4 CD	2 HC 2 CD	1 HC 1 CD	1 HC 1 CD

Notes:
[(a)] ESC Lab Sciences will receive just the Sampling and Analysis Plan/Quality Assurance Project Plan, Appendix A of the Work Plan.
AFB – Air Force Base
AFCEC – Air Force Civil Engineer Center
CD – Compact disc (electronic copy)
HC – Hard copy
NMED HWB – New Mexico Environment Department, Hazardous Waste Bureau

QAPP Worksheet #3 – Distribution List (continued)
(UFP-QAPP Manual Section 2.3.1)

Organization: AFCEC

Project Personnel	Title	Telephone Number
Stephanie Ramon	Contracting Officer Representative	210.863.8628
Layi Oyelowo	Contracting Officer Representative Alternate	(210) 395-8567

Organization: Holloman AFB

Project Personnel	Title	Telephone Number
DeAnna Rothhaupt	Holloman Chief, Environmental	575.572.3931

Organization: NMED HWB

Project Personnel	Title	Telephone Number
David Strasser	Environmental Specialist	505.222.9326

Organization: ESC Lab Sciences

Project Personnel	Title	Telephone Number
Daphne Richards	Project Manager	615.773.9662

QAPP Worksheet #3 Distribution List (continued)
(UFP-QAPP Manual Section 2.3.1)

Organization: FPM

Project Personnel	Title	Telephone Number
Maureen Whalen	Project Manager	315.336.7721 x216

Organization: URS Group

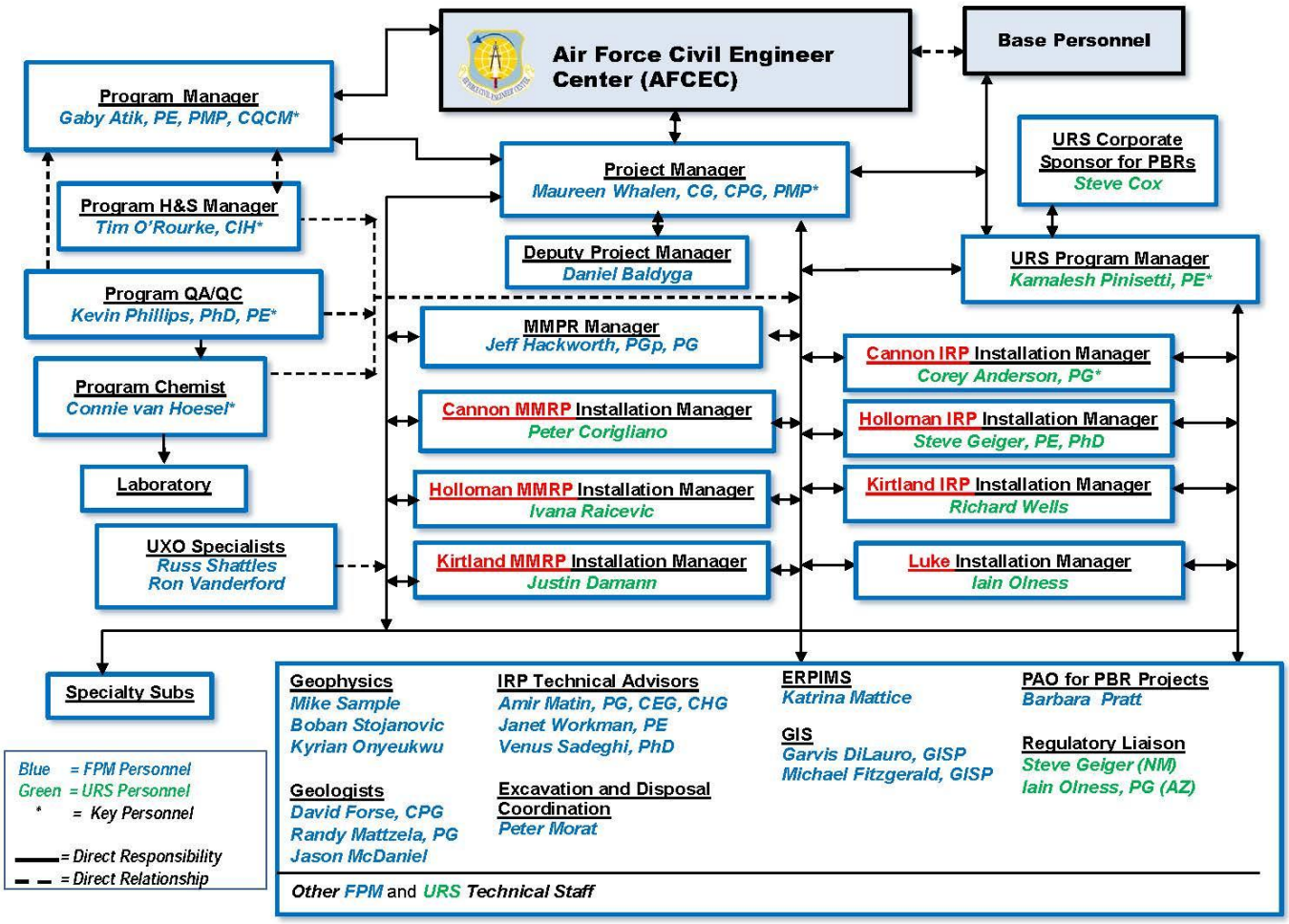
Project Personnel	Title	Telephone Number
Brian Powers	Project Manager	303.740.3924
Jon Mallonee	Field Team Leader	303.740.3967
Larry Brook	Project Chemist	303.740.2787

QAPP Worksheet #4 – Project Personnel Sign Off
(UFP-QAPP Manual Section 2.3.2)

Project Personnel	Title	Telephone Number	Signature *	Date QAPP Read
David Rizzuto	Holloman Environmental	575.572.5395		
Daphne Richards	ESC Project Manager	615.773.9662		
Brian Powers	URS Project Manager	303.740.3924		
Jon Mallonee	URS Field Team Leader	303.740.3967		
Larry Brook	URS Project Chemist	303.740.2787		

* I have read and understand this site-specific SAP/QAPP and will perform project tasks as described within this plan.

QAPP Worksheet #5 – Project Organizational Chart
(UFP-QAPP Manual Section 2.4.1)



QAPP Worksheet #6 – Project Points of Contact
(UFP-QAPP Manual Section 2.4.2)

Name	Affiliation	Title	Phone	Email
Stephanie Ramon	AFCEC	Contracting Officer Representative	210.395.8628	stephanie.ramon.1@us.af.mil
DeAnna Rothhaupt	Holloman AFB	Holloman Chief, Environmental	575.572.3931	deanna.rothhaupt@us.af.mil
David Rizzuto	Holloman AFB	Holloman, Environmental	575.572.5395	david.rizzuto.ctr@holloman.af.mil
Maureen Whalen	FPM	Project Manager	315.336.7721 x216	m.whalen@fpm-remediations.com
Brian Powers	URS	Technical Lead	303.740.3924	brian.powers@urs.com
Daphne Richards	ESC	Project Manager	615.773.9662	drichards@esclabsciences.com
Field/Sampling Points of Contact				
Jon Mallonee	URS	Project Scientist	303-740-3967	jon.mallonee@urs.com
Larry Brook	URS	Project Chemist	303-740-2787	larry.brook@urs.com

QAPP Worksheet #7 – Personnel Responsibilities and Qualifications
(UFP-QAPP Manual Section 2.4.3)

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
Stephanie Ramon	Contracting Officer Representative	AFCEC	Manages project for AFCEC and will participate in decision making for this project	NA
DeAnna Rothhaupt	Chief, Environmental	Holloman AFB	Manages project for Holloman AFB and will participate in decision making for this project	NA
David Rizzuto	Technical Lead	Holloman AFB	Provides technical review for Holloman AFB and participates in decision making for the project	NA
Maureen Whalen	Project Manager	FPM Remediations, Inc.	Manages project for FPM and will participate in decision making for the project	M.S. Quaternary Studies, B.S. Geology. CPG, PG, PMP; over 20 years of environmental experience
Brian Powers	Project Manager	URS Group, Inc.	Manages project for URS and is the point of contact with AFCEC and Holloman AFB; will participate in decision making for the project	M.S. Geology and Mineralogy, B.S. Geology. PG; over 20 years environmental experience
Bill Ruoff	Project Risk Assessor	URS Group, Inc.	Uses collected data to evaluate response complete or the need for human health risk screening	Ph.D Physiology. Over 20 years environmental experience.
Larry Brook	Project Chemist	URS Group, Inc.	Activities related to coordination, acquisition, and validation of analytical data and subcontracted services	B.S. Biochemistry. CHMM; over 20 years environmental experience.
Jon Mallonee	Field Sampling Team Leader	URS Group, Inc.	Oversees implementation of the SAP/QAPP, including management of the field team and schedule.	B.S. Geology, 10 years of environmental experience.

Notes:
AFB – Air Force Base
AFCEC – Air Force Civil Engineer Center
B.S. – Bachelor of Science
M.S. – Master of Science
NA – Not Applicable
Ph.D – Doctorate

QAPP Worksheet #8 – Special Personnel Training Requirements

(UFP-QAPP Manual Section 2.4.4)

Special Personnel Training Requirements Table

Project Function	Specialized Training – Title or Description of Course	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certificates
Field Geology and Sampling	Health and Safety Training per 29 CFR 1910.120 Tailgate meeting to discuss sampling plan and procedures	URS	Prior to Start of Project	TBD	Project Scientist	URS Offices Certificate available upon request

Notes:
CFR – Code of Federal Regulations
TBD – to be determined

Additionally, the laboratory will have an established policy and procedure on training and documenting of the analyst's competency. Each staff member who performs sample preparation and analysis will demonstrate his or her proficiency through preparation and analysis of laboratory control samples (LCSs) as described in EPA SW-846 (EPA, 1986). Analysts will be considered proficient if the acceptance criteria for method accuracy and precision are met. The laboratory will maintain all training records on file.

QAPP Worksheet #9 – Project Scoping Session Participants Sheet
(UFP-QAPP Manual Section 2.5.1)

Project Name: Holloman AFB **Projected Date(s) of Sampling:** TBD **Project Manager:** Brian Powers	**Site Name:** Group 3 Former UST Sites **Site Location:** Otero County, New Mexico

Date of Session: December 16, 2013
Scoping Session Purpose: Project Kickoff Meeting with Regulators

Name	Affiliation	Phone #	E-mail Address	Project Role
Dave Cobrain	NMED	505-476-6055	Dave.cobrain@state.nm.us	Regulator
William Moats	NMED	505-222-9551	William.moats@state.nm.us	Regulator
David Strasser	NMED	505-222-9526	David.strasser@state.nm.us	Regulator
Brian Salem	NMED	505-222-9576	Brian.salem@state.nm.us	Regulator
DeAnna Rothhaupt	49CES/CEIE Chief	575-572-3931	Deanna.rothhaupt@us.af.mil	AFCEC COR
Maureen Whalen	FPM	315-336-7721 ext.216	m.whalen@fpm-remediations.com	FPM Project Manager
Steven Geiger	URS	505-672-2107	Steve.geiger@urs.com	URS Holloman Program Lead
Brian Powers	URS	303-740-3924	Brian.powers@urs.com	URS Project Manager
Rich Wells	URS	602-861-7409	Richard.wells@urs.com	URS Project Manager

Comments/Decisions: The Group 3 UST sites, or sites TU503, TU506, TU508, and TU518 can all be grouped together for purposes of work planning and execution. Previous work for these sites has been completed under the Voluntary Corrective Measures permit program, but future work should be performed under Interim Measures (IMs) which can be converted into Final Remedies if appropriate. Metals background values should be considered on a case-by-case basis for specific sites.

Action Items: Refer to Meeting Minutes.

Consensus Decisions: See above Comments/Decisions and refer to Meeting Minutes.

Notes:
AFB – Air Force Base
AFCEC – U.S. Air Force Civil Engineer Center
COR – Contracting Officer Representative
FPM – FPM Remediations, Inc.
NMED – New Mexico Environment Department
TBD – to be determined
URS – URS Group, Inc.

QAPP Worksheet #10 – Problem Definition
(UFP-QAPP Manual Section 2.5.2)

Problem Definition

In 2012, NMED issued a Public Notice amending the Holloman AFB RCRA Permit to include several Areas of Concern for additional investigation and remediation. Among these AOCs were the four Group 3 UST sites discussed in this Work Plan: AOC-UST-221 (TU503), AOC-UST-901 (TU506), AOC-UST-298 (TU508), and AOC-UST-7003 (TU518). Background of each of these sites is provided in IM Work Plan Section 2.

The IM Work Plan presents the approach for remediation of four former UST sites at Holloman AFB, NM. Each of the four USTs has been excavated and removed from the ground. The USTs ranged in size from approximately 250 gallons to 5,000 gallons, and were removed in the 1990s (except for UST 7003, which was removed in 2008). The sampling programs described within this IM Work Plan were designed to further evaluate the nature and extent of potential hydrocarbon-related contamination at each of the former UST sites and to demonstrate, via confirmation sampling, the effectiveness of any necessary excavation or injection of bioremediation augmentation substrates.

Project Decision Condition:
For this interim measure, information inputs to the decision-making process include the collection and chemical analysis of soil and groundwater. Following soil excavation and/or subsurface injection of bioremediation augmentation substrates, confirmation samples will be collected to demonstrate that affected areas no longer exhibit contaminant of concern concentrations that exceed applicable screening levels. Chemicals detected in soil and groundwater will be compared to screening guidelines that are listed in Worksheet #15. With the exceptions noted in Worksheets #15, the planned laboratory analyses will meet the screening levels.

QAPP Worksheet #11 – Project Quality Objectives/Systematic Planning Process Statements
(UFP-QAPP Manual Section 2.6.1)

Who will use the data? Data will be used by the project team including URS, the U. S. Air Force at Holloman AFB, and AFCEC.
What will the data be used for? Data will be used to evaluate the presence of contaminants, to evaluate contaminate nature and extent, and to determine if further response or remedial action is necessary or if excavation or other remediation technologies adequately reduce contaminant of concern concentrations below applicable screening levels. A complete listing of the project action limits is provided in Worksheet #15.
What types of data are needed? Soil and groundwater samples will be collected as identified in the IM Work Plan and in Worksheet #20.
How much data are needed? The number of samples to be collected is presented in Worksheet #20.
How good does the data need to be? IM activities at these Holloman sites will require the collection of different kinds of data for each site, including both qualitative and quantitative data. From the Project Quality Objective perspective, qualitative data will be categorized as screening data (data of sufficient quality to support an intermediate or preliminary decision but must eventually be supported by definitive data) or definitive data (analytical data that are suitable for final decision making). Definitive site-specific data are required to document confirmatory sampling, and make determinations for site closure. Screening data may be collected to make and support qualitative assessments in the field, including intermediate steps preceding confirmation. Further discussion of data needs is provided in IM Work Plan Section 3. Definitive data will be compared to the screening criteria as applicable or historical data collected presented in Worksheet #15 as applicable. Definitive data will be validated in accordance with Worksheets #34, 35, and 36.
When will data be collected? The data will be collected in 2014.

QAPP Worksheet #12 – Measurement Performance Criteria Table
(UFP-QAPP Manual Section 2.6.2)

Measurement Performance Criteria Table

Matrix	**Soil / Groundwater**	**Laboratory criteria are listed in the DoD QSM Version 4.2 Appendix F Table. Full data verification and validation criteria are listed in Worksheet 36.**			
Analytical Groups	GRO, DRO/ORO, VOCs, SVOCs, PAHs, Metals				
Concentration Level	Low				
Sampling Procedure[1]	**Analytical Method/SOP[2]**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
GRO					
URS SOP 6 Soil Sample Collection URS SOP 11 Groundwater Sample Collection	USEPA SW846 8015/ ESC SOP 330351A	Accuracy/Bias - Laboratory	See Tables 12-1a-12-1b	LCS, MS/MSD, and surrogate recoveries	A
			See Worksheet 24	Calibration – initial and continuing	A
		Precision – Laboratory	See Tables 12-1a-12-1b	MS/MSDs and/or LCS/ LCSD	A
			See Worksheet 24	Calibration – initial and continuing	A
		Precision – Field	For Field Duplicates the following criteria will be used: • If the parent sample and duplicate values are >5xLOQ, then <30% RPD for water samples (<50% soil). • If the parent sample or duplicate sample value is <5xLOQ, then absolute difference is <2xLOQ for water samples (<3.5xLOQ for soil).	Field Duplicates	S & A
		Accuracy/Bias Contamination	No Target Analyte Detected > ½ LOQ	Method Blanks	A
		Sensitivity	Results reported to the LOD; LOQs meet those listed in Worksheet #15	Quarterly LOD verification; LOQs meet screening criteria	A
		Completeness	90%	Data Completeness Check	S & A

QAPP Worksheet #12 – Measurement Performance Criteria Table (continued)

(UFP-QAPP Manual Section 2.6.2)

Measurement Performance Criteria Table

Matrix	**Soil / Groundwater**	**Laboratory criteria are listed in the DoD QSM Version 4.2 Appendix F Table. Full data verification and validation criteria are listed in Worksheet 36.**			
Analytical Groups	GRO, DRO/ORO, VOCs, SVOCs, PAHs, Metals				
Concentration Level	Low				
Sampling Procedure[1]	**Analytical Method/SOP[2]**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
DRO					
URS SOP 6 Soil Sample Collection URS SOP 11 Groundwater Sample Collection	USEPA SW846 8015/ ESC SOP 330350A	Accuracy/Bias - Laboratory	See Table 12-2a-12-2b	LCS, MS/MSD, and surrogate recoveries	A
			See Worksheet 24	Calibration – initial and continuing	A
		Precision – Laboratory	See Table 12-2a-12-2b	MS/MSDs and/or LCS/LCSD	A
			See Worksheet 24	Calibration – initial and continuing	A
		Precision – Field	For Field Duplicates the following criteria will be used: • If the parent sample and duplicate values are >5xLOQ, then <30% RPD for water samples (<50% soil). • If the parent sample or duplicate sample value is <5xLOQ, then absolute difference is <2xLOQ for water samples (<3.5xLOQ for soil).	Field Duplicates	S & A
		Accuracy/Bias Contamination	No Target Analyte Detected > ½ LOQ	Method Blanks	A
		Sensitivity	Results reported to the LOD; LOQs meet those listed in Worksheet #15	Quarterly LOD verification; LOQs meet screening criteria	A
		Completeness	90%	Data Completeness Check	S & A

QAPP Worksheet #12 – Measurement Performance Criteria Table (continued)
(UFP-QAPP Manual Section 2.6.2)

Measurement Performance Criteria Table

Matrix	**Soil / Groundwater**	**Laboratory criteria are listed in the DoD QSM Version 4.2 Appendix F Table. Full data verification and validation criteria are listed in Worksheet 36.**			
Analytical Groups	GRO, DRO/ORO, VOCs, SVOCs, PAHs, Metals				
Concentration Level	Low				
Sampling Procedure[1]	**Analytical Method/SOP[2]**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
VOCs					
URS SOP 6 Soil Sample Collection URS SOP 11 Groundwater Sample Collection	USEPA SW846 8260B/ ESC SOP 330363	Accuracy/Bias - Laboratory	See Table 12-3a-12-3b	LCS, MS/MSD, and surrogate recoveries	A
			See Worksheet 24	Calibration – initial and continuing	A
		Precision – Laboratory	See Table 12-3a-12-3b	MS/MSDs and/or LCS/LCSD	A
			See Worksheet 24	Calibration – initial and continuing	A
		Precision – Field	For Field Duplicates the following criteria will be used: • If the parent sample and duplicate values are >5xLOQ, then <30% RPD for water samples (<50% soil). • If the parent sample or duplicate sample value is <5xLOQ, then absolute difference is <2xLOQ for water samples (<3.5xLOQ for soil).	Field Duplicates	S & A
		Accuracy/Bias Contamination	No Target Analyte Detected > ½ LOQ	Method Blanks	A
		Sensitivity	Results reported to the LOD; LOQs meet those listed in Worksheet #15	Quarterly LOD verification; LOQs meet screening criteria	A
		Completeness	90%	Data Completeness Check	S & A

QAPP Worksheet #12 – Measurement Performance Criteria Table (continued)
(UFP-QAPP Manual Section 2.6.2)

Measurement Performance Criteria Table

Matrix	**Soil / Groundwater**	**Laboratory criteria are listed in the DoD QSM Version 4.2 Appendix F Table. Full data verification and validation criteria are listed in Worksheet 36.**			
Analytical Groups	GRO, DRO/ORO, VOCs, SVOCs, PAHs, Metals				
Concentration Level	Low				
Sampling Procedure[1]	**Analytical Method/SOP[2]**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
SVOCs					
URS SOP 6 Soil Sample Collection URS SOP 11 Groundwater Sample Collection	USEPA SW846 8270C/ ESC SOP 330345	Accuracy/Bias - Laboratory	See Table 12-4a-12-4b	LCS, MS/MSD, and surrogate recoveries	A
			See Worksheet 24	Calibration – initial and continuing	A
		Precision – Laboratory	See Table 12-4a-12-4b	MS/MSDs and/or LCS/LCSD	A
			See Worksheet 24	Calibration – initial and continuing	A
		Precision – Field	For Field Duplicates the following criteria will be used: • If the parent sample and duplicate values are >5xLOQ, then <30% RPD for water samples (<50% soil). • If the parent sample or duplicate sample value is <5xLOQ, then absolute difference is <2xLOQ for water samples (<3.5xLOQ for soil).	Field Duplicates	S & A
		Accuracy/Bias Contamination	No Target Analyte Detected > ½ LOQ	Method Blanks	A
		Sensitivity	Results reported to the LOD; LOQs meet those listed in Worksheet #15	Quarterly LOD verification; LOQs meet screening criteria	A
		Completeness	90%	Data Completeness Check	S & A

QAPP Worksheet #12 – Measurement Performance Criteria Table (continued)
(UFP-QAPP Manual Section 2.6.2)

Measurement Performance Criteria Table

Matrix	**Soil / Groundwater**	**Laboratory criteria are listed in the DoD QSM Version 4.2 Appendix F Table. Full data verification and validation criteria are listed in Worksheet 36.**			
Analytical Groups	GRO, DRO/ORO, VOCs, SVOCs, PAHs, Metals				
Concentration Level	Low				
Sampling Procedure[1]	**Analytical Method/SOP[2]**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
PAHs					
URS SOP 6 Soil Sample Collection URS SOP 11 Groundwater Sample Collection	USEPA SW846 8270C-SIM/ESC SOP 330345	Accuracy/Bias - Laboratory	See Tables 12-5a-12-5b	LCS, MS/MSD, and surrogate recoveries	A
			See Worksheet 24	Calibration – initial and continuing	A
		Precision – Laboratory	See Tables 12-5a-12-5b	MS/MSDs and/or LCS/ LCSD	A
			See Worksheet 24	Calibration – initial and continuing	A
		Precision – Field	For Field Duplicates the following criteria will be used: • If the parent sample and duplicate values are >5xLOQ, then <30% RPD for water samples (<50% soil). • If the parent sample or duplicate sample value is <5xLOQ, then absolute difference is <2xLOQ for water samples (<3.5xLOQ for soil).	Field Duplicates	S & A
		Accuracy/Bias Contamination	No Target Analyte Detected > ½ LOQ	Method Blanks	A
		Sensitivity	Results reported to the LOD; LOQs meet those listed in Worksheet #15	Quarterly LOD verification; LOQs meet screening criteria	A
		Completeness	90%	Data Completeness Check	S & A

QAPP Worksheet #12 – Measurement Performance Criteria Table (continued)

(UFP-QAPP Manual Section 2.6.2)

Measurement Performance Criteria Table

Matrix	**Soil / Groundwater**	**Laboratory criteria are listed in the DoD QSM Version 4.2 Appendix F Table. Full data verification and validation criteria are listed in Worksheet 36.**			
Analytical Groups	GRO, DRO/ORO, VOCs, SVOCs, PAHs, Metals				
Concentration Level	Low				
Sampling Procedure[1]	**Analytical Method/SOP[2]**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
Metals					
URS SOP 6 Soil Sample Collection URS SOP 11 Groundwater Sample Collection	USEPA SW846 6010B, 6020A, 7470A, and 7471A/ ESC SOPs 340386, 340390, 340384A, and 340384B	Accuracy/Bias - Laboratory	See Tables 12-6a-12-6b	LCS, MS/MSD, and surrogate recoveries	A
			See Worksheet 24	Calibration – initial and continuing	A
		Precision – Laboratory	See Tables 12-6a-12-6b	MS/MSDs and/or LCS/LCSD	A
			See Worksheet 24	Calibration – initial and continuing	A
		Precision – Field	For Field Duplicates the following criteria will be used: • If the parent sample and duplicate values are >5xLOQ, then <30% RPD for water samples (<50% soil). • If the parent sample or duplicate sample value is <5xLOQ, then absolute difference is <2xLOQ for water samples (<3.5xLOQ for soil).	Field Duplicates	S & A
		Accuracy/Bias Contamination	No Target Analyte Detected > ½ LOQ	Method Blanks	A
		Sensitivity	Results reported to the LOD; LOQs meet those listed in Worksheet #15	Quarterly LOD verification; LOQs meet screening criteria	A
		Completeness	90%	Data Completeness Check	S & A

QAPP Worksheet #12 – Measurement Performance Criteria Table (continued)
(UFP-QAPP Manual Section 2.6.2)

Measurement Performance Criteria Table

Matrix	**Soil / Groundwater**	**Laboratory criteria are listed in the DoD QSM Version 4.2 Appendix F Table. Full data verification and validation criteria are listed in Worksheet 36.**			
Analytical Groups	GRO, DRO/ORO, VOCs, SVOCs, PAHs, Metals				
Concentration Level	Low				
Sampling Procedure[1]	**Analytical Method/SOP[2]**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
TDS					
URS SOP 11 Groundwater Sample Collection	USEPA 160.1/ ESC SOP340347	Accuracy/Bias - Laboratory	See Worksheet 24	Calibration – initial and continuing	A
		Precision – Laboratory	See Table 12-7	LD	A
			See Worksheet 24	Calibration – initial and continuing	A
		Precision – Field	For Field Duplicates the following criteria will be used: • If the parent sample and duplicate values are >5xLOQ, then <30% RPD for water samples. • If the parent sample or duplicate sample value is <5xLOQ, then absolute difference is <2xLOQ for water samples.	Field Duplicates	S & A
		Accuracy/Bias Contamination	No Target Analyte Detected > ½ LOQ	Method Blanks	A
		Sensitivity	Results reported to the LOD; LOQs meet those listed in Worksheet #15	Quarterly LOD verification; LOQs meet screening criteria	A
		Completeness	90%	Data Completeness Check	S & A

Notes:
[1]Reference number from QAPP Worksheet #21 (see Section 3.1.2).
[2]Reference number from QAPP Worksheet #23 (see Section 3.2).

A – Analytical
DRO/ORO – Diesel Range Organics/Oil Range Organics
DoD – Department of Defense
DQIs – Data Quality Indicators
ESC – ESC Lab Sciences of Mt. Juliet, Tennessee
GRO – Gasoline Range Organics
LCS – Laboratory Control Sample
LCSD – Laboratory Control Sample Duplicate
LOQ – Limit of Quantitation
MS/MSD – Matrix Spike/ Matrix Spike Duplicate
PAHs – Polynuclear Aromatic Hydrocarbons
QC – Quality Control
QSM – Quality Systems Manual
RPD – Relative Percent Difference
S – Sampling
SIM – Selective Ion Monitoring
SOP – Standard Operating Procedure
SVOCs – Semivolatile Organic Compounds
TDS – Total Dissolved Solids
VOCs – Volatile Organic Compounds

Table 12-1a
Accuracy and Precision Criteria for Method 8015 – GRO/Water

Analyte	Accuracy Limits (%R)	Precision (RPD)
GRO	80-120	20

Notes:
%R – Percent Recovery
GRO – Gasoline Range Organics
RPD – Relative Percent Difference

Table 12-1b
Accuracy and Precision Criteria for Method 8015 – GRO/Soil

Analyte	Accuracy Limits (%R)	Precision (RPD)
GRO	63-137	30

Notes:
%R – Percent Recovery
GRO – Gasoline Range Organics
RPD – Relative Percent Difference

Table 12-2a
Accuracy and Precision Criteria for Method 8015 – DRO/ORO/Water

Analyte	Accuracy Limits (%R)	Precision (RPD)
DRO	52-142	20
ORO	52-142	20

Notes:
%R – Percent Recovery
DRO – Diesel Range Organics
ORO – Oil Range Organics
RPD – Relative Percent Difference

Table 12-2b
Accuracy and Precision Criteria for Method 8015 – DRO/ORO/Soil

Analyte	Accuracy Limits (%R)	Precision (RPD)
DRO	61-145	30
ORO	61-145	30

Notes:
%R – Percent Recovery
DRO – Diesel Range Organics
ORO – Oil Range Organics
RPD – Relative Percent Difference

Table 12-3a
Accuracy and Precision Criteria for Method 8260B – Water

Analyte	Accuracy Limits (%R)	Precision (RPD)
1,1,1,2-Tetrachloroethane	80-130	30
1,1,1-Trichloroethane	65-130	30
1,1,2,2-Tetrachloroethane	65-130	30
1,1,2-Trichloroethane	75-125	30
1,1-Dichloroethane	70-135	30
1,1-Dichloroethene	70-130	30
1,1-Dichloropropene	75-130	30
1,2,3-Trichlorobenzene	55-140	30
1,2,3-Trichloropropane	75-125	30
1,2,4-Trichlorobenzene	65-135	30
1,2,4-Trimethylbenzene	75-130	30
1,2-Dibromo-3-chloropropane	50-130	30
1,2-Dibromoethane	80-120	30
1,2-Dichlorobenzene	70-120	30
1,2-Dichloroethane	70-130	30
1,2-Dichloropropane	75-125	30
1,3,5-Trimethylbenzene	75-130	30
1,3-Dichlorobenzene	75-125	30
1,3-Dichloropropane	75-125	30
1,4-Dichlorobenzene	75-125	30
2,2-Dichloropropane	70-135	30
2-Butanone	30-150	30
2-Chlorotoluene	75-125	30
2-Hexanone	55-130	30
4-Chlorotoluene	75-130	30
Methyl Isobutyl Ketone	60-135	30
Acetone	40-140	30
Benzene	80-120	30
Bromobenzene	75-125	30
Bromochloromethane	65-130	30
Bromodichloromethane	75-120	30
Bromoform	70-130	30
Bromomethane	30-145	30
Carbon disulfide	35-160	30
Carbon tetrachloride	65-140	30
Chlorobenzene	80-120	30
Dibromochloromethane	60-135	30
Chloroethane	60-135	30
Chloroform	65-135	30
Chloromethane	40-125	30
cis-1,2-Dichloroethene	70-125	30

Table 12-3a (continued)
Accuracy and Precision Criteria for Method 8260B – Water

Analyte	Accuracy Limits (%R)	Precision (RPD)
cis-1,3-Dichloropropene	70-130	30
Dibromomethane	75-125	30
Dichlorodifluoromethane	30-155	30
Ethylbenzene	75-125	30
Hexachlorobutadiene	50-140	30
Isopropyl benzene	75-125	30
m/p-Xylenes	75-130	30
MTBE	65-125	30
Methylene chloride	55-140	30
Naphthalene	55-140	30
n-Butylbenzene	70-135	30
n-Propylbenzene	70-130	30
o-Xylene	80-120	30
p-Isopropyltoluene	75-130	30
sec-Butylbenzene	70-125	30
Styrene	65-135	30
tert-Butylbenzene	70-130	30
Tetrachloroethylene	45-150	30
Toluene	75-120	30
trans-1,2-Dichloroethene	60-140	30
trans-1,3-Dichloropropene	55-140	30
Trichloroethene	70-125	30
Trichlorofluoromethane	60-145	30
Vinyl chloride	50-145	30

Notes:
%R – Percent Recovery
MTBE – Methyl tert-butyl ether
RPD – Relative Percent Difference

Table 12-3b
Accuracy and Precision Criteria for USEPA Method 8260B – Soil

Analyte	Accuracy Limits (%R)	Precision (RPD)
1,1,1,2-Tetrachloroethane	75-125	50
1,1,1-Trichloroethane	70-135	50
1,1,2,2-Tetrachloroethane	55-130	50
1,1,2-Trichloroethane	60-125	50
1,1-Dichloroethane	75-125	50
1,1-Dichloroethene	65-135	50
1,1-Dichloropropene	70-135	50
1,2,3-Trichlorobenzene	60-135	50
1,2,3-Trichloropropane	65-130	50
1,2,4-Trichlorobenzene	65-130	50
1,2,4-Trimethylbenzene	65-135	50
1,2-Dibromo-3-chloropropane	40-135	50
1,2-Dibromoethane	70-125	50
1,2-Dichlorobenzene	75-120	50
1,2-Dichloroethane	70-135	50
1,2-Dichloropropane	70-120	50
1,3,5-Trimethylbenzene	65-135	50
1,3-Dichlorobenzene	70-125	50
1,3-Dichloropropane	75-125	50
1,4-Dichlorobenzene	70-125	50
2,2-Dichloropropane	65-135	50
2-Butanone	30-160	50
2-Chlorotoluene	71-130	50
2-Hexanone	45-145	50
4-Chlorotoluene	75-125	50
Methyl Isobutyl Ketone	45-145	50
Acetone	20-160	50
Benzene	75-125	50
Bromobenzene	65-120	50
Bromochloromethane	70-125	50
Bromodichloromethane	70-130	50
Bromoform	55-135	50
Bromomethane	30-160	50
Carbon disulfide	45-160	50
Carbon tetrachloride	65-135	50
Chlorobenzene	75-125	50
Dibromochloromethane	65-130	50
Chloroethane	40-155	50
Chloroform	70-125	50
Chloromethane	50-130	50
cis-1,2-Dichloroethene	65-125	50

Table 12-3b (continued)
Accuracy and Precision Criteria for Method 8260B – Soil

Analyte	Accuracy Limits (%R)	Precision (RPD)
cis-1,3-Dichloropropene	70-125	50
Dibromomethane	75-130	50
Dichlorodifluoromethane	35-135	50
Ethylbenzene	75-125	50
Hexachlorobutadiene	55-140	50
Isopropyl benzene	75-130	50
m/p-Xylenes	80-125	50
MTBE	60-150	50
Methylene chloride	55-140	50
Naphthalene	40-125	50
n-Butylbenzene	65-140	50
n-Propylbenzene	65-135	50
o-Xylene	75-125	50
p-Isopropyltoluene	75-135	50
sec-Butylbenzene	65-130	50
Styrene	75-125	50
tert-Butylbenzene	65-130	50
Tetrachloroethylene	65-140	50
Toluene	70-125	50
trans-1,2-Dichloroethene	65-135	50
trans-1,3-Dichloropropene	65-125	50
Trichloroethene	75-125	50
Trichlorofluoromethane	25-185	50
Vinyl chloride	60-125	50

Notes:
%R – Percent Recovery
MTBE – Methyl tert-butyl ether
RPD – Relative Percent Difference

Table 12-4a
Accuracy and Precision Criteria for Method 8270C – Water

Analyte	Accuracy Limits (%R)	Precision (RPD)
2,4,5-Trichlorophenol	50-110	30
2,4,6-Trichlorophenol	50-115	30
2,4-Dichlorophenol	50-105	30
2,4-Dimethylphenol	30-110	30
2,4-Dinitrophenol	15-140	30
2-Chlorophenol	35-105	30
2-Methylphenol	40-110	30
2-Nitrophenol	40-115	30
4-Methylphenol	30-110	30
4,6-Dinitro-2-methylphenol	40-130	30
4-Chloro-3-methylphenol	45-110	30
4-Nitrophenol	10-125	30
Pentachlorophenol	40-115	30
Phenol	10-115	30
3,3'-Dichlorobenzidine	20-110	30
4-Chloroaniline	15-110	30
Bis(2-ethylhexyl)phthalate	40-125	30
Butylbenzylphthalate	45-115	30
Di-n-butylphthalate	55-115	30
Di-n-octylphthalate	35-135	30
Diethylphthalate	40-120	30
Dimethylphthalate	25-125	30
N-Nitroso-di-n-propylamine	35-130	30
N-Nitrosodimethylamine	25-110	30
n-Nitrosodiphenylamine	50-110	30
bis(2-Chloroethoxy)methane	45-105	30
bis(2-Chloroethyl)ether	35-110	30
bis(2-Chloroisopropyl)ether	25-130	30
Hexachlorobutadiene	25-105	30
Hexachloroethane	30-100	30
1,2,4-Trichlorobenzene	35-105	30
1,2-Dichlorobenzene	35-100	30
1,3-Dichlorobenzene	30-100	30
1,4-Dichlorobenzene	30-100	30
2-Chloronaphthalene	50-105	30
4-Bromophenyl-phenyl ether	50-115	30
4-Chlorophenyl-phenyl ether	50-110	30
Hexachlorobenzene	50-110	30
2,4-Dinitrotoluene	50-120	30
2,6-Dinitrotoluene	50-115	30
2-Nitroaniline	50-115	30

Table 12-4a (continued)
Accuracy and Precision Criteria for Method 8270C – Water

Analyte	Accuracy Limits (%R)	Precision (RPD)
3-Nitroaniline	20-125	30
4-Nitroaniline	35-120	30
Nitrobenzene	45-110	30
Carbazole	50-115	30
Dibenzofuran	55-105	30
1,2-Diphenylhydrazine	55-115	30
Benzyl alcohol	30-110	30
Isophorone	50-110	30
Benzoic acid	10-125	30

Notes:
%R – Percent Recovery
RPD – Relative Percent Difference

Table 12-4b
Accuracy and Precision Criteria for Method 8270C – Soil

Analyte	Accuracy Limits (%R)	Precision (RPD)
2,4,5-Trichlorophenol	50-110	50
2,4,6-Trichlorophenol	45-110	50
2,4-Dichlorophenol	45-110	50
2,4-Dimethylphenol	30-105	50
2,4-Dinitrophenol	15-130	50
2-Chlorophenol	45-105	50
2-Methylphenol	40-105	50
2-Nitrophenol	40-110	50
4-Methylphenol	40-105	50
4,6-Dinitro-2-methylphenol	30-135	50
4-Chloro-3-methylphenol	45-115	50
4-Nitrophenol	15-140	50
Pentachlorophenol	25-120	50
Phenol	40-100	50
3,3'-Dichlorobenzidine	10-130	50
4-Chloroaniline	10-100	50
Bis(2-ethylhexyl)phthalate	45-125	50
Butylbenzylphthalate	50-125	50
Di-n-butylphthalate	55-110	50
Di-n-octylphthalate	40-130	50
Diethylphthalate	50-115	50
Dimethylphthalate	50-110	50
N-Nitroso-di-n-propylamine	40-115	50
N-Nitrosodimethylamine	20-115	50
n-Nitrosodiphenylamine	50-115	50
bis(2-Chloroethoxy)methane	45-110	50
bis(2-Chloroethyl)ether	40-105	50
bis(2-Chloroisopropyl)ether	20-115	50
Hexachlorobutadiene	40-115	50
Hexachloroethane	35-110	50
1,2,4-Trichlorobenzene	45-110	50
1,2-Dichlorobenzene	45-100	50
1,3-Dichlorobenzene	40-100	50
1,4-Dichlorobenzene	35-105	50
2-Chloronaphthalene	45-105	50
4-Bromophenyl-phenyl ether	45-115	50
4-Chlorophenyl-phenyl ether	45-110	50
Hexachlorobenzene	45-120	50
2,4-Dinitrotoluene	50-115	50
2,6-Dinitrotoluene	50-110	50
2-Nitroaniline	45-120	50

Table 12-4b (continued)
Accuracy and Precision Criteria for Method 8270C – Soil

Analyte	Accuracy Limits (%R)	Precision (RPD)
3-Nitroaniline	25-110	50
4-Nitroaniline	35-115	50
Nitrobenzene	40-115	50
Carbazole	45-115	50
Dibenzofuran	50-105	50
1,2-Diphenylhydrazine	40-150	50
Benzyl alcohol	20-125	50
Isophorone	45-110	50
Benzoic acid	10-110	50

Notes:
%R – Percent Recovery
RPD – Relative Percent Difference

Table 12-5a
Accuracy and Precision Criteria for Method 8270-SIM – Water

Analyte	Accuracy Limits (%R)	Precision (RPD)
2-Methylnaphthalene	72.4-141	20
Acenaphthene	76.2-136	20
Acenaphthylene	71.3-139	20
Anthracene	77.3-144	20
Benzo(a)anthracene	71.4-142	20
Benzo(a)pyrene	70.8-140	20
Benzo(b)fluoranthene	68-142	20
Benzo(k)fluoranthene	70.1-144	20
Benzo(g,h,i)perylene	62.8-146	20
Chrysene	73.6-143	20
Dibenzo(a,h)anthracene	56.1-147	20
Fluoranthene	77.9-147	20
Fluorene	75.3-136	20
Indeno(1,2,3-cd)pyrene	61.6-147	20
Naphthalene	72.2-137	20
Phenanthrene	76-133	20
Pyrene	73-139	20

Notes:
%R – Percent Recovery
RPD – Relative Percent Difference
SIM – Selective Ion Monitoring

Table 12-5b
Accuracy and Precision Criteria for Method 8270-SIM – Soil

Analyte	Accuracy Limits (%R)	Precision (RPD)
2-Methylnaphthalene	68.6-120	30
Acenaphthene	69.1-118	30
Acenaphthylene	67.8-120	30
Anthracene	67.9-126	30
Benzo(a)anthracene	66.5-122	30
Benzo(a)pyrene	66.3-123	30
Benzo(b)fluoranthene	64.7-122	30
Benzo(k)fluoranthene	62.8-126	30
Benzo(g,h,i)perylene	64.6-129	30
Chrysene	67.9-122	30
Dibenzo(a,h)anthracene	64.3-131	30
Fluoranthene	64.0-131	30
Fluorene	65.3-120	30
Indeno(1,2,3-cd)pyrene	65.3-132	30
Naphthalene	64.1-115	30
Phenanthrene	68-118	30
Pyrene	65.7-124	30

Notes:
%R – Percent Recovery
RPD – Relative Percent Difference
SIM – Selective Ion Monitoring

Table 12-6a
Accuracy and Precision Criteria for Methods 6010B/6020A/7470 – Water

Analyte	Accuracy Limits (%R)	Precision (RPD)
Aluminum	80-120	30
Antimony	80-120	30
Arsenic	80-120	30
Barium	80-120	30
Beryllium	80-120	30
Cadmium	80-120	30
Chromium	80-120	30
Cobalt	80-120	30
Copper	80-120	30
Lead	80-120	30
Manganese	80-120	30
Mercury	80-120	30
Nickel	80-120	30
Selenium	80-120	30
Silver	80-120	30
Thallium	80-120	30
Vanadium	80-120	30
Zinc	80-120	30

Notes:
%R – Percent Recovery
RPD – Relative Percent Difference

Table 12-6b
Accuracy and Precision Criteria for Methods 6010B/6020A/7471 – Soil

Analyte	Accuracy Limits (%R)	Precision (RPD)
Aluminum	80-120	50
Antimony	80-120	50
Arsenic	80-120	50
Barium	80-120	50
Beryllium	80-120	50
Cadmium	80-120	50
Chromium	80-120	50
Cobalt	80-120	50
Copper	80-120	50
Lead	80-120	50
Manganese	80-120	50
Mercury	80-120	50
Nickel	80-120	50
Selenium	80-120	50
Silver	80-120	50
Thallium	80-120	50
Vanadium	80-120	50
Zinc	80-120	50

Notes:
%R – Percent Recovery
RPD – Relative Percent Difference

Table 12-7
Accuracy and Precision Criteria for Method 160.1 – Water

Analyte	Accuracy Limits (%R)	Precision (RPD)
TDS	80-120	30

Notes:
%R – Percent Recovery
RPD – Relative Percent Difference

QAPP Worksheet #13 – Secondary Data Criteria and Limitations Table
(UFP-QAPP Manual Section 2.7)

Secondary Data Criteria and Limitations Table

Secondary Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Originating Org., Data Types, Data Generation/ Collection Dates)	How Data Will Be Used	Limitations on Data Use
Background metals data	Final Background Study Report; Holloman AFB, New Mexico, Revision 3, July 2011	NationView Bhate JV III, LLC; metals concentrations in soils and groundwater; collected 2008	Historical data to serve as preliminary information pertaining to levels for metals at the sites currently under investigation	None
Group 3 UST Site soil and groundwater data	Voluntary Corrective Measures and RFI Reports; Holloman AFB; 2012	Shaw Environmental; metals, PAHs, VOCs, and TPH in soils and groundwater; 2012	Historical data to serve as preliminary information pertaining to levels for metals at the sites currently under investigation	Some results may be considered screening level data.

Notes:
AFB – Air Force Base
PAHs – Polynuclear Aromatic Hydrocarbons
RFI – Resource Conservation and Recovery Act Facility Investigation
TPH – Total Petroleum Hydrocarbons
UST – Underground Storage Tanks
VOCs – Volatile Organic Compounds

QAPP Worksheet #14 – Summary of Project Tasks
(UFP-QAPP Manual Section 2.8.1)

Sampling Tasks:

General

1. Soil and groundwater samples will be collected as identified during the investigation as described in Worksheet #20. Discussion of the sampling approach and sampling design and rationale is provided in Worksheet #17 and IM Section 3.
2. Sampling locations, including temporary and permanent monitoring wells will be surveyed using a Trimble GeoXT, a Global Positioning System instrument or similar instrument that will provide horizontal accuracy to 1 meter or less.
3. Samples will be collected using the URS Standard Operating Procedures (SOPs). The SOPs are included as Appendix C to the IM Work Plan.

Analysis Tasks:

1. ESC will analyze for VOCs using USEPA SW-846 8260B, GRO and DRO using USEPA SW-846 8015, SVOCs using USEPA 8270C, metals using USEPA SW-846 6010B/ USEPA SW-846 6020A/ USEPA SW-846 7470A/ USEPA SW-7471A, and PAHs using USEPA 8270C-SIM.

Quality Control Tasks:

1. ESC will be required to follow DoD QSM 4.2 and the analytical methods for requested analyses, as appropriate.
2. MS/MSDs will be collected at an approximate frequency of 5%.
3. Investigative samples will be duplicated in the field at a rate of 5% and analyzed by ESC to assess field and laboratory precision.
4. Equipment blanks will be collected from non-disposable, non-dedicated decontaminated sampling devices.

QAPP Worksheet #14 – Summary of Project Tasks (continued)
(UFP-QAPP Manual Section 2.8.1)

Secondary Data:

Previously collected information will be evaluated and used to aid in the design of the sampling program, and for comparison of noted analyte concentrations to Holloman AFB background data. See Worksheet #13.

Data Management Tasks:

Data will be delivered in an ERPIMS database compatible format after data verification/validation has been performed and data qualifiers have been added.

Documentation and Records:

1. All samples collected will have coordinate locations documented, records of each sample collected in field logbooks, and all field measurements documented in field logbooks. Chain-of-Custody (COC) forms, airbills, and sample logs will be prepared and retained for each sample.
2. ESC will notify project chemist of any sample receipt issues immediately before log in and sample analysis. Receipt issues include but are not limited to the following:
   - COC not signed and relinquished
   - Copies of COCs and not originals received by the laboratory
   - The absence of custody seals on the cooler
   - Cooler received at a temperature >6 degrees Celsius (°C)
   - Sample breakage
   - ID discrepancies between COC and bottle labels
3. A copy of finalized SAP/QAPP will be retained in central project file, and available for reference for onsite activities.

Data Packages:

ESC will complete analytical Level IV data packages (i.e. summary forms, results, and raw data) in accordance with the AFCEC approved forms, or similar, pre-approved forms, and in an ERPIMS database compatible format.

QAPP Worksheet #14 – Summary of Project Tasks (continued)
(UFP-QAPP Manual Section 2.8.1)

Assessment / Audit Tasks:

Field Sample Collection and Documentation Audits: (to be determined).

Data Review Tasks:

1. ESC will verify that all data are complete for samples received, that DoD QSM version 4.2 protocol have been followed, and that data package deliverable requirements have been met. Data will be 100% verified by URS per this Site-specific QAPP. A data verification report will be produced by URS for each sample delivery group (typically a lab data package).
2. Verified and validated data and related field logbooks/notes/records will be reviewed to assess total measurement error and determine overall usability of the data for project purposes. Data limitations will be determined and data will be compared to project quality objectives and required action limits. Corrective action will be initiated as necessary. Final validated data are placed in an ERPIMS database, with any necessary qualifiers and tables.

IM Report:

The IM Report will present interim measures implemented, a summary of results from both nature/extent delineation and confirmation sampling, and a summary of the effectiveness of the interim measures.

Notes:
°C – Degrees Celsius
CA – Corrective Action
COC – Chain of Custody
DoD – Department of Defense
DRO – Diesel Range Organics
ESC – ESC Lab Sciences of Mt. Juliet, Tennessee
ERPIMS – Environmental Resources Program Information Management System
GRO – Gasoline Range Organics
ID – Identification
MS/MSD – Matrix Spike/Matrix Spike Duplicate
PAHs – Polynuclear Aromatic Hydrocarbons
QSM – Quality Systems Manual
SAP – Sampling and Analysis Plan
SIM – Selective Ion Monitoring
SOPs – Standard Operating Procedures
SVOCs – Semivolatile Organic Compounds
TCLP – Toxicity Characteristic Leaching Procedure
USEPA – United States Environmental Protection Agency
VOCs – Volatile Organic Compounds

QAPP Worksheet #15 – Reference Limits and Evaluation Table
(UFP-QAPP Manual Section 2.8.1)

See attached Tables 15-1 through 15-2 for ESC's DLs and LOQs and the applicable project screening criteria.

Table 15-1
Groundwater Screening Level Criteria

Analyte	Units	LOQ	DL	New Mexico Human Health Standards, Other Standards for Domestic Water Supply, and Agricultural Standards (NMAC 2013)	USEPA MCLs Drinking Water (USEPA 2013)	Minimum Standard
Method 160.1						
TDS	mg/L	10	2.82	1.00E+03(1)	-	1.00E+03(1)
Method 8015						
TPH	mg/L	---	---	0.2 (2)	-	0.2 (2)
GRO	mg/L	0.1	0.0314	NA [a]	-	-
DRO	mg/L	0.1	0.0330	0.4 (2)	-	0.4 (2)
ORO	mg/L	0.1	0.0185	0.2 (2)	-	0.2 (2)
Methods 6010B/ 6020A/ 7470A						
Aluminum	mg/L	0.1	0.035	5.00E+00	-	5.00E+00
Antimony (6020A)	mg/L	0.001	0.0002	-	6.00E-03	6.00E-03
Arsenic (6020A)	mg/L	0.001	0.0003	1.00E-01	1.00E-02	1.00E-02
Barium	mg/L	0.005	0.001	1.00E+00	2.00E+00	1.00E+00
Beryllium	mg/L	0.002	0.0007	-	4.00E-03	4.00E-03
Cadmium (6020A)	mg/L	5E-04	0.0002	1.00E-02	5.00E-03	5.00E-03
Chromium (6020A)	mg/L	0.002	0.0005	5.00E-02	1.00E-01	5.00E-02
Cobalt (6020A)	mg/L	0.001	0.0003	5.00E-02	-	5.00E-02
Copper	mg/L	0.02	0.0053	1.00E+00	1.30E+00	1.00E+00
Lead (6020A)	mg/L	0.001	0.0002	5.00E-02	1.50E-02	1.50E-02
Manganese	mg/L	0.01	0.0011	2.00E-01	-	2.00E-01
Mercury (7470A)	mg/L	2E-04	5E-05	2.00E-03	2.00E-03	2.00E-03
Nickel (6020A)	mg/L	0.001	0.0004	2.00E-01	-	2.00E-01
Selenium (6020A)	mg/L	0.001	0.0004	5.00E-02	5.00E-02	5.00E-02
Silver (6020A)	mg/L	0.001	0.0003	5.00E-02	-	5.00E-02
Thallium (6020A)	mg/L	0.001	0.0002	-	2.00E-03	2.00E-03
Vanadium	mg/L	0.01	0.0022	-	-	-
Zinc	mg/L	0.03	0.0059	1.00E+01	-	1.00E+01
Method 8270-SIM						
2-Methylnaphthalene	ug/L	0.25	0.015	-	-	-
Acenaphthene	ug/L	0.05	0.008	-	-	-
Acenaphthylene	ug/L	0.05	0.0011	-	-	-
Anthracene	ug/L	0.05	0.013	-	-	-
Benzo(a)anthracene	ug/L	0.05	0.012	-	-	-
Benzo(a)pyrene	ug/L	0.05	0.016	7.00E-01	2.00E-01	2.00E-01
Benzo(b)fluoranthene	ug/L	0.05	0.019	-	-	-
Benzo(k)fluoranthene	ug/L	0.05	0.025	-	-	-
Benzo(g,h,i)perylene	ug/L	0.05	0.016	-	-	-
Chrysene	ug/L	0.05	0.014	-	-	-

Table 15-1
Groundwater Screening Level Criteria

Analyte	Units	LOQ	DL	New Mexico Human Health Standards, Other Standards for Domestic Water Supply, and Agricultural Standards (NMAC 2013)	USEPA MCLs Drinking Water (USEPA 2013)	Minimum Standard
Dibenzo(a,h)anthracene	ug/L	0.05	0.0045	-	-	-
Fluoranthene	ug/L	0.05	0.016	-	-	-
Fluorene	ug/L	0.05	0.0089	-	-	-
Indeno(1,2,3-cd)pyrene	ug/L	0.05	0.0073	-	-	-
Naphthalene	ug/L	0.25	0.012	-	-	-
Phenanthrene	ug/L	0.05	0.018	-	-	-
Pyrene	ug/L	0.05	0.0155	-	-	-
Method 8270						
2,4,5-Trichlorophenol	ug/L	10	0.236	-	-	-
2,4,6-Trichlorophenol	ug/L	10	0.297	-	-	-
2,4-Dichlorophenol	ug/L	10	0.284	-	-	-
2,4-Dimethylphenol	ug/L	10	0.264	-	-	-
2,4-Dinitrophenol	ug/L	10	3.25	-	-	-
2-Chlorophenol	ug/L	10	0.283	-	-	-
2-Methylphenol	ug/L	10	0.312	-	-	-
2-Nitrophenol	ug/L	10	0.32	-	-	-
4-Methylphenol	ug/L	10	0.266	-	-	-
4,6-Dinitro-2-methylphenol	ug/L	10	2.62	-	-	-
4-Chloro-3-methylphenol	ug/L	10	0.263	-	-	-
4-Nitrophenol	ug/L	10	2.01	-	-	-
Pentachlorophenol	ug/L	1	0.313	-	1.00E+00	1.00E+00
Phenol	ug/L	10	0.334	-	-	-
3,3'-Dichlorobenzidine	ug/L	10	2.02	-	-	-
4-Chloroaniline	ug/L	10	0.382	-	-	-
Bis(2-ethylhexyl)phthalate	ug/L	3	0.709	-	6.00E+00	6.00E+00
Butylbenzylphthalate	ug/L	3	0.275	-	-	-
Di-n-butylphthalate	ug/L	3	0.266	-	-	-
Di-n-octylphthalate	ug/L	1	0.278	-	-	-
Diethylphthalate	ug/L	3	0.282	-	-	-
Dimethylphthalate	ug/L	3	0.283	-	-	-
N-Nitroso-di-n-propylamine	ug/L	10	0.403	-	-	-
N-Nitrosodimethylamine	ug/L	10	1.26	-	-	-
n-Nitrosodiphenylamine	ug/L	10	0.304	-	-	-
bis(2-Chloroethoxy)methane	ug/L	10	0.329	-	-	-
bis(2-Chloroethyl)ether	ug/L	10	1.62	-	-	-
bis(2-Chloroisopropyl)ether	ug/L	10	0.445	-	-	-
Hexachlorobutadiene	ug/L	10	0.329	-	-	-

Table 15-1
Groundwater Screening Level Criteria

Analyte	Units	LOQ	DL	New Mexico Human Health Standards, Other Standards for Domestic Water Supply, and Agricultural Standards (NMAC 2013)	USEPA MCLs Drinking Water (USEPA 2013)	Minimum Standard
Hexachloroethane	ug/L	10	0.365	-	-	-
1,2,4-Trichlorobenzene	ug/L	10	0.355	-	7.00E+01	7.00E+01
2-Chloronaphthalene	ug/L	1	0.33	-	-	-
4-Bromophenyl-phenyl ether	ug/L	10	0.335	-	-	-
4-Chlorophenyl-phenyl ether	ug/L	10	0.303	-	-	-
Hexachlorobenzene	ug/L	1	0.341	-	1.00E+00	1.00E+00
2,4-Dinitrotoluene	ug/L	10	1.65	-	-	-
2,6-Dinitrotoluene	ug/L	10	0.279	-	-	-
2-Nitroaniline	ug/L	10	1.9	-	-	-
3-Nitroaniline	ug/L	10	0.308	-	-	-
4-Nitroaniline	ug/L	10	0.349	-	-	-
Nitrobenzene	ug/L	10	0.367	-	-	-
Carbazole	ug/L	10	0.162	-	-	-
Dibenzofuran	ug/L	10	0.338	-	-	-
1,2-Diphenylhydrazine	ug/L	10	0.318	-	-	-
Benzyl alcohol	ug/L	10	0.393	-	-	-
Isophorone	ug/L	10	0.272	-	-	-
Benzoic acid	ug/L	10	2.5	-	-	-
Method 8260						
1,1,1,2-Tetrachloroethane	ug/L	1	0.39	-	-	-
1,1,1-Trichloroethane	ug/L	1	0.32	6.00E+01	2.00E+02	6.00E+01
1,1,2,2-Tetrachloroethane	ug/L	1	0.59	1.00E+01	-	1.00E+01
1,1,2-Trichloroethane	ug/L	1	0.38	1.00E+01	5.00E+00	5.00E+00
1,1-Dichloroethane	ug/L	1	0.26	2.50E+01	-	2.50E+01
1,1-Dichloroethene	ug/L	1	0.40	5.00E+00	7.00E+00	5.00E+00
1,1-Dichloropropene	ug/L	1	0.35	-	-	-
1,2,3-Trichlorobenzene	ug/L	1	0.23	-	-	-
1,2,3-Trichloropropane	ug/L	2.5	0.81	-	-	-
1,2,4-Trichlorobenzene	ug/L	1	0.21	-	7.00E+01	7.00E+01
1,2,4-Trimethylbenzene	ug/L	1	0.37	-	-	-
1,2-Dibromo-3-chloropropane	ug/L	5	1.33	-	2.00E-01	2.00E-01
1,2-Dibromoethane	ug/L	1	0.38	1.00E-01	5.00E-02	5.00E-02
1,2-Dichlorobenzene	ug/L	1	0.35	-	6.00E+02	6.00E+02
1,2-Dichloroethane	ug/L	1	0.36	1.00E+01	5.00E+00	5.00E+00
1,2-Dichloropropane	ug/L	1	0.31	-	5.00E+00	5.00E+00
1,3,5-Trimethylbenzene	ug/L	1	0.39	-	-	-
1,3-Dichlorobenzene	ug/L	1	0.22	-	-	-

Table 15-1
Groundwater Screening Level Criteria

Analyte	Units	LOQ	DL	New Mexico Human Health Standards, Other Standards for Domestic Water Supply, and Agricultural Standards (NMAC 2013)	USEPA MCLs Drinking Water (USEPA 2013)	Minimum Standard
1,3-Dichloropropane	ug/L	1	0.37	-	-	-
1,4-Dichlorobenzene	ug/L	1	0.27	-	7.50E+01	7.50E+01
2,2-Dichloropropane	ug/L	1	0.32	-	-	-
2-Butanone	ug/L	10	3.93	-	-	-
2-Chlorotoluene	ug/L	1	0.38	-	-	-
2-Hexanone	ug/L	10	1.57	-	-	-
4-Chlorotoluene	ug/L	1	0.35	-	-	-
Methyl Isobutyl Ketone	ug/L	10	2.14	-	-	-
Acetone	ug/L	50	10.0	-	-	-
Benzene	ug/L	1	0.33	1.00E+01	5.00E+00	5.00E+00
Bromobenzene	ug/L	1	0.35	-	-	-
Bromochloromethane	ug/L	1	0.52	-	-	-
Bromodichloromethane(3)	ug/L	1	0.38	-	8.00E+01	8.00E+01
Bromoform(3)	ug/L	1	0.47	-	8.00E+01	8.00E+01
Bromomethane	ug/L	5	0.87	-	-	-
Carbon disulfide	ug/L	1	0.32	-	-	-
Carbon tetrachloride	ug/L	1	0.38	1.00E+01	5.00E+00	5.00E+00
Chlorobenzene	ug/L	1	0.35	-	1.00E+02	1.00E+02
Dibromochloromethane(3)	ug/L	1	0.33	-	8.00E+01	8.00E+01
Chloroethane	ug/L	5	0.45	-	-	-
Chloroform(3)	ug/L	5	0.32	1.00E+02	8.00E+01	8.00E+01
Chloromethane	ug/L	2.5	0.28	-	-	-
cis-1,2-Dichloroethene	ug/L	1	0.26	-	7.00E+01	7.00E+01
cis-1,3-Dichloropropene	ug/L	1	0.42	-	-	-
Dibromomethane	ug/L	1	0.35	-	-	-
Dichlorodifluoromethane	ug/L	5	0.55	-	-	-
Ethylbenzene	ug/L	1	0.38	7.50E+02	7.00E+02	7.00E+02
Hexachlorobutadiene	ug/L	1	0.26	-	-	-
Isopropyl benzene	ug/L	1	0.33	-	-	-
m/p-Xylenes(4)	ug/L	2	0.72	6.20E+02	1.00E+01	1.00E+01
MTBE	ug/L	1	0.37	-	-	-
Methylene chloride	ug/L	5	1.00	1.00E+02	5.00E+00	5.00E+00
Naphthalene	ug/L	5	1.00	-	-	-
n-Butylbenzene	ug/L	1	0.36	-	-	-
n-Propylbenzene	ug/L	1	0.35	-	-	-
o-Xylene(4)	ug/L	1	0.34	6.20E+02	1.00E+01	1.00E+01
p-Isopropyltoluene	ug/L	1	0.35	-	-	-

Table 15-1
Groundwater Screening Level Criteria

Analyte	Units	LOQ	DL	New Mexico Human Health Standards, Other Standards for Domestic Water Supply, and Agricultural Standards (NMAC 2013)	USEPA MCLs Drinking Water (USEPA 2013)	Minimum Standard
sec-Butylbenzene	ug/L	1	0.37	-	-	-
Styrene	ug/L	1	0.31	-	1.00E+02	1.00E+02
tert-Butylbenzene	ug/L	1	0.40	-	-	-
Tetrachloroethylene	ug/L	1	0.37	2.00E+01	5.00E+00	5.00E+00
Toluene	ug/L	5	0.78	7.50E+02	1.00E+03	7.50E+02
trans-1,2-Dichloroethene	ug/L	1	0.40	-	1.00E+02	1.00E+02
trans-1,3-Dichloropropene	ug/L	1	0.42	-	-	-
Trichloroethene	ug/L	1	0.40	1.00E+02	5.00E+00	5.00E+00
Trichlorofluoromethane	ug/L	5	1.20	-	-	-
Vinyl chloride	ug/L	1	0.26	1.00E+00	2.00E+00	1.00E+00

- – multi–fraction analysis
mg/L – milligrams per liter
ug/L – micrograms per liter
DL – Detection Limit
DRO – Diesel Range Organics
GRO – Gasoline Range Organics
LOD – Limit of Detection
LOQ – Limit of Quantitation
MCL – Maximum Contamination Level
MTBE – Methyl tert–butyl ether
NA [a] – Not applicable; regulated via individual contaminants in Appendix A (NMED 2012).
SIM – Selective Ion Monitoring
TDS – Total Dissolved Solids
TPH – Total Petroleum Hydrocarbon
USEPA – U.S. Environmental Protection Agency

Notes:

The DL and LOQ do not meet the screening values.

1.00 Value is a New Mexico Human Health Standard
1.00 Value is a New Mexico Other Standard for Domestic Water Supply
1.00 Value is a New Mexico Standard for Irrigation Use

(1) Per NMAC 2013 (below), the TDS Standard of 1,000 mg/L applies for Ground Water of 10,000 mg/L TDS concentration or less, unless the existing condition exceeds the standard.
(2) The NMED TPH groundwater screening level reflects aggregate TPH, and is dependent upon classification of the TPH, as described in NMED 2012 (below). The appropriate TPH screening level may vary depending upon site historical data together with TPH analytical results that indicate the class of TPH encountered (e.g., diesel).
(3) USEPA MCL value is for total trihalomethanes.
(4) New Mexico standard and USEPA MCL values are for total xylene.

Sources:
New Mexico Administrative Code (NMAC). 2013. Title 20 Environmental Protection. Chapter 6. Water Quality. Part 2. Ground and Surface Water Protection. 20.6.2.3103. Standards for Ground Water of 10,000 mg/l TDS Concentration or Less.

New Mexico Environment Department (NMED). 2012. Risk Assessment Guidance for Site Investigations and Remediation. Table 6-2: TPH Screening Guidelines for Potable Groundwater. Table 6-3 TPH Screening Guidelines - Vapor Migration and Inhalation of Groundwater. June.

U.S. Environmental Protection Agency (USEPA). 2013. National Primary Drinking Water Regulations. Accessed online at: http://water.epa.gov/drink/contaminants/index.cfm#List.

Table 15-2
Soil Screening Level Criteria

Analyte	Units	LOQ	DL	NMED SSLs Residential Land Use (NMED 2012)	USEPA RSLs Residential Soil (USEPA 2013) (1)
Method 8015					
TPH	mg/kg	-	-	1000 (5)	-
GRO	mg/kg	0.1	0.0217	NA [a]	-
DRO	mg/kg	4	1.33	-	-
ORO	mg/kg	4	2.5	-	-
Methods 6010B/7471A					
Aluminum	mg/kg	5	1.75	7.80E+04	-
Antimony	mg/kg	1	0.375	3.13E+01	-
Arsenic	mg/kg	1	0.325	3.90E+00	-
Barium	mg/kg	0.25	0.85	1.56E+04	-
Beryllium	mg/kg	0.1	0.035	1.56E+02	-
Cadmium	mg/kg	0.25	0.035	7.03E+01	-
Chromium(2)	mg/kg	0.5	0.07	1.17E+05	-
Cobalt	mg/kg	0.5	0.115	-	2.30E+01
Copper	mg/kg	1	0.265	3.13E+03	-
Lead	mg/kg	0.25	0.095	4.00E+02	-
Manganese	mg/kg	0.5	0.06	1.86E+03	-
Mercury(3)	mg/kg	0.02	0.0014	2.35E+01	-
Nickel	mg/kg	1	0.245	1.56E+03	-
Selenium	mg/kg	1	0.37	3.91E+02	-
Silver	mg/kg	0.5	0.14	3.91E+02	-
Thallium	mg/kg	1	0.325	7.82E-01	-
Vanadium	mg/kg	0.5	0.12	3.91E+02	-
Zinc	mg/kg	1.5	0.295	2.35E+04	-
Method 8270-SIM					
2-Methylnaphthalene	ug/kg	20.0	2.0	-	2.30E+05
Acenaphthene	ug/kg	6.0	1.6	3.44E+06	-
Acenaphthylene	ug/kg	6.0	1.1	-	-
Anthracene	ug/kg	6.0	0.8	1.72E+07	-
Benzo(a)anthracene	ug/kg	6.0	1.1	1.48E+03	-
Benzo(a)pyrene	ug/kg	6.0	0.8	1.48E+02	-
Benzo(b)fluoranthene	ug/kg	6.0	1.1	1.48E+03	-

Table 15-2
Soil Screening Level Criteria

Analyte	Units	LOQ	DL	NMED SSLs Residential Land Use (NMED 2012)	USEPA RSLs Residential Soil (USEPA 2013) (1)
Benzo(k)fluoranthene	ug/kg	6.0	0.6	1.48E+04	-
Benzo(g,h,i)perylene	ug/kg	6.0	0.6	-	-
Chrysene	ug/kg	6.0	0.6	1.48E+05	-
Dibenzo(a,h)anthracene	ug/kg	6.0	0.6	1.48E+02	-
Fluoranthene	ug/kg	6.0	0.6	2.29E+06	-
Fluorene	ug/kg	6.0	0.6	2.29E+06	-
Indeno(1,2,3-cd)pyrene	ug/kg	6.0	0.6	1.48E+03	-
Naphthalene	ug/kg	20.0	2.0	4.30E+04	-
Phenanthrene	ug/kg	6.0	0.6	1.83E+06	-
Pyrene	ug/kg	6.0	0.6	1.72E+06	-
Method 8270					
2,4,5-Trichlorophenol	ug/kg	333	10.4	6.11E+06	-
2,4,6-Trichlorophenol	ug/kg	333	7.79	6.11E+04	-
2,4-Dichlorophenol	ug/kg	333	7.46	1.83E+05	-
2,4-Dimethylphenol	ug/kg	333	47.1	1.22E+06	-
2,4-Dinitrophenol	ug/kg	333	98.0	1.22E+05	-
2-Chlorophenol	ug/kg	333	8.31	3.91E+05	-
2-Methylphenol	ug/kg	333	9.86	-	3.10E+06
2-Nitrophenol	ug/kg	333	13.0	-	-
4-Methylphenol	ug/kg	333	7.80	-	6.10E+06
4,6-Dinitro-2-methylphenol	ug/kg	333	124	4.89E+03	-
4-Chloro-3-methylphenol	ug/kg	333	4.77	-	6.10E+06
4-Nitrophenol	ug/kg	333	52.5	-	-
Pentachlorophenol	ug/kg	333	48.0	8.94E+03	-
Phenol	ug/kg	333	6.95	1.83E+07	-
3,3'-Dichlorobenzidine	ug/kg	333	79.4	1.08E+04	-
4-Chloroaniline	ug/kg	333	35.2	-	2.40E+04
Bis(2-ethylhexyl)phthalate	ug/kg	333	12.0	3.47E+05	-
Butylbenzylphthalate	ug/kg	333	10.30	-	2.60E+06
Di-n-butylphthalate	ug/kg	333	10.90	6.11E+06	-
Di-n-octylphthalate	ug/kg	333	9.07	-	6.10E+05

Table 15-2
Soil Screening Level Criteria

Analyte	Units	LOQ	DL	NMED SSLs Residential Land Use (NMED 2012)	USEPA RSLs Residential Soil (USEPA 2013) (1)
Diethylphthalate	ug/kg	333	6.91	4.89E+07	-
Dimethylphthalate	ug/kg	333	5.40	6.11E+08	-
N-Nitroso-di-n-propylamine	ug/kg	333	9.06	-	6.90E+02
N-Nitrosodimethylamine	ug/kg	333	64.7	2.26E+01	-
n-Nitrosodiphenylamine	ug/kg	333	5.94	9.93E+05	-
bis(2-Chloroethoxy)methane	ug/kg	333	7.70	-	1.80E+05
bis(2-Chloroethyl)ether	ug/kg	333	8.96	2.68E+03	-
bis(2-Chloroisopropyl)ether	ug/kg	333	7.60	9.15E+04	-
Hexachlorobutadiene	ug/kg	333	10.00	6.11E+04	-
Hexachloroethane	ug/kg	333	13.4	4.28E+04	-
1,2,4-Trichlorobenzene	ug/kg	333	8.76	7.30E+04	-
2-Chloronaphthalene	ug/kg	33	6.39	-	6.30E+06
4-Bromophenyl-phenyl ether	ug/kg	333	11.40	-	-
4-Chlorophenyl-phenyl ether	ug/kg	333	6.27	-	-
Hexachlorobenzene	ug/kg	333	8.56	3.04E+03	-
2,4-Dinitrotoluene	ug/kg	333	6.07	1.57E+04	-
2,6-Dinitrotoluene	ug/kg	333	7.37	6.11E+04	-
2-Nitroaniline	ug/kg	333	7.55	-	6.10E+05
3-Nitroaniline	ug/kg	333	8.50	-	-
4-Nitroaniline	ug/kg	333	6.39	-	2.40E+05
Nitrobenzene	ug/kg	333	6.95	5.35E+04	-
Carbazole	ug/kg	333	5.24	-	-
Dibenzofuran	ug/kg	333	5.18	-	7.80E+04
1,2-Diphenylhydrazine	ug/kg	333	5.28	6.08E+03	-
Benzyl alcohol	ug/kg	333	7.50	-	6.10E+06
Isophorone	ug/kg	333	5.22	5.12E+06	-
Benzoic acid	ug/kg	333	123	-	2.40E+08
Method 8260					
1,1,1,2-Tetrachloroethane	ug/kg	1	0.264	2.91E+04	-
1,1,1-Trichloroethane	ug/kg	1	0.286	1.56E+07	-
1,1,2,2-Tetrachloroethane	ug/kg	1	0.365	8.02E+03	-
1,1,2-Trichloroethane	ug/kg	1	0.277	2.81E+03	-

Table 15-2
Soil Screening Level Criteria

Analyte	Units	LOQ	DL	NMED SSLs Residential Land Use (NMED 2012)	USEPA RSLs Residential Soil (USEPA 2013) (1)
1,1-Dichloroethane	ug/kg	1	0.199	6.45E+04	-
1,1-Dichloroethene	ug/kg	1	0.303	4.49E+05	-
1,1-Dichloropropene	ug/kg	1	0.317	-	-
1,2,3-Trichlorobenzene	ug/kg	1	0.306	-	4.90E+04
1,2,3-Trichloropropane	ug/kg	2.5	0.741	4.97E+01	-
1,2,4-Trichlorobenzene	ug/kg	1	0.388	7.30E+04	-
1,2,4-Trimethylbenzene	ug/kg	1	0.211	-	6.20E+04
1,2-Dibromo-3-chloropropane	ug/kg	5	1.05	1.86E+03	-
1,2-Dibromoethane	ug/kg	1	0.343	5.88E+02	-
1,2-Dichlorobenzene	ug/kg	1	0.305	2.31E+06	-
1,2-Dichloroethane	ug/kg	1	0.265	7.89E+03	-
1,2-Dichloropropane	ug/kg	1	0.358	1.52E+04	-
1,3,5-Trimethylbenzene	ug/kg	1	0.266	-	7.80E+05
1,3-Dichlorobenzene	ug/kg	1	0.239	-	-
1,3-Dichloropropane	ug/kg	1	0.207	-	1.60E+06
1,4-Dichlorobenzene	ug/kg	1	0.226	3.17E+04	-
2,2-Dichloropropane	ug/kg	1	0.279	-	-
2-Butanone	ug/kg	10	4.68	3.71E+07	-
2-Chlorotoluene	ug/kg	1	0.301	1.56E+06	-
2-Hexanone	ug/kg	10	1.37	-	2.10E+05
4-Chlorotoluene	ug/kg	1	0.24	-	1.60E+06
Methyl Isobutyl Ketone	ug/kg	10	1.88	5.82E+06	-
Acetone	ug/kg	50	10	6.66E+07	-
Benzene	ug/kg	1	0.27	1.54E+04	-
Bromobenzene	ug/kg	1	0.284	-	3.00E+05
Bromochloromethane	ug/kg	1	0.39	-	1.60E+05
Bromodichloromethane	ug/kg	1	0.254	5.41E+03	-
Bromoform	ug/kg	1	0.424	6.16E+05	-
Bromomethane	ug/kg	5	1.34	1.65E+04	-
Carbon disulfide	ug/kg	1	0.221	1.53E+06	-
Carbon tetrachloride	ug/kg	1	0.328	1.08E+04	-

Table 15-2
Soil Screening Level Criteria

Analyte	Units	LOQ	DL	NMED SSLs Residential Land Use (NMED 2012)	USEPA RSLs Residential Soil (USEPA 2013) (1)
Chlorobenzene	ug/kg	1	0.212	3.76E+05	-
Dibromochloromethane	ug/kg	1	0.373	1.21E+04	-
Chloroethane	ug/kg	5	0.946	2.98E+07	-
Chloroform	ug/kg	5	0.229	5.86E+03	-
Chloromethane	ug/kg	2.5	0.375	2.75E+05	-
cis-1,2-Dichloroethene	ug/kg	1	0.235	1.56E+05	-
cis-1,3-Dichloropropene	ug/kg	1	0.262	-	-
Dibromomethane	ug/kg	1	0.382	5.16E+04	-
Dichlorodifluoromethane	ug/kg	5	0.713	1.68E+05	-
Ethylbenzene	ug/kg	1	0.297	6.84E+04	-
Hexachlorobutadiene	ug/kg	1	0.342	6.11E+04	-
Isopropyl benzene	ug/kg	1	0.243	2.43E+06	-
m/p-Xylenes(4)	ug/kg	2	0.332	-	5.90E+05
MTBE	ug/kg	1	0.212	9.01E+05	-
Methylene chloride	ug/kg	5	1	4.09E+05	-
Naphthalene	ug/kg	5	1	4.30E+04	-
n-Butylbenzene	ug/kg	1	0.258	-	3.90E+06
n-Propylbenzene	ug/kg	1	0.206	-	3.40E+06
o-Xylene	ug/kg	1	0.366	8.98E+05	-
p-Isopropyltoluene	ug/kg	1	0.204	-	-
sec-Butylbenzene	ug/kg	1	0.201	-	7.80E+06
Styrene	ug/kg	1	0.234	7.28E+06	-
tert-Butylbenzene	ug/kg	1	0.206	-	7.80E+06
Tetrachloroethylene	ug/kg	1	0.276	7.02E+03	-
Toluene	ug/kg	5	0.434	5.27E+06	-
trans-1,2-Dichloroethene	ug/kg	1	0.264	2.70E+05	-
trans-1,3-Dichloropropene	ug/kg	1	0.267	-	-
Trichloroethene	ug/kg	1	0.279	8.77E+03	-
Trichlorofluoromethane	ug/kg	5	0.382	1.41E+06	-
Vinyl chloride	ug/kg	1	0.291	7.28E+02	-

mg/kg - milligram per kilogram

ug/kg – microgram per kilogram
DL – Detection Limit
DRO – Diesel Range Organics
GRO – Gasoline Range Organics
LOD – Limit of Detection
LOQ – Limit of Quantitation
MTBE – Methyl tert-butyl ether
NA [a] – Not applicable; regulated via individual contaminants in Appendix A (NMED 2012).
NMED – New Mexico Environment Department
RSL – Regional Screening Level
SIM – Selective Ion Monitoring
SSL – Soil Screening Level
TPH – Total Petroleum Hydrocarbon
USEPA – U.S. Environmental Protection Agency

Notes:

The DL and LOQ do not meet the screening values.

(1) USEPA RSLs are shown only for chemicals that do not have an NMED SSL, and have been adjusted to a 1E-05 risk level for carcinogenic RSLs, consistent with NMED Risk Assessment Guidance. Soil sample results will be compared to NMED SSLs, or to USEPA RSLs in instances where there is no SSL. In cases where a detected analyte has neither a SSL or RSL, screening levels will be evaluated as appropriate using NMED guidance.
(2) NMED SSL for chromium III is shown.
(3) NMED SSL for mercury (salts) is shown.
(4) USEPA RSL for p-xylene is shown.
(5) NMED regulates TPH which is comprised of GRO, DRO and ORO. The Residential Direct Exposure screening level is dependent upon the classification of the TPH, as described in NMED 2012, and reflects aggregate TPH of GRO, DRO, and ORO classification.

Sources:
New Mexico Environment Department (NMED). 2012. Risk Assessment Guidance for Site Investigations and Remediation. Table A-1: NMED Soil Screening Levels. Table 6-2: TPH Screening Guidelines for Potable Groundwater. Table 6-3 TPH Screening Guidelines - Vapor Migration and Inhalation of Groundwater. June.

U.S. Environmental Protection Agency (USEPA). 2013. USEPA Regional Screening Level (RSL) Chemical-specific Parameters Supporting Table. November. Accessed online at: http://www.epa.gov/region9/superfund/prg/.

QAPP Worksheet #16 – Project Schedule & Milestones Chart
(UFP-QAPP Manual Section 2.8.2)

The Project Schedule is included in IM Work Plan Section 5.

QAPP Worksheet #17 – Sampling Approach, Sampling Design, and Rationale
(UFP-QAPP Manual Section 3.1.1)

Sampling Approach, Sampling Design, and Rationale:

Section 3 of the IM Work Plan discusses the sampling approach, design, and rationale for each of the sites.

Field parameter measurements will be documented on field forms or field log books, as appropriate. The number of samples to be collected for each site will be determined during field activities as described in IM Work Plan Section 3.

QAPP Worksheet #18 – Sampling Locations and Methods/SOP Requirements Table
(UFP-QAPP Manual Section 3.1.1)

Site	Matrix	Analytical Group	Concentration Level	Number of Samples (identify field duplicates)	Sampling SOP Reference	Rationale for Sampling Location
AOC-UST-221 (TU503)	Soil	GRO, DRO/ORO, VOCs, SVOCs, PAHs, Metals	Low	TBD	SOPs 4 & 6	Analysis for COCs. Section 3 of the IM Work Plan discusses sampling rationale for each of the sites.
	Groundwater	GRO, DRO/ORO, VOCs, SVOCs, PAHs, Metals, TDS	Low	TBD	SOPs 4, 9, and 11	
AOC-UST-901 (TU506)	Soil	GRO, DRO/ORO, VOCs, SVOCs, PAHs, Metals	Low	TBD	SOPs 4 & 6	
	Groundwater	GRO, DRO/ORO, VOCs, SVOCs, PAHs, Metals, TDS	Low	TBD	SOPs 4, 9, and 11	
AOC-UST-298 (TU508)	Soil	GRO, DRO/ORO, VOCs, SVOCs, PAHs, Metals	Low	TBD	SOPs 4 & 6	
	Groundwater	GRO, DRO/ORO, VOCs, SVOCs, PAHs, Metals, TDS	Low	TBD	SOPs 4, 9, and 11	
AOC-UST-7003 (TU518)	Soil	GRO, DRO/ORO, VOCs, SVOCs, PAHs, Metals	Low	TBD	SOPs 4 & 6	
	Groundwater	GRO, DRO/ORO, VOCs, SVOCs, PAHs, Metals, TDS	Low	TBD	SOPs 4, 9, and 11	

Notes:
AOC – Area of Concern
DRO/ORO – Diesel Range Organics/Oil Range Organics
GRO – Gasoline Range Organics
IM – Interim Measures
PAHs – Polynuclear Aromatic Hydrocarbons
SOP – Standard Operating Procedure
SVOCs – Semivolatile Organic Compounds
TBD – To Be Determined
TDS – Total Dissolved Solids
UST – Underground Storage Tank
VOCs – Volatile Organic Compounds

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QAPP Worksheet #19 – Analytical Requirements Table (UFP-QAPP Manual Section 3.1.1)

Analytical Requirements Table

Matrix	Analytical Group	Concentration Level	Analytical and Preparation Method/SOP Reference[1]	Sample Preparation Volume	Containers (number, size, and type)[2]	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/ analysis)
Soil	GRO	Low	SW846 5035 & 8015/ESC SOPs 330751 & 330351A	2 Encores or 2 Pre-weighed, Preserved Vials	2 Encores or 2 Pre-weighed, Preserved Vials	Cool ≤ 6 °C	48 hours – Encores 14 days - Vials
Soil	DRO/ORO	Low	SW846 3546 & 8015/ESC SOPs 330705, 330350A	30 g	1 4-oz Glass Jar	Cool ≤ 6 °C	14 days to extract/ 40 days to analyze
Soil	VOCs	Low	SW846 5035 & 8260B/ESC SOPs 330751 & 330363	2 Encores or 2 Pre-weighed, Preserved Vials	2 Encores or 2 Pre-weighed, Preserved Vials	Cool ≤ 6 °C	48 hours – Encores 14 days - Vials
Soil	SVOCs	Low	SW846 3546 & 8270C/ESC SOPs 330707 & 330345	30 g	1 4-oz Glass Jar	Cool ≤ 6 °C	14 days to extract/ 40 days to analyze
Soil	PAHs	Low	SW846 3546 & 8270C-SIM/ESC SOPs 330707 & 330345	30 g	1 4-oz Glass Jar	Cool ≤ 6 °C	14 days to extract/ 40 days to analyze
Soil	Metals	Low	SW846 3050B & 6010B, 6020A, 7471A/ESC SOPs 340388, 340386, 340390, & 340384B	10 g	1 4-oz Glass Jar	Cool ≤ 6 °C	180 days to analyze, except for mercury which is 28 days to analyze
Water	GRO	Low	SW846 5030B & 8015/ESC SOPs 330752 & 330351A	2 Vials	2 40-mL Vials	HCl, Cool ≤6°C	14 days
Water	DRO/ORO	Low	SW846 3511 & 8015/ESC SOPs 330709 & 330350A	3 Vials	3 40-mL Vials	Cool ≤6°C	7 days to extract/ 40 days to analyze
Water	VOCs	Low	SW846 5030B & 8260B/ESC SOPs 330752 & 330363	2 Vials	2 40-mL Vials	HCl, Cool ≤6°C	14 days
Water	SVOCs	Low	SW846 3510C & 8270C/ESC SOPs 330709 & 330345	2 Vials	2 40-mL Vials	Cool ≤6°C	7 days to extract/ 40 days to analyze
Water	PAHs	Low	SW846 3511 & 8270C-SIM/ESC SOPs 330709 & 330345	2 Vials	2 40-mL Vials	Cool ≤6°C	7 days to extract/ 40 days to analyze

QAPP Worksheet #19 – Analytical Requirements Table (continued)
(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group	Concentration Level	Analytical and Preparation Method/SOP Reference[1]	Sample Preparation Volume	Containers (number, size, and type)[2]	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/ analysis)
Water	Metals	Low	SW846 3015A & 6010B, 6020A, 7470A/ESC SOPs 340389, 340386, 340390, & 340384A	500 mL	1 – 500mL Poly	pH<2, HNO_3, Cool ≤6°C	180 days
Water	TDS	Low	EPA Method 160.1/ ESC SOP 340347	500 mL	1 – 500 mL Glass Amber	Cool ≤6°C	7 days

Notes:
[1] Refer to ESC Analytical SOP References table (Worksheet #23).
[2] The minimum sample size is based on allowing for sufficient sample for reanalysis. Additional volume is needed for laboratory MS/MSD analysis.

≤ – Less Than or Equal to
ESC – ESC Lab Sciences
HCl – Hydrochloric Acid
mL – Milliliter
SIM – Selective Ion Monitoring
TDS – Total Dissolved Solids
°C – Degrees Celsius
g – Gram
HNO_3 – Nitric Acid
oz – Ounce
SOP – Standard Operating Procedure
VOCs – Volatile Organic Compounds
DRO/ORO – Diesel Range Organics/Oil Range Organics
GRO – Gasoline Range Organics
L – Liter
PAHs – Polynuclear Aromatic Hydrocarbons
SVOCs – Semivolatile Organic Compounds

QAPP Worksheet #20 – Field Quality Control Sample Summary Table
(UFP-QAPP Manual Section 3.1.1)

Field Quality Control Sample Summary Table

Site	Matrix	Analytical Group	Concentration Level	Analytical and Preparation SOP Reference[1]	No. of Sampling Locations[2]	No. of Field Duplicates[3]	No. of MS/MSD[3]	No. of FB[3]	No. of EB[3]	No. of TB[3]	Total No. of Samples to Lab
AOC-UST-221 (TU503) AOC-UST-901 (TU506) AOC-UST-298 (TU508) AOC-UST-7003 (TU518)	Soil	GRO	Low	ESC SOPs 330751 & 330351A	TBD	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	TBD
		DRO/ORO	Low	ESC SOPs 330705, 330350A	TBD	1 per 20 samples	1 per 20 samples	0	1 per 20 samples	0	TBD
		VOCs	Low	ESC SOPs 330751 & 330363	TBD	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	TBD
		SVOCs	Low	ESC SOPs 330707 & 330345	TBD	1 per 20 samples	1 per 20 samples	0	1 per 20 samples	0	TBD
		PAHs	Low	ESC SOPs 330707 & 330345	TBD	1 per 20 samples	1 per 20 samples	0	1 per 20 samples	0	TBD
		Metals	Low	ESC SOPs 340388, 340386, 340390, & 340384B	TBD	1 per 20 samples	1 per 20 samples	0	1 per 20 samples	0	TBD
	Groundwater	GRO	Low	ESC SOPs 330752 & 330351A	TBD	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	TBD
		DRO/ORO	Low	ESC SOPs 330709 & 330350A	TBD	1 per 20 samples	1 per 20 samples	0	1 per 20 samples	0	TBD
		VOCs	Low	ESC SOPs 330752 & 330363	TBD	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	TBD
		SVOCs	Low	ESC SOPs 330709 & 330345	TBD	1 per 20 samples	1 per 20 samples	0	1 per 20 samples	0	TBD
		PAHs	Low	ESC SOPs 330709 & 330345	TBD	1 per 20 samples	1 per 20 samples	0	1 per 20 samples	0	TBD
		Metals	Low	ESC SOPs 340389, 340386, 340390, & 340384A	TBD	1 per 20 samples	1 per 20 samples	0	1 per 20 samples	0	TBD
		TDS	Low	ESC SOP 340347	TBD	1 per 20 samples	0	0	1 per 20 samples	0	TBD

QAPP Worksheet #20 – Field Quality Control Sample Summary Table (continued)
(UFP-QAPP Manual Section 3.1.1)

Notes:
[1]Refer to Analytical SOP References table, Worksheet #23.
[2]If samples will be collected at different depths at the same location, each discrete sampling depth will be counted as a separate sampling location.
[3]One field duplicate, MS/MSD, and EB must be collected per 20 investigatory samples sent to ESC, as appropriate for the listed analytical methods and sampling equipment used. The locations of these QC samples will be determined in the field. One TB must be included per each cooler shipment containing VOCs and/or GRO volumes. EBs will be collected only if non-disposable and non-dedicated sampling equipment is used. For FBs and EBs, laboratory grade DI water supplied by ESC will be used.

AOC – Area of Concern
DI – Deionized Water
DRO/ORO – Diesel Range Organics/Oil Range Organics
EB – Equipment Blank
ESC – ESC Lab Sciences of Mt. Juliet, Tennessee
FB – Field Blank
TDS – Total Dissolved Solids
UST – Underground Storage Tank
VOCs – Volatile Organic Compounds
PAHs – Polynuclear Aromatic Hydrocarbons
QC – Quality Control
SOP – Standard Operating Procedure
SVOCs – Semivolatile Organic Compounds
TB – Trip Blank
TBD –To be Determined (refer to IM work Plan Section 3)
GRO – Gasoline Range Organics
MS/MSD – Matrix Spike/ Matrix Spike Duplicate

QAPP Worksheet #21 – Project Specific Sampling SOP Reference Table
(UFP-QAPP Manual Section 3.1.2)
SOPs are included in IM Work Plan Appendix C.

Project Specific Sampling SOP References Table

Reference Number	Title, Revision Date and/or Number	Originating Organization	Equipment Type	Modified for Project Work? (Y/N)	Comments
SOP 1	Utility Clearance	URS Group	Geophysical survey equipment	N	Includes descriptions and procedures for performing utility clearance.
SOP 2	Documentation	URS Group	NA	N	Includes descriptions and procedures for documenting field activities.
SOP 3	Decontamination	URS Group	Decontamination Equipment	N	Includes descriptions and procedures for decontaminating field equipment.
SOP 4	Sample Management	URS Group	NA	N	Includes sampling handling, packaging, shipping, and chain-of-custody requirements.
SOP 5	Drilling and Lithologic Logging	URS Group	Drill rig, hand lens, rock hammer	N	Includes descriptions and procedures for logging soil borings and soil types.
SOP 6	Soil Sample Collection	URS Group	Shovel, trowel, hand auger, or direct push rig, PID, sample containers	N	Includes descriptions and procedures for grab and composite soil sampling.
SOP 7	Monitoring Well Installation	URS Group	Drill rig	N	Includes descriptions and procedures for monitoring well installation.
SOP 8	Groundwater Level Measurement	URS Group	Water level meter	N	Includes procedures for collection of groundwater level measurements.
SOP 9	Field Parameters	URS Group	YSI, Horiba (or equivalent), photoionization detector (PID)	N	Includes descriptions and procedures for field parameter measurements, including equipment calibration.
SOP 10	Well Development	URS Group	Submersible pump, drums for purge water	N	Includes descriptions and procedures for monitoring well development.
SOP 11	Groundwater Sample Collection	URS Group	Pump or bailer	N	Includes descriptions and procedures for groundwater sampling.
SOP 12	Investigation Derived Waste (IDW) Management	URS Group	Waste bins, tanks, or drums	N	Includes descriptions and procedures for the handling and disposal of IDW.
SOP 13	Surveying	URS Group	Surveying Equipment/ GPS Unit	N	Includes descriptions and procedures for field surveying and field GPS measurements.

QAPP Worksheet #21 – Project Specific Sampling SOP Reference Table (continued)
(UFP-QAPP Manual Section 3.1.2)
SOPs are included in IM Work Plan Appendix C.

Project Specific Sampling SOP References Table

Reference Number	Title, Revision Date and/or Number	Originating Organization	Equipment Type	Modified for Project Work? (Y/N)	Comments
SOP 14	Data Validation	URS Group	NA	N	Includes procedures for validation of analytical data.
SOP 15	Data Management	URS Group	NA	N	Includes procedures for management of project data, including analytical data and electronic deliverables.

Notes:
GPS – Global Positioning System
IDW – Investigation Derived Waste
N – No
NA – Not Applicable
PID – Photoionization Detector
SOP – Standard Operating Procedure
YSI – YSI Incorporated

QAPP Worksheet #22 – Field Equipment Calibration, Maintenance, Testing, and Inspection Table
(UFP-QAPP Manual Section 3.1.2.4)

Field Equipment	Calibration Activity	Maint. Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Resp. Person	SOP[1]
YSI 556 man portable system (MPS) water quality meter or equivalent	Calibrate pH and conductivity with autocal solution; calibrate dissolved oxygen (DO) to water saturated air, calibrate oxygen reduction potential (ORP) with Zobell solution	Clean unit weekly	Check with pH (4 and 7 solution) and conductivity solutions 1409 milliSiemens per centimeter (mS/cm)	Inspect probe sensors, clean sensors as necessary	Daily	± 0.2 pH units. ± 10% for conductivity	Clean probe tip and re-analyze standard sample	Field personnel	SOP 9
Turbidity Meter	Calibrate using standard provided with unit	Clean sample test vials after each use	Use standard periodic checks	Inspect weekly	Daily	Within error range indicated by equipment	Follow manufacturers specifications	Field personnel	SOP 9
PID	Calibrate using isobutylene provided by manufacturer	Clean unit daily	Every time the instrument is turned on and every 4 hours after	Inspect weekly	Daily	Within error range indicated by equipment	Follow manufacturers specifications	Field personnel	SOP 9

Notes:

[1] The Project Sampling SOP References table is found on Worksheet #21.
± – Plus or Minus
% – Percent
DO – Dissolved Oxygen
MPS – Man Portable System
mS/cm – MilliSiemens per Centimeter
ORP – Oxidation Reduction Potential
SOP – Standard Operating Procedure
YSI – YSI Incorporated

QAPP Worksheet #23 – ESC Analytical SOP References Tables
(UFP-QAPP Manual Section 3.2.1)

ESC Analytical SOP References Table

ESC Reference Number [a]	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work?
DoD QSM	Department of Defense Quality Systems Manual (DoD QSM), Version 4.2, April October 2010	NA	NA	NA	NA	No
010103	Document Control and Distribution	Definitive	All	Not applicable	ESC	No
030201	Data Handling and Reporting	Definitive	All	Not applicable	ESC	No
060105	Sample Receiving	Definitive	All	Not applicable	ESC	No
060106	Sample Storage, Disposal and Sample Control Technicians	Definitive	All	Not applicable	ESC	No
060110	Sample Shipping	Definitive	All	Not applicable	ESC	No
330345	Semi-Volatile Organics by Gas Chromatography/Mass Spectrometry Using Capillary Column (EPA Method 8270C, EPA 8270D, EPA Method 625, SM 6410B), Including Provisions for Analysis in SIM Mode.	Definitive	SVOCs by SW846 8270C and PAHs by SW846 8270C-SIM	Gas chromatograph (GC) (HP 6890/7890 or equivalent) and mass spectrometer (MS) (HP-5973/ 5975 or equivalent)	ESC	No
330350A	Diesel Range Organics/Total Petroleum Hydrocarbons (C_{10} to C_{28}) by Gas Chromatography With #2 Diesel Fuel (EPA Methods 8015B/C/D)	Definitive	TPH by SW846 8015	GC, model HP 6890 or HP7890	ESC	No
330351A	Gasoline Range Organics (C_6 to C_{10}) (Based on EPA Method 8015B) by Gas Chromatography Using Component Standard Calibration	Definitive	TPH by SW846 8015	GC, model HP 5890 or equivalent	ESC	No
330363	Volatile Organic Compounds by GC/MS (EPA 8260B, 8260C, 624 and SM6200B 20_{TH} Edition)	Definitive	VOCs by SW846 8260B	GC/MS, model HP 5890 or equivalent	ESC	No
330705	Ultrasonic Extraction (EPA Method 3550C)	Definitive	PAHs by SW846 8270C-SIM	Ultrasonic Disrupter	ESC	No

QAPP Worksheet #23 – ESC Analytical SOP References Tables (continued)
(UFP-QAPP Manual Section 3.2.1)

ESC Analytical SOP References Table

ESC Reference Number [a]	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work?
330707	Microwave Extraction (EPA Method 3546)	Definitive	SVOCs and PAHs by SW846 8270C	CEM Microwave MARSX	ESC	No
330709	Microextraction Procedure (EPA Method 3511)	Definitive	SVOCs and PAHs by SW846 8270C	Not applicable	ESC	No
330739	Silica Gel Cleanup (EPA 3630C)	Definitive	All	Not applicable	ESC	No
330740	Sulfuric Acid Cleanup (EPA Method 3665A)	Definitive	As needed	Not applicable	ESC	No
330751	Closed System Purge-and-Trap Extraction for Volatile Organics in Soil and Waste Samples (EPA 5035)	Definitive	VOCs by SW846 8260B	Autosampler and Traps	ESC	No
330752	Purge and Trap for Aqueous Samples (EPA 5030B)	Definitive	VOCs by SW846 8260B	Autosampler and Traps	ESC	No
340347	Total Dissolved Solids (EPA Method 160.1, SM 2540C, 20_{TH} Edition)	Definitive	TDS by EPA 160.1	Not applicable	ESC	No
340384A	Mercury in Aqueous/Liquid Samples (Cold-Vapor Technique) (EPA Methods 7470A & 245.1)	Definitive	Mercury by SW846 7470A	Perkin Elmer FIMS400 Mercury Analyzer or equivalent	ESC	No
340384B	Mercury in Solid Waste (Cold-Vapor Technique) (EPA Methods 7471A & 7471B)	Definitive	Mercury by SW846 7471A	Perkin Elmer FIMS400 Mercury Analyzer or equivalent	ESC	No
340386	Determination of Metals and Trace Elements in Various Matrices by ICP-AES (EPA Methods 6010B, 6010C, and 200.7) Including Hardness (EPA Methods 200.7 and 6010B/C and SM 2340B, 20_{TH} Edition) and Industrial Hygiene Samples (NIOSH 7300, 7301, and 7303 and OSHA ID-125G)	Definitive	Metals by SW846 6010B	Perkin Elmer 4300 DV ICP, Perkin Elmer 5300 DV ICP or equivalent	ESC	No

QAPP Worksheet #23 – ESC Analytical SOP References Tables (continued)
(UFP-QAPP Manual Section 3.2.1)

ESC Analytical SOP References Table

ESC Reference Number [a]	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work?
340388	Acid Digestion of Sediments, Sludge, Soils, and Oils (EPA Methods 3050B, 3051, and 3051A)	Definitive	Metals by SW846 6010B and 6020A	CEM Mars 5 or equivalent Microwave	ESC	No
340389	Acid Digestion of Aqueous Samples and Extracts, Including Total Recoverable and Dissolved Metals (EPA Methods 3005A, 3010A, 3015, 3015A and SM 3030C)	Definitive	Metals by SW846 6010B and 6020A	CEM Microwave	ESC	No
340390	Determination of Metals and Inductively Coupled Plasma Mass Spectroscopy (ICP-MS) (EPA Methods 6020, 6020A, and 200.8)	Definitive	Metals by SW846 6020A	Perkin-Elmer ELAN 9000 ICP-MS, Perkin-Elmer ELAN DRCII ICP-MS and Perkin Elmer ELAN DRC-e	ESC	No

Notes:
[a] ESC SOPs can be provided upon request.

CVAA – Cold Vapor Atomic Absorption
DoD – Department of Defense
DRO – Diesel Range Organics
EPA – U. S. Environmental Protection Agency
ESC – ESC Lab Sciences of Mt. Juliet, Tennessee
GC – Gas Chromatography
GC/ MS – Gas Chromatograph with Mass Spectrometry
GFAA – Graphite Furnace Atomic Absorption
GRO – Gasoline Range Organics
IC – Ion Chromatography
ICP – Inductively Coupled Plasma
ICP-AES - Inductively Coupled Plasma-Atomic Emission Spectrometry
ICP/ MS – Inductively Coupled Plasma Mass Spectrometry
MS – Mass Spectrometry
NA – Not Applicable
NIOSH – National Institute for Occupational Safety and Health
OSHA - Occupational Safety and Health Administration
PAHs – Polynuclear Aromatic Hydrocarbons
QSM – Quality Systems Manual
SIM – Selective Ion Monitoring
SM – Standard Methods
SVOCs – Semivolatile Organic Compounds
TDS – Total Dissolved Solids
TPH – Total Petroleum Hydrocarbons
VOCs – Volatile Organic Compounds

QAPP Worksheet #24 – Analytical Instrument Calibration Table
(UFP-QAPP Manual Section 3.2.2)

Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[1]
GC	Performed in accordance with DoD QSM v4.2				Analyst	330350A, 330351A
GC/MS	Performed in accordance with DoD QSM v4.2				Analyst	330345, 330363
ICP	Performed in accordance with DoD QSM v4.2				Analyst	340386
ICP/MS	Performed in accordance with DoD QSM v4.2				Analyst	340390
CVAA	Performed in accordance with DoD QSM v4.2				Analyst	340384A, 340384B

Notes:
[1]Refer to the Analytical SOP References table (Worksheet #23).

CA – Corrective Action
CVAA – Cold Vapor Atomic Absorption
DoD – Department of Defense
ESC – ESC Lab Sciences of Mt. Juliet, Tennessee
GC – Gas Chromatography
GC/ MS – Gas Chromatograph with Mass Spectrometry
ICP – Inductively Coupled Plasma
ICP/ MS – Inductively Coupled Plasma Mass Spectrometry
QSM – Quality Systems Manual
SOP – Standard Operating Procedure

QAPP Worksheet #25 – Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table
(UFP-QAPP Manual Section 3.2.3)

Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	ESC SOP Reference[1]
GC	Maintenance specified in the Laboratory SOP	Refer to the SOP	Refer to the SOP	Refer to the SOP	Refer to the SOP	Refer to the SOP	Analyst	330350A, 330351A
GC/MS		Refer to the SOP	Refer to the SOP	Refer to the SOP	Refer to the SOP	Refer to the SOP	Analyst	330345, 330363
ICP		Refer to the SOP	Refer to the SOP	Refer to the SOP	Refer to the SOP	Refer to the SOP	Analyst	340386
ICP/MS		Refer to the SOP	Refer to the SOP	Refer to the SOP	Refer to the SOP	Refer to the SOP	Analyst	340390
CVAA		Refer to the SOP	Refer to the SOP	Refer to the SOP	Refer to the SOP	Refer to the SOP	Analyst	340384A, 340384B

Notes:
[1]Refer to the ESC Analytical SOP References table (Worksheet #23).

CA – Corrective Action
CVAA – Cold Vapor Atomic Absorption
DoD – Department of Defense
ESC – ESC Lab Sciences of Mt. Juliet, Tennessee
GC – Gas Chromatography
GC/ MS – Gas Chromatograph with Mass Spectrometry
ICP – Inductively Coupled Plasma
ICP/ MS – Inductively Coupled Plasma Mass Spectrometry
QSM – Quality Systems Manual
SOP – Standard Operating Procedure

QAPP Worksheet #26 – Sample Handling System
(UFP-QAPP Manual Appendix A)

Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Field Personnel/URS
Sample Packaging (Personnel/Organization): Field Personnel /URS
Coordination of Shipment (Personnel/Organization): Field Personnel /URS
Type of Shipment/Carrier: Overnight/Fedex
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Sample Receiving Staff, ESC
Sample Custody and Storage (Personnel/Organization): Sample Management Staff, ESC
Sample Preparation (Personnel/Organization): Chemists and Technicians, ESC
Sample Determinative Analysis (Personnel/Organization): Chemists, Technicians and Analysts, ESC
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 60 days
Sample Extract/Digestate Storage (No. of days from extraction/digestion): 60 days
Biological Sample Storage (No. of days from sample collection): NA
SAMPLE DISPOSAL
Personnel/Organization: Sample Management Staff, ESC
Number of Days from Analysis: 60 days, but confirm first with URS Group.

Notes:
NA – Not Applicable

QAPP Worksheet #27 – Sample Custody Requirements
(UFP-QAPP Manual Section 3.3.3)

Sample Custody Requirements

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory): URS SOP 4 - Sample Management URS SOP 6 - Soil Sample Collection URS SOP 11 - Groundwater Sample Collection
Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal): ESC SOP 010103 - Document Control and Distribution ESC SOP 030201 - Data Handling and Reporting ESC SOP 060105 - Sample Receiving ESC SOP 060106 - Sample Storage, Disposal and Sample Control Technicians ESC SOP 060110 - Sample Shipping
Sample Identification Procedures: URS SOP 4 - Sample Management
Chain-of-custody Procedures: URS SOP 4 - Sample Management

Notes:
ESC – ESC Lab Sciences of Mt. Juliet, Tennessee URS – URS Group, Inc.
SOP – Standard Operating Procedure

QAPP Worksheet #28-1 – QC Samples – GRO
(UFP-QAPP Manual Section 3.4)

QC Samples – GRO

Matrix	Soil/ Water
Analytical Group	GRO
Analytical Method/ SOP Reference	SW-846 8015/ ESC SOP 330351A

QC Sample:	Frequency / Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparation batch	See DoD QSM v4.2	See DoD QSM v4.2	Laboratory QA Manager	Accuracy/Bias	See DoD QSM v4.2
Laboratory Control Sample (LCS)	One per preparation / analytical batch	See Tables 12-1a and 12-1b	See DoD QSM v4.2	Laboratory QA Manager	Precision/Accuracy	See Tables 12-1a and 12-1b
Matrix Spike (MS)	One per preparation / analytical batch	See Tables 12-1a and 12-1b	See DoD QSM v4.2	Laboratory QA Manager	Precision/Accuracy	See Tables 12-1a and 12-1b
Matrix Spike Duplicate (MSD) or sample duplicate	One per preparation / analytical batch	See Tables 12-1a and 12-1b	See DoD QSM v4.2	Laboratory QA Manager	Precision/Accuracy	See Tables 12-1a and 12-1b
Surrogates	In each sample	See DoD QSM v4.2	See DoD QSM v4.2	Laboratory QA Manager	Accuracy/Bias	See Tables 12-1a and 12-1b

Notes:
DoD – Department of Defense
DQI – Data Quality Indicator
ESC – ESC Lab Sciences of Mt. Juliet, Tennessee
GRO – Gasoline Range Organics
LCS – Laboratory Control Sample
MS – Matrix Spike
MSD – Matrix Spike Duplicate
QA – Quality Assurance
QC – Quality Control
QSM – Quality Systems Manual
SOP – Standard Operating Procedure

QAPP Worksheet #28-2 – QC Samples – DRO
(UFP-QAPP Manual Section 3.4)

QC Samples - DRO

Matrix	Soil/ Water
Analytical Group	DRO
Analytical Method/ SOP Reference	SW-846 8015B/ ESC 330350A

QC Sample:	Frequency / Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparation batch	See DoD QSM v4.2	See DoD QSM v4.2	Laboratory QA Manager	Accuracy/Bias	See DoD QSM v4.2
Laboratory Control Sample (LCS)	One per preparation / analytical batch	See Tables 12-2a and 12-2b	See DoD QSM v4.2	Laboratory QA Manager	Precision/Accuracy	See Tables 12-2a and 12-2b
Matrix Spike (MS)	One per preparation / analytical batch	See Tables 12-2a and 12-2b	See DoD QSM v4.2	Laboratory QA Manager	Precision/Accuracy	See Tables 12-2a and 12-2b
Matrix Spike Duplicate (MSD) or sample duplicate	One per preparation / analytical batch	See Tables 12-2a and 12-2b	See DoD QSM v4.2	Laboratory QA Manager	Precision/Accuracy	See Tables 12-2a and 12-2b
Surrogates	In each sample	See DoD QSM v4.2	See DoD QSM v4.2	Laboratory QA Manager	Accuracy/Bias	See Tables 12-2a and 12-2b

Notes:
DoD – Department of Defense
LCS – Laboratory Control Sample
QA – Quality Assurance
SOP – Standard Operating Procedure
DQI – Data Quality Indicator
MS – Matrix Spike
QC – Quality Control
ESC – ESC Lab Sciences of Mt. Juliet, Tennessee
DRO – Diesel Range Organics
MSD – Matrix Spike Duplicate
QSM – Quality Systems Manual

QAPP Worksheet #28-3 – QC Samples - VOCs
(UFP-QAPP Manual Section 3.4)

QC Samples - VOCs

Matrix	Soil/ Water
Analytical Group	VOCs
Analytical Method/ SOP Reference	SW-846 8260B/ ESC 330363

QC Sample:	Frequency / Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparation batch	See DoD QSM v4.2	See DoD QSM v4.2	Laboratory QA Manager	Accuracy/Bias	See DoD QSM v4.2
Laboratory Control Sample (LCS)	One per preparation / analytical batch	See Tables 12-3a and 12-3b	See DoD QSM v4.2	Laboratory QA Manager	Precision/Accuracy	See Tables 12-3a and 12-3b
Matrix Spike (MS)	One per preparation / analytical batch	See Tables 12-3a and 12-3b	See DoD QSM v4.2	Laboratory QA Manager	Precision/Accuracy	See Tables 12-3a and 12-3b
Matrix Spike Duplicate (MSD) or sample duplicate	One per preparation / analytical batch	See Tables 12-3a and 12-3b	See DoD QSM v4.2	Laboratory QA Manager	Precision/Accuracy	See Tables 12-3a and 12-3b
Surrogates/ Internal Standards	In each sample	See DoD QSM v4.2	See DoD QSM v4.2	Laboratory QA Manager	Accuracy/Bias	See Tables 12-3a and 12-3b

Notes:
DoD – Department of Defense
MS – Matrix Spike
QC – Quality Control
VOCs – Volatile Organic Compounds
DQI – Data Quality Indicator
MSD – Matrix Spike Duplicate
QSM – Quality Systems Manual
ESC – ESC Lab Sciences of Mt. Juliet, Tennessee
LCS – Laboratory Control Sample
QA – Quality Assurance
SOP – Standard Operating Procedure

QAPP Worksheet #28-4 – QC Samples - SVOCs
(UFP-QAPP Manual Section 3.4)

QC Samples - SVOCs

Matrix	Soil/ Water
Analytical Group	SVOCs
Analytical Method/ SOP Reference	SW-846 8270C/ ESC 330345

QC Sample:	Frequency / Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparation batch	See DoD QSM v4.2	See DoD QSM v4.2	Laboratory QA Manager	Accuracy/Bias	See DoD QSM v4.2
Laboratory Control Sample (LCS)	One per preparation / analytical batch	See Tables 12-4a and 12-4b	See DoD QSM v4.2	Laboratory QA Manager	Precision/Accuracy	See Tables 12-4a and 12-4b
Matrix Spike (MS)	One per preparation / analytical batch	See Tables 12-4a and 12-4b	See DoD QSM v4.2	Laboratory QA Manager	Precision/Accuracy	See Tables 12-4a and 12-4b
Matrix Spike Duplicate (MSD) or sample duplicate	One per preparation / analytical batch	See Tables 12-4a and 12-4b	See DoD QSM v4.2	Laboratory QA Manager	Precision/Accuracy	See Tables 12-4a and 12-4b
Surrogates/ Internal Standards	In each sample	See DoD QSM v4.2	See DoD QSM v4.2	Laboratory QA Manager	Accuracy/Bias	See Tables 12-4a and 12-4b

Notes:
DoD – Department of Defense
DQI – Data Quality Indicator
LCS – Laboratory Control Sample
MS – Matrix Spike
MSD – Matrix Spike Duplicate
QA – Quality Assurance
QC – Quality Control
QSM – Quality Systems Manual
SOP – Standard Operating Procedure
SVOCs – Semivolatile Organic Compounds
ESC – ESC Lab Sciences of Mt. Juliet, Tennessee

QAPP Worksheet #28-5 – QC Samples - PAHs
(UFP-QAPP Manual Section 3.4)

QC Samples - PAHs

Matrix	Soil/ Water
Analytical Group	PAHs
Analytical Method/ SOP Reference	SW-846 8270C-SIM/ ESC 330345

QC Sample:	Frequency / Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparation batch	See DoD QSM v4.2	See DoD QSM v4.2	Laboratory QA Manager	Accuracy/Bias	See DoD QSM v4.2
Laboratory Control Sample (LCS)	One per preparation / analytical batch	See Tables 12-5a and 12-5b	See DoD QSM v4.2	Laboratory QA Manager	Precision/Accuracy	See Tables 12-5a and 12-5b
Matrix Spike (MS)	One per preparation / analytical batch	See Tables 12-5a and 12-5b	See DoD QSM v4.2	Laboratory QA Manager	Precision/Accuracy	See Tables 12-5a and 12-5b
Matrix Spike Duplicate (MSD) or sample duplicate	One per preparation / analytical batch	See Tables 12-5a and 12-5b	See DoD QSM v4.2	Laboratory QA Manager	Precision/Accuracy	See Tables 12-5a and 12-5b
Surrogates/ Internal Standards	In each sample	See DoD QSM v4.2	See DoD QSM v4.2	Laboratory QA Manager	Accuracy/Bias	See Tables 12-5a and 12-5b

Notes:
DoD – Department of Defense
MS – Matrix Spike
QA – Quality Assurance
SIM – Selective Ion Monitoring
DQI – Data Quality Indicator
MSD – Matrix Spike Duplicate
QC – Quality Control
SOP – Standard Operating Procedure
LCS – Laboratory Control Sample
PAHs – Polyaromatic Hydrocarbons
QSM – Quality Systems Manual
ESC – ESC Lab Sciences of Mt. Juliet, Tennessee

QAPP Worksheet #28-6 – QC Samples - Metals
(UFP-QAPP Manual Section 3.4)

QC Samples - Metals

Matrix	Soil/ Water
Analytical Group	Metals
Analytical Method/ SOP Reference	SW-846 6010B, 6020A, 7470A, 7471A/ESC 340386, 340390, 340384B

QC Sample:	Frequency / Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparation batch	See DoD QSM v4.2	See DoD QSM v4.2	Laboratory QA Manager	Accuracy/Bias	See DoD QSM v4.2
Laboratory Control Sample (LCS)	One per preparation / analytical batch	See Tables 12-6a and 12-6b	See DoD QSM v4.2	Laboratory QA Manager	Precision/Accuracy	See Tables 12-6a and 12-6b
Matrix Spike (MS)	One per preparation / analytical batch	See Tables 12-6a and 12-6b	See DoD QSM v4.2	Laboratory QA Manager	Precision/Accuracy	See Tables 12-6a and 12-6b
Matrix Spike Duplicate (MSD) or sample duplicate	One per preparation / analytical batch	See Tables 12-6a and 12-6b	See DoD QSM v4.2	Laboratory QA Manager	Precision/Accuracy	See Tables 12-6a and 12-6b
Serial Dilution	When the PDS fails (only applicable for analytes with concentrations > 50X LOQ)	See Tables 12-6a and 12-6b	See DoD QSM v4.2	Laboratory QA Manager	Precision/Accuracy	See DoD QSM v4.2
Post Digestion Spike (PDS)	When the MS/MSD fails	See Tables 12-6a and 12-6b	See DoD QSM v4.2	Laboratory QA Manager	Precision/Accuracy	See DoD QSM v4.2

Notes:
DoD – Department of Defense
DQI – Data Quality Indicator
ESC – ESC Lab Sciences of Mt. Juliet, Tennessee
LCS – Laboratory Control Sample
LOQ – Limit of Quantitation
MS – Matrix Spike
MSD – Matrix Spike Duplicate
PDS – Post Digestion Spike
QA – Quality Assurance
QC – Quality Control
QSM – Quality Systems Manual
SOP – Standard Operating Procedure

QAPP Worksheet #28-7 – QC Samples - TDS
(UFP-QAPP Manual Section 3.4)

QC Samples - TDS

Matrix	Water
Analytical Group	TDS
Analytical Method/ SOP Reference	USEPA 160.1/ ESC 340347

QC Sample:	Frequency / Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparation batch	See DoD QSM v4.2	See DoD QSM v4.2	Laboratory QA Manager	Accuracy/Bias	See DoD QSM v4.2
Laboratory Duplicate (LD)	One per preparation / analytical batch	See Table 12-7	See DoD QSM v4.2	Laboratory QA Manager	Precision/Accuracy	See Table 12-7

Notes:
DoD – Department of Defense
QA – Quality Assurance
SOP – Standard Operating Procedure
ESC – ESC Lab Sciences of Mt. Juliet, Tennessee
DQI – Data Quality Indicator
QC – Quality Control
TDS – Total Dissolved Solids
LD – Laboratory Duplicate
QSM – Quality Systems Manual
USEPA – United States Environmental Protection Agency

QAPP Worksheet #29 – Project Documents and Records Table

(UFP-QAPP Manual Section 3.5.1)

Project Documents and Records Table

Sample Collection Documents and Records	On-site Analysis Documents and Records	Off-site Analysis Documents and Records	Data Assessment Documents and Records	Other
• Field Logbook or field forms • Chain-of-Custody Records • Air Bills • Custody Seals • Corrective Action Forms	• Sample Receipt, Custody, and Tracking Records • Standard Traceability Logs • Equipment Maintenance, Testing, and Inspection Logs • Corrective Action Forms • Reported Field Sample Results • Investigation Derived Waste management and disposal	• Sample Receipt, Custody, and Tracking Records • Standard Traceability Logs • Sample Prep Logs • Equipment Maintenance, Testing, and Inspection Logs • Corrective Action Forms • Reported Field Sample Results • Reported Results for Standards, QC Checks, and QC Samples • Data Package Completeness Checklist • Sample Disposal Records • Extraction/Cleanup-up Records • Raw Data (stored on disk CD) • Investigation Derived Waste management and disposal	• Field Sampling Audit Checklists • Data Validation Reports • Corrective Action Forms	

Notes:
CD – Compact Disc
QC – Quality Control

QAPP Worksheet #30 – Analytical Services Table
(UFP-QAPP Manual Section 3.5.2.3)

Analytical Services Table

Matrix	Analytical Group	Concentration Level	Sample Location/ ID Numbers	ESC Analytical SOP	Data Package Turnaround Time	Primary Laboratory/Organization (Name and Address, and Telephone Number)	QA Laboratory/ Organization (Name and Address, and Telephone Number
Water/ Soil	GRO	Low	TBD	330351A	21 days	ESC Lab Sciences 12065 Lebanon Road Mount Juliet, TN 37122 (800) 767-5859	Not Applicable
Water/ Soil	DRO/ORO	Low	TBD	330350A	21 days	ESC Lab Sciences 12065 Lebanon Road Mount Juliet, TN 37122 (800) 767-5859	Not Applicable
Water/ Soil	VOCs	Low	TBD	330363	21 days	ESC Lab Sciences 12065 Lebanon Road Mount Juliet, TN 37122 (800) 767-5859	Not Applicable
Water/ Soil	SVOCs	Low	TBD	330345	21 days	ESC Lab Sciences 12065 Lebanon Road Mount Juliet, TN 37122 (800) 767-5859	Not Applicable
Water/ Soil	PAHs	Low	TBD	330345-SIM	21 days	ESC Lab Sciences 12065 Lebanon Road Mount Juliet, TN 37122 (800) 767-5859	Not Applicable
Water/ Soil	Metals	Low	TBD	340386, 340390, 340384A, 340384B	21 days	ESC Lab Sciences 12065 Lebanon Road Mount Juliet, TN 37122 (800) 767-5859	Not Applicable
Water	TDS	Low	TBD	340347	21 days	ESC Lab Sciences 12065 Lebanon Road Mount Juliet, TN 37122 (800) 767-5859	Not Applicable

QAPP Worksheet #30 – Analytical Services Table (continued)
(UFP-QAPP Manual Section 3.5.2.3)

Notes:
DRO/ORO – Diesel Range Organics/Oil Range Organics
ESC – ESC Lab Sciences of Mt. Juliet, Tennessee
GRO – Gasoline Range Organics
ID – Identification
PAHs – Polynuclear Aromatic Hydrocarbons
SIM – Selected Ion Monitoring
SOP – Standard Operating Procedure
SVOCs – Semivolatile Organic Compounds
TBD – To be determined
TDS – Total Dissolved Solids

QAPP Worksheet #31 – Planned Project Assessment Table
(UFP-QAPP Manual Section 4.1.1)

Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment (Title and Organizational Affiliation)	Person(s) Responsible for Responding to Assessment Findings (Title and Organizational Affiliation)	Person(s) Responsible for Identifying and Implementing Corrective Actions (CA) (Title and Organizational Affiliation)	Person(s) Responsible for Monitoring Effectiveness of CA (Title and Organizational Affiliation)
Review of Work Plans and QAPP	Prior to start of fieldwork	Internal	URS	Project Manager, URS	Field Team Leader, URS	Field Team Leader, URS	QA/QC Manager or Project Manager, URS
Readiness review	At startup of fieldwork	Internal	URS	QA/QC Manager or Project Manager, URS	Field Team Leader, URS	Field Team Leader, URS	QA/QC Manager or Project Manager, URS
Review field logbooks and chain-of-custody forms	As work progresses	Internal	URS	QA/QC Manager or Project Manager, URS	Field Team Leader, URS	Field Team Leader, URS	QA/QC Manager or Project Manager, URS
Internal Laboratory Assessment	Once per project	Internal	ESC	ESC QA Manager	ESC Laboratory Manager	ESC Laboratory Manager	ESC QA Manager and Project Chemist, URS
Field Sampling Audit	As needed as project progresses	Internal	URS	QA/QC Officer, or Project Manager, URS	Field Team Leader, URS	Field Team Leader, URS	QA/QC Manager or Project Manager, URS

Notes:
QA/QC –Quality Assurance/ Quality Control
CA – Corrective Action
ESC – ESC Lab Sciences of Mt. Juliet, Tennessee
URS – URS Group, Inc.

QAPP Worksheet #32 – Assessment Findings and Corrective Action Responses

(UFP-QAPP Manual Section 4.1.2)

Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Title, Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Title, Organization)	Timeframe for Response
Readiness review	Memorandum/ e-mail	Field Team Leader and Project Manager, URS	Within 24-hours of finding deficiency	Memorandum/e-mail, review of corrected documentation	QA/QC Manager or Project Manager, URS	24-hours after notification
Review field logbooks and chain-of-custody forms	Marked up copy of document	Field Team Leader and Project Manager, URS	Within 24-hours of finding deficiency	Memorandum/e-mail, review of corrected documentation	QA/QC Manager or Project Manager, URS	24-hours after notification
Internal Laboratory Assessment	Lab Report to detail project deviations	ESC Project Manager	Within 5 days of sample analysis	Documented in the lab report	ESC QA Manager and Project Chemist, URS	2 weeks
Field Sampling Audit	E-mail or verbal report to detail the deviation from QAPP	Field Team Leader and Project Manager, URS	Within 2 days of the start of sampling	E-mail and/or phone log	QA/QC Manager or Project Manager, URS	2 days

Notes:
QA/QC –Quality Assurance/ Quality Control
CA – Corrective Action
ESC – ESC Lab Sciences of Mt. Juliet, Tennessee
URS – URS Group, Inc.

QAPP Worksheet #33 – QA Management Reports Table
(UFP-QAPP Manual Section 4.2)

QA Management Reports Table

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (Title and Organizational Affiliation)	Report Recipient(s) (Title and Organizational Affiliation)
Off-site laboratory technical system audit (if performed)	Prior to sample analysis.	Within 5 days of on-site audit.	URS Project Chemist	Installation Lead, URS Project Manager, URS QA Manager, ESC Project Manager, ESC
Data review report	One report, after sample analysis and data review are complete.	Following completion of all analyses and receipt of final laboratory reports.	URS Project Chemist	Installation Lead, URS Project Manager, URS Contracting Officer Representative, AFCEC Chief Environmental, Holloman AFB Regulator, NMED
IM Report	After completion of all fieldwork activities, and review of all data.	See Worksheet 16, Project Schedule.	URS Installation Lead or URS Project Manager	Contracting Officer Representative, AFCEC Chief Environmental, Holloman AFB Regulator, NMED

Notes:
AFB – Air Force Base
AFCEC – Air Force Civil Engineer Center
ESC – ESC Lab Sciences of Mt. Juliet, Tennessee
NMED – New Mexico Environment Department
QA – Quality Assurance
URS – URS Group, Inc.

QAPP Worksheet #34 – Verification (Step I) Process Table

(UFP-QAPP Manual Section 5.2.1)

Verification (Step I) Process Table

Verification Input	Description	Internal/ External	Responsible for Verification (Name, Organization)
Field logbooks and field data sheets	Field logbooks and field data sheets will be completed per URS SOP 2 (Documentation) and written in ink unless field conditions preclude use. The logbooks and sheets will be reviewed for proper daily entries such as dates and names of personnel, and for completeness. In addition, items not understood will be reviewed with the author. Field logbooks and field data sheets will be placed in the project file.	Internal	Field Team Leader or Project Chemist, URS
Chain-of-custody and shipping forms	COCs and shipping documentation will be completed per URS SOP 4 (Sample Management) and reviewed internally upon their completion and verified against the packed sample coolers they represent. COCs will also be compared against planned sample collection to verify completeness. A copy of the COCs will be retained in the project file; the original and remaining copies will be taped inside the cooler for shipment.	Internal	Field Team Leader or Project Chemist, URS
Sample Acknowledgment	The sample acknowledgment generated by the laboratory will be reviewed against the COC for accuracy and for potential analytical issues.	External and Internal	Project Manager, ESC Project Chemist, URS
Laboratory data package/ electronic data	Prior to submittal to URS, the laboratory will review the laboratory data and associated data packages for completeness, compliance with governing documents, and technical accuracy/readiness.	External	Project Manager, ESC
Laboratory data package/ electronic data	The laboratory data and electronic data will be reviewed by URS to confirm all sample analyses requested have been provided and that all of the required information for validation has been included in the data package. URS will also spot check the electronic data to the hard copy report for consistency. URS SOPs 14 (Data Validation) and 15 (Data Management) will be applied as appropriate for these steps.	Internal	Project Chemist, URS

Note:
COC – Chain of Custody
ESC – ESC Lab Sciences of Mt. Juliet, Tennessee
URS – URS Group, Inc.

QAPP Worksheet #35 – Validation (Steps IIa and IIb) Process Table
(UFP-QAPP Manual Section 5.2.2)

Validation (Steps IIa and IIb) Process Table

Step IIa/IIb [a]	Validation Input	Description	Responsible for Validation (Name, Organization)
IIb	Field Analytical Measurements	All field analytical parameters will be reviewed against the QAPP requirements for completeness and accuracy based on field calibration records.	Field Team Leader, URS
IIa	SOPs, SAP	Check that sample collection was performed per the plan, and that SOPs were followed. Determine impacts of any deviations from sample collection.	Field Team Leader, URS Project Chemist, URS
IIa	Chain-of-custody forms	Examine COC forms against SAP requirements such as analytical methods, sample identification, etc.	Field Team Leader, URS Project Chemist, URS
IIb	Documentation of QC sample results	Using SOP 14 (Data Validation), establish that all required QC samples were analyzed, results reported, and evaluation criteria met.	Project Chemist, URS
IIb	Laboratory data package	Using SOP 14 (Data Validation), examine laboratory package against SAP requirements and COCs (i.e., sample identification, holding times, quality control samples, field replicates, analytical methods, etc.) Determine impacts of any deviations or quality issues associated with analytical data.	Project Chemist, URS
IIb	Laboratory data package	Using SOP 14 (Data Validation), perform validation on 10% of reported data to confirm calculations.	Project Chemist, URS
IIb	Quantitation limits	Using SOP 14 (Data Validation), determine whether Quantitation Limits identified in the QAPP were met.	Project Chemist, URS

Notes:
[a]IIa = Compliance with methods, procedures, and contracts
IIb = Comparison with measurement performance criteria in the QAPP

COC – Chain of Custody
QAPP – Quality Assurance Project Plan
QC – Quality Control
SAP – Sampling and Analysis Plan
SOPs – Standard Operating Procedures
URS – URS Group, Inc.

QAPP Worksheet #36 – Validation (Steps IIa and IIb) Summary Table
(UFP-QAPP Manual Section 5.2.2)

Validation (Steps IIa and IIb) Summary Table

Step IIa/IIb [a]	Matrix	Analytical Group	Concentration Level	Validation Criteria[b]	Data Validator (title and organizational affiliation)
IIa	Soil/Water	GRO, DRO, VOC, SVOCs, PAHs, Metals, TDS (water)	Low	Criteria presented in the DoD QSM Final Version 4.2, the Analytical Method, and Worksheet #12 and its supporting tables in this SAP/QAPP should be used together with SOP 14 (Data Validation) to perform data validation.	Project Chemist, URS
IIb	Soil/Water	GRO, DRO, VOC, SVOCs, PAHs, Metals, TDS (water)	Low	Criteria presented in the Analytical Method, and Worksheets #12, #15, #19, #24, and #28 and supporting tables in this SAP/QAPP should be used together with SOP 14 (Data Validation) to perform data validation.	Project Chemist, URS

Notes:
DoD – Department of Defense
DRO – Diesel Range Organics
GRO – Gasoline Range Organics
PAHs – Polynuclear Aromatic Hydrocarbons
QAPP – Quality Assurance Project Plan
QSM – Quality Systems Manual
SVOCs – Semivolatile Organic Compounds
TDS – Total Dissolved Solids
URS – URS Group, Inc.
VOCs – Volatile Organic Compounds

[a] IIa = Compliance with methods, procedures, and contracts
IIb = Comparison with measurement performance criteria in the QAPP

[b] Data review will be performed per SOP 14, Data Validation, and any necessary data qualifiers will be assigned as described within SOP 14.

QAPP Worksheet #37 – Usability Assessment
(UFP-QAPP Manual Section 5.2.3)

Usability Assessment

The Data Usability Assessment will be performed by URS personnel. The URS Project Manager will be responsible for information in the Usability Assessment. He will also be responsible for assigning task work to the individual task members who will be supporting the Data Usability Assessment. The Data Usability Assessment will be conducted on verified/validated data to determine whether the project execution and resulting data meet project quality objectives. Both the sampling and analytical activities will be considered, with the ultimate goal of assessing whether the final, qualified results support the decisions to be made with the data. After the Data Usability Assessment has been performed, data deemed appropriate for decision-making purposes will be used for assessment of risks posed to potential receptors. The results of the Data Usability Assessment will be presented in the Remedial Investigation Report. The following items will be assessed and conclusions drawn based on their results.
Precision – Results of field duplicate samples will be presented separately in tabular format for each sample set. For each field duplicate set, the results will be assessed as stated in Tables 12-1 through 12-7; MS/MSD RPDs are calculated by the laboratory and those with RPDs outside the criteria established in Tables 12-1 through 12-7 will be listed in tabular form in the data verification report. A discussion will follow summarizing the results of the laboratory precision. Any conclusions about the precision of the analyses will be drawn and any limitations on the use of the data will be described.
Accuracy/Bias Contamination – Results for all laboratory method blanks will be evaluated and analytes detected in these blanks will be listed in tabular form in the data verification report. Laboratory data will be qualified based on the criteria listed in Tables 12-1 through 12-7. A discussion will follow summarizing the results of the laboratory accuracy/bias. Any conclusions about the accuracy/bias of the analyses based on contamination will be drawn and any limitations on the use of the data will be described.
Overall Accuracy/Bias – Results for all laboratory control sample, surrogate and matrix spike/matrix spike duplicate recoveries that are outside evaluation criteria will be presented in tabular format in the data verification reports. The results will be checked versus those listed in Tables 12-1 through 12-7. A discussion will follow summarizing the overall accuracy/bias. Any conclusions about the accuracy/bias of the analyses based on contamination will be drawn and any limitations on the use of the data will be described.

QAPP Worksheet #37 – Usability Assessment (continued)
(UFP-QAPP Manual Section 5.2.3)

Usability Assessment

Sensitivity –The results for each analyte will be checked against the performance criteria presented on Worksheet #12 and cross checked against the quantitation limits presented on Worksheet #15. Results for analytes that exceed criteria will be identified on the tables. A discussion will follow summarizing the results of the laboratory sensitivity. Any conclusions about the sensitivity of the analyses will be drawn and any limitations on the use of the data will be described.
Representativeness –Representativeness is a qualitative measure of the degree to which data accurately and precisely represent a characteristic of a population, and is mainly addressed in the sample design. A measure of representativeness will be provided by assessing if the proper analytical procedures, appropriate methods, laboratory SOPs, holding times and field duplicate procedures were followed. Any conclusions about the representativeness of the analyses will be drawn and any limitations on the use of the data will be described.
Comparability – In accordance with this UFP QAPP, project data are comparable when sample collection techniques, measurement methods and reporting procedures are the same for each data set.
Completeness – A completeness check will be performed on all data generated by the laboratory. Completeness criteria are presented on Worksheet #12. Completeness will be calculated as the number of data points for each analyte that is deemed useable (not rejected) divided by the total number of data points for each analyte. A discussion will follow summarizing the results of the calculation of data completeness. Any conclusions about the completeness of the data will be drawn and any limitations on the use of the data will be described.

QAPP Worksheet #37 – Usability Assessment (continued)
(UFP-QAPP Manual Section 5.2.3)

Usability Assessment

Reconciliation – Each of the measurement performance criteria listed in Worksheet #12 will be examined to determine if the objective was met. Each analysis will be evaluated separately in terms of the major impacts observed from the data verification/validation, Project Quality Indicators and measurement performance criteria assessments. Based on the results of these assessments, the quality of the data will be determined. Usability of the data will be based on the quality assessment. After establishing the usability of the data, it will be determined if the project quality objective was met and if project action limits were met. The Interim Measures Report will include a summary of all points that comprised the reconciliation of each objective. Any conclusions or limitations on the usability of any of the data will be described.

Notes:
MS/MSD – Matrix Spike/Matrix Spike Duplicate
QAPP – Quality Assurance Project Plan
RPDs – Relative Percent Differences
SOPs – Standard Operating Procedures
UFP – Uniform Federal Policy

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Appendix B
Health and Safety Plan (HASP)

At URS, we believe that all injuries are preventable.

The most effective way to prevent injuries is to identify hazards before they become incidents.

4 Sight is a program that helps us do that.

4Sight reminds you to ask 4 simple questions before beginning a task:

- **What am I about to do?**
- **What could go wrong?**
- **What could be done to make it safer?**
- **What have I done to communicate the hazards?**

Taking a few minutes to stop and think about the task ahead is using 4Sight.

Use 4Sight at the beginning of every task and during your day.

Remember to stop, step back and use a bit of 4Sight.

URS

Health, Safety & Environment

Project Specific Health and Safety Plan (HASP)

Prepared for:

Interim Measures Implementation
Group 3 Former UST Sites
TU515, TU503, TU506, TU508, and TU518
Holloman Air Force Base, New Mexico

Project Number:

23446543

Prepared by:

Name: **Jennie McCormick** Date: 12/17/2013

Approvals:
Printed name and Signature

RSM: **Sally Miller** Date:

PM: **Brian Powers** Date:

SSO: **Jon Mallonee** Date:

Plan Valid Until: Dec. 2013 – Dec. 2016

1.0 SITE-SPECIFIC EMERGENCY RESPONSE INFORMATION

NOTE: EMERGENCY SERVICES ARE AVAILABLE ON THE BASE FOR LIFE-THREATENING CONDITIONS ONLY

Has cell phone signal been confirmed?		☒ Yes ☐ No
	1. TU503	☒ Yes ☐ No
	2. TU506	☒ Yes ☐ No
	3. TU508	☒ Yes ☐ No
	4. TU515	☒ Yes ☐ No
	5. TU518	☒ Yes ☐ No
Are there any cell phone restrictions on site? If YES, describe: No cell phone use while driving		☒ Yes ☐ No

Describe secondary or alternate communication plan if no phone or 911 available:

Utilize accessible buildings on-site or satellite communicators as appropriate. The site safety officer will establish and discuss the best means of secondary communication for each site before work begins.

1.1 SITE-SPECIFIC EMERGENCY PROCEDURES

(Complete for each location where URS is working if information differs from site to site)

Site Specific Emergency Procedures	IS "911" Emergency Service **READILY** (e.g., within 5 minutes) available at the project location?	☐ Yes ☒ No
	Describe how you would direct emergency responders to your location: Emergency services are available on the base for life-threatening conditions only. The site safety officer will ensure that all members of the field team know how to direct responders to their location for each site. This will be discussed before work begins.	
	Alarm: Big Voice	
	Meaning: Voice indicates alarm type	
	Evacuation Route(s): Site-Specific, variable	
	Place(s) of Refuge: Site-Specific, variable	
	Other: Click here to enter other applicable information.	

1.2 EMERGENCY CONTACTS

Response Agency	Name and Location	Telephone Number *(List alternate numbers to 911)*
Police/Sheriff	Otero County Sheriff	911; (575) 437-2210
Fire Department	Otero County Fire Department	911; (575) 437-0071
Hospital	Alamogordo Urgent Care	911; (575) 551-5111
Ambulance	American Medical Response	911; (575) 437-3699
Poison Control		1-800-222-1222
Other:	United States Air Force Security Forces (HAFB)	(575) 572-7171

1.3 HOSPITAL ROUTE	
Name:	Gerald Champion Regional Medical Center
Phone:	911; (575) 439-6100
Address:	2669 N Scenic Dr Alamogordo, NM 88310

Directions from site (attach map with directions):

Holloman AFB, NM

1. Head **southeast** on **Sabre Rd**
Restricted usage road
1.1 mi

2. Continue onto **E Delaware Ave**
Restricted usage road
0.4 mi

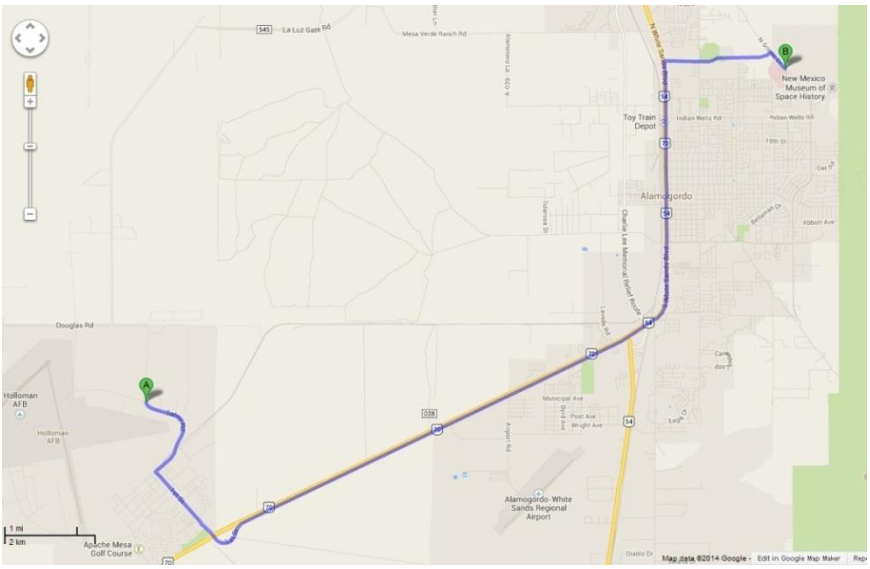
3. Turn left onto **1st St**
Partial restricted usage road
1.8 mi

4. Continue onto **US-70 E**
9.9 mi

5. Turn right onto **Fairgrounds Rd**
1.5 mi

6. Turn right onto **N Scenic Dr**
Destination will be on the right
0.3 mi

Gerald Champion Regional Medical Center
2669 N Scenic Dr
Alamogordo, NM 88310



Approximate distance from site to hospital:	Miles:	Minutes:
	12	19

2.0 INCIDENT/INJURY/ILLNESS REPORTING AND NOTIFICATION		
Basic Response	**In the event of an emergency at the site:** 1. Contact the appropriate emergency services, 2. Secure the site (and preserve the scene of the incident for investigation, if necessary), and 3. Notify the URS PM. 4. Prepare incident report 5. Conduct incident investigation 6. Implement corrective actions The URS PM in coordination with the RSM will notify the client, subcontractors and regulatory agencies, e.g., OSHA, as appropriate. Follow the reporting procedures in URS SMS 049, *Incident Reporting, Notifications, and Investigation*, and SMS 065, *Injury and Claims Management*. Incidents and near-misses of a serious nature will be fully investigated in accordance with SMS 066, *Incident Investigation*, to determine root causes and to develop action plans to prevent reoccurrence. **In the event of any work-related injury or illness, or even ANY SUSPECTED INJURY/ILLNESS, contact the URS NURSE at 866-326-7321 immediately (see page 5).**	
Emergency Response	**For serious injuries or illnesses:** • Call 911 to transport the victim, via ambulance, to the hospital (see page 2 and attached hospital map and directions). **For non-life threatening/minor injuries:** • If it is safe to do so, transport the employee to the occupational clinic (or hospital if no clinic is available) identified on page 2. **For first aid cases:** • Administer first aid on a voluntary basis if you are trained to do so. • Remember to follow "universal precautions" if blood or body fluids are present (i.e., assume all blood and bodily fluids are infectious and avoid contact with these fluids; wash thoroughly after contact). • Use nitrile or latex gloves, face mask, and/or safety glasses when performing first aid. • If you are exposed to another individual's blood or body fluids, contact the RSM or URS Nurse for required follow-up. **For suspected exposure or symptom of exposure to hazardous substances:** • Leave the [contaminated] area. • Remove contaminated clothing/equipment • If symptoms are serious, seek medical assistance immediately. **For suspected dermal or ocular exposures:** • Wash the affected area with plenty of water for a minimum of 15 minutes. • If symptoms are serious, seek medical assistance immediately. **In the event of any work-related injury or illness, or even ANY SUSPECTED INJURY/ILLNESS, contact the URS NURSE at 866-326-7321 immediately (see page 5).**	
Spill Response	URS is responsible for cleaning up any spill caused by their activities on site. Contact the URS PM, who will contact the Client POC and/or Client Environmental Contact, in case of any spill or unplanned release.	
Client Requirement	**Basic Response**	Notify CES Environmental Flight - POC: David L. Rizzuto, HAFB Restoration Contractor, 575-572-5395 / 575-430-3965
	Emergency Response	**Same**
	Spill Response	**Same**

Incident/Illness/Injury Notification Guide

1 **Contact Emergency Services**	Stop work and evaluate the situation
	Evacuate area first, if unsafe conditions exist
	Initiate emergency response alarms/plans
	Describe location and type of emergency/incident to responder
	Conduct 1st Aid if qualified, willing, and safe to do so
	Contact others for additional help
2 **Secure the Site**	Conduct incipient stage (less than 5 gallon) spill response, if safe and trained
	Barricade/cordon off incident area, if safe to do so
	Notify security personnel, if applicable
	Escort unauthorized personnel out of the area, if safe to do so
3 **Notify the PM**	The PM should notify the RSM and Operations Manager/Office Manager *Note: Detailed email follow-up notification is required*
	The RSM and PM will coordinate notifying the client and subcontractors
	Notifications made to regulatory agencies will be conducted by a VP or HSE Director
4 **Incident Reporting**	Record details of the incident using SMS 049-1, Incident Report Form
	Submit form to PM for review and signature
	The completed form should be submitted to RSM within 24 hours of incident
	Discuss incident with all project staff
5 **Incident Investigation**	Must be completed within 7 days of the incident
	Project members must assist the RSM with the incident investigation, if required
	Within 7 days of any incident, PM and field member must review incident
6 **Corrective Actions**	Implement corrective actions as directed by management

2.1 INCIDENT/INJURY/ILLNESS CONTACT LIST

Incident Reporting

Available:
24 hours/7 days/week

URS Nurse: 1-866-326-7321

- Available: 24 hours/7 days/week
- Jeanette Schrimsher/Bonnie Wolf

If injured/ill or *suspect* an injury or illness call the URS Nurse immediately to:

- Get free medical advice
- Start any necessary paperwork
- Comply with URS and OSHA requirements

Company	Title	Name	Phone Number(s)
URS	Project Director or Principal-in-Charge (PIC)	Noelle Cochran	303-796-4611 / 303-250-3823
	Project Manager (PM)	Brian Powers	303-740-3924 / 303-618-7395
	Regional Safety Managers (RSM)	Sally K. Miller, CIH Tim Joseph, CIH	303-740-2721 / 720-321-1814 303-740-2767 / 303-884-2548
Holloman Air Force Base	PM/Point-of-Contact (POC) Safety POC Environmental POC	David L. Rizzuto, HAFB Restoration Contractor	575-572-5395 / 575-430-3965

3.0 EMERGENCY RESPONSE PLANNING

Prior to beginning work at the site, complete Section 3.0 in coordination with the client, as necessary. Include identification of site alarms and their meaning, site evacuation route(s) and place(s) of refuge, as well as primary and secondary means of communication from the site.

Type of Emergency	Possible Site Condition?	Controls/Emergency Plans
Fire or Explosion	☒ Yes ☐ No ☐ Not Applicable	Ensure that injection/remediation equipment is grounded.
Medical Emergencies	☒ Yes ☐ No ☐ Not Applicable	If trained, perform first aid on site. If necessary, transport victim to hospital or call emergency services. If life-threatening, transport to AFB emergency services.
Utility Strike	☒ Yes ☐ No ☐ Not Applicable	Contact local and installation utility locating service before commencing any intrusive work; subcontract private utility locator, if necessary. Be aware of overhead power lines when operating large equipment.
Severe/Adverse Weather	☒ Yes ☐ No ☐ Not Applicable	Check weather each day prior to working on site and prior to driving to/from the site. Seek shelter if adverse conditions exist. Know the location of tornado shelters. Utilize the 30/30 rule when thunderstorms are present. Stop work if time between lightning and thunder is less than 30 seconds. Stop work for 30 minutes after thunder/lightning is present in the area. Temperatures exceed 100°F during the summer months. Sparse vegetation and prevailing winds can create “dust devils.” Rainfall in the July and August Monsoonal Season can be in the form of frequent, intense thunderstorms.
Vehicle/Heavy Equipment Accident	☒ Yes ☐ No ☐ Not Applicable	Check weather prior to driving, carry extra food and clothing, and check rental vehicles for spare tires and equipment to change a tire. Identify and communicate locations of other vehicles or other heavy equipment in the area. Be aware of traffic patterns on site.
Chemical or Biological Exposure	☒ Yes ☐ No ☐ Not Applicable	Refer to the Job Safety Analysis (JSA) for chemical and biological exposure controls
Engulfment/Entrapment	☒ Yes ☐ No ☐ Not Applicable	Refer to the Job Safety Analysis (JSA) for excavation controls
Low Oxygen Content (Confined Space)	☐ Yes ☒ No ☐ Not Applicable	Click to enter controls/plans
Other: Add additional lines to include other potential site specific emergencies.	☐ Yes ☐ No ☐ Not Applicable	Click to enter controls/plans

3.1 EMERGENCY EQUIPMENT LIST		
Prior to beginning work at the site, complete Section 3.2 and include equipment and communication plans that will be used at the site. All URS employees and their subcontractors MUST be equipped with this equipment prior to working on site.		
Communication Equipment and Communication Plan	Cellular phone(s)	☒Primary ☐Secondary
	Radio(s)	☐Primary ☐Secondary ☒ Not Applicable
	Other communication (e.g., satellite phone, spot GPS, etc.)	☒ Yes ☐ No Describe: Secondary communication could consist of satellite phones.
	Alternate communication plan	☒ Yes ☐ No
	Utilize satellite communicators as applicable to each site. Utilize phones inside nearby site buildings if possible.	
Emergency Equipment List	**First aid kits:**	**☒ Yes ☐ No**
	Are supplies current and in good condition (i.e., not expired, adequate supplies, sanitary, etc.)?	☒ Yes ☐ No Date Verified: Enter date here
	Eye wash bottles:	**☒ Yes ☐ No**
	Are supplies current and in good condition (i.e., not expired, adequate supplies, sanitary, etc.)?	☒ Yes ☐ No Date Verified: Enter date here
	Fire extinguishers:	**☒ Yes ☐ No**
	Inspected within last 12 months?	☒ Yes ☐ No Date Verified: Enter date here
	Monthly inspection tag attached?	☒ Yes ☐ No Date Verified: Enter date here
	Drinking water:	☒ Yes ☐ No
	Extra set of PPE:	☒ Yes ☐ No
	Roll of caution tape to flag hazards, mark spills or incident scenes:	☒ Yes ☐ No
Client Requirements:	N/A	

4. INTRODUCTION TO THE PROJECT-SPECIFIC SAFE WORK PLAN

Holloman Air Force Base and URS Corporation (URS) are committed to providing a safe and healthful work environment. Our goal is zero incidents, meaning that we strive to complete every project without injury, illness, property damage, or environmental damage. Safety must always take precedence over expediency.

This Health and Safety Plan (HASP) summarizes health and safety hazard information for URS field activities associated with the Holloman Air Force Base Interim Measures Implementation. The URS HASP delineates procedures that will allow personnel to work safely and respond quickly and appropriately to site emergencies. All site work will be conducted in accordance with requirements of the URS Health, Safety, and Environment Program and Management System, which is available on the SoURSe**.**

All site work will be conducted in accordance with Occupational Safety and Health Administration (OSHA) regulations (CFR 29, Parts 1904, 1910, and 1926) if such are applicable.

The URS Regional Health, Safety, and Environment Manager (RSM) or their designee must review and sign this HASP to verify compliance with applicable requirements. The RSM must approve any modifications to the procedures in this HASP. The Project Manager and his/her designee (e.g., the Site Safety Officer) are responsible for implementation of this HASP.

5. SCOPE OF WORK AND KEY PROJECT INFORMATION

Activities covered under this HASP include all field activities associated with the Holloman Air Force Base near Alamogordo, NM.

Holloman Air Force Base point of contact for this project is David L. Rizzuto at 575-572-5395 / 575-430-3965.

Refer to the Project Execution Plan for detailed descriptions of the scope of work for this project. This plan has been developed for URS personnel only. It may be shared with others for information purposes only.

This plan is valid from December 31, 2013 to December 31, 2015 This HASP must be updated and reviewed by the RSM as necessary, but not less than annually.

Scope of Work and Major Tasks	**Scope of Work**		
	Site assessment will consist of environmental investigation and remediation over various secured sites around and within Holloman Air Force Base.		
	Tasks	**JSA (Check one or both)**	
	List Major Tasks	General Site Hazards/Controls	Needs JSA
	1. Mobilization/Demobilization	☒	☒
	2. Utility Location and Marking	☒	☐
	3. Soil Sampling 3.1. Direct Push Drilling, Asphalt/Concrete cutting and coring	☒	☒
	4. Groundwater Monitoring Well Drilling, Installment, and Development 4.1. Groundwater Monitoring	☒	☒
	5. Excavation and Trenching	☒	☒
	6. Remediation 6.1. DPT Injections and Angled Drilling	☒	☒

High-Hazard or High-Frequency Tasks/Jobs 	**Do any of the tasks listed above involve the following?**		
	Hazardous waste operation	☒ Yes	☐ No
	Construction/demolition activities	☒ Yes	☐ No
	Facility, bridge, or dam inspections	☐ Yes	☒ No
	Confined space entry or tunnel work	☐ Yes	☒ No
	Work where falls of more than 6 feet are possible; high angle work	☐ Yes	☒ No
	Work in remote areas or outside the U.S. (international travel)	☒ Yes	☐ No
	Work on/over water, from boats, or underwater	☐ Yes	☒ No
	Work on or near roadways and railways or involving aircraft	☒ Yes	☐ No
	Work with ATVs, snowmobiles, or other non-standard transportation	☐ Yes	☒ No
	Excavation and trenching	☒ Yes	☐ No
	Laboratory operations or pilot plant operations	☐ Yes	☒ No
	Archeological or natural/cultural surveys	☐ Yes	☒ No

Site Location, Features, Active Processes, History	Holloman Air Force Base is located near Alamogordo and White Sands, NM. It is an active United States Air Force installation.

Key URS Project Personnel and Assigned Roles

Role	Name	Phone
Project Manager	Brian Powers	303-740-3924 / 303-618-7395
Field Supervisor or equivalent	Jon Mallonee	303-740-3967 / 301-512-3395
SSO or equivalent		
Field Personnel	Taylor Weber	303-740-3897 / 720-402-6968
	Dave Estrella	303-740-2665 / 401-556-7095
	Christy Eschenfeldt	303-740-3940 / 970-218-1436
	Jennie McCormick	303-740-2772 / 720-308-7973

URS Personnel Responsibilities

All personnel have the responsibility to stop work if conditions that jeopardize health or safety are identified. Subcontractors are responsible for addressing safety issues associated with their site activities. Responsibilities for URS personnel are detailed in the URS Health and Safety Program and Management System. The URS field manager, in coordination with the field team, is required to complete a tailgate H&S meeting and a site specific JSA before commencing work onsite. The URS SSO is responsible for evaluating the job site for unsafe conditions, coordinating with the client to address safety concerns, conducting the tailgate H&S meeting, communicating safety messages with URS field personnel, collecting safety observations and near miss reports from field personnel and conducting exposure monitoring, as necessary.

URS Subcontractors

List each subcontractor. Include the names and roles of all subcontract personnel assigned to the project

Subcontractor Company Name	Name	Role	Phone
TBD			
Have subcontractors been prequalified per SMS 46?			☐ Yes ☐ No
Have variances been required for use of any subcontractor?			☐ Yes ☐ No
If yes, attach copy of variance (SMS 46-3).			☐ Yes ☐ No

Equipment Anticipated to Be Needed to Perform Tasks

List hand tools, power tools, mobile equipment; instrumentation, generators, ladders, etc. that will be required for the project.

- DPT Drill Rig, Hollow Stem Auger Drill Rig, Concrete/Asphalt Corer/Saw, Excavation/trenching equipment-backhoe, Well development and sampling equipment (bailers, pumps, etc.), hydraulic pumps, sample jars and coolers, Soil Sampling equipment, Work Vehicles, PID

Remember safe cutting tools; URS prohibits fixed open-blade knives.

Anticipated Dates of Work

January 1, 2014 to December 31, 2015

6. PROJECT-SPECIFIC TRAINING/MEDICAL REQUIREMENTS

All URS project personnel and URS subcontractors

NOTE: All URS project personnel who are not required by project activities to have Hazardous Waste Operations and Emergency Response (HAZWOPER) training (as described below) must have current URS Field Safety or URS Office Safety training, at a minimum.

☒	OSHA HAZWOPER Training (40-hour initial; 8-hour refreshers)	☒	First Aid/CPR (at least 1 person per team)
☒	Annual HAZWOPER medical surveillance	☒	OSHA Construction Safety
☐	URS Field Safety	☐	URS Office Safety
☒	National Safety Council Defensive Driving Training	☐	
Task Specific Training			
☐	Confined Space Entry	☐	Respiratory Protection
☐	Hazardous Communication (HAZCOM)	☐	Lock-out Tag-out Try-out
☐	Fall Protection	☒	Working at Remote Locations (LMS)

URS SSO and Field Supervisor

Current First Aid/CPR training:

Is training current for all personnel? ☐ Yes ☒ No

Names of personnel first aid trained:
Jon Mallonee, Taylor Weber, Christy Eschenfeldt, Jennie McCormick

The Level of overall training and experience must be commensurate with project safety/supervisory requirements:

Do the Field Supervisor and SSO have at least 6 months experience with URS? ☒ Yes ☐ No

If No, has PM reviewed their level of training/experience, and completed and signed a Short-Service Employee Waiver? ☐ Yes ☐ No

URS Short Service Employees (SSE)

Short Service Employees: None

When was a Short-Service Employee Waiver completed and signed by the PM? Click here to enter a date. Attach waiver to this HASP.

Was the level of training and experience reviewed by the PM and Employee? ☐ Yes ☐ No

7. TASK/OPERATION HEALTH AND SAFETY HAZARD ASSESSMENT	
Chemical Hazards	The chemicals of most concern are concentrations of DRO, GRO, chlorinated solvents, PAHs, and heavy metals such as manganese and iron. Target organs, symptoms of exposure, and exposure limits are presented in Table 7-1. The exposure limits indicated are the most recent published values of the Occupational Safety and Health Administration (OSHA) permissible exposure limits (PELs) or the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit values (TLVs). The more conservative of the two values has been used to determine worker exposure limits for this HASP. Material safety data sheets (MSDSs) for the chemicals of concern are included in Attachment D. The potential for exposure to chemicals on site is considered moderate. Additional chemical hazards include materials that will be brought on site for use during the project. Hazards associated with these chemicals will be controlled through implementation of Safety Management Standard (SMS) 2, the URS Hazard Communication (HAZCOM) Program, and by using safe work practices. The Site Health and Safety Officer/Field Supervisor will maintain a chemical inventory and MSDSs of all of the chemicals brought onsite by URS. This HAZCOM program will be maintained at the job site.
Physical Hazards	Slips, trips, and falls, noise, weather (extreme heat and cold), dust devils, proximity to heavy equipment (overhead hazards and pinch points), ergonomic injury (lifting equipment, bailing wells), eye hazards (proximity to coring machines, intense sunlight),
Biological Hazards	Biting insects and snakes, poisonous plants
Hazard Controls	Chemical, physical, and biological hazards will be minimized through employee training, engineering controls, administrative controls, and when necessary, personal protective equipment. Specific controls are addressed in the Job Safety Analysis (JSA) contained in Attachment B.

Table 7-1 SITE-SPECIFIC CHEMICAL HAZARD DATA								
Chemical Name	**Carcinogen (Y/N)**	**Skin Notation (Y/N)**	**TWA**			**STEL**	**IDLH**	**Routes of Exposure/Target Organs**
			NIOSH REL	**OSHA PEL**	**ACGIH TLV**			
Gasoline	Confirmed animal, unknown to humans	Y	None	None	300 ppm	500 ppm	900 ppm	ROE: inhalation, skin absorption, ingestion, skin and/or eye contact TO: Eyes, skin, respiratory system, central nervous system, liver, kidneys
Diesel	Confirmed animal, unknown to humans	Y	None	None	100 mg/m3	15 ppm	None	ROE: inhalation, skin absorption, ingestion, skin and/or eye contact TO: Eyes, skin, respiratory system, central nervous system, liver, kidneys
PAHs	Y	N	3.5 mg/m3	3.5 mg/m3	3.5 mg/m3	None	None	ROE: inhalation, skin and/or eye contact TO: respiratory system, eyes
Manganese	N	Y	0.2 mg/m3	5 mg/m3	0.2 mg/m3	3 mg/m3	500 mg/m3	ROE: inhalation, skin absorption, ingestion, skin and/or eye contact TO: Eyes, central nervous system, liver, kidneys
Iron (as dust)	Confirmed animal, unknown to humans	N	5 mg/m3	10 mg/m3	5 mg/m3	0.2 ppm	2,500 mg/m3	ROE: inhalation TO: respiratory system

Notes:

OSHA PEL = Occupational Safety and Health Administration Permissible Exposure Limits

IDLH = Immediately Dangerous to Life and Health

ACGIH TLV = American Conference of Governmental Industrial Hygienists Threshold Limit Value

STEL = Short-Term Exposure Limit

Skin Notation = Refers to the potential significant contribution to the overall exposure by the coetaneous route, either by contact with vapors or by direct skin contact with substance.

CNS = Central Nervous System

Table 7-2 AIR MONITORING ACTION LEVELS				
Instrument: PID 10.6 eV lamp				
Reading above Background	**Location**	**Duration**	**Action**	**PPE**
< 2.5 ppm reading on PID	Point of Operations/ Release Source point	> 1 minute	Continue periodic monitoring.	Minimum Site Ensemble (Hardhat, Steel-toed boots, eye protection, hearing protection)
≥ 2.5 ppm reading on PID	Point of Operations/ Release Source point	>1 minute	Monitor OBZ; don protective clothing; establish work zones	Minimum Site Ensemble, Plus: Coveralls, Nitrile Outer Gloves, and Nitrile Inner (surgical) Glove
< 5 ppm reading on PID	Breathing Zone	> 1 minute	No respirators required.	Same as above
≥ 5 ppm reading on PID	Breathing Zone	>1 minute	Improve engineering controls; if not effective, upgrade respiratory protection; establish decontamination area and contact the RSM	Add full-face air purifying respirators with combo organic vapor /P, N or R 100 particulate cartridges. Cartridges will be changed on a daily basis or if breakthrough is detected.
≥500 ppm reading on PID	Breathing Zone	Instantaneous	Stop work; move upwind while vapors dissipate. If elevated levels remain, cover boring and cuttings, evacuate upwind and notify RSM	As specified by RSM.
Visible dust	Breathing Zone	> 1 minute	Improve engineering controls; if not effective, upgrade respiratory protection; establish decontamination area and contact the RSM	Add full-face air purifying respirators with combo organic vapor /P, N or R 100 particulate cartridges. Cartridges will be changed on a daily basis.

8. DECONTAMINATION	
General	Decontamination will be performed as indicated in the sections below. Contamination prevention techniques, such as wrapping monitoring equipment in plastic, will be used on equipment wherever feasible.
Personnel Decontamination	Decontamination for Level D PPE will include dry decontamination of PPE. Disposable coveralls, gloves, or outer boot coverings, if worn, will be discarded in an appropriate container. Personnel will wash hands and face after sampling and before eating. Personnel are advised to shower as soon as possible after leaving the site.
Equipment Decontamination	Equipment decontamination will be performed to limit the spread of contamination and limit worker exposure to contamination. Equipment will be decontaminated before personnel decontamination (i.e., personnel will remain in the appropriate level of PPE until equipment decontamination is complete). All decontamination waste and discarded PPE will be disposed of in accordance with the work plan. Heavy equipment decontamination is the responsibility of the subcontractor. Dry decon of equipment and tools using brushes will be performed to remove gross contamination. Wet decon using Alconox will be used as appropriate.
Personal Protective Equipment	Hardhats-when near drill rigs or heavy equipment High-Visibility vests Safety Glasses and/or safety sunglasses with side shields Hearing Protection-when normal conversation is difficult Steel-Toed Boots Sunscreen

9. Site Control	
General Access	Sites are located on a secure US Air Force Base. Access to sites is controlled by USAF Security Forces.
Work Zones	During site work, affected areas will be cordoned off (e.g., traffic cones around a 50 foot radius, caution tape, and other appropriate methods) to deter unexpected site visitors and create a safe work zone for site workers and members of the general public.

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ATTACHMENT A
FORMS

Tailgate Safety Meeting Form

Date:	Time:	JOB NUMBER: 23446543
Client: Holloman Air Force Base		
Site Location: Holloman AFB, NM		
Task:		
SAFETY TOPICS PRESENTED		
Protective Clothing/Equipment: Modified Level D		
Chemical Hazards:		
Physical Hazards:		
Special Equipment:		
Other: Sally Miller: 303-740-2721 **URS Nurse: 1866-326-7321**		
Emergency Procedures:		
Hospital:	Phone:	Ambulance Phone:
Hospital Address and Route:		
ATTENDEES		
Printed Name:	Signature:	
_____	_____	
_____	_____	
_____	_____	
_____	_____	
_____	_____	
_____	_____	
_____	_____	
_____	_____	
_____	_____	
_____	_____	
Meeting Conducted By:		
Signature:		

EMPLOYEE ACKNOWLEDGEMENT

I hereby certify that I understand the safety and health guidelines contained in the URS Corporation site Safe Work Plan for the field activities associated with Holloman Air Force Base Interim Measures Implementation Project near Alamogordo, NM.

Employee Name: Date:

Employee Signature:

In case of emergency, please contact:

Name: Relationship: Phone No:

List any allergies, such as to bee stings, which may require an emergency response.

Received by:

Health and Safety Manager or Field Supervisor Date

ATTACHMENT B
JOB SAFETY ANALYSIS

Holloman Air Force Base Site Assessment

Job Safety Analysis

Major Task #1: Mobilization/Demobilization

Task Steps (What am I about to do?)	Hazards (What could go wrong?)	Controls (What can be done to make it safer?)
1.) Driving to/from the Site and on the site	Site Traffic Heavy equipment	• Be aware of established traffic patterns • If possible, conduct work in a manner that allows you to view the oncoming traffic • Be aware of the possibility that debris could fly off of passing vehicles • Use caution when entering/exiting work zone/roadways • Park as far away from vehicle traffic and work zone as possible • Do not operate vehicles in unsafe conditions (e.g., on steep slopes, in deep mud or snow) • Wear a high-visibility vest when working around heavy equipment
2.) Equipment Setup	Slips, trips, falls Ergonomic Injuries Traffic Shifting equipment Electrical hazards	• Set up equipment to minimize slips, trips, falls and ergonomic hazards • Orient equipment in a way that the driller and spotter have a clear view of traffic and other potential hazardous situations • Ensure that equipment will not shift or be blown around by the wind • Ensure that car battery powered equipment are properly connected before running equipment • Ensure that it is safe to hook up the equipment to the car battery (sparking hazards, flammable atmospheres, adverse weather, etc.)

Major Task #2: Direct Push Drilling, Asphalt/Concrete cutting and coring

Task Steps (What am I about to do?)	Hazards (What could go wrong?)	Controls (What can be done to make it safer?)
1.) Direct Push Drilling	Overhead hazards Pinch points Noise Heavy Equipment	• Wear a hard hat when near drill rig and do not walk under while in operation • Wear hearing protection while the rig is in operation or when regular conversation becomes difficult. • Ensure eye contact with operator before approaching rig Refer to SMS 56, *Drilling Safety Guidelines*
2.) Asphalt/concrete cutting or coring	Noise Dust Rotating equipment	• Minimize dust as much as possible utilizing methods, etc. • Stand upwind of the operation if possible • Ensure that the coring machine is firmly bolted and that torque maximums are not exceeded • Stand out of the range of the coring machine if it were to become un-bolted.

Major Task #3:	**Hollow-stem Auger Drilling, Monitoring Well Installation, and Development**	
Task Steps (What am I about to do?)	Hazards (What could go wrong?)	Controls (What can be done to make it safer?)
1.) Selecting drilling locations	Overhead utilities Underground utilities	• If overhead utilities are present in work areas, place warning signs at ground level • Always check for overhead utilities before raising the mast • Maintain at least one mast length or 20 feet (whichever is greater) from all power lines • Contact the RSM if high voltage lines are present • Complete utility locates and mark locations prior to drilling • Field verify utility locations • Observe the area around the intended bore location for indications of utilities and move if signs of utilities are present. Refer to SMS 34, *Utility Clearances and Isolation*
2.) Moving Drill Rig	Rig Stability	• Plan the route prior to moving rig to ensure it is stable and free of (ground and overhead) obstacles • Never move the rig with the mast up Refer to SMS 056, *Drilling Safety Guidelines*
	Operator blind spots	• Never assume the operator sees you and can stop the equipment instantly • Maintain eye and hand signal contact with the operator; do not assume the equipment operator can hear you • Never position yourself between two moving pieces of equipment or a place where you could become pinned by the equipment • Stay out of the way of the equipment • Wear a high-visibility vest • Do not park personal or company vehicles where they are in the route (entry/exit/escape) of the equipment • Do not leave equipment (monitoring, coolers, samples) on the ground; the equipment operator may not see them
3.) Advance the Boring	Rotating equipment	• All team members should know the location of the kill switch • At least two persons must be present when advancing the auger • Stand clear if possible • Do not wear loose clothing, jewelry, hair, or equipment near the auger • Remove cuttings with a shovel, not your hand or foot • Properly control the area around the drill rig to prevent unauthorized/trained personnel from entering
	Environmental Contamination	• Cuttings from the saturated zone may contain low levels of volatile organic compounds, PCE, PCB's, or petroleum hydrocarbons; monitor with PID • Contain cuttings in drums or plastic sheeting, AWAY from the work location • Wear nitrile gloves and minimize contact with this soil • Monitor for organic vapors with PID • Work upwind of the boring

Task Steps (What am I about to do?)	Hazards (What could go wrong?)	Controls (What can be done to make it safer?)
3.) Advance the Boring (cont.)	Drilling through concrete-Dust (silica) generation	• Minimize generation of dust • Wet concrete and soil if visible dust is present • Wear hearing protection • If dust masks are used for comfort purposes only, and if visible dust is not observed, ensure all personnel read 20 CFR 1910.134 Appendix D and must contact the RSM to sign an voluntary dust mask use and limitations acknowledgement form
	Noise	• Wear hearing protecting when operating or working near the rig or when normal conversation becomes difficult Refer to SMS 26, *Noise and Hearing Conservation*

Major Task #4: Groundwater and Soil Sampling

Task Steps (What am I about to do?)	Hazards (What could go wrong?)	Controls (What can be done to make it safer?)
1.) Moving Coolers	Lifting	• Get help to lift heavy sample coolers • Bend at the knees; do not use your back • Keep objects close to your body • Do not twist • Minimize movement of heavy objects • Use multiple coolers as appropriate to keep coolers from getting too heavy • Refer to SMS 69, *Manual Materials Handling*
	Slips and falls	• CAUTION – surfaces may be oily, wet, and/or muddy ensure that when carrying equipment or coolers that these surfaces are avoided • Take your time • Wear sturdy shoes with good traction • Organize equipment to minimize tripping hazards • Do not carry too much equipment at one time

2.) Collecting the Sample	Working around traffic or drill rigs	• Use caution when developing wells and/or sampling/logging soil borings:
		• Due to the level of effort involved with developing wells/logging soil borings it is possible to be unaware of:
		  ○ Vehicle traffic and drill rig movements
		  ○ Hazardous conditions
		• Ensure that your sampling/well development location is not obscured
		• Position yourself to view oncoming traffic and drill rig movements
		• Wear a high-visibility vest
		• Do not position yourself between two moving objects or a stationary object and a moving object
		Refer to SMS 19, *Heavy Equipment Operations*

	Logging/collecting the soil boring sample	• Do not approach the drill rig to collect the soil core; have the driller provide you with the core • Use caution when logging core to ensure you are not in a hazardous situation • Wear nitrile gloves when collecting samples to avoid contact with potentially contaminated soil • Use appropriate tools to cut acetate liners • Use appropriate ergonomics when logging/sampling core

Task Steps (What am I about to do?)	Hazards (What could go wrong?)	Controls (What can be done to make it safer?)
2.) Collecting the Sample (cont.)		• Verify that the soil core cannot roll off the logging/sampling surface and fall to the ground • Verify that your footing is solid
	Sample preservatives and decontamination solutions	• Wear nitrile gloves and safety glasses when working with chemicals • Watch out for broken glass and spilled preservatives • Always wear gloves when reaching into boxes or coolers that contain preserved bottles • Ensure that broken glass is disposed in such a way to prevent cuts or lacerations of skin • Containers must be labeled Refer to SMS 2, *Hazard Communication*
3.) Removing flush mount or well cap	Sharp edges Insects	• Ensure that flush mount or casing is free of debris, wasp or spider nests, or sharp edges before opening • If well cap is below casing or flush mount watch out for sharp rusty edges • Use appropriate tools to remove flush mount

Major Task #5: Excavation and Trenching

Task Steps (What am I about to do?)	Hazards (What could go wrong?)	Controls (What can be done to make it safer?)
4.) Excavation of Contaminated Soils	Heavy Equipment Noise	• Excavation and trenching competent person will be present for excavations. • Ensure eye contact with the operator before approaching any heavy equipment • Wear a high-visibility vest, eye protection, and a hard hat when around equipment • Wear hearing protection when equipment is in operation or when normal conversation becomes difficult. Refer to SMS 19, *Heavy Equipment Operations*
5.) Piling and Removal of Soils	Trench collapse Haul truck traffic Dust	• Ensure that proper shoring methods and points of egress are utilized • Ensure that spoil piles are far removed from the edge of the excavation • Inspections of the excavation must be performed per OSHA standards • Stay out of the way when haul trucks are being filled and driving to and from the site • Stand upwind if possible and use dust suppression methods Refer to SMS 13, *Excavation*

Major Task #6: Remediation - DPT Injections

Task Steps (What am I about to do?)	Hazards (What could go wrong?)	Controls (What can be done to make it safer?)
1.) DPT Injection of remediation material	Heavy equipment Noise Energized system Pressurized system Dust/chemical exposure	• Ensure appropriate grounding of injection equipment • Personnel must know the location of the kill switch • Stay out of the “line-of-fire” and wear eye protection when around pressurized equipment • Stand upwind of remediation products and do not inhale chemicals

Major Task #7:	**All Site Activities**	
Task Steps (What am I about to do?)	Hazards (What could go wrong?)	Controls (What can be done to make it safer?)
1.) All Site Activities	Heat Stress Biological Hazards (Bee and wasp stings, Insects) (Vector Borne Disease, Ticks, Mosquitoes, Other Insects and Fleas), Poisonous Plants, Rodents (Vector Borne Disease, Small Biting Animals, Spiders) Severe Weather - Temperatures exceed 100°F during the summer months. Sparse vegetation and prevailing winds can create "dust devils." Rainfall in the July and August Monsoonal Season can be in the form of frequent, intense thunderstorms.	**Heat Stress** • Train workers regarding heat stress prevention and symptoms • Use vehicles for shelter and take breaks as needed • Drink plenty of fluids • Use cooling devices if necessary • Use acclimatized workers • Use the "buddy system" to monitor effects of heat stress • Create shaded work areas if appropriate • Schedule outdoor work during mild weather • If necessary schedule heavy work for cooler times of day Refer to SMS 18, *Heat Stress* **Bee or Wasp Stings** • Look for signs of bee or wasp activity before you touch or move items that could harbor these insects. • If you are aware of allergic reactions to bee or wasp stings, inform your field task manager and carry appropriate emergency response medications (antihistamine or epi pens, etc.) **Insects (Vector Borne Disease, Ticks, Mosquitoes, Other Insects and Fleas)** • These insects can carry diseases including Lyme disease, plague and West Nile virus • Cover skin with light colored clothing • Wear insect repellant with DEET • Tape the interface between boots and pants • Check for ticks or insect bites • Avoid heavily vegetated areas and wet areas, especially at dusk/night • Be familiar with symptoms of exposure to vector borne disease and seek treatment immediately if symptoms develop • If contact occurs, wash immediately with soap and water. Wash clothing after contact • Seek immediate medical attention if any flu-like symptoms develop. Refer to SMS 47, *Biological Hazards* **Spiders** • Wear gloves when lifting objects that may provide shelter for spiders • Poisonous spiders include black widows, brown recluse and hobo spiders Refer to SMS 47 *Biological Hazards* **Severe Weather** • Listen to radio for warnings; check weather each day prior to working at site and prior to driving to/from the site. • Discontinue work and seek shelter if severe weather is approaching • Passenger vehicles with the windows rolled up provide good shelter • Stop work for 30 minutes after thunder/lightning is present in the area.

Staff briefed on JSA (What have I done to communicate the hazards?):

Analysis prepared by: Jennie McCormick

Date: 12/20/2013

Site-Specific Details
TU503

Site-Specific Details
TU506

Site-Specific Details
TU508

Site-Specific Details
TU518

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Appendix C
Standard Operating Procedures (SOPs)

Interim Measures Work Plan – Group 3 UST Sites – Holloman AFB, NM

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SOP No. 1 Utility Clearance
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SOP No. 7 Installation of Groundwater Monitoring Wells
SOP No. 8 Measurement of Groundwater and Fluid Levels in Wells
SOP No. 9 Measurement of Groundwater Field Parameters
SOP No. 10 Monitoring Well Development
SOP No. 11 Monitoring Well Purging and Groundwater Sampling
SOP No. 12 Investigation Derived Waste Management
SOP No. 13 Surveying
SOP No. 14 Data Validation
SOP No. 15 Data Management

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This Standard Operating Procedure (SOP) provides technical guidance for utility clearance at locations selected for intrusive field activities (e.g., borehole drilling, excavation, trenching, etc.). Each location may be cleared for the following utilities: natural gas, telecommunications (cable, telephone, fiber optic, etc.), electrical, water, and sewer. At some locations there may be additional utilities and features that may require clearance, for example, buried lines associated with remedial systems, irrigation lines, and building foundations, etc. In addition to this SOP, refer to the site-specific Health and Safety Plan (HASP) for additional requirements regarding investigations near underground and aboveground utilities.

1.0 EQUIPMENT AND MATERIALS NEEDED

- Maps and plans of utility locations
- Wooden stakes, hubs, surveyor's flags, spray paint, and/or other materials that can be used in reasonable combination to ensure that sampling locations are visible and distinct from other surveying operations or markers
- A hammer to pound stakes into the ground, if necessary
- A steel T-probe (4 feet long), hand auger, vacuum excavator, or other similar non-destructive method to check locations that have been cleared by utilities before actual penetration of the ground with the sampling equipment, if applicable.
- GPS unit (or survey equipment), as applicable
- Field logbook

2.0 METHODOLOGY

1. Request an underground utility locate with the local utility locate service, the local municipality, property owners, and private utility locating service, as appropriate. Provide detailed information on the area where utility locates are needed. Schedule a meeting date and time for utility locates.
2. Where available, utility maps should be procured ahead of time to select preliminary sampling locations to avoid utilities. The person staking sample locations should visually scan the locations for evidence of underground lines or overhead obstructions. Monitoring well and soil borehole locations should be located well away from overhead obstructions such as power lines and steam lines. Maps may be used to review the locations for potential overhead utilities, but such information must be verified in the field.
3. Prior to the utility locate meeting, mark the proposed monitoring well, borehole, or other sample locations. It is recommended that white painted wooden stakes or hubs be used along with surveying flags, with the hub or stake being the permanent marker for sample locations. The hub/stake should be clearly marked with the borehole or well number. The following color code is recommended:

WHITE	Proposed location of well or sampling point
RED	Electric power lines, cables, conduits, steam, and buried lines of unknown purpose

YELLOW	Natural gas, oil, or other petroleum materials
ORANGE	Communications, alarm or signal lines, cables or conduit
BLUE	Water, irrigation, and slurry lines
GREEN	Sewers and drain lines
PINK	Temporary survey markings

4. If an intrusive location must be moved to avoid utilities, it should be relocated to a position that satisfies the investigative or remedial intent of the original location. The revised location will be clearly documented on a map and in the field logbook.
5. Documentation of the utility clearance will be maintained on the URS Utility Clearance Checklist (Attachment 1), or in the field logbook in accordance with proper field documentation protocol. Documentation will include the names of personnel present during the utility clearance, the date and time of the utility locate meeting, description of utility clearance activities, and sign-off. Other documentation may include certification provided by utility companies, sketch maps or historical maps used in locating utilities, survey or GPS coordinates, and photographs. Utility clearance documentation will be kept in the project file.

URS	Health, Safety and Environment **UTILITY CLEARANCE CHECKLIST**	Attachment 034-1 NA Issue Date: June 1999 Revision 6: September 2011

Project Name:	Project Number:
Project Location:	Client Name:
URS Project Manager Name:	Date Completed:

For any item answered 'No', Project Manager approval required before work can proceed.	
Within the last 10 days, and not less than 72 hours from the initiation of the task, contacts were notified that the public utility locate service (One Call) was made.	☐ Yes ☐ No ☐ N/A
Available records have been referenced and a plot plan indicating the location of all underground utilities have been provided and are available for reference at the work site.	☐ Yes ☐ No ☐ N/A

Completed Site Walk Over With Site Personnel (site manager, property owner or tenant representative)			
Site Personnel Name:		Site Personnel Signature:	
Does Site Personnel have any additional information regarding site utilities?		☐ Yes ☐ No Comment:	
Building Utility Service Line Connections Identified:	☐ Yes ☐ No ☐ N/A	Cleared:	☐ Yes ☐ No ☐ N/A

Field Observations – Any ** responses must be explained in box below.	
Field walk completed and utilities identified on page 2 of this form are cleared?	☐ Yes ☐ No**
Apparent saw cuts or patches in concrete/pavement?	☐ Yes** ☐ No
Piping along building exterior? Identify purposed and layout.	☐ Yes** ☐ No ☐ N/A
Manholes, vault covers, drains, pipes present?	☐ Yes** ☐ No
Piping inside of manholes correlate to utility markings?	☐ Yes ☐ No** ☐ N/A
Clear line-of-sight (equipment/vehicles/snow not blocking view or potential utilities)?	☐ Yes ☐ No**
Work between potential utilities or manholes?	☐ Yes** ☐ No
Work areas clear of overhead utilities?	☐ Yes ☐ No**
All known utilities located on plot/site map for personnel to review?	☐ Yes ☐ No**
Explanations:	

Public Utility Locate (OneCall)			
Date Called:		Called By:	
Ticket Number:		Valid Until:	
Area Requested To Be Cleared:			

Private Utility Locate		
Company Performing Locate:		Date Completed:
Area(s) Requested To Be Cleared (including distance around marked locations):		
Method(s) Used (e.g., GPR, EM):		
Confirm Area(s) Cleared:		

URS	Health, Safety and Environment **UTILITY CLEARANCE CHECKLIST**	Attachment 034-1 NA Issue Date: June 1999 Revision 6: September 2011

OneCall Utilities			Field Observation
Utility	**Notified by**	**Comments**	**Marked** (mains and services)
Electric (Red)	☐ OneCall ☐ Other		☐ Yes ☐ No ☐ Above
Gas/Petroleum Pipeline (Yellow)	☐ OneCall ☐ Other		☐ Yes ☐ No
Sewer/Drainage (Green)	☐ OneCall ☐ Other		☐ Yes ☐ No
Water (Blue)	☐ OneCall ☐ Other		☐ Yes ☐ No
Communications (Orange)	☐ OneCall ☐ Other		☐ Yes ☐ No ☐ Above
Other	☐ OneCall ☐ Other		☐ Yes ☐ No ☐ Above

Utilities Not Identified By OneCall (Includes both Public and Private along with Regional and Site Utilities)			Field Observation
Utility (Colors may vary)	**Owner / Contact / Phone #**	**Notified**	**Marked**
Communications: (Orange) TV, computer, phone, cell towers, site communication, cameras, security, etc.		☐Yes ☐No	☐ Yes ☐ No ☐ Above
Electricity: (Red) Mains / Supplies / Interior / Exterior (signs, fuel pumps, low voltage security perimeters, gates, property light posts, equipment, substations, etc.)		☐Yes ☐No	☐ Yes ☐ No ☐ Above
Gas: (Yellow) Mains / Supplies / Equipment / Pipelines (Natural, Process, Oil, Crude, Refined (Gas, Diesel, Jet), etc.)		☐Yes ☐No	☐ Yes ☐ No ☐ Above
Steam (Yellow)		☐Yes ☐No	☐ Yes ☐ No ☐ Above
Structures: Possible horizontally installed facilities, vaults, basements, tunnels, sub-grade structures, foundations, overhead obstructions, etc.		☐Yes ☐No	☐ Yes ☐ No ☐ Above
UST Systems (Tanks / piping / electric)		☐Yes ☐No	☐ Yes ☐ No
Sewer: (Green) Sanitary, storm, combined, septic, drainage (parking, buildings, fields), irrigation		☐Yes ☐No	☐ Yes ☐ No
Water: (Blue) Process, Plant, potable, well, cooling, return/makeup, fire, sprinkler, landscape irrigation, reclaim (Purple) other		☐Yes ☐No	☐ Yes ☐ No ☐ Above
Other: Abandoned Lines, invisible dog fences, shopping cart perimeter monitoring, traffic lights		☐Yes ☐No	☐ Yes ☐ No ☐ Above

If subsurface work is within five feet (1.5 meters) of a confirmed or suspected utility or other subsurface structure, nondestructive clearing techniques (e.g., air knife, vacuum excavation, hand auger) must be completed to visually locate and expose the utility.	☐ Yes ☐ No ☐ N/A
Precautions have been taken to prevent contact with overhead or underground utilities.	☐ Yes ☐ No ☐ N/A

Printed Name of Person Completing Checklist:	Signature:

1.0 PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) provides procedures for the use, review, and maintenance of field forms, field log books, and photographs (collectively "field documents"). Various field forms will be used to support different activities and procedures; for example: sample logs, field sampling sheets, field logs, chain of custody forms, shipments received, and shipments sent off-site. Specific field forms are not included here, but are included with the associated SOPs, as appropriate. With a few exceptions, all field documents will be reviewed periodically by the URS Field Manager, and maintained by specific field personnel until field activities are complete.

Field documents provide a means for recording data, observations, decisions, and activities at the Site. In addition to recording data and measurements, these documents are intended to accomplish a number of other objectives: (1) show compliance with applicable laws, regulations, and procedures; (2) create an official record of field decisions made; (3) enable non-field personnel to understand Site observations and activities for future decision making; and (4) enable field personnel to reconstruct events which occurred while performing field activities to facilitate completion of daily reports and similar documents.

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The URS Field Manager has the overall responsibility for implementing this SOP and will assign staff to implement the applicable procedures and confirm that these procedures are followed.

Field personnel are responsible for completing required documentation as specified in field activity-specific SOPs. In addition, a designated member from each field team will record the team's daily activities, significant events, observations, and measurements taken in a field log book.

The URS Field Manager will confirm that, prior to commencing documentation activities, all field personnel have the appropriate health and safety training, as well as an understanding of the procedures described within this SOP. The procedures may be reviewed with field teams prior to commencement of field work and additional specific training will be provided, as necessary.

Project field team members will notify the URS Field Manager if they identify a need for deviation from this SOP or from any other established procedure for completing field documentation. If the deviation involves a substantive change, the URS Field Manager will evaluate and initially approve such change prior to communicating the deviation to the URS Project Manager for final approval. Every substantive change will be documented by the URS Field Manager in his field log book.

3.0 PROCEDURES

As a general rule, information that is systematically and repeatedly collected (e.g. sample location data) will be recorded on appropriate field forms. Information unique to the day (e.g., activity summary or procedural deviation) will be recorded in a field log book. Log books shall

be bound books with consecutively numbered pages. Log books may be assigned to a field team and/or person for the duration of the project.

3.1 LOG BOOK ENTRY PROCEDURE

Some field personnel with specific responsibilities (e.g., URS Field Manager) and each field team will have a log book. Each field activity will be recorded in the log book by a designated field team member to provide daily records of measurements, significant events, observations, and worker, public safety, and environmental precautions taken during field operations.

Log book entries will be made in indelible black or blue ink unless conditions require use of pencil. No erasers are permitted for ink or pencil entries. If an incorrect entry is made, the entry will be crossed out with a single strike mark and initialed and dated by the originator. Entries may be organized into easily understandable tables if desired.

Log book pages will be numbered and dated at the top of the page. Times will be recorded next to each entry. No pages or spaces will be left blank. If the last entry for a day is not at the end of the page, a diagonal line will be drawn through the remaining space and the line will be initialed and dated.

Log books can become contaminated when used in the field. Every effort should be made by the field team to avoid contaminating the log book. Log books can be kept in sealed-top poly bags or temporary plastic covers may be used.

Some information may be pertinent to record in the field log book for repeated reference. Such information may be entered at the beginning on the first numbered page and extending through as many pages as necessary. Some reference (look-up) information may also be attached to the last pages of the field log book. The following list provides examples of useful and pertinent information which may be recorded.

- Serial numbers and model numbers for equipment which will be used for the project duration
- SOP references
- Decontamination procedures
- Formulas, constants, and example calculations
- Useful phone numbers
- Site county, state, and address

At a minimum, log book entries must include the following information at the beginning of each day:

- Date and page number at top of each page
- Task(s) of the day
- Start time

- Weather
- Field personnel present and site visitors
- Equipment used and procedures followed, and
- Any field calculations

In addition, information recorded in the log book during the day may include (but is not limited to) the following:

- Health and Safety meetings, observations, or actions
- Sample descriptions including sample names/numbers, time, volume, containers, preservative, and media sampled, unless otherwise recorded on a separate field form
- Record of photo documentation, unless otherwise recorded on a separate form.
- Information on field quality control (QC) samples (i.e., duplicates), unless recorded on a separate form
- Information about any activities that may affect the integrity of samples collected
- Any public involvement, unexpected visitors, or press interest
- Equipment used on-Site including time and date of calibration
- PPE worn by site workers
- Wildlife, sensitive vegetation, or cultural/archaeological resources encountered
- Actions taken to protect public health and safety and the environment
- Background concentrations for each instrument and possible background interferences, if applicable
- Unusual observances, irregularities or problems noted on-Site
- Instrumentation problems
- Maps or documents acquired, including descriptions
- If field forms are used, the log book and field form may cross-reference each other
- Document investigation derived waste (IDW) generated and its management and/or disposal

3.2 FIELD FORMS

Field forms are created prior to commencement of field work, and are typically task-specific (e.g., drilling logs, groundwater sampling forms, etc.). Field forms will contain, at a minimum, the following information:

- Project name and number
- Location identification reference

- Date
- Name(s) of field personnel making observations recorded
- Cross-reference with log book (e.g., log book number), as applicable
- Comments related to changes in original location, special observances, or any other comments the field personnel (e.g., sampler, surveyor, geologist) regards as noteworthy.
- Deviations from the sampling SOP's

Specific field forms may also be provided for Health and Safety. These may include tailgate safety forms, Work Permits, and other applicable forms. Each of these will be designed to capture as much pertinent information as possible.

4.0 REVIEW

The URS Field Manager or designee will check field forms and log books for completeness and accuracy on an approximately daily basis. Discrepancies in these documents will be noted and returned to the originator for correction in a timely manner.

5.0 FIELD DOCUMENT MANAGEMENT

The URS Field Manager is responsible for maintaining field documents and implementing these document management procedures. With a few exceptions, all field documents will be maintained by the URS Field Manager.

Log books are assigned to a field team and/or person for the duration of the project and each field team will have a log book at all times during field activity.

Completed field forms will be retained by the URS Field Manager. Completed sampling field forms may also be submitted to the URS Sample Manager at the time of relinquishing sample custody, if appropriate.

All completed field forms and field log book pages will be copied and scanned at the completion of the field activities. The original forms and scanned electronic files will be maintained by URS and placed in the appropriate project file.

This Standard Operating Procedure (SOP) details the procedures for decontamination of personnel and equipment during field activities. Decontamination of personnel and equipment (e.g., water and soil sampling equipment, vehicles, etc.), is required to minimize the possibility of cross-contamination of environmental samples between sampling locations. In addition to this SOP, refer to the site-specific Health and Safety Plan (HASP) for additional requirements regarding decontamination procedures.

1.0 EQUIPMENT

The following is a list of equipment that may be necessary to perform decontamination activities:

- Personal protective equipment (PPE) as outlined in the HASP
- Paper towels
- Alconox® / Liquinox® detergent (or equivalent)
- Potable or non-potable water
- Deionized or distilled water
- Water sprayers or hand-held spray bottles
- Disposable nitrile gloves
- Clean plastic sheeting, and/or trash bags

2.0 DECONTAMINATION PROCEDURES

Section 2 describes decontamination of sampling equipment that may be utilized to prevent cross-contamination between sampling locations. Decontamination procedures to be implemented for the protection of worker and public health, safety, and the environment are also set forth in the following section. Different types of decontamination may be necessary for the following:

- Soil sampling equipment;
- Water sampling equipment;
- Instruments; and
- Vehicles and personnel.

2.1 DECONTAMINATION OF SAMPLING EQUIPMENT

The procedures in this section are designed to prevent cross-contamination of samples collected in different sample locations. Procedures for decontamination of sampling equipment apply to equipment that is re-usable (e.g. funnels and shovels) and contacts a sampled medium (e.g., water). Decontamination of sampling equipment may be performed at each sample collection location upon completion of sampling.

General requirements for decontamination are listed below:

- Personnel may wear appropriate safety equipment to reduce personal exposure, as required by the HASP.
- New nitrile gloves may be worn when performing equipment decontamination.
- Detergent and rinse solutions to be used for decontamination procedures may be replaced with new solutions between sample collection events unless the solution is stored in a water sprayer.
- Bulk contamination, such as large pieces of soil, may first be removed by hand or tools.
- Equipment may then be washed in a detergent/water solution, using brushes and other tools, as appropriate, until clean. The water used may be clean and may be potable, non-potable, deionized, or distilled.
- Washed equipment may be rinsed first by potable water, or by deionized/distilled water, if potable water is not available.
- A final rinse may be by deionized or distilled water.
- Equipment may be inspected for visible contamination and washed again if necessary.
- Equipment may be dried and stored in a clean location. Air-drying is an acceptable method for most equipment.

2.2 DECONTAMINATION OF PERSONNEL

The procedures in this section are designed to protect the worker and public health, safety, and the environment. Procedures for decontamination of personnel apply to any person (including clothing) who is exposed to contaminated site material such as groundwater or soil. Decontamination of personnel may be performed prior to leaving the site, or as necessary to protect health and safety.

General requirements for decontamination are listed below:

- Personnel may wear appropriate safety equipment to reduce personal exposure, as required by the HASP.
- Bulk contamination, such as large pieces of soil, may first be removed by hand or tools, with special attention to boots and coveralls.
- Personnel and clothing may then be washed with a detergent/water solution, using brushes and other tools, as appropriate, until clean. The water used may be clean and may be potable, non-potable, deionized, or distilled.
- Following washing, a water rinse may be conducted to flush contaminated media and detergents from the affected area.

2.3 DECONTAMINATION OF VEHICLES

The procedures in this section are designed to protect the worker and public health, safety, and the environment. Procedures for decontamination of vehicles apply to any vehicle or piece of heavy equipment that is exposed to contaminated site material such as groundwater or soil. Decontamination of vehicles may be performed prior to leaving the site, or as necessary to protect health and safety.

General requirements for decontamination are listed below:

- Personnel may wear appropriate safety equipment to reduce personal exposure, as required by the HASP.
- Bulk contamination, such as large pieces of soil, may first be removed by hand or tools, with special attention to tires or tracks, wheel-wells, and compartments such as dump truck beds and excavator or backhoe buckets.
- A rinse with water may be conducted to flush contaminated media from the affected area. If necessary, a high-pressure washer and/or detergent solution may be used to remove contaminated media.

2.4 INVESTIGATION DERIVED WASTE MANAGEMENT

Solid and liquid IDW generated during decontamination procedures may be managed as described in the SOP for IDW.

Solid IDW generated during decontamination procedures may consist of: (1) PPE used during the decontamination process and (2) disposable material used to decontaminate equipment.

Liquid IDW may generally consist of wash/rinse water, and may contain a substantial amount of solids. It is permissible, after solids settle, to decant clear water from such a container to another IDW container, thus separating solid and liquid IDW.

3.0 DOCUMENTATION

Sampling personnel may document the decontamination that occurs within a sample collection site in the field log book. The information entered in field log books concerning decontamination may include the following:

- Decontamination personnel
- Date/time
- Location
- Type of containment for decontamination fluids
- Other pertinent information

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This Standard Operating Procedure (SOP) provides technical guidance and methods that will be used for sample identification, labeling, packing, documentation, and Chain-of-Custody (COC) procedures. All activities will be conducted in accordance with the site-specific Health and Safety Plan (HASP).

1.0 EQUIPMENT NECESSARY FOR SAMPLE HANDLING, SHIPPING, AND DOCUMENTATION

The following equipment may be used for sample labeling, packing, documentation, and COC procedures:

- Personal protective equipment (PPE) as specified in the Health and Safety Plan (HASP)
- Decontamination equipment and supplies
- Clean sample containers with preservatives, if required.
- Shipping coolers
- Re-sealable plastic bags (Ziplock® or equivalent)
- Sample labels
- Shipping forms (provided by shipping courier)
- Shipping labels (e.g. Fragile, This Side Up, etc.)
- Chain-of-Custody forms
- Custody seals
- Bubble wrap or equivalent packing material
- Tape (e.g., clear tape, strapping/packing tape)
- Ice or other refrigeration method
- Paper towels
- Large trash bags

2.0 SAMPLE IDENTIFICATION

Each sample collected will have a unique sample identification (ID). These IDs are necessary to identify and track each sample collected for analysis during the project. Accurate and comprehensive sampling records are necessary to create a complete record of field procedures, including circumstances of collection and integrity of a given sample.

3.0 SAMPLE HANDLING, SHIPPING, AND DOCUMENTATION PROCEDURES

3.1 FIELD SAMPLE PROCESSING AND CUSTODY

A Chain-of Custody (COC) for each sample will be maintained and documented from the sampling location through its delivery to the laboratory for analysis. Each sample must be in the custody of the sampling team or Sample Manager from the moment it is extracted and containerized until sample shipment. Samples will be containerized and labeled at the sample collection location. Samplers may relinquish containerized samples to the Sample Manager for completion of the documentation and preparation of the samples for shipment. Changes in custody (e.g. from sampler to Sample Manager) will be documented in logbooks that identify the personnel relinquishing custody and personnel receiving the custody of the samples. The COC accompanies the samples and is used by the Sample Manager to document transfer of custody from the field team to the shipping agent.

3.2 SAMPLE LABELING

Sample labels may be filled out partially before field sampling activities begin. The date, time, and sampler's initials or signature should not be completed until the time of sample collection. Sample labels will be filled out using waterproof ink.

Care will be taken during labeling and taping to preclude the possibility of sample contact with label or tape adhesive.

3.3 SAMPLE HANDLING

This section discusses proper sample containers, preservatives, and handling and shipping procedures.

3.3.1 Sample Containers

Commercially clean sample containers will be obtained from a subcontracted analytical laboratory or vendor and filled with sample material in accordance with these SOP procedures.

3.3.2 Sample Preservation and Storage

All samples collected for chemical analysis will be stored on ice (or similar) in an insulated cooler to maintain a temperature of <6°C and shipped on ice (or similar) to the laboratory for preparation and analysis.

3.3.4 Sample Packaging and Shipping

The Sample Manager is responsible for confirming that samples collected by the sampling team have been properly containerized, packed, and labeled. Once the Sample Manager has custody of samples, he/she is responsible for maintaining custody (i.e., keeping samples in the designated secure location), and packaging and shipping the samples in a timely and proper manner.

Samples and sample containers will be packaged properly to protect the integrity of the sample and its seal, prevent breakage of containers, and prevent leakage of contents.

A copy of the shipping bill will be retained by the Sample Manager for attachment to the corresponding copy of the COC form, and these forms will be maintained by the URS Field Manager in accordance with SOP s.

Packing and Shipping Samples for Chemical Analysis

- Place sufficient amounts of packing material (e.g., bubble wrap) in the bottom and sides of the shipping cooler to prevent movement of contents.
- Line the inside of the cooler with a plastic trash bag, add enough ice (in double bags) to the cooler to maintain the required temperature of <6°. Line the bottom, sides, and top of cooler to retain proper shipment temperature; using at least 3-4 one gallon bags of ice per 48-quart cooler is recommended.
- A bottle containing tap water and identified as a temperature blank will be included with each cooler containing samples cooled to <6°C. Upon receipt of the samples at the laboratory, the temperature blank will be used to determine the cooler temperature. The temperature blank will not be assigned a sample identification number and will not appear as a line item on the chain-of-custody form.
- Place samples and temperature blank inside the bag in an upright position. Tie shut the trash bag holding the samples and ice.
- Fill excess space in the cooler with ice bags or other packing material (e.g., bubble wrap) to prevent movement of sample containers.
- Place the original signed copy of the COC form inside a plastic bag, and tape the bag inside the cooler lid, reserve the carbon copy or photocopy of the COC for URS' records.
- Close the cooler lid, and seal the cooler and the cooler spout with appropriate packaging tape.
- Place two custody seals (tampering seals) after signing and dating on the cooler in separate areas across the gap between the lid and the cooler base. Tape the custody seals to the cooler to confirm that custody seal is adequately affixed.

Samples may be shipped for Saturday delivery; however, Saturday delivery will require laboratory approval before shipment.

3.3.5 Sample Container Tampering

If, at any time after samples have been sealed and secured, custody seals on the sample container, or cooler are identified as having been tampered with, the following procedures will be conducted:

- Check with personnel having access to sample coolers/containers to evaluate whether inadvertent tampering can be documented.
- Document findings of the incident in a logbook.

If it cannot be confirmed and documented that the custody seal was broken inadvertently and that the integrity of samples is unimpaired, the samples will be re-collected and the URS Project Manager and URS Quality Assurance Manager (QAM) will be notified.

3.3.6 Holding Times and Analyses

The holding time is specified as the maximum allowable time between sample collection and analysis or extraction, based on the analyte of interest, stability factors, and preservative (if any) used. Any storage of samples on Site will be scheduled to be kept to the minimum period, based on logistic considerations (e.g. samples will not be shipped over weekends unless advance arrangements for receipt have been made with the laboratory).

4.0 CHAIN-OF-CUSTODY PROCEDURES

The custody of samples shall be documented on the COC. These forms document possession of the sample from collection through laboratory receipt, including transfer, handling, and shipping of samples.

Sample custody and documentation procedures will be followed to preserve sample integrity and to confirm the validity of field and laboratory data. As a result, sample data will be traceable from the time and location of sample collection through chemical analyses and data reporting. The following information will be recorded on the COC form that will accompany samples to the laboratory:

- Sample ID
- Sampling date and time
- Required analyses
- Number of containers
- Sample Manager (or designee) signature

The objective of the custody identification and control system for the samples is to confirm, to the extent practicable, that the following occur:

- Samples scheduled for collection are uniquely identified.
- The correct samples are analyzed and are traceable to their records.
- Samples have been appropriately preserved.
- Samples are protected from loss or damage.
- A record of sample integrity is established.
- Legally traceable custody and possession records are maintained.

Observe general documentation rules, including the use of blue or black ink. Make any changes to the COC form by drawing a single line through the incorrect information and initialing the mark-out. Put a line through and initial blank lines on the COC form.

Upon receiving the samples, the laboratory's representative shall do the following:

- Sign and keep copies of shipping documents.
- Sign the COC form and return the second copy to the URS Project Manager or designee (may be included with the analytical results).
- Measure and document the temperature of the samples using temperature blank.
- Document the condition of the custody seals and of the samples.
- Notify the URS Project Manager or designee if any breakage or improper preservation has occurred or if there is a discrepancy between the COC form, sample labels, and requested analyses.
- Provide copies of the above documentation to the URS Project Manager or designee with the final laboratory data package.
- At the laboratory, custody of samples will be in accordance with the laboratory's SOPs from sample receipt through sample residual disposal.

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This Standard Operating Procedure (SOP) provides technical guidance for drilling boreholes and recording lithologic information during drilling, excavation, or similar intrusive activities (logging). Boreholes may be drilled for the purpose of collecting stratigraphic data, installing wells, and/or collecting other subsurface information. The procedures in this SOP are related to drilling and logging of unconsolidated materials (including logging during excavation). All activities will be conducted in accordance with the site-specific Health and Safety Plan (HASP).

1.0 EQUIPMENT AND MATERIALS NEEDED

The following is a list of equipment that may be used to perform drilling and logging of subsurface material, depending on the work defined in the Work Plan:

- Monitoring equipment and personal protective equipment (PPE) as outlined in the HASP
- Drilling rig with appropriate sized drill rods and downhole bit/casing systems for drilling in unconsolidated materials (e.g., hollow-stem augers)
- Hydraulic excavator, backhoe, or similar equipment for excavating trenches, pits, etc.; or, shovels, hand augers, or similar manual equipment for smaller excavations
- Potable water, if needed, for drilling
- Soil sampling equipment (e.g., such as split-spoon samplers, Macrocore® samplers, continuous core barrels, trowels, scoops, etc.)
- High pressure washer for decontamination of drilling equipment
- Decontamination equipment and supplies for soil sampling equipment
- 55-gallon drums, roll-off, baker tank, or other container, as specified in the Work Plan, to place drill cuttings and water produced from the borehole
- Field logbook
- Boring log forms (see Attachment 1 for an example)
- Pens, permanent markers
- Tape measure, or similar
- Stainless steel knife, screwdriver, rock hammer
- Photoionization detector (PID)

Other materials and equipment may be used based on field conditions and the scope of work.

2.0 DRILLING METHODOLOGY

Prior to drilling (or excavation), the boring locations will be cleared for utilities in accordance with the Work Plan, HASP, and SOPs. Boring and excavation locations may be adjusted in the field due to the presence of underground utilities, overhead power lines, or other structures, or if access problems are encountered. Drilling and excavation locations will be approved by the Field Manager, geologist, or engineer prior to initiating drilling activities. Each boring location may be assigned a unique identification number, if specified in the Work Plan.

Health and safety equipment specified in the HASP will be donned before proceeding with subsurface drilling activities. The HASP will specify action levels for various contaminants and the field monitoring required to measure ambient conditions.

Downhole, or other invasive equipment will be decontaminated prior to proceeding to the site, and between subsequent boreholes using the procedures in the Work Plan. Soil sampling equipment will be decontaminated at the site between each sample interval, as applicable.

All work around borings and excavations will be restored to a physical condition equivalent to that of pre-intrusive activities as practical. This will include drill cuttings removal and rut repair.

The equipment shall be free of leaks that could contaminate the boreholes (e.g., hydraulic fluid, oil, fuel, etc.). Pipe lubricants that are used should not introduce contaminants into the borehole. Lubricants that are environmentally acceptable include Green Stuff®, King Stuff®, vegetable oil, Criso™, and some Teflon™-based lubricants. Lubricants that are not acceptable include petroleum-based and most metal-based lubricants. The Field Manager will approve lubricants that will be used.

3.0 BOREHOLE AND EXCAVATION LOGGING

The site geologist or engineer will be responsible for logging samples, monitoring drilling and/or excavation operations, and preparing field boring logs. Procedures for completing boring logs are described below:

- Boring log information will be recorded on the boring log form (see Attachment 1 for an example). Lithologic data obtained from excavations may be recorded on the boring log form, in the field book, or on other appropriate forms.
- Logs will be prepared in the field by the site geologist or engineer as the borings are drilled, or the excavations dug.
- All log entries will be legibly printed such that photo reproductions will be clear and legible.
- Borehole depth information will be recorded to the nearest 0.5 foot, if possible. Excavation information will be recorded to the nearest 1.0 foot, if possible.
- All relevant information in the log heading and log body will be completed. If surveyed horizontal control will not be available, location sketches referenced by measuring distances or prominent surface features shall be shown on, or attached to the log.
- An appropriate scale will be used on the log form (e.g., a scale of 1 inch or one row on the log form equaling 1 foot of boring).
- Each material type encountered will be described on the boring log form. Material types will be logged directly from soil samples. Professional judgment may be used to interpret soil types between sampling intervals based on drill cuttings, drill action, etc.
- Material may be described in the following order:
    1. Material type (i.e., sand, silt, clay, etc.)
    2. Grain size, sorting, rounding, and make-up of the material (for sand or gravel)

3. Types and amounts of secondary constituents
4. Other pertinent characteristics (plasticity, hardness, bedding, etc.)
5. Moisture content
6. Universal Soil Classification System (USCS) code (for unconsolidated material)
7. Color

- Unconsolidated materials will be classified in general accordance with American Society for Testing and Materials (ASTM) Method D2488-09a (Standard Practice for Description and Identification of Soils [Visual-Manual Procedure]) or the United States Environmental Protection Agency (USEPA) Manual 625/12-91/002 (Description and Sampling of Contaminated Soil). Soil classification will be made in the field at the time of sampling by the site geologist or engineer and is subject to change based on subsequent review.
- Drill cuttings and excavated soil may be described in terms of the appropriate parameters, to the extent practical. "Classification" will be minimally described for this material, along with a description of drilling actions and water losses/gains for the corresponding depth. Notations will be made on the log that these descriptions are based on observations other than formal samples (i.e., from cuttings).
- All special problems encountered during drilling/excavation and their resolution will be recorded on the log. This would include loss of circulation, sudden tool drops, unrecovered tools in the borehole, and lost casing or sampler.
- The dates for the start and completion of borings/excavations will be recorded on the log. Changes in shift, day, driller, and site geologist or engineer will also be noted at the depth they occur.
- Stratigraphic/lithologic changes will be identified on the boring log by a solid horizontal line at the appropriate scale depth on the log which corresponds to measured borehole depths at which changes occur, measured and recorded to the nearest 0.5 foot. Gradational transitions and changes identified from cuttings or methods other than direct observation and measurement will be identified by a horizontal dashed line at the appropriate scale depth based on the best judgment of the logger.
- Logs will show borehole and sample diameters and depths at which drilling, excavation, or sampling methods or equipment change. This includes diameters of bits, core barrels, outer casing, etc.
- Logs will show total depth of penetration and sampling. The bottom of the hole will be identified on the log by solid double lines from margin to margin with the notation "Total Depth" or similar.
- Logs will identify the depth at which water is first encountered. The absence of water in borings or excavations will also be indicated.
- Logs will identify any drilling fluid (water) losses, including depths at which they occur, rate of loss and total volume lost. Document the amount of potable water added to the borehole during drilling, if any, and the amount of water removed from the hole.

- Blow counts will be recorded in half-foot increments when a standard penetration test is performed. For penetration less than a half-foot, the count will be annotated with the distance over which the count was taken. Refusal, if reached, will be noted. No more than fifty (50) blows will be performed over a half-foot interval; refusal will be noted if the blow count reaches 50 and the log will be noted as specified.
- Logs will include other information relevant to a particular investigation, such as odors, field screening or test results (e.g., organic vapors), the interval and identification numbers for soil or groundwater samples collected, and any observed evidence of contamination in samples, cuttings, or drilling fluid.
- Significant color changes in any drilling fluid return will be recorded, even when intact soil samples or rock core are being obtained. The color change (from and to), depth at which change occurred, and a lithologic description of the cuttings before and after the change will be recorded.
- Special (non-standard) abbreviations used on a log will be defined either in the log where used, or in a general legend.

4.0 BOREHOLE ABANDONMENT

Borehole abandonment may be necessary in some cases. Abandonment will proceed immediately after drilling and completion of sampling or testing. The following generalized procedures will be used to abandon boreholes.

- All downhole equipment will be removed from the borehole. Cuttings will be scraped from the drill rods and bits and contained and disposed of in accordance with the procedures for IDW management specified in the Work Plan.
- Boreholes will be backfilled in accordance with appropriate state or local regulations depending on the location, depth, and other properties of the boreholes.
- If there is insufficient water in the hole to saturate bentonite chips, potable water may be added in the amount of approximately 4 gallons per 50 pound bag.
- Details concerning the abandonment process will be recorded on the boring log and in the field logbook.

5.0 DOCUMENTATION

Documentation during drilling and logging of boreholes will be in accordance with SOPs. Documentation of the observations and data acquired in the field will provide information on the activities conducted and also provide a permanent recorded of field activities. The observations and data will be recorded on the boring log forms (see Attachment 1 for an example) or in the field logbook, as applicable. The following information at a minimum will be recorded in the field logbook:

- Names of personnel at the drill site
- Weather conditions
- Drilling procedures

- Dates and times of drilling and sampling
- Location and borehole identification
- Times that procedures and measurements are completed
- Decontamination times and procedures
- Field instrument calibration information
- Records of visitors to the drill site
- Other applicable information

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Attachment 1

Example of Boring Log Form

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DRILLING RECORD - LITHOLOGY AND WELL CONSTRUCTION

WELL ID	PROJECT	LOCATION		SHEET OF
GEOLOGIST	DRILLING CONTRACTOR	DRILLING EQUIPMENT		DATE
GROUND ELEV.	DRILLER	DRILLING METHOD	SAMPLING METHOD	FIRST WATER
M.P. ELEV.	CASING	SCREEN		FINAL DTW
B.H. DIAMETER	FILTER PACK	SEAL		PERMIT #

DEPTH BELOW SURFACE	PID	SAMPLE NO.	REC. % or IN.	BLOWS PER 6 IN.	NAPL Y/N	LITHOLOGY	WELL CONSTRUCTION
1							
2							
3							
4							
5							
6							
7							
8							
9							
0							
1							
2							
3							
4							
5							
6							
7							
8							
9							

URS, 8181 EAST TUFTS AVENUE, DENVER, CO 80236, PH: (303) 740-2600 FAX: (303) 694-3946

This Standard Operating Procedure (SOP) provides technical guidance and methods that will be used to collect surface and subsurface soil samples. Soil samples will be collected for chemical analyses, physical analyses (e.g., grain size, permeability), and/or analysis of other properties (e.g., oil saturation, residual saturation, etc.).

This SOP provides descriptions of equipment, field procedures, and documentation necessary to properly collect soil samples for laboratory analysis. Sampling locations and specific details of sampling activities, equipment selection, and laboratory analyses are presented in the Work Plan and/or the Quality Assurance Project Plan (QAPP).

All soil sampling activities will be conducted in accordance with the site-specific Health and Safety Plan (HASP).

1.0 EQUIPMENT

The following is a list of equipment that may be used to collect surface and subsurface soil samples, depending on the work scope defined in the Work Plan:

- Stainless-steel scoop/trowel or plastic disposable sampling tool
- Hand-auger, shovel, or other appropriate excavation tool, or drill rig, as applicable
- Laboratory-supplied sample containers
- Field logbook
- Photoionization detector (PID) with appropriate lamp, if specified in the Work Plan
- Decontamination supplies for soil sampling equipment
- Sample containers
- Sample labels, chain-of-custody forms/seals, and shipping labels
- Sample packing supplies
- Garbage bags
- Ziploc®, or similar, bags
- Cooler(s) and shipping supplies
- Ice
- Soil sampling form (if used)
- Appropriate health and safety equipment and personal protective equipment (PPE) as required by the HASP

2.0 METHODOLOGY

This section provides the methodology for collecting surface soil samples (Section 2.1) and subsurface soil samples from borings (Section 2.2).

2.1 SURFACE SOIL SAMPLING

Surface soil samples will be collected at locations and depths specified in the Work Plan. For samples collected for chemical analyses, the order of sample collection should be from locations expected to have lower concentrations of constituents of interest first, to locations with higher expected concentrations. Surface soil sampling will be performed as follows:

1. At each sampling site, clear a surface area of approximately one square foot of any rocks or organic material greater than approximately 3 inches in size.
2. Using a decontaminated excavation or sampling tool, excavate soil to the depth specified in the Work Plan.
3. Label containers with sample tags prior to filling.
4. Collect soil sample using a decontaminated stainless-steel or disposable plastic sampling tool. If analytical testing will be performed for volatile organic compounds (VOCs), the VOC sample will be collected first (with a minimum of disturbance) by placing the sample into the container with a minimum amount of headspace and sealed tightly. If specialized sampling methods (e.g., Terracore®) are to be used, refer to the manufacturer's recommended procedures. VOC samples collected into glass jars should fill the jars with no headspace left open.
5. For analyses other than VOCs, sample material may be placed in a decontaminated plastic or stainless-steel mixing bowl using the designated sampling tool and thoroughly mixed and homogenized, if necessary.
6. Rocks that are greater than approximately 0.5 inches in diameter may be discarded from the soil to be sampled.
7. Place soil to be sampled in the appropriate size sample container. The sample container should be filled with soil to just below the container lip, and the container should be sealed tightly.
8. Complete all pertinent documentation, including field quality assurance/quality control (QA/QC) documentation, logbook entries, and sample labels. Sample identifications may be assigned by the Work Plan or QAPP.
9. Mark the sampling site with a wire flag, wooden stake, metal rebar, or flagging, as appropriate, for subsequent surveying (if specified in the Work Plan).
10. Decontaminate all sampling equipment in accordance with SOPs, as appropriate for the type of equipment.
11. Package and ship samples according to SOPs.

2.2 SUBSURFACE SOIL SAMPLING

Subsurface soil samples may be collected from borings during drilling at locations and depths specified in the Work Plan. Subsurface soil samples will be collected from drill cuttings, sonic soil cores, split spoon samplers, Shelby tubes, or other applicable methods specified in the Work Plan. The method of sample collection is dependent on several factors including the type of drilling that is used, the type of analysis that will be performed on the sample, and the end use of

the data. Each type of sampling is described below. In general, subsurface soil samples may be collected directly from the sampling equipment into appropriate containers for chemical analysis.

2.2.1 Sampling of Air Rotary Drill Cuttings

Subsurface samples collected from air rotary drill cuttings are used for lithologic logging, screening of soil headspace using a PID, and the collection of samples for analyses specified in the Work Plan. Soil samples will be collected from air rotary cuttings as follows:

- For target sampling intervals (e.g., depth of every five feet or sampling interval specified in the Work Plan), collect air rotary soil cuttings directly from the cyclone into a container (such as a 5-gallon bucket)
- If groundwater is produced during drilling, decant the water off the bucket into an appropriate container
- Collect soil subsamples from the container of cuttings in accordance with Steps 3 through 11 for surface soil sampling (Section 2.1)

2.2.2 Sampling of Sonic Soil Core

During sonic drilling, continuous soil samples are generally collected in the sonic core barrel and extruded into a plastic sleeve. The Sonic soil core samples are used for lithologic logging, screening of soil headspace using a PID, and the collection of samples for analyses specified in the Work Plan.

Some analyses (such as oil mobility parameters) require that the pore structure of the soil or aquifer matrix remain as intact as practicable. For these analyses a soil sample will be collected with as little disturbance to the sample as possible, thus the sample will be handled differently than the procedures described in the paragraph above. Low disturbance samples will be collected as follows:

- On inspection of the sonic core contained in the plastic sleeve, a sample interval one-half to one foot in length will be selected based on criteria specified in the Work Plan (observed oil, etc.). During inspection, the sample interval will not be disturbed.
- The selected sample interval carefully will be removed from the sample core by cutting the plastic sleeve on the top and bottom of the sample interval and taping the plastic sleeve back up around the sample.
- As soon as practical, the sample will be placed on ice or in an on-site refrigerator for purposes of preservation.
- Sample collection documentation will be recorded in the field logbook or appropriate field form.

2.2.3 Sampling Using Split-Spoons, Continuous Core Barrel, Macrocore® or Similar

Samples may be collected using a split spoon sampler, a Macrocore®, or a modified California sampler during air /mud rotary, hollow-stem auger, or sonic drilling, or direct-push. Samples collected for geotechnical analysis (e.g., permeability), require minimal disturbance of the sample. Shelby tubes are the preferred method for collection of soils for geotechnical analyses. Shelby tubes will pushed slowly and smoothly into the formation using the hydraulics on the

drill rig. Procedures for geotechnical sample collection will generally follow the American Society for Testing and Materials (ASTM) standard D1587 (Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes).

In general, soil samples will be collected by the following procedures:

- The split-spoon sampler will be driven into the formation with a 140 pound drop hammer falling 30 inches in accordance with ASTM D1586. The number of blows to advance the sampler string every 6 inches will be recorded. A modified California split barrel sampler lined with brass sleeves to contain soil samples may also be used following this method for the collection of soil samples for geotechnical analyses.
- Shelby tubes may be advanced by drop hammer, direct-push, or other appropriate drilling methods.
- Macrocores® will be advanced by direct-push drilling methods.
- Continuous core barrels will be advanced within the auger sting during hollow-stem auger drilling, although other methods such as split-spoons may also be used with hollow-stem augers.
- After the appropriate depth has been reached, the sampler string will be extracted from the drill hole.
- The samples contained in the brass sleeves or Shelby tube will be capped on both ends and taped to contain the sample.
- Sample location, depth and orientation (up/down) will be noted in permanent ink on the sample container, if appropriate.
- Sample collection documentation will be recorded in the field logbook or appropriate field form as specified in SOPs.
- The sample will be shipped to the laboratory in accordance with SOP s.

3.0 DOCUMENTATION

Documentation during surface and subsurface soil sampling will be in accordance with the Work Plan, QAPP, and SOPs. Documentation of the observations and data acquired in the field will provide information on the activities conducted and also provide a permanent record of field activities. Observations and data will be recorded in the field logbook.

The following soil sampling information will be recorded in a bound field logbook using indelible ink:

- Names of sampling personnel
- Weather conditions
- Date and time of sampling
- Sampling locations, including locations of QA/QC samples
- Time of each location sampled
- Decontamination and calibration records

- Other information as specified in the Work Plan
- Any other pertinent information that may have a bearing on sample quality

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Attachment 1

Example of Soil Sampling Form

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DRILLING RECORD - LITHOLOGY AND WELL CONSTRUCTION

WELL ID	PROJECT	LOCATION		SHEET OF
GEOLOGIST	DRILLING CONTRACTOR	DRILLING EQUIPMENT		DATE
GROUND ELEV.	DRILLER	DRILLING METHOD	SAMPLING METHOD	FIRST WATER
M.P. ELEV.	CASING	SCREEN		FINAL DTW
B.H. DIAMETER	FILTER PACK	SEAL		PERMIT #

DEPTH BELOW SURFACE	PID	SAMPLE NO.	REC. % or IN.	BLOWS PER 6 IN.	NAPL Y/N	LITHOLOGY	WELL CONSTRUCTION
1							
2							
3							
4							
5							
6							
7							
8							
9							
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This Standard Operating Procedure (SOP) provides procedures for installing groundwater monitoring wells in unconsolidated materials. The drilling contractor will be responsible for well installation and the field geologist or engineer will be responsible for seeing that the well is installed in accordance with this SOP. Refer to the Work Plan for the rationale for selecting the monitoring well locations and depths. All activities will be conducted in accordance with the site-specific Health and Safety Plan (HASP).

1.0 EQUIPMENT AND MATERIALS

The following is a list of equipment that may be used to perform monitoring well installations, depending on the work defined in the Work Plan:

- Well casing, screen, and end caps
- Silica sand for filter pack
- Bentonite pellets, chips, or slurry
- Portland cement
- Stainless steel centralizers, if needed
- Concrete surface seal
- Protective steel well casing with locking cap (above-ground or flush-mount)
- Steel guard posts (bollards) or concrete blocks to protect above-ground casing
- Decontamination equipment
- Well location map
- Drill rig capable of installing wells to the desired depth
- Weighted tape measure
- Water level probe
- Health and Safety equipment
- Field logbook
- Well completion diagram form (example provided in Attachment 1)

2.0 GROUNDWATER MONITORING WELL INSTALLATION PROCEDURES

Well construction procedures will fulfill all applicable regulatory agency requirements for permit applications, material standards, and construction/completion protocols. Licensing and/or certification of the driller may be required. In order to maintain quality control and obtain representative information, a field geologist or engineer will be on the Site to supervise well construction and log details of the procedure.

2.1 MAINTENANCE OF DRILL RIG EQUIPMENT AND WELL MATERIALS

Any leaks from the drill rig occurring during well installation will be fixed or contained in such a way that they will not contaminate the borehole or Site.

Care will be taken not to contaminate the well casing or borehole with fuel, hydraulic fluid, WD-40™, oil, dirty tools, and so forth.

Drillers will use clean gloves when handling downhole equipment. Different gloves will be used for performing activities such as fueling, adding oil, and working on equipment.

Pipe lubricants that are used should not introduce contaminants into the borehole. Lubricants that are environmentally acceptable include Green Stuff®, King Stuff®, vegetable oil, Crisco™, and some Teflon™-based lubricants. Lubricants that are not acceptable include petroleum-based and most metal-based lubricants. The Field Manager may pre-approve lubricants that will be used.

All well casing and screen will be free of foreign material. Casing and screen will be stored off the ground in the original manufacturer's packaging/wrapping until they are installed in the borehole. Before installation, well casing, screen, and centralizers will be certified clean from the manufacturer or will be decontaminated in accordance with decontamination procedures in the SOPs. Acid rinse solutions should not be used for PVC decontamination. Clean latex or nitrile gloves should be worn when handling well materials.

Drill rig, injection pump, and water pump will be cleaned as necessary.

Decontamination procedures for the drilling equipment will be in accordance with SOPs.

2.2 MONITORING WELL DESIGN AND COMPLETION

2.2.1 General Well Installation Procedures

Monitoring wells will be constructed in accordance with state-specific requirements. In general:

Monitoring wells will be constructed through surface casing (e.g., hollow-stem augers) so that the unconsolidated materials do not collapse in the borehole during well installation. For boreholes that may need to be backfilled to a certain depth before well installation, hydrated bentonite (slurry, pellets, or chips), clean sand, or other appropriate material may be added to fill the borehole to the desired depth for well installation. Wax coated pellets that sink easily may be easiest to install if the water column in the borehole is greater than 50 feet. Bentonite backfill should be topped with approximately 1 to 3 feet of sand to form the new borehole base for well installation.

The well casing and screen will be placed in the borehole. The annular space will be filled with a silica sand filter pack (adjacent to and slightly above the well screen), a bentonite seal, and casing backfill (grout or hydrated bentonite) between the well string and the borehole wall. As the annular space is being filled, the well string will be centered and suspended. Stainless steel centralizers may be used if the well depth or state or local regulations requires them.

Measurements made during filling of the annular space will be performed to the nearest 0.1 foot below ground surface (bgs) and may consist of the following:

- Total depth of the borehole at the completion of drilling.

- Total depth of the open borehole before the start of well construction.
- Lengths of the end cap, screen sections, riser blank sections, and stickup of well above the ground surface.
- The depth to the top of the filter pack, top of the bentonite seal, and the top of each grout backfill lift (if grout is used).

Following well completion, the horizontal location of the monitoring well will be surveyed in accordance with SOPs. The elevation of the ground surface and top of the well casing where depth to groundwater will be measured will also be surveyed. This SOP is generally applicable to both permanent monitoring wells and temporary monitoring wells or well points. Temporary monitoring wells and well points do not require the same level of effort in well construction as standard, permanent wells and do not necessarily require a filter pack, seal, or surface completion.

2.2.2 Casing and Screen Requirements

The well casing requirements are as follows:

- All casing will be new, unused, and clean according to the specifications of Section 2.1 of this SOP.
- PVC well casing will be used in areas where no non-aqueous phase liquid (NAPL) is present. Stainless steel well casing may be used in areas where encountering NAPL is likely (such as in contaminant source areas), depending on the project-specific needs.
- All PVC will conform to the American Society for Testing and Materials (ASTM) Standard F-480-881 or the National Sanitation Foundation Standard 14 (Plastic Pipe System).
- The casing will be straight and plumb.

Well screen requirements include:

- All requirements for casing, except for strength requirements, apply to well screens.
- Wells screens generally will be 10 to 20 feet in length, unless specified differently in the Work Plan.
- Screens shall be machine slotted.
- Screen slot openings shall generally be 0.010 inches or 0.020 inches, depending on the subsurface material grain sizes, unless specified differently in the Work Plan.
- The bottom of the screen will be capped with a threaded cap.
- For wells to be screened at the water table, the top of the well screen will be placed above the static water level, so that normal fluctuations in groundwater levels will not result in water levels above the well screen.

2.2.3 Well Filter Pack

The purpose of the well filter pack is to provide lateral support for the well screen, increase yield by improving the hydraulic conductivity in the immediate vicinity of the well, and retain the

formation to prevent natural materials from entering the well. The filter pack will consist of a #2, 10-20, or 16-30 mix or equivalent of clean silica sand, or similar (unless specified differently in the Work Plan). The filter pack material will be clean and inert. The filter pack material will be certified free of contaminants by the vendor or contractor. The filter pack may be placed from the bottom of the screened interval to at least 2 feet, but not more than 4 feet, above the top of the well screen, depending on regulations. The size of the filter pack material used will be selected as appropriate for the well screen slot size installed so that no more than 10% of the filter pack material is smaller than the slot size (ASTM 1996, EPA 1990). The filter pack will be placed in the hole by pouring the sand through the surface casing and slowly raising the casing out of the hole. The length of the filter pack placed in the well will be recorded.

After the filter pack is placed in the hole, the top of the filter pack will be sounded using a weighted tape to verify the depth during placement. If the filter pack has settled in the borehole, additional filter pack material will be placed as required to return the level of the pack to an appropriate height above the screen and the depth will be measured and recorded.

2.2.4 Well Seal

The materials used to seal the annulus between the borehole wall and casing must prevent potential water and/or contaminant migration from the ground surface or intermediate zones, isolate a discrete monitoring zone, preserve confining conditions, prevent intrusion of overlying grout into the filter pack, and prevent cross-contamination between strata. The seal will consist of at least 2 feet of hydrated bentonite pellets between the filter pack and the casing backfill, depending on regulations. Wax-coated sodium bentonite pellets (delayed hydration) may be used to allow the bentonite to fall through the water column and prevent bridging if the saturated water column is greater than 50 feet. If the bentonite seal is placed above the water table, then the bentonite will be hydrated using potable water.

2.2.5 Annulus Backfill/Grout

The annular space above the filter pack and seal may be grouted with either a bentonite/cement mixture or with hydrated bentonite slurry, pellets, or chips, depending on specific regulations. The backfilling material will minimize the vertical migration of water to the screened interval and provide stability and integrity of the well casing.

Depending on state-specific requirements, the cement/bentonite grout mixture, if used, may consist of 95 to 97 percent Type V or Type II-V Portland Cement and 3 to 5 percent bentonite powder by weight (equivalent to one 94-pound bag of cement and between 2.8 and 4.7 pounds of bentonite). Approximately 8.5 gallons of water may be used for each cement/bentonite batch. The grout mixture shall be prepared by thoroughly mixing the bentonite powder with water first and then mixing in the cement (EPA 1990).

The casing annular space may be backfilled with hydrated bentonite (slurry, pellets, or chips), especially if there is concern that bentonite/cement grout could cross-contaminate nearby wells. Evidence of grout contamination is pH levels in groundwater samples elevated above what is typically observed in groundwater (e.g., pH > 10). This may occur when wells are installed in clusters, and the grouted interval in a deep well coincides with the water bearing zone screened in a shallow well. If bentonite pellets or chips are used to backfill the well annulus, they will be installed so that no bridging occurs and depth measurements will be taken and recorded to verify that no bridging has occurred.

If cement/bentonite grout is used as casing backfill, the requirements are as follows (depending on state-specific requirements):

- The bentonite seal will be allowed to hydrate for a minimum of ½ hour before grout is placed.
- The annular grout will extend from the top of the bentonite seal to approximately 2 feet below the ground surface (bgs).
- Grout may be placed in the well annulus using a gravity feed or a side-discharge tremie pipe located within approximately 10 feet of the top of the bentonite seal and the tremie pipe will be pulled up as the annular space if filled. The tremie pipe should have a minimum inner diameter of 1.25 inches and be composed of steel or PVC.
- No single lift of grout will exceed 100 feet and each lift will be allowed to set before the next lift is placed.
- Pumping will continue until undiluted grout has been returned to the surface.
- After grouting, the well shall not be disturbed or be developed for a minimum of 24 hours. Additional grout will be added if settling occurs.

2.2.6 Surface Seal Installation

Groundwater monitoring wells may be constructed with above-ground or flush-mount completions as described below.

Above-ground completions may extend approximately 2-3 feet above land surface. A concrete surface seal will be placed around the annulus of the well to a minimum depth of one foot or to the top of the casing backfill, whichever is deeper. If bentonite/cement grout is used, then twenty-four hours should elapse between grout emplacement and installation of the surface seal to allow the grout to cure and shrink and prevent a cavity from forming between the two seals. A reference point will be marked for future water level measurements on the north (or highest) side of the casing. A casing cap for each well will be provided, and the extended casing will be shielded with a protective steel casing that has a locking cap placed over the well casing.

Steel protective casings will be cemented in place and will extend a minimum of 2 feet below ground surface and 3 feet above ground surface. Center the protective steel casing around the monitoring well casing and insert the steel casing approximately 2 feet into the cemented annulus. The protective casings will be a minimum of 4 inches larger in diameter than the monitoring well casing. The protective steel casing may be seated in a 3-foot by 3-foot by 6-inch or a 24 inch diameter by 6 inch thick concrete surface pad. The pad should be sloped away from the protective casing. The concrete pad surface will extend approximately 1 inch above the ground surface with about 5 inches below grade.

A small hole may be drilled at the base of the protective casing to allow water to drain from the casing. The well number or identification code will be indelibly marked on the protective casing. A lockable cap or lid will be installed on the protective casing. In high traffic areas near roads or parking areas, the steel protective casing will be protected by three, 4-inch diameter, Schedule 40, steel guard posts or concrete blocks surrounding the base. The guard posts will be 6 feet in total length, with at least 2 feet below ground and at least 3 feet above ground surface.

The guard posts will be set in concrete, but will not be installed in the concrete pad placed at the well base (ASTM 1996, EPA 1990).

Flush-mount completions will be installed similarly to the above-ground completions with the following exceptions. A flush-mount protective steel casing will be cemented in place to approximately one inch below the ground surface to allow for mowing over the covers. They will have bolted lids and be constructed of durable boxes. The well numbers will be indelibly marked on the inside of the covers. The steel casing will be seated in concrete surface pad. No protective guard posts or drainage holes will be necessary for this type of construction.

All wells will be secured as soon as possible after drilling. Corrosion-resistant locks will be provided for the steel protective casing. The locks may be keyed for opening with one master key.

3.0 DOCUMENTATION

Documentation during well installation will be in accordance with the work plan. Documentation of the observations and data acquired in the field will provide information on the activities conducted and also provide a permanent record of field activities. Observations and data will be recorded on monitoring well completion diagrams (Section 3.1) and in the field logbook (Section 3.2).

3.1 MONITORING WELL COMPLETION DIAGRAM

A well completion diagram will be prepared for each groundwater monitoring well when installed (see example in Attachment 1). It will include the following information:

- Borehole identification, as specified in the Work Plan
- Well identification, if different from the borehole identification, as specified in the Work Plan
- Drilling method
- Installation date(s)
- Total boring depth and total well depth
- Screen slot size (in inches), slot configuration, nominal casing size, schedule, composition, and manufacturer
- Lengths and descriptions of the filter pack, bentonite seal, and casing backfill
- Elevation of groundwater surface before and immediately after well installation
- Summary of the material penetrated by the boring

3.2 FIELD LOGBOOK

Field notes will also be kept during well installation activities. The following information at a minimum will be recorded in a bound field logbook in accordance with the work plan:

- Project name and number

- Names and titles of all field personnel
- Drilling company name and personnel
- Type of drill rig
- Date well installation started and finished
- Boring number
- Well installation observations
- Daily progress
- Problems encountered and resolution
- Decontamination observations
- Weather conditions
- Other pertinent information

4.0 REFERENCES

EPA. 1990. Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells. U.S. Environmental Protection Agency, Washington D.C., Document No. EPA/600/4-89/034.

American Society for Testing and Materials (ASTM). 1996. ASTM Standards in Groundwater and Vadose Zone Investigations: Drilling, Sampling, Well Installation and Abandonment Procedures.

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Attachment 1

Example of Well Completion Diagram

URS

DRILLING RECORD - LITHOLOGY AND WELL CONSTRUCTION

WELL ID	PROJECT	LOCATION		SHEET OF
GEOLOGIST	DRILLING CONTRACTOR	DRILLING EQUIPMENT		DATE
GROUND ELEV.	DRILLER	DRILLING METHOD	SAMPLING METHOD	FIRST WATER
M.P. ELEV.	CASING	SCREEN		FINAL DTW
B.H. DIAMETER	FILTER PACK	SEAL		PERMIT #

DEPTH BELOW SURFACE	PID	SAMPLE NO.	REC. % or IN.	BLOWS PER 6 IN.	NAPL Y/N	LITHOLOGY	WELL CONSTRUCTION
1							
2							
3							
4							
5							
6							
7							
8							
9							
0							
1							
2							
3							
4							
5							
6							
7							
8							
9							

URS, 8181 EAST TUFTS AVENUE, DENVER, CO 80236, PH: (303) 740-2600 FAX: (303) 694-3946

This Standard Operating Procedure (SOP) provides technical guidance and methods to be used for measurement of groundwater and fluid levels in wells (well gauging). In addition to groundwater, fluid levels that are routinely monitored are light and dense non-aqueous phase liquids (LNAPL and DNAPL, respectively). Where possible, well gauging should be conducted first in areas least affected by Site constituents, followed by increasingly affected areas. Sampling locations will be specified in the Work Plan. All activities will be conducted in accordance with the site-specific Health and Safety Plan (HASP).

1.0 EQUIPMENT AND MATERIALS

The following equipment is may be used for the collection of fluid level data:

- Field log book
- Monitoring well gauging form (Attachment 1)
- Electronic water level indicator with depth intervals marked to the nearest 0.01 feet
- Oil/water interface probe with depth intervals marked to the nearest 0.01 feet
- Weighted steel measuring tape with decimal foot increments (if depth to the bottom of the well is to be determined)
- Peristaltic pump (for evaluating the presence/absence of DNAPL)
- Standard hand tools (wrench, pliers, screwdrivers, cutting tools, etc.)
- Keys to well locks
- Decontamination equipment per SOPs.
- Appropriate health and safety equipment as required by the HASP
- Personal protective equipment (PPE) as required by the HASP

2.0 METHODOLOGY

The methodology for measuring groundwater levels, well depths, LNAPL levels, and DNAPL levels is provided below. The owner's manual for the water level indicator meter and the oil/water interface probe shall be referenced to ensure proper operation of the instruments.

2.1 GROUNDWATER LEVEL MEASUREMENTS

Groundwater level measurements will be performed using a water level indicator meter that has been decontaminated in accordance with SOPs. Efforts should be made to complete the groundwater level gauging event during one day. Should one day prove to be insufficient time, gauging shall be completed over further consecutive days, as necessary.

The following procedures will be followed to measure the depth to groundwater in wells:

1. Locate and open the monitoring well or piezometer. Sometimes vapor pressure builds up within the well casing due to the well cap restricting the ability of the well to vent to atmosphere. The pressure build up may depress the water/fluid level in the well. Allow fluid levels to equilibrate to atmospheric pressure for several minutes prior to gauging.

2. Check the operation of the water level indicator meter by turning on the indicator switch and pressing the test button.
3. Holding the water level meter above the well casing, lower the probe into the well until the indicator contacts the water surface. The contact with water is indicated by the buzzer sounding and illumination of the indicator light.
4. Record the point on the graduated cable that corresponds to the surveyed well casing measuring point when the alert is first produced. If necessary, grasp cable with thumb and index finger exactly at the measuring point marked at the top of the well casing. Pull tape out of well slowly and read measurement.
5. Record the depth to water surface to the nearest 0.01 ft on the gauging form.
6. Remove the water level cable and probe from the well. Inspect the probe for evidence of LNAPL. Evidence includes petroleum or solvent odor or a visible oil sheen or film on the probe. Record presence or absence of LNAPL on the gauging form (see Section 2.3 for instructions on LNAPL level measurements).
7. Decontaminate the water level probe in accordance with SOP 2.

2.2 MEASURING TOTAL DEPTH OF WELL

In situations where it is necessary to measure the total depth of a well (such as during well development, etc.), the following procedures may be followed:

1. Lower a weighted steel measuring tape slowly from center of well to sound the bottom of the well. Sounding the bottom of the well prior to sampling of the well is not recommended due to the potential for re-suspension of settled formation solids in the well.
2. When the weight is felt to hit the bottom or tape slackens noticeably, draw tape up very slowly until it is taut again.
3. Record the well depth at the surveyed well casing measuring point to the nearest 0.1 feet.
4. A water-level indicator or oil/water interface probe may also be used; however, the depth measured on the tape may reference a point other than the tip of the probe. In this case, a measurement from the tip of the probe to the measuring point should be made and that length added to the total measured depth.

2.3 LNAPL LEVEL MEASUREMENTS

The following steps will be followed to measure the thickness of LNAPL in wells:

1. LNAPL level measurements will be preceded by groundwater level measurements. Complete Steps 1 through 8 of Section 2.1 prior to measuring LNAPL levels.
2. Use a clean oil/water interface probe that has been decontaminated in accordance with SOPs.

3. Lower the oil/water interface probe into the well until the air/LNAPL interface is detected by the instrument. Record the depth relative to the well casing measuring point to the nearest 0.01 foot on the well gauging form or in the field logbook.
4. Continue to lower the oil/water interface probe in the well to detect the oil/water interface. Once the instrument detects the water surface, continue to lower the probe approximately one foot and gently raise the probe up and down in the water column to rinse off LNAPL that has adhered to the probe that may affect the reading. Then slowly raise the probe to detect the water/oil interface and record the depth relative to the well casing measuring point to the nearest 0.01 foot on the well gauging form or in the field logbook. *Note: If the thickness of LNAPL is small enough that the lower bound of LNAPL cannot be measured with the oil/water interface probe, then record this observation as a film or sheen on the fluid level gauging form or field logbook.*
5. If gauging of DNAPL level is also to be performed in the well, proceed to Section 2.4. If not, proceed to Step 6 below.
6. Remove the oil/water interface cable and probe from the well.
7. Decontaminate the oil/water interface probe and cable in accordance with SOP 2.

2.4 DNAPL LEVEL MEASUREMENT

The oil/water interface of DNAPL in a well, if present, will be estimated using the following procedures:

1. DNAPL level measurements will be preceded by groundwater level measurements (Section 2.1) and LNAPL level measurements (Section 2.3), if LNAPL exists in the well.
2. After measuring the thickness of LNAPL in the well (if present), lower the oil/water interface probe in the well until DNAPL is encountered, if any. Measure the depth to the water/oil interface of DNAPL in the same manner as that for air/oil interface of LNAPL, as described in Section 2.3 above.
3. A high suspended solids content at the bottom of a well has been found to produce false positive results for the detection of DNAPL with an oil/water interface probe. Therefore, if DNAPL is detected using an oil/water interface probe, a peristaltic pump, or similar methods, should be used to confirm the presence or absence of DNAPL. About one pint of fluid may be pumped from the bottom of the well for visual inspection of the presence or absence of DNAPL.
4. The results of the visual inspection will be recorded on the well gauging form or in the field logbook.
5. Peristaltic pump tubing, if not dedicated, will be disposed of in accordance with IDW handling specified in the Work Plan or SOPs. The oil/water interface probe and cable will be decontaminated in accordance with SOPs.

3.0 DOCUMENTATION

Documentation during well purging and sampling will be in accordance with the work plan (Field Documentation). Documentation of the observations and data acquired in the field will

provide information on the activities conducted and also provide a permanent record of field activities. Observations and data will be recorded on a well gauging form and in the field logbook.

3.1 FIELD NOTES

The following information will be recorded in a bound field logbook using indelible ink:

- Names of gauging personnel
- Weather conditions
- Date
- Start time of gauging
- End time of gauging
- Gauging locations
- Gauging equipment used
- Any significant difference in time between gauging individual wells
- Decontamination records
- Any other pertinent information

3.2 FIELD FORMS

A well gauging form will be completed for each day of gauging. The form will contain entries for each well gauged during that day. The following information will be recorded:

- Project name / number
- Location
- Date
- Gauging personnel
- Monitoring well identification numbers
- Static LNAPL depths (if any)
- Static water depths
- Static DNAPL depths (if any)
- Well depth (sounding), if measured

Attachment 1

Water Level Measurement Form

URS

8181 E. Tufts Avenue
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Groundwater Level Measurement Form

Date: _____

Page _____ of _____

Project Name: _____ **Location:** _____

Project Number: _____ **Measured By:** _____

Well ID	TOC Elevation (ft MSL)	LNAPL Depth (ft bTOC)	Water Depth (ft bTOC)	DNAPL Depth (ft bTOC)	Comments

Casing Volume

Casing I.D. (in.)	Unit Casing Volume Gal/Lin. Ft.)
1.0	0.04
1.5	0.09
2.0	0.16
2.2	0.20
3.0	0.37
4.0	0.65
4.3	0.75
5.0	1.00
6.0	1.55
7.0	2.00
8.0	2.60

Additional Remarks

This Standard Operating Procedure (SOP) provides technical guidance and methods that will be used for field measurement of water quality parameters (e.g., pH, specific conductance, oxidation-reduction potential, dissolved oxygen, and temperature) in the field. The measurements will be taken to provide data on the general quality of surface water and groundwater, as well as to verify the presence of non-stagnant groundwater during monitoring well sampling. The procedures outlined in this SOP are in accordance with groundwater sampling methods recommended by the U.S. Environmental Protection Agency (U.S. EPA 1992, 1996). Details on Site-specific sampling activities are presented in the Work Plan. Where possible, field parameter measurement should be conducted first in areas least affected by Site constituents, followed by increasingly affected areas.

This SOP will provide descriptions of equipment, field procedures, and documentation necessary to properly measure selected field parameters. Due to the variety and complexity of water quality meters available, calibration and measurement procedures should be conducted in accordance with manufacturer's recommendations for specific meters used.

All activities will be conducted in accordance with the site-specific Health and Safety Plan (HASP).

1.0 EQUIPMENT AND MATERIALS

- Field log book
- Water quality parameter multimeter or meters specific to parameters of interest (i.e., pH, specific conductance, dissolved oxygen, oxidation-reduction potential, temperature, and turbidity)
- 250- to 500-mL beakers or flow-through cell for groundwater
- Calibration solutions and deionized distilled water
- Sample logs / well sampling forms
- Sampling equipment

2.0 METHODOLOGY

Calibrate meter(s) in the field at the beginning of each day of field or laboratory work when water quality parameters will be measured. Check meters with calibration standards after every four hours of continuous use. If drift is evident, recalibrate. Record appropriate information in accordance with Section 3 of this SOP.

The measurement of surface water and groundwater field parameters will be conducted in the following steps:

1. Fill multimeter cell, beaker, or jar with fresh sample water.
2. Immerse electrodes in sample while swirling the sample, if needed, to provide thorough mixing. If a flow-through cell is used, install probes and connect sample water to bottom port of flow-through cell, directing sample water up through the cell, exiting through the top port. Direct effluent tubing into an appropriate container for storage and handling.

3. When the readings have stabilized, record the measurements displayed on the meter. It is important to determine that the correct units and unit scale are displayed on the meter and recorded for each parameter measured. Record and correct any problems encountered during measurement. Note: parameter measurements may not stabilize for a given measurement when using a flow-through cell- professional judgment should be used when selecting parameters to be recorded in this case.
4. If available, field measurement results should be compared to previous measurements for quality control.

3.0 DOCUMENTATION

Documentation during water quality parameter measurement will be in accordance with the work plan. Documentation of the observations and data acquired in the field will provide information on the activities conducted and also provide a permanent record of field activities. Observations and data will be recorded on a sampling log (i.e., well sampling form) and in the field logbook.

3.1 FIELD NOTES

The following water quality parameter measurement information will be recorded in a bound field logbook using indelible ink:

- Names of sampling personnel
- Weather conditions
- Decontamination and calibration records
- Other information as specified in the Work Plan
- Any other pertinent information that may have a bearing on data quality

3.2 FIELD FORMS

A well sampling form will be completed for each well location where field water quality parameters are measured. The following information will be recorded:

- Project name / number
- Location
- Date and time of parameter measurement
- Sampling personnel
- Monitoring well identification number or sampling location
- Static water depth
- Depth of pump or tubing intake
- Water quality measurement equipment (meter model, etc.)
- Sampling locations, including locations of QA/QC samples

4.0 REFERENCES

U. S. EPA. 1992. RCRA Ground-Water Monitoring: Draft Technical Guidance. Office of Solid Waste, Washington, DC EPA/530/R-93/001, NTIS PB 93-139350, November.

U.S. 1996. Low-flow (minimal drawdown) ground-water sampling procedures, by R. W. Puls and M.J. Barcelona. U.S. EPA Ground Water Issue: EPA/540/S-95/504, April.

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This Standard Operating Procedure (SOP) provides technical guidance and methods that will be used for developing groundwater monitoring wells. The purpose of well development is to (1) remove fine-grained native soil material that may have collected in the well casing during construction, (2) grade the filter pack from the formation to the well screen, and (3) restore the hydraulic conductivity of the aquifer material surrounding the well screen to pre-well installation conditions. All activities will be conducted in accordance with the site-specific Health and Safety Plan (HASP).

1.0 EQUIPMENT AND MATERIALS

The following is a list of equipment that may be used to perform monitoring well development, depending on the work defined in the Work Plan:

- Copies of well drilling and installation records, including boring logs and well completion diagrams for the wells to be developed.
- Well keys
- Electronic water level meter
- Weighted tape measure
- Appropriate submersible pump with a flow rate capacity of approximately 2 to 5 gallons per minute (gpm), a power source, and tubing
- Mechanical reel or truck-mounted wireline rig (for deep wells)
- Graduated 5 gallon bucket for flow rate measurements
- Well development form (see Attachment 5-1 for an example)
- Calculator
- Decontamination equipment
- Waste management equipment (baker tank, drum, etc.)
- Health and safety equipment

2.0 MONITORING WELL DEVELOPMENT PROCEDURES

Well development may be applicable to both new and existing wells. Existing wells are typically recommended for well development once approximately 10-25 % of the screened interval is blocked by accumulated sediment, depending on a number of factors including formation grain size, depth of well, and length of screen. Professional judgment of the field geologist is often used to determine whether accumulated sediment in an existing well may present an impediment to groundwater monitoring and therefore require re-development.

Begin well development no sooner than 24 hours after new well installation is completed to allow adequate time for the bentonite chips and pellets to fully hydrate, or grout to set up. Prior to the start of development activities, clean well development equipment following decontamination procedures in SOPs. Measure the total well depth and the depth to groundwater, and record the measurements on the well development log.

The specific method of development may also be selected based on experience and professional judgment.

Initial Well Development Steps:

- Well volumes are calculated using the following equation for a 2-inch diameter well:

  1 well volume (gallons) = h (0.163)

  Where the h is the height of water in the well in feet (the total depth of the well minus the depth to groundwater).

- If there are indications of silt or fines at the bottom of the well (e.g. "spongy or soft feeling" when total depth of well is measured or shallower total depth measurement compared to well construction records) a bailer or other applicable means may be used to collect sediment at the bottom of the well prior to installing the submersible pump.

- After fines have been removed from the well, a submersible pump will be lowered into the well and set at the top of the well screen. The pump will be plugged into the controller and generator (or 12 volt battery, if applicable). The out flow end of the tubing will be secured in a 55-gallon drum or poly tank used to containerize the development water.

Monitoring Well Development Method (Overpumping):

Begin pumping and surging the well following the steps below:

Step 1. Lower the pump to the top of the well screen and pump the well to remove fine material that entered the well casing during installation (or surging following Step 2). Pump the well until the fines are removed, while gently lowering the pump through the well screen to just above the bottom of the well. Allow at least 10 minutes of pumping to remove the fines before proceeding to Step 2. If the water does not clear within 10 minutes, continue to Step 2. During the development process, measure the water quality parameters (temperature, pH, specific conductivity, oxidation-reduction potential, and visual turbidity) after each casing volume, if possible. Due to the high extraction rate, the water quality parameters may also be recorded after every three to five minutes.

Step 2. Surge the well with the pump by moving the pump up and down swiftly (but gently) within the screened interval. Surging should continue for about 5 minutes.

Repeat Steps 1 and 2 until surging does not produce fine material or until there is no longer a decrease in production of fine materials after several consecutive surging actions. Well development will be considered complete when one or more of the following criteria are met: (1) pH, temperature and specific conductivity measurements have stabilized (three consecutive readings where pH is within +/- 0.1 unit, and temperature and specific conductivity are within 10% and turbidity is less than 50 NTUs, (2) a minimum of 10 well volumes of water has been removed from the well, (3) the estimated volume of water added to the screened interval of the borehole during drilling (if any) is removed, (4) the well has been run dry and recharged to approximately 75% of the initial volume three times, or (5) 2 hours of development time has elapsed.

Contain and handle the water and solids generated during development in accordance with the Investigation Derived Waste (IDW) handling procedures specified in the Work Plan.

When development is complete, remove and decontaminate the pump in accordance with SOPs and measure and record a final total well depth and depth to groundwater.

The development procedures described above are appropriate for wells screened in relatively moderate to high hydraulic conductivity material. Such wells typically clear of fines and reach maximum production rates relatively early in the development process. If different Site conditions are expected to be encountered, such as low permeable materials, a different well development method may need to be used for development.

3.0 DOCUMENTATION

Documentation during well development will be in accordance with SOPs. Documentation of the observations and data acquired in the field will provide information on the activities conducted and also provide a permanent record of field activities. Observations and data will be recorded on a well development form (Section 3.1) and in the field logbook (Section 3.2).

3.1 WELL DEVELOPMENT FORM

The following well development information will be recorded on the Well Development Form (Attachment 1).

- Well identification and location
- Date of well installation
- Date and time of well development
- Static water level from the top of casing before and after development
- Physical description of water removed during development
- Types of equipment used to remove water
- Quantity of water removed and time of removal
- Description of well development techniques (e.g. overpumping, surging)

3.2 FIELD NOTES

Field notes will also be kept during well development activities. The following information at a minimum will be recorded in a bound field logbook in accordance with the work plan:

- Project name
- Names of personnel
- Weather conditions
- Well identification and location
- Dates and times of well development
- Other information as specified in the Work Plan.

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Attachment 1
Example of Well Development Form

URS

8181 E. Tufts Avenue
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Well Development Form

Well Identification _____

Page _____ of _____

Project Name: _____ **Developed By:** _____

Project Number: _____ **Date:** _____

Location: _____ **Start Time:** _____

Purging Information

Casing I.D. [a] (in.): _____ Static Water Column Height [e] = [d] - [c] (ft): _____

Unit Casing Volume [b] (gal/ft) _____ Casing Volume [f] = [b] x [e] (gal) _____

Initial Depth to Water [c] (ft, bTOC): _____ Total Purged Volume [g] (gal): _____

Initial Depth of Well [d] (ft, bTOC): _____ Number of Purged Volumes [h] = [g] / [f]: _____

Time	Volume Purged (gal)	Temp (C)	pH	Conductivity (mS/cm)	DO (mg/L)	Turbidity (NTU)	Comments

End Time: _____ **Purged Dry (Y/N):** _____

Casing Volume

Casing I.D. (in.)	Unit Casing Volume Gal/Lin. Ft.)
1.0	0.04
1.5	0.09
2.0	0.16
2.2	0.20
3.0	0.37
4.0	0.65
4.3	0.75
5.0	1.00
6.0	1.55
7.0	2.00
8.0	2.60

Additional Remarks

This Standard Operating Procedure (SOP) provides technical guidance and methods that will be used for monitoring well purging and groundwater sampling using low-flow sampling methods. The samples will be analyzed to provide data on the presence and concentration of Site constituents in groundwater on the site. The procedures outlined in this SOP are accordance with groundwater sampling methods recommended by the U.S. Environmental Protection Agency (EPA) (1992, 1996). Details on site-specific sampling activities, equipment selection (i.e., pumps), site-specific field parameters, and laboratory analyses are presented in the Work Plan and/or the Quality Assurance Project Plan (QAPP).

This SOP will provide descriptions of equipment, field procedures, and documentation necessary to properly collect groundwater samples for laboratory analysis. Sampling locations are specified and shown in the Work Plan.

All activities will be conducted in accordance with the site-specific Health and Safety Plan (HASP).

1.0 EQUIPMENT AND MATERIALS

- Field log book
- Electronic water level indicator or interface probe
- Peristaltic pump, bladder pump, centrifugal pump, bailer, or submersible pump
- Appropriate power source and cords for pump (i.e., generator, compressor, or inverter)
- Flow-rate controller for pump, as applicable
- Graduated cylinder or other volumetric measuring device
- Plastic sheeting or other clean work surface
- Disposable polyethylene discharge tubing
- Disposable Pharmed®, Tygon®, or equivalent tubing (for peristaltic pump only)
- Water quality meters (at a minimum pH, conductance, and temperature; ORP, and turbidity may also be used)
- New disposable or decontaminated stainless-steel bailer, if specified in the Work Plan
- Rope or twine: nylon, polypropylene, or similar
- Watch
- Purge water collection system (bucket(s) with lid(s), drum, etc.)
- Standard hand tools (wrench, pliers, screwdrivers, cutting tools, etc.)
- Keys to well locks
- Decontamination equipment per SOP 2
- Appropriate health and safety equipment as required by the HASP
- Personal protective equipment (PPE) as required by the HASP
- Paper towels

- Copies of well drilling and installation records, including boring logs and well completion diagrams for the wells to be sampled
- 0.45-µm in-line filter or other appropriate filtering approaches (for dissolved constituents only), if applicable
- Flow-through cell
- Sample containers (including temperature blanks)
- Sample labels
- Sample logs / well sampling forms
- Chain of custody forms
- Custody seals
- Shipping labels / AirBills
- Strapping / shipping tape
- Garbage bags
- Ziploc®, or similar, bags
- Cooler(s)
- Ice

2.0 PURGING AND SAMPLING METHODOLOGY

Groundwater sampling incorporates several phases of multiple steps in order to achieve the highest possible accuracy and precision of laboratory analytical results. Proper preparation, purging, and sampling techniques greatly reduce the risk of cross-contamination or other unwanted variances of the analytical data. Where possible, sampling should be conducted first in areas least affected by Site constituents, followed by increasingly affected areas. The proper information will be recorded in the field log book or well sampling form as specified in Section 3 of this SOP.

2.1 PREPARATION FOR SAMPLING

Preparation for sampling includes inspecting the condition of the well, monitoring health and safety conditions, and calibrating and decontaminating sampling equipment. General procedures are presented below:

1. Make sure area around well head is clean and free of debris.
2. Inspect condition of well (e.g., well locked, loose-fitting cap, measuring point well marked, surface casing disturbed, well casing straight, condition of concrete pad). Indicate condition of well on the sampling form.
3. Remove well cap. If the HASP identifies organic compounds as potential contaminants of concern and requires breathing zone monitoring, screen well headspace and breathing zone headspace for organic vapors using the appropriate field monitoring instrument.

4. All equipment should be decontaminated in accordance with SOPs before introduction to each well. Protective latex or nitrile gloves should be worn during possible water-contact or equipment-contact activities. At a minimum, gloves should be changed between each well or when introduction of potential contaminants to the well is possible.
5. Measure water level using a decontaminated electronic water level meter as described in SOPs. Sounding the bottom of the well using a weighted tape (i.e., for well casing volume calculations) prior to sampling is not recommended due to the potential for resuspension of settled solids in the formation. Well depth information should be obtained from the well logs or collected after sampling activities are complete, if possible.
6. If light non-aqueous phase liquid (LNAPL) is suspected, measure fluid level in accordance with SOPs.
7. Calculate the well casing volume as follows:

   $$\text{well casing volume (gal)} = \pi\,(r^2)(h)(7.48\ \text{gal/ft}^3)$$

   Where h = height of water in the well casing (i.e., depth to bottom of the well minus depth to water (in ft), and r = radius of well casing in feet. Record this volume on the well sampling form.
8. Calibrate water quality meters for measuring field parameters as specified by the equipment manufacturer(s). At a minimum, temperature, pH, and specific conductance measurements will be collected during purging and prior to sampling; however, do not immerse water quality meter probes into purge water containing free product. Other field parameters, including dissolved oxygen, Eh (redox, ORP), and turbidity (recommended for inorganics), etc. may be required as specified in the Work Plan. Record equipment calibration and maintenance in the field book. Decontaminate meters between wells by rinsing with distilled water. Manage rinse water used for these measurements in the same manner as purge water, as defined in the Work Plan.

2.2 WELL PURGING METHODS

Monitoring wells will be purged prior to collecting groundwater samples for analyses. Low flow purging procedures (EPA 1996) generally will be followed; however, certain wells or sites may also be sampled by purging three well volumes of groundwater prior to sample collection. The purpose of well purging is to remove stagnant groundwater from the well (which has interacted with air in the well casing). Field parameters (i.e., pH, temperature, and specific conductance) are measured during the purging process to verify that stagnant water has been removed and groundwater conditions are stable prior to sampling. A variety of pumps may be used to purge and sample the monitoring well: the pump type will be specified in the Work Plan. Refer to the manufacturer's instructions for operation of the specified pump. General procedures for purging are outlined below:

1. Lower the pump intake, bailer, or tubing (as applicable) into the water column. The pump intake or tubing should be placed at the middle or slightly above the bottom of the screened interval.
2. For low-flow purging, conduct purging at a rate that will minimize drawdown in the well (i.e., purge at a rate less than or equal to recharge, if possible). Recommended purge

rates are generally less than 0.13 gal/min (0.5 L/min), or a rate that results in minimal drawdown in the well (e.g., less than 1 foot). Actual purge rates will vary based on aquifer material and well construction.

3. Continue purging the well until field parameters have stabilized within 10 percent, according to SOPs. Once field parameters have stabilized, reduce the pump rate to approximately 0.025 to 0.13 gal/min (0.1 L/min to 0.5 L/min). The pump should continue to operate at the lower rate to allow the water collected at that rate to travel to the surface discharge point.
4. In the event that even very low purge rates result in evacuation of the well, groundwater samples for laboratory analyses should be collected as soon as sufficient groundwater accumulates in the well, regardless of field parameters or total volume purged.
5. If the three-volume purge method is utilized, field parameters will be recorded after each well volume of groundwater is purged.

2.3 GROUNDWATER SAMPLING METHODS

Groundwater sampling is conducted following purging of the well. Where possible, groundwater samples for analyses should be collected directly from the pump discharge at the lowest rate possible to minimize cross contamination, suspension of solids, and aeration of the sample. Bladder pumps, peristaltic pumps, and submersible pumps (e.g. Grundfos®, Whale, Typhoon) are generally suitable for purging and sampling of all groundwater parameters. Bailers are generally not recommended for purging or sampling of groundwater monitoring wells due to the potential for agitating solids in and adjacent to the well; however, the three-volume purge method often uses bailers, especially when turbidity of the groundwater is not a concern.

Target analytes, container types, and preservatives are specified in the Work Plan, or QAPP.

The general procedures for groundwater sample collection are as follows:

1. Groundwater samples should be introduced directly from the pump discharge into the proper sample container and filled to capacity.
2. In general, groundwater samples collected for multiple compounds should be collected in the following order (EPA 1992):
   - VOCs
   - Dissolved gases and total organic carbon (TOC)
   - SVOCs
   - Metals and cyanide
   - Major water quality cations and anions
   - Radionuclides
   - Other analytes
3. When collecting samples for VOCs, direct flow from the pump discharge down the interior side of the sample container to minimize aeration. Hold caps in hand to minimize contamination of sample. Fill all VOC sample containers to the top. A

positive meniscus at the top of the container will help ensure that no air is trapped inside when cap is screwed down on the container. No air bubbles should be trapped in the sample when the container is sealed.

4. In some cases, field filtration may be required (recommended for dissolved metals). If applicable, attach a new, disposable filter cartridge (typically 0.45 µm) to the discharge line. Filtered water should be introduced directly into the appropriate sample container. Alternate field filtration methods may be specified in the Work Plan or QAPP. *Although not recommended, the laboratory can sometimes filter the samples if the samples are NOT preserved and are filtered within 24–48 hours of collection.*
5. Collect quality assurance and quality control (QA/QC) samples (i.e., field duplicate, laboratory matrix spike, and laboratory matrix spike duplicate, as applicable) at the same time by filling all bottles from the same flow. Ambient or field blanks should be filled using distilled or de-ionized (DI) water (supplied by the laboratory) in the same area as the primary samples. The number and types of QA/QC samples are specified in the Work Plan or QAPP.
6. Sample bottles must be labeled with date, sample number, time, sampler's name, and type of preservative, as described in the QAPP. Sample bottles must be placed in a cooler or on ice to keep the sample cool (≤6 °C). Samples must be cooled continuously from time of collection to time of receipt at the laboratory.
7. Disconnect the peristaltic pump from the dedicated tubing in the well. If using a submersible pump, remove the pump and tubing from the well. Close and lock the well. Decontaminate the sampling equipment in accordance with SOPs. Purge, wash, and rinse water should be managed as specified in the Work Plan.
8. Complete chain-of-custody forms, package samples for shipment, and ship samples or arrange for courier to laboratory.
9. All field observations made and data generated in conjunction with the sample collection will be documented on the groundwater field sampling form.

3.0 DOCUMENTATION

Documentation during well purging and sampling will be in accordance with the work plan. Documentation of the observations and data acquired in the field will provide information on the activities conducted and also provide a permanent record of field activities. Observations and data will be recorded on a well sampling form and in the field logbook.

3.1 FIELD NOTES

The following groundwater purging and sampling information will be recorded in a bound field logbook using indelible ink:

- Names of sampling personnel
- Weather conditions
- Date and time of sampling
- Sampling locations, including locations of QA/QC samples

- Start and stop time for each well sampled
- Decontamination and calibration records
- Other information as specified in the Work Plan
- Any other pertinent information that may have a bearing on sample quality

3.2 FIELD FORMS

A well sampling form will be completed for each well sampled. The following information will be recorded:

- Project name / number
- Location
- Date
- Sampling personnel
- Monitoring well identification number
- Static water depth
- Well depth and diameter
- Water column thickness and well volume, if necessary
- Depth of pump or tubing intake
- Time of purge monitoring readings
- Sample time
- Identification of QA/QC samples
- Sampling equipment (pump and tubing types, etc.)
- Sampling pump rate

4.0 REFERENCES

EPA. 1992. RCRA Ground-Water Monitoring: Draft Technical Guidance. Office of Solid Waste, Washington, DC EPA/530/R-93/001, NTIS PB 93-139350, November.

EPA. 1996. Low-flow (minimal drawdown) ground-water sampling procedures, by R.W. Puls and M.J. Barcelona. U.S. EPA Ground Water Issue: EPA/540/S-95/504, April.

Attachment 1
Example of Well Sampling Form

URS
8181 E. Tufts Avenue
Denver, Colorado 80237
Tel: 303.694.2770
Fax: 303.694.3946

Groundwater Sample Collection Form

Well Identification _____

Page _____ of _____

Project Name: _____
Project Number: _____
Location: _____
Date: _____

Sampled By: _____
Sample ID: _____
Sample Date: _____
Sample Time: _____

Equipment

Purging Method/Equipment _____
Sampling Equipment _____
Filtering Equipment _____

Field Parameters

Initial Water Temp. (C) _____
Initial pH: _____
Initial Conductance (mS/cm): _____
Reference Point _____

Sampling Packaging

Number	Type and Volume of Container(s)	Filtered	Preservatives	Parameters

Purging Information

Casing I.D. [a] (in.): _____
Unit Casing Volume [b] (gal/ft) _____
Depth to Water [c] (ft, bgs): _____
Depth to Bottom of Well [d] (ft, bgs): _____

Length of Static Water Column [e] = [d] - [c] (ft): _____
Casing Water Volume [f] = [b] x [e] (gal) _____
Total Purged Volume [g] (gal): _____
Number of Purged Volumes [h] = [g] / [f]: _____

Volume Purged (gal)	Temp (C)	pH	Conductance (mS/cm)	Time	DO (mg/L)	Turbidity (NTU)	Water Description

Total Volumes Removed (gallons): _____ **Time:** _____ **Purged Dry (Y/N):** _____

Casing Volume

Casing I.D. (in.)	Unit Casing Volume Gal/Lin. Ft.)
1.0	0.04
1.5	0.09
2.0	0.16
2.2	0.20
3.0	0.37
4.0	0.65
4.3	0.75
5.0	1.00
6.0	1.55
7.0	2.00
8.0	2.60

Additional Remarks

This Standard Operating Procedure (SOP) provides technical guidance and methods for the management, storage, characterization, transportation, and disposal of waste generated. Waste generated at the Site during field activities is referred to as Investigation Derived Waste (IDW). The project has been carefully designed to avoid the creation of a substantial volume of IDW. IDW will be properly managed and disposed off-Site in compliance with RCRA, CERCLA, and other applicable legal authorities as detailed below or in the Work Plan. All activities will be conducted in accordance with the site-specific Health and Safety Plan (HASP).

1.0 MATERIALS AND EQUIPMENT

- Personal protective equipment (PPE) as outlined in the HASP; and
- Labeling materials(e.g., permanent markers, labels, etc.).

2.0 APPLICABLE LAWS, REGULATIONS, AND GUIDANCE

This SOP is designed to confirm that all waste generated during the course of the investigation is managed in compliance with applicable laws and regulations. It is also based on waste management policy and guidance documents, such as the "*Guide to Management of Investigation-Derived Wastes"* (U.S. Environmental Protection Agency [EPA] 1992). CERCLA activities conducted entirely on Site must comply with the substantive requirements of other applicable laws and regulations, but not permitting and other procedural requirements. CERCLA activities conducted off Site, however, must comply with both administrative and substantive requirements. See CERCLA Section 121 (e).

Off-site disposal of CERCLA waste will be in compliance with CERCLA Section 121 (d)(3) and 40 C.F.R Section 300.440 (also known as the "CERCLA Off-Site Rule"), as well as applicable NRC, DOT, RCRA, and state regulations, as further explained below or in the Work Plan.

3.0 TYPES AND MANAGEMENT OF IDW

<u>Solid IDW may include the following</u>:

- Drill cuttings or soil/rock.
- Disposable used PPE (e.g., gloves) and other disposable investigation materials (e.g., paper towels).
- Trash

PPE and trash will be disposed of in a normal trash receptacle following their usage in the field.

<u>Liquid IDW may include the following</u>:

- Groundwater produced by well development or purging, etc.
- Decontamination water.

Solid and liquid IDW shall be containerized in proper containers, in good repair, which are suitable for short-term storage, transportation, and disposal by a subcontractor. Examples of proper containers include DOT-approved steel or plastic drums, roll-off containers, and fractionation tanks.

Spray bottle discharge from the washing of small sampling equipment within each sample collection point. The spray discharge may be considered *de minimis* and may be discharged to the ground at the corresponding sampling locations.

4.0 LOG BOOK DOCUMENTATION

An inventory log of waste will be entered into the log book and must include the following**:**

- Project Name
- Name of person logging the waste
- Date waste generated
- Type of waste material (e.g., PPE, instrument, or trash), and solid or liquid
- Estimated waste volume
- Characterization and disposition of equipment and instruments.
- Comments
- Any variance to procedures described in this SOP

5.0 REFERENCES

U.S. Environmental Protection Agency (EPA). 1992 (April). *Guide to Management of Investigation-Derived Wastes*. Office of Emergency and Remedial Response Hazardous Site Control Division. OSWER Publication Number 9345.3-03FS.

U.S. Occupational Safety and Health Administration (OSHA) Standard – Ionizing Radiation – 29 C.F.R. 1910.1096

U.S. OSHA Standard – Ionizing Radiation – 29 C.F.R. 1926.53

Department of Transportation Standard – Hazardous Materials and Oil Transportation – 49 C.F.R. 100-180

This Standard Operating Procedure (SOP) provides technical guidance and procedures that will be employed to conduct surveying using conventional land surveying and Global Positioning System (GPS). The survey method to be used will be dependent on the accuracy required for the task to be performed, as specified in the work scope. This SOP covers surveying elevations and location coordinates (i.e., northing-easting or x-y) of site features such as monitoring wells, soil vapor monitoring points, boreholes, surface soil samples, site structures, and other surface and subsurface features.

1.0 RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager , Field Manager, or licensed Surveyor has the overall responsibility for implementing this SOP. All personnel engaged in surveying will be knowledgeable and experienced in the surveying methods and equipment used. Surveying will be performed and/or directly overseen by a surveyor who is licensed and registered in the applicable state(s). The Project Manager will be responsible for assigning appropriate staff or contractor(s) to implement this SOP and for ensuring that the procedures are followed.

All personnel performing these procedures are required to have the appropriate health and safety training.

2.0 EQUIPMENT LIST

All materials and equipment necessary for conventional and GPS surveying will be provided by the land surveying contractor. Examples of equipment that may be used are:

- Trimble R8 GNSS Survey Grade GPS System (or equivalent)
- Nikon DTM 520 Total Station (or equivalent)
- Trimble DiNi 12 Digital Level (or equivalent)

3.0 SURVEY POINTS

Prior to surveying, all features and/or locations to be surveyed may be marked in the field with labeled stakes, survey flags, paint, or other marking devices. A meeting will be held prior to commencement of survey activities to discuss the surveying requirements and locations prior to initiating surveying. The following guidelines will be used when surveying:

- Abandoned boreholes and surface soil samples will be surveyed, if specified in the scope of work, at the center of the grout plug or backfill material.
- Soil vapor monitoring points will be surveyed, if specified in the scope of work, at the ground surface on the highest side of the casing.
- Monitoring well nests, where two to three wells are installed in one boring, and individual wells and piezometers will be surveyed as follows:

  Elevations will be surveyed using conventional survey equipment at (1) the top of the PVC well/piezometer casing with the well cap off on the highest edge unless otherwise specified or marked (remove all visible debris from the tip of the survey rod prior to

placing on the open well), and (2) the ground surface immediately adjacent to the cement surface seal or cement pad (unless otherwise specified in the work scope)

The x-y coordinates will be surveyed using GPS (or conventional methods) at the center top of the protective casing (for above-ground monument or flush-mounted vault).

- Other surface features (e.g., surface sampling locations, buildings or other man-made features) will be surveyed at the point marked (elevation and/or x-y coordinates as specified in the work scope).

4.0 BENCHMARKS AND COORDINATE SYSTEMS

Vertical land surveying control will be established from a known National Geodetic Survey (NGS) datum, such as NAVD 88. Horizontal datum will be NAD83 International Feet (or other appropriate datum). Survey coordinates will be reported in the applicable state plane, Universal Transverse Mercator (UTM), or other appropriate coordinate system.

5.0 REQUIRED ACCURACY

Vertical

In general, surveyed monitoring well elevations will be reported to an accuracy of ±0.01 foot. This level of accuracy is required for the measuring point elevations of monitoring wells to collect groundwater elevation data. Vertical precision for other site features may be stated in the Work Plan or QAPP.

Horizontal

In general, surveyed monitoring well x-y location coordinates will be reported to an accuracy of ±0.10 foot. Closed traverse using conventional land survey equipment, GPS, or other appropriate method may be used to achieve this accuracy. Horizontal precision for other site features may be stated in the Work Plan or QAPP.

6.0 CONVENTIONAL SURVEYING

The following provides general procedures for conventional land surveying; however, these procedures should be supplemented by specific survey instrument manufacturer's recommendations and generally accepted surveying practices.

- Survey level equipment shall be checked and adjusted as necessary each day to ensure vertical accuracy is maintained and consistent throughout the extent of the project.
- Surveyed level data shall be recorded in a survey logbook indicating benchmark identifier, backsight, foresight, intermediate foresight, and specific feature information (i.e. identifier and elevation) information.

7.0 GPS SURVEYING

The following provides general procedures for GPS surveying; however, these procedures should be supplemented by specific survey instrument manufacturer's recommendations and generally accepted surveying practices.

- Surveying equipment will be field-verified each day before beginning surveying by establishing the coordinates of a known control point using the GPS unit. The identification (or description) of this control point and measured coordinates will be recorded in the survey logbook.
- A base station may be established within an appropriate distance from the furthest survey point, as determined by the instrument manufacturer's specifications. Alternatively, the data may be post-processed by the surveyor using NGS OPUS. The base station may be used in connection with the field unit measurements to provide differential corrections to the field data.
- At each survey location, the location identifier and coordinates will be measured and stored in the data collector. As a backup, the same information will be recorded in the survey logbook.
- Data stored in the data collector will be downloaded at the end of each day of surveying and checked to determine if the data is reliable and to verify that coordinates have been collected for each survey location.
- Existing NGS benchmarks in the site area may be horizontally scaled, and therefore not within the accuracy level required by a project. New horizontal benchmarks may be established by utilizing NGS OPUS.
- If the coordinates at a survey location cannot be determined due to the presence of tree cover or other obstacles which prohibit adequate signal reception, coordinates will be obtained at a minimum of two alternate locations (offsets) close to the original survey location. The distance and bearing from each of the alternate locations to the original survey location will then be determined using a conventional total station surveying device.
- Each horizontally surveyed position may be measured twice at different times of the day. This "double tie" procedure is a way of ensuring positional accuracy by measuring each position as the satellite constellation changes throughout the day. These double ties are then used to create a mean coordinate for each position – a redundant way of minimizing satellite geometry errors in data collection.

8.0 DOCUMENTATION

Documentation of observations and data acquired in the field will provide a permanent record of field activities and shall conform to accepted surveying standards approved by the land surveying professional registration organization. The observations and data will be recorded in a permanently bound weatherproof field logbook with consecutively numbered pages, and on field data sheets as applicable.

The survey location identifier (i.e., sample location designation or monitoring well designation) and corresponding coordinates and elevation will be recorded in the data collector. As a backup, this information will also be recorded in the survey logbook. The documentation must be of sufficient adequacy to relocate survey points if station markers are lost or destroyed. Surveying activities and field observations will also be recorded in the survey logbook. Information that will be documented in the logbook includes:

- Project name and number

- Surveying personnel
- Weather conditions
- Equipment used
- Daily field verification information (i.e., benchmark or control point identification and coordinates)
- Survey location identification and x-y coordinates, if not stored in a data collector
- Descriptions and coordinates of alternate survey locations (offsets)
- Measured distances from alternate survey locations to original survey locations
- A description of any conditions that may affect data integrity

This standard operating procedure (SOP) describes procedures to be used to conduct an independent review of environmental analytical laboratory data so that data of known and documented quality will be used for decision making as part of this Interim Measures (IM) at Holloman Air Force Base. Procedures for review of field data are included in SOPs

This SOP includes two levels of data review, evaluation of sample-specific parameters and evaluation of laboratory performance parameters. Environmental data generated for this Holloman Air Force Base IM will receive an evaluation of sample-specific parameters for all data packages. In addition, laboratory performance parameters will be reviewed for at least 2% of the data collected (per method, per sampling event).

This SOP addresses the protocols that will be followed for the sample-specific parameters and laboratory performance parameters data review levels. The review of sample-specific parameters is described in Section 4.1. The review of laboratory performance parameters is discussed in Section 4.2. This SOP was developed using guidance from the U.S. Environmental Protection Agency (USEPA) Contract Laboratory Program (CLP) National Functional Guidelines for Inorganic Data Review (October, 2004) and the USEPA CLP National Functional Guidelines for Organic Data Review (June 2008).

1.0 RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager or designee has the overall responsibility for implementing this SOP. He/she will be responsible for assigning appropriate environmental staff to implement this SOP and for ensuring that the procedures are followed.

Personnel performing these procedures are required to be familiar with environmental data, its generation, and its reporting. In addition, all personnel are required to have a complete understanding of the procedures described within the SAP and this SOP, as applicable.

Environmental staff are responsible for reporting deviations from this SOP to the Project Manager or designee.

2.0 DATA REVIEW PROCEDURES

As noted in Section 1.0, analytical IM data used for reporting and environmental decision making at Holloman Air Force Base will receive a review independent of the laboratory to ensure that data are of known and documented quality.

The review of sample-specific parameters includes evaluating parameters that are sample-related. These include: case narrative comments, chain-of-custody and sample condition upon receipt, holding times, method blank results, surrogate recoveries, matrix spike recoveries, laboratory duplicate or spike duplicate analysis, post-digestion spike recoveries, inductively coupled plasma (ICP) serial dilution analysis agreement, internal standard performance sample-specific chemical recovery, and results for field quality control samples (e.g. field duplicates, rinsate blanks, field

blanks, and trip blanks). The sample-specific review is described in Section 4.1. Sample-specific parameters will be reviewed and evaluated for all data packages.

The review of laboratory performance parameters includes evaluating operations that are in the control of the laboratory, but are independent of the field samples being analyzed. As applicable these include: instrument tune, initial calibration, initial and continuing calibration verification, laboratory control sample analysis, compound identification, result calculation (i.e., quantitation), radionuclide quantitation and implied detection limits, chemical separation specificity, data transcription (i.e., verification), and method-specific quality control requirements (e.g. thermal stability, tuning, resolution, mass calibration, interference check sample analysis). Evaluation of these parameters provides an assessment of overall system performance. The review of laboratory performance parameters is discussed in Section 4.2. For stringent use data, laboratory performance parameters will be reviewed for at least 2% of the data collected (per method, per sampling event).

During the data review process, and as necessary, data validation qualifiers, as defined in Table 4-1, will be assigned to the results to indicate any potential limitation on the use of the data. In addition, data qualifier codes and bias codes as defined in Table 4-2 will be added to the results to indicate the reason(s) for qualification and the associated bias direction, if discernable. Data validation narratives will be generated which document the results of data review activities, data qualification assigned, and any limitations on the use of the data.

2.1 REVIEW OF SAMPLE-SPECIFIC CRITERIA

The review of sample-specific criteria includes evaluating parameters that are sample-related. Each of the subsections below describes how each parameter is evaluated. While most parameters to evaluate are pertinent to all methods, some are method-specific (e.g., see Section 4.1.6). In general, the hierarchy for acceptance criteria used to evaluate each parameter is as follows:

- Criteria specified in the SAP.
- Method-specified acceptance criteria.
- Acceptance ranges based on laboratory historical data.

According to this hierarchy, a parameter is first evaluated against the requirements set forth in the SAP. If the criteria are not specified in the SAP, then the parameter is evaluated against the requirements stated in the analytical method. If the method does not specify acceptance criteria, results for the parameter are compared to acceptance ranges based on laboratory historical data.

A collective assessment of affected field sample data will be performed for field duplicate results, matrix spike recoveries, laboratory or matrix spike duplicates, field blanks, and rinsate blanks. When QC issues account for less than 35% of the QC analyses conducted, applicable data qualification will be limited to qualification of the parent sample results. When QC issues account for more than 35% of the QC analyses conducted, applicable data qualification will be extended to qualification of all sample results associated with the QC analyses.

No recalculation of results from the raw data or transcription error checking will be performed during the review of the sample-specific criteria as recalculation and transcription error checking is completed during the review of laboratory performance criteria.

2.1.1 Case Narrative Comments

The data validation process begins with an examination of the laboratory case narrative. Any analytical problems noted in the case narrative are noted in the data validation narrative along with a summary of the effect on the usability of the data.

2.1.2 Chain-of-Custody and Sample Receipt

The chain of custody (COC) documentation, sample receipt, and log-in information are reviewed. The analytical results received are compared against those requested on the COC form. Any COC problems or discrepancies and any problems noted by the laboratory with regard to sample condition upon receipt are noted in the data validation narrative along with a statement of the effect on the usability of the data.

2.1.3 Holding Times

Collection-to-analysis, collection-to-preparation (extraction/ digestion), and preparation-to-analysis holding times are calculated by computing the difference between the respective dates (e.g., sample collection date and the sample analysis date for collection-to-analysis holding time). The collection dates are found on the COC and analysis dates are reported on the analysis run logs. The holding times are compared to the acceptance limits contained in the SAP and/or respective analytical methods, as applicable. Results for analyses not performed within holding time limits will be qualified as estimated ("J/UJ"). If the holding time is grossly exceeded (more than two times the holding time limit), the data reviewer should use professional judgment to evaluate the need to reject non-detectable results.

A reason code of "HT" will be assigned to all results qualified or rejected on the basis of holding times.

2.1.4 Blanks (Organic and Inorganic)

Blank analysis results are used to assess the existence and magnitude of contamination problems. If a problem exists with any blank, the reviewer will evaluate whether there is an inherent variability in the data for the entire data set or if the problem is an isolated occurrence not affecting other data.

Blanks should be analyzed for every matrix and every batch, or at a frequency of 5 percent, whichever is more frequent. The results for all blanks should be plotted by the laboratory's QA department to determine that each blank result falls within the recommended tolerance limits of ± 3 standard deviations.

The results for method blanks and calibration blanks will be reviewed. Sample results for analytes detected in an associated blank at concentrations <5x the equivalent blank concentration

will be qualified as non-detect (U). For the common organic laboratory contaminants (e.g., acetone, methylene chloride, 2-butanone, cyclohexane, and phthalates), sample results <10x the concentration in the associated blank will be qualified as non-detect (U). Method blanks are associated with the samples in the same sample preparation/extraction batch. Continuing calibration blank samples are considered to be associated with all samples analyzed in the analytical run.

Because sample analyses will be performed following the Department of Defense Quality Systems Manual Version 4.2 (DoD QSM V4.2), blanks will be evaluated using the Detection Limit (DL), Limit of Detection (LOD), and Limit of Quantitation (LOQ). If the reported sample result was a detection at a concentration between the DL and LOD which was qualified as non-detectable based on blank contamination levels, the result would be reported as non-detect at the LOD, the LOQ would remain unchanged, and the reported sample concentration would be used as the DL. So for example, if the laboratory reported a detected sample concentration of 1.5 milligrams per liter (mg/l) (that should be qualified as non-detect due to blank contamination) with an DL of 1 mg/l , LOD of 2mg/l, and an RL of 4 mg/l, the qualified data sheets should be annotated and the database revised to indicate that the sample result is a non-detect with an associated value (result) of 2mg/l, that the LOQ would remain as 4 mg/l, and the DL should be revised to 1.5 mg/l.

If the reported sample result was a detection at a concentration between the LOD and LOQ which was qualified as non-detectable based on blank contamination levels, the result would be reported as non-detect at the reported concentration, the LOQ would remain unchanged, and the reported sample concentration would be used as the LOD and DL. So for example, if the laboratory reported a detected sample concentration of 3 mg/l (that should be qualified as non-detect due to blank contamination) with an DL of 1 mg/l , LOD of 2mg/l, and an RL of 4 mg/l, the qualified data sheets should be annotated and the database revised to indicate that the sample result is a non-detect with an associated value (result) of 3 mg/l, that the LOQ would remain as 4 mg/l, and the LOD and DL should be revised to 3 mg/l.

If the originally reported detectable result is greater than the LOQ, then the DL, LOD and LOQ should be changed to be equal to the originally reported concentration and the value flagged as a non-detect. So for example if the originally reported result was 6 mg/l, the DL was 1 mg/l , LOD was 2 mg/l, and the RL was 4 mg/l, the qualified datasheets should indicate the result is nondetectable with an associated numeric value equal to the originally reported concentration, and the LOQ, LOD, and DL values should be revised to 6 mg/l.

The sample result should be flagged as a non-detect in the database and on the data sheets and the qualifier code should be MB-I.

If reported, negative blank concentrations will be evaluated for potential effects (low bias) on sample data when the absolute value of the negative concentration is >LOQ. If the negative concentration in a blank may potentially have produced more than a 25% effect on a reported sample result or sample reporting limit, the associated sample result will be qualified as estimated (J/UJ). For example, if the associated blank result is –2 mg/L, the LOQ is 1 mg/L, and the associated sample result is 5 mg/L, the sample result will be qualified as estimated because a

potential low bias of 2 mg/L represents 40% of the reported concentration and the absolute value of the blank concentration is >LOQ.

A reason code of "MB" or "CCB" will be assigned to all results qualified on the basis of method blank or continuing calibration blank results, respectively. For results qualified as non-detect, the bias direction is considered to be indeterminate as the reporting limit is adjusted accordingly. For results qualified as estimated on the basis of negative blank results, the bias direction is low.

2.1.5 Matrix-Dependent Quality Control

Matrix dependent quality control (QC) samples are used to evaluate how the sample matrix affects the accuracy and precision of the analytical results.

In order to evaluate how the site-specific sample matrix affects the accuracy of the analysis, the laboratory will spike one or two additional aliquots of a field sample with known amounts of target analytes and prepare the spiked samples in a fashion identical to that of the field samples. The amount of each spiked analyte recovered can be used to infer the accuracy of the analysis on the site-specific sample matrix.

To assess the precision of the analysis on the site-specific sample matrix, a laboratory duplicate or spike duplicate sample is prepared. A laboratory duplicate sample is a laboratory split of a homogenized environmental sample that is prepared and analyzed in a manner identical to that of the original sample. A matrix spike duplicate is similar with the exception that both aliquots are spiked with known amounts of target analytes. The closeness of the agreement between the two results can be used to infer the precision of the analysis on the site-specific sample matrix.

For inorganic methods, one aliquot is typically spiked and for organic methods, two aliquots are typically spiked. For inorganic methods, a duplicate sample is typically used to assess precision whereas for organic methods, a spiked duplicate is typically used. These conventions were developed based on the probability of finding the target analytes in the sample matrix. However, some laboratories choose to do matrix spike and matrix spike duplicates for some of their inorganic analyses.

The subsections below describe how the results for matrix QC samples will be evaluated.

2.1.5.1 Matrix Spike (MS) Analysis

The matrix spike results, expressed as percent recovery of the spiked analytes, are used to assess effects of the general sample matrix on the accuracy of the analysis. Samples identified as field blanks should not be used for MS analyses. At least one MS should be analyzed for every matrix, every batch, or for every 20 samples (5 percent of samples), whichever is more frequent.

The matrix spike recoveries are compared to the appropriate acceptance ranges per the hierarchy presented in Section 4.1 when the native sample concentration is less than four times the spike level. When native sample analyte concentrations are four times the spiking concentration, the results are considered to be inappropriate for assessing accuracy. The reviewer should also be aware that a matrix spike recovery may be outside acceptance limits when the parent sample was

quantified by method of standard additions but the matrix spike recovery was not. In such a case, the matrix spike recovery is not an appropriate measure of accuracy. Data associated with matrix spike recoveries that are outside the acceptance range will be qualified as follows using guidance from Functional Guidelines.

- If an analyte matrix spike recovery exceeds the upper limit of the acceptance range, suggesting a potential high bias in sample results, the positive result for that target analyte in the parent sample is qualified as estimated ("J"); whereas, a non-detect result for that analyte is considered to be acceptable for use without qualification.
- If an analyte matrix spike recovery is below the lower limit of the acceptance range, but 30% for inorganics or 10% for organics, suggesting a potential low bias in sample results, both positive and non-detect results for that analyte in the parent sample are qualified as estimated ("J/UJ").
- If an analyte matrix spike recovery is <30% for inorganics or <10% for organics, non-detect results are qualified as unusable ("R") and positive results in the parent sample are qualified as estimated ("J") per Functional Guidelines guidance.

If a matrix spike duplicate is also prepared, the reviewer must use professional judgment and consider the recoveries for both the matrix spike sample and the matrix spike duplicate sample prior to assigning data qualifiers to data. Instances in which professional judgment is used to assign data qualifiers will be detailed in the individual data review narratives.

The reviewer should note that for organic data, no qualification of associated samples in the batch or data package will be performed on the basis of matrix spike recoveries alone. The data reviewer should use professional judgment and consider the results of other QC measures such as surrogate recoveries in conjunction with MS/MSD results to determine the need for extending qualification for the affected analytes to the other associated samples. A collective assessment will be performed for both inorganic and organic methods as discussed in Section 4.1 above.

A reason code of "MS" will be assigned to all results qualified as estimated or unusable (rejected) on the basis of matrix spike and/or matrix spike duplicate recoveries. The assigned bias code will reflect the inferred bias direction.

2.1.5.2 Laboratory Duplicate (LD) Sample Analysis

Duplicate Analysis (matrix duplicate or spiked duplicate)

Duplicate analyses are indicators of laboratory precision based on each sample matrix. Samples identified as field blanks should not be used for duplicate analyses. At least one duplicate should be analyzed for every matrix, every batch, or for every 20 samples (5 percent of samples), whichever is more frequent.

The duplicate and spike duplicate sample analysis results are used to evaluate the precision of the laboratory analyses. Laboratory duplicate or spike duplicate results are evaluated using concentration dependent evaluation criteria.

- When both results are > 5x RL, compare the relative percent difference (RPD) between the sample results to a criterion of 20% for aqueous samples and 35% for soil and sediment samples.
- If either sample concentration is 5x RL, compare the absolute difference between the results to a criterion of 1x the greater RL for aqueous samples and 2x the greater RL for soil and sediment samples.

All evaluations are done using the higher RL and the RL is used in calculating the absolute difference for a non-detect result. If the applicable duplicate evaluation criterion is not met for an analyte, all associated sample data for that analyte will be qualified as estimated (J/UJ).

A reason code of "D" will be assigned to all results qualified on the basis of laboratory duplicate or spike duplicate results. A bias direction of indeterminate will be assigned to results qualified on the basis of duplicate results.

2.1.6 Method-Specific Quality Control Measures

The individual methods include method-specific QC measures. The procedures used to evaluate the results obtained for method-specific quality control measures are described below. Section 4.1.6.1 describes method-specific QC measure for inorganic methods and Section 4.1.6.2 describes method-specific QC measures for organic methods.

Use of professional judgment will be documented in the data validation report.

2.1.6.1 Inorganic Method Specific QC Measures

For inorganic methods, method-specific QC measures may include post-digestion spikes, serial dilution tests, internal standard performance, and cation/anion balance calculation. Evaluation procedures for each of these QC measures are described below.

2.1.6.1.1 Post Digestion Spike Recovery (Metals)

The analyte recoveries obtained for post-digestion spike analyses will be compared to the appropriate acceptance ranges per the hierarchy presented in Section 4.1. Under some circumstances, laboratories will quantify results by the method of standard additions to compensate for low post-digestion spike recovery. In such a case, the low post-digestion spike recovery would not indicate poor accuracy. However, if the result for the sample on which the post-digestion spike analysis was performed was not obtained by the method of standard additions and the post-digestion spike recovery is outside of the acceptance limits, qualify the result for the sample on which the post-digestion spike was run based on the following guidance:

- If the recovery is > the upper acceptance limit, detectable results are qualified as estimated ("J"). No action needs to be taken for non-detects.
- If the recovery is < the lower acceptance limit, but 30%, detectable and non-detectable results are qualified as estimated ("J/UJ").
- If the recovery is <30%, detectable results are qualified as estimated ("J") and non-detectable results are qualified as unusable ("R").

The data reviewer should use professional judgment in conjunction with other QC sample results, such as matrix spike recoveries, to determine the need for qualification of results for other samples (if any) associated with the post-digestion spike analysis.

A reason code of "PDS" will be assigned to all results qualified or rejected on the basis of post-digestion recoveries and the assigned bias code will reflect the inferred bias direction.

2.1.6.1.2 Serial Dilution Test (Metals)

ICP serial dilutions are run to help evaluate whether or not significant physical or chemical interferences exist due to sample matrix. Serial dilution analyses are typically conducted at a frequency of 1/20 samples (one analysis per metals data package). When analyte concentrations are sufficiently high (the concentration in the original sample is minimally a factor of 50 above the instrument detection limit [IDL] or method detection limit [MDL]), the results obtained for a five-fold-dilution of the original sample are compared to the original results by means of a percent difference (%D). The %D is compared to a precision acceptance limit of ±10%. If the absolute value of the %D between the diluted and original result is >10%, all results for that analyte in that sample batch are qualified as estimated ("J/UJ").

Generally, the diluted result can be considered to be the more accurate result, as long as the diluted concentration is well above the detection limit. Therefore, the data reviewer can generally discern a potential bias direction from a comparison of the diluted and undiluted results. For example, if the diluted result is higher than the original result, the bias direction (associated with the original result) is considered to be potentially low.

A reason code of "DL" will be assigned to all results qualified on the basis of serial dilution results along with an appropriate bias code.

2.1.6.1.3 Internal Standards (Metals)

Internal standards are used routinely in the analysis for metals by ICP-MS; however, internal standards may be used in the analysis of metals by ICP-AES. Internal standard recoveries for every sample and standard (as the requested level of reporting permits evaluation) will be compared to the metals acceptance range. Results associated with internal standard recoveries outside the acceptance range where the sample was not diluted and reanalyzed will be qualified as estimated (J/UJ). If upon reanalysis the internal standard recoveries are still outside the acceptance range, the results will be qualified as estimated (J/UJ).

A reason code of "IS" will be assigned to all results qualified on the basis of internal standard area counts.

2.1.6.1.4 Anion/Cation Balance

Because water is generally electrically neutral, the sum of the dissolved cation concentrations (expressed in milli-equivalents per liter) should equal the sum of the dissolved anion concentrations. For projects in which the major cations and anions are being analyzed, the data reviewer may evaluate whether there is an acceptable balance between anion concentrations and cation concentrations. It should be noted that both major cations and anions must be analyzed to complete the anion/cation balance. In accordance with Standard Methods #1030F, the equation used to calculate anion-cation balances is:

percent difference = 100% x (cations - anions) / (cations + anions)

Laboratory accuracy control limits for these types of analytes are typically ±30%. This level of accuracy is considered to be fully acceptable in meeting the end use objectives of groundwater monitoring. A 30% bias in the metals analysis corresponds to an anion-cation balance percent difference of approximately 13%. Therefore, since a 30% bias is considered not to adversely affect the usability of the data, an evaluation criterion of a percent difference less than ± 13% will be utilized for anion-cation balance evaluation. If the anion/cation balance is greater than ±13% the data reviewer should use professional judgment to discern likely causes of the imbalance and need for qualification of associated sample data.

2.1.6.2 Organic Method Specific QC Measures

For organic methods, method-specific QC measures may include surrogate compound recovery and internal standard performance. Evaluation procedures for each of these QC measures are described below.

2.1.6.2.1 Surrogate Spike Compound Recovery

The surrogate recoveries obtained for each sample analysis for which surrogates were analyzed will be compared to the acceptance range specified in the SAP, method, or that provided by the laboratory, as appropriate (per Section 4.1). Results for analytes in the sample associated with surrogate recoveries outside the acceptance range will be qualified as follows:

- If the surrogate recovery is greater than the upper acceptance limit for any surrogate (for semivolatile organics by GC/MS, two or more surrogates in either fraction must be high), suggesting a potential high bias in reported results, all positive results for associated analytes in that sample are qualified as estimated ("J") whereas non-detect results are considered to be acceptable for use without qualification.
- If the surrogate recovery is < the lower acceptance limit but 10% (for semivolatile organics by GC/MS, two or more surrogates in either fraction are out with at least one of them being less than the lower limit but 10%), suggesting a potential low bias in reported results, positive and non-detect results for associated analytes in that sample are qualified as estimated ("J" or "UJ").
- If any surrogate recovery is <10%, positive results for associated analytes in that sample are qualified as estimated ("J") whereas associated non-detect results are qualified as unusable ("R").

It is important to note that professional judgment may be utilized in assigning data qualification especially for methods in which more than one surrogate compound is used or in which there may have been multiple reasons for qualification on an individual result, or there may have been multiple analyses of the same sample. The data review narrative will detail any instance in which professional judgment was used.

A reason code of "SUR" will be assigned to all results qualified or rejected on the basis of surrogate recoveries. An appropriate bias code will be assigned.

2.1.6.2.2 Internal Standards (Organic)

The site wide SAP and/or analytical method, as appropriate (per Section 4.1) will be used to determine the QC acceptance criteria for internal standard area counts for GC/MS organic analysis. Internal standard area counts are not a direct measure of the accuracy of the analysis. Low internal standard area counts for sample analysis relative to those observed in the associated continuing calibration analysis may be indicative of low extraction or purging efficiency which decreases the analysis sensitivity (raises the detection limit). High internal standard area counts may be indicative of co-eluting interferences at the retention time of the internal standard in the sample, may be caused by a drift in detector sensitivity, or may be caused by injection of a different amount of sample extract. Co-eluting interferences to the internal standard may result in a low bias in reported results quantified by the given internal standard. Injection of a larger volume of extract would result in increased sensitivity of the analysis (lowered detection limit).

- If data validation indicates that internal standard area counts are below the lower acceptance limit, then results reported as not-detected shall be qualified as estimated ("UJ") and results reported as detected will not require qualification since the calculation corrects for reduced extraction efficiency.
- If data validation indicates that internal standard area counts are above the upper acceptance limit, then results reported as detected or as non-detected shall be qualified as estimated ("J/UJ").
- If the internal standard recovery is less than 5%, qualify positive hits and non-detects associated with the failed internal standard as unusable ("R").

A reason code of "IS" will be assigned to all results qualified on the basis of internal standard area counts.

2.1.6.2.3 Internal Standard Recoveries for Chlorinated Biphenyl Congeners (CBs)

The internal standard recoveries for CBs by high resolution gas chromatography/high resolution mass spectrometry will be compared to acceptance limits specified in the method Table 6 (e.g., 25% to 150%). Note that because 1) the quantitation equations compensate for low extraction efficiency based on the recovery of internal standards and 2) in isotope dilution quantitation the internal standard is chemically the same as the compound being quantified, differing only in isotopic composition; thus, internal standard recoveries are not a direct measure of accuracy of the analysis. If the recoveries were outside the acceptance range, qualify analytes quantified using the out-of-limits internal standard in accordance with the following:

- If the internal standard recovery was below LLC or above UCL, qualify positive results and non-detects for analytes quantified with the internal standard as estimated ("J/UJ").
- If the internal standard recovery is less than 5%, qualify positive detects and non-detects associated with the failed internal standard as unusable ("R").
- If the internal standard recovery is greater than 200% contact the laboratory to resolve the situation.

2.1.6.2.4 Estimated Maximum Concentrations for CBs

For a CB to be identified, it must meet all of criteria specified in Section 16 of Method 1668A.

For results not meeting the qualitative identification criteria listed in Section 16 of the method may be reported as Estimated Maximum Possible Concentrations (EMPCs). Results for analytes not meeting the identification criteria may be qualified as non-detect with an "E" qualifier at the reported EMPC value and the associated bias direction for the detection limit is considered to be high. A qualifier code of ID-H will be assigned to these results. For these results, the reported concentration is considered to be the "effective" detection limit.

2.1.7 Balance of Total versus Partial Analyses

Results for the total analysis of a particular analyte should be greater than the results for a partial analysis of that analyte. For example, the results for total metals should be greater than or equal to the results for dissolved metals and ammonia concentrations should not be greater than Total Kjeldahl Nitrogen (TKN) concentrations. Because all results are limited by the accuracy of the analysis, the criteria for accuracy of the analysis are used as the basis for criteria to evaluate the agreement between the results for the partial analysis and the total portion.

- In instances where the value for a partial analysis exceeds that for a total analysis and both of the results are >5xRL, the criterion utilized is that the two values should agree within ±30%. For example, the partial analysis result should not be more than 30% higher than the total analysis result.
- In instances where the value for a partial analysis exceeds that for a total analysis and either of the results is 5xRL, the absolute difference between the results is compared against an evaluation criterion of 2x RL.

All evaluations are done using the higher RL and the RL is used for calculating the absolute difference for non-detect results. If the results for the partial versus total analyses do not satisfy the appropriate evaluation criterion, when the result for partial analysis was greater than that for the total analysis, the reviewer should use professional judgment to discern the probable cause and need for qualification of the data.

A reason code of "TvP" will be assigned to results qualified as estimated based on the comparison of the results for a total analysis and its corresponding partial analysis.

2.1.8 Field Quality Control Samples

The types of field quality control samples that will be collected under this SAP include field duplicates, rinsate blanks, field blanks, and trip blanks. The evaluation for each type of field quality control sample is described below.

2.1.8.1 Field Duplicate Agreement

Field duplicate sample results will be used as an indication of overall precision (i.e., field and laboratory precision) and/or the representativeness of the samples to the medium sampled.

Analytical results obtained for field duplicate sample pairs are compared to each other using the concentration dependent criteria described below.

- When both the sample and duplicate values are >5xRL, acceptable sampling and analytical precision is indicated by an RPD between the results of 30% (50% for soil samples).
- Where the result for one or both analytes of the field duplicate pair is <5xRL, satisfactory precision is indicated if the absolute difference between the field duplicate results is <2xRL (<3.5xRL for soil samples).

All evaluations are done using the higher RL and the RL is used for calculating the absolute difference for non-detect results. If the above criteria are not met for an analyte, the parent and field duplicate results for that analyte should be qualified as estimated ("J/UJ"). A collective assessment will be performed as discussed in Section 4.1.

A reason code of "FD" will be assigned to results qualified as estimated on the basis of field duplicate agreement.

2.1.8.2 Rinsate Blank Results

The results for rinsate blanks reported in the data package will be reviewed. Sample results for analytes detected in an associated rinsate blank at concentrations <5x the equivalent blank concentration (<10x for common laboratory contaminants) will be qualified as non-detect ("U"). The result will be qualified as non-detect at the reported concentration if the reported concentration is >RL or as non-detect (U) at the RL if the reported concentration is <RL.

For aqueous blanks applied to soil/sediment samples, qualification is assigned based on comparison of the sample result to the equivalent concentration in the blank. The equivalent concentration is determined by assuming that all of the analyte present in the blank aliquot analyzed is present in the soil sample aliquot analyzed. The reviewer should note that the blank analyses may not involve the same weights, volumes, or dilution factors as the associated samples. These factors must be taken into consideration when applying the 5x or 10x criterion, such that a comparison of the total contamination is actually made. A collective assessment will be performed as discussed in Section 4.1.

A reason code of "RB" will be assigned to all results qualified on the basis of rinsate blank results. A bias code of indeterminate will be assigned.

2.1.8.3 Field Blank Results

The results for field blanks reported in the data package will be reviewed. Sample results for analytes detected in an associated field blank at concentrations <5x the equivalent blank concentration (<10x for common laboratory contaminants) will be qualified as non-detect (U). The result will be qualified as non-detect at the reported concentration if the reported concentration is >RL or as non-detect (U) at the RL if the reported concentration is <RL.

For aqueous blanks applied to soil/sediment samples, qualification is assigned based on comparison of the sample result to the equivalent concentration in the blank. The equivalent concentration is determined by assuming that all of the analyte present in the blank aliquot analyzed is present in the soil sample aliquot analyzed. The reviewer should note that the blank analyses may not involve the same weights, volumes, or dilution factors as the associated

samples. These factors must be taken into consideration when applying the 5x or 10x criterion, such that a comparison of the total contamination is actually made. A collective assessment will be performed as discussed in Section 4.1.

A reason code of "FB" will be assigned to all results qualified on the basis of field blank results. A bias code of indeterminate will be assigned.

2.1.8.4 Trip Blank Results

The results for trip blanks reported in the data package will be reviewed. Sample results for analytes detected in an associated trip blank at concentrations <5x the equivalent blank concentration (<10x for common laboratory contaminants) will be qualified as non-detect (U). The result will be qualified as non-detect at the reported concentration if the reported concentration is >RL or as non-detect at the RL if the reported concentration is <RL.

For aqueous blanks applied to soil/sediment samples, qualification is assigned based on comparison of the sample result to the equivalent concentration in the blank. The equivalent concentration is determined by assuming that all of the analyte present in the blank aliquot analyzed is present in the soil sample aliquot analyzed. The reviewer should note that the blank analyses may not involve the same weights, volumes, or dilution factors as the associated samples. These factors must be taken into consideration when applying the 5x or 10x criterion, such that a comparison of the total contamination is actually made.

A reason code of "TB" will be assigned to all results qualified on the basis of trip blank results. A bias code of indeterminate will be assigned.

2.1.9 Reporting Limits

The contracted laboratories are reporting positive results below their standard RLs when the values are greater than the instrument detection limit (IDL) or method detection limit (MDL). These detection and/or reporting levels and associated degree of uncertainty are discussed below.

The MDL is defined in the Environmental Protection Agency's Protection of the Environment Guidelines Establishing Test Procedures for the Analysis of Pollutants (40CFR136), Appendix B as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. The MDL is determined from the analysis of spiked samples containing the analyte in a given matrix. MDLs are preparation- and method-specific. The MDL is calculated by multiplying the standard deviation of the measurements by the student t-value for seven replicate analyses (i.e., 3.14).

At the MDL, results may have a high degree of uncertainty in the actual concentration (often more than 100%). Results reported as detected at the IDL may also have about a 50% chance of being non-detects (i.e. false positives meaning that the true sample concentrations are less than the IDL or MDL).

RLs or Practical Quantitation Limits (PQLs) are typically set at some factor above the IDL or MDL to ensure greater confidence in the accuracy of the associated quantitative value. Thus, at

the RL (or PQL), a value typically set at 3-10 times the IDL or MDL, the degree of uncertainty would be more like +/- 25%. Thus, the RL or PQL is the smallest concentration of the analyte that can be reported with a specific degree of confidence (i.e., the low concentration point of the calibration curve is less than or equal to the RL/PQL). When the RL/PQL is adjusted for sample weight, percent moisture, and dilution factor for individual samples, the result is a sample-specific quantitation limit or SQL.

To reflect the higher degree of uncertainty associated with values reported between the IDL/MDL and RL/PQL, these results are qualified as estimated ("F"). A qualifier code of SQL, denoting sample quantitation limit, is assigned to results qualified for this reason. A bias direction of indeterminate is assigned.

2.1.10 Other Items Identified in the Case Narrative

If an issue identified in the case narrative is not covered by the subsections above and is found to potentially adversely affect data quality, the data reviewer shall evaluate the problem based on SAP and/or method requirements, as applicable. If the SAP and/or analytical method does not specify requirements related to the criterion under evaluation, the data reviewer should utilize professional judgment to evaluate the effect of the reported item or condition on the associated analytical data. All uses of professional judgment shall be described in the report of the data validation process.

2.1.11 Completeness of the Data Package

The analytical data packages are evaluated for completeness of deliverables against the following criteria:

- Presence of tabulated results for all specified compounds identified and quantified and RLs for all analytes.
- Presence of results for all methods requested on the COC forms for each sample.
- Presence of a case narrative, COC forms, and the sample receiving forms.
- Presence of: QC summary forms for blank results; QC summary forms for MS results with calculated percent recoveries; QC summary forms for post-digestion spike recoveries (as required) with calculated percent recoveries; QC summary forms for laboratory duplicates and/or spike duplicate results and calculated RPDs; QC summary forms for serial dilution test with calculated %Ds; and QC summary forms for laboratory control sample (LCS) sample results with calculated percent recoveries.
- When full data packages are requested, the package will also be reviewed for QC summary forms for initial and continuing calibration verification as well as supporting raw data for all of the aforementioned items and any pertinent review parameter discussed in Section 4.2.

Data package deliverables that do not meet the above criteria are documented, and the missing deliverables will be requested from the contracted laboratory. Any documents not obtainable from the laboratory are noted in the data review narrative.

2.2 REVIEW OF LABORATORY PERFORMANCE PARAMETERS

The review of laboratory performance parameters includes evaluating operations that are in the control of the laboratory, but are independent of the field samples being analyzed. Evaluation of these parameters provides an overall representation of the analytical system at the time of analysis. Laboratory performance parameters will be reviewed for 2% of the data collected per method per sampling event. If review of any of the laboratory performance parameters indicates a systematic problem may exist, that review parameter will be evaluated for all data packages from that laboratory for that sampling event/episode.

The subsections below describe in general how each laboratory performance parameter is evaluated. As noted in the introduction to Section 4, the hierarchy for criteria used to evaluate each parameter is as follows. A parameter is first evaluated against the requirements set forth in the SAP. If the SAP does address that parameter, the parameter is evaluated against the requirements stated in the analytical method. If the method does not specify acceptance criteria, results for the parameter are compared to acceptance ranges based on laboratory historical data.

While conducting the review described below, the data reviewer will evaluate whether the case narrative adequately summarizes all issues potentially affecting data quality (i.e., is the case narrative a reliable indicator of potential problems within the entire data package?). This assessment will be used to determine the need to evaluate specific laboratory performance parameters for the entire data set rather than just the predetermined portion of the data set (i.e., 2%).

2.2.1 Instrument Tune

A satisfactory tuning event will be conducted at the appropriate frequency and will be within the acceptance limits as specified in the individual methods.

2.2.2 Initial Calibration

The requirements set forth in the SAP and/or method, as applicable, will be used to evaluate whether:

- The initial calibration was performed at the required frequency using the proper number of standards at the proper concentrations,
- Whether the RL or contract-required quantitation limit (CRQL) is supported by the calibration low point standard,
- Whether adequate response was obtained for each analyte for each standard,
- Whether the applicable linearity criteria were met, and
- Whether the initial calibration was verified properly.

If the initial calibration evaluation criteria for any analyte are not satisfied, then all results for that analyte associated with the initial calibration will be qualified as estimated ("J/UJ"). A reason code of "ICAL" or "ICV" will be used depending on whether the condition was due to the initial calibration or verification of the initial calibration. If the data reviewer can discern a probable

magnitude and/or direction of bias to the associated sample results based on the information provided, then appropriate qualifier bias codes will be assigned.

2.2.3 Continuing Calibration Verification

The requirements set forth in the SAP and/or method, as applicable, will be used to evaluate whether:

- The continuing calibration verification was performed at the required frequency using the proper standard at the proper concentration,
- Whether adequate response was obtained for each analyte, and
- Whether the responses obtained indicate that the instrumentation is still operating within an acceptable range (i.e., acceptable drift).

If the continuing calibration evaluation criteria for any analyte are not satisfied, then all results for that analyte associated with the unsatisfactory continuing calibration (i.e. bracketed before and after) will be qualified as estimated ("J/UJ"). A reason code of "CCV" or "CCAL" will be used for inorganic and organic methods, respectively. If the data reviewer can discern a probable magnitude and/or direction of bias to the associated sample results based on the information provided, then appropriate qualifier bias codes will be assigned.

2.2.4 Laboratory Control Sample Analysis

Laboratory control samples (LCSs) are "clean" well characterized samples used to monitor the laboratory's day to day performance of routine analytical methods. LCSs are prepared by spiking samples of a "clean" matrix with known amounts of target analytes and then processing the sample in the same fashion as all other samples. LCSs are used to monitor the accuracy and precision of the analytical process independent of matrix effects. The accuracy of the analytical process is evaluated using the calculated percent recoveries (%Rs) of the spiked analytes.

The reviewer will verify that all target analytes were spiked into the LCS. The LCS percent recoveries will then be compared to the acceptance limits in the SAP (Tables 12-1a through 12-16), as applicable.

- If the LCS recovery for an analyte is greater than the upper acceptance limit, suggesting a potential high bias in reported results, all positive results for that analyte in all associated samples will be qualified as estimated ("J") whereas non-detect results will be considered acceptable for use without qualification because the high bias does not affect non-detect results.
- If the LCS recovery for an inorganic analyte is less than the lower acceptance limit but 30%, suggesting a potential low bias in reported results, positive and non-detect results for that analyte in all associated samples will be qualified as estimated ("J" or "UJ").
- If the LCS recovery for an inorganic analyte is <30%, positive sample results will be qualified as estimated ("J"), whereas non-detect sample results will be qualified as unusable ("R") for all associated sample results.

- If the LCS recovery for an organic analyte is less than the lower acceptance limit but 10%, positive and non-detect results for that analyte in all associated samples will be qualified as estimated ("J" or "UJ").
- If the LCS recovery for an organic analyte is <10%, positive sample results will be qualified as estimated ("J") whereas non-detect sample results will be qualified as unusable ("R") for all associated sample results.

In the case of unacceptably low LCS recoveries, the reviewer will verify that the laboratory re-prepared and re-analyzed all associated samples, including the LCS and that acceptable results were obtained for the new LCS.

A reason code of "LCS" will be assigned to all results qualified as estimated or rejected on the basis of LCS recoveries.

2.2.5 Dual Column Confirmation Results (Pesticides)

A second, dissimilar column confirmation is required by some of the gas chromatographic analysis methods. If the analytical method or laboratory contract specifies quantitative evaluation of second column result agreement, the following qualification should be considered:

- If the RPD between primary and secondary column results is greater than 40%, and the difference between the values reported for the two columns is likely due to coeluting interference, the data reviewer should qualify the reported sample results as presumptive evidence of compound presence but at an estimated quantity ("NJ"). If the result reported by the laboratory was the higher of the two results, then the data reviewer may cross out the reported result and replace it with the lower of the two results, if there is evidence that the higher value is caused by coeluting interference.
- If the samples analyzed would not be considered as previously well-characterized for the constituents present and second column confirmation was not performed for a GC analysis, the reported sample results may be qualified as presumptive evidence of presence at an estimated quantity ("NJ").

2.2.6 Compound Identification

For 10% of the results reported in the data packages undergoing an evaluation of laboratory performance parameters, the reviewer will verify that positively identified results meet all identification acceptance criteria as specified in the SAP and/or analytical method. In addition, the reviewer will examine the data for false negative results.

For organics, this may encompass comparing retention times against retention time windows, evaluating the agreement between dual column confirmation results, comparing relative retention times (RRTs) for samples to RRTs for standards, and comparison of mass spectral data to reference spectra, depending on the analytical technique employed (note: this listing is not all inclusive).

For inorganic methods, analyte identification is generally not reviewable from the data packages. However, for some methods, there are items the reviewer can check such as comparing the %RSDs for replicate measurements to a method-specific criterion and that target analytes elute in the proper order and expected retention time.

2.2.7 Target Analyte Quantification

The reviewer will verify that reported sample concentrations can be recalculated from the raw data for 10% of the reported sample results in the data packages undergoing an evaluation of laboratory performance parameters. The reviewer will verify that reported results were calculated using the proper signal response for the sample, calibration factor or relative response factor, internal standard response, dilution factor, internal standard concentration or mass, percent solids, sample weights or volumes, final extract volume, etc., as applicable to the analytical method.

If errors are found in the reported sample results, the laboratory will be contacted and corrected results will be requested. The data review narrative will detail any such instances and the resultant resolution. The reviewer will collate the revised data into the data package and mark the revised and superseded data accordingly.

In some cases, multiple analyses for the same sample may be reported. The multiple analyses may be due to high target analyte concentrations that necessitate dilutions, interferences, or QC failures (e.g. low surrogate recoveries). When there is more than one set of data reported for a sample, the reviewer will need to select the best set of data to report based on all of the supporting QC information. This may involve selecting results from each of the multiple analyses for a given sample. The data review narrative will detail the results selected for reporting and the supporting rationale. The data sheets will be marked to indicate which sample results were selected for reporting and which results were not.

2.2.8 Verification

The reviewer will verify that information reported on the summary forms was calculated properly and that the results are traceable back to the raw data. In addition, the reviewer may also verify that all spike solutions and standards were used within their recommended shelf lives.

If errors are found in the reported sample results, the laboratory will be contacted and corrected results will be requested. The data review narrative will detail any such instances and the resultant resolution. The reviewer will collate the revised data into the data package and mark revised and superseded data accordingly.

Tables

Table 4-1. Data Validation Qualifier Definitions

Qualifier	Definitions [1]
U	The analyte was analyzed for, but was not detected.
J	The analyte was positively identified; the associated numeric value is the approximate concentration of the analyte in the sample (i.e., estimated value).
UJ	The analyte was not detected. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
NJ	The analysis indicates the presence of an analyte that has been "tentatively identified" and the associate numerical value represents its approximate concentration.
F	The analysis meets all qualitative identification criteria, but the measured concentration is less than the reporting limit.
R	The data are unusable and have been rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.
E	The analyte was qualified as non-detect at the Estimated Maximum Possible Concentration (EMPC).

[1] Definitions cited were modified after the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, June 2008.

Table 4-2. Data Validation Qualifier Reason and Bias Direction Codes

Qualifier Code	Data Quality Condition Resulting in Assigned Qualification
General Use	
HT	Holding time requirement was not met
P	Preservation requirement(s) not met
MB	Method blank or preparation blank contamination
LCS	Laboratory control sample evaluation criteria not met
MS	Matrix spike and/or matrix spike duplicate accuracy evaluation criteria not met
D	Duplicate or spike duplicate precision evaluation criteria not met
TB	Trip Blank Contamination
FB	Field blank contamination
RB	Rinsate blank contamination
FD	Field duplicate evaluation criteria not met
TvP	Partial analysis results greater than total analysis results; difference is greater than accuracy limitations of the method
ID	Target compound identification criteria not met
IS	Internal standard evaluation criteria not met
CO	Suspected carry-over from previously analyzed sample(s).
SQL	Reported sample concentration is between the method detection limit and the sample quantitation limit.
RL	Reporting limit exceeds decision criterion (for non-detects)
LR	Over linear range of calibration without re-analysis
TUNE	Instrument performance (tuning) criteria not met
ICAL	Initial calibration evaluation criteria not met
Inorganic Methods	
ICV	Initial calibration verification evaluation criteria not met
CCV	Continuing calibration verification evaluation criteria not met
CCB	Continuing calibration blank contamination
ICS	Interference Check Sample evaluation criteria not met
PDS	Post-digestion spike recovery outside acceptance range
MSA	Method of standard additions correlation coefficient < 0.995
DL	Serial dilution results did not met evaluation criteria

Table 4-2. Data Validation Qualifier Reason and Bias Direction Codes (continued)

Qualifier Code	Data Quality Condition Resulting in Assigned Qualification
Organic Methods	
CCAL	Continuing calibration evaluation criteria not met
SUR	Surrogate recovery outside acceptance range
Bias Codes	**Bias Direction**
H	Bias in sample result likely to be high
L	Bias in sample result likely to be low
I	Bias in sample result is indeterminate

This Standard Operating Procedure (SOP) provides technical guidance and methods used to manage environmental data collected during the course of site investigations. The data management program is generally compliant with the Air Force Civil Engineer Center (AFCEC) Environmental Resources Program Information Management System (ERPIMS) Data Loading Handbook (AFCEC 2013). However, the data management program expands and enhances the system required under ERPIMS. This plan serves to supplement task-specific work plans and field sampling plans and is intended to be used in conjunction with these documents.

1.0 RESPONSIBILITIES AND QUALIFICATIONS

Data management will be performed by personnel knowledgeable and experienced in environmental data management for similar projects, or personnel who will work under the direct supervision of knowledgeable and experienced personnel.

1.1 DATA MANAGER

The data manager will have a bachelor's degree in information management or equivalent experience and will be familiar with the operation and requirements of the data management program. The data manager has overall responsibility for implementation of this data management plan. Specific responsibilities include:

- Implementation of the data management program
- Design and installation of the database environmental data management system
- Oversee loading of data into the database
- Ensure the integrity of the data in the database
- Oversee production of output from the database to meet project requirements
- Oversee production of AFCEE deliverables required under ERPIMS

1.1.1 Other Data Management Personnel

The project manager has overall responsibility for the data management program and for providing construction and location information for all sampling locations to the data manager as soon as they become available.

The Project Chemist is responsible for coordinating with the laboratory regarding the required Electronic Data Deliverable (EDD) format and for all direct communications with the laboratory regarding data management issues. The Project Chemist is also responsible for providing a copy of the data validation report for all new data to the Data Manager and for checking data validation information entered by the Data Manager to ensure its accuracy. Finally, the Project Chemist is responsible for selecting the analytical results in the database that are considered useable for their intended purpose.

The Field Team Leader is responsible for ensuring that field sampling teams follow the sample numbering scheme and for providing the Data Manager with legible copies of all field records for data entry and quality assurance purposes.

Laboratory personnel are responsible for providing the Data Manager with the official hard copy laboratory report, with the appropriate electronic data in the prescribed format, and for ensuring that the electronic and hard copy reports match.

2.0 DESCRIPTION OF DATA MANAGEMENT COMPONENTS

The data management program facilitates effective management of investigation data. The program provides for efficient upload of field parameters and laboratory analytical data, quality assurance, routine data analysis, and reporting. Many of the routine tasks involved in data management are automated under this program. The details of data management activities are described below.

The environmental data management system was designed to facilitate implementation of the data management program. This system consists of a backend relational database and a customized Database Management System (DBMS) developed specifically for environmental data management. The database is generally compliant with ERPIMS but includes a number of enhancements to the database structure specified under ERPIMS. The DBMS provides the basic user interface to the database. The design master database is maintained on a server, which may be accessed by users at various workstations using the DBMS. Activities that may be performed by each individual granted access to the database depends on the rights (i.e., read only, read/write, administrator) granted to that user at login. The data manager is responsible for adding users to the system on an as-needed basis and for assigning access rights to all users. Normally, only the data managers as directed by the project manager will be assigned administrator rights. This includes full read/write access to the database via the DBMS and the ability to add and delete users from the system. Personnel with responsibility for uploading laboratory data and entering field data into the database are assigned read/write access. All others, including managers and staff with the need to access the database, are assigned read-only rights. The data manager is also responsible for providing access to the database directly to perform specialized operations that may not be available from the DBMS. Users to be granted direct access are selected by the data manager on a case-by-case basis as directed by the project manager. Copies of the design master database may be distributed periodically to the project team at remote locations as directed by the project manager.

2.1 LABORATORY ELECTRONIC DATA DELIVERABLE

In addition to the hard-copy analytical data package, the laboratory prepares an EDD containing all field sample and quality assurance analytical results for each sample delivery group. The EDD format is specified in each laboratory bid package and will be produced by the laboratory as shown on Table 2-1. The Primary (unique) Keys for the EDD include the FLDSAMPID, LABSAMPID, LOGDATE, EXMCODE, RUN_NUMBER, MATRIX, SACODE, SAMPNO, LABCODE, ANMCODE, and PARLABEL fields. EDDs are output directly by the Laboratory Information Management System (LIMS) with additional electronic processing as necessary to

produce the format shown on Table 2-1. Each EDD is provided to the data manager as a Microsoft Access database with the laboratory's sample delivery group as the file name. This database contains one table called "Lab Results" which contains the EDD for that sample delivery group. Lookup tables containing Valid Values Lists for any non-ERPIMS fields are provided to the laboratory prior to the beginning of each task. Lookup tables for ERPIMS fields may be requested from the ERPIMS helpdesk.

The laboratory will put into place procedures to ensure compliance with the format requirements and the associated valid values lists.

It is the responsibility of the laboratory to ensure that the EDD matches the official hard copy laboratory report. The EDD may be transferred from the laboratory to the data manager via e-mail attachment. Alternatively, the laboratory may set up a secure FTP site for posting and download of project EDDs.

2.2 DATABASE STRUCTURE

Tables 2-2 through 2-12 list the structure, data types, and field descriptions for the primary tables of the database. Additionally, Table 2-13 provides the list of tables where the valid values are located in the database.

2.2.1 Sampling Location Identification

Each sampling location for which data are included in the database is described in the LDI table (Table 2 2). This table includes available information that is unique to that sampling location such as location name, elevation and horizontal coordinates, and total depth, and is the parent of all other primary data tables in the database. The LOCID is comprised of the Installation Restoration Program (IRP) Site Number and the monitoring well or location identification number. Each LOCID may be associated with one or more sites identified in the SLX table (Table 2-3). The SLX table is used to establish the spatial and hydrologic relationships between individual sampling locations and contaminant sites at the installation. For new sites, the project manager is responsible for providing the information required to update the LDI and SLX tables to the data manager. The ERPIMS help desk will be contacted as new sampling locations and sites are established.

2.2.2 Other Sampling Location Data

The LTD table includes lithologic descriptions and classifications of cuttings and cores from boreholes. The WCI table (Table 2-5) holds general monitoring well completion information such as well type and development procedures (AFCEE 2013). The LOCID field is the primary key for the WCI table. The WINT table (Table 2-6) contains well construction interval data, such as depths at which well components (casing, screen, filter pack, etc.) begin and end. Finally, the WMI table (Table 2-7) contains any information related to well maintenance events, especially activities that change the measuring point or ground surface elevation (AFCEE 2013). Referential integrity is maintained between LDI and its child tables LTD and WCI based on the LOCID field. WCI is the parent of WINT and WMI, and this relationship is also based on the LOCID field. Maintenance of referential integrity means, in this case, that each record in the

LTD and WCI tables must have a related record in the LDI table. Further, each record in both WINT and WMI must have a related record in WCI. Cascading updates of related records in the location tables will occur automatically. For example, if the LOCID for a sample location in the LDI table was modified, then the related field in all child tables for that sample location would be automatically updated.

2.2.3 Water Depth

The GWD table (Table 2-8) is used to store data related to groundwater depth measurements. Each record in this table represents one groundwater depth measurement and is identified uniquely by the LOCID and the LOGDATE of measurement. Because it is possible for the measurement point elevation (MPELEV) at a particular well to change over time, this value is extracted from the WCI table at the time of data entry and included in the GWD table along with the measurement. The parent of GWD is the WCI. It is the responsibility of the field sample manager to provide appropriate water-level measurement records to the data manager and to ensure that these records are accurate. The data manager is responsible for ensuring that water-level measurements are accurately entered into the database.

2.2.4 Samples, Tests, and Results

All field sample data (including field screening parameter data) are contained in three related tables. Sample-specific data such as sample location, sample date, and sample matrix type, are included in the SAMPLES table (Table 2-9). Data that are pertinent to sample preparation and handling such as analytical method, analysis date, and laboratory sample identification is contained in the TESTS table (Table 2-10). Finally, data that are unique to each analytical result such as analyte label, CAS Number, and concentration are included in the RESULTS table (Table 2-11).

The parent of SAMPLES is the LDI table. Referential integrity between the three chemistry tables will be maintained based on one-to-many relationships between the SAMPLES and TESTS tables and between the TESTS and RESULTS tables. In addition to cascading updates, cascading deletes of related records in the chemistry tables will occur automatically. For example, if a record that defines a particular sample in the SAMPLES table is deleted, all related records in the TESTS and RESULTS tables will also be deleted.

It is the responsibility of the field sample manager to provide copies of all completed chain-of-custody forms and field sampling records to the data manager and to ensure the accuracy of these forms. Chain-of-custody forms are used to verify receipt and completeness of laboratory EDDs. Field sampling sheets are used to enter sample data not included in the EDD such as site identification, sample matrix, and type of sample (original, field duplicate, etc.).

In addition to reporting the analytical results from the field samples, laboratory EDDs will include results of all required laboratory QA/QC analyses. These data will be uploaded into the LAB_QC table (Table 2 12.

2.2.5 Valid Values

In addition to the primary tables described above, a variety of lookup tables are employed in the database to provide lists of valid values for the fields in the primary tables. The lookup tables are listed in Table 2-13. These tables reduce data entry time and provide a measure of quality assurance by limiting the choices for data entry and upload to valid values. Further, referential integrity with cascading updates is maintained between the lookup tables and associated primary tables so that changes to valid values in the lookup tables are updated in all related records in the primary tables.

2.3 DATABASE MANAGEMENT SYSTEM

The DBMS is a application, which provides the interface between the user and the database. The DBMS is completely self-contained, and therefore, it is not necessary to have Microsoft Access or any other application installed on the workstation in order to execute. Once the initial setup is performed and the application has been run for the first time, the connection to the database is automatic, requiring no user intervention.

The DBMS performs three primary functions. These include:

- Data Input
- Analysis
- Reporting

The core components of these functions are described briefly here. Additional modules may be added in the future depending on specific project needs.

2.3.1 Data Input

The data input module of the DBMS includes tools for importing a laboratory EDD, templates for entering sampling location details (such as coordinates and location type), and field parameters (pH, specific conductivity, etc.), and templates for entering groundwater depth values.

2.3.1.1 Laboratory Data Import

The laboratory EDD is initially uploaded into a template table for review and quality checks. During import, the DBMS checks to ensure that the required table is present in the EDD and that the structure of this table is in accordance with Table 2-1. Additionally, the DBMS performs a series of integrity checks on the EDD to ensure that key violations will not occur when the flat file structure of the EDD is converted to the relational structure of the database. If errors are noted during this process, the DBMS provides the option of viewing the problem records, but the required changes must be made to the EDD outside of the DBMS environment prior to importing to the database. This would normally be accomplished by requiring the laboratory to submit a revised EDD.

After the initial import is completed, the user is required to execute an option which checks all numeric values in the EDD to ensure that they fall within an acceptable site-wide range. Further,

this procedure checks all fields for which valid values are required in the EDD against the appropriate lookup tables. If a value is encountered in the EDD that is not valid, a message is displayed asking the user to select a new value from a dropdown list of the lookup table contents, to delete that record from the template, or to continue with the import. Normally, the first or third option would be chosen to either modify the syntax of the value or to log the error and continue. If the third option is chosen, the DMBS will not allow the EDD to be appended to the database because referential integrity would be violated. A log of errors encountered during import and any changes made to the EDD are saved to the data directory in the form of a text file. The project manager and project chemist will be provided copies of all import logs for the purpose of resolving errors encountered during import and preventing future syntax errors recorded by field staff on chain-of-custody forms.

Once the EDD has been successfully imported and checked the user must review the EDD for quality assurance purposes prior to appending to the permanent chemistry tables. This may be performed either on-line using a spreadsheet-like grid provided by the DBMS, or the grid can be printed so that a check can be performed on paper. This review consists of a 10% check of all fields in the database against the official hard copy laboratory report. If errors are encountered, then 100% of the records for that sample delivery group will be checked. After quality checks have been completed, and any errors are corrected and checked, the EDD will be uploaded to the permanent chemistry database tables.

The original EDD for each delivery group will be archived on the server and backed up according to URS file management policies and procedures.

2.3.1.2 Manual Data Input

Groundwater depth data and field parameters are normally input manually from field records using data entry templates provided in the DBMS. The user is given the opportunity to specify default entries for text (such as sampling event code) and date fields to minimize data entry errors and to limit repetitive data entry tasks. Other non-repetitive text fields may be selected from dropdown lists of valid values. Further, the DBMS checks each numeric value against a predetermined valid site-wide range for a given parameter.

After data are entered into the appropriate template, the user performs quality checks of the data using the on-line grid provided in the DBMS which can optionally be printed out for paper comparison. One hundred percent of the data entry is checked against the appropriate field records. After quality checks are performed and any corrections are made and checked, data are appended to the appropriate data tables.

2.3.1.3 Data Validation Entry

This section describes procedures for adding data validation qualifiers to the database that have been assigned as part of the validation process.

Once laboratory EDDs have been uploaded to the database and data validation has been completed, the data manager updates the database based on the Data Validation Report provided by the project chemist. The QAPPFLAGS field in the RESULTS table is designated specifically for data validation. The DBMS provides a Data Validation Query to facilitate manual entry of

data validation codes. For sample analytes that are assigned an "R" or rejected validation code in the QAPPFLAGS field, the USEABLE field for that same record will be assigned a value of false.

After validation data entry is complete, the project chemist is responsible for ensuring that assigned validation codes in the database are in accordance with the Data Validation Report. To facilitate this process, the data validation query will be printed and 100% of the entered codes will be quality checked against the Data Validation Report.

Changes to the reported laboratory results (reporting limits, concentrations, etc.) may be required as a result of data validation activities. For example, laboratory reporting limits may be increased and a detected value changed to non-detect during data validation for some results that do not meet specific quality assurance guidelines. In these cases, changes to the database are performed in accordance with the data validation report during data validation entry. After any required changes are completed, 100% of the changes are quality checked.

After data validation entry for a given sample delivery group is completed in accordance with the data validation report as described above, the project chemist will set the USEABLE field in the RESULTS table to "true" for one result per sample and analyte unless all results for a given sample and analyte were rejected during data validation. Finally, the IS_FINAL field in the RESULTS table is set to True for each record in the group. This is performed to indicate that the results contained in the record are final and may be used for their intended purpose, subject to restrictions based on any assigned data validation codes. The DBMS provides a tool that allows the user to perform global updates of the IS_FINAL field for samples selected by the user. Changes made to the database subsequent to this point must be performed and documented in accordance with Section 3.1.

2.3.2 Analysis

The Analysis module of the DBMS provides a variety of pre-defined data queries, tools for performing ad-hoc database queries, tools for exporting tables for ERPIMS submittal, a Geographic Information System (GIS) spatial querying tool, time-series graphics, and basic statistical analyses including sampling event statistics, temporal statistics, and comparisons between sampling events. Other specialized data analyses statistics can be automated based on specific task needs. The results of all of the analysis options may be printed directly from the DBMS for inclusion in reports. At a minimum, analysis reports that form the basis of calculations included in report text or tables will be printed and included in the project file.

2.3.3 Reporting

A variety of customized tabular and/or cross-tabulated data reports may be produced from the DBMS for inclusion in investigation documents. These reports may be printed directly from the DBMS or, in some cases, can be exported to other formats including Adobe Acrobat, Microsoft Word, Microsoft Excel, comma delimited text, etc., if desired. To produce a report, the user is prompted to select a date range and/or sampling event that will indicate the time period of the report. In some cases, the user will also be prompted to provide information to be included in the report title. All reports may be reviewed on-line before printing. The Reports module also

includes an integrated tool for quickly generating time-series graphs. The original data report for all reports included in investigation submittals are maintained in the project file.

3.0 GENERAL PROCEDURES

3.1 DATABASE CHANGES

Infrequently, changes may be required to the database after data from field records are entered and checked or after the IS_FINAL field in the RESULTS table is set to True. Changes of this nature are only performed under the direct supervision of the data manager and should be kept to an absolute minimum. When a change of this nature is required, all assigned DBMS users will be notified. It is the responsibility of the data manager to ensure that the appropriate notifications in accordance with this section are made. Assigned users are responsible for notifying individuals for whom they have provided database output of any such changes to the database.

The database structure may require changes to facilitate data management operations for this project. These changes to the underlining structure will be made to minimize impact to the DBMS user, and will be communicated to all affected parties as appropriate.

3.2 DATABASE DISTRIBUTION

Ideally, only one copy of the database would be maintained on a central server, and all users would access the same database via client network connections using the DBMS. Practically, because users may need to query the database from locations where access to the database server is limited, it will be necessary to distribute copies of the database to specific users. As a quality assurance measure, the number of copies of the database that are distributed is kept to a minimum, and a strict inventory of those copies distributed is maintained by the data manager. Further, updates to the database are only authorized for the design master database installation.

Periodically, copies of the database will be exported and distributed to the appropriate users who will be responsible for replacing their existing copy of the database with the newer version. Distribution of database copies will normally be performed when significant updates to the database are completed.

The data manager will be responsible for distributing updated databases to the appropriate users. Individual users are responsible for replacing their copies of the database with the appropriate updates provided by the data manager.

In addition to full database copies, subsets of the database may be transmitted by the data manager to the appropriate investigation team members on an as-needed basis in a variety of formats including Microsoft Access, Excel, Word, etc.

4.0 REFERENCES

AFCEC. 2013. Environmental Resources Program Information Management System (ERPIMS) 2013 Data Loading Handbook, Version 6. July 2013.

Tables

Table 2-1. Laboratory EDD Table Structure

Field Name	Data Type	Description
FLDSAMPID*	Text	Field Sample Identification (See section 3.3).
LABSAMPID*	Text	Laboratory Sample Identification.
LOGDATE*	Date/Time	Date and time of sample collection
REC_DATE	Date/Time	Date and time that sample was received by laboratory.
EXTDATE	Date/Time	Date and time of laboratory sample extraction for this FLDSAMPID, ANMCODE, PARLABEL, and RUN_NUMBER.
ANADATE	Date/Time	Date and time that this FLDSAMPID, ANMCODE, PARLABEL, and RUN_NUMBER was analyzed by the laboratory.
ANMCODE*	Text	Analytical Method (from valid values list).
SAMP_FRACTION	Text	Fraction of sample analyzed (T – Total, D – Dissolved) (from valid values list).
EXMCODE*	Text	Code from method used to prepare or extract a sample; from valid values list.
PARLABEL*	Text	Parameter Label (from valid values list).
RUN_NUMBER*	Number	Numerical code applied to repeat analyses of the same sample using the same method on the same day.
MATRIX*	Text	Sample matrix type; from valid values list.
PARVAL	Number	Concentration of the PARLABEL expressed in UNITS. PARVAL = 0 if PARVQ = "ND"
PRECISION	Number	Number indicating the precision (number of digits after the decimal point) that applies to the reported PARVAL, MDL, and RL fields.
RL[1]	Number	Concentration of Reporting Limit (also known as quantitation limit) in UNITS.
MDL	Number	The concentration of Method Detection Limit in UNITS.
UNITS	Text	Concentration units used in PARVAL, RL and MDL (from valid values list).
DILUTION	Number	Laboratory dilution factor for PARVAL, RL, and MDL (1 - No dilution).
LAB_QC_FLAG	Text	Used by the laboratory to indicate samples that may be affected by laboratory QA/QC issues. At a minimum, the laboratory will use this field to enter a unique flag to indicate that the associated value reported is below the RL concentration.
LABLOTCTL	Text	Batch designator for a group of environmental samples and their associated QC samples prepared together.
BASIS	Text	Basis for reporting solid sample results (e.g. "wet" or "dry"); from valid values list.
PRCCODE	Text	Analytical suite classification; from valid values list.
PARVQ	Text	ERPIMS data qualifier for result (not laboratory or data validator qualifier); from valid values list.
EXPECTED	Number	Target result for field duplicates, ambient blanks, equipment blanks, and trip blanks.

Table 2-1. Laboratory EDD Table Structure (continued)

Field Name	Data Type	Description
SACODE*	Text	Sample type (e.g. normal environmental or QA/QC); from valid values list.
ANALOT	Text	Batch designator for a group of environmental samples and their associated QC samples analyzed together.
SAMPNO*	Text	Sequential sample number assigned to sample of a given type collected at the same location on the same day.
LABCODE*	Text	Code for analytical laboratory performing analyses; from valid values list.
REC_DATE	Date/Time	Date the sample was received at the lab
SAMPNO	Number	Numerical identifier for the samples taken
SDG	Text	Lab created code to identify a group or selection of samples
LAB_DQT	Text	Data qualifier type, coded value indicating the specific QAPP or DQO document which the entered performance criteria data originates
PERCENT_RECOVERY	Number	Calculated recovery for the spiked and surrogate analyte.
RPD	Number	Measure of variability the adjust for the magnitude of observations. This is used to assess total analytical precision of duplicate measurements
UPPER_RPD	Number	Upper Relative Percent Difference
UPPER_ACCURACY	Number	Upper control limit of percent recovery as measured for a known target analyte spiked into a QC sample
LOWER_ACCURACY	Number	Lower control limit of a percent recovery as measured for a known target analyte spiked into a QC sample
SPIKE_ADDED	Number	Final concentration of an analyte spiked into a sample
SDG	Number	Analyzed lot is the batch designator of a group of environmental samples and associated QC samples analyzed together
LAB_DQT	Number	Numerical identifier for the samples taken
PERCENT_RECOVERY	Number	Lab created code to identify a group or selection of samples
RPD	Number	Data qualifier type, coded value indicating the specific QAPP or DQO document which the entered performance criteria data originates

* Primary Key Field

[1] The Reporting Limit (RL) for a given analyte is the smallest concentration that can be reported with a specific degree of confidence (approximately +/- 25%).

Table 2-2. LDI Table Structure

Field Name	Data Type	Description
ID	Number	Auto ID generated by the database
LOCID*	Text	Sampling location name.
AFIID	Text	Air Force Installation identification.
LTCCODE	Text	Location type; from valid values list.
LPRCODE	Text	Location proximity code; indicates whether sampling location is within or outside of installation boundaries; from valid values list.
NCOORD	Number	Northing coordinate of LOCID location.
ECOORD	Number	Easting coordinate of LOCID location.
CRDTYPE	Text	Type of coordinate system used from surveying location; from valid values list.
CRDMETH	Text	Survey method; from valid values list.
CRDUNITS	Text	Units of measure for the surveyed northing (NCOORD) and easting (ECOORD) coordinates; from valid values list.
ESTDATE	Date/Time	Date that sampling/testing location was established; for monitor wells, assumed to be installation date.
ESCCODE	Text	Code for company that established sampling location.
DRLCODE	Text	Drilling company code; from valid values list; use “NA” if not applicable (i.e., not a borehole/well).
CMCCODE	Text	Construction method code identifying how a borehole was constructed; from valid values list.
ELEV	Number	Ground surface elevation (soil, groundwater, sediment locations) or water surface (surface water locations).
ELEVMETH	Text	Elevation measuring method; from valid values list.
ELEVUNITS	Text	Elevation units; from valid values list
DEPTH	Number	Borehole depth (feet below ground surface); includes boreholes drilled to install monitoring wells.
BHDIAM	Number	Borehole diameter (inches).
DATUM	Text	Vertical survey datum.
LOCDESC	Text	Brief text describing the sample location.
SRVY_SRC	Text	Survey contractor used for horizontal coordinates.
Comments	Text	Additional textual information necessary to understand characteristics of data being described.

* Primary Key Field

Table 2-3. SLX Table Structure

Field Name	Data Type	Description
SITEID*	Text	Site Identification Number; must be obtained from ERPIMS Help Desk.
LDI_ID*	Text	Auto number relationship to LDI table
GFCCODE	Text	Geohydrologic flow classification code describing the hydraulic relationship between a sampling location and SITEID; from valid values list.
SPCODE	Text	Site proximity code indicating the sampling location relative to a site; from valid values list.

* Primary Key Field

Table 2-4. LTD Table Structure

Field Name	Data Type	Description
LDI_ID*	Text	Auto number relationship to LDI table
BEGDEPTH*	Number	Upper depth of a lithologic section (feet below ground surface).
ENDDEPTH*	Number	Lower depth of a lithologic section (feet below ground surface).
LOGDATE	Date/Time	Date that lithologic sample was collected.
LOGCODE	Text	Code indicating company that logged the borehole.
LITHCODE	Text	Code indicating lithologic description of sample interval; from valid values list.
ASTMCODE	Text	Code indicating the ASTM soil classification of the sample interval; from valid values list.
VISDESC	Text	Textural and mineralogical description of material in sample interval.

* Primary Key Field

Table 2-5. WCI Table Structure

Field Name	Data Type	Description
LDI_ID*	Text	Auto number relationship to LDI table
INSDATE	Date/Time	Well installation date.
WELCODE	Text	Well owner code; from valid values list.
WTCCODE	Text	Well type classification code; from valid values list.
WCMCODE	Text	Code value identifying the method used to complete the well or the screen type; from valid values list.
GZCCODE	Text	Hydrogeologic completion zone.
SAQCODE	Text	Code value identifying the sole source aquifer in which the well is completed; from valid values list.
WDPROC	Text	Well development procedure; from valid values list.
MPELEV	Number	Measuring point elevation for water-level measurements (feet above Mean Sea Level).
MPFLAG	Text	"Y" indicates the measuring point elevation was modified; See WMI table.
TOTDEPTH	Number	Total well depth (feet below ground surface); includes well casing, screen, well foot.
REMARKS	Text	Text providing any additional information regarding well construction.
MP_ELEV_SOURCE	Text	Company that surveyed MPELEV.
WCZONE	Text	Well completion zone; ("S"=shallow, "M"=intermediate, "D"=deep).

* Primary Key Field

Table 2-6. WINT Table Structure

Field Name	Data Type	Description
WCI_ID*	Text	Auto number relationship to WCI table.
IBDEPTH*	Number	Well interval beginning depth (e.g., top of screen interval, etc.); relative to ground surface.
IEDEPTH*	Number	Well interval ending depth (e.g., bottom of screen interval, etc.); relative to ground surface.
CLASS*	Text	Classification of well interval (e.g., screen, seal, filter pack, etc.); from valid values list.
SCRNO	Number	Number assigned to all components of a specific screened interval; screened intervals are numbered sequentially with SCRNO =1 being the most shallow screen interval.
MATERIAL	Text	Code for material used for constructing a particular well interval (e.g., PVC, bentonite, concrete, etc.); from valid values list.
SDIAM	Number	Inside diameter of well interval being described (inches).
SOUA	Number	Screen slot size in inches.
PCTOPEN	Number	Percent of screened interval this is open for water flow.
REMARKS	Text	Additional textual information necessary to understand characteristics of well interval being described.
WCZONE	Text	Well completion zone; (“S”=shallow, “M”=intermediate, “D”=deep).

* Primary Key Field

Table 2-7. WMI Table Structure

Field Name	Data Type	Description
LDI_ID*	Text	Auto number relationship to LDI table.
LOGDATE*	Date/Time	Date of well maintenance activity.
MAINT_TYPE	Text	Type of maintenance performed on well; from valid values list.
MPELEV	Number	Elevation of monitoring point used for groundwater level measurements; feet above Mean Seal Level.
ELEV	Number	Ground surface elevation at monitoring well.
ELEVDATUM	Text	Datum used for elevation measurements.
REMARKS	Text	Comments regarding well maintenance activities.

*Primary Key Field

Table 2-8. GWD Table Structure

Field Name	Data Type	Description
WCI_ID*	Text	Auto number relationship to WCI table.
LOGDATE*	Date/Time	Date that lithologic sample was collected.
LOGCODE	Text	Code indicating company that measured the water level; from valid values list.
STATDeP	Number	Depth to static water level; value expressed in feet below measuring point.
SOUNDING	Number	Depth to bottom of well as measured at the time of water level measurement; value expressed in feet below measuring point
FTCODE	Text	Code representing type of liquid encountered in well (e.g., water, DNAPL, LNAPL); from valid values list.
MEASMETH	Text	Water-level measurement method; from valid values list.
DRY	Text	Flag indicating if well is dry; valid entries or “D” (dry) or “W” (wet).
REMARKS	Text	Brief text describing groundwater measurement; as needed.
EVENTCODE_ID	Text	ID of the sampling event during which the sample was collected.
MPELEV	Number	Measuring point elevation for water-level measurements (feet above Mean Sea Level).

* Primary Key Field

Table 2-9. SAMPLES Table Structure

Field Name	Data Type	Description
ID	Number	Auto number for the Samples table generated by the database
LDI_ID*	Number	Auto number relationship to LDI table.
LOGDATE*	Date/Time	Date and time that sample was collected or field measurement was made (LOGDATE/LOGTIME).
MATRIX	Text	Sample matrix type; from valid values list.
SBD	Number	Depth to top of sample interval (feet below ground surface for soil samples); enter zero for groundwater samples.
SED	Number	Depth to bottom of sample interval (feet below ground surface for soil samples); enter zero for groundwater samples.
SACODE*	Text	Sample type (e.g., normal environment or QA/QC); from valid values list.
SACODE_Base*	Text	Sample type of the parent sample.
SAMPNO*	Text	Sequential sample number assigned to sample of a given type collected at the same location on the same day.
SAMP_FRACTION*	Text	Indicates “T” total or “D” dissolved sample.
LOGCODE	Text	Code for company collecting samples or performing field test; from valid values list.
SMCODE	Text	Sampling method used to collect sample; from valid values list.
FLDSAMPID	Text	Field sample identification.
COOLER	Text	Number assigned to cooler containing VOC fraction of sample; will always be cooler No. 1 of a shipment.
ABLOT	Text	Ambient blank field lot identification; applies to environmental samples associated with ambient blanks; does not apply to blanks themselves.
EBLOT	Text	Equipment blank field lot identification; applies to environmental samples associated with equipment blanks; does not apply to blanks themselves.
TBLOT	Text	Trip blank field lot identification; applies to environmental samples associated with ambient blanks; does not apply to blanks themselves.
EVENTCODE_ID	Text	ID of the sampling event during which the sample was collected.
REMARKS	Text	Text comments or descriptions about the sample.

* Primary Key Field

Table 2-10. TESTS Table Structure

Field Name	Data Type	Description
ID	Number	Auto number ID for the Tests table generated by the database.
Samples_ID*	Number	Auto number relationship to Samples table.
LABCODE	Text	Code for analytical laboratory performing the analyses; from valid values list.
ANMCODE*	Text	Method used from sampling analysis; from valid values list.
EXMCODE	Text	Code from method used to prepare or extract a sample; from valid values list.
RUN_NUMBER*	Number	Numerical code applied to repeat analyses of the same sample using the same method on the same day.
LABSAMPID	Text	Laboratory sample identification; space character entered for field tests.
REC_DATE	Date/Time	Date the sample was received at the lab.
EXTDATE	Date/Time	Date and time the laboratory extracted the sample for analysis (equivalent to ERPIMS “EXTDATE” and “EXTTIME” fields).
SDG	Text	Lab created code to identify a group or selection of samples
ANADATE	Date/Time	Date and time the laboratory analyzed the sample (equivalent to ERPIMS “ANADATE” and “ANATIME” fields).
LABLOTCTL	Text	Batch designator for a group of environmental samples and their associated QC samples.
BASIS	Text	Basis for reporting solid sample results (e.g., “wet” or “dry”); from valid values list.

* Primary Key Field

Table 2-11. RESULTS Table Structure

Field Name	Data Type	Description
ID	Text	Field sample identification.
Test_ID	Text	Sample type (e.g., normal environment or QA/QC); from valid values list.
PARLABEL*	Text	Parameter (analyte) name; from valid values list.
PRCCODE	Text	Analytical suite classification; from valid values list.
PARVAL	Number	Concentration of parameter expressed in units specified in UNITS field.
PARVQ	Text	ERPIMS data qualifier for result (not laboratory or data validator qualifier); from valid values list.
PRECISION	Number	Number indicating the precision (number of digits after the decimal point) that applies to the reported PARVAL, MDL, and RL fields.
EXPECTED	Number	Target result for field duplicates, ambient blanks, equipment blanks, and trip blanks.
MDL	Number	Method detection limit; represents smallest quantity of analyte that can be detected for a particular method.
RL	Number	Reporting limit as specified in project Quality Assurance Project Plan (QAPP).
UNITS	Text	Concentration units used for PARVAL, MDL, and RL fields; from valid values list.
DILUTION	Number	Laboratory dilution factor for result in PARVAL, MDL, and RL fields (1- no dilution).
Prime_DQT	Text	Data qualifier type, coded value indicating the specific QAPP or DQO document which the entered performance criteria data originates
EPA_FLAGS	Text	Data validation qualifier.
PRIME_FLAG	xxxText	Coded value applied to PARVAL according to QAPP requirements.
REASON_CODE	xxxText	Coded value explaining reason(s) for QAPPFLAGS assignment.
Lab_QC_flag	Text	Qualifier assigned by the analytical laboratory.
USEABLE	Yes/No	Boolean flag indicating whether an individual result is the most appropriate for this FLDSAMPID, ANMCODE, PARLEVEL, AND RUN_NUMBER.
IS_FINAL	Yes/No	YES indicates result is suitable for its intended use, subject to data qualifiers.
LAB_DQT	Text	Data qualifier type, coded value indicating the specific QAPP or DQO document which the entered performance criteria data originates
PERCENT_RECOVERY	Number	Calculated recovery for the spiked and surrogate analyte.

Table 2-11. RESULTS Table Structure (continued)

Field Name	Data Type	Description
RPD	Number	Measure of variability to adjust for the magnitude of observations. This is used to assess total analytical precision of duplicate measurements
UPPER_RPD	Number	Upper Relative Percent Difference
UPPER_ACCURACY	Number	Upper control limit of percent recovery as measured for a known target analyte spiked into a QC sample
LOWER_ACCURACY	Number	Lower control limit of a percent recovery as measured for a known target analyte spiked into a QC sample
SPIKE_ADDED	Number	Final concentration of an analyte spiked into a sample
LOD	Number	Level of detection

* Primary Key Field

Table 2-12. LAB_QC Table Structure

Field Name	Data Type	Description
LABSAMPID*	Text	Laboratory sample identification.
SACODE	Text	Sample type (e.g., normal environment or QA/QC); from valid values list.
ANMCODE*	Text	Method used from sampling analysis; from valid values list.
RUN_NUMBER*	Number	Numerical code applied to repeat analyses of the same sample using the same method on the same day.
MATRIX	Text	Sample matrix type; from valid values list.
EXTDATE	Date/Time	Date and time the laboratory extracted the sample for analysis (equivalent to ERPIMS "EXTDATE" and "EXTTIME" fields).
ANADATE	Date/Time	Date and time the laboratory analyzed the sample (equivalent to ERPIMS "ANADATE" and "ANATIME" fields).
REMARKS	Text	Text comments or descriptions about the sample.
LABCODE	Text	Code for analytical laboratory performing the analyses; from valid values list.
EXMCODE	Text	Code from method used to prepare or extract a sample; from valid values list.
LABLOTCTL*	Text	Batch designator for a group of environmental samples and their associated QC samples.
BASIS	Text	Basis for reporting solid sample results (e.g., "wet" or "dry"); from valid values list.
PARLABEL*	Text	Parameter (analyte) name; from valid values list.
PRCCODE	Text	Analytical suite classification; from valid values list.
PARVAL	Number	Concentration of parameter expressed in units specified in UNITS field.
PARVQ	Text	ERPMIS data qualifier for result (not laboratory or data validator qualifier); from valid values list.
PRECISION	Number	Number indicating the precision (number of digits after the decimal point) that applies to the reported PARVAL, MDL, and RL fields.
EXPECTED	Number	Target result for field duplicates, ambient blanks, equipment blanks, and trip blanks.
MDL	Number	Method detection limit; represents smallest quantity of analyte that can be detected for a particular method.
RL	Number	Reporting limit as specified in project Quality Assurance Project Plan (QAPP).
UNITS	Text	Concentration units used for PARVAL, MDL, and RL fields; from valid values list.
DILUTION	Number	Laboratory dilution factor for result in PARVAL field.

Table 2-12. LAB_QC Table Structure (continued)

Field Name	Data Type	Description
Lab_QC_flag	Text	Qualifier assigned by the analytical laboratory.
REC_DATE	Date/Time	Date the sample was received at the lab.
LOD	Number	Level of detection
RPD	Number	Measure of variability to adjust for the magnitude of observations. This is used to assess total analytical precision of duplicate measurements
REC_DATE	Date/Time	Date the sample was received at the lab
ANALOT	Text	Analyzed lot is the batch designator of a group of environmental samples and associated QC samples analyzed together
SAMPNO	Number	Numerical identifier for the samples taken
SDG	Text	Lab created code to identify a group or selection of samples
LAB_DQT	Text	Data qualifier type, coded value indicating the specific QAPP or DQO document which the entered performance criteria data originates
PERCENT_RECOVERY	Number	Calculated recovery for the spiked and surrogate analyte.
RPD	Number	Measure of variability the adjust for the magnitude of observations. This is used to assess total analytical precision of duplicate measurements
UPPER_RPD	Number	Upper Relative Percent Difference
UPPER_ACCURACY	Number	Upper control limit of percent recovery as measured for a known target analyte spiked into a QC sample
LOWER_ACCURACY	Number	Lower control limit of a percent recovery as measured for a known target analyte spiked into a QC sample
SPIKE_ADDED	Number	Final concentration of an analyte spiked into a sample

* Primary Key Field

Table 2-13. Lookup Table List

Lookup_AFIID
Lookup_ANATYPE
Lookup_ANMCODE
Lookup_ASTMCODE
Lookup_BASIS
Lookup_CALCMETHOD
Lookup_CALCPARCODE
Lookup_CLASS
Lookup_Class_Val
Lookup_CMCCODE
Lookup_CMP
Lookup_CRDMETH
Lookup_CRDTYPE
Lookup_DQTYPE
Lookup_DRLCODE
Lookup_DRY
Lookup_ELEVMETH
Lookup_ERPIMSTable
Lookup_ESCCODE
Lookup_EventCode
Lookup_EXCCODE
Lookup_EXMCODE
Lookup_EXT_AMC
Lookup_FIELDANMCODE
Lookup_FIELDDEFAULTS
Lookup_FIELDPARLABEL
Lookup_FIELDUNITS
Lookup_FTCODE
Lookup_GFCCODE
Lookup_GSISite
Lookup_GZCCODE
Lookup_HEADDIR
Lookup_LABCODE
Lookup_LITHCODE
Lookup_LOCDESC
Lookup_LOGCODE
Lookup_LPRCODE
Lookup_LTCCODE
Lookup_MAINT_TYPE
Lookup_MATERIAL
Lookup_MATRIX
Lookup_Matrix_Type
Lookup_MEASMETH
Lookup_PARLABEL
Lookup_PARVQ
Lookup_PRC_AMC
Lookup_PRCCODE
Lookup_QAPPFLAGS
Lookup_Reason_Code
Lookup_REMEDIALACTION
Lookup_SACODE
Lookup_SampFraction
Lookup_SAQCODE
Lookup_SCREEN_ZONE
Lookup_SITECODE
Lookup_SMCODE
Lookup_SPCODE
Lookup_TESTMETH
Lookup_UNITS
Lookup_WCMCODE
Lookup_WCZONE
Lookup_WDPROC
Lookup_WELCODE
Lookup_WTCCODE
Lookup_ZONE