

KIRTLAND AIR FORCE BASE ALBUQUERQUE, NEW MEXICO

Quality Assurance Project Plan

Bulk Fuels Facility Spill Solid Waste Management Units ST-106 and SS-111

August 2011



**377 MSG/CEANR
2050 Wyoming Blvd. SE
Kirtland AFB, New Mexico 87117-5270**

**KIRTLAND AIR FORCE BASE
ALBUQUERQUE, NEW MEXICO**

**QUALITY ASSURANCE PROJECT PLAN
BULK FUELS FACILITY SPILL
SOLID WASTE MANAGEMENT UNITS ST-106 and SS-111**

August 2011

Prepared for

U.S. Army Corps of Engineers
Albuquerque District
Albuquerque, New Mexico 87109

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QA/QC = Quality Assurance/Quality Control

QAPjP = BFF Spill Quality Assurance Project Plan

QC = Quality Control

USACE = U.S. Army Corps of Engineers

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PREFACE

This Quality Assurance Project Plan (QAPjP) has been prepared by Shaw Environmental & Infrastructure, Inc. (Shaw) under the U.S. Army Corps of Engineers (USACE), Huntsville Center, Contract No. W912DY-10-D-0014, Delivery Order No. 0002. This QAPjP was developed to support activities to be conducted in accordance with the Groundwater Investigation, Vadose Zone Investigation, Interim Measures, Light Non-Aqueous Phase Liquid Containment Interim Measure, and the Pre-Remedy Monitoring Work Plans for the remediation at the Bulk Fuels Facility (BFF) Spill, Solid Waste Management Units (SWMUs) ST-106 and SS-111, Kirtland Air Force Base (AFB), Albuquerque, New Mexico. The work plans were developed in response to April 2, June 4, and August 6, 2010 correspondence from the New Mexico Environment Department Hazardous Waste Bureau to the Air Force, requiring the Air Force to submit work plans to address soil and groundwater contamination at the BFF Spill site. The investigation activities will provide data necessary to supplement and optimize remedial efforts currently ongoing at the BFF.

This work was performed under the authority of the USACE, Contract No. W912DY-10-D-0014, Delivery Order No. 0002. All work was conducted from January 2011 through April 2011. Mr. Walter Migdal is the Project Manager for the USACE Albuquerque District. Mr. Wayne Bitner, Jr. is the Kirtland AFB Restoration Section Chief, and Mr. Tom Cooper is the Shaw Project Manager. This plan was prepared by Ms. Pam Moss, Ms. Susan Huang, and Mr. Craig Givens.



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ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
AFB	Air Force Base
APH	air-phase petroleum hydrocarbon
API	American Petroleum Institute
AST	aboveground storage tank
ASTM	ASTM International
AvGas	aviation gasoline
BFF	Bulk Fuels Facility
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
CO	carbon monoxide
CO ₂	carbon dioxide
COC	chain of custody
COPC	contaminant of potential concern
DoD	U.S. Department of Defense
DOT	U.S. Department of Transportation
DQA	data quality assessment
DQCR	daily quality control report
DQO	data quality objective
EDB	ethylene dibromide
EIMS	Environmental Information Management System
ELAP	Environmental Laboratory Accreditation Program
EPA	U.S. Environmental Protection Agency
EPH	extractable petroleum hydrocarbon
ERPIMS	Environmental Resources Program Information Management System
FFOR	Former Fuel Offloading Rack
ft	foot/feet
GIS	geographical information system
HC	hydrocarbon
HWB	Hazardous Waste Bureau (NMED)
ID	identification
IDW	investigation-derived waste
JP-4	Jet Propellant-4 fuel
JP-8	Jet Propellant-8 fuel

ACRONYMS AND ABBREVIATIONS (continued)

LAS	Log ASCII Standard
LCS	laboratory control sample
LCS D	laboratory control sample duplicate
LNAPL	light non-aqueous phase liquid
LOQ	limit of quantitation
MA DEP	Massachusetts Department of Environmental Protection
MCL	maximum contaminant level
MDL	method detection limit
mg/L	milligram(s) per liter
MNA	monitored natural attenuation
MS	matrix spike
MSD	matrix spike duplicate
NAPL	non-aqueous phase liquid
NCR	Nonconformance Report
NIST	National Institute of Standards and Technology
NMED	New Mexico Environment Department
NMWQCC	New Mexico Water Quality Control Commission
NOD	Notice of Deficiency
O ₂	oxygen (molecular)
OSRTI	Office of Superfund Remediation and Technology Innovation
OSWER	Office of Solid Waste and Emergency Response
PG	Professional Geologist
PIANO	paraffin, isoparaffin, aromatics, naphthene, olefins
PID	photoionization detector
PMP	Project Management Professional
QA	quality assurance
QAPjP	Quality Assurance Project Plan
QC	quality control
QSM	Quality Systems Manual
RCRA	Resource Conservation and Recovery Act
RFI	RCRA facility investigation
RP	Recommended Practice
RPD	relative percent difference
RSL	regional screening level
Shaw	Shaw Environmental & Infrastructure, Inc.
SM	Standard Method
SOP	standard operating procedure
SSL	soil screening level
SVE	soil-vapor extraction
SVM	soil-vapor monitoring

ACRONYMS AND ABBREVIATIONS (concluded)

SVOC	semivolatile organic compound
SWMU	solid waste management unit
TCLP	toxicity characteristic leaching procedure
TPH	total petroleum hydrocarbons
USACE	U.S. Army Corps of Engineers
VOC	volatile organic compound
VPH	volatile petroleum hydrocarbon

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EXECUTIVE SUMMARY

This Quality Assurance Project Plan (QAPjP) has been prepared by Shaw Environmental & Infrastructure, Inc. under the U.S. Army Corps of Engineers, Huntsville Center, Contract No. W912DY-10-D-0014, Delivery Order No. 0002. This QAPjP was developed to support activities identified in the Groundwater Investigation, Vadose Zone Investigation, Interim Measures, Light Non-Aqueous Phase Liquid Containment Interim Measure, and Pre-Remedy Monitoring Work Plans for the remediation at the Bulk Fuels Facility (BFF) Spill, Solid Waste Management Units ST-106 and SS-111, Kirtland Air Force Base (AFB), Albuquerque, New Mexico. The Work Plans were developed in response to April 2, June 4, and August 6, 2010 correspondence from the New Mexico Environment Department Hazardous Waste Bureau to the Air Force, requiring the Air Force to submit work plans to address soil and groundwater contamination at the BFF Spill site. The investigation activities will provide data necessary to supplement and optimize remedial efforts currently ongoing at the BFF.

Beginning in 2003, the U.S. Department of Defense (DoD) Environmental Workshop developed the DoD Quality Systems Manual (QSM), which provides baseline requirements for the establishment of quality systems for environmental laboratories. This QAPjP was developed for the Kirtland AFB BFF Spill remediation to meet the quality control requirements defined in the DoD QSM (Version 4.2, October 25, 2010).

This QAPjP covers pre-remedy quarterly groundwater monitoring; quarterly vadose-zone monitoring; quarterly vapor monitoring associated with the existing soil-vapor extraction systems; soil sampling associated with the groundwater and vadose-zone investigations and well installation; and soil sampling activities for the interim measures investigation at the Former Fuel Offloading Rack. The QAPjP documents project management procedures and describes data generation and acquisition; data validation and usability; assessment and oversight; data management processes; field and sampling procedures;

laboratory analytical methods; quality assurance/quality control protocols; and reporting requirements to be implemented for the BFF Spill remediation project, as well as related sampling and analysis activities for the period of December 2010 through September 2014.

1. INTRODUCTION

1.1 Background Information

Kirtland Air Force Base (AFB) is located in Bernalillo County, in central New Mexico, southeast of and adjacent to the City of Albuquerque and the Albuquerque International Sunport. The approximate area of the base is 52,287 acres. The Bulk Fuels Facility (BFF) Spill site is located in the northwestern part of Kirtland AFB (Figure 1-1). Historical aerial photography has revealed that the area was used for fuel storage and processing as early as 1951 (CH2M HILL, 2001). At that time, the fueling area was separated into a distinct tank holding area where bulk shipments of fuel were received (near the location of existing well KAFB-1066) and a separate fuel loading area where individual fuels trucks were filled. The truck loading area appears to have been approximately 250 feet (ft) north of the tank area.

Subsequent aerial photographs indicate that construction of the facility and associated infrastructure took place from 1951 until 1953. Once completed, the facility operated until it was removed from service in 1999, as a result of below-ground line leakage along the offloading rack (CH2M HILL, 2001). Bulk storage for Jet Propellant-8 fuel (JP-8), diesel fuel, and aviation gasoline (AvGas) was managed in the eastern portion of the facility. A 250-gallon underground storage tank was located near the Pump House, Building 1033 (CH2M HILL, 2001). The three types of fuel handled by the BFF were AvGas, Jet Propellant-4 fuel (JP-4), and JP-8. The use of AvGas and JP-4 at Kirtland AFB was phased out in 1975 and 1993, respectively. JP-8 was handled through the Former Fuel Offloading Rack (FFOR) until the leak was discovered in 1999.

The exact history of releases is unknown. Conceptually, releases could have occurred when fuel was transferred through the FFOR from railcars initially, followed by tanker trucks in later years, to the pump house, and then to the bulk fuel storage containers on the south end of the site (Tanks 2420 and 2422). Probable release points have been investigated and are summarized in subsequent sections. Fuel transfer

from the railcars to the pump house was done under vacuum transfers. Transfer of fuel from the pump house to the bulk storage containers was performed under pressurized conditions. Fuel transfer infrastructure for vacuum transfers was exempt from pressure testing, whereas fuel infrastructure for pressurized transfer did undergo regular pressure testing. Only when the vacuum portion of the fuel system underwent pressure testing in 1999 was any problem noted in the fueling system (CH2M HILL, 2001).

An underground fuel pipeline delivery system failure occurred over several decades at the BFF (Solid Waste Management Units [SWMUs] ST-106 and ST-111). The fuels Avgas, JP-4, and JP-8 have percolated to the groundwater table, resulting in a light non-aqueous phase liquid (LNAPL) plume and a dissolved-phase groundwater plume that is migrating off-base toward the City of Albuquerque municipal water supply wells. The leaks have been investigated since the 1990s; however, the fuel plume was not discovered until 2007.

At present, jet fuel is stored in two aboveground storage tanks (ASTs) (2.1 and 4.2 million gallons), diesel fuel is stored in two ASTs (one 5,000-gallon and one 10,000-gallon AST), and unleaded gasoline is stored in one 10,000-gallon AST. The site currently has one temporary JP-8 offloading rack located in the southwest corner of the facility, west of the fuel loading structure, Building 2404. This rack was placed into service following the piping failure at the FFOR (ST-106). A second small offloading rack (Building 2401) is used for the delivery of diesel and unleaded gasoline motor vehicle fuels.

Fuel delivered to the temporary JP-8 offloading rack is conveyed to the Pump House (Building 1033) via subsurface transfer lines. The fuel is then pumped to the JP-8 ASTs by piping of varying sizes that runs aboveground for approximately 750 ft and runs below ground for approximately 300 ft. Figure 1-2 presents the infrastructure present at the eastern portion of the BFF Spill source area.

1.2 Contaminant Sources

In November 1999, three known discharges occurred as a result of pressure testing of the lines that transfer fuel from the JP-8 offloading rack (Building 2405) to the pump house at the facility:

- Failure of one of the 14-inch-diameter below-ground transfer pipelines (pipeline #22) during a hydrostatic pressure test,
- Failure of a cam-lock coupling during pressure test of the second below-ground transfer pipeline (pipeline #23), and
- Failure of the second below-ground transfer pipeline (pipeline #23) during a hydrostatic pressure test after the cam-lock coupling problem had been corrected.

Testing revealed that the primary below-ground transfer pipeline (pipeline #22) had been in a state of failure for an unknown duration; therefore, the total amount of fuel released is unknown. The volumes of the second two discharges were estimated to be approximately 200 to 400 gallons and 30 gallons, respectively. For all discharges documented in November 1999, the product released was JP-8. However, because of the presence of multiple types of fuel contamination on the water table and the size of the LNAPL plume, it is likely that the primary pipeline had been in a state of failure for many years. The presence of LNAPL fuel hydrocarbons on the water table also indicates that substantial releases have occurred and that a range of fuel types may have been released. Fuel types include AvGas, diesel, JP-4, and JP-8 (Tetra Tech, 2004).

Over the past several years, potential sources in addition to the offloading rack were evaluated as possible contributors to LNAPL on the water table. These previously investigated potential sources include the pump house, a fueling island, underground piping, an evaporation pond, and areas where water from the bottom water holding tanks was released. The bulk fuel ASTs will be investigated following demolition of the standing ASTs. Demolition in this area is anticipated to be completed in the second quarter of 2011.

1.3 Identification of Contaminants of Potential Concern

Petroleum contamination associated with the BFF Spill has been identified in groundwater, subsurface soil, and soil vapor. Contamination appears to be a result of various releases that have occurred over the operational history of the facility. Information is available on some of the releases whereas other releases are not well documented and are inferred to have been ongoing for unknown periods of time. All contaminants of potential concern (COPCs) at the BFF Spill are constituents of refined petroleum products and include, but are not limited to, the following: benzene, toluene, ethylbenzene, and xylene (BTEX); naphthalene; ethylene dibromide (EDB); and lead.

COPCs for the BFF Spill are compared to the New Mexico Water Quality Control Commission (NMWQCC) water quality standards 20.6.2.3103 and 20.6.2.4103 New Mexico Administrative Code and the drinking water maximum contaminant levels (MCLs) adopted by the U.S. Environmental Protection Agency (EPA) under the federal Safe Drinking Water Act. If both standards have been established for a contaminant, then the more stringent of the two standards will be used as the cleanup level for the contaminant. The NMWQCC and MCL for the COPCs are:

<u>Parameter</u>	<u>NMWQCC</u>	<u>EPA MCL</u>
Benzene	0.01 milligrams/liter (mg/L)	0.005 mg/L
Toluene	0.75 mg/L	1.0 mg/L
Ethylbenzene	0.75 mg/L	0.70 mg/L
Total xylenes	0.62 mg/L	10.0 mg/L
EDB	0.0001 mg/L	0.00005 mg/L

2. PROJECT MANAGEMENT AND ORGANIZATION

Project management for the BFF Spill remediation activities will be performed in accordance with the requirements and the authority of the U.S. Army Corps of Engineers (USACE), Contract No. W912DY-10-D-0014, Delivery Order 0002; and other applicable federal and state regulations.

The project team consists of representatives from USACE, the Air Force, Shaw Environmental & Infrastructure, Inc. (Shaw), and regulatory support and oversight from the New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB). The USACE is the lead federal agency for direction of site activities and decision-making.

2.1 Project Quality Assurance Organization

The project quality assurance (QA) organization, presented in Figure 2-1, identifies key individuals and responsibilities to ensure project QA objectives are achieved for investigation and remediation of the BFF Spill.

2.2 Personnel Qualifications

Personnel qualifications for key individuals supporting the BFF Spill remediation are listed on Table 2-1 in addition to the title, organization, responsibility, and education and experience.

2.3 Problem Definition Background

Several decades ago, an underground fuel pipeline delivery system failed at the BFF Spill site at SWMUs ST-106 and ST-111, Kirtland AFB. The fuels Avgas, JP-4, and JP-8 have percolated to the groundwater table, resulting in a LNAPL plume and a dissolved-phase groundwater plume that is migrating off-base toward the City of Albuquerque municipal water supply wells. The leaks have been

investigated since the 1990s, but the fuel plume was not discovered until 2007. The total plume has been estimated to be 2 to 4 million gallons with another 5 million gallons remaining in the vadose zone.

In 2010, NMED changed oversight of the BFF Spill from the Ground Water Quality Bureau to the Hazardous Waste Bureau. Through Notice of Deficiency (NOD) letters, prescriptive requirements were issued to Kirtland AFB to investigate the vadose zone and groundwater at the BFF Spill, and to implement an interim measure to contain the fuel plume from migrating further downgradient toward the municipal supply wells, thus protecting human health and the environment. The Air Force prepared and submitted draft work plans responding to the NOD letters. The work plans proposed a less robust investigation monitoring network than required by NMED and a phased interim measure approach. NMED reviewed the draft work plans and rejected the approach with a NOD letter on August 6, 2010. In that letter, NMED directed the Air Force to conduct groundwater, vadose zone, and interim measure investigations in accordance with the requirements prescribed in the NMED August 6, 2010 letter.

The primary objectives for the BFF Spill investigations include:

- Determine the location of fine-grained lithologic units within the vadose zone at the BFF Spill, which control LNAPL migration.
- Determine the extent of the LNAPL plume on the water table.
- Determine gradients and flow paths within all three groundwater horizons at the site.
- Delineate contaminated versus uncontaminated (from LNAPL plume) locations at BFF Spill.
- Determine the extent of the dissolved-phase contaminant plume that exceeds the established EPA MCLs/NMWQCC standards for groundwater at the site.
- Characterize the nature and extent of contaminants within the vadose zone and FFOR.
- Conduct quarterly pre-remedy monitoring for groundwater and vadose zone.

2.4 Task Description

The specific tasks to be included with the BFF Spill investigation are identified under each of the programs listed below.

2.4.1 Pre-Remedy Monitoring

Pre-remedy monitoring will be conducted in accordance with sampling, analysis, and reporting requirements specified by the NMED HWB and in accordance with requirements contained in the *Base-Wide Plans for Investigations under the Environmental Restoration Program*, Kirtland AFB, 2004 Update. Pre-remedy monitoring activities include quarterly sampling for the following:

- Collecting soil-vapor samples from the 15 existing soil-vapor monitoring (SVM) wells,
- Collecting soil-vapor samples from the four existing soil-vapor extraction (SVE) units,
- Collecting groundwater samples from the 29 existing BFF groundwater monitoring wells and four municipal wells, and
- On-site monitoring of the 13 existing SVE wells on a quarterly basis.

Sampling activities will be expanded to include all new wells to be installed during implementation of the groundwater and vadose zone investigations being conducted at the BFF Spill.

2.4.2 Groundwater Investigation

The groundwater investigation activities at the BFF will support defining the nature of the contaminants and delineating fuel contamination within groundwater at the BFF Spill. Specific goals of the investigation include:

- Characterize the nature, horizontal and vertical extent, and fate and rate of migration of groundwater contamination;

- Characterize the geology and hydrogeology at and below the water table; and
- Characterize groundwater flow and velocity.

Groundwater investigation activities include installation of shallow-, intermediate-, and deep-depth groundwater monitoring wells in accordance with the NMED August 6, 2010 letter; collection and analysis of borehole soil samples; borehole geophysics; and groundwater analyses to determine groundwater quality and add to the knowledge base of groundwater chemistry. The geophysical investigation and borehole soil samples will provide information on subsurface geology and contaminant location and migration. Groundwater sampling will provide immediate, as well as long-term, sampling data on subsurface contaminant distribution in different horizons within the aquifer. Existing and proposed groundwater monitoring well locations are identified on Figure 2-2.

2.4.3 Vadose Zone Investigation

Vadose zone investigation activities at the BFF will support defining the nature of the contaminants and delineating fuels contamination of soil and vapor within the vadose zone. Specific goals will be to:

- Estimate the amount of fuel that exists within the vadose zone as absorbed or residual liquid, or as soil vapor;
- Identify the probable source of the LNAPL fuel plume; and
- Characterize the vadose zone geology, hydrology, hydrogeology, and soil/soil-vapor contamination in sufficient detail to prepare an updated conceptual site model, which incorporates current and potential soil and groundwater contamination pathways, vadose zone sources, and the distribution, fate, and transport of contaminants.

Vadose zone investigation activities include subsurface geophysical investigations, soil and soil-gas vapor sampling, and installation of vapor monitoring points throughout the vadose zone. The geophysical investigation will provide information on subsurface geology and contaminant location and migration. Soil and vapor sampling will provide immediate, as well as long-term, sampling data on subsurface

contaminant distribution in the vadose zone. Existing and proposed SVM well locations are identified on Figure 2-3.

2.4.4 Interim Measures Investigation

Interim remediation measures were developed to begin addressing the LNAPL plume present beneath the BFF Spill. The focus of these interim remediation measures is mitigation of LNAPL migration in the subsurface to limit further impact to the regional aquifer that supplies drinking water for the Albuquerque Bernalillo County Water Utility Authority. The Air Force has adopted a strategy to halt and prevent further migration of LNAPL in the capillary and saturated zone of the aquifer. The primary mechanism for preventing further LNAPL migration is the removal of LNAPL mass, both through SVE and groundwater/LNAPL extraction, from the subsurface to the extent practicable during these interim measures.

Specific remediation measures include:

- A shallow soil boring program using Geoprobe[®] technology will be employed at the FFOR to establish the location of shallow soil that requires interim remediation (i.e., shallow soil that exceeds NMED soil screening levels (SSLs) for hazardous constituents [NMED, 2009]). FFOR, Pump house, and underground pipe soil sampling locations are identified on Figures 2-4 and 2-5.
- Analytical testing of the soil at the FFOR will be performed to determine the extents of contamination at the FFOR for excavation activities.
- All contaminated soil along the former pipeline at the FFOR will be excavated.
- PneuLog[™] vertical profiling of newly installed vadose zone wells, baildown testing, and radius of influence testing will be performed to determine the most favorable locations and depths for SVE to remediate LNAPL in the unsaturated LNAPL source zone at the water table and throughout the vadose zone. Location of PneuLog[™] well locations are identified on Figure 2-6.

2.4.5 LNAPL Containment Interim Measure

This objective of LNAPL activities is containment and capture of the non-aqueous phase liquid (NAPL) plume at Solid Waste Management Units ST-106 and SS-111. As part of the system design, existing data for the Kirtland AFB BFF Spill were evaluated for usability. Several data gaps affecting NAPL

containment system design and operations were identified. Five data gaps will be addressed to complete the final design of this NAPL containment system: 1) hydraulic conductivity of the aquifer, particularly in the NAPL plume; 2) groundwater quality in the immediate vicinity of the NAPL plume; 3) NAPL chemical and physical parameters; 4) NAPL migration soil parameters; and 5) the three-dimensional geologic framework. Additional tests and sampling will be conducted and include slug testing, aquifer testing, and NAPL analyses.

3. DATA GENERATION AND ACQUISITION

3.1 Sampling Design

This section discusses the sampling and analysis strategy for groundwater, soil, and soil-vapor samples required to meet the project data quality objectives (DQOs). Locations of the groundwater monitoring wells, SVM wells, and soil sampling locations are depicted on the site maps for SWMUs ST-106 and SS-111 (Figures 2-2, 2-3, 2-4, and 2-5).

Groundwater, soil, and soil-vapor samples will be labeled, packaged, and shipped to an off-site laboratory that maintains a U.S. Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP) certification, excluding the geotechnical, product, and investigation-derived waste (IDW) analyses. Samples collected in 2011 are planned to be analyzed at the following laboratories:

- Empirical Laboratories, Nashville, TN – groundwater;
- Gulf Coast Analytical Laboratories, Baton Rouge, LA – soil;
- RTI Laboratories, Livonia, MI – soil vapor;
- Hall Environmental Analysis Laboratory, Inc., Albuquerque, NM – IDW soil and water;
- PTS Laboratories, Santa Fe Springs, CA – soil (geotechnical analysis); and
- Core Laboratories, Deer Park, TX – LNAPL product.

3.1.1 Pre-Remedy Monitoring – Groundwater

Currently, there are a total of 29 existing groundwater monitoring wells and 4 municipal wells at the BFF.

In compliance with NMED requirements, quarterly groundwater monitoring will be performed at these 33 wells during January 2011. In addition, a Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) of the groundwater associated with BFF Spill SWMUs ST-106 and SS-111 will be conducted. The RFI will consist of installing additional groundwater monitoring wells, performing down-hole geophysics of existing and new monitoring wells, and sampling existing and new monitoring wells.

As part of the groundwater investigation and to further characterize the LNAPL and dissolved-phase plumes, an additional 78 groundwater monitoring wells, 2 extraction wells, and 2 injection wells, will be

installed in conjunction with the BFF Spill investigation. These groundwater monitoring wells will be installed in the locations required by NMED to determine the lateral and vertical extent of the LNAPL and dissolved-phase plumes. Following well installation and development, new wells in addition to the 33 existing wells will be sampled during the quarterly sampling events as they become completed. During July 2011 through December 2014, a total of 111 monitoring wells will be sampled on a quarterly basis, including the 33 existing and the 78 new wells to be installed.

3.1.1.1 Water Level and LNAPL Measurements

Monthly water-level and LNAPL measurements will be conducted at 29 existing monitoring wells starting in January 2011 and continuing for the duration of the year, with the 78 groundwater monitoring wells added as they become completed. Results of the monthly water-level and LNAPL measurements will be recorded on the Monthly Water Level Field Measurement form in Appendix C, in Shaw's project-specific database, and the Air Force data repository. Water-level and LNAPL measurements will be conducted quarterly for years 2012 through 2014.

3.1.1.2 Quarterly Groundwater Sampling

In accordance with the low-flow sampling procedure, field measurements for temperature, specific conductance, pH, oxygen reduction potential, turbidity, and dissolved oxygen will be recorded on the Groundwater Purge Log form in Appendix C. After water quality parameters are stabilized, groundwater samples will be collected and analyzed for the parameters listed below.

- Volatile organic compounds (VOCs) – EPA Method 8260B;
- Semivolatile organic compounds (SVOCs) – EPA Method 8270C;
- EDB – EPA Method 8011;
- Total petroleum hydrocarbons (TPH) gasoline – EPA Method 8015B;
- TPH diesel – EPA Method 8015B;

- Volatile petroleum hydrocarbons (VPHs) (C5-C8) and (C9-C12) – Massachusetts Department of Environmental Protection (MA DEP); will be collected for four (4) events;
- Extractable petroleum hydrocarbons (EPH) (C12-C40) – MA DEP; will be collected for four (4) events;
- Dissolved iron and manganese – EPA Method 6010B (field-filtered);
- Total cations (calcium, potassium, magnesium, and sodium) and total lead – EPA Method 6010B;
- Anions (nitrate, chloride, sulfate) – EPA Method 300.0;
- Carbonate and bicarbonate alkalinity – Standard Method (SM) 2320B and field measurement by HACH Method 8203 (or equivalent);
- Ammonia nitrogen – SM 4500 B, D; and
- Total sulfide – SM 4500 S-2CF.

For risk evaluation purposes, the VPH/EPH analysis will be conducted for four quarterly groundwater monitoring events. For those four quarters, no groundwater samples will be collected for EPA Method 8015B gasoline and diesel analysis.

3.1.2 Pre-Remedy Monitoring Program – Soil Vapor

There are 15 existing SVM wells at the BFF. In accordance with the NMED requirements, quarterly soil-vapor sampling will be collected at the existing vapor well locations during January 2011. In addition, in conjunction with the RFI of the vadose zone at the BFF Spill site, an additional 35 deep SVMs and five shallow SVMs wells will be installed at locations and screen intervals specified in the NMED letters.

Soil-vapor samples will be collected quarterly from the new and existing SVM well locations for the remainder of the pre-remedy monitoring or until Remedy-in-Place is achieved. To maximize efficiency, quarterly soil-vapor monitoring may be conducted concurrently with quarterly groundwater monitoring.

Prior to soil-vapor sampling, the laboratory will clean and leak check all associated Bottle Vac® canister sampling equipment, including flow controllers and critical orifice assemblies. One Bottle Vac® canister

sample from each batch will be analyzed for VOCs to ensure cleanliness prior to shipping to the site for sampling use.

Bottle Vac® canister soil-vapor samples will be collected with a flow controller to obtain a time-integrated soil-vapor sample. Soil-vapor samples will be analyzed for the following parameters:

- VOCs and TPH gasoline – EPA Method TO-15;
- Air-phase petroleum hydrocarbon (APH) (C5-C8 and C9-C12) – MA DEP; will be collected for four (4) events; and
- Fixed gases (oxygen, nitrogen, carbon monoxide, carbon dioxide, methane) – ASTM International (ASTM) D2504 (collected in Tedlar bag).

The APH analysis is required for only four quarters of SVM events for risk evaluation purposes. For those four quarters, no soil-vapor samples will be collected for TPH gasoline analysis.

3.1.2.1 Quarterly Monitoring of the Existing Soil-Vapor Extraction Units

Presently there are four internal combustion engine SVE units operating at the BFF. Quarterly monitoring of the existing SVE units will be conducted under this program. Vapor samples will be collected from the inlet and exhausts from the four units on a quarterly basis from January 2011 through December 2014 or until operation ceases. These samples will be analyzed for the same parameters as the soil-vapor well samples:

Laboratory Parameters:

- VOCs and TPH gasoline – EPA Method TO-15; and
- Fixed gases (oxygen, nitrogen, carbon monoxide, carbon dioxide, methane) – ASTM International (ASTM) D2504 (collected in Tedlar bag).

In addition, soil-vapor samples from the SVE units will be analyzed routinely in the field for the following parameters:

Field Testing Parameters:

- Hydrocarbons,
- Oxygen,
- Carbon monoxide, and
- Carbon dioxide.

Results of the vapor samples will be used to evaluate VOC destruction efficiency and to determine the optimization and effectiveness of the SVE systems.

3.1.3 Groundwater Investigation – Soil Sampling

During groundwater monitoring well installation, soil samples will be collected to characterize the nature and extent of contaminants in newly installed groundwater monitoring well locations. It is anticipated that a total of 72 soil samples will be collected at 4 well locations and 18 depth intervals. Soil samples will be analyzed for the following parameters:

- VOCs – EPA Method 8260B,
- TPH gasoline and diesel – EPA Method 8015B,
- SVOCs – EPA Method 8270D, and
- Lead – EPA Method 6010C.

3.1.3.1 Monitored Natural Attenuation Groundwater Monitoring

It is planned that 30 groundwater monitoring wells will be installed for the monitored natural attenuation (MNA) assessment effort. Following well installation and well development, four quarters of MNA groundwater sampling will be performed concurrently with the routine quarterly groundwater monitoring. Groundwater samples will be collected from these 30 groundwater monitoring wells for a total of four sampling events. Following the low-flow sampling procedure, samples will be collected and analyzed for the parameters listed below:

- Filtered cations (calcium, potassium, magnesium, and sodium) – EPA Method 6010B;
- Filtered manganese – EPA Method 6010B;
- Anions (chloride, sulfate and nitrate) – EPA Method 300.0;
- Ammonia as nitrogen – SM 4500 B, D;
- Ortho-phosphate – SM 4500 PE;
- Total sulfide – SM 4500 S-2CF;
- Carbonate and bicarbonate alkalinity – SM 2320B;
- Dissolved gases – RSK 175;
- Carbon-specific isotope analysis – Laboratory Standard Operating Procedure (SOP) AM24; and
- Hydrogen specific isotope analysis – Laboratory SOP.

Additionally, samples will be collected and analyzed in the field for ferrous iron, carbon dioxide, and alkalinity using HACH test kit methods, or equivalent procedures.

3.1.4 Vadose Zone Investigation – Soil Sampling

During installation of the 35 deep SVMs and 5 shallow SVMs, soil samples will be collected and analyzed to estimate the amount of residual fuel adsorbed to soil, as soil vapor and as residual liquid in the soils. Soil samples will be collected from the nested SVMs borings using a split-spoon sampler at 10-ft intervals from ground surface to 50 ft below ground surface (bgs) followed by 50-ft interval samples and at changes in lithology to the total depth (water table). Soil samples from the shallow SVMs will be collected in 4-ft intervals. It is anticipated that a total of 515 soil samples will be collected and analyzed for the following parameters:

- VOCs – EPA Method 8260B,
- TPH gasoline and diesel – EPA Method 8015B,
- VPH (C5-C8) and (C9-12) – MA DEP (at KAFB-106117 and KAFB-106134),
- EPH (C9-C18) and (C19-C36) – MA DEP at KAFB-106117 and KAFB-106134),
- SVOCs – EPA Method 8270D, and
- Lead – EPA Method 6010C.

3.1.5 Interim Measures Investigation – Soil Sampling

Soil samples will be collected at the FFOR pump house and associated pipelines to identify the area of shallow soil containing LNAPL or hazardous constituents above the NMED SSLs down to 20 ft bgs. Soil samples will be collected using Direct Push sampling and in accordance with the Interim Measures Work

Plan. It is anticipated that approximately 1,200 soil samples (including quality control [QC] samples) will be collected for the FFOR soil sampling and analyzed for the parameters listed below.

- VOCs – EPA Method 8260B,
- TPH gasoline and diesel – EPA Method 8015B,
- SVOCs – EPA Method 8270D, and
- Lead – EPA Method 6010C.

3.1.6 LNAPL Containment Interim Measures Investigation – Groundwater Monitoring

To support the LNAPL containment interim measures investigation and to complete data gaps, one groundwater sampling event will be conducted at six existing monitoring wells. Samples will be collected using the low-flow sampling procedure and analyzed for the following parameters:

- VOCs – EPA Method 8260B;
- SVOCs – EPA Method 8270C,
- TPH gasoline and diesel – EPA Method 8015B;
- Total metals (manganese) and major cations – EPA Method 6010B;
- Ferrous iron – field measurement;
- Anions – EPA Method 300.0;
- Ammonia nitrogen – SM 4500 B, D
- Ortho-phosphate – SM 4500 PE; and
- Aerobic and anaerobic degrading bacteria – lab proprietary method.

In addition, LNAPL samples will be collected from the same six wells and analyzed by a petroleum hydrocarbon specialty testing laboratory for the following list of parameters:

- Density – ASTM D1481;
- Single point viscosity – ASTM D445;
- Surface and interfacial tension – ASTM D971;
- Flashpoint – ASTM D93;
- American Petroleum Institute (API) gravity – ASTM D287;

- PIANO (paraffin, isoparaffin, aromatics, naphthene, olefins)/BTEX/EDB – lab proprietary method; and
- Oxygenates and lead – lab proprietary method.

Eight geotechnical samples will also be collected and analyzed by a geotechnical specialty laboratory for the following parameters:

- Grain size – ASTM D4464;
- Pore fluid saturation – API Recommended Practice (RP) 40;
- Flow NAPL cleaning – laboratory proprietary method;
- Air/water drainage capillary pressure – ASTM D6836, API RP 40;
- Water/LNAPL drainage capillary pressure – ASTM D6836, API RP 40; and
- Van Genuchten parameters – calculation.

3.1.7 Investigation-Derived Waste Management

IDW anticipated to be generated during BFF Spill investigation and remediation field activities will consist of contaminated environmental media and associated waste materials from soil (excavation and sampling), drill/soil cuttings (from boreholes and well installation), monitoring well purge and development water, decontamination water, and water generated from pump tests. Waste material associated with these activities includes disposable personnel protective equipment, disposable sampling equipment (e.g., scoops, bowls), and other inert materials (e.g., plastic, rope, tape, and paper). IDW will be managed and disposed of in accordance with the project-specific Waste Management Plan.

All purge water and equipment decontamination liquid (if any) from the quarterly groundwater monitoring activities will be containerized in approved drums or collected in temporary storage tanks pending characterization for discharge or disposal. Environmental samples collected from the monitoring wells will be used to characterize liquid IDW and determine disposition. Purge water will be discharged to ground surface pending approval from Kirtland AFB and the NMED Ground Water Quality Bureau.

Prior to waste disposal, soil IDW generated from the SVM installation, groundwater monitoring well installation, and FFOR soil sampling activities will be collected in lined roll-offs and/or U.S. Department of Transportation (DOT) approved drums as appropriate. IDW soil samples will be analyzed for the following parameters per the Kirtland AFB on-site nonhazardous waste landfill disposal requirements:

- Toxicity characterization leaching procedure (TCLP) VOCs – EPA Methods 1311/8260B;
- TCLP SVOCs – EPA Methods 1311/8270C;
- TCLP pesticides – EPA Methods 1311/8081B;
- TCLP herbicides – EPA Method 1311/8151A;
- TCLP metals – EPA Methods 1311/6010C/7470A;
- Reactivity, corrosivity, and ignitability – SW846, Chapter 7, 7.3.3.2;
- BTEX – EPA Method 8260B; and
- TPH gasoline and diesel – EPA Method 8015B.

All IDW drums and or roll offs will be labeled and stored at the site until appropriate disposal is determined. Non-hazardous waste will be disposed of at the Kirtland AFB landfill or appropriate off-site facility. Shaw will coordinate with Kirtland AFB on disposal of all IDW to the on-base landfill.

3.2 Quality Objectives and Criteria for Measurement Data

The DQO process is designed to ensure that the type, quantity, and quality of environmental data used for decision-making are appropriate for the intended application. The objectives of the BFF Spill remediation include the following:

- Determine the location of fine-grained lithologic units within the vadose zone at the BFF Spill, which control LNAPL migration.
- Determine the extent of the LNAPL plume on the water table.
- Determine gradients and flow paths within all three groundwater horizons at the site.
- Delineate contaminated versus uncontaminated (from LNAPL plume) locations at BFF Spill.
- Determine the extent of the dissolved-phase contaminant plume that exceeds the established EPA MCLs/NMWQCC standards for groundwater at the site.
- Characterize the nature and extent of contaminants within vadose zone and FFOR.

Groundwater monitoring associated with the BFF Spill will be conducted quarterly from 2011 through 2014 (four events per year). To maximize efficiency, quarterly vadose-zone monitoring (four events per year) may be conducted along with groundwater monitoring. Additionally, soil sampling associated with groundwater monitoring well installation (one event), vadose-zone investigation (one event), interim measures investigation at the FFOR (one event), LNAPL containment groundwater monitoring (one event), and MNA assessment (four events) will be performed in support of the BFF Spill remediation.

3.2.1 Comparison Criteria

Analytical results from the quarterly groundwater monitoring events and analysis of decontamination water will be compared to EPA MCLs and NMWQCC standards contained in New Mexico Administrative Code Title 20 – Environmental Protection, Chapter 6 – Water Quality, Part 2 – Ground and Surface Water Protection. Soil samples results will be compared to EPA residential regional soil screening levels (RSLs) (EPA, 2010) and NMED SSLs (NMED, 2009). Currently, there are no established regulatory standards for soil vapor. Regulatory limits are summarized in Appendix A tables by parameter.

Analytical methods selected for the project will provide sufficient sensitivity to meet the DQOs and the NMED requirements and will achieve the respective regulatory standard for all analytes with two exceptions for SVOC analytes: benzo(a)pyrene, n-nitrosodimethylamine, and n-nitrosodiethylamine in soil and benzo(a)pyrene and hexachlorobenzene in water.

In order to meet the regulatory limits, laboratories will report positive results down to the method detection limit (MDL) and results between the MDL and the limit of quantitation (LOQ) will be flagged with a J-qualifier and reported as estimated data. Estimated data are still usable to achieve project DQOs. Target analytes with LOQs greater than the regulatory limits are highlighted in Appendix A tables.

SVOCs are being analyzed in soil in conjunction with the vadose zone and groundwater investigations to further determine the extent of fuel related contamination. However, benzo(a)pyrene, hexachlorobenzene, n-nitrosodimethylamine, and n-nitrosodiethylamine have not been identified as contaminants of concern at the BFF Spill. Therefore, the elevated LOQs for these four analytes do not impact the project DQOs.

3.2.2 Decision Criteria

The following decisions may be made based on the results of the Kirtland AFB BFF Spill pre-remedy groundwater and soil-vapor monitoring:

- If proposed groundwater and SVM wells being used for the purpose of monitoring contamination within the LNAPL plume do not address areas that have been delineated as possible preferential flow paths for LNAPL to the groundwater table, consider modifying proposed SVE well locations within the LNAPL plume.
- If proposed groundwater and SVM wells being installed for the purpose of monitoring contamination within the LNAPL plume are not within the plume, consider adjusting the location of these points or eliminating them from the drilling program.
- If groundwater and soil-vapor samples in monitoring wells proposed for the purpose of delineating the extent of the groundwater plume are impacted above MCLs, the dissolved-phase plume has not been delineated and additional wells must be installed to complete the delineation.

The following decisions may be made based on the results of the Kirtland AFB BFF soil monitoring:

- If soil samples collected during SVM installation are impacted above EPA RSLs/NMED SSLs, consider collecting additional samples or adjusting SVM locations.
- If soil samples collected during groundwater monitoring well installation are impacted above EPA RSLs/NMED SSLs, evaluate adjusting groundwater monitoring well locations.
- If soil samples collected at the FFOR for the purpose of delineating excavation contamination are impacted above EPA RSLs/NMED SSLs, consider collecting samples further from the excavation points.

3.2.3 Project Performance and Acceptance Criteria

To limit uncertainty in obtained environmental data, criteria for the sensitivity, precision, bias, representativeness, completeness, and comparability parameters were developed and are presented in this

Quality Assurance Project Plan (QAPjP). Measurement errors will be controlled by using appropriate sampling and analytical methods, adhering to the DoD Quality Systems Manual (QSM) (2010), following established SOPs, and having data review to verify laboratory processes. Field crews will be trained in the appropriate sample collection procedures and will review the QAPjP before sample collection to limit sample collection errors. Subcontract analytical laboratories will have a copy of the QAPjP and will adhere to DoD QSM guidance to limit measurement errors. Following DoD QSM requirements, laboratories will conduct quarterly detection limit studies to verify method sensitivity. In addition, laboratories will perform quarterly LOQ studies to verify precision and bias at the LOQ. For each matrix and each method, laboratories will analyze applicable QC samples, including laboratory method blanks, surrogates, laboratory control samples (LCS)/laboratory control sample duplicates (LCSD), matrix spike (MS)/matrix spike duplicates (MSD), and internal standards to determine that results of these QC samples are within acceptable precision and bias limits. Acceptance criteria for precision, bias, and sensitivity are presented in Appendix B. The data that meet these criteria will be of definitive quality and of less uncertainty than data which were acquired with a less rigorous approach.

3.3 Sampling Methods

This section presents field methods and sampling procedures, including groundwater, soil, and soil vapor sampling, and equipment decontamination procedures.

3.3.1 Water Level and LNAPL Measurements

Monthly water level and LNAPL will be measured in 2011 in accordance with the procedures outlined in the Groundwater Investigation Work Plan. Measurements will be documented on the Monthly Water Level Field Measurements form included in Appendix C.

3.3.2 Groundwater Monitoring

Groundwater samples from the quarterly pre-remedy groundwater monitoring, LNAPL groundwater monitoring, and MNA groundwater monitoring activities will be collected using the low-flow sampling procedures as described in the Groundwater Investigation and Pre-Remedy Monitoring Work Plans.

3.3.3 Soil-Vapor Monitoring

Soil-vapor samples for the quarterly Pre-Remedy Monitoring Program will be collected from soil-vapor wells following procedures described in the Pre-Remedy Monitoring Work Plan. Additionally, vapor samples from the SVE units will be collected into passivated Bottle Vac® canisters using the RTI

Laboratories specific sampling technique described below:

- Purge the sampling train to remove stagnant gas. A volume of 1 to 3 liters at a rate of 0.2 – 2.0 milliliters per minute should be sufficient.
- Measure the static vacuum pressure using a vacuum gauge and record the measurement, temperature, date, and time on the field form. Samples are collected in the Bottle-Vac canisters attached to a QT-connector and flow-restrictor assembly. Attach tubing to the end of the flow-restrictor assembly. At the end of the union should be a ¼-inch Swagelok®. Attach the ¼-inch diameter tubing to collect the vapor sample. As the Bottle-Vac fills, the sampling rate will slow due to drop in vacuum in the bottle and will require a minimum of 10 minutes of fill time.
- Disconnect the tubing from the sampling port, label, and store the canister properly to avoid exposure to high temperatures before shipping to the off-site laboratory for analysis.

3.3.4 Soil Sampling

Soil samples will be collected in support of the vadose zone investigation, monitoring well installation, and the interim measure sampling at the FFOR. These samples will be collected in accordance with the procedures specified in the Groundwater Investigation, Vadose Zone Investigation, and Interim Measures Work Plans.

3.3.5 Equipment Decontamination Procedure

It is anticipated that dedicated or disposable sampling equipment will be used to collect groundwater, soil, and soil-vapor samples to minimize cross-contamination during sampling activities. When non-dedicated equipment is used to collect samples, decontamination of non-dedicated sampling equipment that comes in contact with samples will be performed to prevent the introduction of extraneous material into samples, and to prevent cross contamination between samples. Equipment decontamination will be performed according to the procedure listed below. Decontamination water will be collected in 55 gallon, DOT-approved drums or other suitable storage tanks.

Specification for Decontamination Materials:

- Use a standard brand of phosphate-free detergent, such as liquid Liquinox® or Alconox®. These surfactant type detergents are used industry-wide and have proven to be effective in cleaning oily residue from field equipment.
- Detergent solution will be rubbed over the surface of the equipment to appropriately remove any residues, using a brush or by hand using sponge, paper towel, etc.
- Use tap water from any municipal water treatment system or deionized water for rinsing off detergent. Dry equipment with paper towel or allow to air dry.
- Inspect prior to use to ensure that no residue remains.

3.4 Sample Handling and Custody

The following sections describe sample packaging and shipment, sample numbering and labeling, and chain-of-custody (COC) requirements associated with collecting water, soil and soil-vapor samples.

3.4.1 Sample Packaging and Shipment

Samples will be collected in the appropriate certified clean sample containers provided by the laboratories, and in accordance with the specific Work Plan procedures and Table 3-1. Upon collection, all glass sample containers will be protected with bubble wrap (or the equivalent) to prevent breakage during shipment. A temperature blank will be placed in every cooler shipment.

Ice will be added to the cooler in sufficient quantity to keep the samples cooled to below 6 degrees Celsius (°C) for the duration of the shipment to the laboratory. Sample cooler drain spouts will be taped from the inside and outside of the cooler to prevent any leakage. Saturday deliveries will be coordinated with the laboratory, as needed.

If samples are picked up by a laboratory courier service, the COC will be completed and signed by the laboratory courier. The cooler will then be released to the courier for transportation to the laboratory.

If a commercial carrier is used, the COC will include the air bill number in the “transfers accepted by” column, and will be sealed in a resealable bag. The COC will then be taped to the inside of the sample cooler lid. The cooler will be taped shut with strapping tape, and two custody seals will be taped across the cooler lid: one seal in the front and one seal in the back. Clear tape will be applied to the custody seals to prevent accidental breakage during shipping. The samples will then be shipped to the analytical laboratory. A copy of the courier air bill will be retained for documentation.

Samples will be shipped to the analytical laboratory via overnight carrier services according to DOT regulations. International Air Transportation Association regulations will be adhered to when shipping samples by air courier services. Transportation methods will be selected to ensure that the samples arrive at the laboratory in time to permit testing according to established holding times and project schedules. The receiving laboratory will only accept samples with a properly prepared COC and properly labeled and sealed shipping container(s).

3.4.2 Monitoring Well and Field Sample Identification

Field sample identification (ID) will be assigned consistent with the established Kirtland AFB sample ID nomenclature for monitoring well and field sample IDs. This will ensure that newly generated well

installation, investigation, and quarterly monitoring data associated with the BFF Spill will be recognizable and easily identified once uploaded to the Air Force data repository.

3.4.2.1 Monitoring Well ID

Monitoring well IDs will follow the format of the base designator (KAFB), the SWMU identifier (106) and the sequential monitoring well number (XXX). Well numbers will follow sequentially those wells that have already been installed at the BFF Spill. The first well to be installed will have a sample ID as follows:

Monitoring Well ID:

- KAFB – Kirtland AFB
- 106 – BFF SWMU
- 029 – sequential well number

3.4.2.2 Field Sample IDs

Sample IDs for groundwater, soil-vapor, and soil samples will be assigned with a consistent and sequential sample number such that the laboratory will not be able to distinguish the same samples between quarterly sampling events. The designation for field samples will be as follows:

- Groundwater – GWXXXX;
- Soil borings – SBXXXX;
- Soil vapor – SVMXXXX;
- IDW soil – KAFB-106XXXIDW1, 2, etc. (designated to the well installation ID); and
- IDW water – 106XXXWW1 (designated to the associated well installation ID).

3.4.2.3 Field Quality Control Sample IDs

Field duplicate samples will have designations consistent with the sequential field sample IDs such that they will not be distinguishable by the laboratories as being a duplicate sample. Matrix spike samples, trip blank, field blank, and rinse blank samples will have sample designations as listed below:

- Matrix spike – GWXXX-MS, SBXXX-MS;
- Trip blanks (VOCs) – GW8001-TB, SB8001-TB;
- Rinse blanks – GW8001-RB, SB8001-RB; and
- Field blanks (VOCs) – GW8001-AB, SB8001-AB.

3.4.3 Sample Custody and Documentation

Sampling information will be recorded on a COC form and sample collection forms for tracking. All entries will be legible and recorded in indelible ink. Because samples will be analyzed by multiple laboratories, the terms laboratory and Sample Custodian are generic. The custody procedures described herein apply to all laboratories that are involved in the analysis of groundwater, soil, and soil-vapor samples.

3.4.3.1 Chain of Custody

An example COC form is included in Appendix C. In most cases the COC form will be generated from the ShawView database system. In addition to providing a custody exchange record for the samples, the COC serves as a formal request for sample analyses. The COC form will be completed, signed, and distributed as follows:

- One copy retained by the sample coordinator for inclusion in the project files.
- The original sent to the analytical laboratory with the sample shipment.

After the laboratory receives the samples, the Sample Custodian will inventory each shipment before signing for it, and note on the original COC form any discrepancy in the number of samples, temperature of the cooler, or broken samples. The Project Chemist will be notified immediately of any problems identified with shipped samples. The Project Chemist will in turn notify the Project QC Manager, and together they will determine the appropriate course of action. The Project Chemist will also notify the Project Manager if the project budget and schedule may be impacted.

The laboratory will initiate an internal COC that will track the sample within the various areas of the laboratory. The relinquishing signature of the Sample Custodian and the custody acceptance signature of the laboratory personnel transfer custody of the sample. This procedure is followed each time a sample changes hands. The laboratory will archive the samples and maintain their custody as required by the contract or until further notification from the Project Chemist, at which time the samples will either be returned to the project for disposal, or disposed by the laboratory.

3.4.3.2 Field Sample Custody

The COC form will be the controlling document to ensure that sample custody is maintained. Upon collecting a sample, sampling personnel will initiate the COC in the field. Each individual who has the sample(s) in their possession will sign the COC. Each time the sample custody is transferred, the former custodian will sign the COC on the “Relinquished by” line, and the new custodian will sign the COC on the “Received by” line. The date, time, and name of their project or company affiliation will accompany each signature.

The waybill number or courier name will be recorded on the COC form when a commercial carrier is used. The shipping container will be secured with two custody seals, thereby allowing shipping personnel to maintain custody until receipt by the laboratory.

If the Laboratory Sample Custodian judges sample custody to be invalid (e.g., custody seals have been broken), the laboratory will notify the Project Chemist who will in turn contact the field team to resolve any discrepancies with field sample documentation. Any corrections required to be made to COC forms will be made by the field team, reviewed by the Project Chemist to determine impact to sample custody, and transferred to the laboratory. Sample receipt discrepancies will be noted by the laboratory upon sample login.

3.4.3.3 *Sample Collection Log*

The Sample Collection Log form will be used to document all samples collected in the field. A copy of this form can be found in Appendix C. All entries will be recorded in indelible ink.

At a minimum, the sample collection log will contain the following information:

- Project name and location;
- Sampling team;
- Date and time of collection for each sample;
- Sampling method;
- Sample number;
- Sample location (i.e., soil boring or sampling point);
- Sample matrix (i.e., soil and water);
- Sample type (i.e., normal sample, field duplicate, blank);
- Composite type (the number of grab samples);
- Depth of sample;
- Weather information (e.g., rain, sunny, approximate temperature, etc.);
- Containers used (e.g., brass liners, glass bottles, etc.);
- Requested analyses; and
- Any other events that may affect the samples.

The sample team will cross out the unused portion and sign each page.

3.4.3.4 *Groundwater Purge Log*

The Groundwater Purge Log form will be used to document the well ID, well observations, purge volume calculations, sampling equipment, and measurement of field parameters for each groundwater monitoring well to be sampled quarterly. A copy of this form can be found in Appendix C. All entries will be recorded in indelible ink. At a minimum, the groundwater purge logs will contain the following information:

- Project name and site;
- Well identification number;
- Field team;
- Sample date and time;

- Weather conditions;
- Equipment information;
- Purge calculations;
- Water level;
- Screen interval;
- Photoionization detector (PID) reading;
- Purge information (time, purge rate, volume purged, depth to water); and
- Field parameter measurements - temperature, pH, dissolved oxygen, specific conductivity, turbidity, oxidation reduction potential, alkalinity).

The groundwater purge log will undergo an independent review by the other field team personnel or designee before shipping the samples to the off-site laboratory.

3.4.3.5 Vapor Purge Log

The Vapor Purge Log form will be used to document field sample collection information associated with quarterly soil-vapor sampling. A copy of the form can be found in Appendix C. All entries will be recorded in indelible ink, and will be reviewed by the sampling team. At a minimum, the vapor purge log will contain the following information:

- Project name and site;
- Well identification number;
- Field team;
- Sample date and time;
- Weather conditions;
- Well observations;
- Purge calculations;
- Purge volume; and
- Field measurements (carbon monoxide, carbon dioxide, molecular oxygen, and hydrocarbon).

The vapor purge log will undergo an independent review by the other field team member or designee before shipping the samples to the off-site laboratory.

3.4.3.6 Document Corrections

Changes or corrections on any project field or analytical documentation will be made by crossing out the item with a single line, initialing by the person performing the correction, and dating the correction. The original item, although erroneous, will remain legible beneath the cross out. The new information will be written above the crossed-out item. Corrections will be written clearly and legibly with indelible ink.

3.5 Analytical Methods

Analytical methods, container, and preservative requirements for groundwater, soil, and soil-vapor samples are summarized in Tables 3-2, 3-3, and 3-4. The required target analytes for each method, applicable regulatory limits, project reporting limits, and laboratory LOQs are presented in Appendix A, Tables A-1 through A-3.

3.6 Quality Control

This section discusses field and laboratory QC requirements.

3.6.1 Field Quality Control Samples

Field QC samples will be collected and analyzed during the project to assess the precision and accuracy of the sampling program. Field QC samples for this project will include MS/MSD samples, field duplicates, QA split samples if required by client, equipment rinse blank samples, trip and ambient blanks for VOC samples, and temperature blanks, as discussed below. Field and QC sample summary tables are included with the Groundwater Investigation, Vadose Zone Investigation, and Interim Measure Work Plans.

3.6.1.1 Matrix Spike and Matrix-Spike Duplicate

MS/MSD samples will be collected at one pair per 20 groundwater or soil field samples. MS/MSD analyses will not be performed on IDW samples, or soil-vapor samples, or for alkalinity analysis, as

MS/MSD analysis for these methods and matrix are not applicable. Accuracy for these analyses will be assessed through a review of field duplicates, laboratory duplicates, and surrogate recoveries (when applicable). Field personnel will collect extra volumes for water and soil for MS/MSD analysis and designate the MS/MSD sample on the COC form (Appendix C).

3.6.1.2 Field Duplicates

Field duplicate pairs consist of two samples of the same matrix (a primary and a duplicate) collected at the same time and location to the extent possible, using the same sampling techniques. The purpose of field duplicate samples is to evaluate sampling precision. Field duplicate samples will be collected for quarterly groundwater, soil, and soil-vapor sampling associated with SVM and groundwater monitoring well installations and FFOR soil sampling. No field duplicates will be collected for IDW waste characterization purposes. Field duplicate samples will be collected at a frequency of 10 percent and will be analyzed for the same analytical parameters as their corresponding primary samples. For this project, the acceptance criteria for field duplicate precision is established at less than or equal to 35 percent for groundwater samples, and 50 percent for soil and soil-vapor samples. Field duplicate precision will be calculated when target analytes are detected above the reporting limit in both the primary and duplicate sample.

3.6.1.3 Field QA Split Samples

QA split samples will be collected by the client or designee if deemed necessary. QA splits are samples that are collected at the same time as the primary field sample. If collected, the QA split sample will be sent to an independent analytical laboratory to be analyzed for the same analytical parameters as the primary field sample. The results will serve as an independent QA check for the field sampling and analytical method protocol precision.

3.6.1.4 Equipment Rinse Blanks

Equipment rinse blanks are used to evaluate the effectiveness of the decontamination procedure and to identify potential cross-contamination during sampling events. When dedicated or disposable sampling equipment is used for sample collection, equipment rinse blanks will not be collected. However, if non-disposable sampling equipment is used, equipment rinse blanks will be collected at one per 20 samples. Equipment rinse blanks consist of distilled or laboratory grade water collected from the final rinse of the decontamination process and placed in appropriate pre-cleaned containers supplied by the analytical laboratory. The equipment rinse blanks will be analyzed for VOCs, TPH-diesel, and metals. Results from these analyses will provide sufficient information to evaluate the effectiveness of equipment decontamination procedures.

3.6.1.5 Trip Blanks

Trip blank samples will accompany each cooler containing groundwater and soil samples for VOC analysis. Trip blanks are 40-milliliter volatile organic analysis vials that contain analyte-free water, which are kept with the field samples during sampling and shipping to an off-site laboratory. Results of trip blank samples will be used to determine if samples have been contaminated with VOCs during sampling or shipping to the laboratory.

3.6.1.6 Ambient/Field Blanks

Ambient blanks will be collected for VOC analysis only. They serve as a check on environmental contamination from airborne contaminants at the sampling location. The ambient blank is prepared by pouring distilled or laboratory grade water into a clean sample container either at the laboratory or in the field, and exposing this blank in the field at the time of sample collection and at a particular well location. Ambient blanks will be collected for both groundwater and soil samples for VOC analysis at a frequency of one per week.

3.6.1.7 Temperature Blanks

Each cooler containing soil and groundwater samples will be shipped with a temperature blank. A temperature blank is a sample container filled with tap water and shipped in the cooler to the off-site laboratory. The laboratory will record the temperature of the blank upon receipt of the samples. The temperature blank is to ensure that the temperature of the samples when received at the laboratory is less than or equal to 6°C. Temperature blanks are not required to accompany soil-vapor samples to the off-site laboratory.

3.6.2 Laboratory Quality Control Samples

To ensure acceptable data quality, laboratory QC analysis will be performed for each method and for each matrix. Laboratory QC samples will include method blanks, initial and continuing calibration blanks, surrogates, LCSs, and internal standards. Tables 3-5 through 3-8 present these QC samples, acceptance criteria, and corrective actions. These QC requirements are consistent with the DoD QSM (2010) guidance. The DoD QSM and laboratory in-house control limits are presented in Appendix B.

3.7 Instrument/Equipment Testing, Inspection, and Maintenance

This section provides field and analytical instrument testing, inspection, and maintenance requirements.

All requirements are presented in tabular format on Table 3-9 (Field Instrument Quality Control), Table 3-10 (Laboratory Instrument Quality Control – Groundwater Monitoring), Table 3-11 (Laboratory Instrument Quality Control – Soil), and Table 3-12 (Laboratory Instrument Quality Control – Soil-Vapor Monitoring).

3.8 Instrument/Equipment Calibration and Frequency

This section discusses calibration requirements, frequencies, and corrective actions for each method.

These calibration requirements are established in accordance with the DoD QSM requirements.

Calibration is a reproducible reference point to which all sample measurements can be correlated. Instrumentation calibration is necessary for accurate sample quantitation. Calibrations establish the dynamic range of an instrument, establish response factors to be used for quantitation, and demonstrate instrument sensitivity.

All requirements are presented in tabular format in Table 3-13 (Analytical Instrument Calibration - Gas Chromatography/Mass Spectrometry), Table 3-14 (Analytical Instrument Calibration (Gas Chromatography)), Table 3-15 (Analytical Instrument Calibration (Inductively Coupled Plasma Atomic Emission Spectrometry), and Table 3-16 (Analytical Instrument Calibration (Ion Chromatography/Colorimetric)).

3.9 Inspection/Acceptance of Supplies and Consumables

The accuracy of sample target analyte quantitation is directly related to the accuracy of the standards used for instrument calibration. To ensure the highest quality standard, primary reference standards used by laboratories are obtained from reliable commercial sources. Inorganic standards must be traceable to the National Institute of Standards and Technology (NIST) and organic standards must be traceable to NIST, or American Association of Laboratory Accreditation vendors when available. When standards are received at the laboratory, the date received, supplier, lot number, purity and concentration, and expiration date are recorded in a standard preparation log book. Vendor certifications sent with the standards are also filed and are available upon request.

Standards purchased by the laboratory may be in a pure form, in a stock, or working standard solution. All standards made are given a standard identification number and have the following information recorded in a standards log book: source of standard used to prepare dilution; preparer's initials; initial concentration; final concentration; solvent; source and lot number of solvent; volume of final solution; and volume of standard diluted. Records must unambiguously trace the preparation of standards, their use

in calibration, and the quantitation of sample results. After preparation and before routine use, the identity and concentration of standards are verified. Verification procedures include a check for chromatographic purity (if applicable) and verification of the concentration of the standard using a standard prepared at a different time or obtained from a different source. Reagents are also examined for purity by subjecting an aliquot or subsample to the analytical method in which it will be used. Standards are routinely checked for signs of deterioration (e.g., discoloration, formation of precipitates, and changes in concentration) and are discarded if deterioration is suspected or their expiration date has passed. Expiration dates may be taken from the vendor recommendation, the analytical methods, or from internal research.

3.10 Other Field Measurement Activities

This section describes types of data that are generated from BFF Spill field activities aside from sampling and analysis. These measurement activities include items such as boring logs from drilling operations and well installations, geophysical logs, well development records, and other field type testing that will be performed in conjunction with the BFF Spill remediation.

3.10.1 Soil Boring Logs and Well Reports

Soil boring logs will be kept for each well that is installed at Kirtland AFB BFF. Soil boring logs will be incorporated into well reports that will be submitted with each quarterly report.

3.10.1.1 Soil Boring Logs (Deep and Shallow)

At the completion of a well, the qualified geologist logging the hole will turn in the field boring log and well construction field form to the Project Professional Geologist (PG). The logs will be reviewed for completeness and consistency. If any discrepancies or errors are noted in the logs during review, the Project PG will contact the geologist for corrections, if possible. Any missing information or less than standard areas in the logging will be identified and communicated to the geologist before the start of the next well. Additionally, the Project PG will perform random checks on the field logging by visiting the

geologist during borehole advancement and well construction, to ensure that logs are complete and accurate.

During the logging of a borehole, the qualified geologist will collect samples every 5 ft to add to a chip tray specific to the well. The chip-tray samples will be used to conduct periodic checks of the logs against the samples collected, by the Project PG. The chip-tray samples will also provide the geologist reference material to ensure that observed units are logged consistently between boreholes.

3.10.1.2 Well Reports

Upon the completion of the boring advancement and well construction, the field logs will be entered into the gINT® software to generate an electronic database of the logging and construction information and to generate a log to be included in the well report for a given well. Each boring log will be reviewed against the field log as a QC review to ensure that all information on the field log are accurately and completely transferred to the electronic log. Well development documentation will be reviewed daily (during well development activities) by the Project PG and/or Project Hydrogeologist to verify that the well development requirements have been met.

Each well report will consist of information on the design, construction, and development of each monitoring well. The well report will include the elements listed below:

1. Well, boring name/number;
2. Date/time of construction;
3. Borehole diameter and casing diameter;
4. Surveyed location coordinates;
5. Total depth, expressed as both depth below ground surface and elevation above sea level;
6. Name of drilling contractor;

7. Casing length;
8. Casing materials;
9. Casing and screen joint type;
10. Screened interval(s), expressed as both depth(s) below ground surface and elevation(s) above sea level;
11. Screen materials;
12. Screen slot size and design;
13. Filter-pack material and size;
14. Filter-pack volume (calculated and actual);
15. Filter-pack placement method;
16. Filter-pack interval(s), expressed both as depth(s) below ground surface and elevation(s) above sea level;
17. Annular sealant composition;
18. Annular sealant placement method;
19. Annular sealant volume (calculated and actual);
20. Annular sealant interval; expressed both as depth below ground surface and elevation above sea level;
21. Surface sealant composition;
22. Surface sealant placement method;
23. Surface sealant volume (calculated and actual);
24. Surface sealant interval, expressed both as depth below ground surface and elevation above sea level;
25. Surface seal and well apron design and construction;
26. Development procedure and turbidity measurements;
27. Well development purge volume(s) and stabilization parameter measurements;
28. Type, design, and construction of protective casing;
29. Type of cap and lock;
30. Ground surface elevation above sea level;
31. Survey reference point elevation above sea level on well casing;

32. Top of casing elevation above sea level;
33. Top of protective seal casing elevation above sea level;
34. Drilling method(s); and
35. Types, quantities, and dates/times that additives were introduced, if any.

The Project PG will review all well reports prior to the submittal of the reports for review. With Project PG approval, the well reports will be posted for USACE and Kirtland AFB review. Any comments received will be incorporated into the reports and changes will be reviewed by the Project PG. If comments received are global to the type/quality of data being recorded initially by the Qualified Geologist, the information will be passed along verbally and in email to the team of Qualified Geologists for correction in subsequent logs.

3.10.2 Geophysical Logging

Downhole geophysical logging will be conducted on wells installed during the investigation. The data will be reviewed as collected in the field to identify any issues requiring resolution during data collection. Additionally, raw logging data will be processed following field data collection. Subsequent logging reports will be generated and reviewed as described below.

3.10.2.1 Field QC Data Review

The specific protocols for review of the data in the field are discussed in the individual project work plans. The Wireline Summary Sheet will be used by the Shaw QC Geophysicist in the field to document the parameters for each logging run and the instrument functional checks for each probe used. The instrument functional checks will be transferred to an Excel spreadsheet so they can be assessed in graphical form over the duration of the project. Hard-copy prints of the logs will be reviewed in real-time by the logging engineer and Shaw QC Geophysicist to determine repeat interval(s) and ensure the measurements from each probe are reasonable in terms of the expected response. At the end of logging

operations each day, the raw digital data from the probes will be transferred to the Shaw QC Geophysicist for backup and the data also will be transferred to the subcontractor's processing center for additional analysis and processing.

3.10.2.2 Data Processing and Review

The geophysics subcontractor will perform processing of the data for each probe and generate a Log ASCII Standard (LAS) file and hard-copy prints of the final processed data for each well. Shaw will review the LAS files for consistent format, including revising the log curve names so they are compatible with input into Rockware software. After review of the LAS file format, the digital data for each probe will be transferred to Microsoft Excel as requested by the NMED. A Shaw Geophysicist will perform limited processing in Excel that will include smoothing of the natural gamma data (if necessary) and plotting of the induction and neutron data on logarithmic scales. Excel logging curves will be visually compared to the curves from the hard-copy prints of the final processed data to ensure consistency.

3.10.3 Surveying

Each well will be surveyed following well completion for inclusion in the well reports. Surveying will be done in batches. Shaw personnel will accompany the surveying team to provide field oversight and to ensure that wells are surveyed in accordance with the project and Shaw requirements. Processed data are required to be delivered to Shaw within 10 days of data collection as a Grid file. The file will be imported into Excel and parsed to get X, Y, Ground Elevation, Top of Outer Steel Elevation, and Measuring Point Elevation. The data will then be imported into the geographical information system (GIS) project database where it will be checked and plotted to determine if there are any anomalies in the data. If anomalies are identified in the elevations or offset, the well(s) will be resurveyed.

3.10.4 Slug and Pump Tests

Slug tests and the pump test(s) will be conducted in accordance with the procedures outlined in the applicable work plan. During the conducting of slug and pump tests, the data will be reviewed in real-time to determine if the data collected are of sufficient quality for analysis. If data from the tests are determined to be satisfactory, field equipment will be removed and the data submitted for analysis. The Project Hydrologist will review data analysis and results to determine quality. If any issues were observed in the processing of data that would warrant repeating a test, the test will be repeated and the new data will be analyzed.

3.10.5 PneuLog™ Testing

Proper use of PneuLog™ information allows for optimization of SVE well placement and optimizes the location of screen placement to target the contaminant-producing soil layer. This project will use a procedure combining site characterization and the collection of SVE data in vadose-zone soils containing VOCs to optimize SVE placement.

Pneumatic well logging is used to develop a detailed conceptual site model to aid in the design, optimization, or closure of SVE systems. The following data will be collected in addition to lithologic logging and conventional sample analyses to build the conceptual site model:

- Flow and vacuum data from extraction wells,
- Vertical vapor concentration data from extraction wells, and
- Vertical air production profiles from extraction wells.

During vertical profiling of flow from the vent well, the change in cumulative gas flow measured by the velocity sensor as it travels from one depth interval to another is equal to the gas flow emanating from that soil interval. The gas permeability value for each interval is then determined from Darcy's Law. The

technique is analogous to techniques applied in water wells to identify preferential pathways for groundwater.

Flow and vacuum data will be measured using calibrated in-line meters. When collecting samples for VOC analysis, flow rates will not exceed 200 milligrams per minute and vacuums will be maintained to below 10 inches of water, if practical. The vacuum pressure will be recorded for each sample collected. A flow controller will be used to provide a consistent flow rate for each collected sample.

Appropriate QA procedures will be followed during all aspects of sample collection and analysis of air samples to ensure that sampling error is minimized and high quality data are obtained. Sampling team members will avoid actions (e.g., fueling vehicles, using permanent marking pens, wearing freshly dry-cleaned clothing or personal fragrances, etc.) that can cause sample interference in the field. Portable air monitoring equipment or field instrumentation will be properly maintained, calibrated, and tested to ensure validity of measurements. Air sampling equipment will be stored, transported, and between samples decontaminated in a manner consistent with the best environmental practices to minimize problems such as field contamination and cross-contamination. Samples will be collected using certified clean sample devices. Where applicable, steps will be taken to ensure that the gas used by the laboratory to clean the sample device is different from the gas used as a tracer during sampling (e.g., helium). Samples will meet sample holding times and temperatures and be delivered to the analytical laboratory as soon as possible after collection. In addition, laboratory appropriate procedures will be followed, including field documentation (sample collection information and locations), chain of custody, and field and laboratory QC samples, as appropriate.

Soil-vapor samples will be analyzed in the field using a PID and a field gas chromatograph. The PID will be calibrated at least daily in accordance with manufacture's recommended procedure. Vapor phase

standards will be used for system calibration. Duplicate samples will be collected and analyzed per batch of 10 field samples.

3.10.6 SVE Radius of Influence

Various instruments are used in radius of influence testing. The instrumentation used for radius of influence testing will be checked for proper operation and accuracy. Calibration will be checked using manufacturer's procedures. Accuracy will be checked by comparing the portable instrument readings against secondary instruments, such as vacuum gauges or in-line flow meters. All instrument calibration and accuracy checks will be recorded on either the field activity daily logs or separate SVE data collection forms.

The distance between the various wells used in the radius of influence testing will be determined from the survey coordinates using standard GIS procedures.

3.10.7 Hydrocarbon Baildown Tests

The instruments used in baildown tests are an interface probe and a volumetric container. The interface probe measuring table will be checked for accuracy by measuring the distance from the probe sensor to the 10-ft marker against a standard steel tape and measuring between two permanent markers across any cable splices. If the difference between the interface probe permanent markers and the steel tape distance is more than 0.10 ft, the interface probe cable shall be repaired. Results will be recorded on the field activity daily log. Volumetric containers used will have permanent volume markers and will not require additional calibration.

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4. DATA VALIDATION AND USABILITY

4.1 Analytical Data Review, Verification, and Validation

The laboratory analyst who generates the analytical data will have the primary responsibility for the correctness and completeness of data. Each step of this verification and review process will involve the evaluation of data quality based on both the results of the QC data and the professional judgment of those conducting the review. This application of technical knowledge and experience to the evaluation of data is essential in ensuring that data of known quality are generated consistently. All data generated and reduced will follow well-documented in-house protocols.

4.1.1 Level 1: Technical (Peer) Data Review

Analysts will review the quality of their work based on an established set of guidelines, including the QC criteria established in each method, in this QAPjP, and as stated within the laboratory QA manual. This review will, at a minimum, ensure that the following conditions have been met:

- Sample preparation information is correct and complete.
- Analysis information is correct and complete.
- Appropriate SOPs have been followed.
- Calculations are verified.
- There are no data transposition errors.
- Analytical values are correct and complete.
- QC samples results are within established control limits.
- Blank and LCS results are within appropriate QC limits.
- Special sample preparation and analytical requirements have been met.
- Documentation is complete; for example, any anomalies and holding times have been documented and forms have been completed.

4.1.2 Level 2: Technical Data Review

A supervisor or data review specialist whose function is to provide an independent review of data packages will perform this review. This review will also be conducted according to an established set of guidelines and will be structured to verify the Level 1 data review. This review will, at a minimum, ensure that the following conditions have been met:

- Appropriate laboratory SOPs have been followed.
- Calibration data are scientifically sound and appropriate to the method.
- QC samples results are within established guidelines.
- Qualitative identification of contaminants is correct.
- Manual integrations are justified and documented.
- Quantitative results and calculations are correct.
- Data are qualified correctly.
- Documentation is complete.
- The data package is complete and complies with contract requirements.

The Level 2 review will be structured so that all calibration data and QC sample results are reviewed and all of the analytical results from at least 10 percent of the samples are checked back to the sample preparation and analytical bench sheets. If no problems are found with the data package, the review will be considered complete. If discrepancies are identified, additional data evaluation is required.

4.1.3 Level 3: Administrative Quality Assurance Data Review

The Laboratory QA Manager will review 10 percent of all data packages. This review should be similar to the review as provided in Level 2, except that it will provide a total overview of the data package to ensure its consistency and compliance with project requirements. All errors noted will be corrected and documented.

4.2 Analytical Data Verification and Validation

The Shaw Project Chemist or designee will use established data validation procedures (manually or automated) to perform 100 percent EPA Level III data review. The review will be performed for groundwater, soil, and soil-vapor analytical data obtained from each of the field tasks.

The data review will be performed using the QC criteria specified in the following analytical method and data validation guidelines:

- Project-specific QAPjP;
- *DoD Quality Systems Manual for Environmental Laboratories, Version 4.2* (October 2010);
- *USEPA Test Methods for Evaluating Solids Waste, Physical/Chemical Methods* (SW 846, 2006 and updates);
- *USEPA Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, Compendium Method TO-15, Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS)* (January 1999);
- MA DEP, *Method for the Determination of Extractable Petroleum Hydrocarbons (EPH)* (May 2004a);
- MA DEP, *Method for the Determination of Volatile Petroleum Hydrocarbons (VPH)*(May 2004b);
- MA DEP, *Method for the Determination of Air-Phase Petroleum Hydrocarbons (APH)* (December 2008);
- American Public Health, Association, American Water Works Association, and Water Environment Federation, *Standard Methods for the Examination of Water and Wastewater, 21st Edition* (2005);
- *USEPA Contract Laboratory Program, National Functional Guidelines for Superfund Organic Methods Data Review* (June 2008); and
- *USEPA Contract Laboratory Program, National Functional Guidelines for Inorganic Superfund Data Review, Final* (January 2010).

The following QC elements will be included in the EPA Level III data review:

- Sample extraction and analysis holding times,
- Laboratory method blanks,
- Surrogate spike recoveries,
- LCS/LCSD recoveries,

- MS/MSD recoveries,
- Relative percent difference (RPD),
- Initial calibrations,
- Continuing calibrations,
- Trip, rinse, and ambient field blank results, and
- Field duplicate sample precision.

Data will be validated and flagged with the following data qualifiers as applicable:

- **J+ qualifier** denotes the analyte was positively identified, but the associated numerical value is estimated with a potential high bias.
- **J- qualifier** denotes the analyte was positively identified, but the associated numerical value is estimated with a potential low bias.
- **U qualifier** denotes the analyte was analyzed for, but was not detected above the MDL.
- **UJ qualifier** denotes that the analyte was not detected above the reported sample LOQ. However, the reported LOQ is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
- **R qualifier** denotes the data are unusable due to deficiencies in the ability to analyze the sample and meet QC criteria and DQOs.

As a result of the data validation process, EPA qualifiers will be generated and applied to the affected sample results that exceeded the established QC criteria. EPA level III data review findings will be summarized and documented with each quarterly monitoring report.

4.3 Reconciliation with User Requirements

Based on data review and data qualification, the Project Chemist will determine if the project DQOs have been met, and data completeness will be calculated. To reconcile the collected data with project DQOs and to establish and document data usability, the data will be reviewed against data quality indicators discussed below.

The Project Chemist will prepare a data quality assessment (DQA) report for each of the quarterly monitoring events. The DQA report will document:

- Implementation of sampling design and analysis according to the approved QAPjP (or sample completeness and representativeness);
- Proper frequency of field QC samples and the adequacy of field decontamination procedures;
- Accuracy and precision of the data;
- Data comparability, if applicable; and
- Data usability for project decisions.

4.3.1 Data Quality Indicators

This section defines the data quality indicators and their use for assessment of data quality.

4.3.1.1 Precision

Precision measures the reproducibility of measurements under a given set of conditions. The following equation illustrates the method for calculating RPD to assess a method's precision:

$$\text{Precision as RPD} = \frac{\text{Absolute (Result - Duplicate Result)}}{\text{Average (Result + Duplicate Result)}} \times 100\%$$

The laboratory uses MS/MSD samples to assess the precision of analytical procedures. According to USACE requirements, analytical laboratories perform MS/MSD on the project samples. This allows determining whether matrix interferences may be present.

In addition, laboratory LCS/LCSD samples can be used to determine analytical method precision when MS/MSD samples are not practical due to the nature of sample or analytical method used. Laboratories will use precision limits specified in the DoD QSM for both LCS and MS analyses (DoD, 2010). When precision limits are not available in the DoD QSM, laboratories may use statistically-based acceptability

limits for RPDs established for each method of analysis and sample matrix. The laboratory will review the QC samples to ensure that internal QC data achieve limits of acceptability. Any suspect trends will be investigated and corrective actions taken.

4.3.1.2 Accuracy

Accuracy measures the bias of an analytical system by comparing the difference of a measurement with a reference value. The percent recovery of an analyte, which has been added to the environmental samples at a known concentration before extraction and analysis, provides a quantitation tool for analytical accuracy. The spiking solutions used for accuracy determinations are not used for instrument calibrations. The following equation illustrates how accuracy is evaluated:

$$\text{Accuracy as Percent Recovery} = \frac{\text{Spiked Sample Result} - \text{Sample Result}}{\text{Spiked Sample True Value}} \times 100\%$$

Percent recoveries for MS, MSD, and LCS serve as a measure of analytical accuracy. Surrogate standards are added to all samples, blanks, MS, MSD, and LCS analyzed for gas chromatography and mass spectrometry analytical methods to evaluate accuracy of the method and help to determine matrix interferences.

Laboratories will use LCS limits specified in the DoD QSM for both LCS and MS analyses (DoD 2010). When LCS limits are not available in the DoD QSM, the laboratory may use in-house, statistically-based, control limits or control limits specified in EPA methods.

4.3.1.3 Representativeness

Unlike precision and accuracy, which can be expressed in quantitative terms, representativeness is a qualitative parameter. Representativeness is the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. A qualitative parameter depends on proper design of the sampling program.

Field personnel will be responsible for ensuring that samples are representative of field conditions by collecting and handling samples according to the approved QAPjP and work plans. Errors in sample collection, packaging, preservation, or COC procedures may result in samples being judged non-representative and may form a basis for rejecting the data.

Data generated by the laboratory must be representative of the laboratory database of accuracy and precision measurements for analytes in different matrices. Laboratory procedures for sample preparation will ensure that aliquots used for analysis are representative of the whole sample. Aliquots to be analyzed for volatile (if any) parameters will be removed before the laboratory composites/homogenizes the samples, to avoid losing volatile compounds during mixing.

4.3.1.4 Comparability

Comparability is a qualitative parameter expressing the confidence where one data set can be compared with another, whether it was generated by a single laboratory or during laboratory studies. The use of standardized field and analytical procedures ensures comparability of analytical data.

Sample collection and handling procedures will adhere to EPA-approved protocols. Laboratory procedures will follow standard analytical protocols, use standard units and standardized report formats, follow the calculations as referenced in approved analytical methods, and use a standard statistical approach for QC measurements.

4.3.1.5 *Completeness*

Completeness goals for each sampling round are defined in the following section.

4.3.1.5.1 *Contractual Completeness*

The contractual completeness goal is set at 95 percent for all methods and is calculated as defined below.

The following QC elements are evaluated for the purpose of determining completeness calculation.

- Holding time,
- Laboratory blank contamination,
- Initial calibration verification,
- Continuing calibration verification, and
- LCSs.

$$\% \text{ Contract Completeness} = \frac{\text{Number of Unqualified Results}^*}{\text{Number of Results Reported}} \times 100\%$$

** Determined by subtracting the results qualified based on contractual deficiencies from the total number of results*

4.3.1.5.2 *Analytical Completeness*

The analytical completeness goal is set at 90 percent for all methods and is calculated as defined below.

The following QC elements will be considered analytical deficiencies for the purposes of the analytical completeness calculation.

- Holding time;
- Laboratory blank contamination;
- Field blank contamination (trip, equipment, ambient and rinse);
- Initial calibration verification;
- Continuing calibration verification;
- LCS recovery;
- MS recovery;
- MS precision, and
- Surrogate recovery.

$$\% \text{ Analytical Completeness} = \frac{\text{Number of Unqualified Results}^*}{\text{Number of Results Reported}} \times 100\%$$

* *Determined by subtracting results qualified for any of the deficiencies from the total number of results.*

4.3.1.5.3 **Technical Completeness**

The technical completeness goal is set at 95 percent for all methods and is calculated as defined below.

Results considered unusable (or rejected) for the intended purpose based on contractual or technical deficiencies will be included for the purposes of the technical completeness calculation.

$$\% \text{ Technical Completeness} = \frac{\text{Number of Useable Results}^*}{\text{Number of Results Reported}} \times 100\%$$

* *Technical completeness (i.e., usability) will be determined by subtracting results rejected for any reason from the total number of results reported.*

4.3.2 **Project-Required Reporting Limits – Sensitivity**

Following the DoD QSM requirements, the laboratory will determine the MDLs for each method, instrument, analyte, and matrix by using the procedure described in Title 40 Code of Federal Regulations Part 136B. The MDL is defined as the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero.

Following MDL studies, the laboratory will establish the reporting limit or LOQ for each method, analyte, matrix, and instrument in accordance with the DoD QSM requirements (2010). The LOQ is the lowest concentration of a substance that produces a quantitative result within specific limits of precision and bias. The laboratory will perform quarterly LOQ verifications to verify precision and bias at the LOQ. The LOQ is greater than the limit of detection and must be within the calibration range prior to sample analysis. For this project, laboratories will report positive results down to the MDL and results between the MDL and LOQ will be flagged with a J qualifier and reported as estimated data.

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5. ASSESSMENT AND OVERSIGHT

Performing assessments and conducting QA oversight of project activities are vital to verifying that project objectives are being met and assuring the continued quality of the work performed. Assessments will take the form of field surveillances. QA oversight includes inspections of work performed, verification of field documentation, and site walk-downs.

5.1 QA Assessments

Independent assessments shall be planned and conducted to measure item and service quality, to evaluate the adequacy of work performance, and to promote improvement. The purpose of these assessments is to evaluate the performance of work processes with regard to regulatory, contract, and project requirements and expectations of the client. The group performing independent assessments shall have sufficient authority and freedom from the line to carry out its responsibilities. Persons conducting independent assessments must be technically qualified and knowledgeable in the areas assessed.

The Shaw QA functional line is responsible for performing independent quality assessments. The Shaw project QA Manager is part of the QA functional line, which is organizationally independent from the Kirtland AFB BFF Spill Project group as shown in the quality assurance organization (Figure 2-1).

The independent assessment program will include periodic field surveillances of Shaw Kirtland AFB BFF Spill field activities (e.g., drilling, sampling, waste management, etc.). Special emphasis will focus on areas with the greatest consequences of failure and the greatest benefit from improvement.

The surveillance processes will consist of monitoring or observing an item, activity, system, or process to verify that it conforms to specified requirements. These types of assessments are intended to facilitate the frequent monitoring of work in progress to determine and document compliance with established

requirements and procedures. Surveillances will be performed and documented as described in the Shaw SOP EI-Q006 (Surveillance).

5.2 QA Oversight

QA oversight will be performed on site on a daily basis and is intended to be an interactive part of the field work performed. QA oversight will be performed by the Shaw Site Safety/QC Lead, or designee. QA oversight includes inspections of work performed, verification of field documentation, and site walk-downs.

5.2.1 Inspections

Inspection activities will be used to monitor project activities and materials to ensure compliance with established requirements. The objective of inspections is to determine whether the properties, composition, and performance of activities or materials are within established requirements. Inspections shall be performed periodically during the work process to prevent unintended use or installation, to provide monitoring, to minimize delays in work, and to identify nonconformances while they are still correctible without impacting work.

5.2.2 Verification of Field Documentation

Field documentation (e.g., Field Activity Daily Logs, Sample Collection Logs, etc.) will be reviewed and verified for accuracy and completeness on a regular basis. This verification process is an informal process performed as part of the Daily QC Report preparation; allowing for the quick and efficient correction of documentation deficiencies.

5.2.3 Site Walk-downs

Site walk-downs are informal observations of field work being performed. The intent of a site walk-down is to verify that the work is being performed as planned in a safe and orderly manner. Any deficiencies

identified during a walk-down are immediately pointed out to the field crew and corrected. Walk-downs are performed on a daily basis by the Site Safety/QC Lead, but may also be performed by the Shaw Field Chemical QA/QC Manager, the Construction Manager, the Project QA Manager, the Project Manager, or any other senior Shaw personnel.

5.3 Nonconformances and Response Actions

Shaw processes for detecting, preventing, and correcting quality problems are discussed in this section. The Project QA/QC staff focuses on continuous improvement of the products and services provided by Shaw with emphasis on the processes that generate products and deliver services. Items and processes that do not meet established criteria shall be identified, controlled, and corrected, as applicable. Personnel at all levels are responsible for identifying problems and process improvement opportunities and are encouraged to offer solutions.

5.3.1 Problem Identification/Reporting

It is the responsibility of all Shaw and subcontractor personnel to assess activities and inspect items used within the project to verify that each meets specified requirements and to document incidences of nonconforming items, activities, or conditions on a Nonconformance Report (NCR) per Shaw SOP EI 007 (Nonconformance Reporting). It is the responsibility of the project management staff to promptly report, respond to, and resolve nonconforming conditions and to foster a “no-fault” attitude that encourages the identification of nonconforming items and processes.

Personnel who identify a nonconforming condition that is potentially hazardous to workers, the public, or the environment or that jeopardizes the integrity of the program or project have the responsibility and authority to suspend work and report the condition to the responsible manager.

5.3.2 Control and Disposition of Nonconforming Items

Items that do not meet specified requirements, known as nonconforming items, shall be identified by marking, tagging, or other methods that do not adversely affect their end use. Nonconforming items shall be segregated, when practical, by placing them in a clearly identified and designated hold area until properly dispositioned. If segregation is impractical or impossible due to physical conditions, then other administrative controls and precautions should be employed to preclude inadvertent use of nonconforming items.

5.3.3 Nonconforming Activities

Activities or documentation identified as out of compliance with requirements shall be documented as a nonconformance for the purpose of identification of corrective actions and evaluation of the effect on the project objectives. When the integrity of the work is left in question, the work should be performed again, if possible. When not possible, limitations of the results of the work must be documented in the final report of the work.

5.3.4 Cause Analysis

Cause analysis will be performed whenever the understanding of the basic underlying cause is important to the prevention of similar or related problems or when the nonconformance relates to safety. The extent of the cause analysis should be based on the possible negative consequences of a repeat occurrence of a problem. A cause analysis will be used to gain an understanding of the deficiency, its causes, and the necessary corrective actions to prevent recurrence. This analysis should be a systematic process of investigation that uncovers the most basic cause. A summary of the cause analysis shall be documented on the NCR.

5.3.5 Corrective Actions

Responsible managers shall develop and document corrective actions, as applicable, for identified nonconformances. Corrective actions should be targeted at the primary causes of the problem rather than the resulting conditions or secondary causes. These actions shall be reviewed for adequacy and effectiveness in correcting the problem and approved by the Project QA Manager or a designee.

5.3.6 Improvements and Efficiencies

It is important to identify and report process improvements and efficiency gains. Successful techniques and processes will be evaluated by the Shaw Project Manager, or designee, to determine the potential for performance improvements in other areas or projects.

5.4 Reports to Management

Reports to management may include assessment reports, daily quality control reports (DQCRs), inspection reports, and NCRs.

5.4.1 Assessment Reports

Surveillance activities will be documented in surveillance reports. Surveillance reports will identify the project activities that were observed/reviewed, the associated requirements documents, and the results of the surveillances, including deficiencies identified and noteworthy practices. Surveillance reports will be prepared/approved by the Shaw QA Manager and presented to the Project Manager within 30 days of performance. Surveillance checklists used during the performance of the surveillance may be included with the final surveillance report. A copy of the final surveillance report shall be placed in the project files.

5.4.2 Daily Quality Control Reports

The Shaw QA Manager, or designee, will be responsible for the preparation and submittal of the DQCRs to the USACE. The DQCR will be posted to the Project SharePoint site.

The DQCR will provide an overview of project activities performed each day, including those performed by subcontractors and suppliers. The DQCRs will present an accurate and complete picture of project and QC activities, including inspections, accomplished; forecasted activities for the following day; and deficiencies/problems encountered. These reports will be precise, factual, legible, and objective. Copies of supporting documentation, such as daily logs, inspection checklists, sample collection logs, COC forms, and waste manifests should also be attached.

Each DQCR is to be assigned and tracked by a unique number identifying the current project and date. DQCRs with attachments are to be maintained on the project SharePoint site as part of the project files.

5.4.3 Nonconformance Reports

Nonconformance reporting will be on NCR forms (Shaw SOP EI-Q007, Nonconformance Reporting) and will include a description of the nonconforming item or activity, a summary of the corrective action to be taken, assignment of who is responsible for completing the corrective action, and verification that the corrective action is completed. Nonconformance reports will be tracked by the Shaw QA Manager and evaluated by the Shaw Project Manager. A copy of the NCR shall be placed in the project files.

6. DATA MANAGEMENT

ShawView™ is an Oracle-based Environmental Information Management System (EIMS), which will be used for sample planning, data loading, data management, and data reporting. This system supports all aspects of the project from the planning stages throughout the project lifecycle and ultimately data archiving, and thus maintains the integrity of all project-related data. All quarterly monitoring field data, including but not limited to water-level data, survey data, boring logs, and well construction logs, will be uploaded into the contractor EIMS and will be linked with validated analytical results in order to generate output files that will be used to populate Environmental Restoration Program tools and generate Environmental Resources Program Information Management System (ERPIMS) Version 5.0 submittals. ERPIMS data submittals will be reviewed for accuracy and completeness before submittal to the Air Force. ERPIMS submittals will be provided to the Air Force, at a minimum, every six months or as appropriate for data generation for uploading to the Air Force data repository. ERPIMS submittals will be deemed complete upon receipt of the insertion letter from the Air Force data management contractor.

Site characterization and remediation data will be managed using a GIS in accordance with Shaw GIS SOPs: SOP-T-GIS-001 (Folder structure), SOP-T-GIS-002 (Map naming), SOP-T-GIS-009 (Metadata creation), and SOP-T-GIS-011 (Citrix data management). The GIS dataset will include metadata conforming to the Federal Geographic Data Committee's Content Standard for Digital Geospatial Metadata. All GIS spatial data will be stored in the base-standard New Mexico State Plane Central Zone, North American Datum 83, Federal Information Processing Standard Code 3002, the feet horizontal coordinate system, the North American Vertical Datum of 1988, and the feet vertical coordinate system. Permanent GIS data will be stored in the ArcGIS Spatial Database Engine database system.

The GIS effort will involve preparation, analysis, processing, and interpretation of data acquired from sampling and analysis, geophysical surveys, and intrusive investigations. The GIS Coordinator will

manage GIS data such that it is readily available to GIS analysts using the Shaw GIS Citrix server system. The GIS data will be updated as survey data for the respective data locations become available. Contractor GIS analysts will prepare maps depicting site-specific attributes for continuous updates to be provided to project stakeholders. No data will be released to project stakeholders without the approval of the USACE.

6.1 Documents and Records

All project-related documents and records will be maintained and archived in the electronic project files on the Shaw corporate server and will be made available to the government as necessary. All data generated in support of this contract will be maintained in accordance with contract requirements.

REFERENCES

- American Public Health Association, American Water Works Association, and Water Environment Federation. 2005. *Standard Methods for the Examination of Water and Wastewater, 21st Edition*. American Public Health Association: Washington, DC. ISBN: 9780875530475.
- CH2M HILL. 2001. *Stage 1 Abatement Plan Report for the Bulk Fuels Facility (ST-106)*. Kirtland Air Force Base, New Mexico. May 21
- DoD. 2010. *DoD Quality Systems Manual for Environmental Laboratories, Version 4.2*. October 25.
- EPA. 2010. *USEPA Contract Laboratory Program, National Functional Guidelines for Inorganic Superfund Data Review, Final*. Office of Superfund Remediation and Technology Innovation (OSRTI). Office of Solid Waste and Emergency Response (OSWER) 8240.1-51 and USEPA-540-R-10-011. January.
- EPA. 2010. *Regional Screening Levels (RSL) Master Table*. Available online at <www.epa.gov/...table/...Tables/.../master_sl_table_run. December 10.
- EPA. 2008. *USEPA Contract Laboratory Program, National Functional Guidelines for Superfund Organic Methods Data Review, Final*. OSRTI. OSWER 9240.1-48 and USEPA-540-R-08-01. June.
- EPA. 2006. *USEPA Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods*. SW-846 (see 2008 update). Office of Solid Waste, Washington D.C. Online at <http://www.epa.gov/osw/hazard/testmethods/sw846>.
- MA DEP. 2008. *Method for the Determination of Air-Phase Petroleum Hydrocarbons (APH)*. December.
- MA DEP. 2004a. *Method for the Determination of Extractable Petroleum Hydrocarbons (EPH)*. May.
- MA DEP. 2004b *Method for the Determination of Volatile Petroleum Hydrocarbons (VPH)*. May.
- NMED. 2009. *Technical Background Document for Development of Soil Screening Levels, Revision 5.0*. Hazardous Waste Bureau and Ground Water Quality Bureau Voluntary Remediation Program. August, updated December 2009.
- New Mexico. 2009. New Mexico Administrative Code, Attachment 4, Title 20 - Environmental Protection, Chapter 6 - Water Quality, Part 2 - Ground and Surface Water Protection. October.
- Tetra Tech. 2004. *Base-Wide Plans for Investigation under the Environmental Restoration Program, 2004 Update*. Albuquerque, New Mexico: Kirtland AFB. April 1.

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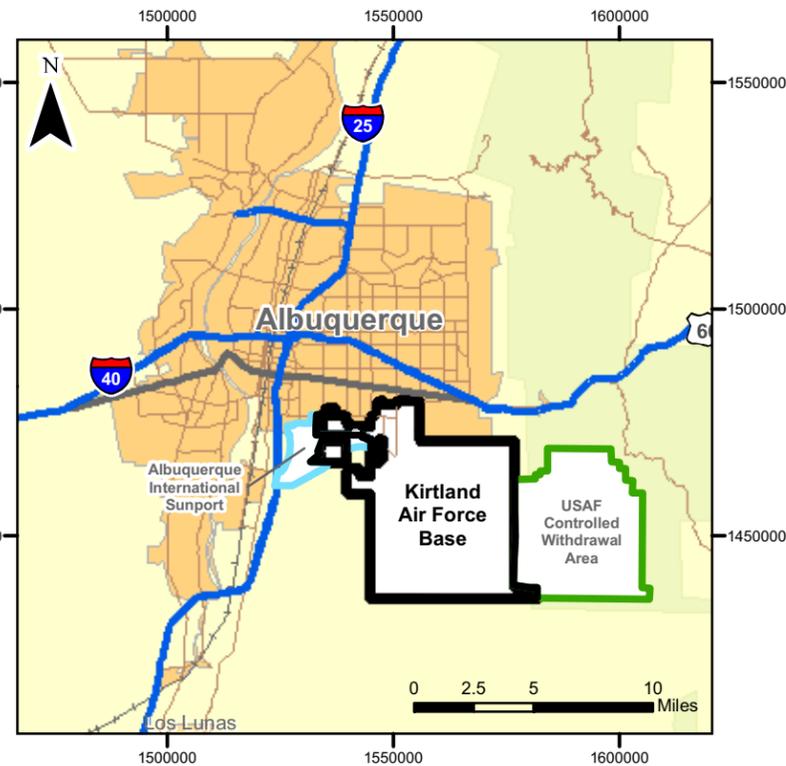
FIGURES

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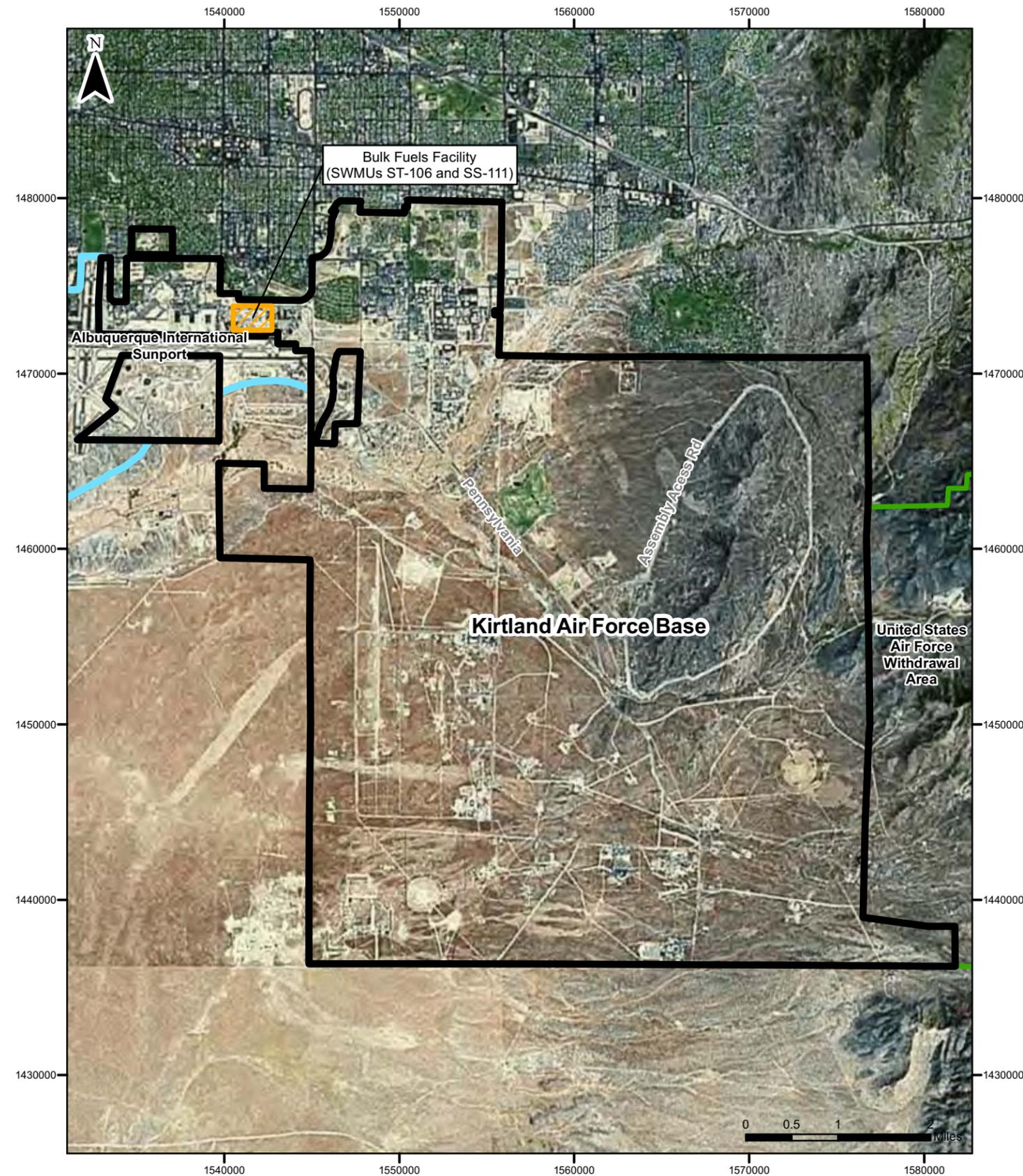
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Project Number: 140705



State Map



Local Area Map



Kirtland AFB Area Map

- Bulk Fuels Facility (SWMUs ST-106 and SS-111)
- State Boundary
- Urban Area
- Installation Location
- Kirtland Air Force Base Installation Boundary
- Albuquerque Intl_Sunport
- United States Air Force Withdrawal Area
- Limited Access
- Highway
- Major Road

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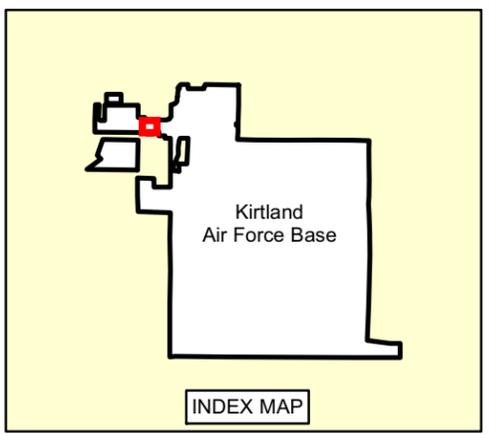
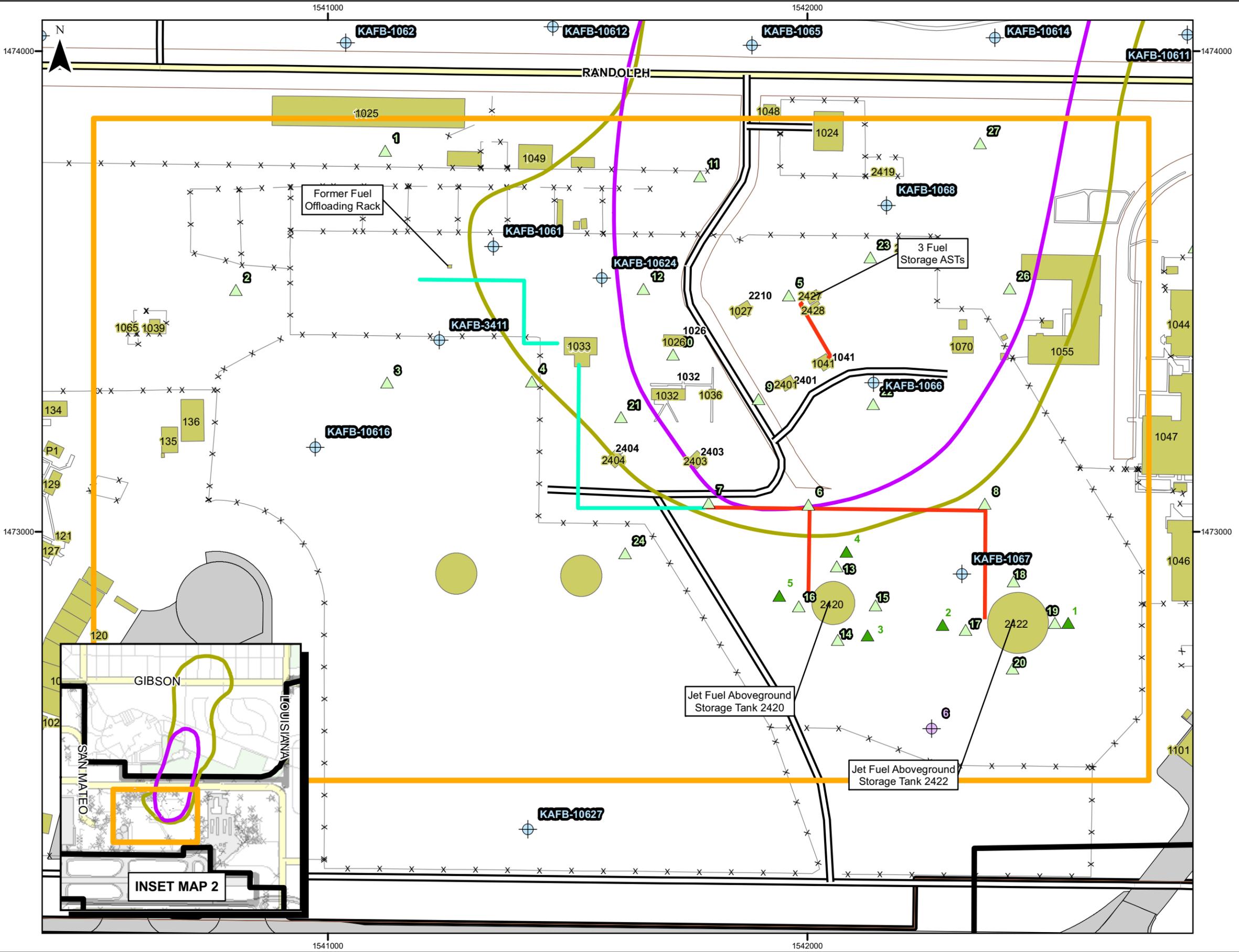
BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 1-1

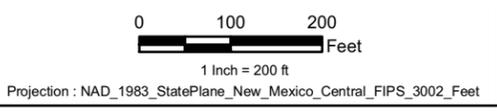
SITE LOCATION MAP

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- Borehole Locations for Soil Sampling and for Conversion to Soil-Vapor Monitoring Wells (Labeled with ID provided by NMED)
- Locations for Shallow Soil Borings in Tank Farm Area (Labeled with ID provided by NMED)
- Proposed Soil-Gas Monitoring Wells (Labeled with ID provided by NMED)
- Existing Monitoring Well
- Aboveground Fuel Transfer Lines
- Underground Fuel Transfer Lines
- Bulk Fuels Facility (SWMUs ST-106 and SS-111)
- Estimated Extent of LNAPL
- Estimated Extent of Dissolved Phase Contaminant Plume
- Installation Boundary
- Fence
- Interstate
- Major Road
- Road
- Parcels
- Structure
- Structure (other)
- Runway
- Bridge
- Sidewalk
- *Park
- Installation Boundary



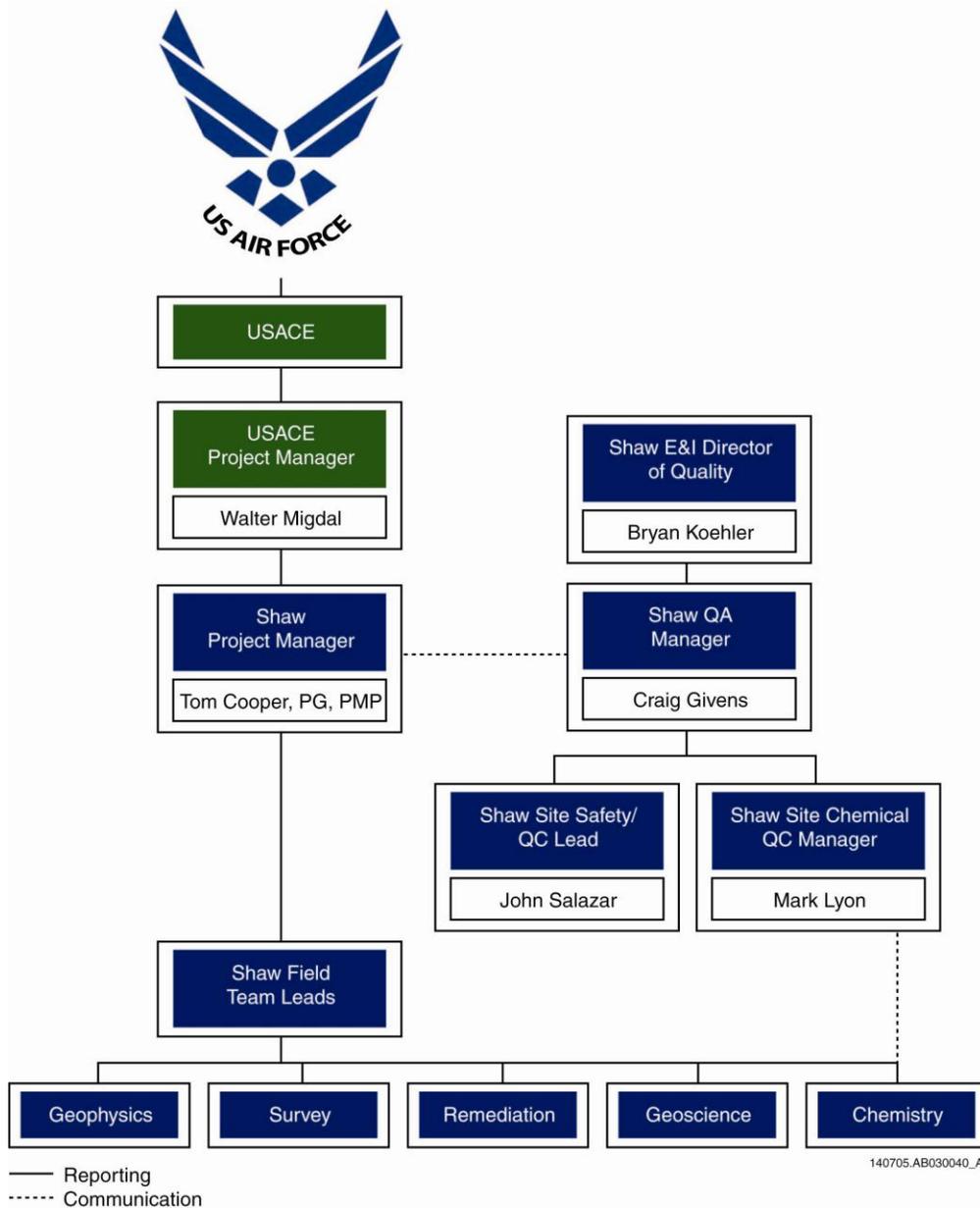
BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 1-2

SOURCE AREA AND
INFRASTRUCTURE

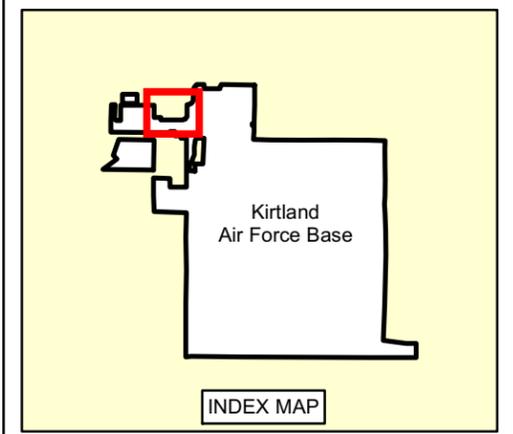
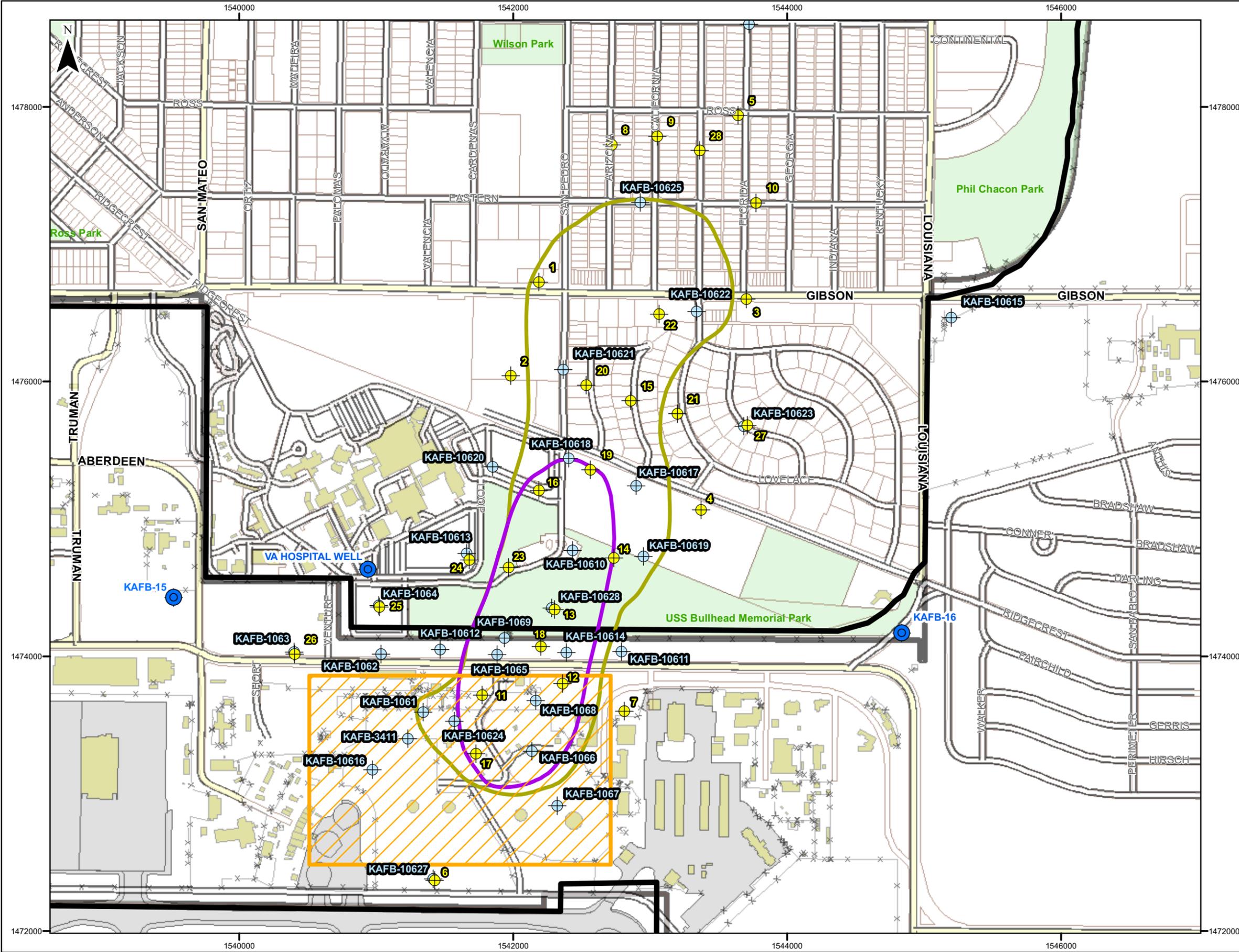
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Figure 2-1. Quality Assurance Organization



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- Proposed Monitoring Well Cluster (Labeled with ID provided by NMED)
- Water Well/Monitoring Well
- Existing Monitoring Well
- Bulk Fuels Facility (SWMUs ST-106 and SS-111)
- Estimated Extent of LNAPL
- Estimated Extent of Dissolved Phase Contaminant Plume
- Installation Boundary
- Fence
- Interstate
- Major Road
- Road
- Parcels
- Structure
- Structure (other)
- Runway
- Bridge
- Park
- Installation Boundary



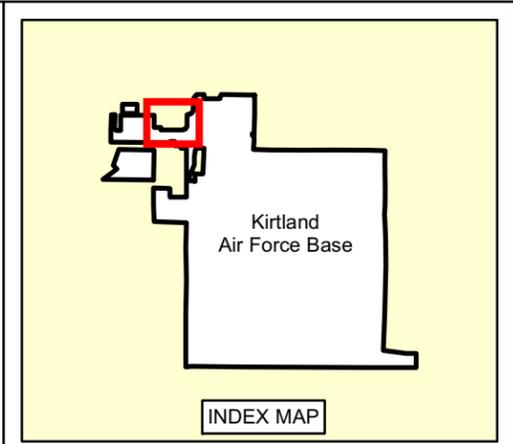
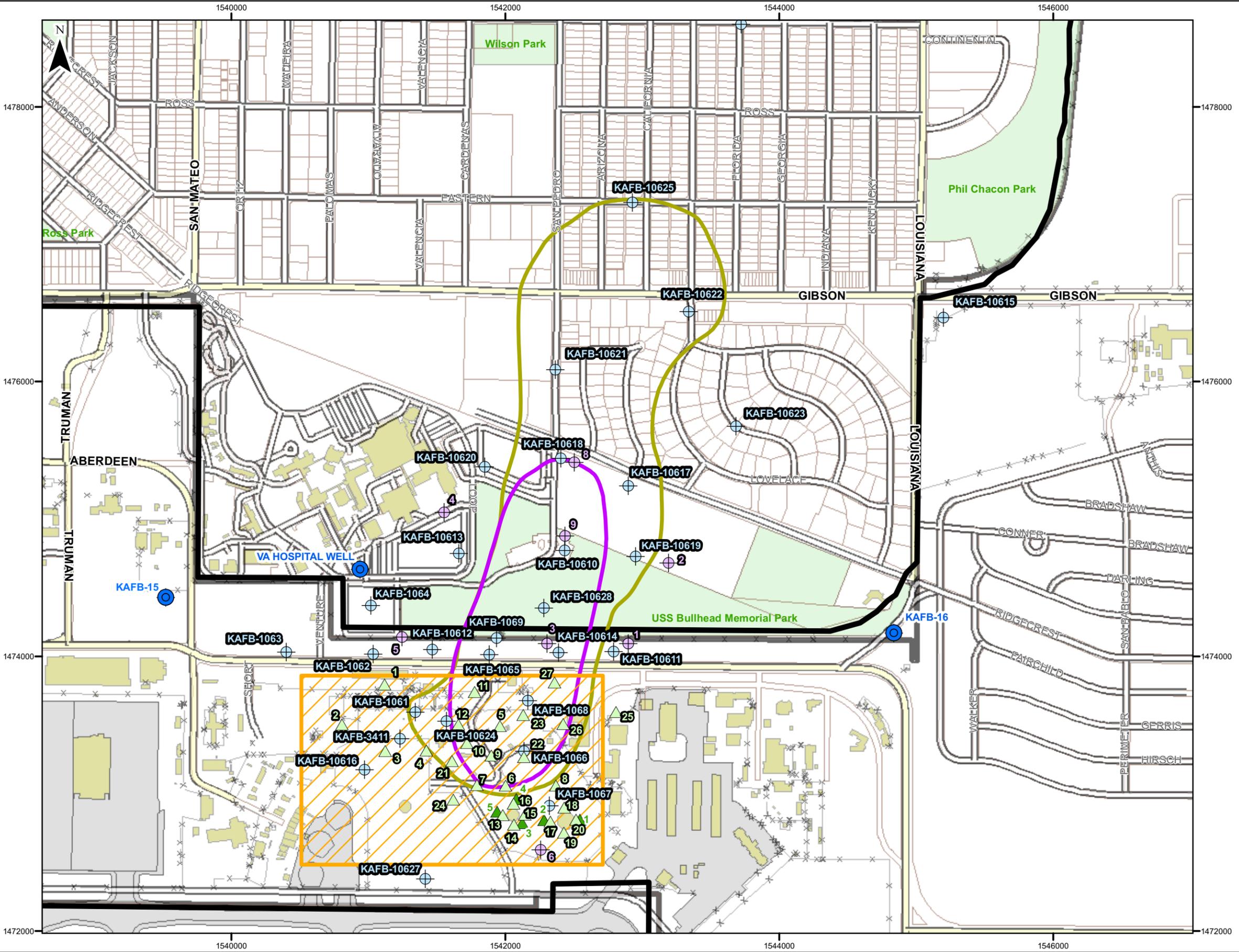
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BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 2-2

GROUNDWATER PLUME EXTENT AND EXISTING AND PROPOSED MONITORING WELLS

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- Borehole Locations for Soil Sampling and for Conversion to Soil-Vapor Monitoring Wells (Labeled with ID provided by NMED)
- Locations for Shallow Soil Borings in Tank Farm Area (Labeled with ID provided by NMED)
- Proposed Soil-Gas Monitoring Wells (Labeled with ID provided by NMED)
- Water Well/Monitoring Well
- Existing Monitoring Well
- Bulk Fuels Facility (SWMUs ST-106 and SS-111)
- Estimated Extent of LNAPL
- Estimated Extent of Dissolved Phase Contaminant Plume
- Installation Boundary
- Fence
- Interstate
- Major Road
- Road
- Parcels
- Structure
- Structure (other)
- Runway
- Bridge
- *Park
- Installation Boundary



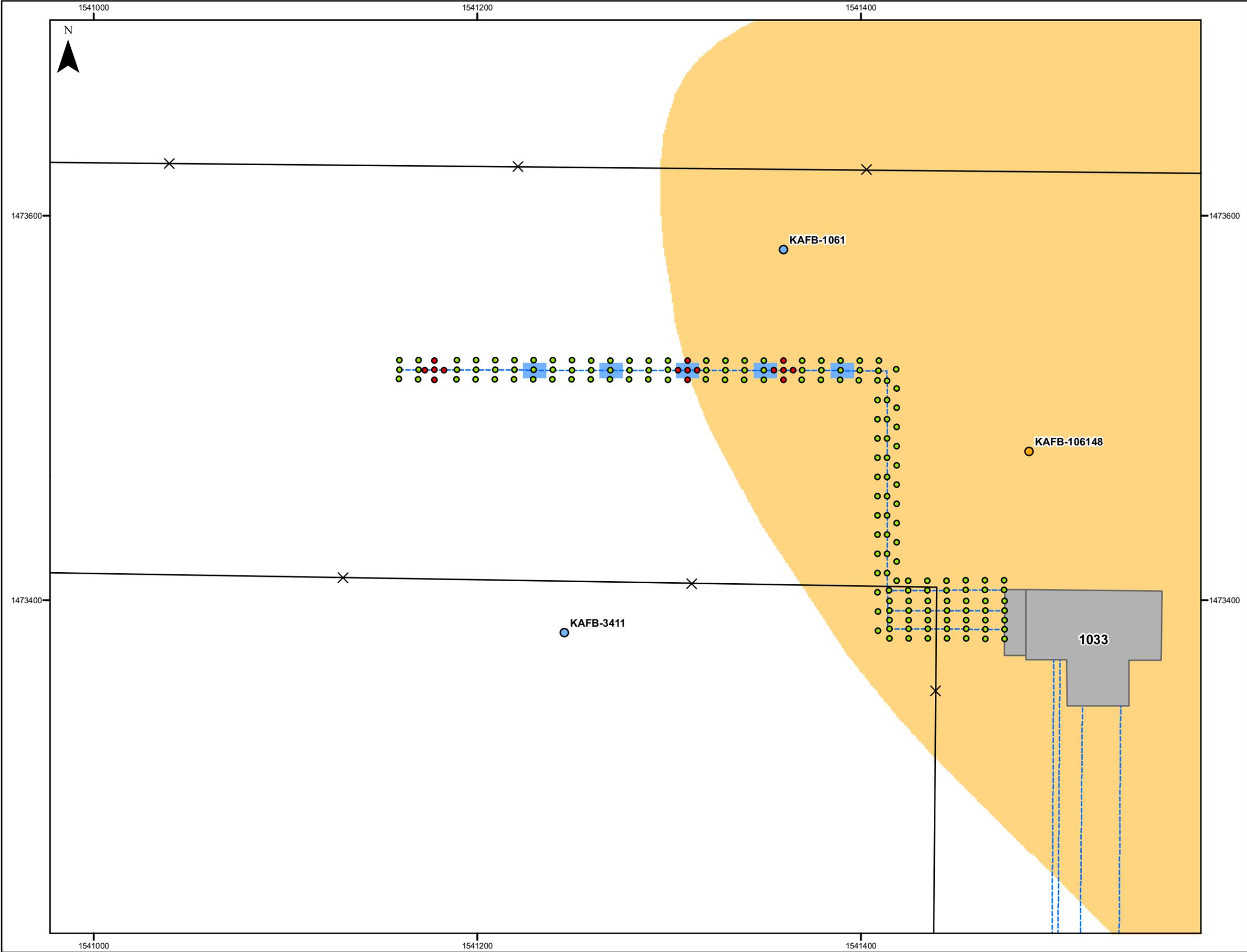
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BULK FUELS FACILITY
 KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 2-3

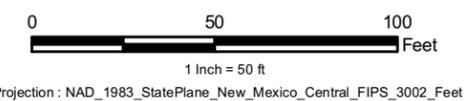
VADOSE ZONE
 EXISTING AND PROPOSED MONITORING WELLS

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- Suspected Leak Location Samples - 5 ft nodes
- Proposed Soil Sample Locations - 10 ft spacing
- Pneulog Well Location
- Existing Groundwater Monitoring Well
- ✕✕ Fence
- Former Fuel Transfer Lines
- Structures
- Former Fuel Transfer Stations
- Estimated Extent of Dissolved Phase Contaminant Plume

Note:
169 soil samples total.



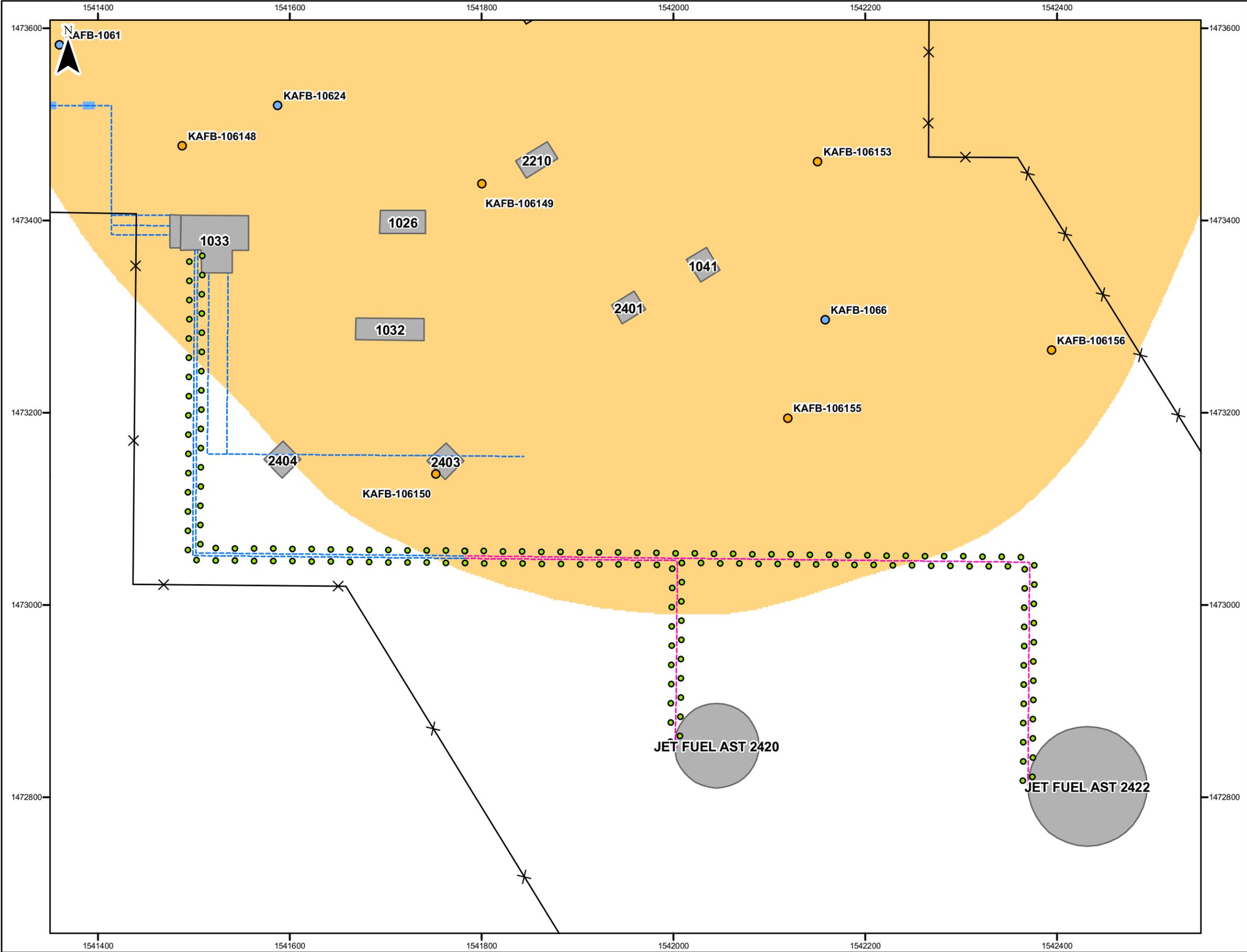
BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 2-4

FORMER FUEL OFFLOADING RACK TO
PUMP HOUSE SOIL INVESTIGATION AREAS

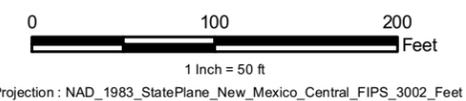
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Project Number: 140705



- Proposed Soil Sample Locations - 20 ft spacing
- Existing Groundwater Monitoring Well
- Pneulog Well Location
- Fence
- Fuel Transfer Lines
- Aboveground Fuel Transfer Lines
- Structures
- Fuel Transfer Stations
- Estimated Extent of Dissolved Phase Contaminant Plume

Note:
164 soil samples total.

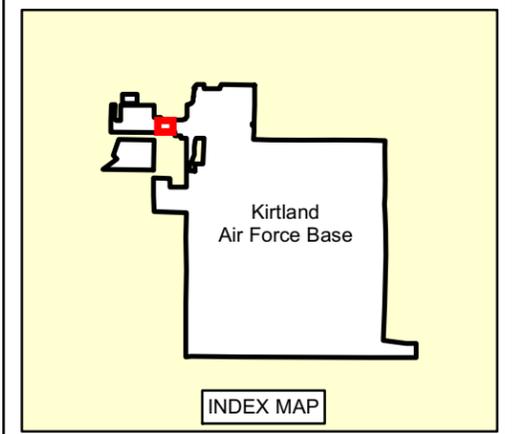
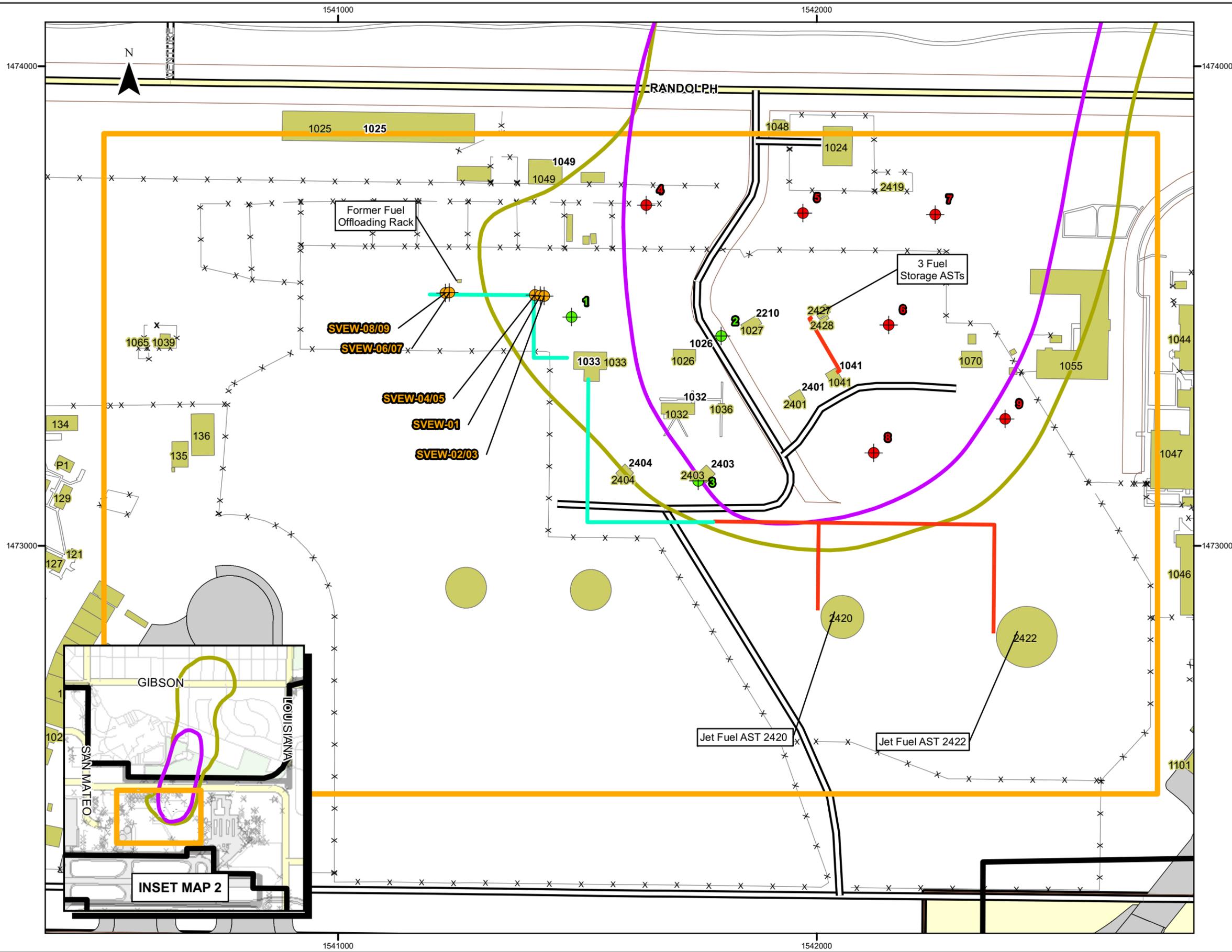


BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

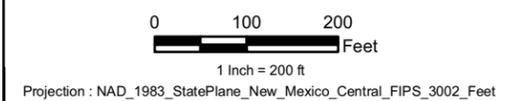
FIGURE 2-5

PUMP HOUSE AND UNDERGROUND
PIPE SOIL INVESTIGATION AREAS

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- SVE Well
- PneuLog Well Cluster
- Proposed Step-out locations for PneuLog Clusters 4 through 9
- Aboveground Fuel Transfer Lines
- Underground Fuel Transfer Lines
- Estimated Extent of LNAPL
- Estimated Extent of Dissolved Phase Contaminant Plume
- Bulk Fuels Facility (SWMUs ST-106 and SS-111)
- Installation Boundary
- Fence
- Interstate
- Major Road
- Road
- Parcels
- Structure
- Structure (other)
- Runway
- Bridge
- Sidewalk
- *Park
- Installation Boundary



INTERIM MEASURES WORK PLAN
 BULK FUELS FACILITY SPILL
 KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 2-6

LOCATION OF PNEULOG WELLS

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TABLES

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Table 2-1. Personnel Qualifications

Name	Title	Organizational Affiliation	Responsibility	Education and Experience Qualification
Walter Migdal	USACE Project Manager	USACE	<ul style="list-style-type: none"> • Manages governmental oversight of the project • Manages project funding and scope 	NA
Michael D'Auben	USACE QA Manager	USACE	<ul style="list-style-type: none"> • Provides governmental oversight of the Shaw QA Program • Provides quality-related directives through Contracting Officer's Technical Representative • Provides technical and administrative oversight of Shaw surveillance audit activities • Acts as point-of-contact on all matters concerning QA and the client's laboratory QA program • Authorized to suspend project execution if QA requirements are not adequately followed 	BS, Environmental Chemistry 22+ years of experience
Mark Phaneuf	USACE Technical Lead	USACE	<ul style="list-style-type: none"> • Provides technical oversight of groundwater monitoring activities • Point of contact for technical matters 	NA
Tom Cooper	Project Manager	Shaw	<ul style="list-style-type: none"> • Manages oversight of the project for Shaw • Ensures that all requirements of project contract are attained in a manner consistent with project plans • Manages project budgets and schedules 	MS, Geology 11+ years of experience
Craig Givens	QA Officer	Shaw	<ul style="list-style-type: none"> • Independent oversight of all project implementation in accordance with the project-specific QAPjP 	BS, Geological Engineering 23 + years of experience
Pamela Moss	Field Team Manager – Chemistry	Shaw	<ul style="list-style-type: none"> • Reviews and approves the QAPjP • Guides the selection of subcontract analytical laboratories • Serves as a point-of-contact for the USACE QA Manager • Develops corrective action as required • Serves as a technical advisor to the project 	BS, Chemistry 32+ years of experience
Dale Flores	Field Team Manager - Geoscience	Shaw	<ul style="list-style-type: none"> • Develops work plans to address project scope of work • Prepares work plan variances, if necessary • Manages technical project elements • Reports to Project Manager 	BS, Geology 16+ years of experience

Table 2-1. Personnel Qualifications (concluded)

Name	Title	Organizational Affiliation	Responsibility	Education and Experience Qualification
Gary Hecox	Field Team Manager – Remediation	Shaw	<ul style="list-style-type: none"> • Develops work plans to address project scope of work • Prepares work plan variances, if necessary • Manages technical project elements • Reports to Project Manager 	PhD, Geology 32+ years of experience
Terry Rulon	Site Supervisor	Shaw	<ul style="list-style-type: none"> • Advises field personnel on any technical issues that arise during work execution • Reviews field and laboratory data • Authors Quarterly Monitoring Reports and makes recommendations 	AS, Construction Management 20 years of experience

Notes:

AS = Associate's of Science degree

BS = Bachelor's of Science degree

MS = Master's of Science degree

NA = not applicable

PhD = Doctor of Philosophy

QA = quality assurance

QAO = Quality Assurance Officer

QAPjP = BFF Spill Quality Assurance Project Plan

USACE = U.S. Army Corps of Engineers

Table 3-1. Sample Requirements for Analytical Testing

Low-Concentration Samples					
Matrix	Parameter ¹	Container ^{2,3}	Preservation	Maximum Holding Times ⁴	
				Extraction	Analysis
Water	Volatiles	2 x 40-mL ⁵ G, Septa Vial	Ice to 4°C 4 drops conc. HCl or sodium bisulfate (NaHSO ₄) to pH<2	---	14 days
Water	SVOCs	2 x 1-L ^{5,6} amber G	Ice to 4°C	7 days	40 days
Water	Metals ⁶	1 x 1-L P	Nitric acid (HNO ₃) to pH<2		6 months ⁷
Water	TPH –gasoline TPH – diesel	2 x 40-mL ⁵ G, Septa Vial 2 x 1-L G	Ice to 4°C		14 days
Water	Common parameters	1 x 1-L ⁸ G	Ice to 4°C		28 days ⁸
Soils/Sediments	Volatiles	3 – 5 gram Terra Core	Ice to 4°C Sodium bisulfate		48 hr, 14 days frozen
Soils/Sediments	SVOCs, PCBs, pesticides	1 x 8-oz G	Ice to 4°C	14 days	40 days
Soils/Sediments	Metals, cyanide, TPH	1 x 8-oz G 5-gram Terra Core for TPH- gasoline	Ice to 4°C		6 months, ⁷ 14 days, 48 hr, 14 days frozen
Vapor	VOCs/TPH gasoline/ APH	1 x 1-L Bottle Vac	None	N/A	30 days
Vapor	Fixed gases	1 x 1-L Tedlar bag	None	N/A	30 days
Medium-Concentration Samples					
Water/Liquid	Volatiles	2 x 40-mL G	Ice to 4°C ⁵		14 day
Water/Liquid	SVOCs ⁵	2 x 32-oz wide- mouth jars, G	Ice to 4°C ⁵	7 days	40 days
Water/Liquid	PCBs ⁵ , pesticides	2 x 32-oz wide- mouth jar G	Ice to 4°C ⁵	7 days	40 days
Water/Liquid	Metals	1 x 16-oz wide- mouth jar, G	HNO ₃ to pH<2		6 months ⁷
Water/Liquid	Explosives	2 x 1-L amber G	Ice to 4°C	7 days	40 days
Water/Liquid	Cyanide	1 x 1- L P	Sodium hydroxide (NaOH) to pH>12 Ice to 4°C		14 days
Soils/Sediments	Volatiles	3- 5 gram Encore	Ice to 4°C		48 hr, 14 days frozen
Soils/Sediments	SVOCs, PCBs, pesticides	1 x 8-oz wide- mouth jar, G	Ice to 4°C	14 days	40 days

Table 3-1. Sample Requirements for Analytical Testing (concluded)

Medium-Concentration Samples (continued)					
Matrix	Parameter ¹	Container ^{2,3}	Preservation	Maximum Holding Times ⁴	
				Extraction	Analysis
Soils/Sediments	Metals, cyanide, TPH	1 x 8-oz wide-mouth jar, G 5-gram Terra Core for TPH-gasoline	Ice to 4°C		6 months, ⁷ 14 days, 48 hr, 14 days frozen
Liquid	All organic and inorganic analyses	1 x 8-oz wide-mouth jar, G		See comment 9	
Solids	All organic and inorganic analyses	2 x 8-oz wide-mouth jars, G		See comment 9	

- 1 APH = air-phase petroleum hydrocarbon; PCB = polychlorinated biphenyl; SVOC = semivolatile organic compound; TPH = total petroleum hydrocarbon; and VOC = volatile organic compound.
- 2 All containers must have Teflon-lined seals (Teflon-lined septa for volatile organic analysis [VOA] vials).
- 3 G = glass; L = liter; mL = milliliter; and P = high-density polyethylene. Sample preservation will be done in the field immediately upon sample collection. If water samples are filtered in the field, differential pressure methods using 45-micron filters will be used, and preservatives added after filtration. VOA samples should never be filtered.
- 4 When only one holding time is given, it implies total holding time from sampling until analysis.
- 5 Samples with residual chlorine present will be dechlorinated with sodium thiosulfate as specified in SW-846 (third edition).
- 6 Three bottles are required on at least 5 to 10 percent (but at least one) sample so that the laboratory can perform all method quality control checks for SW-846 method.
- 7 Total recoverable metals for water samples. Holding time for mercury is 28 days in glass; for hexavalent chromium is 24 hours.
- 8 Chlorine, bromine, fluorine, nitrate, nitrite, phosphate, sulfate; 1 L for each method; orthophosphate requires filtration. Holding time for extraction is 48 hours for nitrate, nitrite, and phosphate if not preserved with sulfuric acid to pH<2.
- 9 Holding times for medium-concentration samples are the same as those specified for low-concentration samples.

Table 3-2: Analytical Method, Preservation, and Holding Time Requirements – Groundwater Monitoring

Matrix	Analytical Group	Analytical and Preparation Method/SOP Reference	Sample Volume	Container (number, Size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/analysis)
Water	VOCs – EPA 8260B	Preparation: EPA 5030B Analysis: EPA 8260B	40 mL	3 X 40 mL VOA with Teflon® septa	HCL to pH <2 Cool at 0-6°C	14 days for analysis
Water	EDB – EPA 8011	Preparation: EPA 8011 Analysis: EPA 8011	40 mL	3 X 40 mL VOA with Teflon® septa	Cool at 0-6°C	14 days for analysis
Water	TPH gasoline – EPA 8015B	Preparation: EPA 5030B Analysis: EPA 8015B	40 mL	3 X 40 mL VOA with Teflon® septa	HCL Cool at 0-6°C	14 days for analysis
Water	TPH diesel – EPA 8015B	Preparation: EPA 3510C and silica gel cleanup Analysis: EPA 8015B	1 L	1 X 1 L Amber	Cool at 0-6°C	7 days for extraction 40 days for analysis
Water	VPH – MA DEP	Preparation: Method MA DEP Analysis: Method MA DEP	40 mL	3 X 40 mL VOA with Teflon® septa	HCL to pH <2 Cool at 0-6°C	14 days for analysis
Water	EPH – MA DEP	Preparation: Method MA DEP and silica gel cleanup Analysis: Method MA DEP	1 L	1 X 1 L Amber	Cool at 0-6°C	7 days for extraction 40 days for analysis
Water	SVOCs – EPA 8270C	Preparation: EPA 3510C Analysis: EPA 8270D	1 L	1 X 1 L Amber	Cool at 0-6°C	7 days for extraction 40 days for analysis
Water	Dissolved Iron and Manganese – EPA 6010C	Preparation: EPA 3005A/3010A Analysis: EPA 6010C	100 mL	1 X 250 mL polyethylene (field filtered with 0.45 micrometers filter)	HNO ₃ to pH <2 Cool at 0-6°C	180 days for analysis
Water	Total Cations and Lead– EPA 6010C	Preparation: EPA 3005A/3010A Analysis: EPA 6010C	100 mL	1 X 250 mL polyethylene	HNO ₃ to pH <2 Cool at 0-6°C	180 days for analysis
Water	Anions – EPA 300.0	Preparation: EPA 300.0 Analysis: EPA 300.0	100 mL	1 X 250 mL polyethylene	Cool at 0-6°C	48 hours for nitrate and 28 days for all other anions

Table 3-2: Analytical Method, Preservation, and Holding Time Requirements – Groundwater Monitoring (concluded)

Matrix	Analytical Group	Analytical and Preparation Method/SOP Reference	Sample Volume	Container (number, Size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/analysis)
Water	Alkalinity – SM 2320B	Preparation: SM 2320B Analysis: SM 2320B	100 mL	1 X 250 mL polyethylene	Cool at 0-6°C	14 days for analysis
Water	Ammonia – SM 4500B, D	Preparation: EPA 4500B, D Analysis: EPA 4500B, D	100 mL	1 X 250 mL polyethylene	H ₂ SO ₄ to pH<2 Cool at 0-6°C	28 days for analysis
Water	O-Phosphate – SM 4500 PE	Preparation: SM 4500 PE Analysis: SM 4500 PE	100 mL	1 X 250 mL polyethylene	H ₂ SO ₄ to pH<2 Cool at 0-6°C	28 days for analysis
Water	Sulfide – SM 4500 S-2CF	Preparation: EPA 4500 S-2CF Analysis: EPA 4500 S-2CF	100 mL	1 X 250 mL polyethylene	Zinc Acetate and Sodium Hydroxide to pH>9 Cool at 0-6°C	7 days for analysis
Water	Dissolved Gases – RSK 175	Preparation: RSK 175 Analysis: RSK 175	40 mL	3 x 40 mL VOA with Teflon septa	Cool at 0-6°C	7 days for analysis
Water	Stable Carbon Isotope – Laboratory SOP AM 24	Preparation: Lab SOP AM 24 Analysis: Lab SOP AM 24	40 mL	9x40 mL VOA	HCL to pH<2 Cool at 0-6°C	14 days for initial VOC analysis NA for isotope analysis
Water	Stable Hydrogen Isotope Laboratory SOP	Preparation: Lab SOP Analysis: Lab SOP	40 mL	9x40 mL VOA	HCL to pH<2 Cool at 0-6°C	14 days for initial VOC analysis NA for isotope analysis

Notes:

°C = degrees Celsius

EDB = ethylene dibromide

EPA = U.S. Environmental Protection Agency

EPH = Extractable petroleum hydrocarbon

HCl = hydrochloric acid

HNO₃ = nitric acidH₂SO₄ = sulfuric acid

L = liter

MA DEP = Massachusetts Department of Environmental Protection

mL = milliliter

NA = not applicable

SM = standard method

SOP = standard operating procedure

SVOC = semivolatile organic compound

TPH = total petroleum hydrocarbon

VOA = volatile organic analysis

VOC = volatile organic compound

VPH = volatile petroleum hydrocarbon

Table 3-3: Analytical Method, Preservation, and Holding Time Requirements – Soil Sampling

Matrix	Analytical Group	Analytical and Preparation Method/SOP Reference	Sample Volume	Container (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/analysis)
Soil	VOCs – EPA 8260B	Preparation: EPA 5035 Analysis: EPA 8260B	5 grams	3 X 5 gram Terra Core	Cool at 0-6°C Sodium bisulfate	48 hours for analysis 14 days for analysis if kept frozen
Soil	VPH – MA DEP	Preparation: Method MA DEP Analysis: Method MA DEP	5 grams	3 X 5 gram Terra Core	Cool at 0-6°C	48 hours for analysis 14 days for analysis if kept frozen
Soil	EPH – MA DEP	Preparation: Method MA DEP; and silica gel cleanup Analysis: Method MA DEP	30 grams	1 X 8 oz Jar	Cool at 0-6°C	14 days for extraction 40 days for analysis
Soil IDW	TPH gasoline – EPA 8015B VOCs – EPA 8260B	Preparation: EPA 5035 Analysis: EPA 8015C	5 grams	1 X 4 oz Jar	Cool at 0-6°C	48 hours for analysis 14 days for analysis if kept frozen
Soil IDW	TPH diesel – EPA 8015C	Preparation: EPA3540C/3550C, and silica gel cleanup Analysis: EPA 8015C	30 grams	1 X 8 oz Jar	Cool at 0-6°C	14 days for extraction 40 days for analysis
Soil	SVOCs – EPA 8270D	Preparation: EPA3540C/3550C Analysis: EPA 8270D	30 grams	1 X 8 oz Jar	Cool at 0-6°C	14 days for extraction 40 days for analysis
Soil	Lead – EPA 6010C	Preparation: Method 3050B Analysis: 6010C	2 grams	1 X 8 oz Jar	Cool at 0-6°C	180 days for analysis
Soil IDW	VOCs – EPA 1311/8260B	Preparation: EPA 1311/5035 Analysis: EPA 8260B	25 grams	1 X 8 oz. Jar	Cool at 0-6°C	48 hours for analysis 14 days for analysis
Soil IDW	SVOCs – EPA 1311/8270D	Preparation: EPA 1311/3540C/3550C Analysis: EPA 8270D	30 grams	1 X 8 oz Jar	Cool at 0-6°C	14 days for extraction 40 days for analysis

Table 3-3: Analytical Method, Preservation, and Holding Time Requirements – Soil Sampling (concluded)

Matrix	Analytical Group	Analytical and Preparation Method/SOP Reference	Sample Volume	Container (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/analysis)
Soil IDW	Pesticides – EPA 1311/8081B	Preparation: EPA 1311/3540C/3550C Analysis: EPA 8081B	30 grams	1 X 8 oz Jar	Cool at 0-6°C	14 days for extraction 40 days for analysis
Soil IDW	Herbicides – EPA 1311/8151A	Preparation: EPA 1311/3540C/3550C Analysis: EPA 8151A	30 grams	1 X 8 oz Jar	Cool at 0-6°C	14 days for extraction 40 days for analysis
Soil IDW	Metals – EPA 1311/6010C/7470B	Preparation: EPA 1311/3050B Analysis: EPA 6010C/7471B	2 grams	1 X 8 oz Jar	Cool at 0-6°C	28 days for mercury and 180 days for all other metals
Soil IDW	RCI – SW846 Chapter 7, 7.3.2	Preparation: SW846 Chapter 7, 7.3.2 Analysis: SW846 Chapter 7, 7.3.2	2 grams	1 X 8 oz Jar	Cool at 0-6°C	14 days for reactivity and ignitability, and 24 hours for corrosivity

Notes:

°C = degrees Celsius

EPA = U.S. Environmental Protection Agency

EPH = extractable petroleum hydrocarbon

IDW = investigation-derived waste

MA DEP = Massachusetts Department of Environmental Protection

oz = ounce

RCI = reactivity, corrosivity, and ignitability

SOP = standard operating procedure

SVOC = semivolatile organic compound

TPH = total petroleum hydrocarbon

VOC = volatile organic compound

VPH = volatile petroleum hydrocarbon

Table 3-4: Analytical Method, Preservation, and Holding Time Requirements – Soil-Vapor Monitoring

Matrix	Analytical Group	Analytical and Preparation Method/SOP Reference	Sample Volume	Container (number, Size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/analysis)
Vapor	VOCs/TPH gasoline – EPA TO15	Preparation: EPA TO15 Analysis: EPA TO15	1 L	1 L Bottle Vac Canister 1L for Vapor	NA	14 days for analysis
Vapor	APH – Method MA DEP	Preparation: Method MA DEP Analysis: Method MA DEP	1 L	1 L Bottle Vac Canister	NA	14 days for analysis
Vapor	Fixed Gases – ASTM D2504	Preparation: ASTM D2504 Analysis: ASTM D2504	1 L	Tedlar Bag	NA	14 days for analysis

Notes:

APH = air-phase petroleum hydrocarbon

ASTM = ASTM International

EPA = U.S. Environmental Protection Agency

L = liter

MA DEP = Massachusetts Department of Environmental Protection

NA = not applicable

SOP = standard operating procedure

TPH = total petroleum hydrocarbon

VOC = volatile organic compound

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Table 3-5. Laboratory QC Samples (Gas Chromatography/Mass Spectrometry)

Matrix	Groundwater, Soil, and Soil Vapor					
Analytical Group	VOCs, SVOCs, and APH					
Analytical Method	EPA Methods 8260B, 8270D, MA DEP, and TO15					
QC Sample	Frequency	QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicators	Measurement Performance Criteria
Internal standards	Every field sample and QC samples	RT within ±30 seconds from RT of initial calibration midpoint standard; area counts within -50% to +100% of initial calibration midpoint standard	Correct problem, then re-analyze affected samples.	Lab Manager/Analyst	Bias	RT within ±30 seconds and area count within -50% to +100%
Method blank	One per preparation batch	No target analytes detected greater than one-half RL and 1/10 the amount measured in any sample or 1/10 regulatory limit (whichever is greater). No laboratory common contaminants detected greater than RL.	Correct problem, then re-analyze method blank and all samples processed with the contaminated blank	Lab Manager/Analyst	Representativeness	No target analytes detected greater than one-half RL and 1/10 the amount measured in any sample or 1/10 regulatory limit (whichever is greater). No laboratory common contaminants detected greater than RL.

Table 3-5. Laboratory QC Samples (Gas Chromatography/Mass Spectrometry) (continued)

Matrix	Groundwater, Soil, and Soil Vapor					
Analytical Group	VOCs, SVOCs, and APH					
Analytical Method	EPA Methods 8260B, 8270D, MA DEP, and TO15					
QC Sample	Frequency	QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicators	Measurement Performance Criteria
MS/MSD for all analytes	One MS/MSD pair per preparation batch per matrix	<u>EPA 8260B and EPA 8270D</u> : LCS control limits specified in the DoD QSM RPD less than 30% between MS and MSD	Identify problem; if not related to matrix interference, re-reanalyze MS/MSD and all associated batch samples	Lab Manager/Analyst	Precisions and Bias	<u>EPA 8260B and EPA 8270D</u> : LCS control limits specified in the DoD QSM RPD less than 30% between MS and MSD
LCS or LCS/LCSD pair for all analytes	One LCS or LCS/LCSD pair per preparation batch per matrix	<u>EPA 8260B and EPA 8270D</u> : LCS control limits specified in the DoD QSM <u>TO15 and MA DEP</u> : Laboratory in-house LCS control limits RPD less than 30% between LCS and LCSD	Correct problem, then re-reanalyze the LCS and all associated batch samples	Lab Manager/Analyst	Precisions and Bias	<u>EPA 8260B and EPA 8270D</u> : LCS control limits specified in the DoD QSM <u>TO15 and MA DEP</u> : Laboratory in-house LCS control limits. RPD less than 30% between LCS and LCSD

Table 3-5. Laboratory QC Samples (Gas Chromatography/Mass Spectrometry) (continued)

Matrix	Groundwater, Soil, and Soil Vapor					
Analytical Group	VOCs, SVOCs, and APH					
Analytical Method	EPA Methods 8260B, 8270D, MA DEP, and TO15					
QC Sample	Frequency	QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicators	Measurement Performance Criteria
Surrogate standards	Every field sample and QC sample	<u>EPA 8260B and EPA 8270D</u> : Surrogate recovery acceptance criteria specified in the DoD QSM. <u>TO15</u> : Laboratory in-house surrogate control limits	Correct problem, then re-analyze all affected samples	Lab Manager/Analyst	Bias	<u>EPA 8260B and EPA 8270D</u> : Surrogate recovery acceptance criteria specified in the DoD QSM <u>TO15</u> : Laboratory in-house surrogate control limits
Sample duplicate	Every 20 samples	<u>TO15</u> : RPD less than 25% per method requirements. <u>MA DEP</u> : RPD less than 30% per method requirements	NA	Lab Manager/Analyst	Bias	<u>TO15</u> : RPD less than 25% per method requirements. <u>MA DEP</u> : RPD less than 30% per method requirements
MDL study	Initial setup	Detection limits established will be below the LOQs	Correct problem, then repeat the MDL study	Lab Manager/Analyst	Sensitivity	

Table 3-5. Laboratory QC Samples (Gas Chromatography/Mass Spectrometry) (continued)

Matrix	Groundwater, Soil, and Soil Vapor					
Analytical Group	VOCs, SVOCs, and APH					
Analytical Method	EPA Methods 8260B and 8270D, MA DEP, and TO15					
QC Sample	Frequency	QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicators	Measurement Performance Criteria
LOD study	Initial setup and quarterly LOD verification	Signal to noise ratio at the LOD will be greater than 3 and meet method requirements.	Correct problem, then repeat detection limit study and LOD verification at a higher concentration, or pass two consecutive LOD verifications at a higher concentration and set the LOD at the higher concentration in accordance with DoD QSM requirements.	Lab Manager/Analyst	Sensitivity	
LOQ study	Annually and quarterly LOQ verification	LOQ will be greater than LOD and within calibration range. Laboratory procedure for establishing the LOQ will empirically demonstrate precision and bias at the LOQ LOQ>LOD>DL		Lab Manager/Analyst	Sensitivity	

Table 3-5. Laboratory QC Samples (Gas Chromatography/Mass Spectrometry) (concluded)*Notes:**% = percent**APH = air-phase petroleum hydrocarbon**DL = detection limit**DoD = U.S. Department of Defense**EPA = U.S. Environmental Protection Agency**LCS = laboratory control sample**LCSD =laboratory control sample duplicate**LOD = limit of detection**LOQ = limit of quantitation**MA DEP = Massachusetts Department of Environmental Protection**MDL = method detection limit**MS = matrix spike**MSD = matrix spike duplicate**QC = quality control**QSM = Quality Systems Manual**RL = reporting limit**RPD = relative percent difference**RT = retention time**SVOC = semivolatile organic compound**VOC = volatile organic compound*

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Table 3-6. Laboratory QC Samples (Gas Chromatography)

Matrix	Groundwater, Soil, and Soil Vapor					
Analytical Group	EDB, TPH, VPH/EPH, Fixed Gases, Stable Isotopes					
Analytical Method	EPA Methods 8011 and 8015B, MA DEP, ASTM 2504, SOPs					
QC Sample	Frequency	QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicators	Measurement Performance Criteria
Method blank	One per preparation batch	No target analytes detected greater than one-half RL and >1/10 amount detected in project samples or 1/10 the regulatory limit (whichever is greater).	Correct problem, then re-extract and reanalyze method blank and all samples processed with the contaminated blank	Lab Manager/Analyst	Representativeness	No target analytes detected greater than one-half RL and >1/10 amount detected in project samples or 1/10 the regulatory limit (whichever is greater).
MS/MSD for all analytes	One MS/MSD pair per preparation batch per matrix	<u>EPA 8011 and EPA 8015B, MA DEP:</u> Laboratory in-house LCS control limits RPD less than 30% between MS and MSD	Identify problem; if not related to matrix interference, re-extract and reanalyze MS/MSD and all associated batch samples	Lab Manager/Analyst	Precisions and Bias	<u>EPA 8011 and EPA 8015B, MA DEP .:</u> Laboratory in-house LCS control limits RPD less than 30% between MS and MSD

Table 3-6. Laboratory QC Samples (Gas Chromatography) (continued)

Matrix	Groundwater, Soil, and Soil Vapor					
Analytical Group	EDB, TPH, VPH/EPH, Fixed Gases, Stable Isotopes					
Analytical Method	EPA Methods 8011 and 8015B, MA DEP, ASTM 2504, SOPs					
QC Sample	Frequency	QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicators	Measurement Performance Criteria
LCS or LCS/LCSD pair for all analytes	One LCS or LCS/LCSD pair per preparation batch per matrix	<u>EPA 8011 and EPA 8015B, MA-DEP, ASTM 2504, SOPs (stable isotopes)</u> : Laboratory in-house LCS control limits RPD less than 30% between LCS and LCSD	Correct problem, then re-extract and reanalyze the LCS and all associated batch samples	Lab Manager/Analyst	Precisions and Bias	<u>EPA 8011 and EPA 8015B, MA-DEP, ASTM 2504, SOPs (stable isotopes)</u> : Laboratory in-house LCS control RPD less than 30% between LCS and LCSD
Surrogate standards	Every field sample and QC sample	<u>EPA 8015B, MA-DEP, and SOP AM24</u> : Laboratory in-house surrogate acceptance criteria	Correct problem, then re-extract and reanalyze all affected samples	Lab Manager/Analyst	Bias	<u>EPA 8015B, MA-DEP and AM24</u> : Laboratory in-house surrogate acceptance criteria

Table 3-6. Laboratory QC Samples (Gas Chromatography) (continued)

Matrix	Groundwater, Soil, and Soil Vapor					
Analytical Group	EDB, TPH, VPH/EPH, Fixed Gases, Stable Isotopes					
Analytical Method	EPA Methods 8011 and 8015B, MA DEP, ASTM 2504, SOPs					
QC Sample	Frequency	QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicators	Measurement Performance Criteria
Confirmation of positive results using second column or second detector	All positive results must be confirmed	<u>EPA 8011</u> : Same calibration and QC requirements as for initial or primary column analysis. RPD between primary and second column results less than 40%	NA	Lab Manager/Analyst	Precision	<u>EPA 8011</u> : RPD between primary and second column results less than 40%
MDL study	Initial setup	Detection limits established will be below the LOQs	Correct problem, then repeat the MDL study in accordance with DoD QSM requirements	Lab Manager/Analyst	Sensitivity	

Table 3-6. Laboratory QC Samples (Gas Chromatography) (continued)

Matrix	Groundwater, Soil, and Soil Vapor					
Analytical Group	EDB, TPH, VPH/EPH, Fixed Gases, Stable Isotopes					
Analytical Method	EPA Methods 8011 and 8015B, MA DEP, ASTM 2504, SOPs					
QC Sample	Frequency	QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicators	Measurement Performance Criteria
LOD study	Initial setup and quarterly LOD verification	Signal to noise ratio at the LOD will be greater than 3 and meet method requirements.	Correct problem, then repeat detection limit study and LOD verification at a higher concentration, or pass two consecutive LOD verifications at a higher concentration and set the LOD at the higher concentration per DoD QSM	Lab Manager/Analyst	Sensitivity	
LOQ study	Annually and quarterly LOQ verification	LOQ will be greater than LOD and within calibration range. Laboratory procedure for establishing the LOQ will empirically demonstrate precision and bias at the LOQ LOQ>LOD>DL		Lab Manager/Analyst	Sensitivity	

Table 3-6. Laboratory QC Samples (Gas Chromatography) (concluded)*Notes:**% = percent**ASTM = ASTM International**DoD = U.S. Department of Defense**EDB = ethylene dibromide**EPA = U.S. Environmental Protection Agency**EPH = extractable petroleum hydrocarbon**LCS = laboratory control sample**LCSD =laboratory control sample duplicate**LOD = limit of detection**LOQ = limit of quantitation**MA DEP = Massachusetts Department of Environmental Protection**MDL = method detection limit**MS = matrix spike**MSD = matrix spike duplicate**QC = quality control**QSM = Quality Systems Manual**RL = reporting limit**RPD = relative percent difference**SOP = standard operating procedure**TPH = total petroleum hydrocarbon*

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Table 3-7. Laboratory QC Samples (Inductively Coupled Plasma Atomic Emission Spectrometry)

Matrix	Groundwater and Soil					
Analytical Group	Metals					
Analytical Method	EPA Method 6010C					
QC Check	Frequency	QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicators	Measurement Performance Criteria
Calibration blank	After initial calibration, before CCV calibration, after every 10 samples, and at the end of the sequence	No target analytes detected greater than LOD in accordance with DoD QSM requirements	Re-prepare and reanalyze the blank and the affected samples in accordance with DoD QSM requirements	Lab Manager/Analyst	Representativeness	<u>EPA 6010C</u> : No target analytes detected greater than LOD
Method blank	One per preparation batch	No target analytes detected greater than one-half RL and greater than 1/10 amount measured in any sample or 1/10 the regulatory limit (whichever is greater).	Correct problem, then re-prepare and reanalyze the method blank and all samples processed with the contaminated blank in accordance with DoD QSM requirements	Lab Manager/Analyst	Representativeness	No target analytes detected greater than one-half RL and greater than 1/10 amount measured in any sample or 1/10 the regulatory limit (whichever is greater).
Interference check solution	At the beginning of an analytical run	Within ±20% of expected value in accordance with DoD QSM requirements	Identify and correct problem, then reanalyze the interference check solution and all affected samples in accordance with DoD QSM requirements	Lab Manager/Analyst	Bias	Within ±20% of expected value

Table 3-7. Laboratory QC Samples (Inductively Coupled Plasma Atomic Emission Spectrometry) (continued)

Matrix	Groundwater and Soil					
Analytical Group	Metals					
Analytical Method	EPA Method					
QC Check	Frequency	QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicators	Measurement Performance Criteria
MS/MSD for all analytes	One MS/MSD pair per preparation batch per matrix	LCS control limits specified in the DoD QSM RPD less than 20% between MS and MSD	Identify problem, if not related to matrix interference, then re-prepare and reanalyze the MS/MSD pair and all samples in the associated batch in accordance with DoD QSM requirements	Lab Manager/Analyst	Precision and Bias	LCS control limits specified in the DoD QSM
LCS for all analytes	One LCS per each preparation batch	LCS control limits specified in the DoD QSM RPD less than 20% between LCS and LCSD	Identify and correct the problem, then reanalyze the LCS and all affected samples in accordance with DoD QSM requirements	Lab Manager/Analyst	Precision and Bias	LCS control limits specified in the DoD QSM

Table 3-7. Laboratory QC Samples (Inductively Coupled Plasma Atomic Emission Spectrometry) (continued)

Matrix	Groundwater and Soil					
Analytical Group	Metals					
Analytical Method	EPA Methods 6010C					
QC Check	Frequency	QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicators	Measurement Performance Criteria
Dilution test	Each preparation batch	Five-fold dilution results within $\pm 10\%$ of the original results in accordance with DoD QSM requirements	Perform post-digestion spike	Lab Manager/Analyst	Bias	within $\pm 10\%$ difference
Post digestion spike addition	When dilution test fails	Recovery within 75% -125% of expected results in accordance with DoD QSM requirements	Correct problem, then rerun samples by method of standard addition in accordance with DoD QSM requirements	Lab Manager/Analyst	Bias	Recovery within 75% -125% of expected values
MDL study	Initial setup	Detection limits established will be below the LOQs	Correct problem, then repeat the MDL study in accordance with DoD QSM requirements	Lab Manager/Analyst	Sensitivity	

Table 3-7. Laboratory QC Samples (Inductively Coupled Plasma Atomic Emission Spectrometry) (continued)

Matrix	Groundwater and Soil					
Analytical Group	Metals					
Analytical Method	EPA Method 6010C					
QC Check	Frequency	QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicators	Measurement Performance Criteria
LOD study	Initial setup and quarterly LOD verification	Signal to noise ratio at the LOD will be greater than 3 and meet method requirements.	Correct problem, then repeat detection limit study and LOD verification at a higher concentration, or pass two consecutive LOD verifications at a higher concentration and set the LOD at the higher concentration per DoD QSM	Lab Manager/Analyst	Sensitivity	
LOQ study	Annually and quarterly LOQ verification	LOQ will be greater than LOD and within calibration range. Laboratory procedure for establishing the LOQ will empirically demonstrate precision and bias at the LOQ LOQ>LOD>DL		Lab Manager/Analyst	Sensitivity	

Table 3-7. Laboratory QC Samples (Inductively Coupled Plasma Atomic Emission Spectrometry) (concluded)*Notes:**% = percent**CCV = continuing calibration verification**DL = detection limit**DoD = U.S. Department of Defense**EPA = U.S. Environmental Protection Agency**LCS = laboratory control sample**LCSD = laboratory control sample duplicate**LOD = limit of detection**LOQ = limit of quantitation**MDL = method detection limit**MS = matrix spike**MSD = matrix spike duplicate**QC = quality control**QSM = Quality Systems Manual**RL = reporting limit**RPD = relative percent difference*

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Table 3-8. Laboratory QC Samples Table (Wet Chemistry)

Matrix	Groundwater					
Analytical Group	Anions, Ammonia, Sulfide, Alkalinity, and o-Phosphate					
Analytical Method	EPA Method 300.0, SM4500B, D, 4500S-2CF, 2320B, 4500PE					
QC Check	Frequency	QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicators	Measurement Performance Criteria
EPA 300.0, SM4500B,D, 4500PE, 4500S-2CF, 2320B; Method blank	EPA 300.0, SM 4500B,D, 4500PE, 4500S-2CF, and 2320B: One per preparation batch	EPA 300.0, SM 4500B, D, 4500PE, 4500S-2CF, and 2320B: No target analytes detected greater than one-half RL and 1/10 the amount measured in any samples or 1/10 the regulatory limit (whichever is greater)	EPA 300.0, SM 4500B,D, 4500PE, 4500S-2CF, and 2320B: Correct problem, then re-prepare and reanalyze the method blank and all samples processed with the contaminated blank.	Lab Manager/ Analyst	Representativeness	EPA 300.0, SM 4500B, D, 4500PE, 4500S-2CF, and 2320B: No target analytes detected greater than one-half RL and 1/10 the amount measured in any samples or 1/10 the regulatory limit (whichever is greater)
EPA 300.0, 4500B, D, 4500PE, 4500S-2CF: MS/MSD for all analytes	EPA 300.0, SM 4500B, D, 4500PE, 4500S-2CF: One MS/MSD pair per preparation batch	EPA 300.0, SM 4500B, D, 4500PE, 4500S-2CF: Laboratory in-house LCS control limits RPD less than 15% between MS and MSD	EPA 300.0, SM 4500B,D, 4500PE, 4500S-2CF: Identify problem, if not related to matrix interference, then re-prepare and reanalyze the MS/MSD pair and all samples in the associated batch	Lab Manager/ Analyst	Precision and Bias	EPA 300.0, 3SM 4500B, D, 4500PE, 4500S-2CF: Laboratory in-house LCS control limits RPD less than 15% between MS and MSD

Table 3-8. Laboratory QC Samples Table (Wet Chemistry) (continued)

Matrix	Groundwater					
Analytical Group	Anions, Ammonia, Sulfide, Alkalinity, and o-Phosphate					
Analytical Method	EPA Method 300.0, SM4500B, D, 4500S-2CF, 2320B, 4500PE					
QC Check	Frequency	QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicators	Measurement Performance Criteria
<u>EPA 300.0, SM 4500B,D, 4500PE, 4500S-2CF and 2320B: LCS for all analytes</u>	<u>EPA 300.0, SM 4500B,D, 4500PE, 4500S-2CF and 2320B: One LCS per each preparation batch</u>	<u>EPA 300.0, SM 4500B, D, 4500PE, 4500S-2CF, and 2320B: Laboratory in-house LCS control limits RPD less than 15% RPD less than 15% between LCS and LCSD</u>	<u>EPA 300.0, SM 4500B,D, 4500PE, 4500S-2CF and 2320B: Identify and correct the problem, then reanalyze the LCS and all affected samples</u>	Lab Manager/ Analyst	Precision and Bias	<u>EPA 300.0, SM 4500B, D,4500PE, 4500S-2CF, and 2320B: Laboratory in-house LCS control limits not to exceed +20% RPD less than 15% between LCS and LCSD</u>
<u>EPA 300.0, SM 4500B,D, 4500PE, 4500S-2CF, and 2320B: Sample duplicate</u>	<u>EPA 300.0, SM 4500B, D, 4500PE, 4500S-2CF, and 2320B: One per every 10 samples</u>	<u>EPA 300.0, SM 4500B,D, 4500PE, 4500S-2CF, and 2320B: Within 10% difference between sample and duplicate</u>	<u>EPA 300.0, SM 4500B, D,4500PE, 4500S-2CF, and 2320B: Correct problem, reanalyze sample and duplicate</u>	Lab Manager/ Analyst	Bias	<u>EPA 300.0, SM 4500B, D, 4500PE, 4500S-2CF, and 2320B: Within 10% difference</u>
<u>MDL study</u>	<u>Initial setup</u>	<u>Detection limits established will be below the LOQs</u>	<u>Correct problem, then repeat the MDL study</u>	Lab Manager/ Analyst	Sensitivity	

Table 3-8. Laboratory QC Samples (Wet Chemistry) (continued)

QC Check	Frequency	QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicators	Measurement Performance Criteria
LOD study	Initial setup and quarterly LOD verification	Signal to noise ratio at the LOD will be greater than 3 and meet method requirements.	Correct problem, then repeat detection limit study and LOD verification at a higher concentration, or pass two consecutive LOD verifications at a higher concentration and set the LOD at the higher concentration per DoD QSM	Lab Manager/ Analyst	Sensitivity	
LOQ study	Annually and quarterly LOQ verification	LOQ will be greater than LOD and within calibration range. Laboratory procedure for establishing the LOQ will empirically demonstrate precision and bias at the LOQ LOQ>LOD>DL		Lab Manager/ Analyst	Sensitivity	

Table 3-8. Laboratory QC Samples (Wet Chemistry) (concluded)

Notes:

% = percent

DL = detection limit

DoD = U.S. Department of Defense

EPA = U.S. Environmental Protection Agency

LCS = laboratory control sample

LCSD = laboratory control sample duplicate

LOD = limit of detection

LOQ = limit of quantitation

MDL = method detection limit

MS = matrix spike

MSD = matrix spike duplicate

QC = quality control

QSM = Quality Systems Manual

RL = reporting limit

RPD = relative percent difference

SM = standard method

Table 3-9. Field Instrument Quality Control

Field Equipment	Calibration Verification Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Photoionization Detector	Check calibration to 100 parts per million isobutylene	Once per day before first use	± 5% of standard value	Recalibrate	Shaw Sampler	Manufacture's Operation Manual
YSI (or equivalent) water quality meter with flow cell	Check calibration against two of the following three traceable standards with nominal pH of 4.0, 7.00 and 10.00	Once per day before first use	± 0.05 pH units	Recalibrate	Shaw Sampler	Manufacture's Operation Manual
	Check calibration against specific conductance standard	Once per day before first use	± 5% of standard value	Recalibrate	Shaw Sampler	Manufacture's Operation Manual
	Check calibration against turbidity standards	Once per day before first use	± 5% of standard value	Recalibrate	Shaw Sampler	Manufacture's Operation Manual
	Check calibration against dissolved oxygen (ambient air)	One per day before first use	± 10% of 100% saturation	Recalibrate	Shaw Sampler	Manufacture's Operation Manual
	Check calibration against oxygen reduction potential standards	One per day before first use	± 10% standard value	Recalibrate	Shaw Sampler	Manufacture's Operation Manual

Notes:

% = percent

SOP = standard operating procedure

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Table 3-10. Laboratory Instrument Quality Control – Groundwater Monitoring

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person²	SOP Reference¹
GC/MS - VOC	Check pressure and gas supply daily. Bake out trap and column, manual tune if BFB not in criteria, change septa as needed, cut column as needed, change trap as needed.	VOCs	Ion source, injector liner, column, column flow, purge lines, purge flow, trap.	Prior to initial calibration and/or as necessary.	Acceptable tune and calibration or CCV.	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Empirical Analyst and Laboratory Manager	Empirical SOP 202
GC/MS - SVOC	Check pressure and gas supply daily. Manual tune if DFTPP not in criteria, change septa as needed, change liner as needed, cut column as needed.	SVOCs	Ion source, injector liner, column, column flow.	Prior to initial calibration and/or as necessary.	Acceptable tune and calibration or CCV.	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Empirical Analyst and Laboratory Manager	Empirical SOP 201/300

Table 3-10. Laboratory Instrument Quality Control – Groundwater Monitoring (continued)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person²	SOP Reference¹
GC	Check pressure and gas supply daily. Change septa and/or liner as needed; replace or cut column as needed.	GRO 8015B, EPH/VPH MA DEP, 8011, DRO 8015B	Liner, seal, septum, column.	Prior to initial calibration or as necessary.	Acceptable calibration or CCV.	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Empirical Analyst and Laboratory Manager	Empirical SOPs 218, 219, 322, 227
ICP-AES	Clean torch assembly and spray chamber when discolored or when degradation in data quality is observed. Clean nebulizer, check argon, replace peristaltic pump tubing as needed.	Metals	Torch, nebulizer chamber, pump, pump tubing.	Prior to initial calibration and as necessary.	Acceptable calibration or CCV.	Correct the problem and repeat calibration or CCV.	Empirical Analyst and Laboratory Manager	Empirical SOP 100/105

Table 3-10. Laboratory Instrument Quality Control – Groundwater Monitoring (continued)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person²	SOP Reference¹
Lachat	Check and clean segments weekly, clean reagent tubes monthly. Change lamp, change diluent and wash tubes, change mixing paddles and syringes, and change dispensing needle, all as needed.	Ammonia	Tubing and rollers.	Prior to ICAL or as necessary.	Acceptable ICAL and CCV.	Recalibrate and/or perform necessary equipment maintenance. Reanalyze samples not bracketed by passing CCV.	Empirical Analyst and Laboratory Manager	Empirical SOP 176
IC	Replace column	Anions	Check gas supply, check for leaks, check pistons.	Daily or as needed.	Must meet ICAL and continuing calibration criteria.	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards. Reanalyze affected data.	Empirical Analyst and Laboratory Manager	Empirical SOP 145
Buret	Check buret for any cracks or chips. Rinse buret prior to each use and at the end of each day.	Sulfide	Visual inspection for cracks or chips.	Each use.	NA	Remove from service.	Empirical Analyst and Laboratory Manager	Empirical SOP 153

Table 3-10. Laboratory Instrument Quality Control – Groundwater Monitoring (continued)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person²	SOP Reference¹
pH Meter	Keep probe wet at all times and inspect prior to use. Rinse thoroughly between uses.	Alkalinity	Visual inspection of probe.	Each use.	Must meet factory specified start up limits.	Remove from service.	Empirical Analyst and Laboratory Manager	Empirical SOP 154
Spectrophotometer	Clean reagent tubes. Change lamp.	Ortho Phosphate	Check wave length.	At the beginning of every run.	Must meet ICAL and continuing calibration criteria.	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards. Reanalyze affected data.	Empirical Analyst and Laboratory Manager	Empirical SOP 165
Gas Chromatograph/ Isotope Ratio Mass Spectrometer (GC/IRMS)	Check for leaks, replace gas line filters, recondition or replace trap, replace column, clean injection port/liner. Monitor oxidation, pyrolysis, and reduction tubes.	Carbon and hydrogen stable isotopes	Monitor instrument performance via linearity and low LCS and high LCS.	Linearity checks are performed on daily basis. Low LCS and high LCS analyzed every ten samples.	Linearity check must have a slope less than 0.2. LCS should have deltas for compounds being measured that meet acceptance range specified by the SOP.	Replace connections, clean source, replace gas line filters, replace trap, replace GC column, clip column, replace injection port liner, clean injection port. Replace oxidation, pyrolysis and reduction tubes as needed to maintain performance.	Microseeps and its subcontractor Analyst and Laboratory Manager	SOP AM 24 for stable carbon isotope and Lab SOP for stable hydrogen isotope

Table 3-10. Laboratory Instrument Quality Control – Groundwater Monitoring (concluded)*Notes:**AES = atomic emission spectroscopy**BFB = bromofluorobenzene**CCV = continuing calibration verification**DFTPP = decafluorotriphenylphosphine**DRO = diesel range organic**EPH = extractable petroleum hydrocarbon**GC/MS = gas chromatography/mass spectrometry**GRO = gasoline range organic**IC = ion chromatography**ICAL = initial calibration**ICP = inductively coupled plasma**IRMS = isotope ratio mass spectrometer**LCS = laboratory control sample**MA DEP = Massachusetts Department of Environmental Protection**NA = not applicable**SOP = standard operating procedure**SVOC = semivolatile organic compound**VOC = volatile organic compound**VPH = volatile petroleum hydrocarbon*

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Table 3-11. Laboratory Instrument Quality Control – Soil

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person²	SOP Reference¹
Gas Chromatograph/ Mass Spectrometer (GC/MS)	Check for leaks, replace gas line filters, recondition or replace trap, replace column, clean injection port/liner.	Volatiles	Monitor instrument performance via continuing calibration verification.	As needed.	No maintenance is required as long as instrument QC meets DoD criteria.	Replace connections, clean source, replace gas line filters, replace trap, replace GC column, clip column, replace injection port liner, clean injection port, replace electron multiplier.	Gulf Coast Analytical Analyst and Supervisor	Gulf Coast Analytical SOP GCMSV-003
Gas Chromatograph/ Mass Spectrometer (GC/MS)	Clean Injection port and replace liner, clip column, check for leaks. Maintain pumps by checking replacing pump oil.	Semi-volatiles	Monitor instrument performance via continuing calibration verification, DFTPP tune, breakdown and tailing.	Daily.	No maintenance is required as long as instrument QC meets DoD criteria.	Change column. Clean source.	Gulf Coast Analytical Analyst and Supervisor	Gulf Coast Analytical SOP GCMSSV-001
Gas Chromatograph	Check for leaks, replace gas line filters, replace column, clean injection port/liner.	EPH	Monitor instrument performance via continuing calibration verification.	As needed.	No maintenance is required as long as instrument QC meets DoD criteria.	Replace connections, replace gas line filters, replace GC column, clip column, replace injection port liner, clean injection port.	Gulf Coast Analytical Analyst and Supervisor	Gulf Coast Analytical SOP GC-032

Table 3-11. Laboratory Instrument Quality Control – Soil (concluded)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person²	SOP Reference¹
Gas Chromatograph	Check for leaks, replace gas line filters, recondition or replace trap, replace column, clean injection port/liner.	VPH	Monitor instrument performance via continuing calibration verification.	As needed.	No maintenance is required as long as instrument QC meets DoD criteria.	Replace connections, replace gas line filters, replace trap, replace GC column, clip column, replace injection port liner, clean injection port.	Gulf Coast Analytical Analyst and Supervisor	Gulf Coast Analytical SOP GC-025
ICP - Metals	Perform leak test, change pump tubing, change torch and window, clean filters.	Metals	Monitor instrument performance via continuing calibration verification and CC blank.	As needed.	No maintenance is required as long as instrument QC meets DoD criteria.	Change pump tubing, change torch and window, clean filters. Recalibrate and reanalyze affected data.	Gulf Coast Analytical Analyst and Supervisor	Gulf Coast Analytical SOP MET-010

Notes:

CC = continuing calibration
DFTPP = decafluorotriphenylphosphine
DoD = U.S. Department of Defense
EPH = extractable petroleum hydrocarbon
GC/MS = gas chromatography/mass spectrometry

ICP = inductively coupled plasma
QC = quality control
SOP = standard operating procedure
VPH = volatile petroleum hydrocarbon

Table 3-12. Laboratory Instrument Quality Control – Soil-Vapor Monitoring

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
GC/MS	Daily/regular as specified.	Air samples	Instrument operating parameters	Daily.	Per SOP.	Recalibrate/ stop for service on failure.	RTI Laboratory Analyst and Laboratory Manager	RTI SOP TO15_083109_R0_1_v1
GC	Daily during use.	Air/gas samples	Instrument operating parameters	Daily.	Per SOP.	Recalibrate/ stop for service on failure.	RTI Laboratory Analyst and Laboratory Manager	RTI SOP TO15_083109_R0_1_v1
Decon/Cleaning Oven	Vacuum/helium adjust.	None	Temperature /flow	Daily.	1 clean check per batch.		RTI Laboratory Analyst and Laboratory Manager	RTI SOP TO15_083109_R0_1_v1

Notes:

GC = gas chromatography

GC/MS = gas chromatography/mass spectrometry

SOP = standard operating procedure

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Table 3-13. Analytical Instrument Calibration - Gas Chromatography/Mass Spectrometry

Matrix	Groundwater, Soil, and Soil Vapor				
Analytical Group	VOCs, SVOCs, and APH				
Analytical Method	EPA Methods 8260B, 8270D; MA DEP, TO15				
Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Actions
GC/MS	<p><u>EPA 8260B, MA DEP and TO15:</u> Check of mass spectral ion intensities (tuning procedure) using bromofluorobenzene.</p> <p><u>EPA 8270D:</u> Check of mass spectral ion intensities (tuning procedure) using decafluorotriphenylphosphine in accordance with DoD QSM requirements</p>	<p><u>EPA 8260B and EPA 8270D:</u> Prior to initial calibration and every 12 hours during sample analysis.</p> <p><u>TO15 and MA DEP:</u> Prior to initial calibration and meet frequency requirements specified in the method.</p>	Must meet the method requirements before samples are analyzed.	Retune instrument and verify the tune acceptability, rerun the affected samples.	Lab Manager/Analyst
	Five-point initial calibration for target analytes, lowest calibration standard at or near the LOQ in accordance with DoD QSM requirements.	Initial calibration prior to sample analysis.	<p><u>EPA 8260B:</u> The minimum average system performance check compound response factor is 0.1 for chloromethane, 1,1-dichloroethane, and bromoform; and 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane.</p> <p><u>EPA 8270D:</u> The minimum average system performance check compound response factor is 0.05.</p> <p><u>EPA 8260B and EPA 8270D:</u> RSD is less than 30% in accordance with DoD QSM requirements.</p> <p><u>TO15 and MA DEP:</u> RSD is less than 30% per method requirements.</p>	Correct problem, then rerun initial calibration in accordance with DoD QSM/method requirements.	Lab Manager/Analyst

Table 3-13. Analytical Instrument Calibration (Gas Chromatography/Mass Spectrometry) (continued)

Matrix	Groundwater, Soil, and Soil Vapor				
Analytical Group	VOCs, SVOCs, and APH				
Analytical Method	EPA Methods 8260B, 8270D; MA DEP, TO15				
Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Actions
GC/MS	Second-source calibration verification in accordance with DoD QSM requirements.	Once per five-point initial calibration.	<u>EPA 8260B and EPA 8270D</u> : Less than 20% difference for all target analytes in accordance with DoD QSM requirements. <u>MA DEP</u> : 70-130% recovery through LCS analysis per method requirements.	Correct problem, then rerun second source calibration verification in accordance with DoD QSM/method requirements.	Lab Manager/Analyst
	Daily calibration verification in accordance with DoD QSM requirements.	Before sample analysis and every 12 hours of analysis.	<u>EPA 8260B</u> : The minimum average system performance check compound response factor is 0.1 for chloromethane, 1,1-dichloroethane, and bromoform; and 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane. <u>EPA 8270D</u> : The minimum average system performance check compound response factor is 0.05. <u>EPA 8260B and EPA 8270D</u> : Less than 20% difference for all target analytes in accordance with DoD QSM requirements <u>TO15 and MA DEP</u> : Less than 30% difference for all target analytes per method requirements.	Correct problem, then rerun calibration verification in accordance with DoD QSM/method requirements.	Lab Manager/Analyst
	Breakdown check.	Before sample analysis and every 12 hours of analysis.	<u>EPA 8270D</u> : Degradation less than 20% for DDT. Benzidine and pentachlorophenol are present at normal response and not greater than a tailing factor of 2.	Correct problem, then rerun breakdown check.	Lab Manager/Analyst

Table 3-13. Analytical Instrument Calibration (Gas Chromatography/Mass Spectrometry) (concluded)*Notes:**% = percent**APH = air phase petroleum hydrocarbon**DDT = dichlorodipheyl trichloroethane**DoD = U.S. Department of Defense**EPA = U.S. Environmental Protection Agency**GC/MS = gas chromatography/mass spectrometry**LCS = laboratory control sample**LOQ = limit of quantitation**MA DEP = Massachusetts Department of Environmental Protection**QSM = Quality Systems Manual**RSD = relative standard deviation**SVOC = semivolatile organic compound**VOC = volatile organic compound*

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Table 3-14. Analytical Instrument Calibration (Gas Chromatography)

Matrix	Groundwater, Soil, and Soil Vapor				
Analytical Group	EDB, TPH, VPH/EPH, Fixed Gases, Stable Isotopes				
Analytical Method	EPA Methods 8011 and 8015B, MA DEP, ASTM 2504, SOPs				
Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Actions
GC	Minimum five-point initial calibration for target analytes, lowest calibration standard at or near the LOQ in accordance with DoD QSM requirements. Stable Isotope: perform external calibration of working standard per laboratory SOPs.	Initial calibration prior to sample analysis.	<u>EPA 8011, EPA 8015B, ASTM 2504</u> : RSD less than or equal to 20% for all target analytes in accordance with DoD QSM requirements. <u>MA DEP</u> : RSD less than 25% for all target analytes per method requirements. <u>Stable Isotope SOPs</u> : RSD less than 0.5% per method requirements.	Correct problem, then rerun initial calibration in accordance with DoD QSM requirements.	Lab Manager/Analyst
	Second-source calibration verification.	Once per five-point initial calibration.	<u>EPA 8011, EPA 8015B, ASTM 2504</u> : Less than 20% of expected values from the initial calibration for all target analytes in accordance with DoD QSM requirements. <u>MA DEP</u> : Less than 25% of expected values from the initial calibration for all target analytes per method requirements.	Correct problem, then rerun second source calibration verification in accordance with DoD QSM requirements.	Lab Manager/Analyst

Table 3-14. Analytical Instrument Calibration (Gas Chromatography) (concluded)

Matrix	Groundwater, Soil, and Soil Vapor				
Analytical Group	EDB, TPH, VPH/EPH, Fixed Gases, Stable Isotopes				
Analytical Method	EPA Methods 8011 and 8015B, MA DEP, ASTM 2504, SOPs				
Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Actions
GC	Daily calibration verification.	<u>EPA 8011 and EPA 8015B</u> : Before sample analysis and every 10 samples. <u>MA DEP, ASTM 2504</u> : Before sample analysis and at frequency specified in the method.	<u>EPA 8011, EPA 8015B, ASTM 2504</u> : Less than 20% of expected values from the initial calibration for all target analytes in accordance with DoD QSM requirements. <u>MA DEP</u> : Less than 25% of expected values from the initial calibration for all target analytes per method requirements.	Correct problem, then rerun calibration verification in accordance with DoD QSM requirements.	Lab Manager/ Analyst

Notes:

% = percent

ASTM = ASTM International

DoD = U.S. Department of Defense

EDB = ethylene dibromide

EPA = U.S. Environmental Protection Agency

EPH = extractable petroleum hydrocarbon

GC = gas chromatography

LOQ = limit of quantitation

MA DEP = Massachusetts Department of Environmental Protection

QSM = Quality Systems Manual

RSD = relative standard deviation

SOP = standard operating procedure

TPH = total petroleum hydrocarbon

VPH = volatile petroleum hydrocarbon

Table 3-15. Analytical Instrument Calibration (Inductively Coupled Plasma Atomic Emission Spectrometry)

Matrix	Groundwater and Soil				
Analytical Group	Metals				
Analytical Method	EPA Method 6010C				
Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Actions
ICP	Initial calibration with a minimum of one high standard and one calibration blank in accordance with DoD QSM requirements.	Initial calibration prior to sample analysis.	Correlation coefficient greater than 0.995 in accordance with DoD QSM requirements.	Correct problem, then repeat initial calibration in accordance with DoD QSM requirements.	Lab Manager/Analyst
	Low standard at or near the LOQ in accordance with DoD QSM requirements (ICP/MS only).	Daily after one-point initial calibration.	Within 20% difference from initial calibration for all target analytes in accordance with DoD QSM requirements.	Correct problem, then rerun low standard in accordance with DoD QSM requirements.	Lab Manager/Analyst
	Second source calibration standard, prepared at the calibration midpoint in accordance with DoD QSM requirements.	Once per initial calibration, prior to sample analysis.	Within 10% difference from the expected value for all target analytes in accordance with DoD QSM requirements.	Correct problem, then rerun second source calibration in accordance with DoD QSM requirements.	Lab Manager/Analyst

Table 3-15. Analytical Instrument Calibration (Inductively Coupled Plasma Atomic Emission Spectrometry (concluded))

Matrix	Groundwater and Soil				
Analytical Group	Metals				
Analytical Method	EPA Method 6010C				
Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Actions
ICP	CCV in accordance with DoD QSM requirements.	Following initial calibration, after every 10 samples and the end of the sequence.	Within 10% difference from initial calibration for all target analytes.	Correct problem, then repeat CCV in accordance with DoD QSM requirements.	Lab Manager/Analyst

Notes:

% = percent

CCV = continuing calibration verification

DoD = U.S. Department of Defense

EPA = U.S. Environmental Protection Agency

ICP = inductively coupled plasma

LOQ = limit of quantitation

MS = mass spectrometry

QSM = Quality Systems Manual

Table 3-16. Analytical Instrument Calibration (Ion Chromatography/Colorimetric)

Matrix	Groundwater				
Analytical Group	Anions and Ammonia				
Analytical Method	EPA Method 300.0, SM4500B, D				
Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Actions
IC/Colorimetric	<u>EPA 300.0 and SM4500B, D</u> : Initial calibration with a minimum of three calibration standards and one calibration blank	<u>EPA 300.0 and SM4500B, D</u> : Initial calibration prior to sample analysis	<u>EPA 300.0 and SM4500B, D</u> : Correlation coefficient greater than 0.995	<u>EPA 300.0 and SM4500B, D</u> : Correct problem, then repeat initial calibration	Lab Manager/Analyst
	<u>EPA 300.0 and SM4500B, D</u> : Initial calibration verification, prepared at the calibration midpoint.	<u>EPA 300.0 and SM4500B, D</u> : Once after initial calibration, before sample analysis	<u>EPA 300.0 and SM4500B, D</u> : Less than 10% difference from initial calibration for all target analytes	<u>EPA 300.0 and SM4500B, D</u> : Correct problem, then rerun initial calibration verification	Lab Manager/Analyst
	<u>EPA 300.0 and SM4500B, D</u> : CCV	<u>EPA 300.0 and SM4500B, D</u> : Following initial calibration, after every 10 samples and the end of the sequence	<u>EPA 300.0 and SM4500B, D</u> : Less than 10% difference from initial calibration for all target analytes	<u>EPA 300.0 and SM4500B, D</u> : Correct problem, then repeat CCV	Lab Manager/Analyst

Notes:

CCV = continuing calibration verification

EPA = U.S. Environmental Protection Agency.

IC = ion chromatography

SM = standard method

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APPENDIX A

Laboratory Analytical Method Reporting Limits

Table A-1: Method Reporting Limits – Groundwater

Table A-2: Method Reporting Limits – Soil

Table A-3: Method Reporting Limits – Soil Vapor

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APPENDIX A-1

Table A-1: Method Reporting Limits - Groundwater

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Table A-1. Method Reporting Limits – Groundwater (Empirical Laboratories, LLC, Nashville, TN)

Analytical Group/ Method	Analyte and Location	CAS Number	Units	Project Comparison Limit	Project Comparison Limit Reference	Project RL	Laboratory-Specific	
							LOQ	MDL
VOCs EPA 8260B	1,1,1,2-Tetrachloroethane	630-20-6	µg/L	NE	Note 1	1.0	1.0	0.25
	1,1,1-Trichloroethane	71-55-6	µg/L	60	NMWQCC	1.0	1.0	0.25
	1,1,2,2-Tetrachloroethane	79-34-5	µg/L	NE	Note 1	1.0	1.0	0.25
	1,1,2-Trichloro-1,2,2-Trifluoroethane	76-13-1	µg/L	NE	Note 1	1.0	1.0	0.25
	1,1,2-Trichloroethane	79-00-5	µg/L	5	EPA MCL	1.0	1.0	0.25
	1,1-Dichloroethane	75-34-3	µg/L	25	NMWQCC	1.0	1.0	0.25
	1,1-Dichloroethene	75-35-4	µg/L	5	NMWQCC	1.0	1.0	0.25
	1,1-Dichloropropene	563-58-6	µg/L	NE	Note 1	1.0	1.0	0.25
	1,2,3-Trichlorobenzene	87-61-6	µg/L	NE	Note 1	2.0	2.0	0.5
	1,2,3-Trichloropropane	96-18-4	µg/L	NE	Note 1	2.0	2.0	0.5
	1,2,4-Trichlorobenzene	120-82-1	µg/L	70	EPA MCL	1.0	1.0	0.25
	1,2,4-Trimethylbenzene	95-63-6	µg/L	NE	Note 1	1.0	1.0	0.25
	1,3,5-Trimethylbenzene	108-67-8	µg/L	NE	Note 1	1.0	1.0	0.25
	1,2-Dibromo-3-Chloropropane	96-12-8	µg/L	NE	Note 1	2.0	2.0	0.5
	1,2-Dibromoethane	106-93-4	µg/L	NE	Note 1	1.0	1.0	0.25
	1,2-Dichlorobenzene	95-50-1	µg/L	600	EPA MCL	1.0	1.0	0.25
	1,2-Dichloroethane	107-06-2	µg/L	5	EPA MCL	1.0	1.0	0.25
	1,2-Dichloropropane	78-87-5	µg/L	5	EPA MCL	1.0	1.0	0.25
	1,3-Dichlorobenzene	541073-1	µg/L	NE	Note 1	1.0	1.0	0.25
	1,3-Dichloropropane	142-28-9	µg/L	NE	Note 1	1.0	1.0	0.25
1,4-Dichlorobenzene	106-46-7	µg/L	75	EPA MCL	1.0	1.0	0.25	
1-Chlorohexane	544-10-5	µg/L	NE	Note 1	2.0	2.0	0.5	

Table A-1. Method Reporting Limits – Groundwater (Empirical Laboratories, LLC, Nashville, TN) (continued)

Analytical Group/ Method	Analyte and Location	CAS Number	Units	Project Comparison Limit	Project Comparison Limit Reference	Project RL	Laboratory-Specific	
							LOQ	MDL
VOCs EPA 8260B	2,2-Dichloropropane	594-20-7	µg/L	NE	Note 1	1.0	1.0	0.25
	2-Butanone	78-93-3	µg/L	NE	Note 1	10	10	2.5
	2-Chloro Vinyl Ether		µg/L	NE	Note 1	5.0	5.0	1.25
	2-Chlorotoluene	95-49-8	µg/L	NE	Note 1	1.0	1.0	0.25
	2-Hexanone	591-78-6	µg/L	NE	Note 1	5.0	5.0	1.25
	4-Chlorotoluene	166-43-4	µg/L	NE	Note 1	1.0	1.0	0.25
	4-Methyl-2-Pentanone	108-10-1	µg/L	NE	Note 1	5.0	5.0	1.25
	Acetone	67-64-1	µg/L	NE	Note 1	10	10	2.5
	Acrolein	107-02-8	µg/L	NE	Note 1	5.0	5.0	1.25
	Acrylonitrile	107-13-1	µg/L	NE	Note 1	10	10	2.5
	Benzene	71-43-2	µg/L	5	EPA MCL	1.0	1.0	0.25
	Bromobenzene	108-86-1	µg/L	NE	Note 1	1.0	1.0	0.25
	Bromochloromethane	74-97-5	µg/L	NE	Note 1	1.0	1.0	0.25
	Bromodichloromethane	75-27-4	µg/L	NE	Note 1	1.0	1.0	0.25
	Bromoform	75-25-2	µg/L	NE	Note 1	2.0	2.0	0.5
	Bromomethane	74-83-9	µg/L	NE	Note 1	1.0	1.0	0.25
	Carbon Disulfide	75-15-0	µg/L	NE	Note 1	1.0	1.0	0.25
	Carbon Tetrachloride	56-23-5	µg/L	5	EPA MCL	1.0	1.0	0.25
	Chlorobenzene	108-90-7	µg/L	100	EPA MCL	1.0	1.0	0.25
	Chloroethane	75-00-3	µg/L	NE	Note 1	1.0	1.0	0.25
Chloroform	67-66-3	µg/L	100	NMWQCC	1.0	1.0	0.25	
Chloromethane	74-87-3	µg/L	NE	Note 1	1.0	1.0	0.25	

Table A-1. Method Reporting Limits – Groundwater (Empirical Laboratories, LLC, Nashville, TN) (continued)

Analytical Group/ Method	Analyte and Location	CAS Number	Units	Project Comparison Limit	Project Comparison Limit Reference	Project RL	Laboratory-Specific	
							LOQ	MDL
VOCs EPA 8260B	cis-1,2-Dichloroethene	156-59-2	µg/L	70	EPA MCL	1.0	1.0	0.25
	cis-1,3-Dichloropropene	10061-01-5	µg/L	NE	Note 1	1.0	1.0	0.25
	Cyclohexane	110-82-7	µg/L	NE	Note 1	1.0	1.0	0.25
	Dibromochloromethane	74-95-3	µg/L	NE	Note 1	1.0	1.0	0.25
	Dibromomethane	74-95-3	µg/L	NE	Note 1	1.0	1.0	0.25
	Dichlorodifluoromethane	75-71-8	µg/L	NE	Note 1	1.0	1.0	0.25
	Di-Isopropyl Ether	108-203	µg/L	NE	Note 1	1.0	1.0	0.25
	Ethyl tert-Butyl Ether	637-92-3-	µg/L	NE	Note 1	1.0	1.0	0.25
	Ethyl Methacrylate	97-63-2	µg/L	NE	Note 1	1.0	1.0	0.25
	Ethylbenzene	100-41-4	µg/L	700	EPA MCL	1.0	1.0	0.25
	Hexachlorobutadiene	87-68-3	µg/L	NE	Note 1	1.0	1.0	0.25
	Iodomethane	74-88-4	µg/L	NE	Note 1	1.0	1.0	0.25
	Isopropylbenzene	98-82-8	µg/L	NE	Note 1	1.0	1.0	0.25
	Methyl Acetate	79-209	µg/L	NE	Note 1	2.0	2.0	0.5
	Methyl Methacrylate	80-62-6	µg/L	NE	Note 1	1.0	1.0	0.25
	Methyl tert-Butyl Ether	1634-04-4	µg/L	NE	Note 1	1.0	1.0	0.25
	Methylcyclohexane	108-87-2	µg/L	NE	Note 1	1.0	1.0	0.25
	Methylene Chloride	75-09-2	µg/L	5	EPA MCL	1.0	1.0	0.25
	Naphthalene	91-20-3	µg/L	NE	Note 1	1.0	1.0	0.25
	n-Butylbenzene	104-51-8	µg/L	NE	Note 1	1.0	1.0	0.25
n-Propylbenzene	103-65-1	µg/L	NE	Note 1	1.0	1.0	0.25	
p-Isopropyltoluene	99-87-6	µg/L	NE	Note 1	1.0	1.0	0.25	

Table A-1. Method Reporting Limits – Groundwater (Empirical Laboratories, LLC, Nashville, TN) (continued)

Analytical Group/ Method	Analyte and Location	CAS Number	Units	Project Comparison Limit	Project Comparison Limit Reference	Project RL	Laboratory-Specific	
							LOQ	MDL
VOCs EPA 8260B	sec-Butylbenzene	135-98-8	µg/L	NE	Note 1	1.0	1.0	0.25
	Styrene	100-42-5	µg/L	NE	Note 1	1.0	1.0	0.25
	t-Butyl Alcohol	75-65-0	µg/L	NE	Note 1	5.0	5.0	1.25
	tert-Amyl Methyl Ether	994-05-8	µg/L	NE	Note 1	10	10	2.5
	tert-Butylbenzene	98-06-6	µg/L	NE	Note 1	1.0	1.0	0.25
	Tetrachloroethene	127-18-4	µg/L	5	EPA MCL	1.0	1.0	0.25
	Tetrahydrofuran	109-99-9	µg/L	NE	Note 1	5.0	5.0	1.25
	Toluene	108-88-3	µg/L	750	NMWQCC	1.0	1.0	0.25
	trans-1,2-Dichloroethene	156-60-5	µg/L	100	EPA MCL	1.0	1.0	0.25
	trans-1,3-Dichloropropene	10061-02-6	µg/L	NE	Note 1	1.0	1.0	0.25
	Trichloroethene	79-01-6	µg/L	5	EPA MCL	1.0	1.0	0.25
	Trichlorofluoromethane	75-69-4	µg/L	NE	Note 1	1.0	1.0	0.25
	Vinyl Acetate	108-05-4	µg/L	NE	Note 1	5.0	5.0	1.25
	Vinyl Chloride	75-01-4	µg/L	2	EPA MCL	1.0	1.0	0.25
Xylenes	1330-20-7	µg/L	620	NMWQCC	3.0	3.0	0.75	
EDB EPA 8011	Ethylene dibromide	1832-54-8	µg/L	0.05	EPA MCL	0.030	0.030	0.010
TPH EPA 8015B	TPH as Gasoline (C6-C10)	2691-41-0	µg/L	NE	Note 1	50	50	150
	TPH as Diesel (C10-C28)	121-82-4	µg/L	NE	Note 1	100	100	100
VPH MA DEP	C5-C8 Aliphatics	NA	µg/L	NE	Note 1	100	100	100
	C9-C12 Aliphatics	NA	µg/L	NE	Note 1	100	100	100

Table A-1. Method Reporting Limits – Groundwater (Empirical Laboratories, LLC, Nashville, TN) (continued)

Analytical Group/ Method	Analyte	CAS Number	Units	Project Comparison Limit	Project Comparison Limit Reference	Project RL	Laboratory-Specific	
							LOQ	MDL
EPH MA DEP	C12-C40 Aliphatics	NA	µg/L	NE	Note 1	100	100	100
SVOC EPA 8270C	1-Methylnaphthalene	90-12-0	µg/L	NE	Note 1	5.00	5.00	1.25
	1,1'-Biphenyl	92-52-4	µg/L	NE	Note 1	5.00	5.00	1.25
	1,2,4,5-Tetrachlorobenzene	95-94-3	µg/L	NE	Note 1	5.00	5.00	1.25
	1,2,4-Trichlorobenzene	120-82-1	µg/L	NE	Note 1	5.00	5.00	1.25
	1,2-Dichlorobenzene	95-50-1	µg/L	600	EPA MCL	5.00	5.00	1.25
	1,2-Diphenylhydrazine	122-66-7	µg/L	NE	Note 1	5.00	5.00	1.25
	1,3-Dichlorobenzene	541-73-1	µg/L	NE	Note 1	5.00	5.00	1.25
	1,4-Dichlorobenzene	106-46-7	µg/L	75	EPA MCL	5.00	5.00	1.25
	2,3,4,6-Tetrachlorophenol	58-90-2	µg/L	NE	Note 1	5.00	5.00	1.25
	2,4,5-Trichlorophenol	95-95-4	µg/L	NE	Note 1	5.00	5.00	1.25
	2,4,6-Trichlorophenol (TCP)	88-06-2	µg/L	NE	Note 1	5.00	5.00	1.25
	2,4-Dichlorophenol (DCP)	120-83-2	µg/L	NE	Note 1	5.00	5.00	1.25
	2,4-Dimethylphenol	105-67-9	µg/L	NE	Note 1	20.0	20.0	5.00
	2,4-Dinitrophenol	51-28-5	µg/L	NE	Note 1	50.0	50.0	12.5
	2,4-Dinitrotoluene (DNT)	121-14-2	µg/L	NE	Note 1	5.00	5.00	1.25
	2,6-Dinitrotoluene	606-20-2	µg/L	NE	Note 1	5.00	5.00	1.25
	2-Chloronaphthalene	91-58-7	µg/L	NE	Note 1	5.00	5.00	1.25
	2-Chlorophenol	95-57-8	µg/L	NE	Note 1	5.00	5.00	1.25
2-Methylnaphthalene	91-57-6	µg/L	NE	Note 1	5.00	5.00	1.25	
2-Methylphenol (o-Cresol)	95-48-7	µg/L	NE	Note 1	5.00	5.00	1.25	
2-Nitroaniline	88-74-4	µg/L	NE	Note 1	20.0	20.0	5.00	

Table A-1. Method Reporting Limits – Groundwater (Empirical Laboratories, LLC, Nashville, TN) (continued)

Analytical Group/ Method	Analyte	CAS Number	Units	Project Comparison Limit	Project Comparison Limit Reference	Project RL	Laboratory-Specific	
							LOQ	MDL
SVOC EPA 8270C	2-Nitrophenol (ONP)	88-75-5	µg/L	NE	Note 1	5.00	5.00	1.25
	3,3'-Dichlorobenzidine (DCB)	91-94-1	µg/L	NE	Note 1	5.00	5.00	1.25
	3-Methylphenol	108-39-4	µg/L	NE	Note 1	5.00	5.00	1.25
	3-Nitroaniline	99-09-2	µg/L	NE	Note 1	20.0	20.0	5.00
	4,6-Dinitro-2-methylphenol (DNOC)	534-52-1	µg/L	NE	Note 1	20.0	20.0	5.00
	4-Bromophenyl phenyl ether	101-55-3	µg/L	NE	Note 1	5.00	5.00	1.25
	4-Chloro-3-methylphenol	59-50-7	µg/L	NE	Note 1	5.00	5.00	1.25
	4-Chloroaniline	106-47-8	µg/L	NE	Note 1	5.00	5.00	1.25
	4-Chlorophenyl phenyl ether	7005-72-3	µg/L	NE	Note 1	5.00	5.00	1.25
	4-Methylphenol (p-Cresol)	106-44-5	µg/L	NE	Note 1	5.00	5.00	1.25
	4-Nitroaniline (PNA)	100-01-6	µg/L	NE	Note 1	20.0	20.0	5.00
	4-Nitrophenol (PNP)	100-02-7	µg/L	NE	Note 1	20.0	20.0	5.00
	Acenaphthene	83-32-9	µg/L	NE	Note 1	5.00	5.00	1.25
	Acenaphthylene	208-96-8	µg/L	NE	Note 1	5.00	5.00	1.25
	Acetaphenone	98-86-2	µg/L	NE	Note 1	5.00	5.00	1.25
	Aniline	62-53-3	µg/L	NE	Note 1	5.00	5.00	1.25
	Anthracene	120-12-7	µg/L	NE	Note 1	5.00	5.00	1.25
	Benzidine	92-87-5	µg/L	NE	Note 1	50.0	50.0	12.5
	Benzo(a)anthracene	56-55-3	µg/L	NE	Note 1	5.00	5.00	1.25
	Benzo(a)pyrene	50-32-8	µg/L	0.2	EPA MCL	5.00	5.00	1.25

Table A-1. Method Reporting Limits – Groundwater (Empirical Laboratories, LLC, Nashville, TN) (continued)

Analytical Group/ Method	Analyte	CAS Number	Units	Project Comparison Limit	Project Comparison Limit Reference	Project RL	Laboratory-Specific	
							LOQ	MDL
SVOC EPA 8270C	Benzo(b)fluoranthene	205-99-2	µg/L	NE	Note 1	5.00	5.00	1.25
	Benzo(g,h,i)perylene	191-24-2	µg/L	NE	Note 1	5.00	5.00	1.25
	Benzo(k)fluoranthene	207-08-9	µg/L	NE	Note 1	5.00	5.00	1.25
	Benzoic Acid	65-85-0	µg/L	NE	Note 1	50.0	50.0	12.5
	Benzyl alcohol	100-51-6	µg/L	NE	Note 1	5.00	5.00	1.25
	bis(2-Chloroethoxy)methane	111-91-1	µg/L	NE	Note 1	5.00	5.00	1.25
	bis(2-Chloroethyl)ether (BCEE)	111-44-4	µg/L	NE	Note 1	5.00	5.00	1.25
	Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane)	108-60-1	µg/L	NE	Note 1	5.00	5.00	1.25
	bis(2-Ethylhexyl)phthalate (BEHP)	117-81-7	µg/L	NE	Note 1	5.00	5.00	1.25
	Butyl benzyl phthalate (BBP)	85-68-7	µg/L	NE	Note 1	5.00	5.00	1.25
	Carbazole	86-74-8	µg/L	NE	Note 1	5.00	5.00	1.25
	Chrysene	218-01-9	µg/L	NE	Note 1	5.00	5.00	1.25
	Dibenz(a,h)anthracene	53-70-3	µg/L	NE	Note 1	5.00	5.00	1.25
	Dibenzofuran (DBF)	132-64-9	µg/L	NE	Note 1	5.00	5.00	1.25
	Diethyl phthalate (DEP)	84-66-2	µg/L	NE	Note 1	5.00	5.00	1.25
	Dimethyl phthalate (DMP)	131-11-3	µg/L	NE	Note 1	5.00	5.00	1.25
	Di-n-butyl phthalate (DBP)	84-74-2	µg/L	NE	Note 1	5.00	5.00	1.25
	Di-n-octyl phthalate (DNOP)	117-84-0	µg/L	NE	Note 1	5.00	5.00	1.25
	Fluoranthene	206-44-0	µg/L	NE	Note 1	5.00	5.00	1.25
	Fluorene	86-73-7	µg/L	NE	Note 1	5.00	5.00	1.25
Hexachlorobenzene (HCB)	118-74-1	µg/L	1.0	EPA MCL	5.00	5.00	1.25	

Table A-1. Method Reporting Limits – Groundwater (Empirical Laboratories, LLC, Nashville, TN) (continued)

Analytical Group/ Method	Analyte	CAS Number	Units	Project Comparison Limit	Project Comparison Limit Reference	Project RL	Laboratory-Specific	
							LOQ	MDL
SVOC EPA 8270C	Hexachlorobutadiene (HCBd)	87-68-3	µg/L	NE	Note 1	5.00	5.00	1.25
	Hexachlorocyclopentadiene (HCCPD)	77-47-4	µg/L	50	EPA MCL	5.00	5.00	1.25
	Hexachloroethane (HCE)	67-72-1	µg/L	NE	Note 1	5.00	5.00	1.25
	Indeno(1,2,3-cd)pyrene	193-39-5	µg/L	NE	Note 1	5.00	5.00	1.25
	Isophorone	78-59-1	µg/L	NE	Note 1	5.00	5.00	1.25
	Hexachlorobutadiene (HCBd)	87-68-3	µg/L	NE	Note 1	5.00	5.00	1.25
	Naphthalene	91-20-3	µg/L	NE	Note 1	5.00	5.00	1.25
	Nitrobenzene	98-95-3	µg/L	NE	Note 1	5.00	5.00	1.25
	N-Nitrosodimethylamine	62-75-9	µg/L	NE	Note 1	5.00	5.00	1.25
	N-Nitroso-di-n-propylamine (NDPA)	621-64-7	µg/L	NE	Note 1	5.00	5.00	1.25
	N-nitrosodiphenylamine (NDPHA)	86-30-6	µg/L	NE	Note 1	5.00	5.00	1.25
	Pentachlorophenol	87-86-5	µg/L	1.0	EPA MCL	20.0	20.0	5.0
	Phenanthrene	85-01-8	µg/L	NE	Note 1	5.00	5.00	1.25
	Phenol	108-95-2	µg/L	5.0	NMWQCC	5.00	5.00	1.25
	Pyrene	129-00-0	µg/L	NE	Note 1	5.00	5.00	1.25
Pyridine	110-86-1	µg/L	NE	Note 1	5.00	5.00	1.25	
Metals EPA 6010C	Dissolved Iron (field filtered)	2691-41-0	µg/L	300	EPA MCL	100	100	30
	Dissolved Manganese (field filtered)	121-82-4	µg/L	50	EPA MCL	15	15	3.0
	Total Lead	99-35-4	µg/L	15	EPA MCL	3.0	3.0	1.5
Cations EPA 6010C	Sodium	99-65-0	µg/L	NE	Note1	5,000	5,000	1,000
	Potassium	479-45-8	µg/L	NE	Note1	5,000	5,000	1,000

Table A-1. Method Reporting Limits – Groundwater (Empirical Laboratories, LLC, Nashville, TN) (continued)

Analytical Group/ Method	Analyte	CAS Number	Units	Project Comparison Limit	Project Comparison Limit Reference	Project RL	Laboratory-Specific	
							LOQ	MDL
Cation EPA 6010C	Calcium	98-95-3	µg/L	NE	Note1	5,000	5,000	1,000
	Magnesium	118-96-7	µg/L	NE	Note1	5,000	5,000	1,000
Anions EPA 300.0	Nitrate	14797-55-8	mg/L	10	EPA MCL and NMWQCC	0.20	0.20	0.0330
	Sulfate	14808-79-8	mg/L	250	EPA MCL	2.0	2.0	0.330
	Chloride	16887-006	mg/L	250	EPA MCL and NMWQCC	5.00	5.00	0.170
Alkalinity SM2320B	Alkalinity	NA	mg/L	NE	Note 1	5.00	5.00	1.0
Ammonia SM 4500B, D	Ammonia	7664-41-7	mg/L	NE	Note 1	5.00	5.00	0.11
Sulfide SM4 500 S-2CF	Total Sulfide	18496-25-8	mg/L	NE	Note 1	5.00	5.00	0.80
o-Phosphate SM 4500 PE	o-Phosphate	14265-44-2	mg/L	NE	Note 1	0.040	0.040	0.010

Notes:

NM SSL denotes New Mexico Soil Screening Level (New Mexico Environmental Department, Technical Background Document for Development of Soil Screening Levels, Revision 4.0, June 2006)

EPA SSL denotes EPA regional soil screening Level (May 2010)

Note 1: project comparison levels not established.

In accordance with the DoD QSM requirements, the most current version of the EPA methods will be implemented for each sampling event.

Bold values indicate the LOQ exceeds the standard.

CAS = Chemical Abstract Service

EDB = ethylene dibromide

EPA = U.S. Environmental Protection Agency

Table A-1. Method Reporting Limits – Groundwater (Empirical Laboratories, LLC, Nashville, TN) (concluded)

Notes (continued):

EPH = extractable petroleum hydrocarbon

LOQ = limit of quantitation

µg/L = microgram per liter

MA DEP = Massachusetts Department of Environmental Protection

MCL = maximum contaminant level

MDL = method detection limit

NE = not established

NMWQCC = New Mexico Water Quality Control Commission

RL = reporting limit

SM = standard method

SVOC = semivolatile organic compound

TPH = total petroleum hydrocarbon

APPENDIX A-2

Table A-2: Method Reporting Limits – Soil

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Table A-2: Method Control Limits– Soil (Gulf Coast Analytical Laboratories, Inc., Baton Rouge, LA)

Analytical Group/ Method	Analyte and Location	CAS Number	Units	Project Comparison Limit	Project Comparison Limit Reference	Project RL	Laboratory-Specific	
							LOQ	MDL
VOCs EPA 8260B	Acetone	67-64-1	µg/kg	2.81E07	NM SSL	5.0	5.0	1.06
	Acrolein	107-02-8	µg/kg	150	EPA SSL	25	25	2.00
	Acrylonitrile	75-05-8	µg/kg	4.27E03	NM SSL	25	25	1.07
	Benzene	71-43-2	µg/kg	1100	EPA SSL	2.0	2.0	0.137
	Bromobenzene	108-86-1	µg/kg	3.7E04	NM SSL	2.0	2.0	0.301
	Bromochloromethane	74-97-5	µg/kg	NE	Note 1	2.0	2.0	0.386
	Bromodichloromethane	75-27-4	µg/kg	270	EPA SSL	2.0	2.0	0.150
	Bromoform	75-25-2	µg/kg	6.1E04	EPA SSL	2.0	2.0	0.231
	Bromomethane	74-83-9	µg/kg	7.3E03	EPA SSL	2.0	2.0	1.46
	2-Butanone (MEK)	78-93-3	µg/kg	2.8E07	EPA SSL	5.0	5.0	0.603
	n-Butylbenzene	104-51-8	µg/kg	6.21E04	NM SSL	2.0	2.0	0.349
	sec-Butylbenzene	135-98-8	µg/kg	6.06E04	NM SSL	2.0	2.0	0.251
	tert-Butylbenzene	98-06-6	µg/kg	1.6E05	NM SSL	2.0	2.0	0.237
	Carbon disulfide	75-15-0	µg/kg	4.6E05	NM SSL	2.0	2.0	0.465
	Carbon tetrachloride	56-23-5	µg/kg	610	EPA SSL	2.0	2.0	0.236
	Chlorobenzene	108-90-7	µg/kg	1.94E05	NM SSL	2.0	2.0	0.188
	Chlorodibromomethane	124-48-1	µg/kg	680	EPA SSL	2.0	2.0	0.140
	Chloroethane	75-00-3	µg/kg	6.33E04	NM SSL	2.0	2.0	0.659
	Chloroform	67-66-3	µg/kg	290	EPA SSL	2.0	2.0	0.246
	Chloromethane	74-87-3	µg/kg	2.81E04	NM SSL	2.0	2.0	0.757
2-Chlorotoluene	95-49-8	µg/kg	2.02E05	NM SSL	2.0	2.0	0.264	

Table A-2: Method Control Limits – Soil (Gulf Coast Analytical Laboratories, Inc., Baton Rouge, LA) (continued)

Analytical Group/ Method	Analyte and Location	CAS Number	Units	Project Comparison Limit	Project Comparison Limit Reference	Project RL	Laboratory-Specific	
							LOQ	MDL
VOCs EPA 8260B	4-Chlorotoluene	106-43-4	µg/kg	5.5E06	EPA SSL	2.0	2.0	0.306
	1,2-Dibromo-3-chloropropane	96-12-8	µg/kg	5.4	EPA SSL	2.0	2.0	0.801
	1,2-Dibromoethane	106-93-4	µg/kg	34	EPA SSL	2.0	2.0	0.239
	Dibromomethane	74-95-3	µg/kg	2.5E04	EPA SSL	2.0	2.0	0.314
	1,2-Dichlorobenzene	95-50-1	µg/kg	3.74E04	NM SSL	2.0	2.0	0.325
	1,3-Dichlorobenzene	541-73-1	µg/kg	3.26E04	NM SSL	2.0	2.0	0.319
	1,4-Dichlorobenzene	106-46-7	µg/kg	2.4E03	EPA SSL	2.0	2.0	0.411
	Dichlorodifluoromethane	75-71-8	µg/kg	1.61E05	NM SSL	2.0	2.0	0.111
	1,1-Dichloroethane	75-34-3	µg/kg	3.3E03	EPA SSL	2.0	2.0	0.332
	1,2-Dichloroethane	107-06-2	µg/kg	430	EPA SSL	2.0	2.0	0.131
	1,1-Dichloroethene	75-35-4	µg/kg	2.06E05	NM SSL	2.0	2.0	0.667
	cis-1,2-Dichloroethene	156-59-2	µg/kg	7.65E04	NM SSL	2.0	2.0	0.172
	trans-1,2-Dichloroethene	156-60-5	µg/kg	1.12E05	NM SSL	2.0	2.0	0.202
	1,2-Dichloropropane	78-87-5	µg/kg	890	EPA SSL	2.0	2.0	0.108
	1,3-Dichloropropane	142-28-9	µg/kg	1.2E04	NM SSL	2.0	2.0	0.179
	2,2-Dichloropropane	594-20-7	µg/kg	NE	Note 1	2.0	2.0	1.16
	1,1-Dichloropropene	563-58-6	µg/kg	NE	Note 1	2.0	2.0	0.208
	cis-1,3-Dichloropropene	10061-01-5	µg/kg	NE	Note 1	2.0	2.0	0.145
	trans-1,3-Dichloropropene	10061-02-6	µg/kg	NE	Note 1	2.0	2.0	0.220
	Ethylbenzene	100-41-4	µg/kg	5.4E03	EPA SSL	2.0	2.0	0.206
Hexachlorobutadiene	87-68-3	µg/kg	6.2E03	EPA SSL	2.0	2.0	0.233	
2-Hexanone	591-78-6	µg/kg	2.1E05	EPA SSL	5.0	5.0	0.339	

Table A-2: Method Control Limits – Soil (Gulf Coast Analytical Laboratories, Inc., Baton Rouge, LA) (continued)

Analytical Group/ Method	Analyte and Location	CAS Number	Units	Project Comparison Limit	Project Comparison Limit Reference	Project RL	Laboratory-Specific	
							LOQ	MDL
VOCs EPA 8260B	Isopropylbenzene	98-82-8	µg/kg	2.71E05	NM SSL	2.0	2.0	0.195
	p-Isopropyltoluene	99-87-6	µg/kg	NE	Note 1	2.0	2.0	0.266
	Methylene chloride	75-09-2	µg/kg	1.1E04	EPA SSL	5.0	5.0	0.348
	Methyl-tert-butyl ether	1634-04-4	µg/kg	4.3E04	EPA SSL	2.0	2.0	0.167
	4-Methyl-2-pentanone	108-10-1	µg/kg	5.3E06	EPA SSL	5.0	5.0	0.341
	Naphthalene	91-20-3	µg/kg	3.6	EPA SSL	2.0	2.0	0.825
	n-Propylbenzene	103-65-1	µg/kg	6.21E04	NM SSL	2.0	2.0	0.271
	Styrene	100-42-5	µg/kg	1.0E05	NM SSL	2.0	2.0	0.264
	1,1,1,2-Tetrachloroethane	630-20-6	µg/kg	1.9E03	EPA SSL	2.0	2.0	0.105
	1,1,2,2-Tetrachloroethane	79-34-5	µg/kg	560	EPA SSL	2.0	2.0	0.276
	Tetrachloroethene	127-18-4	µg/kg	550	EPA SSL	2.0	2.0	0.207
	Toluene	108-88-3	µg/kg	2.52E05	NM SSL	2.0	2.0	0.200
	1,2,3-Trichlorobenzene	87-61-6	µg/kg	4.9E04	EPA SSL	2.0	2.0	0.270
	1,2,4-Trichlorobenzene	120-82-1	µg/kg	2.2E04	EPA SSL	2.0	2.0	0.305
	1,1,1-Trichloroethane	71-55-6	µg/kg	5.63E05	NM SSL	2.0	2.0	0.231
	1,1,2-Trichloroethane	79-00-5	µg/kg	1.1E03	EPA SSL	2.0	2.0	0.235
	Trichloroethene	79-01-6	µg/kg	638	NM SSL	2.0	2.0	0.234
	Trichlorofluoromethane	75-69-4	µg/kg	5.88E05	NM SSL	2.0	2.0	0.134
	1,2,3-Trichloropropane	96-18-4	µg/kg	5	EPA SSL	2.0	2.0	0.347
	1,2,4-Trimethylbenzene	95-63-6	µg/kg	5.8E04	NM SSL	2.0	2.0	0.298
1,3,5-Trimethylbenzene	108-67-8	µg/kg	2.48E04	NM SSL	2.0	2.0	0.241	
Vinyl acetate	108-05-4	µg/kg	9.7E05	EPA SSL	2.0	2.0	0.222	

Table A-2: Method Reporting Limits – Soil (Gulf Coast Analytical Laboratories, Inc., Baton Rouge, LA) (continued)

Analytical Group/ Method	Analyte and Location	CAS Number	Units	Project Comparison Limit	Project Comparison Limit Reference	Project RL	Laboratory-Specific	
							LOQ	MDL
VOCs EPA 8260B	Vinyl chloride	75-01-4	µg/kg	60	EPA SSL	2.0	2.0	0.135
	o-Xylene	95-47-6	µg/kg	9.95E04	NM SSL	2.0	2.0	0.189
	m,p-Xylene	136777-61-2	µg/kg	8.2E04	NM SSL	4.0	4.0	0.503
	Xylenes, total	1330-20-7	µg/kg	8.2E04	NM SSL	6.0	6.0	0.686
	1-Chlorohexane	544-10-5	µg/kg	NE	Note 1	2.0	2.0	0.141
VPH MA DEP	C5-C8 Aliphatics	NA	µg/kg	NE	Note 1	1,500	1,500	220
	C9-C12 Aliphatics	NA	µg/kg	NE	Note 1	1,000	1,000	264
EPH MA DEP	C9-C18 Aliphatics	NA	µg/kg	NE	Note 1	20,000	20,000	1,926
	C19 –C36 Aliphatics	NA	µg/kg	NE	Note 1	20,000	20,000	1,112
TPH Gasoline and Diesel EPA 8015B	C-6-C10	8006-61-9	µg/kg	NE	Note 1	5,000	5,000	1,000
	C10-C28	GCSV-00-4	µg/kg	NE	Note 1	5,000	5,000	1,000
SVOC EPA 8270D	Acenaphthene	83-32-9	µg/kg	3.4E06	EPA SSL	330	330	18.7
	Acenaphthylene	208-96-8	µg/kg	NE	Note 1	330	330	11.1
	Aniline	62-53-3	µg/kg	8.5E04	EPA SSL	330	330	17.7
	Anthracene	120-12-7	µg/kg	1.7E07	EPA SSL	330	330	11.6
	Benzo(a)anthracene	56-55-3	µg/kg	150	EPA SSL	330	330	14.1
	Benzo(b)fluoranthene	205-99-2	µg/kg	150	EPA SSL	330	330	10.3
	Benzo(k)fluoranthene	207-08-9	µg/kg	1.5E03	EPA SSL	330	330	15.1
	Benzo(g,h,i)perylene	191-24-2	µg/kg	NE	Note 1	330	330	9.12
	Benzo(a)pyrene	50-32-8	µg/kg	15	EPA SSL	330	330	19.0
	4-Bromophenyl-phenylether	101-55-3	µg/kg	NE	Note 1	330	330	29.1
	Butyl benzyl phthalate	85-68-7	µg/kg	2.6E05	EPA SSL	330	330	6.96

Table A-2: Method Reporting Limits – Soil (Gulf Coast Analytical Laboratories, Inc., Baton Rouge, LA) (continued)

Analytical Group/ Method	Analyte and Location	CAS Number	Units	Project Comparison Limit	Project Comparison Limit Reference	Project RL	Laboratory-Specific	
							LOQ	MDL
SVOC EPA 8270D	Carbazole	86-74-8	µg/kg	NE	Note1	330	330	23.7
	4-Chloroaniline	106-47-8	µg/kg	2.4E03	EPA SSL	330	330	32.9
	4-Chloro-3-methylphenol	59-50-7	µg/kg	6.1E06	EPA SSL	330	330	26.0
	Bis(2-chloroethoxy)methane	111-91-1	µg/kg	1.8E05	EPA SSL	330	330	18.2
	bis(2-Chloroethyl)ether	111-44-4	µg/kg	210	EPA SSL	330	330	24.9
	Bis(2-chloroisopropyl) ether	108-60-1	µg/kg	4.6E03	EPA	330	330	17.0
	2-Chloronaphthalene	91-58-7	µg/kg	3.99E06	NM SSL	330	330	17.9
	2-Chlorophenol	95-47-8	µg/kg	1.66E05	NM SSL	330	330	25.4
	4-Chlorophenyl-phenylether	7005-72-3	µg/kg	NE	Note 1	330	330	36.7
	Chrysene	218-01-9	µg/kg	1.5E04	EPA SSL	330	330	11.1
	Dibenzo(a,h)anthracene	53-70-3	µg/kg	15	EPA SSL	330	330	9.06
	Dibenzofuran	132-64-9	µg/kg	7.8E04	EPA SSL	330	330	11.4
	Di-n-butylphthalate	84-74-2	µg/kg	6.1E06	EPA SSL	330	330	7.97
	1,2-Dichlorobenzene	95-50-1	µg/kg	3.74E04	NM SSL	330	330	17.7
	1,3-Dichlorobenzene	541-73-1	µg/kg	3.26E04	NM SSL	330	330	18.5
	1,4-Dichlorobenzene	106-46-7	µg/kg	2.4E03	EPA SSL	330	330	10.4
	3,3'-Dichlorobenzidine	91-94-1	µg/kg	1.1E03	EPA SSL	660	660	211
	2,4-Dichlorophenol	120-83-2	µg/kg	1.8E05	EPA SSL	330	330	53.1
	2,6-Dichlorophenol	87-65-0	µg/kg	NE	Note 1	330	330	13.3
	Diethylphthalate	84-66-2	µg/kg	4.89E04	NM SSL	330	330	30.5
2,4-Dimethylphenol	105-67-9	µg/kg	1.22E03	EPA SSL	330	330	42.0	
Dimethylphthalate	131-11-3	µg/kg	NE	Note 1	330	330	7.31	
2,4-Dinitrophenol	51-28-5	µg/kg	1.2E05	EPA SSL	1650	1650	177	

Table A-2: Method Reporting Limits– Soil (Gulf Coast Analytical Laboratories, Inc., Baton Rouge, LA) (continued)

Analytical Group/ Method	Analyte and Location	CAS Number	Units	Project Comparison Limit	Project Comparison Limit Reference	Project RL	Laboratory-Specific	
							LOQ	MDL
SVOC EPA 8270D	2,4-Dinitrotoluene	121-14-2	µg/kg	1.6E03	EPA SSL	330	330	46.5
	2,6-Dinitrotoluene	606-20-2	µg/kg	1.6E04	EPA SSL	330	330	19.5
	Di-n-octylphthalate	117-84-0	µg/kg	NE	Note 1	330	330	10.8
	Bis(2-ethylhexyl)phthalate	117-81-7	µg/kg	3.5E04	EPA SSL	330	330	12.7
	Fluoranthene	206-44-0	µg/kg	2.29E06	NM SSL	330	330	7.30
	Fluorene	86-73-7	µg/kg	2.3E06	NM SSL	330	330	10.1
	Hexachlorobenzene	118-74-1	µg/kg	300	EPA SSL	330	330	39.5
	Hexachlorobutadiene	87-68-3	µg/kg	6.2E03	EPA SSL	330	330	21.7
	Hexachlorocyclopentadiene	77-47-4	µg/kg	3.66E05	NM SSL	330	330	49.3
	Hexachloroethane	67-72-1	µg/kg	3.5E04	EPA SSL	330	330	49.0
	Indeno(1,2,3-cd)pyrene	193-39-5	µg/kg	150	EPA SSL	330	330	13.2
	Isophorone	78-59-1	µg/kg	5.1E05	EPA SSL	330	330	10.8
	2-Methyl-4,6-Dinitrophenol	534-52-1	µg/kg	4.9E03	EPA SSL	1650	1650	32.4
	2-Methylnaphthalene	91-57-6	µg/kg	3.1E05	EPA SSL	330	330	17.7
	2-Methylphenol	95-48-7	µg/kg	3.1E06	EPA SSL	330	330	10.1
	4-Methylphenol (and/or 3-Methylphenol)	1319-77-3	µg/kg	7.5E06	EPA SSL	330	330	58.1
	Naphthalene	91-20-3	µg/kg	3.6E06	EPA SSL	330	330	11.0
	2-Nitroaniline	88-74-4	µg/kg	6.1E05	EPA SSL	1650	1650	37.1
	3-Nitroaniline	99-09-2	µg/kg	NE	Note 1	1650	1650	40.3
	4-Nitroaniline	100-01-6	µg/kg	2.4E04	EPA SSL	1650	1650	61.6
Nitrobenzene	98-95-3	µg/kg	4.8E03	EPA SSL	330	330	15.3	
2-Nitrophenol	88-75-5	µg/kg	NE	Note 1	330	330	15.1	

Table A-2: Method Reporting Limits – Soil (Gulf Coast Analytical Laboratories, Inc., Baton Rouge, LA) (continued)

Analytical Group/ Method	Analyte and Location	CAS Number	Units	Project Comparison Limit	Project Comparison Limit Reference	Project RL	Laboratory-Specific	
							LOQ	MDL
SVOC EPA 8270D	4-Nitrophenol	100-02-7	µg/kg	NE	Note 1	1650	1650	114
	N-Nitrosodiethylamine	55-18-5	µg/kg	0.77	EPA SSL	330	330	17.4
	N-Nitrosodimethylamine	62-75-9	µg/kg	2.3	EPA SSL	330	330	17.0
	N-Nitrosodiphenylamine	86-30-6	µg/kg	9.9E04	EPA SSL	330	330	10.5
	N-Nitroso-di-n-propylamine	621-64-7	µg/kg	69	EPA SSL	330	330	16.7
	Pentachlorobenzene	608-93-5	µg/kg	4.89E04	NM SSL	330	330	26.4
	Pentachlorophenol	87-86-5	µg/kg	3.0E06	EPA SSL	1650	1650	27.0
	Phenanthrene	85-01-8	µg/kg	1.83E06	NM SSL	330	330	13.4
	Phenol	108-95-2	µg/kg	1.8E07	NM SSL	330	330	16.0
	Pyrene	129-00-0	µg/kg	1.7E06	EPA SSL	330	330	46.3
	Pyridine	110-86-1	µg/kg	7.8E04	EPA SSL	330	330	18.6
	1,2,4,5-Tetrachlorobenzene	95-94-3	µg/kg	1.8E04	EPA SSL	330	330	7.95
	2,3,4,6-Tetrachlorophenol	58-90-2	µg/kg	1.8E06	EPA SSL	330	330	13.5
	1,2,4-Trichlorobenzene	120-82-1	µg/kg	2.2E04	EPA SSL	330	330	22.0
	2,4,5-Trichlorophenol	95-95-4	µg/kg	6.1E06	EPA SSL	330	330	39.4
2,4,6-Trichlorophenol	88-06-2	µg/kg	6.11E06	EPA SSL	330	330	51.8	
1,2-Diphenylhydrazine	122-66-7	µg/kg	610	EPA SSL	330	330	7.51	
Lead EPA 6010C	Lead	7439-92-1	mg/kg	400	EPA and NM SSL	0.6	0.6	0.0662

Table A-2: Method Reporting Limits– Soil (Gulf Coast Analytical Laboratories, Inc., Baton Rouge, LA) (concluded)

Note:

NM SSL denotes Technical Background Document for Development of Soil Screening Levels, Revision 5.0. Hazardous Waste Bureau and Ground Water Quality Bureau Voluntary Remediation Program. August, updated December 2009.

EPA SSL denotes U.S. Environmental Protection Agency regional soil screening Level (May 2010)

Note 1: project comparison levels not established.

In accordance with the U.S. Department of Defense Quality System Manual requirements, the most current version of the EPA methods will be implemented for each sampling event.

CAS = Chemical Abstract Service

EPH = extractable petroleum hydrocarbon

LOQ = limit of quantitation

µg/kg = microgram per kilogram

MA DEP = Massachusetts Department of Environmental Protection

MDL = method detection limit

NE = not established

RL = reporting limit

SVOC = semivolatile organic compound

VPH = volatile petroleum hydrocarbon

APPENDIX A-3

Table A-3: Method Reporting Limits – Soil Vapor

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Table A-3: Method Reporting Limits - Soil Vapor (RTI Laboratories, Livonia, MI)

Analytical Group/ Method	Analyte and Location	CAS Number	Units	Project Comparison Limit	Project Comparison Limit Reference	Project RL	Laboratory-Specific	
							LOQ	MDL
VOCs/TPH EPA TO-15	1,1,1-Trichloroethane	71-55-6	ppbv	NE	Note 1	1	1	0.33
	1,1,2,2-Tetrachloroethane	79-34-5	ppbv	NE	Note 1	1	1	0.42
	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	ppbv	NE	Note 1	1	1	0.31
	1,1,2-Trichloroethane	79-00-5	ppbv	NE	Note 1	0.5	0.5	0.23
	1,1-Dichloroethane	75-34-3	ppbv	NE	Note 1	1	1	0.38
	1,1-Dichloroethene	75-35-4	ppbv	NE	Note 1	2	2	0.65
	1,2,4-Trichlorobenzene	120-82-1	ppbv	NE	Note 1	2	2	0.52
	1,2,4-Trimethylbenzene	95-63-6	ppbv	NE	Note 1	1	1	0.42
	1,2-Dibromoethane	106-93-4	ppbv	NE	Note 1	0.5	0.5	0.19
	1,2-Dichlorobenzene	95-50-1	ppbv	NE	Note 1	1	1	0.37
	1,2-Dichloroethane	594-20-7	ppbv	NE	Note 1	1	1	0.33
	1,2-Dichloropropane	78-87-5	ppbv	NE	Note 1	0.5	0.5	0.23
	1,3,5-Trimethylbenzene	108-67-8	ppbv	NE	Note 1	1	1	0.38
	1,3-Butadiene	106-99-0	ppbv	NE	Note 1	3	3	1.34
	1,3-Dichlorobenzene	541-73-1	ppbv	NE	Note 1	1	1	0.36
	1,4-Dichlorobenzene	106-46-7	ppbv	NE	Note 1	1	1	0.45
	1,4-Dioxane	123-91-1	ppbv	NE	Note 1	5	5	1.8
	2-Butanone	78-93-3	ppbv	NE	Note 1	2	2	0.54
	2-Hexanone	591-78-6	ppbv	NE	Note 1	5	5	2.16
2-Propanol	67-63-0	ppbv	NE	Note 1	1	1	0.44	
4-Methyl-2-pentanone	108-10-1	ppbv	NE	Note 1	5	5	1.07	

Table A-3: Method Reporting Limits - Soil Vapor (RTI Laboratories, Livonia, MI) (continued)

Analytical Group/ Method	Analyte and Location	CAS Number	Units	Project Comparison Limit	Project Comparison Limit Reference	Project RL	Laboratory-Specific	
							LOQ	MDL
VOCs/TPH EPA TO-15	Acetone	67-64-1	ppbv	NE	Note 1	2	2	0.44
	Benzene	71-43-2	ppbv	NE	Note 1	1	1	0.39
	Benzyl chloride	100-44-7	ppbv	NE	Note 1	1	1	0.54
	Bromodichloromethane	75-27-4	ppbv	NE	Note 1	0.5	0.5	0.21
	Bromoform	75-25-2	ppbv	NE	Note 1	1	1	0.41
	Bromomethane	74-83-9	ppbv	NE	Note 1	2	2	0.71
	Carbon disulfide	75-15-0	ppbv	NE	Note 1	2	2	0.41
	Carbon tetrachloride	56-23-5	ppbv	NE	Note 1	1	1	0.35
	Chlorobenzene	108-90-7	ppbv	NE	Note 1	1	1	0.39
	Chlorodibromomethane	124-48-1	ppbv	NE	Note 1	1	1	0.34
	Chloroethane	75-00-3	ppbv	NE	Note 1	1	1	0.49
	Chloroform	67-66-3	ppbv	NE	Note 1	1	1	0.3
	Chloromethane	74-87-3	ppbv	NE	Note 1	2	2	0.68
	cis-1,2-Dichloroethene	156-59-2	ppbv	NE	Note 1	1	1	1
	cis-1,3-dichloropropene	10061-01-5	ppbv	NE	Note 1	0.5	0.5	0.24
	Cyclohexane	110-82-7	ppbv	NE	Note 1	1	1	0.37
	Dichlorodifluoromethane	75-71-8	ppbv	NE	Note 1	1	1	0.4
	Ethanol	64-17-5	ppbv	NE	Note 1	1	1	0.53
	Ethyl acetate	141-78-6	ppbv	NE	Note 1	1	1	0.55
	Ethylbenzene	100-41-4	ppbv	NE	Note 1	1	1	0.35
Heptane	142-82-5	ppbv	NE	Note 1	1	1	0.37	
Hexachlorobutadiene	87-68-3	ppbv	NE	Note 1	2	2	0.54	

Table A-3: Method Reporting Limits- Soil Vapor (RTI Laboratories, Livonia, MI) (continued)

Analytical Group/ Method	Analyte and Location	CAS Number	Units	Project Comparison Limit	Project Comparison Limit Reference	Project RL	Laboratory-Specific	
							LOQ	MDL
VOCs/TPH EPA TO-15	m,p-Xylene	179601-23-1	ppbv	NE	Note 1	2	2	0.75
	Methylene chloride	75-09-2	ppbv	NE	Note 1	2	2	0.31
	n-Hexane	110-54-3	ppbv	NE	Note 1	1	1	0.31
	o-Xylene	95-47-6	ppbv	NE	Note 1	1	1	0.39
	Propylene	115-07-1	ppbv	NE	Note 1	1	1	0.37
	Styrene	100-42-5	ppbv	NE	Note 1	1	1	0.43
	tert-Butyl Methyl Ether	1634-04-4	ppbv	NE	Note 1	2	2	0.61
	Tetrachloroethene	127-18-4	ppbv	NE	Note 1	0.5	0.5	0.21
	Tetrahydrofuran	109-99-9	ppbv	NE	Note 1	2	2	0.58
	Toluene	108-88-3	ppbv	NE	Note 1	0.5	0.5	0.24
	trans-1,2-Dichloroethene	156-60-5	ppbv	NE	Note 1	1	1	0.38
	trans-1,3-dichloropropene	10061-02-6	ppbv	NE	Note 1	1	1	0.31
	Trichloroethene	79-01-6	ppbv	NE	Note 1	1	1	0.35
	Trichlorofluoromethane	75-69-4	ppbv	NE	Note 1	1	1	0.31
	Vinyl acetate	108-05-4	ppbv	NE	Note 1	1	1	0.31
Vinyl chloride	75-01-4	ppbv	NE	Note 1	1	1	0.41	
Xylenes, Total	1330-20-7	ppbv	NE	Note 1	3	3	1.14	
VOC/TPH EPA TO-15	C5-C12, range	NA	ppbv	NE	Note 1	50	50	50

Table A-3: Method Reporting Limits- Soil Vapor (RTI Laboratories, Livonia, MI) (concluded)

Analytical Group/ Method	Analyte and Location	CAS Number	Units	Project Comparison Limit	Project Comparison Limit Reference	Project RL	Laboratory-Specific	
							LOQ	MDL
APH Method MA DEP	C5-C8 Aliphatic	NA	ppbv	NE	Note 1	50	50	50
	C9-C12 Aliphatic	NA	ppbv	NE	Note 1	50	50	50
	Benzene	71-43-2	ppbv	NE	Note 1	1	1	.39
	Toluene	108-88-3	ppbv	NE	Note 1	0.5	0.5	.24
	Ethylbenzene	100-41-4	ppbv	NE	Note 1	1	1	.35
	Xylenes	1330-20-7	ppbv	NE	Note 1	3	3	1.14
	Naphthalene	91-20-3	ppbv	NE	Note 1	5	5	5
Fixed Gases ASTM D2504	Oxygen	7782-44-7	%	NE	Note 1	0.1	0.1	0.1
	Nitrogen	7727-37-9	%	NE	Note 1	0.1	0.1	0.1
	Carbon Monoxide	630-08-0	%	NE	Note 1	0.1	0.1	0.1
	Carbon Dioxide	124-38-9	%	NE	Note 1	0.1	0.1	0.1
	Methane	74-82-8	%	NE	Note 1	0.5	0.5	0.5

*Notes:**Note 1: Project comparison limits not established.**In accordance with the U.S. Department of Defense Quality Systems Manual requirements, the most current version of the EPA methods will be implemented for each sampling event.**APH = air-phase petroleum hydrocarbon**ASTM = ASTM International**CAS = Chemical Abstract Service**MDL = method detection limit**EPA = U.S. Environmental Protection Agency**LOQ = limit of quantitation**MA DEP = Massachusetts Department of Environmental Protection**NE = not established**ppbv = parts per billion by volume**RL = reporting limit**TPH = total petroleum hydrocarbon**VOC = volatile organic compound*

APPENDIX B

DoD Quality Systems Manual (QSM) and Laboratory Method Control Limits

- B-1. DoD QSM Control Limits**
- B-2. Laboratory Method Control Limits – Groundwater**
- B-3. Laboratory Method Control Limits – Soil**
- B-4. Laboratory Method Control Limits – Soil Gas**

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APPENDIX B-1

DoD QSM Control Limits

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DoD Quality Systems Manual for Environmental Laboratories

Version 4.1

Based on NELAC Voted Revision
5 June 2003

4/22/2009

presented in Table G-2. The lower control limit generated for alternative or modified methods must be greater than 10% to be considered acceptable.

G.6 Surrogates

The surrogate compounds for each method are added to all samples, standards, and blanks to assess the ability of the method to recover specific non-target analytes from a given matrix and to monitor sample-specific recovery. Control limits for these compounds were calculated in the same study as the other analytes on the target analyte lists. Below are the limits for some of the surrogates of Methods 8260, 8270, 8081, and 8082, based on 3 standard deviations around the mean (Table G-3). Sufficient data were not received for those analytes during the LCS study to perform statistically significant analyses. No ME limits are presented as marginal exceedances are not acceptable for surrogate spikes.

Note: DoD prefers the use of those surrogates not identified as poor performing analytes in Table G-2 above.

Table G-3. Surrogates

Analyte	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit
8260 Water:				
1,2-Dichloroethane-d ₄	95	8	70	120
4-Bromofluorobenzene	98	7	75	120
Dibromofluoromethane	100	5	85	115
Toluene-d ₈	102	6	85	120
8260 Solid:				
4-Bromofluorobenzene	101	6	85	120
Toluene-d ₈	100	5	85	115
8270 Water:				
2-Fluorobiphenyl	79	10	50	110
Terphenyl-d ₁₄	92	14	50	135
2,4,6-Tribromophenol	82	13	40	125
2-Fluorophenol	63	14	20	110
Nitrobenzene-d ₅	76	11	40	110
8270 Solid:				
2-Fluorobiphenyl	72	10	45	105
Terphenyl-d ₁₄	78	15	30	125
2,4,6-Tribromophenol	80	15	35	125
2-Fluorophenol	70	11	35	105
Phenol-d ₅ /d ₆	71	10	40	100
Nitrobenzene-d ₅	69	10	35	100
8081 Water:				
Decachlorobiphenyl	83	17	30	135
TCMX	81	19	25	140
8081 Solid:				
Decachlorobiphenyl	94	13	55	130
TCMX	97	9	70	125
8082 Water:				
Decachlorobiphenyl	88	15	40	135
8082 Solid:				
Decachlorobiphenyl	91	11	60	125

G.7 In-House LCS Control Limits

The acceptability of LCS results within any preparatory batch shall be based on project-specified limits or the following DoD-specified LCS control limits, if project-specific limits are not available. If DoD limits are not available, the laboratory must use its in-house limits for batch acceptance.

DoD strongly believes that it is important for laboratories to maintain their own in-house LCS limits. These in-house limits must be consistent with (i.e., within) the DoD limits (project-specific, if available; otherwise the following LCS-CLs). The laboratory in-house limits shall be calculated from the laboratory's historical LCS data in accordance with a documented procedure (e.g., SOP) that is consistent with good laboratory practice. That document must describe the process for establishing and maintaining LCS limits and the use of control charts.

The laboratory in-house limits are to be used for several purposes:

- Laboratories are expected to utilize their in-house limits as part of their quality control system, and to evaluate trends and monitor and improve performance.
- When a laboratory's in-house limits are outside the DoD control limits (upper and/or lower), they must report their in-house limits in the laboratory report (see Appendix E) even if the LCS associated with the batch fell within the DoD limits. Using this information, DoD will be able to determine how laboratory performance affects the quality of the environmental data.
- DoD may review the laboratory in-house limits and associated trends, as reflected in control charts, to determine whether the laboratory's overall performance is acceptable. If deemed unacceptable, this can allow DoD to decide not to use the laboratory again until substantial improvement has occurred.

Table G-4. LCS Control Limits for Volatile Organic Compounds SW-846 Method 8260 Water Matrix²

Analyte	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit	Lower ME Limit	Upper ME Limit
1,1,1,2-Tetrachloroethane	105	8	80	130	75	135
1,1,1-Trichloroethane	100	11	65	130	55	145
1,1,2,2-Tetrachloroethane	96	11	65	130	55	140
1,1,2-Trichloroethane	100	8	75	125	65	135
1,1-Dichloroethane	101	11	70	135	60	145
1,1-Dichloroethene	99	10	70	130	55	140
1,1-Dichloropropene	102	10	75	130	65	140
1,2,3-Trichlorobenzene	99	14	55	140	45	155
1,2,3-Trichloropropane	98	9	75	125	65	130
1,2,4-Trichlorobenzene	100	11	65	135	55	145
1,2,4-Trimethylbenzene	103	10	75	130	65	140
1,2-Dibromo-3-chloropropane	91	14	50	130	35	145
1,2-Dibromoethane	100	7	80	120	75	125
1,2-Dichlorobenzene	96	9	70	120	60	130
1,2-Dichloroethane	100	10	70	130	60	140
1,2-Dichloropropane	100	8	75	125	65	135
1,3,5-Trimethylbenzene	102	10	75	130	65	140
1,3-Dichlorobenzene	100	8	75	125	65	130
1,3-Dichloropropane	100	9	75	125	65	135
1,4-Dichlorobenzene	99	8	75	125	65	130
2,2-Dichloropropane	103	11	70	135	60	150
2-Butanone	91	20	30	150	10	170

² A number of sporadic marginal exceedances of the control limits are allowed, depending on the number of analytes spiked in the LCS. Refer to section G.2 and Table G-1 for guidance on the appropriate application of control and ME limits. LCS control limits are not available for Total Xylene. Xylene may be reported on a project-specific basis as a total number; however, for the purposes of the DoD QSM, it will be analyzed and reported as m,p-Xylene and o-Xylene. Additional limits for poor performing compounds can be found in section G.5 and for surrogate compounds in section G.6.

**Table G-4. LCS Control Limits for Volatile Organic Compounds SW-846 Method 8260
Water Matrix² (continued)**

Analyte	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit	Lower ME Limit	Upper ME Limit
2-Chlorotoluene	100	9	75	125	65	135
2-Hexanone	92	12	55	130	45	140
4-Chlorotoluene	101	9	75	130	65	135
4-Methyl-2-pentanone	96	13	60	135	45	145
Acetone	91	17	40	140	20	160
Benzene	102	7	80	120	75	130
Bromobenzene	100	8	75	125	70	130
Bromochloromethane	97	11	65	130	55	140
Bromodichloromethane	98	8	75	120	70	130
Bromoform	99	10	70	130	60	140
Bromomethane	88	19	30	145	10	165
Carbon disulfide	100	21	35	160	15	185
Carbon tetrachloride	102	12	65	140	55	150
Chlorobenzene	102	7	80	120	75	130
Chlorodibromomethane	96	13	60	135	45	145
Chloroethane	99	12	60	135	50	145
Chloroform	100	12	65	135	50	150
Chloromethane	83	15	40	125	25	140
cis-1,2-Dichloroethene	99	9	70	125	60	135
cis-1,3-Dichloropropene	100	10	70	130	60	140
Dibromomethane	101	8	75	125	65	135
Dichlorodifluoromethane	93	21	30	155	10	175
Ethylbenzene	100	9	75	125	65	135
Hexachlorobutadiene	97	15	50	140	35	160
Isopropylbenzene	101	9	75	125	65	135
m,p-Xylene	102	9	75	130	65	135
Methyl tert-butyl ether	94	10	65	125	55	135
Methylene chloride	96	14	55	140	40	155
Naphthalene	96	14	55	140	40	150
n-Butylbenzene	103	11	70	135	55	150
n-Propylbenzene	101	9	70	130	65	140
o-Xylene	100	7	80	120	75	130
p-Isopropyltoluene	102	10	75	130	65	140
sec-Butylbenzene	100	9	70	125	65	135
Styrene	100	11	65	135	55	145
tert-Butylbenzene	99	10	70	130	60	140
Tetrachloroethene	96	18	45	150	25	165
Toluene	100	7	75	120	70	130
trans-1,2-Dichloroethene	99	13	60	140	45	150
trans-1,3-Dichloropropene	98	15	55	140	40	155
Trichloroethene	99	9	70	125	60	135
Trichlorofluoromethane	103	15	60	145	45	160
Vinyl chloride	99	16	50	145	35	165

Table G-5. LCS Control Limits for Volatile Organic Compounds SW-846 Method 8260 Solid Matrix³

Analyte	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit	Lower ME Limit	Upper ME Limit
1,1,1,2-Tetrachloroethane	100	9	75	125	65	135
1,1,1-Trichloroethane	101	11	70	135	55	145
1,1,2,2-Tetrachloroethane	93	13	55	130	40	145
1,1,2-Trichloroethane	95	11	60	125	50	140
1,1-Dichloroethane	99	9	75	125	65	135
1,1-Dichloroethene	100	12	65	135	55	150
1,1-Dichloropropene	102	11	70	135	60	145
1,2,3-Trichlorobenzene	97	12	60	135	50	145
1,2,3-Trichloropropane	97	11	65	130	50	140
1,2,4-Trichlorobenzene	98	11	65	130	55	140
1,2,4-Trimethylbenzene	100	12	65	135	55	145
1,2-Dibromo-3-chloropropane	87	16	40	135	25	150
1,2-Dibromoethane	97	9	70	125	60	135
1,2-Dichlorobenzene	97	7	75	120	65	125
1,2-Dichloroethane	104	11	70	135	60	145
1,2-Dichloropropane	95	8	70	120	65	125
1,3,5-Trimethylbenzene	99	11	65	135	55	145
1,3-Dichlorobenzene	98	9	70	125	65	135
1,3-Dichloropropane	100	8	75	125	70	130
1,4-Dichlorobenzene	98	9	70	125	65	135
2,2-Dichloropropane	101	11	65	135	55	145
2-Butanone	94	22	30	160	10	180
2-Chlorotoluene	98	10	70	130	60	140
2-Hexanone	97	16	45	145	30	160
4-Chlorotoluene	100	9	75	125	65	135
4-Methyl-2-pentanone	97	17	45	145	30	165
Acetone	88	23	20	160	10	180
Benzene	99	9	75	125	65	135
Bromobenzene ⁴	93	9	65	120	55	130
Bromochloromethane	99	9	70	125	60	135
Bromodichloromethane	100	9	70	130	60	135
Bromoform	96	13	55	135	45	150
Bromomethane	95	21	30	160	10	180
Carbon disulfide	103	19	45	160	30	180
Carbon tetrachloride	100	11	65	135	55	145
Chlorobenzene	99	8	75	125	65	130
Chlorodibromomethane	98	11	65	130	55	140
Chloroethane	98	20	40	155	20	175

³ A number of sporadic marginal exceedances of the control limits are allowed, depending on the number of analytes spiked in the LCS. Refer to section G.2 and Table G-1 for guidance on the appropriate application of control and ME limits. LCS control limits are not available for Methyl tert-butyl ether and Total Xylene. Sufficient data to perform statistically significant analyses were not received for MTBE during the LCS study. Xylene may be reported on a project-specific basis as a total number; however, for the purposes of the DoD QSM, it will be analyzed and reported as m,p-Xylene and o-Xylene. Additional limits for poor performing compounds can be found in section G.5 and for surrogate compounds in section G.6.

⁴ Provisional limits – outlier analyses during the LCS study resulted in LCS-CLs generated with data from fewer than four laboratories. Limits may be adjusted in the future as additional data become available.

**Table G-5. LCS Control Limits for Volatile Organic Compounds SW-846 Method 8260
Solid Matrix³ (continued)**

Analyte	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit	Lower ME Limit	Upper ME Limit
Chloroform	98	9	70	125	65	135
Chloromethane	90	13	50	130	40	140
cis-1,2-Dichloroethene	96	10	65	125	55	135
cis-1,3-Dichloropropene	99	9	70	125	65	135
Dibromomethane	100	9	75	130	65	135
Dichlorodifluoromethane ⁴	85	17	35	135	15	155
Ethylbenzene	101	9	75	125	65	135
Hexachlorobutadiene	98	15	55	140	40	155
Isopropylbenzene	103	9	75	130	70	140
m,p-Xylene	102	8	80	125	70	135
Methylene chloride	97	14	55	140	40	155
Naphthalene	84	14	40	125	25	140
n-Butylbenzene	101	12	65	140	50	150
n-Propylbenzene	99	12	65	135	50	145
o-Xylene	101	8	75	125	70	135
p-Isopropyltoluene	104	10	75	135	65	140
sec-Butylbenzene	97	11	65	130	50	145
Styrene	101	9	75	125	65	135
tert-Butylbenzene	99	11	65	130	55	145
Tetrachloroethene	103	12	65	140	55	150
Toluene	99	9	70	125	60	135
trans-1,2-Dichloroethene	100	11	65	135	55	145
trans-1,3-Dichloropropene	96	10	65	125	55	140
Trichloroethene	101	8	75	125	70	130
Trichlorofluoromethane	106	27	25	185	10	215
Vinyl chloride	92	11	60	125	45	140

**Table G-6. LCS Control Limits for Semivolatile Organic Compounds SW-846 Method 8270
Water Matrix⁵**

Analyte	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit	Lower ME Limit	Upper ME Limit
Polynuclear Aromatics						
2-Methylnaphthalene	75.0	9.5	45	105	35	115
Acenaphthene	77.6	10.1	45	110	35	120
Acenaphthylene	78.5	9.4	50	105	40	115
Anthracene	83.0	9.7	55	110	45	120
Benz[a]anthracene	82.7	8.9	55	110	45	120
Benzo[a]pyrene	81.3	9.5	55	110	45	120

⁵ A number of sporadic marginal exceedances of the control limits are allowed depending on the number of analytes spiked in the LCS. Refer to section G.2 and Table G-1 for guidance on the appropriate application of control and ME limits. LCS control limits are not available for Benzidine, 2,6-Dichlorophenol, and N-nitrosopyrrolidine. Sufficient data to perform statistically significant analyses were not received for those analytes during the LCS study. Additional limits for poor performing compounds can be found in section G.5.

**Table G-6. LCS Control Limits for Semivolatile Organic Compounds SW-846 Method 8270
Water Matrix⁵ (continued)**

Analyte	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit	Lower ME Limit	Upper ME Limit
Benzo[b]fluoranthene	81.8	12.1	45	120	35	130
Benzo[k]fluoranthene	84.6	13.2	45	125	30	135
Benzo[g,h,i]perylene	80.5	14.1	40	125	25	135
Chrysene	82.1	8.9	55	110	45	120
Dibenz[a,h]anthracene	84.7	14.1	40	125	30	140
Fluoranthene	85.2	10.4	55	115	45	125
Fluorene	80.6	10.3	50	110	40	120
Indeno[1,2,3-cd]pyrene	84.3	13.6	45	125	30	140
Naphthalene	70.8	10.5	40	100	30	115
Phenanthrene	84.0	11.0	50	115	40	130
Pyrene	88.6	13.2	50	130	35	140
Phenolic/Acidic						
2,4,5-Trichlorophenol	79.7	10.3	50	110	40	120
2,4,6-Trichlorophenol	80.7	10.7	50	115	40	125
2,4-Dichlorophenol	76.3	9.6	50	105	40	115
2,4-Dimethylphenol	68.8	13.5	30	110	15	125
2,4-Dinitrophenol	75.8	20.6	15	140	10	160
2-Chlorophenol	71.3	11.4	35	105	25	115
2-Methylphenol	73.3	11.7	40	110	25	120
2-Nitrophenol	75.8	12.4	40	115	25	125
3-Methylphenol/4-Methylphenol	71.3	13.0	30	110	20	125
4,6-Dinitro-2-methylphenol	84.9	15.0	40	130	25	145
4-Chloro-3-methylphenol	78.6	10.7	45	110	35	120
Pentachlorophenol	77.6	13.3	40	115	25	130
Basic						
3,3'-Dichlorobenzidine	65.2	15.3	20	110	10	125
4-Chloroaniline	62.2	15.6	15	110	10	125
Phthalate Esters						
Bis(2-ethylhexyl) phthalate	84.2	14.0	40	125	30	140
Butyl benzyl phthalate	81.1	11.7	45	115	35	130
Di-n-butyl phthalate	84.8	10.3	55	115	45	125
Di-n-octyl phthalate	87.4	16.6	35	135	20	155
Diethyl phthalate	79.2	12.9	40	120	30	130
Dimethyl phthalate	75.9	16.9	25	125	10	145
Nitrosoamines						
N-Nitrosodi-n-propylamine	80.9	15.7	35	130	20	145
N-Nitrosodimethylamine	67.9	14.1	25	110	10	125
N-Nitrosodiphenylamine	79.6	10.6	50	110	35	120
Chlorinated Aliphatics						
Bis(2-chlorethoxy)methane	76.2	10.2	45	105	35	115
Bis(2-chloroethyl) ether	73.3	12.3	35	110	25	120
Bis(2-chloroisopropyl) ether	78.2	17.5	25	130	10	150
Hexachlorobutadiene	65.2	12.6	25	105	15	115
Hexachloroethane	60.9	11.1	30	100	15	105

Table G-6. LCS Control Limits for Semivolatile Organic Compounds SW-846 Method 8270 Water Matrix⁵ (continued)

Analyte	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit	Lower ME Limit	Upper ME Limit
Halogenated Aromatics						
1,2,4-Trichlorobenzene	71.7	11.6	35	105	25	120
1,2-Dichlorobenzene	67.3	11.4	35	100	20	115
1,3-Dichlorobenzene	64.8	10.9	30	100	20	110
1,4-Dichlorobenzene	64.8	10.9	30	100	20	110
2-Chloronaphthalene	76.5	9.3	50	105	40	115
4-Bromophenyl phenyl ether	82.9	10.2	50	115	40	125
4-Chlorophenyl phenyl ether	80.6	10.3	50	110	40	120
Hexachlorobenzene	82.3	10.0	50	110	40	120
Nitroaromatics						
2,4-Dinitrotoluene	84.3	11.2	50	120	40	130
2,6-Dinitrotoluene	82.7	11.3	50	115	35	130
2-Nitroaniline	81.8	11.2	50	115	35	125
3-Nitroaniline	72.6	17.7	20	125	10	145
4-Nitroaniline	77.2	13.7	35	120	20	130
Nitrobenzene	76.8	10.8	45	110	35	120
Neutral Aromatics						
Carbazole	82.5	11.4	50	115	35	130
Dibenzofuran	80.3	8.8	55	105	45	115
Others						
1,2-Diphenylhydrazine	84.8	9.4	55	115	45	120
Benzyl alcohol	71.0	13.8	30	110	15	125
Isophorone	81.0	10.5	50	110	40	125

Table G-7. LCS Control Limits for Semivolatile Organic Compounds SW-846 Method 8270 Solid Matrix⁶

Analyte	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit	Lower ME Limit	Upper ME Limit
Polynuclear Aromatics						
2-Methylnaphthalene	77.3	10.0	45	105	35	115
Acenaphthene	77.3	10.3	45	110	35	120
Acenaphthylene	75.7	10.4	45	105	35	115
Anthracene	79.9	9.0	55	105	45	115
Benz[a]anthracene	81.6	9.8	50	110	40	120
Benzo[a]pyrene	80.7	10.3	50	110	40	120
Benzo[b]fluoranthene	79.7	11.4	45	115	35	125
Benzo[k]fluoranthene	83.8	12.9	45	125	30	135
Benzo[g,h,i]perylene	81.8	14.7	40	125	25	140
Chrysene	82.6	9.9	55	110	45	120

⁶ A number of sporadic marginal exceedances (ME) of the control limits are allowed, depending on the number of analytes spiked in the LCS. Refer to section G.2 and Table G-1 for guidance on the appropriate application of control and ME limits. LCS control limits are not available for Benzidine, 2,6-Dichlorophenol, 1,2-Diphenylhydrazine, and N-nitrosopyrrolidine. Sufficient data to perform statistically significant analyses were not received for those analytes during the LCS study. Additional limits for poor performing compounds can be found in section G.5.

**Table G-7. LCS Control Limits for Semivolatile Organic Compounds
SW-846 Method 8270 Solid Matrix⁶ (continued)**

Analyte	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit	Lower ME Limit	Upper ME Limit
Dibenz[a,h]anthracene	82.9	13.9	40	125	25	140
Fluoranthene	83.9	10.1	55	115	45	125
Fluorene	78.3	9.8	50	110	40	115
Indeno[1,2,3-cd]pyrene	79.7	13.8	40	120	25	135
Naphthalene	73.4	11.1	40	105	30	120
Phenanthrene	80.1	10.0	50	110	40	120
Pyrene	84.4	12.8	45	125	35	135
Phenolic/Acidic						
2,4,5-Trichlorophenol	80.1	10.4	50	110	40	120
2,4,6-Trichlorophenol	76.3	11.0	45	110	30	120
2,4-Dichlorophenol	77.2	10.9	45	110	35	120
2,4-Dimethylphenol	67.3	11.9	30	105	20	115
2,4-Dinitrophenol	72.6	20.0	15	130	10	150
2-Chlorophenol	74.7	10.3	45	105	35	115
2-Methylphenol	71.7	10.6	40	105	30	115
2-Nitrophenol	76.2	11.5	40	110	30	120
3-Methylphenol/4-Methylphenol	73.9	10.9	40	105	30	120
4,6-Dinitro-2-methylphenol	83.1	18.0	30	135	10	155
4-Chloro-3-methylphenol	79.5	11.1	45	115	35	125
4-Nitrophenol	77.0	20.2	15	140	10	160
Pentachlorophenol	71.9	15.6	25	120	10	135
Phenol	69.7	10.2	40	100	30	110
Phthalate Esters						
Bis(2-ethylhexyl) phthalate	87.4	13.3	45	125	35	140
Butyl benzyl phthalate	86.4	12.3	50	125	35	135
Di-n-butyl phthalate	83.2	9.1	55	110	45	120
Di-n-octyl phthalate	86.4	15.2	40	130	25	145
Diethyl phthalate	82.2	10.6	50	115	40	125
Dimethyl phthalate	79.6	10.2	50	110	40	120
Nitrosoamines						
N-Nitrosodi-n-propylamine	76.8	12.3	40	115	30	125
N-Nitrosodimethylamine	66.1	15.9	20	115	10	130
N-Nitrosodiphenylamine	82.4	11.1	50	115	40	125
Chlorinated Aliphatics						
Bis(2-chlorethoxy)methane	75.5	10.9	45	110	30	120
Bis(2-chloroethyl) ether	71.1	11.2	40	105	25	115
Bis(2-chloroisopropyl) ether	68.4	15.7	20	115	10	130
Hexachlorobutadiene	78.2	12.9	40	115	25	130
Hexachloroethane	71.9	12.6	35	110	20	120
Halogenated Aromatics						
1,2,4-Trichlorobenzene	77.4	11.2	45	110	30	120
1,2-Dichlorobenzene	70.9	8.7	45	100	35	105
1,3-Dichlorobenzene	69.7	10.3	40	100	30	110
1,4-Dichlorobenzene	69.0	11.4	35	105	25	115

**Table G-7. LCS Control Limits for Semivolatile Organic Compounds
SW-846 Method 8270 Solid Matrix (continued)**

Analyte	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit	Lower ME Limit	Upper ME Limit
2-Chloronaphthalene	75.2	9.9	45	105	35	115
4-Bromophenyl phenyl ether	81.7	11.8	45	115	35	130
4-Chlorophenyl phenyl ether	79.6	10.7	45	110	35	120
Hexachlorobenzene	82.5	11.7	45	120	35	130
Nitroaromatics						
2,4-Dinitrotoluene	82.0	11.4	50	115	35	130
2,6-Dinitrotoluene	80.2	10.7	50	110	35	125
2-Nitroaniline	81.0	12.2	45	120	30	130
3-Nitroaniline	68.8	13.8	25	110	15	125
4-Nitroaniline	73.6	13.1	35	115	20	125
Nitrobenzene	77.2	11.9	40	115	30	125
Neutral Aromatics						
Carbazole	80.4	12.3	45	115	30	130
Dibenzofuran	77.1	8.8	50	105	40	110
Others						
Benzyl alcohol	70.9	17.4	20	125	10	140
Isophorone	77.0	11.4	45	110	30	125

Table G-8. LCS Control Limits for Chlorinated Herbicides SW-846 Method 8151 Water Matrix⁷

Analyte	Median	Lower Control Limit	Upper Control Limit
2,4-D	88	35	115
2,4-DB	99	45	130
2,4,5-T	83	35	110
2,4,5-TP (Silvex)	87	50	115
Dalapon	62	40	110
Dicamba	86	60	110
Dichloroprop	91	70	120
Dinoseb	65	20	100
MCPA	93	60	145

⁷ LCS control limits were generated using non-parametric statistics (see section G.1 for further explanation). LCS control limits are not available for MCPP. Sufficient data to perform statistically significant analyses were not received for the analyte during the LCS study.

Table G-9. LCS Control Limits for Chlorinated Herbicides SW-846 Method 8151 Solid Matrix⁸

Analyte	Median	Lower Control Limit	Upper Control Limit
2,4-D	88	35	145
2,4-DB	108	50	155
2,4,5-T	86	45	135
2,4,5-TP (Silvex)	90	45	125
Dicamba	90	55	110
Dichloroprop	99	75	140

Table G-10. LCS Control Limits for Polynuclear Aromatic Hydrocarbons SW-846 Method 8310 Water Matrix⁹

Analyte	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit	Lower ME Limit	Upper ME Limit
Acenaphthene	70	11	35	105	25	115
Acenaphthylene	74	13	35	115	20	125
Anthracene	77	12	40	110	30	125
Benz[a]anthracene	81	11	50	110	40	125
Benzo[a]pyrene	79	11	45	115	35	125
Benzo[b]fluoranthene	82	10	50	110	40	125
Benzo[k]fluoranthene	79	10	50	110	40	120
Benzo[g,h,i]perylene	77	14	35	120	20	135
Chrysene	83	11	50	115	40	125
Dibenz[a,h]anthracene	64	15	20	110	10	125
Fluoranthene	82	11	50	115	35	125
Fluorene	69	11	35	105	25	115
Indeno[1,2,3-cd]pyrene	80	11	45	110	35	125
Naphthalene	68	12	35	105	20	115
Phenanthrene	80	13	40	120	25	135
Pyrene	80	9	50	110	45	115

⁸ LCS control limits were generated using non-parametric statistics (see section G.1 for further explanation). LCS control limits are not available for Dalapon, MCPA, and MCPP. Sufficient data to perform statistically significant analyses were not received for those analytes during the LCS study. Additional limits for poor performing compounds can be found in section G.5.

⁹ A number of sporadic marginal exceedances of the control limits are allowed, depending on the number of analytes spiked in the LCS. Refer to section G.2 and Table G-1 for guidance on the appropriate application of control and ME limits.

Table G-11. LCS Control Limits for Polynuclear Aromatic Hydrocarbons SW-846 Method 8310 Solid Matrix¹⁰

Analyte	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit	Lower ME Limit	Upper ME Limit
Acenaphthene	71	12	35	110	20	120
Acenaphthylene	73	13	35	115	20	125
Anthracene	86	13	45	125	35	140
Benz[a]anthracene	78	9	50	105	40	115
Benzo[a]pyrene	86	15	40	135	25	150
Benzo[b]fluoranthene	89	11	55	120	45	130
Benzo[k]fluoranthene	84	12	50	120	35	135
Benzo[g,h,i]perylene ¹¹	85	10	55	115	45	125
Chrysene	87	11	55	120	45	130
Dibenz[a,h]anthracene	81	11	45	115	35	125
Fluoranthene	88	16	40	135	25	150
Fluorene	76	10	45	105	35	115
Indeno[1,2,3-cd]pyrene	95	13	55	135	45	145
Naphthalene	80	11	50	110	40	120
Phenanthrene	91	12	55	125	45	135
Pyrene	82	11	50	115	40	125

Table G-12. LCS Control Limits for Explosives SW-846 Methods 8330 and 8330A Water Matrix¹²

Analyte	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit	Lower ME Limit	Upper ME Limit
1,3,5-Trinitrobenzene	102	13	65	140	50	150
1,3-Dinitrobenzene	103	18	45	160	30	175
2,4-Dinitrotoluene	98	12	60	135	50	145
2,6-Dinitrotoluene	99	13	60	135	50	150
2,4,6-Trinitrotoluene (TNT)	98	15	50	145	35	160
2-Amino-4,6-dinitrotoluene ¹³	101	17	50	155	35	170
2-Nitrotoluene	88	15	45	135	30	150
3-Nitrotoluene	90	14	50	130	35	145
4-Amino-2,6-dinitrotoluene ¹³	104	16	55	155	40	170
4-Nitrotoluene	90	14	50	130	35	145
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	106	18	50	160	35	180
Methyl-2,4,6-trinitrophenylnitramine (Tetryl) ¹³	98	25	20	175	10	200
Nitrobenzene	94	15	50	140	35	155
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	99	6	80	115	75	120

¹⁰ A number of sporadic marginal exceedances of the control limits are allowed, depending on the number of analytes spiked in the LCS. Refer to section G.2 and Table G-1 for guidance on the appropriate application of control and ME limits.

¹¹ Provisional limits – outlier analyses during the LCS study resulted in LCS-CLs generated with data from fewer than four laboratories. Limits may be adjusted in the future as additional data become available.

¹² A number of sporadic marginal exceedances of the control limits are allowed, depending on the number of analytes spiked in the LCS. Refer to section G.2 and Table G-1 for guidance on the appropriate application of control and ME limits. LCS control limits were generated using solid phase extraction with acetonitrile only, without removing outliers from the data set (see section G.1 for further explanation).

¹³ Provisional limits – outlier analyses during the LCS study resulted in LCS-CLs generated with data from fewer than four laboratories. Limits may be adjusted in the future as additional data become available.

Table G-13. LCS Control Limits for Explosives SW-846 Methods 8330 and 8330A Solid Matrix¹⁴

Analyte	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit	Lower ME Limit	Upper ME Limit
1,3,5-Trinitrobenzene	99	9	75	125	65	135
1,3-Dinitrobenzene	102	8	80	125	70	135
2,4-Dinitrotoluene	102	7	80	125	75	130
2,6-Dinitrotoluene	100	7	80	120	70	130
2,4,6-Trinitrotoluene (TNT)	99	14	55	140	45	155
2-Amino-4,6-dinitrotoluene	102	7	80	125	75	130
2-Nitrotoluene	101	7	80	125	70	130
3-Nitrotoluene	100	7	75	120	70	130
4-Amino-2,6-dinitrotoluene	101	7	80	125	75	130
4-Nitrotoluene	101	8	75	125	70	135
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	103	10	70	135	65	145
Nitrobenzene	100	8	75	125	70	130
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	100	9	75	125	65	135

Table G-14. LCS Control Limits for Organochlorine Pesticides SW-846 Method 8081 Water Matrix¹⁵

Analyte	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit	Lower ME Limit	Upper ME Limit
4,4'-DDD	88	20	25	150	10	170
4,4'-DDE	87	18	35	140	15	160
4,4'-DDT	92	15	45	140	30	155
Aldrin	83	19	25	140	10	155
alpha-BHC	94	11	60	130	50	140
alpha-Chlordane	93	10	65	125	55	135
beta-BHC	96	10	65	125	55	135
delta-BHC	91	15	45	135	30	150
Dieldrin	95	11	60	130	50	140
Endosulfan I ¹⁶	80	10	50	110	40	120
Endosulfan II	79	17	30	130	10	150
Endosulfan sulfate	96	14	55	135	40	150
Endrin	95	13	55	135	45	145
Endrin aldehyde	96	14	55	135	40	150
Endrin ketone	102	8	75	125	70	135
gamma-BHC	82	18	25	135	10	155
gamma-Chlordane	94	11	60	125	50	135
Heptachlor	87	15	40	130	30	145
Heptachlor epoxide	96	11	60	130	50	140
Methoxychlor	103	16	55	150	40	165

¹⁴ A number of sporadic marginal exceedances of the control limits are allowed, depending on the number of analytes spiked in the LCS. Refer to section G.2 and Table G-1 for guidance on the appropriate application of control and ME limits. Additional limits for poor performing compounds can be found in section G.5.

¹⁵ A number of sporadic marginal exceedances of the control limits are allowed, depending on the number of analytes spiked in the LCS. Refer to section G.2 and Table G-1 for guidance on the appropriate application of control and ME limits. LCS control limits are not available for Hexachlorobenzene and Toxaphene. Sufficient data to perform statistically significant analyses were not received for those analytes during the LCS study. Additional limits for surrogate compounds can be found in section G.6.

¹⁶ Provisional limits – outlier analyses during the LCS study resulted in LCS-CLs generated with data from fewer than four laboratories. Limits may be adjusted in the future as additional data becomes available.

Table G-15. LCS Control Limits for Organochlorine Pesticides SW-846 Method 8081 Solid Matrix¹⁷

Analyte	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit	Lower ME Limit	Upper ME Limit
4,4'-DDD	81	18	30	135	10	155
4,4'-DDE	97	10	70	125	60	135
4,4'-DDT	92	16	45	140	30	155
Aldrin	93	16	45	140	30	155
alpha-BHC	93	10	60	125	50	135
alpha-Chlordane	92	10	65	120	55	130
beta-BHC	95	11	60	125	50	135
delta-BHC	94	12	55	130	45	145
Dieldrin	96	10	65	125	55	135
Endosulfan I	74	20	15	135	10	155
Endosulfan II	89	17	35	140	20	160
Endosulfan sulfate	99	12	60	135	50	145
Endrin	97	12	60	135	50	145
Endrin aldehyde	92	18	35	145	20	165
Endrin ketone	100	11	65	135	55	145
gamma-BHC	91	11	60	125	50	135
gamma-Chlordane	96	10	65	125	55	135
Heptachlor	96	15	50	140	35	155
Heptachlor. epoxide	98	11	65	130	55	140
Methoxychlor	100	14	55	145	45	155

Table G-16. LCS Control Limits for Polychlorinated Biphenyls SW-846 Method 8082 Water Matrix¹⁸

Analyte	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit
Aroclor 1016	85	20	25	145
Aroclor 1260	87	19	30	145

Table G-17. LCS Control Limits for Polychlorinated Biphenyls SW-846 Method 8082 Solid Matrix¹⁸

Analyte	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit
Aroclor 1016	90	16	40	140
Aroclor 1260	96	12	60	130

¹⁷ A number of sporadic marginal exceedances of the control limits are allowed, depending on the number of analytes spiked in the LCS. Refer to section G.2 and Table G-1 for guidance on the appropriate application of control and ME limits. LCS control limits are not available for Hexachlorobenzene, Hexachlorocyclopentadiene, and Toxaphane. Sufficient data to perform statistically significant analyses were not received for those analytes during the LCS study. Additional limits for surrogate compounds can be found in section G.6.

¹⁸ LCS control limits are not available for Aroclors 1221, 1232, 1242, 1248, 1262, and 1268. Sufficient data to perform statistically significant analyses were not received for those analytes during the LCS study. Additional limits for surrogate compounds can be found in section G.6.

**Table G-18. LCS Control Limits for Metals SW-846
Methods 6010 and 7470 Water Matrix¹⁹**

Analyte	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit	Lower ME Limit	Upper ME Limit
Aluminum	97	5	80	120	80	120
Antimony	98	4	80	120	80	120
Arsenic	98	4	80	120	80	120
Barium	99	4	80	120	80	120
Beryllium	99	4	80	120	80	120
Cadmium	100	4	80	120	80	120
Calcium	98	4	80	120	80	120
Chromium	100	4	80	120	80	120
Cobalt	99	3	80	120	80	120
Copper	99	3	80	120	80	120
Iron	102	4	80	120	80	120
Lead	99	4	80	120	80	120
Magnesium	98	4	80	120	80	120
Manganese	100	4	80	120	80	120
Mercury	100	5	80	120	No ME	No ME
Molybdenum	95	5	80	120	75	120
Nickel	100	4	80	120	80	120
Potassium	98	4	80	120	80	120
Selenium	98	6	80	120	75	120
Silver	97	5	80	120	75	120
Sodium	99	4	80	120	80	120
Thallium	97	4	80	120	80	120
Vanadium	99	4	80	120	80	120
Zinc	100	4	80	120	80	120

¹⁹ The as-generated limits have been adjusted to reflect Method requirements and acceptable calibration uncertainty. A number of sporadic marginal exceedances of the control limits are allowed for Method 6010, depending on the number of analytes spiked in the LCS. Refer to section G.2 and Table G-1 for guidance on the appropriate application of control and ME limits.

Table G-19. LCS Control Limits for Metals SW-846 Methods 6010 and 7471 Solid Matrix²⁰

Analyte	Mean	Standard Deviation	Lower Control Limit	Upper Control Limit	Lower ME Limit	Upper ME Limit
Aluminum	95	5	80	120	75	120
Antimony	96	5	80	120	75	120
Arsenic	95	4	80	120	80	120
Barium	98	3	80	120	80	120
Beryllium	99	4	80	120	80	120
Cadmium	97	4	80	120	80	120
Calcium	97	4	80	120	80	120
Chromium	99	5	80	120	80	120
Cobalt	98	4	80	120	80	120
Copper	97	3	80	120	80	120
Iron	100	4	80	120	80	120
Lead	95	4	80	120	80	120
Magnesium	96	3	80	120	80	120
Manganese	97	4	80	120	80	120
Mercury	100	6	80	120	No ME	No ME
Molybdenum	96	5	80	120	75	120
Nickel	97	4	80	120	80	120
Potassium	96	4	80	120	80	120
Selenium	93	4	80	120	75	120
Silver	96	7	75	120	70	125
Sodium	96	4	80	120	80	120
Thallium	94	4	80	120	80	120
Vanadium	99	3	80	120	80	120
Zinc	95	5	80	120	75	120

²⁰ The as-generated limits have been adjusted to reflect Method requirements and acceptable calibration uncertainty. A number of sporadic marginal exceedances of the control limits are allowed for Method 6010, depending on the number of analytes spiked in the LCS. Refer to section G.2 and Table G-1 for guidance on the appropriate application of control and ME limits.

APPENDIX B-2

Laboratory Method Control Limits - Groundwater

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Empirical Laboratories, LLC Control Limits

Method	Analyte	Laboratory Specific Control Limits		
		Lower	Upper	RPD
SW846 8260B	1,1,1,2-Tetrachloroethane	80	130	30
Waters	1,1,1-Trichloroethane	65	130	30
	1,1,2,2-Tetrachloroethane	65	130	30
	1,1,2-Trichloro-1,2,2-Trifluoroethane	60	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
	1,3,5-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-Dichlorobenzene	75	125	30
	1,3-Dichloropropane	75	125	30
	1,4-Dichlorobenzene	75	125	30
	1-Chlorohexane	75	125	30
	2,2-Dichloropropane	70	135	30
	2-Butanone	30	150	30
	2-Chloro Vinyl Ether	10	165	30
	2-Chlorotoluene	75	125	30
	2-Hexanone	55	130	30
	4-Chlorotoluene	75	130	30
	4-Methyl-2-Pentanone	60	135	30
	Acetone	40	140	30
	Acrolein	10	200	30
	Acrylonitrile	35	180	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
	Chloroethane	60	135	30
	Chloroform	65	135	30
	Chloromethane	40	125	30

	cis-1,2-Dichloroethene	70	125	30
	cis-1,3-Dichloropropene	70	130	30
	Cyclohexane	60	130	30
	Dibromochloromethane	60	135	30
	Dibromomethane	75	125	30
	Dichlorodifluoromethane	30	155	30
	Di-Isopropyl Ether	60	130	30
	ETBE	50	150	30
	Ethyl Methacrylate	70	135	30
	Ethylbenzene	75	125	30
	Hexachlorobutadiene	50	140	30
	Iodomethane	50	140	30
	Isopropylbenzene	75	125	30
	Methyl Acetate	55	150	30
	Methyl Methacrylate	70	135	30
	Methyl tert-Butyl Ether	65	125	30
	Methylcyclohexane	60	125	30
	Methylene Chloride	55	140	30
	Naphthalene	55	140	30
	n-Butylbenzene	70	135	30
	n-Propylbenzene	70	130	30
	p-Isopropyltoluene	75	130	30
	sec-Butylbenzene	70	125	30
	Styrene	65	135	30
	t-Butyl Alcohol	60	130	30
	tert-Amyl Methyl Ether	50	150	30
Surrogates	Bromofluorobenzene	75	125	
	Dibromofluorobenzene	85	115	
	1,2 Dichloroethane-d4	70	120	
	Toluene-d8	85	120	

Empirical Laboratories, LLC Control Limits

Method	Analyte	Laboratory Specific Control Limits		
		Lower	Upper	RPD
SW846 8270C	1-Methylnaphthalene	30	115	30
Waters	1,1'-Biphenyl	50	110	30
	1,2,4,5-Tetrachlorobenzene	50	125	30
	1,2,4-Trichlorobenzene	35	105	30
	1,2-Dichlorobenzene	35	100	30
	1,2-Diphenylhydrazine	55	115	30
	1,3-Dichlorobenzene	30	100	30
	1,4-Dichlorobenzene	30	100	30
	2,3,4,6-Tetrachlorophenol	50	125	30
	2,4,5-Trichlorophenol	50	110	30
	2,4,6-Trichlorophenol (TCP)	50	115	30
	2,4-Dichlorophenol (DCP)	40	110	30
	2,4-Dimethylphenol	30	110	30
	2,4-Dinitrophenol	15	140	30
	2,4-Dinitrotoluene (DNT)	50	120	30
	2,6-Dinitrotoluene	50	115	30
	2-Chloronaphthalene	50	105	30
	2-Chlorophenol	35	105	30
	2-Methylnaphthalene	45	105	30
	2-Methylphenol (o-Cresol)	40	110	30
	2-Nitroaniline	50	115	30
	2-Nitrophenol (ONP)	40	115	30
	3,3'-Dichlorobenzidine (DCB)	20	110	30
	3-Methylphenol	30	110	30
	3-Nitroaniline	20	125	30
	4,6-Dinitro-2-methylphenol (DNOC)	40	130	30
	4-Bromophenyl phenyl ether	50	115	30
	4-Chloro-3-methylphenol	45	110	30
	4-Chloroaniline	15	110	30
	4-Chlorophenyl phenyl ether	50	110	30
	4-Methylphenol (p-Cresol)	30	110	30
	4-Nitroaniline (PNA)	35	120	30
	4-Nitrophenol (PNP)	0	125	30
	Acenaphthene	45	110	30
	Acenaphthylene	50	105	30
	Acetaphenone	50	110	30
	Aniline	10	110	30
	Anthracene	55	110	30
	Benzidine	0	200	30
	Benzo(a)anthracene	55	110	30
	Benzo(a)pyrene	55	110	30
	Benzo(b)fluoranthene	45	120	30
	Benzo(g,h,i)perylene	40	125	30
	Benzo(k)fluoranthene	45	125	30

	Benzoic Acid	0	125	30
	Benzyl alcohol	30	110	30
	bis(2-Chloroethoxy)methane	45	105	30
	bis(2-Chloroethyl)ether (BCEE)	35	110	30
	Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane)	25	130	30
	bis(2-Ethylhexyl)phthalate (BEHP)	40	125	30
	Butyl benzyl phthalate (BBP)	45	115	30
	Carbazole	50	115	30
	Chrysene	55	110	30
	Dibenz(a,h)anthracene	40	125	30
	Dibenzofuran (DBF)	55	105	30
	Diethyl phthalate (DEP)	40	120	30
	Dimethyl phthalate (DMP)	25	125	30
	Di-n-butyl phthalate (DBP)	55	115	30
	Di-n-octyl phthalate (DNOP)	35	135	30
	Fluoranthene	55	115	30
	Fluorene	50	110	30
	Hexachlorobenzene (HCB)	50	110	30
	Hexachlorobutadiene (HCBD)	25	105	30
	Hexachlorocyclopentadiene (HCCPD)	10	110	30
	Hexachloroethane (HCE)	30	95	30
	Indeno(1,2,3-cd)pyrene	45	125	30
	Isophorone	50	110	30
	Naphthalene	40	100	30
	Nitrobenzene	30	110	30
	N-Nitrosodimethylamine	25	110	30
	N-Nitroso-di-n-propylamine (NDPA)	35	130	30
	N-nitrosodiphenylamine (NDPHA)	50	110	30
	Pentachlorophenol	40	115	30
	Phenanthrene	50	115	30
	Phenol	0	115	30
	Pyrene	50	130	30
	Pyridine	10	110	30
Surrogates:	2-Fluorobiphenyl	50	110	
	2-Fluorophenol	20	110	
	Nitrobenzene-d5	40	110	
	Phenol-d5	15	110	
	Terphenyl-d14	50	135	

Empirical Laboratories, LLC Control Limits

Method	Analyte	Laboratory Specific Control Limits		
		Lower	Upper	RPD
SW846 8011	Ethylene Dibromide	70	130	20
Waters				

Empirical Laboratories, LLC Control Limits

Method	Analyte	Laboratory Specific Control Limits		
		Lower	Upper	RPD
SW846 8015B DRO	DRO C10- C28	50	150	50
Waters				
Surrogates:	2-Fluorobiphenyl	50	150	
	o-Terphenyl	30	140	

Method	Analyte	Laboratory Specific Control Limits		
		Lower	Upper	RPD
SW846 8015B GRO	GRO C6-C8	50	150	50
Waters				
Surrogate:	Bromofluorobenzene	50	150	

Empirical Laboratories, LLC Control Limits

Method	Analyte	Laboratory Specific Control Limits LCS			Laboratory Specific Control Limits Matrix Spikes		
		Lower	Upper	RPD	Lower	Upper	RPD
EPH MA DEP	C12 - C40	50	150	20	50	150	50
Waters							
Surrogate	o-Terphenyl	50	150				

Method	Analyte	Laboratory Specific Control Limits		
		Lower	Upper	RPD
VPH MA DEP	C5-C8 Aliphatics	70	130	40
Waters	C9-C12 Aliphatics	70	130	40
Surrogate	2,5 Dibromotoluene	70	130	

Empirical Laboratories, LLC Control Limits

Method	Analyte	Laboratory Specific Control Limits		
		Lower	Upper	RPD
SW846 6010B	Dissolved Iron	80	120	20
Waters	Dissolved Manganese	80	120	20
	Lead	80	120	20
	Sodium	80	120	20
	Potassium	80	120	20
	Calcium	80	120	20
	Magnesium	80	120	20

Empirical Laboratories, LLC Control Limits

Method	Analyte	Laboratory Specific Control Limits LCS			Laboratory Specific Control Limits MS		
		Lower	Upper	RPD	Lower	Upper	RPD
SW846 9056	Nitrate	90	110	20	80	120	20
Waters	Nitrite	90	110	20	80	120	20
	Sulfate	90	110	20	80	120	20
	Chloride	90	110	20	80	120	20

Empirical Laboratories, LLC Control Limits

Method	Analyte	Laboratory Specific Control Limits LCS			Laboratory Specific Control Limits MS		
		Lower	Upper	RPD	Lower	Upper	RPD
SM2320B	Alkalinity	80	120	20	75	125	20
Waters							

Empirical Laboratories, LLC Control Limits

Method	Analyte	Laboratory Specific Control Limits LCS			Laboratory Specific Control Limits MS		
		Lower	Upper	RPD	Lower	Upper	RPD
SM4500SCF	Sulfide	80	120	20	75	125	20
Waters							

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APPENDIX B-3

Laboratory Method Control Limits – Soil

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Control Limits

Gulf Coast Analytical Laboratories

Method: SW-846 8260B

Analyte	Name	LCS	LCL-UCL	Matrix
630-20-6	1,1,1,2-Tetrachloroethane		77-122	S
71-55-6	1,1,1-Trichloroethane		70-130	S
79-34-5	1,1,2,2-Tetrachloroethane		66-129	S
79-00-5	1,1,2-Trichloroethane		74-120	S
75-34-3	1,1-Dichloroethane		71-126	S
75-35-4	1,1-Dichloroethene		68-129	S
563-58-6	1,1-Dichloropropene		70-138	S
87-61-6	1,2,3-Trichlorobenzene		69-130	S
96-18-4	1,2,3-Trichloropropane		63-132	S
120-82-1	1,2,4-Trichlorobenzene		64-135	S
95-63-6	1,2,4-Trimethylbenzene		75-130	S
96-12-8	1,2-Dibromo-3-chloropropane		60-123	S
106-93-4	1,2-Dibromoethane		74-122	S
95-50-1	1,2-Dichlorobenzene		76-125	S
107-06-2	1,2-Dichloroethane		68-126	S
78-87-5	1,2-Dichloropropane		72-129	S
108-67-8	1,3,5-Trimethylbenzene		74-136	S
541-73-1	1,3-Dichlorobenzene		77-127	S
142-28-9	1,3-Dichloropropane		77-121	S
106-46-7	1,4-Dichlorobenzene		74-123	S
544-10-5	1-Chlorohexane		68-136	S
594-20-7	2,2-Dichloropropane		74-129	S
78-93-3	2-Butanone		47-142	S
95-49-8	2-Chlorotoluene		75-132	S
591-78-6	2-Hexanone		47-137	S
106-43-4	4-Chlorotoluene		74-133	S
99-87-6	4-Isopropyltoluene		71-136	S
108-10-1	4-Methyl-2-pentanone		52-136	S
67-64-1	Acetone		38-152	S
107-02-8	Acrolein		34-158	S

107-13-1	Acrylonitrile	49-142	S
71-43-2	Benzene	73-128	S
108-86-1	Bromobenzene	73-124	S
74-97-5	Bromochloromethane	73-127	S
75-27-4	Bromodichloromethane	74-126	S
75-25-2	Bromoform	67-122	S
74-83-9	Bromomethane	48-139	S
75-15-0	Carbon disulfide	68-133	S
56-23-5	Carbon tetrachloride	71-133	S
108-90-7	Chlorobenzene	75-121	S
75-00-3	Chloroethane	57-144	S
67-66-3	Chloroform	74-124	S
74-87-3	Chloromethane	61-130	S
124-48-1	Dibromochloromethane	74-122	S
74-95-3	Dibromomethane	72-125	S
75-71-8	Dichlorodifluoromethane	59-138	S
100-41-4	Ethylbenzene	74-130	S
87-68-3	Hexachlorobutadiene	71-140	S
98-82-8	Isopropylbenzene (Cumene)	74-125	S
75-09-2	Methylene chloride	66-130	S
91-20-3	Naphthalene	54-132	S
100-42-5	Styrene	72-128	S
127-18-4	Tetrachloroethene	70-127	S
108-88-3	Toluene	74-121	S
79-01-6	Trichloroethene	78-127	S
75-69-4	Trichlorofluoromethane	64-141	S
108-05-4	Vinyl acetate	53-140	S
75-01-4	Vinyl chloride	67-131	S
1330-20-7	Xylene (total)	71-129	S
156-59-2	cis-1,2-Dichloroethene	72-130	S
10061-01-5	cis-1,3-Dichloropropene	72-129	S
136777-61-2	m,p-Xylene	72-128	S
104-51-8	n-Butylbenzene	68-144	S
103-65-1	n-Propylbenzene	73-137	S
95-47-6	o-Xylene	69-133	S
135-98-8	sec-Butylbenzene	72-141	S
1634-04-4	tert-Butyl methyl ether (MTBE)	69-126	S
98-06-6	tert-Butylbenzene	72-136	S
156-60-5	trans-1,2-Dichloroethene	67-134	S
10061-02-6	trans-1,3-Dichloropropene	72-126	S
17060-07-0	1,2-Dichloroethane-d4	62-125	Surrogate
460-00-4	4-Bromofluorobenzene	62-127	Surrogate

1868-53-7
2037-26-5

Dibromofluoromethane
Toluene-d8

65-130
71-132

Surrogate
Surrogate

Control Limits

Gulf Coast Analytical Laboratories

Method: SW-846 8260B

LCSD			
Analyte	Name	LCL-UCL	Matrix
630-20-6	1,1,1,2-Tetrachloroethane	0-30	S
71-55-6	1,1,1-Trichloroethane	0-30	S
79-34-5	1,1,2,2-Tetrachloroethane	0-30	S
79-00-5	1,1,2-Trichloroethane	0-30	S
75-34-3	1,1-Dichloroethane	0-30	S
75-35-4	1,1-Dichloroethene	0-30	S
563-58-6	1,1-Dichloropropene	0-30	S
87-61-6	1,2,3-Trichlorobenzene	0-30	S
96-18-4	1,2,3-Trichloropropane	0-30	S
120-82-1	1,2,4-Trichlorobenzene	0-30	S
95-63-6	1,2,4-Trimethylbenzene	0-30	S
96-12-8	1,2-Dibromo-3-chloropropane	0-30	S
106-93-4	1,2-Dibromoethane	0-30	S
95-50-1	1,2-Dichlorobenzene	0-30	S
107-06-2	1,2-Dichloroethane	0-30	S
78-87-5	1,2-Dichloropropane	0-30	S
108-67-8	1,3,5-Trimethylbenzene	0-30	S
541-73-1	1,3-Dichlorobenzene	0-30	S
142-28-9	1,3-Dichloropropane	0-30	S
106-46-7	1,4-Dichlorobenzene	0-30	S
544-10-5	1-Chlorohexane	0-30	S
594-20-7	2,2-Dichloropropane	0-30	S
78-93-3	2-Butanone	0-30	S
95-49-8	2-Chlorotoluene	0-30	S
591-78-6	2-Hexanone	0-30	S
106-43-4	4-Chlorotoluene	0-30	S
99-87-6	4-Isopropyltoluene	0-30	S
108-10-1	4-Methyl-2-pentanone	0-30	S
67-64-1	Acetone	0-30	S
107-02-8	Acrolein	0-30	S

107-13-1	Acrylonitrile	0-30	S
71-43-2	Benzene	0-30	S
108-86-1	Bromobenzene	0-30	S
74-97-5	Bromochloromethane	0-30	S
75-27-4	Bromodichloromethane	0-30	S
75-25-2	Bromoform	0-30	S
74-83-9	Bromomethane	0-30	S
75-15-0	Carbon disulfide	0-30	S
56-23-5	Carbon tetrachloride	0-30	S
108-90-7	Chlorobenzene	0-30	S
75-00-3	Chloroethane	0-30	S
67-66-3	Chloroform	0-30	S
74-87-3	Chloromethane	0-30	S
124-48-1	Dibromochloromethane	0-30	S
74-95-3	Dibromomethane	0-30	S
75-71-8	Dichlorodifluoromethane	0-30	S
100-41-4	Ethylbenzene	0-30	S
87-68-3	Hexachlorobutadiene	0-30	S
98-82-8	Isopropylbenzene (Cumene)	0-30	S
75-09-2	Methylene chloride	0-30	S
91-20-3	Naphthalene	0-30	S
100-42-5	Styrene	0-30	S
127-18-4	Tetrachloroethene	0-30	S
108-88-3	Toluene	0-30	S
79-01-6	Trichloroethene	0-30	S
75-69-4	Trichlorofluoromethane	0-30	S
108-05-4	Vinyl acetate	0-30	S
75-01-4	Vinyl chloride	0-30	S
1330-20-7	Xylene (total)	0-30	S
156-59-2	cis-1,2-Dichloroethene	0-30	S
10061-01-5	cis-1,3-Dichloropropene	0-30	S
136777-61-2	m,p-Xylene	0-30	S
104-51-8	n-Butylbenzene	0-30	S
103-65-1	n-Propylbenzene	0-30	S
95-47-6	o-Xylene	0-30	S
135-98-8	sec-Butylbenzene	0-30	S
1634-04-4	tert-Butyl methyl ether (MTBE)	0-30	S
98-06-6	tert-Butylbenzene	0-30	S
156-60-5	trans-1,2-Dichloroethene	0-30	S
10061-02-6	trans-1,3-Dichloropropene	0-30	S

Control Limits

Gulf Coast Analytical Laboratories

Method: SW-846 8270

Analyte	Name	LCS	LCL-UCL	Matrix
95-94-3	1,2,4,5-Tetrachlorobenzene		60-120	S
120-82-1	1,2,4-Trichlorobenzene		46-120	S
95-50-1	1,2-Dichlorobenzene		44-120	S
122-66-7	1,2Diphenylhydrazine/Azobenzen		49-120	S
541-73-1	1,3-Dichlorobenzene		40-120	S
106-46-7	1,4-Dichlorobenzene		42-120	S
58-90-2	2,3,4,6-Tetrachlorophenol		60-120	S
95-95-4	2,4,5-Trichlorophenol		47-120	S
88-06-2	2,4,6-Trichlorophenol		46-120	S
120-83-2	2,4-Dichlorophenol		47-120	S
105-67-9	2,4-Dimethylphenol		47-120	S
51-28-5	2,4-Dinitrophenol		14-120	S
121-14-2	2,4-Dinitrotoluene		45-120	S
87-65-0	2,6-Dichlorophenol		60-120	S
606-20-2	2,6-Dinitrotoluene		47-120	S
91-58-7	2-Chloronaphthalene		52-120	S
95-57-8	2-Chlorophenol		48-120	S
91-57-6	2-Methylnaphthalene		43-120	S
88-74-4	2-Nitroaniline		44-120	S
88-75-5	2-Nitrophenol		49-120	S
91-94-1	3,3'-Dichlorobenzidine		35-120	S
99-09-2	3-Nitroaniline		29-120	S
534-52-1	4,6-Dinitro-2-methylphenol		29-120	S
101-55-3	4-Bromophenyl phenyl ether		51-125	S
59-50-7	4-Chloro-3-methylphenol		46-120	S
106-47-8	4-Chloroaniline		20-120	S
7005-72-3	4-Chlorophenyl phenyl ether		50-120	S
100-01-6	4-Nitroaniline		32-120	S
100-02-7	4-Nitrophenol		32-120	S
83-32-9	Acenaphthene		50-120	S

208-96-8	Acenaphthylene	53-120	S
62-53-3	Aniline	21-131	S
120-12-7	Anthracene	52-120	S
56-55-3	Benzo(a)anthracene	48-120	S
50-32-8	Benzo(a)pyrene	44-120	S
205-99-2	Benzo(b)fluoranthene	31-130	S
191-24-2	Benzo(g,h,i)perylene	29-134	S
207-08-9	Benzo(k)fluoranthene	36-122	S
111-91-1	Bis(2-Chloroethoxy)methane	51-120	S
111-44-4	Bis(2-Chloroethyl)ether	46-120	S
108-60-1	Bis(2-Chloroisopropyl)ether	46-120	S
117-81-7	Bis(2-Ethylhexyl)phthalate	46-129	S
85-68-7	Butyl benzyl phthalate	46-130	S
86-74-8	Carbazole	47-120	S
218-01-9	Chrysene	51-120	S
84-74-2	Di-n-butyl phthalate	50-120	S
117-84-0	Di-n-octyl phthalate	41-122	S
53-70-3	Dibenz(a,h)anthracene	27-129	S
132-64-9	Dibenzofuran	50-120	S
84-66-2	Diethyl phthalate	36-120	S
131-11-3	Dimethyl phthalate	50-120	S
206-44-0	Fluoranthene	39-120	S
86-73-7	Fluorene	48-120	S
118-74-1	Hexachlorobenzene	48-120	S
87-68-3	Hexachlorobutadiene	46-120	S
77-47-4	Hexachlorocyclopentadiene	23-121	S
67-72-1	Hexachloroethane	40-120	S
193-39-5	Indeno(1,2,3-cd)pyrene	43-132	S
78-59-1	Isophorone	49-120	S
91-20-3	Naphthalene	48-120	S
98-95-3	Nitrobenzene	45-120	S
608-93-5	Pentachlorobenzene	60-120	S
87-86-5	Pentachlorophenol	30-124	S
85-01-8	Phenanthrene	53-120	S
108-95-2	Phenol	42-120	S
129-00-0	Pyrene	38-136	S
110-86-1	Pyridine	11-120	S
1319-77-3MP	m,p-Cresol	46-120	S
621-64-7	n-Nitrosodi-n-propylamine	46-120	S
55-18-5	n-Nitrosodiethylamine	60-120	S
62-75-9	n-Nitrosodimethylamine	34-126	S
86-30-6	n-Nitrosodiphenylamine	54-125	S
95-48-7	o-Cresol	46-120	S

118-79-6	2,4,6-Tribromophenol	44-121	Surrogate
321-60-8	2-Fluorobiphenyl	47-127	Surrogate
367-12-4	2-Fluorophenol	51-119	Surrogate
4165-60-0	Nitrobenzene-d5	46-123	Surrogate
4165-62-2	Phenol-d5	43-123	Surrogate
1718-51-0	Terphenyl-d14	38-167	Surrogate

Control Limits

Gulf Coast Analytical Laboratories

Method: SW-846 8270

Analyte	Name	LCL-UCL	Matrix
95-94-3	1,2,4,5-Tetrachlorobenzene	0-40	S
120-82-1	1,2,4-Trichlorobenzene	0-40	S
95-50-1	1,2-Dichlorobenzene	0-40	S
122-66-7	1,2Diphenylhydrazine/Azobenzen	0-40	S
541-73-1	1,3-Dichlorobenzene	0-40	S
106-46-7	1,4-Dichlorobenzene	0-40	S
58-90-2	2,3,4,6-Tetrachlorophenol	0-40	S
95-95-4	2,4,5-Trichlorophenol	0-40	S
88-06-2	2,4,6-Trichlorophenol	0-40	S
120-83-2	2,4-Dichlorophenol	0-40	S
105-67-9	2,4-Dimethylphenol	0-40	S
51-28-5	2,4-Dinitrophenol	0-40	S
121-14-2	2,4-Dinitrotoluene	0-40	S
87-65-0	2,6-Dichlorophenol	0-40	S
606-20-2	2,6-Dinitrotoluene	0-40	S
91-58-7	2-Chloronaphthalene	0-40	S
95-57-8	2-Chlorophenol	0-40	S
91-57-6	2-Methylnaphthalene	0-40	S
88-74-4	2-Nitroaniline	0-40	S
88-75-5	2-Nitrophenol	0-40	S
91-94-1	3,3'-Dichlorobenzidine	0-40	S
99-09-2	3-Nitroaniline	0-40	S
534-52-1	4,6-Dinitro-2-methylphenol	0-40	S
101-55-3	4-Bromophenyl phenyl ether	0-40	S
59-50-7	4-Chloro-3-methylphenol	0-40	S
106-47-8	4-Chloroaniline	0-40	S
7005-72-3	4-Chlorophenyl phenyl ether	0-40	S
100-01-6	4-Nitroaniline	0-40	S
100-02-7	4-Nitrophenol	0-40	S
83-32-9	Acenaphthene	0-40	S

208-96-8	Acenaphthylene	0-40	S
62-53-3	Aniline	0-40	S
120-12-7	Anthracene	0-40	S
56-55-3	Benzo(a)anthracene	0-40	S
50-32-8	Benzo(a)pyrene	0-40	S
205-99-2	Benzo(b)fluoranthene	0-40	S
191-24-2	Benzo(g,h,i)perylene	0-40	S
207-08-9	Benzo(k)fluoranthene	0-40	S
111-91-1	Bis(2-Chloroethoxy)methane	0-40	S
111-44-4	Bis(2-Chloroethyl)ether	0-40	S
108-60-1	Bis(2-Chloroisopropyl)ether	0-40	S
117-81-7	Bis(2-Ethylhexyl)phthalate	0-40	S
85-68-7	Butyl benzyl phthalate	0-40	S
86-74-8	Carbazole	0-40	S
218-01-9	Chrysene	0-40	S
84-74-2	Di-n-butyl phthalate	0-40	S
117-84-0	Di-n-octyl phthalate	0-40	S
53-70-3	Dibenz(a,h)anthracene	0-40	S
132-64-9	Dibenzofuran	0-40	S
84-66-2	Diethyl phthalate	0-40	S
131-11-3	Dimethyl phthalate	0-40	S
206-44-0	Fluoranthene	0-40	S
86-73-7	Fluorene	0-40	S
118-74-1	Hexachlorobenzene	0-40	S
87-68-3	Hexachlorobutadiene	0-40	S
77-47-4	Hexachlorocyclopentadiene	0-40	S
67-72-1	Hexachloroethane	0-40	S
193-39-5	Indeno(1,2,3-cd)pyrene	0-40	S
78-59-1	Isophorone	0-40	S
91-20-3	Naphthalene	0-40	S
98-95-3	Nitrobenzene	0-40	S
608-93-5	Pentachlorobenzene	0-40	S
87-86-5	Pentachlorophenol	0-40	S
85-01-8	Phenanthrene	0-40	S
108-95-2	Phenol	0-40	S
129-00-0	Pyrene	0-40	S
110-86-1	Pyridine	0-40	S
1319-77-3MP	m,p-Cresol	0-40	S
621-64-7	n-Nitrosodi-n-propylamine	0-40	S
55-18-5	n-Nitrosodiethylamine	0-40	S
62-75-9	n-Nitrosodimethylamine	0-40	S
86-30-6	n-Nitrosodiphenylamine	0-40	S
95-48-7	o-Cresol	0-40	S

Control Limits

Gulf Coast Analytical Laboratories

**Method: Massachusetts EPH
& VPH**

LCS			
Test	Name	LCL-UCL	Matrix
Mass EPH	C9-C18 Aliphatic Hydrocarbons	40-140	S
Mass EPH	C19-C36 Aliphatic Hydrocarbons	40-140	S
Mass EPH	C11-C22 Aromatics Hydrocarbons	40-140	S
Mass EPH	1-Chlorooctadecane	40-140	EPH Surr
Mass EPH	o-Terphenyl	40-140	EPH Surr
Mass VPH	C5-C8 Aliphatic Hydrocarbons	60-140	S
Mass VPH	C9-C12 Aliphatic Hydrocarbons	60-140	S
Mass VPH	C9-C10 Aromatic Hydrocarbons	60-140	S
Mass VPH	2,5-Dibromotoluene	60-140	VPH Surr

Control Limits

Gulf Coast Analytical Laboratories

Method: Massachusetts EPH & VPH

LCSD			
Test	Name	LCL-UCL	Matrix
Mass EPH	C9-C18 Aliphatic Hydrocarbons	0-40	S
Mass EPH	C19-C36 Aliphatic Hydrocarbons	0-40	S
Mass EPH	C11-C22 Aromatics Hydrocarbons	0-40	S
Mass VPH	C5-C8 Aliphatic Hydrocarbons	0-30	S
Mass VPH	C9-C12 Aliphatic Hydrocarbons	0-30	S
Mass VPH	C9-C10 Aromatic Hydrocarbons	0-30	S

Control Limits

Gulf Coast Analytical Laboratories

Method: SW-846 6010

LCS				
Analyte	Name		LCL-UCL	Matrix
7439-92-1	Lead		80-120	S

Control Limits

Gulf Coast Analytical Laboratories

Method: SW-846 6010

LCSD			
Analyte	Name	LCL-UCL	Matrix
7439-92-1	Lead	0-20	S

APPENDIX B-4

Laboratory Method Control Limits – Soil Gas

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RTI QA Acceptance Criteria
ASTM 2504

10/21/2010

ASTM 2504

	&Analyte	Units	MDL	PQL	CCV		DUP	LCS/LCSD				
					SPK	Low	High	RPD	SPK	Low	High	RPD
	Carbon dioxide	%	0.1	0.1	1	85	115	20	0.25	70	130	20
	Carbon Monoxide	%	0.1	0.1	1	85	115	20	0.25	70	130	20
	Ethane	%	0.5	0.5	1	85	115	20	0.25	70	130	20
	Hydrogen	%	0.5	0.5	1	85	115	20	0.25	70	130	20
	Methane	%	0.5	0.5	1	85	115	20	0.25	70	130	20
	Nitrogen	%	0.1	0.1	1	85	115	20	0.25	70	130	20
	Oxygen	%	0.1	0.1	1	85	115	20	0.25	70	130	20

RTI QA Acceptance Criteria
TO-15

10/21/2010

TO-15

	&Analyte	Units	MDL	PQL	CCV			DUP	ICV		
					SPK	Low	High	RPD	SPK	Low	High
	1,1,1-Trichloroethane	ppbv	0.33	1	9.6	70	130	25	9.6	70	130
	1,1,2,2-Tetrachloroethane	ppbv	0.42	1	10	70	130	25	10	70	130
	1,1,2-Trichloro-1,2,2-trifluoroethane	ppbv	0.31	1	9.8	70	130	25	9.8	70	130
	1,1,2-Trichloroethane	ppbv	0.23	0.5	9.8	70	130	25	9.8	70	130
	1,1-Dichloroethane	ppbv	0.38	1	9.7	70	130	25	9.7	70	130
	1,1-Dichloroethene	ppbv	0.65	2	9.9	70	130	25	9.9	70	130
	1,2,4-Trichlorobenzene	ppbv	0.52	2	9.1	70	130	25	9.1	70	130
	1,2,4-Trimethylbenzene	ppbv	0.42	1	9.8	70	130	25	9.8	70	130
	1,2-Dibromoethane	ppbv	0.19	0.5	9.6	70	130	25	9.6	70	130
	1,2-Dichlorobenzene	ppbv	0.37	1	9.7	70	130	25	9.7	70	130
	1,2-Dichloroethane	ppbv	0.33	1	9.7	70	130	25	9.7	70	130
	1,2-Dichloropropane	ppbv	0.23	0.5	9.8	70	130	25	9.8	70	130
	1,3,5-Trimethylbenzene	ppbv	0.38	1	9.7	70	130	25	9.7	70	130
	1,3-Butadiene	ppbv	1.34	3	9.8	70	130	25	9.8	70	130
	1,3-Dichlorobenzene	ppbv	0.36	1	9.7	70	130	25	9.7	70	130
	1,4-Dichlorobenzene	ppbv	0.45	1	9.6	70	130	25	9.6	70	130
	1,4-Dioxane	ppbv	1.8	5	9.6	70	130	25	9.6	70	130
	2-Butanone	ppbv	0.54	2	9.9	70	130	25	9.9	70	130
	2-Hexanone	ppbv	2.16	5	9.8	70	130	25	9.8	70	130
	2-Propanol	ppbv	0.44	1	10.1	70	130	25	10.1	70	130
	4-Methyl-2-pentanone	ppbv	1.07	5	10	70	130	25	10	70	130
	Acetone	ppbv	0.44	2	10	70	130	25	10	70	130
	Benzene	ppbv	0.39	1	9.6	70	130	25	9.6	70	130
	Benzyl chloride	ppbv	0.54	1	9.7	70	130	25	9.7	70	130
	Bromodichloromethane	ppbv	0.21	0.5	9.6	70	130	25	9.6	70	130
	Bromoform	ppbv	0.41	1	9.6	70	130	25	9.6	70	130
	Bromomethane	ppbv	0.71	2	9.3	70	130	25	9.3	70	130
	Carbon disulfide	ppbv	0.41	2	9.7	70	130	25	9.7	70	130
	Carbon tetrachloride	ppbv	0.35	1	9.5	70	130	25	9.5	70	130
	Chlorobenzene	ppbv	0.39	1	9.9	70	130	25	9.9	70	130
	Chlorodibromomethane	ppbv	0.34	1	9.2	70	130	25	9.2	70	130
	Chloroethane	ppbv	0.49	1	9.8	70	130	25	9.8	70	130
	Chloroform	ppbv	0.3	1	9.4	70	130	25	9.4	70	130

RTI QA Acceptance Criteria
TO-15

10/21/2010

	Chloromethane	ppbv	0.68	2	9.8	70	130	25	9.8	70	130
	cis-1,2-Dichloroethene	ppbv	1	1	9.8	70	130	25	9.8	70	130
	cis-1,3-dichloropropene	ppbv	0.24	0.5	9.5	70	130	25	9.5	70	130
	Cyclohexane	ppbv	0.37	1	9.8	70	130	25	9.8	70	130
	Dichlorodifluoromethane	ppbv	0.4	1	9.2	70	130	25	9.2	70	130
	Ethanol	ppbv	0.53	1	9.2	70	130	25	9.2	70	130
	Ethyl acetate	ppbv	0.55	1	9.8	70	130	25	9.8	70	130
	Ethylbenzene	ppbv	0.35	1	9.8	70	130	25	9.8	70	130
	Heptane	ppbv	0.37	1	9.9	70	130	25	9.9	70	130
	Hexachlorobutadiene	ppbv	0.54	2	9.4	70	130	25	9.4	70	130
	m,p-Xylene	ppbv	0.75	2	19.2	70	130	25	19.2	70	130
	Methylene chloride	ppbv	0.31	2	10	70	130	25	10	70	130
	n-Hexane	ppbv	0.31	1	10.1	70	130	25	10.1	70	130
	o-Xylene	ppbv	0.39	1	10	70	130	25	10	70	130
	Propylene	ppbv	0.37	1	10.2	70	130	25	10.2	70	130
	Styrene	ppbv	0.43	1	9.8	70	130	25	9.8	70	130
	tert-Butyl Methyl Ether	ppbv	0.61	2	9.9	70	130	25	9.9	70	130
	Tetrachloroethene	ppbv	0.21	0.5	9.6	70	130	25	9.6	70	130
	Tetrahydrofuran	ppbv	0.58	2	10	70	130	25	10	70	130
	Toluene	ppbv	0.24	0.5	9.8	70	130	25	9.8	70	130
	trans-1,2-Dichloroethene	ppbv	0.38	1	9.8	70	130	25	9.8	70	130
	trans-1,3-dichloropropene	ppbv	0.31	1	9.1	70	130	25	9.1	70	130
	Trichloroethene	ppbv	0.35	1	9.6	70	130	25	9.6	70	130
	Trichlorofluoromethane	ppbv	0.31	1	9.6	70	130	25	9.6	70	130
	Vinyl acetate	ppbv	0.31	1	9.9	70	130	25	9.9	70	130
	Vinyl chloride	ppbv	0.41	1	9.4	70	130	25	9.4	70	130
	Xylenes, Total	ppbv	1.14	3	29.2	70	130	25	29.2	70	130
SUR	4-Bromofluorobenzene	ppbv	0	0.5	12.5	70	130	25	12.5	70	130

RTI QA Acceptance Criteria
APH

10/21/2010

MADEP APH

	&Analyte	Units	MDL	LOD	PQL	CCV			DUP	ICV		
						SPK	Low	High	RPD	SPK	Low	High
	C5-C8 Aliphatic	µg/m³	3.7	6	12	120	70	130	25	120	70	130
	C9-C12 Aliphatic	µg/m³	4.7	6	12	120	70	130	25	120	70	130
	C9-C10 Aromatic	µg/m³	1.9	5	8	80	70	130	25	80	70	130
	1,3-Butadiene	µg/m³	3.0	4.5	6.6	21.7	70	130	25	21.7	70	130
	tert-Butyl Methyl Ether	µg/m³	2.2	3.6	7.2	35.7	70	130	25	35.7	70	130
	Benzene	µg/m³	1.3	1.6	3.2	30.7	70	130	25	30.7	70	130
	Toluene	µg/m³	0.9	1.9	1.9	36.9	70	130	25	36.9	70	130
	Ethylbenzene	µg/m³	1.5	2.2	4.4	42.6	70	130	25	42.6	70	130
	m,p-Xylene	µg/m³	3.3	4.3	8.7	83.4	70	130	25	83.4	70	130
	o-Xylene	µg/m³	1.7	2.2	4.3	43.4	70	130	25	43.4	70	130
	Naphthalene	µg/m³	6.0	10.5	15.7	53.5	70	130	25	53.5	70	130
SUR	4-Bromofluorobenzene	µg/m³	0		3.6	89	70	130	25	89	70	130

APPENDIX C

Field Forms

- C-1. Groundwater Purge Log**
- C-2. Vapor Purge Log**
- C-3. Kirtland AFB, BFF Spill, Monthly Water Level Field Measurements Form**
- C-4. Visual Classification of Soils Form**
- C-5. Monitoring Well Completion Diagram**
- C-6. Soil Vapor Monitoring Well Construction Diagram**
- C-7. Well Development Record**
- C-8. Well Abandonment Form**
- C-9. Example Completed Chain-of-Custody Form**
- C-10. Sample Collection Log**

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Form C-1. Groundwater Purge Log



GROUNDWATER PURGE LOG
Kirtland Air Force Base, Bulk Fuels Facility Spill

Project Name: _____ Well ID No.: _____
 Site / SWMU No.: _____ Date: _____
 Weather: _____ Time: _____
 Field Crew: _____ Crew Signature: _____
 Review Signature: _____ Date Review: _____

WELL OBSERVATIONS

Protective Casing / Vault: - Intact - Damaged - Locked: Yes - No Well ID Mark: Yes - No
 Notes: _____

CALCULATIONS

(A) Depth to Well Bottom	ft	(J) Filter Pack Volume (H x I)	gal
(B) Pre-Purge Depth to Water	ft	(K) Min Purge Volume (E + J)	gal
(C) Water Column Height (A-B)	ft	EQUIPMENT / MODEL	ID NUMBER
(D) Casing Factor: 4"=0.65 5"=1.02		Parameter Meter	
(E) One Well Casing Volume (C x D):	gal	Turbidity Meter	
(F) Depth to Top of Screen	ft	Pump	
(G) Depth to Bottom of Screen	ft	Field Alkalinity	
(H) Saturated Filter Pack Length (G - F, or B)	ft		
(I) Casing/Borehole Factor 4/10 = 1.2, 5/10 = 1.07, _____			

PURGING INFORMATION

Description first water purged: _____

Date and / or Time	Gallons Removed	Depth to Ground-water (Ft)	Temp (°C)	pH	Spec Cond (µS/cm ²)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comment

Values Prior to Sampling

--	--	--	--	--	--	--	--	--	--

Field Alkalinity Result _____

Note: For calculations, additional casing factors (D) and casing/borehole factors (I) can be found in the *Groundwater Investigation Work Plan, Part I: Field Investigation Activities* 140705

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Form C-2. Vapor Purge Log



VAPOR PURGE LOG
Kirtland Air Force Base, Bulk Fuels Facility Spill

Project Name: _____	Well ID No/Interval: _____	Field Crew: _____
Site / SWMU No.: _____	Date: _____	Crew Signature: _____
Weather: _____	Time: _____	Review Signature and Date: _____

WELL OBSERVATIONS

Protective Casing / Vault: Intact - Damaged **Locked:** Yes - No **Well ID Mark:** Yes - No

Notes:

CALCULATIONS

(A) Depth to Well Bottom	ft	(F) Filter Pack Length (E - D)	ft
(B) Casing Factor: ½" = .00136, ¾" = .00306, 2" = .0218, 3" = .04906	ft ²	(G) Casing/Borehole Factor: .545 sq. ft (10" Casing at 30% porosity)	0.1635 ft ²
(C) One Well Casing Volume (A x B):	ft ³	(J) Filter Pack Volume (F x G)	ft ³
(D) Depth to Top of Screen	ft	(K) One Purge Volume (C + J)	ft ³
(E) Depth to Bottom of Screen	ft	(L) 10 Purge Volumes (K*10)	ft ³

Static Pressure: _____ **Purge Flow Rate:** _____

PURGE DATA

Date/Time	Volume Purged (ft ³)	Horiba Mexa - 584 L				Comments
		CO (%)	CO ₂ (%)	O ₂ (%)	HC (ppmv)	

Values Prior to Sampling

--	--	--	--	--	--	--

Sample ID:

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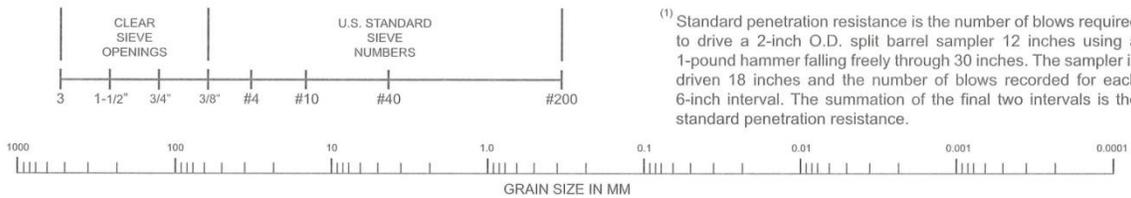
Form C-4. Visual Classification of Soils Form (concluded)

Consistency of Cohesive Soils

Consistency	Unconfined Compressive Strength (Tons per Square Foot)
Very Soft	Less than 0.25
Soft	0.25 to 0.50
Firm	0.50 to 2.0
Hard	2.0 to 4.0
Very Hard	More than 4.0

Density of Granular Soils

Density	Standard Penetration Resistance ⁽¹⁾
Very Loose	0-4
Loose	5-10
Medium Dense	11-30
Dense	31-50
Very Dense	Over 50



⁽¹⁾ Standard penetration resistance is the number of blows required to drive a 2-inch O.D. split barrel sampler 12 inches using a 1-pound hammer falling freely through 30 inches. The sampler is driven 18 inches and the number of blows recorded for each 6-inch interval. The summation of the final two intervals is the standard penetration resistance.

Cobbles	Gravel		Sand			Silt and Clay
	Coarse	Fine	Coarse	Medium	Fine	

USCS CLASSIFICATION FOR SOILS

Coarse-Grained Soils

Clean Gravels (little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
	GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
Gravel with Fines (appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures
	GC	Clayey gravels, gravel-sand-clay mixtures
Clean Sands (little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines
	SP	Poorly-graded sands, gravelly sands, little or no fines
Sands with Fines (appreciable amount of fines)	SM	Silty sands, sand-silt mixtures
	SC	Clayey sands, sand-silt mixtures

Fine-Grained/Highly Organic Soils

Silts and Clays Liquid Limit (less than 50)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	OL	Organic silts and organic silty clays of low plasticity
Silts and Clays Liquid Limit (greater than 50)	MH	Inorganic silts, micaceous or diatomaceous; fine, sandy or silty soils
	CH	Inorganic clays or high plasticity, fat clays
	OH	Organic clays of medium to high plasticity, organic silts
Highly Organic Soils	PT	Peat, humus, swamp soils with high organic contents

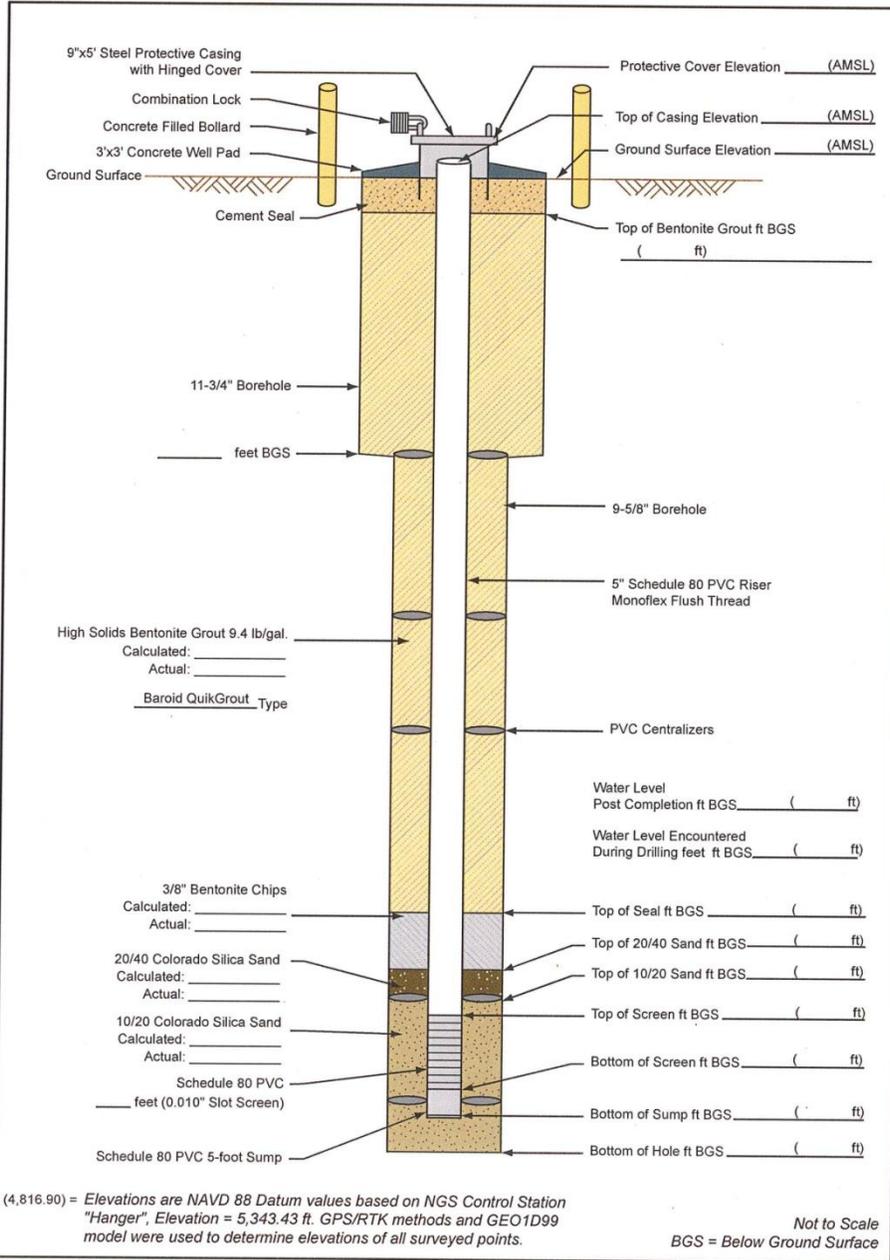
Form Number: 252_2
Rev. 05-12-09

Form C-5. Monitoring Well Completion Diagram

Monitoring Well Completion Diagram KAFB-_____

Installation Start Date/Time: _____

Installation End Date/Time: _____



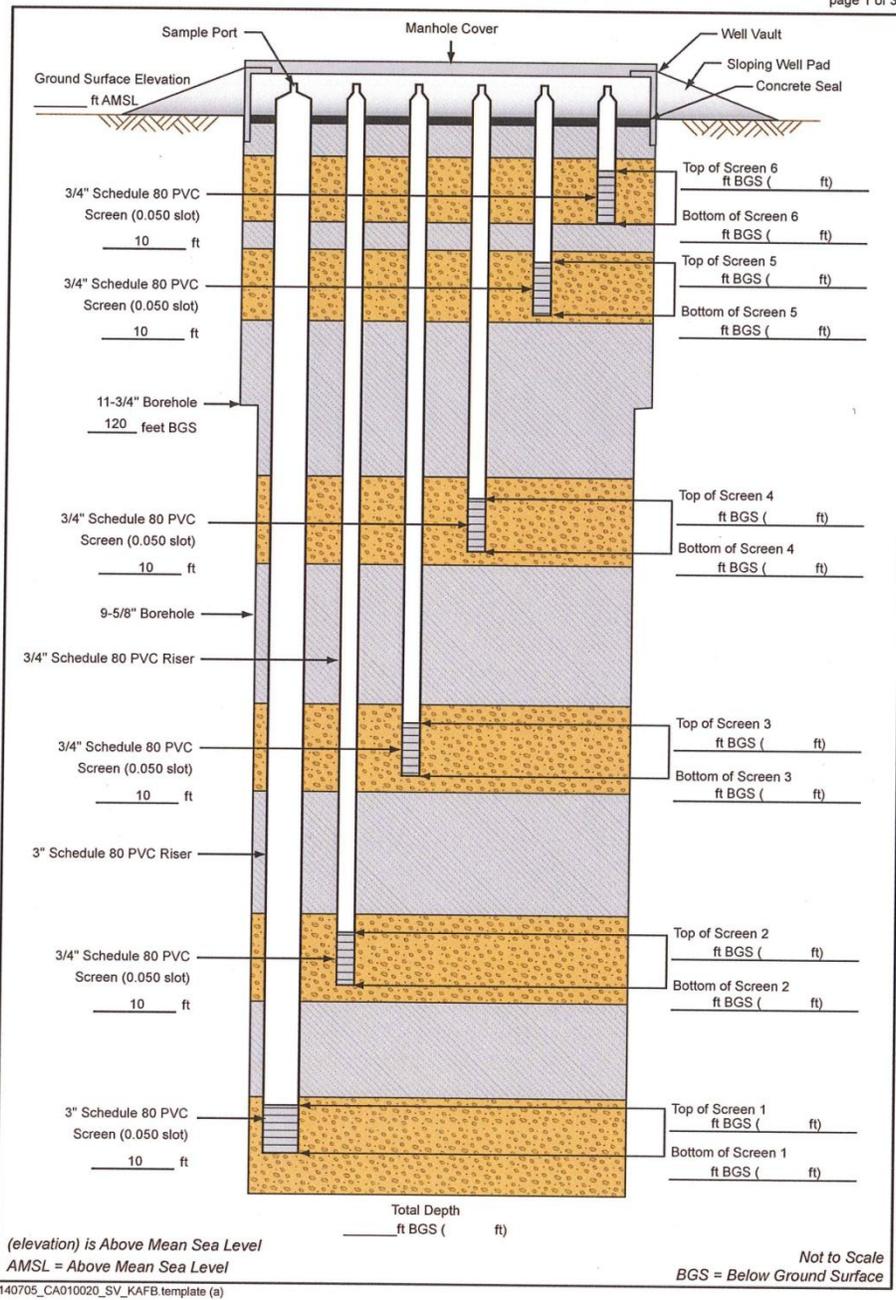
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Form C-6. Soil Vapor Monitoring Well Construction Diagram

Nested Soil Vapor Well Completion Diagram for KAFB-_____

Installation Start Date/Time: _____
 Installation End Date/Time: _____

page 1 of 3



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Form C-7. Well Development Record



Pg 1 of ____

Well Development Record

Project Name: KAFB BFF _____

Location: KAFB _____

Personnel: _____

Date: _____

Samplers: _____

Well/Piez. No.: _____

Date Installed: _____

Csg. Diameter (I.D.): _____

Total Depth (ft. BGL): _____

Method of Development:

Surging Bailing Pumping Other (State Method)

Original Development Redevelopment

Development Date: _____

Depth to Water Before Developing Well: _____

Vol. (V) Purge Factor Volume to Purge

Height of Water Column: _____ feet = _____ gal.* = _____

$V = (B * r_c^2 * L_c * 7.48) + (B * (r_w - r_c)^2 * L_s * \phi_s * 7.48) =$ _____ gallons

Depth Purging From: _____ feet Time Purging Begins: _____

Weather: _____ Screened Interval (ft BGL): _____

Equipment Nos.: pH Meter: _____ EC Meter: _____ Turbidity Meter: _____

Equipment Decontaminated Prior to Development: Y _____ N _____

Describe: _____

Collected Sample of Water Added to Well: Y _____ N _____

Describe: _____

Date	Time	Water Level (ft. Below TOC)	Volume Removed (gal.)	Temp.°C	pH	EC (ms/cm)	Turbidity N.T.U.	Comments

Notes:

- * Water Levels - Reported to the nearest 0.01 foot
- * pH - Reading rounded to 0.1 pH units
- * Water temperature - Reported to nearest 0.1C
- * Turbidity report in NTV nearest whole #

Where:

- B=3.14
- ϕ_s = porosity of the sand pack
- r_c = radius of the well casing and screen in feet
- L_c = length of water column inside the casing and screen in feet
- r_w = radius of the well bore in feet
- L_s = length of saturated portion of the sand pack in feet
- 7.48 gallons/cubic foot= conversion from cubic feet to gallons

Form C-8. Well Abandonment Form

Well Abandonment Form		Project Name _____		Borehole Number _____	
		Location _____		Well Number _____	
		Project Number _____		Page _____ of _____	
Logged By _____		Checked By _____		Reason For Abandonment _____	
Driller _____					
Drilling Method _____		Measured Depth of Well _____		Depth to Water _____	
Sampling Method _____		Was Old Well Removed? Yes _____ No _____ Partial _____			
Start Date _____		End Date _____		Drilled Diameter _____	
				Quality of Backfill (Gal) _____	
DEPTH (feet)	SAMPLE NUMBER	MATERIAL DESCRIPTION	BACKFILL DESCRIPTION	WELL CONSTRUCTION DETAILS	WELL SCHEMATIC
				TOP OF SEAL _____ TOP OF SAND _____ TOP OF SCREEN _____ WATER LEVEL _____ DEPTH OF WELL _____ DEPTH OF HOLE _____	

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Form C-9. Example Completed Chain-of-Custody Form



**ANALYSIS REQUEST AND
CHAIN OF CUSTODY RECORD**

Reference Document No: 140705-IDW032

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Project Number: 140705
Project Name: Kirtland AFB
Sample Coordinator: Mark Lyon
Turnaround Time: 10 day

Samples Shipment Date: 24 MAR 2011
Lab Destination: Hall Environmental Analysis Laboratory
Lab Contact: Andy Freeman
Project Contact: Pamela Moss
Carrier/Waybill No.: Courier/N/A

Bill To: Shaw Environmental, Inc. - Accounts P
PO Box 98519
Baton Rouge LA 70884
Report To: Pamela Moss
7604 Technology Way, Suite 300
Denver CO 80237

Special Instructions: 10 day TAT

Possible Hazard Identification: Radiological
 Non-hazard Flammable Skin Irritant Poison B Unknown

Sample Disposal: Return to Client Disposal by Lab Archive (mos.)

1. Relinquished By <i>Kimberly Jones</i> (Signature/Affiliation)	Date: 3/24/11 Time: 1514	1. Received By <i>Michael Barr</i> (Signature/Affiliation)	Date: 3/24/11 Time: 1514
2. Relinquished By (Signature/Affiliation)	Date: Time:	2. Received By (Signature/Affiliation)	Date: 3/24/11 Time: 1540
3. Relinquished By (Signature/Affiliation)	Date: Time:	3. Received By (Signature/Affiliation)	Date: Time:

Comments: 3 Rolloffs

1103932

Sample No	Sample Name	Sample Date	Sample Time	Container	Ctr Qty	Preservative	Requested Testing Program	Sample Vol	Units	FI	CID	Condition On Receipt
106047IDW2	KAFB10647-SO-106047IDW2-REG	24 MAR 2011	14:16	8 oz CWM	1	None except cool to 4 C	TCLP Metals by SW846 1311 6010B, TCLP Mercury by SW846 1311 7470A				N	
106047IDW2	KAFB10647-SO-106047IDW2-REG	24 MAR 2011	14:16	8 oz CWM	1	None except cool to 4 C	TCLP Pesticides by SW846 1311 8081B, TCLP Herbicides by SW846 1311 8151A, TCLP VOCs by SW846 1311 8260B, TCLP SVOCs by SW846 1311 8270D				N	
106047IDW2	KAFB10647-SO-106047IDW2-REG	24 MAR 2011	14:16	8 oz CWM	1	None except cool to 4 C	Reactivity, Comosivity, and Ignitability by SW846 Chapter 7.7.3.4.2				N	
106047IDW2	KAFB10647-SO-106047IDW2-REG	24 MAR 2011	14:16	4 oz CWM	1	None except cool to 4 C	TPH as Diesel by SW846 8015B, TPH as Gasoline by SW846 8015B, BTEX				N	

Form C-9. Example Completed Chain-of-Custody Form (concluded)



1103 932

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

Reference Document No: 140705-IDW032
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Sample No	Sample Name	Sample Date	Sample Time	Container	Preservative	Requested Testing Program	Sample Vol	Units	Fill	CID	Condition On Receipt
-2	106047IDW3 KAFB10647-SO-106047IDW3-REG	24 MAR 2011	14:19	4 oz CWM	1 None except cool to 4 C	by SW846 8021 TPH as Diesel by SW846 8015B, TPH as Gasoline by SW846 8015B, BTEX by SW846 8021				N	
-2	106047IDW3 KAFB10647-SO-106047IDW3-REG	24 MAR 2011	14:19	8 oz CWM	1 None except cool to 4 C	TCLP Metals by SW846 1311 6010B, TCLP Mercury by SW846 1311 7470A				N	
-2	106047IDW3 KAFB10647-SO-106047IDW3-REG	24 MAR 2011	14:19	8 oz CWM	1 None except cool to 4 C	Reactivity, Corrosivity, and Ignitability by SW846 Chapter 7.7.3.4.2				N	
-2	106047IDW3 KAFB10647-SO-106047IDW3-REG	24 MAR 2011	14:19	8 oz CWM	1 None except cool to 4 C	TCLP Pesticides by SW846 1311 8081B, TCLP Herbicides by SW846 1311 8151A, TCLP VOCs by SW846 1311 8260B, TCLP SVOCs by SW846 1311 8270D				N	
-3	106081IDW1 KAFB10681-SO-106081IDW1-REG	24 MAR 2011	14:13	8 oz CWM	1 None except cool to 4 C	TCLP Metals by SW846 1311 6010B, TCLP Mercury by SW846 1311 7470A				N	
-3	106081IDW1 KAFB10681-SO-106081IDW1-REG	24 MAR 2011	14:13	8 oz CWM	1 None except cool to 4 C	TCLP Pesticides by SW846 1311 8081B, TCLP Herbicides by SW846 1311 8151A, TCLP VOCs by SW846 1311 8260B, TCLP SVOCs by SW846 1311 8270D				N	
-3	106081IDW1 KAFB10681-SO-106081IDW1-REG	24 MAR 2011	14:13	8 oz CWM	1 None except cool to 4 C	Reactivity, Corrosivity, and Ignitability by SW846 Chapter 7.7.3.4.2				N	
-3	106081IDW1 KAFB10681-SO-106081IDW1-REG	24 MAR 2011	14:13	4 oz CWM	1 None except cool to 4 C	TPH as Diesel by SW846 8015B, TPH as Gasoline by SW846 8015B, BTEX by SW846 8021				N	

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