KIRTLAND AIR FORCE BASE
ALBUQUERQUE, NEW MEXICO

WORK PLAN FOR VADOSE ZONE CORING, VAPOR MONITORING, AND WATER SUPPLY SAMPLING
BULK FUELS FACILITY
SOLID WASTE MANAGEMENT UNIT ST-106/SS-111
Revision 1

December 2017

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2050 Wyoming Boulevard Southeast
Kirtland Air Force Base, New Mexico 87117-5270

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December 2017

Prepared for
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Albuquerque District
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NOTICE

This Work Plan was prepared for the U.S. Army Corps of Engineers by EA Engineering, Science, and Technology, Inc., PBC for the purpose of performing vadose zone characterization and monitoring activities in addition to water supply sampling associated with the Kirtland Air Force Base (AFB) Bulk Fuels Facility, Solid Waste Management Unit ST-106/SS-111. This work is performed under the U.S. Air Force Environmental Restoration Program, under requirements set forth in the Resource Conservation and Recovery Act permit issued to Kirtland AFB, with the New Mexico Environment Department serving as the lead regulatory agency. Addressed are the tasks related to the installation of soil vapor monitoring wells for future pilot testing; soil vapor monitoring, continuous coring, and sampling water supply wells.

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This Work Plan describes specific vadose zone treatability studies to be conducted under the Resource Conservation and Recovery Act for the Bulk Fuels Facility leak at Solid Waste Management Unit ST-106/SS-111 at Kirtland Air Force Base, New Mexico. The Work Plan includes the technical approach for continuous coring of soil borings to investigate the distribution and characteristics of petroleum hydrocarbons submerged by increasing aquifer elevations. This Work Plan also includes the technical approach for installation of soil vapor monitoring wells for future pilot testing in three of the coring locations, dual-completion soil vapor/groundwater monitoring wells in eight coring locations, performance of vadose zone network monitoring and maintenance, and sampling of water supply wells.

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Work Plan, Kirtland AFB, Bulk Fuels Facility; continuous coring; soil vapor monitoring wells installation; soil vapor monitoring, water supply well sampling, Solid Waste Management Unit ST-106/SS-111, Interim Measure; LNAPL

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PREFACE

This Work Plan is prepared by EA Engineering, Science, and Technology, Inc., PBC for the U.S. Army Corps of Engineers (USACE), under Contract Number W9128F-13-D-0006, Delivery Order DM02. This Work Plan pertains to the conductance of vadose zone treatability studies to address a leak at the Kirtland Air Force (AFB) Base Bulk Fuels Facility (BFF) (site), Solid Waste Management Unit ST-106/SS-111. The site is located in Albuquerque, New Mexico. This Work Plan was prepared in accordance with the permit issued to Kirtland AFB under the Resource Conservation and Recovery Act (RCRA) and applicable federal, state, and local laws and regulations.

The objective of the Work Plan is to describe specific vadose zone field activities to be performed in the source area of the BFF as well as water supply sampling. The Work Plan provides the technical approach for the continuous coring for subsurface sample collection, installation of soil vapor monitoring wells for future pilot testing at three of the coring locations, dual-completion soil vapor/groundwater monitoring wells in eight of the coring locations, soil vapor network monitoring and maintenance, and sampling of water supply wells.

This Work Plan is prepared for work to be performed between December 1, 2017 and September 22, 2021. Mr. Trent Simpler, PE, is the USACE–Albuquerque District Project Manager. The Environmental Restoration Section Chief for this program is Mr. Scott Clark of Kirtland AFB. The Work Plan was prepared by Devon Jercinovic, PG, CPG, PMP; Theresa McMillan, PG; Dustin Graves, PG, CHMM; Pamela Moss; Joshua Messenger; and Denise Wilt of EA, as well as Rachel Hobbs and Ryan Wortman of Sundance Consulting, Inc. and Dr. Robert Hinchee of Integrated Science & Technology, Inc. Devon Jercinovic is the EA Project Manager.

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CONTENTS

Section **Page**

EXECUTIVE SUMMARY 1
1. INTRODUCTION 1-1
1.1 SCOPE OF ACTIVITIES 1-1
1.2 WORK PLAN ORGANIZATION 1-1
2. BACKGROUND INFORMATION 2-1
2.1 SITE DESCRIPTION 2-1
2.2 SITE HISTORY 2-1
2.3 ONGOING SOIL VAPOR MONITORING 2-1
2.4 ONGOING WATER SUPPLY MONITORING 2-1
3. TASKS AND ACTIVITIES 3-1
3.1 PROJECT TASKS 3-1
3.1.1 Continuous Coring 3-1
3.1.2 Soil Vapor Monitoring Point Installation in Boreholes KAFB-106V1 and KAFB-106V2 3-4
3.1.3 Air-Lift Well Completion KAFB-106S1 3-5
3.1.4 Dual-Completion Vadose Zone/Groundwater Monitoring Wells 3-5
3.1.5 Vadose Zone Monitoring and Reporting 3-6
3.1.6 Maintenance of the Soil Vapor Monitoring Well Network 3-6
3.1.7 Water Supply Sampling and Reporting 3-7
3.2 ACTIVITIES COMMON TO MORE THAN ONE TASK 3-8
3.2.1 Site Clearance and Utilities Location/Relocation 3-8
3.2.2 Permitting, Right-of-Way Agreements, and Right-of-Entry Agreements 3-8
3.2.3 Readiness Review Meetings 3-9
3.2.4 Mobilization/Demobilization 3-9
3.2.5 Site Security 3-10
3.2.6 Barricading/Traffic Control 3-10
3.2.7 Erosion and Sediment Control 3-10
3.2.8 Decontamination 3-10
3.2.9 Borehole Logging 3-11
3.2.10 Photoionization Detector 3-11
3.2.11 Headspace Screening 3-11
3.2.12 Sonic Core Handling and Photography 3-12
3.2.13 Well Construction Diagrams 3-12
3.2.14 Soil Sampling 3-13
3.2.15 Well Development 3-14
3.2.16 Groundwater Gauging and Sampling 3-14
3.2.17 Sample Packaging and Shipping 3-15
3.2.18 Site Restoration 3-15
3.2.19 Survey 3-15
3.2.20 Analytical Services 3-16

3.2.21 Data Validation 3-17
3.2.22 Environmental Resources Program Information Management System Data Upload 3-17
3.2.23 Public Notification 3-17

4. PROJECT SCHEDULE 4-1
5. ORGANIZATIONAL PLAN 5-1
5.1 ORGANIZATIONAL STRUCTURE 5-1
5.2 RESPONSIBILITIES, QUALIFICATIONS, AND AUTHORITY OF KEY PERSONNEL 5-1

6. DATA MANAGEMENT 6-1
6.1 PERSONNEL ROLES AND RESPONSIBILITIES SPECIFIC TO DATA MANAGEMENT 6-1
6.2 PROJECT DATA TYPES AND RECORDS 6-1
6.2.1 Project Data and Records 6-1
6.2.2 Laboratory Analytical Testing 6-2
6.2.3 Chemical Analytical Data 6-2
6.2.4 Geotechnical Data 6-3
6.3 HANDLING AND MANAGEMENT OF PROJECT GENERATED DATA 6-3
6.3.1 Data Management Processes for Field-Related Data 6-3
6.3.2 Analytical Data Management and Data Validation 6-4
6.4 DATA SECURITY 6-5

7. QUALITY ASSURANCE/QUALITY CONTROL 7-1
8. WASTE MANAGEMENT 8-1
8.1 WATER INVESTIGATION-DERIVED WASTE 8-1
8.1.1 Non-Hazardous Water 8-1
8.1.2 Hazardous/Potentially Hazardous Water 8-2
8.1.3 Water of Unknown Quality 8-2
8.2 SOIL INVESTIGATION-DERIVED WASTE 8-3

9. ACCIDENT PREVENTION PLAN/SITE SAFETY AND HEALTH PLAN 9-1
10. REFERENCES 10-1

APPENDICES

A Quality Assurance Project Plan

B Bioventing Well Design, Air-Lift Enhanced Bioremediation Well Design, and Dual-Completion Soil Vapor/Groundwater Wells

C Relevant Standard Operating Procedures from Kirtland Air Force Base Basewide Plan (Appendix B; 2004)

D Soil Vapor Sampling Standard Operating Procedure

E Water Supply Well Monitoring Standard Operating Procedure

F Field Forms

G Definition of Land Survey Objective/Measuring Points and Land Survey Campaign among the Kirtland Air Force Base Monitoring Well Network

H Project Schedule

FIGURES

1-1 Site Map

3-1 Proposed Continuous Coring Locations

3-2 Drilling Decision Logic

3-3 Geologic Cross-Sections of Proposed Continuous Coring Locations in the Source Area

3-4 Geologic Cross-Sections of Proposed Continuous Coring Locations Downgradient of the Source Area

3-5 Proposed Source Area Continuous Coring Locations Cross-Section Transects

3-6 Geologic Cross-Section A-A’ and B-B’

3-7 Decision Logic Schematic for Sample Collection

3-8 Soil Vapor Monitoring Point Locations

3-9 Soil Vapor Monitoring Locations Designated for Data Validation

3-10 Drinking Water Supply Wells

3-11 Site Laydown Areas

5-1 Organizational Structure for Vadose Zone Coring, Vapor Monitoring, and Water Supply Sampling

TABLES

3-1 Continuous Coring Location Rationale

3-2 Drilling Summary for Continuous Coring Locations

3-3 Proposed Sampling Plan for Continuous Coring

3-4 Proposed Vapor Well Construction for Locations KAFB-106V1 and KAFB-106V2

3-5 Available Vapor Wells for Injection/Observation Pairing

3-6 Soil Vapor Monitoring Point Locations and Coordinates

3-7 Soil Vapor Monitoring Points Designated for Data Validation

3-8 Drinking Water Supply Well Names and Coordinates

5-1 Staff Roles, Responsibilities, and Authorities for Vadose Zone and Water Supply Sampling Tasks

8-1 Summary of Investigation-Derived Waste Sampling

ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
%	percent
AFB	Air Force Base
AFCEC	Air Force Civil Engineer Center
APP	Accident Prevention Plan
ARCH	air-rotary casing hammer
bgs	below ground surface
BFF	Bulk Fuels Facility
BTEX	benzene, toluene, ethylbenzene, and total xylenes
C&D	construction and demolition
CFR	Code of Federal Regulations
COA	City of Albuquerque
DO	dissolved oxygen
DoD	Department of Defense
EA	EA Engineering, Science, and Technology, Inc., PBC
EDB	ethylene dibromide (also known as 1,2-dibromoethane)
EDD	electronic data deliverable
ELAP	Environmental Laboratory Accreditation Program
ELLE	Eurofins Lancaster Laboratories Environmental, LLC
EPA	U.S. Environmental Protection Agency
ERPIMS	Environmental Resources Program Information Management System
GWM	groundwater monitoring
GWTS	groundwater treatment system
IDW	investigation-derived waste
LNAPL	light non-aqueous phase liquid
mg/kg	milligram(s) per kilogram
NMED	New Mexico Environment Department
No.	number
NTU	nephelometric turbidity unit
O&M	operation(s) and maintenance
ORP	oxidation reduction potential
PDF	portable document format
PID	photoionization detector
PLSOP	primary land survey objective point
QA	quality assurance

ACRONYMS AND ABBREVIATIONS (CONCLUDED)

QAPjP	Quality Assurance Project Plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
Site	Bulk Fuels Facility site
SOP	Standard Operating Procedure
SSHP	Site Safety and Health Plan
SVE	soil vapor extraction
SVEW	soil vapor extraction well
SVM	soil vapor monitoring
SVMP	soil vapor monitoring point
SWMU	Solid Waste Management Unit
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force
VA	Veterans Affairs
VOC	volatile organic compound

EXECUTIVE SUMMARY

This Work Plan has been prepared by EA Engineering, Science, and Technology, Inc., PBC (EA) with support from Sundance Consulting, Inc. and Integrated Science & Technology, Inc. to address activities to be performed at Solid Waste Management Unit (SWMU) ST-106/SS-111, the Bulk Fuels Facility (BFF) at Kirtland Air Force Base (AFB), New Mexico. The Work Plan demonstrates the U.S. Air Force's commitment to continue addressing fuel contamination resulting from the BFF fuel leaks. This Work Plan outlines activities to be performed in support of vadose studies that will advance the remediation in the BFF leak source area. In conjunction with the Quality Assurance Project Plan (QAPjP) provided in Appendix A, this Work Plan will become the procedural guidance document for conducting these activities. These documents meet the most recent requirements of the Department of Defense (DoD) regarding planning documents for DoD facilities. The Work Plan was written in accordance with Kirtland AFB's Resource Conservation and Recovery Act Permit Number NM9570024423.

The objective of the Work Plan is to detail the activities to be implemented performing vadose zone treatability studies to support a future corrective measures evaluation, and continued monitoring of water supply wells in proximity to the BFF plume. The work to be completed is presented under each of the tasks listed below:

- Perform continuous coring and sample collection from up to 12 borehole locations

- Install soil vapor monitoring (SVM) points for future pilot testing in two continuous coring locations, and an air-lift enhanced well in an additional coring location

- Install dual-completion soil vapor/groundwater monitoring wells for future pilot testing in up to eight of the continuous coring locations

- Perform vadose zone monitoring, maintenance, and reporting of the existing SVM network

- Perform sampling and reporting of water supply wells.

1. INTRODUCTION

Under Contract Number (No.) W9128F-13-D-0006, Delivery Order DM02, EA Engineering, Science, and Technology, Inc., PBC (EA) was contracted to perform tasks associated with vadose zone treatability studies at Solid Waste Management Unit (SWMU) ST-106/SS-111, at Kirtland Air Force Base (AFB), New Mexico. This SWMU is known as the Bulk Fuels Facility (BFF) site. Environmental restoration efforts at the BFF site are being conducted under requirements set forth in Resource Conservation and Recovery Act (RCRA) Permit No. NM9570024423 (RCRA Permit) with the New Mexico Environment Department (NMED) serving as the lead regulatory agency (NMED, 2010).

This Work Plan addresses tasks supporting vadose zone treatability studies and water supply sampling and is the procedural guidance document for activities to be executed as part of the RCRA Corrective Action Process. Additionally, the work to be performed in accordance to this plan will also address outstanding data gaps in the delineation of the nature and extent of residual light non-aqueous phase liquid (LNAPL) in the vadose zone and groundwater. This Work Plan meets the most recent requirements of the Department of Defense (DoD) regarding planning documents for DoD facilities.

The requirements for the protection of health and attaining safety on the job sites are addressed in the companion *Accident Prevention Plan (APP) for the Kirtland AFB BFF Expansion of the Groundwater Treatment System (GWTS) and Vadose Zone Treatability Studies (Revision 4)* (EA, 2017). The APP also incorporates the Site Safety and Health Plan (SSHP). The APP is a dynamic document that will be revised to cover all activity-specific concerns and will be updated as necessary.

1.1 Scope of Activities

The BFF site is located in Albuquerque, New Mexico (Figure 1-1). This Work Plan covers activities required to meet the performance objectives associated with supporting vadose zone treatability studies as well as sampling water supply wells. The work associated with the vadose zone treatability studies includes continuous coring at up to 12 locations in the vadose zone to characterize contaminant zones; installation of soil vapor monitoring (SVM) wells for future pilot tests at three of the coring locations; installation of dual-completion soil vapor/groundwater monitoring wells in up to eight of the coring locations; SVM network sampling, maintenance, and reporting; and water supply sampling. This Work Plan was prepared in accordance with the RCRA Permit for Kirtland AFB (NMED, 2010) and applicable federal, state, and local laws and regulations. For completeness, this Work Plan includes the required elements of a Sampling and Analysis Plan/Field Sampling Plan including soil sampling associated with drilling activities, water supply well sampling, soil vapor sampling, data management, and waste management.

1.2 Work Plan Organization

The Work Plan is divided into the following sections:

- ***Section 1***—Presents an introduction to the plan and the scope of activities and organization of the Work Plan.

- ***Section 2***—Presents the site description and operational history.

- ***Section 3***—Summarizes the project tasks with sufficient detail on how the objectives will be accomplished. To avoid repetitiveness, activities that are common to more than one project task are presented only once, in Section 3.2.

- ***Section 4***—Presents the project schedule.

- ***Section 5***—Provides information on the organizational plan for the execution of work.

- ***Section 6***—Refers to the data management requirements.

- ***Section 7***—Refers to the quality assurance (QA) and quality control (QC) requirements that are further detailed in the QAPjP provided in Appendix A.

- ***Section 8***—Presents information on the management and disposal of the waste generated during this project.

- ***Section 9***—Refers to the safe work practices to be employed while executing this project, which are further detailed in the APP (EA, 2017).

- ***Section 10***—Provides references cited in the Work Plan.

Figures and tables follow the main body of the Work Plan. Appendices provided at the end of this Work Plan include:

- Appendix A—QAPjP

- Appendix B— Bioventing Well Design, Air-Lift Enhanced Bioremediation Well Design, and Dual-Completion Soil Vapor/Groundwater Wells

- Appendix C—Relevant Standard Operating Procedures from Kirtland AFB Basewide Plan (Appendix B; 2004)

- Appendix D—Soil Vapor Sampling Standard Operating Procedure (SOP)

- Appendix E—Water Supply Well Monitoring SOP

- Appendix F—Field Forms

- Appendix G—Definition of Land Survey Objective/Measuring Points and Land Survey Campaign among the Kirtland AFB Monitoring Well Network

- Appendix H—Project Schedule

2. BACKGROUND INFORMATION

2.1 Site Description

Kirtland AFB is located in Bernalillo County, in central New Mexico, southeast of and adjacent to the City of Albuquerque (COA) and the Albuquerque International Sunport (Figure 1-1). The approximate area of the base is 52,287 acres. The BFF site is located in the northwestern portion of Kirtland AFB.

2.2 Site History

The BFF and associated infrastructure operated from 1953 until 1999. During this time, the fueling area was separated into a tank holding area where bulk shipments of fuel were received and a fuel loading area where individual fuel trucks were filled. Kirtland AFB removed the underground piping at the facility from service in 1999 due to discovery of underground leakage. Even though the fuel leak was identified by Kirtland AFB, the exact history of the leaks or releases is unknown. Releases could have occurred when fuel was transferred from railcars to the pump house. Initially, it was thought that the leak only affected surface soil around the identified source area; however, Kirtland AFB learned through characterization activities that the leaked fuel had reached the groundwater and the dissolved-phase fuel contamination migrated northeast and north of Kirtland AFB.

To comply with NMED Hazardous Waste Bureau requirements, Interim Measures were implemented for both groundwater and soil. The goals of the groundwater Interim Measure are to protect drinking water supply wells and collapse the distal ethylene dibromide (EDB) plume. The soil vapor extraction (SVE) system addressing light non-aqueous phase liquid (LNAPL) in the source area was shut down in Quarter 2 of 2015 (U.S. Army Corps of Engineers [USACE], 2017a).

2.3 Ongoing Soil Vapor Monitoring

Semiannual SVM has been ongoing as part of the ST-106/SS-111 investigation to monitor the nature and extent of soil vapor contamination in the vadose zone. A total of 284 soil vapor monitoring points (SVMPs) at 56 SVM locations are sampled. Future sampling activities will be conducted under this work plan beginning in January 2018.

2.4 Ongoing Water Supply Monitoring

Three drinking water production wells have been sampled monthly as part of the ST-106/SS-111 investigation to confirm that they have not been impacted by groundwater contaminants. These wells include ST106-VA2 on Raymond G. Murphy Veterans Affairs (VA) Medical Center property, and KAFB-003, KAFB-015, and KAFB-016 on Kirtland AFB property. Monthly sampling of these wells under this work plan will be conducted beginning in 2018. In addition, at least one private water supply well will be sampled quarterly.

3. TASKS AND ACTIVITIES

Section 3.1 describes the tasks that will be performed under this project. Section 3.2 provides detail of activities that are common to more than one task.

3.1 Project Tasks

3.1.1 Continuous Coring

One of the principal drivers for the completion of continuous coring near the BFF source area is to address the data gaps of horizontal and vertical extent of LNAPL. Due to capillary forces and the physical properties of LNAPL, and after over 10 years of active SVE, residual fuel may remain in pore spaces and sorbed to soil particles in both the vadose zone and in the smear zone near the groundwater and vadose zone interface. Soil vapor hydrocarbon measurements as high as 30,000 parts per million by volume, suggest the hold up of free-phase fuel hydrocarbons in the vadose zone; however, the amount and chemical composition of the residual are not known. The objectives of the continuous coring are to provide supplemental data on the nature and extent of the residual fuels, and to characterize the subsurface biogeochemical conditions relative to residual hydrocarbon and EDB treatment potential.

When the fuel leak began, the water table was approximately 60 feet higher than current elevations (Rice et al., 2014). Water levels began dropping due to the development of the COA well fields, and reached their lowest level at the end of 2009. Groundwater fluctuations created a smear zone located from the maximum height of the LNAPL layer above the highest historical water table elevation to the minimum height of LNAPL-water interface at the lowest water table elevation (USACE, 2017a).

Nine continuous core locations (Figure 3-1) including one background location, were selected to characterize residual hydrocarbon within the vadose zone and saturated zone. Three additional locations are optional, and will be cored if field observations dictate a need for additional data in between the nine planned coring locations. Specific data objectives for the coring include:

- Provide supplemental information on the nature and thickness of the smeared LNAPL zone
- Collect data to support future intrinsic biodegradation pilot tests
- Accommodate well construction for future bioventing wells (KAFB-106V1 and KAFB-106V2)
- Accommodate well construction as air-lift enhanced well (KAFB-106S1) to support the future air-lift enhanced bioremediation pilot test
- Accommodate dual-completion of soil vapor/groundwater monitoring wells to support future vadose zone pilot tests and soil vapor and groundwater monitoring.

3.1.1.1 Drilling Approach and Methodology

Each proposed borehole location is referenced to an existing logged borehole; the closest existing borehole present that is believed to afford the best idea of the underlying geology at the location of the proposed coring locations. Table 3-1 provides a summary of the coring locations and rationale for each location.

Table 3-2 summarizes the drilling methodology and depths for each boring location. Figure 3-2 provides a decision logic and borehole sequence that is discussed in more detail below. The designated coring intervals (Table 3-3) at all borehole locations will be drilled using an 8-inch diameter sonic drilling rig with 4-inch diameter core barrel. Figures 3-3 and 3-4 show a cross sectional view of the lithology, historical data, and anticipated coring intervals for KAFB-106S1 through KAFB-106S9. Figures 3-5 and 3-6 show cross sectional transects, and cross sections, respectively, for the area near KAFB-106V1 and KAFB-106V2.

KAFB-106V1 and KAFB-106V2 will be cored continuously from ground surface to total depth. Due to the relatively shallow depths for KAFB-106V1 and KAFB-106V2, these borings will be completed entirely with sonic drilling to 10-inch nominal diameter. KAFB-106S1 and KAFB-106S9 will also be cored continuously from ground surface to total depth, and these borings will be over-reamed via air-rotary casing hammer (ARCH) technique to the nominal 10-inch diameter. All other borings will be accomplished using a combination of ARCH drilling to the designated coring depth, followed by sonic drilling to obtain undisturbed cores from the designated coring intervals. Upon achieving the top of the designated coring interval depth, the ARCH rig will be moved off each location while leaving the casing downhole, and the sonic rigs will be positioned at the cased holes to core the prescribed designated coring intervals and then subsequently reamed with a 9 ⅝-inch bit with the ARCH drilling rig to provide a large enough borehole for well construction. Figure 3-2 provides a decision logic and borehole sequence that will be followed to allow for modifications of the designated coring intervals, target depth intervals, and selection of optional borings to be completed.

Heating during continuous core collection can impact contaminant, geochemical and microbial properties and adversely affect sample representativeness. In addition to advancing the borehole to the designated coring depth with the ARCH rig, to minimize the heating potential, heating of the sonic drilling core barrels in the unsaturated zone can be controlled by any one or combination of the following:

- Advancing shorter sampling runs (5-10 feet versus 20 feet)
- Allowing the core barrel to cool (or pre-cooling the core barrel) before tripping back into the borehole
- Changing the vibration level and rotation speed
- Injecting small quantities of potable water between the override casing and the core barrel without compromising sample integrity as described in ASTM International D6914/D6914M-16.

Temperature inside the core will be monitored when returned to the surface to ensure that heating of the core barrel is not impacting sample selection or integrity. Background soil vapor temperatures in the vadose zone have historically averaged from 20 to 22 degrees Celsius (ºC). Average groundwater temperatures at the site are 19ºC. Any core heating over 20ºC will require mitigation steps as outlined above. If water is injected, the bottom few inches of the core intervals that are possibly in contact with water accumulating in the bottom of borehole will be discarded prior to collection of samples. Sonic core barrels in the saturated zone are naturally cooled by the presence of formation water; however, similar steps will be implemented as described above to ensure sample representativeness.

Table 3-3 summarizes the designated coring intervals and target sample depths for each borehole based on historical lithology, noted presence of hydrocarbons, and maximum and minimum depth to groundwater since the historical release. For borings that are not continuously cored from ground surface to total depth, the top of the designated coring intervals was selected based on historical data, anticipated lithology (from nearby boreholes), or as 10-feet above the historical high water elevation (approximately 4930 feet amsl). The bottom of the designated coring intervals extends approximately 10 - 20 feet below the lowest historic recorded water level (2009) to ensure that the deepest vertical LNAPL migration elevation is evaluated. Target sample depths have been prescribed within each designed coring interval, as discussed in detail in Section 3.1.1.2. The designated coring intervals and target sample depths may be modified based on field observations and field screening measurements, and will be collaboratively coordinated with NMED and the project team. The target sample depths are intended as a baseline minimum (that maybe modified based on field conditions) that will not be eliminated or replaced, but may be supplemented with additional samples as outlined in the Decision Logic (Figure 3-7), and summarized on Table 3-3.

3.1.1.2 Rationale for Sampling Depth Intervals

KAFB-106S9 will be drilled first (Figure 3-2) and will be continuously cored to total depth. Designated coring intervals on subsequent borings may be adjusted based on field observations and data from KAFB-106S9 (with exception of KAFB-106S1 which will also be cored continuously to total depth), and other borings as the work progresses. Prescribed designated coring intervals were established from site data, as discussed below, and to serve as a baseline for planning purposes.

The probable underlying geology present at the location of the selected boreholes is inferred from borehole logs created during the construction of nearby monitoring wells. Photoionization detector (PID) measurements and qualitative data (e.g., presence of petroleum odor) recorded during the construction of these wells, and historic water level measurements were considered. The compilation of information was used to construct a cross-section of each proposed coring, and assisted in the determination of the number and location of target samples (Figures 3-3 and 3-4). Ultimately, the selected target sampling depths are located where changes in lithology were noted (e.g., lean clay to poorly graded sand) that could have influenced vertical hydrocarbon migration, where historical high PID readings or notable odor were recorded (from drilling or soil vapor monitoring in Quarter 4 2016 (USACE, 2017b)), or at historical or current water elevations. Target sample depths are generally prescribed in fine-grained lithologic units that might retain organics (i.e., silt and clay), or locations where the contaminants might have become perched or smeared. As discussed in Section 3.1.1.3, additional sample locations may be selected within each boring based on field screening (i.e. PID measurements).

3.1.1.3 Field Screening for Hydrocarbons

When advancing the borehole to the designated coring interval with ARCH, all cuttings will be logged and PID measurements will be taken at a minimum of every 20 feet as described in Section 3.2.10. If any PID measurements exceed 500 ppm, the material with the highest PID reading within the prescribed 100-foot depth interval(s) will be sampled for total petroleum hydrocarbons (TPH) (Table 3-3 and Figure 3-7), and PID measurements will subsequently be recorded for every 10 feet to the top of the designated coring interval depth.

Within the designated coring interval, PID readings will be collected every 10 ft. Additional measurements will be collected if qualitative data (e.g., staining, odor, etc.) indicate possible LNAPL (Figure 3-7). If any PID measurements exceed 1,000 ppm, the material with the highest PID reading within the prescribed 100-foot depth interval(s) will be sampled for multiple analytes, as discussed in Section 3.1.1.4 and shown on Table 3-3 and Figure 3-7. Historical PID measurements in the source area on split-spoon samples collected in advance of ARCH were on the magnitude of 4,000-6,000 ppm in fine grained units and directly above fine-grained units where LNAPL is indicated (Figure 3-6). PID measurements were not recorded on boring logs for wells that had historical LNAPL present, or had core samples/LNAPL fluorescence collected (2011). Although references that correlate PID readings to the presence of LNAPL were not readily found, at least one reference provided an approximation that 1,000 ppm could potentially indicate NAPL presence (Golder Associates, 2011).

3.1.1.4 Laboratory Analyses for Selected Core Samples

Samples for laboratory analyses will be selected based on PID measurements (augmented by lithologic and qualitative data) and the prescribed sampling and analytical methodology outlined in Table 3-3. Selection of target sample depths will follow the decision logic presented in Figure 3-7, or may be modified based on field observations and data. Table 3-3 summarizes the laboratory analyses for selected samples, and provides information for each of the analyses regarding sample containers, required sample volumes, and sample preservation methods, and includes the laboratories to which specific samples should be shipped. Analyses are detailed in the QAPjP and include:

- Volatile organic compounds (VOCs) (EPA Method 8260C); EDB (EPA Method 8011), total petroleum hydrocarbons-gasoline range organics/diesel range organics/oil range organics (EPA Method 8015D); TestAmerica, Inc., Arvada, Colorado.

- LNAPL transmissivity and mobility, grain size, fluid properties, capillary pressure air/water drainage, free product mobility, relative permeability, and hydraulic conductivity; PTS Laboratories, Santa Fe Springs, California.

- LNAPL physical properties including gravity, hydrocarbon component analysis, flash point, and viscosity; Saybolt LP, Core Companies, Deer Park, Texas.

- Mineralogy using x-ray diffraction and energy dispersive x-ray spectrometry; IMR Metallurgical Services, Louisville, Kentucky.

- Microbial analysis using QuantArray-Chlor to identify and quantify halorespiring bacteria; Microbial Insights, Inc., Knoxville, Tennessee.

- Moisture analyses (ASTM D2216); Daniel B. Stephens & Associates Soil Testing Laboratory, Albuquerque, New Mexico.

3.1.2 Soil Vapor Monitoring Point Installation in Boreholes KAFB-106V1 and KAFB-106V2

KAFB-106V1 and KAFB-106V2 SVMPs will be completed in 10-inch diameter boreholes for use as observation SVMPs in the Bioventing Pilot Test, and will be a nested construction using Schedule 80 ¾-inch polyvinyl chloride from ground surface to deepest well depth of approximately 275 feet below ground surface (bgs). Screened intervals for both nested SVMP locations, and the rationale for the depth selections, are summarized on Table 3-4 and are shown on diagrams B-1 through B-6 (Appendix B).

The screened intervals for each SVMP are 2.5 feet in length with 20-slot screen and 10-20 filter pack. A schematic of the KAFB-106V1 and KAFB-106V2 completions are provided in Appendix B. The final construction diagrams will be submitted to NMED following installation, in the first post-construction report, to accurately document as-built conditions.

Table 3-4 also identifies possible future injection SVMPs and their paired screened intervals with these observation SVMP screened intervals. Table 3-5 summarizes possible injection SVMPs and the available observation SVMPs (including the new KAFB-106V1 and KAFB-106V2) that could be utilized in a future test and includes the lateral distances between the injection SVMPs and the available observation SVMPs.

3.1.3 Air-Lift Well Completion KAFB-106S1

KAFB-106S1 will be completed in a 10-inch diameter borehole for use in the Air-Lift Enhanced Bioremediation Pilot Test, and will be constructed using Schedule 80, 4-inch polyvinyl chloride. The air-lift enhanced bioremediation well will include a 4-inch diameter, continuous 60-foot screen (30-slot), with approximately 20 feet of screen below the water table, and approximately 40 feet of screen above the water table. A general schematic of the KAFB-106S1 completion is provided as diagram B-7 (Appendix B).

The pilot test Work Plan for bioventing has been submitted to NMED under separate cover. The Air-Lift Enhanced Bioremediation Pilot Test will be conducted using the 4-inch well installed in soil coring KAFB-106S1. The proposed air lift mechanism will consist of an air diffuser installed in a 2-inch diameter conductor pipe. The conductor pipe will be open near the base of the well and the air-lift diffuser installed inside the conductor pipe on a ¾-inch diameter airline pipe. The conductor pipe will serve as the “stripping reactor” in the air-lift process and will be open above the anticipated high water level to facilitate outflow of air-lifted oxygenated groundwater to the impacted aquifer at the water table. This oxygenated groundwater will then flow outward through the well screen setting up a vertical “recirculation” cell.

Two piezometers will be installed in the annulus of the air-lift pilot test well to allow placement of downhole multi-parameter probe to record water levels and geochemical parameters (e.g., dissolved oxygen [DO], oxidation reduction potential [ORP], pH, temperature, and specific conductance). Air supply to the system will be via air compressor and pressure regulator to ensure adjustable, constant air flow rates during the test.

Further details of the well and apparatus completion are documented in the Work Plan for Bioventing and Air-lift Enhanced Bioremediation Pilot Tests, to be submitted to NMED under separate cover.

3.1.4 Dual-Completion Vadose Zone/Groundwater Monitoring Wells

KAFB-106S2 through KAFB-106S9 will be completed in 10-inch diameter boreholes for use in future vadose zone pilot tests and monitoring, and will be constructed using Schedule 80, 4-inch polyvinyl chloride from ground surface to a depth approximately six feet below the current water table. Multiple 30-slot screened intervals will be installed with five feet of blank casing between each screened interval. The deepest screen will be 20 feet in length and the two screened intervals above will be 10 feet in length. The annulus will be completed with a 10/20 Colorado sand silica filter pack with bentonite seals placed across each interval of blank casing. A general schematic of the KAFB-106S2-KAFB-106S9 completion is provided as diagram B-8 (Appendix B). The design of the wells is intended to allow for options of future monitoring, for both soil vapor and/or groundwater, including possible retrofitting in the future with the anticipation of continued water level rise. The final construction diagrams will be submitted to NMED following construction.

3.1.5 Vadose Zone Monitoring and Reporting

The current SVM network consists of a total of 284 SVMPs installed at 56 SVM locations (Figure 3-8). Table 3-6 describes the SVM network including each SVM location, its associated SVMPs, and their associated easting and northing coordinates. In Summary, the SVM network includes:

- One SVM location contains four SVMPs co-located in the same vault as a GWM well in Bullhead Park (KAFB-106028; see location number one in Table 3-6).

- Thirty-five locations installed in 2010 and 2011, each with six SVMPs, are located throughout the BFF, on base property north of the BFF, on COA property in Bullhead Park and its open space area, and on VA property. These locations are named using the convention KAFB-106XXX to signify that they were installed as part of the investigation at SWMU ST-106/SS-111. Numbering at these 35 SVM locations ranges from KAFB-106108 through KAFB-106142 (see locations 2 through 36 in Table 3-6). Individual SVMPs at each location are further identified using the bottom of the screen depth of each point (e.g., KAFB-106108-050).

- Twenty locations installed inside the BFF named using the convention “soil vapor extraction well (SVEW)-XX” or “soil vapor monitoring well (SVMW)-XX” (see locations 37 through 56 in Table 3-6).

    - Four of these 20 locations have both SVMW and SVEW type SVMPs at a single location. For example, SVM Location Number 54 includes SVMW-13 (comprised of four SVMPs screened between 150 and 450 feet deep) and SVEW-11 (with one SVMP) all located together in a single well vault.

Semiannual monitoring of the SVM network was approved for ST-106/SS-111 on January 4, 2017 (NMED, 2017a), and will include sampling of the entire 284 SVMP network beginning in Quarter 2 2018. All field personnel collecting soil vapor samples are required to be trained and fully understand the sampling SOP provided in Appendix D. The Horiba Model MEXA 584L (or equivalent) will be used to measure total hydrocarbons, oxygen, and carbon dioxide.

Samples will be shipped to TestAmerica, Inc. in West Sacramento, California, where they will be analyzed for an optimized list of VOCs in air by modified Method TO-15 (NMED, 2017a, 2017b).

Data validation will be performed at the SVM locations listed in Table 3-7 and shown on Figure 3-9. A total of 21 locations (68 SVMPs) were chosen for data validation based on their location in relation to residential neighborhoods, or planned interim measures. The rationale for each location chosen is listed in Table 3-7. The SVM locations listed in Table 3-7 represent 23 percent (%) data validation, which exceeds the industry standard of 10%, and meets EPA guidance and the requirements of Section 6.5.1.8.3 of the RCRA permit. A 100% data validation will be performed at any new SVM locations until four events of baseline sampling have been established.

3.1.6 Maintenance of the Soil Vapor Monitoring Well Network

Maintenance for the SVM network will be performed during the sampling events. Prior to the first sampling event in 2018, the SVM network will be retrofitted to accommodate a transition to SUMMA® canister sampling (versus the previously utilized Bottle Vac™ samplers). During each sampling event, the condition of each well port will be examined by the field personnel to confirm the integrity of each fitting and to immediately address and mitigate any problems or replace any defective parts. Wellheads will be inspected for integrity and necessary repairs will be performed as soon as possible. The findings of the inspections and any repairs made will be documented by photographs and on the appropriate field forms (Appendix F), which will be included in the corresponding Quarterly Monitoring Reports.

3.1.7 Water Supply Sampling and Reporting

Four drinking water supply wells (ST-106-VA-2 on the VA Medical Center property and KAFB-003, KAFB-015, and KAFB-016 at Kirtland AFB) will be sampled monthly beginning in January 2018 to confirm that they have not been impacted by groundwater contaminants (Figure 3-10). Table 3-8 lists the coordinates of each of these four wells. Samples will be analyzed for volatile organic compounds including EDB and benzene, toluene, ethylbenzene, and xylene (BTEX). Under another contract, additional analyses are performed semiannually for select total metals (total arsenic, calcium, lead, magnesium, potassium, and sodium), and select dissolved metals (iron and manganese), anions (ammonia nitrogen, bromide, chloride, nitrite/nitrate nitrogen, sulfate, and sulfide), and alkalinity. Field parameters will be recorded during sampling. These analytical requirements may also be revised in the future based on Technical Working Group recommendations and NMED agreement.

These existing drinking water supply wells at Kirtland AFB and the VA Hospital actively provide drinking water to the facilities' employees and inhabitants. Because the wells will be actively producing water during sampling, water levels at these wells will not be measured prior to sampling. In addition, one well volume will not be purged prior to sampling.

The drinking water supply well analytical data will be provided monthly in a technical memorandum. Analytical results will also be reported in the Quarterly Monitoring reports for Solid Waste Management Unit (SWMU) ST-106/SS-111.

In addition to the drinking water supply well sampling, private water supply wells within the vicinity of the EDB plume will be sampled on a quarterly basis with the consent of the well owner. Samples will be analyzed for volatile organic compounds including EDB and BTEX. Field parameters will be recorded during sampling. Production of a one-page technical memorandum with a summary of the quarterly analytical results will also be prepared and provided to USACE and Air Force Civil Engineer Center (AFCEC) for approval prior to sending to the homeowner(s) and NMED. Sampling and reporting will be performed in accordance with the Water Supply Well SOP (Appendix E). The private water supply wells are used for irrigation purposes, not for drinking water.

TestAmerica, Inc., Savannah, Georgia, will provide analytical testing services in support of this task for the EDB and BTEX analyses using EPA drinking water methods EPA 504.1 and 524.2, respectively. TestAmerica, Inc. maintains State of New Mexico drinking water certification for these methods. The metals and anions will be analyzed at Eurofins Lancaster Laboratories Environmental (ELLE), Lancaster, Pennsylvania. ELLE maintains current DoD Environmental Laboratory Accreditation Program (ELAP) certification and has the analytical expertise to perform the analyses required for this task in accordance with DoD Quality Systems Manual Version 5.0 (DoD, 2013) and EPA or other industry standard analytical methodologies. ELLE is also analyzing the quarterly groundwater samples associated with the BFF monitoring wells. TestAmerica, Inc. and ELLE reporting limits will achieve the EPA maximum contaminant levels and the New Mexico Water Quality Control Commission standards.

3.2 Activities Common to More than One Task

This section details the activities that are pertinent to more than one project task outlined in Section 3.1. The activities involve field implementation, and are described herein to avoid repetitiveness. Overall, the activities presented herein conform to the requirements of the Base-Wide Plans for the Environmental Restoration Program at Kirtland AFB (U.S. Air Force [USAF], 2004) ensuring that the data will be appropriate for the decision-making process. The following Kirtland AFB SOPs (USAF, 2004) are applicable to the work performed under this project, unless otherwise indicated in this Work Plan:

- B1.1, Borehole and Sample Logging
- B1.4, Monitoring Well Development
- B1.11, Equipment Decontamination
- B2.3, Subsurface Soil Sampling
- B3.1, PIDs and Organic Vapor Analyzers
- B5.1, pH
- B5.2, Specific Conductance
- B5.3, Water Temperature
- B5.4, DO
- B5.5, ORP.

The SOPs listed above are included in Appendix C.

3.2.1 Site Clearance and Utilities Location/Relocation

A utilities clearance will be conducted to locate all underground and suspended utilities both on Kirtland AFB property and off-base. On-base, utilities clearance activities will be conducted as prescribed by and in accordance with the Kirtland AFB site representative policies and procedures. Clearances will be renewed if they expire. No intrusive work will be initiated unless all locations are staked, the clearances from all on-base and off-base utilities have been obtained, and digging permits have been obtained. Utilities clearance activities at adjacent off-Base locations and COA right-of-ways will be prescribed by and in accordance with state of New Mexico utilities regulations. All underground utilities will be clearly marked before the start of any intrusive activities. All intrusive activities will take into account any existing utilities. The state of New Mexico's "New Mexico One Call" utility excavation clearance system will be used for all off-base drilling and excavation locations. Pot-holing will be performed to physically observe all utilities (using an approach adequately protective of the utility [e.g., hydro-vacuuming, air knife, hand digging, etc.]).

3.2.2 Permitting, Right-of-Way Agreements, and Right-of-Entry Agreements

Prior to any mobilization, copies of the right-of-way and right-of-entry agreements will be obtained for the location where work will be performed and documentation will be onsite with the field crew so that it is available in case inspections are being performed. In addition to access and site clearance, the appropriate permits will be obtained for the various field activities. The representative list of permits is presented below. Special attention will be taken for those permits that have an expiration date. The permitting process will be timed such that permit approvals will be received in time to maintain the schedule, but not too early in the process so that they expire before work is initiated. Permit renewals will be initiated such that the work will proceed with no interruption. Depending on the timing, permits may be combined. The list of permits/plans applicable to this project include:

- USACE Work Plan Vadose Zone Coring, Soil Vapor Monitoring, and Water Supply Sampling (when approved by NMED Hazardous Waste Bureau).
- USACE Work Plan for Bioventing and Air-Lift Enhanced Bioremediation Pilot Tests (in progress)
- New Mexico Office of the State Engineer Well Drilling Permits for each of the coring locations, SVM well locations, and GWM well locations with no consumptive use of water.
- COA Right-of-Way Licenses for SVM and GWM wells: these are already in place and will be kept on file to be available in case of inspections.
- COA specific plans:
  - Noise Control Plan/Permit for drilling.
  - Excavation/Barricade Permits for each drilling location off-Base.
- Kirtland AFB specific permits:
  - Erosion and Sediment Control Plan
  - 813 Request for Environmental Impact Analysis
  - Civil Engineer Digging Permit Request.
- Right-of-Entry Agreements and Licenses for accessing off-base locations for coring and SVM monitoring:
  - COA
  - Department of VA Health Care System
  - Private property owners of private irrigation wells.

3.2.3 Readiness Review Meetings

Readiness review meetings will be conducted with USACE and USAF a minimum of one week in advance of any new field activities. The meeting will be conducted to ensure that all pre-mobilization elements (e.g., approved plans, permits, right-of-way agreements, Kirtland AFB badging, and community notification) and mobilization elements (e.g., required staffing, equipment, and materials) have been completed.

3.2.4 Mobilization/Demobilization

Subject to USACE and USAF approval, EA (and our subcontractors) will maintain four laydown areas to support field activities. A BFF field office location has been located at Kirtland AFB, proximal to the BFF and a second field office near the GWTS and existing investigation-derived waste (IDW) storage yard. A secure fenced equipment yard has been established near the Truman gate for both heavy machinery and materials; this yard will also hold materials and supplies meant for use on the project at locations outside of Kirtland AFB, as required. Roll-off containers filled with solid waste (soil cuttings and mud) may be stored at the IDW storage area near the GWTS. Due to the large number of roll-off containers required for delivery and transfer during daily drilling activities, waste management support is a key element of mobilization. Laydown site locations are presented on Figure 3-11.

3.2.5 Site Security

A safe and secure construction site will be maintained during the execution of all activities taking place inside or outside of Kirtland AFB. EA site and safety personnel will coordinate with USACE, USAF point of contact, and the current contractor to gain insight into site security precautions (i.e., after hours security guards) that are currently in progress. Based on lessons learned, a plan to control public access and reduce interference with the surrounding area (traffic control, noise control, and site security) will be implemented and a safe work environment for the field teams and the surrounding community will be established. On-Base, all critical laydown yards will be secured by fencing and locked gates and the office trailer will be locked.

3.2.6 Barricading/Traffic Control

Work areas for coring, SVM, or GWM well drilling, installation, or abandonment will be protected from pedestrian and vehicular access. Barricades, temporary traffic control measures, and detour routes will be established where necessary in accordance with COA Construction Services Division requirements. EA will comply with the COA's Construction Coordination Section for work within the public right-of-way, including barricade and excavation permits and fees, and providing data for traffic reports.

3.2.7 Erosion and Sediment Control

All construction subcontractor(s) will obtain the necessary National Pollutant Discharge Elimination System Construction General Permit and submit any required Notice of Intent to the local agencies if required to support tasks on this project. A Stormwater Pollution Prevention Plan will be developed and posted at the work site. Stormwater Pollution Prevention Plan inspections will be completed in compliance with the permit and after rain events. Best management practices for sediment control (i.e., silt fences) will be implemented and maintained to manage stormwater and sediment discharge from work areas.

3.2.8 Decontamination

Final decontamination of all equipment will take place in designated decontamination areas specific to the work activity and approved by Kirtland AFB. Water from decontamination will be managed as per Section 8.

The objective of field decontamination is to remove contaminants of concern from sampling, drilling, and other field equipment to concentrations that will not impact study objectives. Specifications for decontamination materials are as follows:

- Use a standard brand of phosphate-free laboratory detergent, preferably either liquid Liquinox® or powder Alconox®.

- Use tap water from a municipal water treatment system or use bottled drinking water for the wash. Soap and tap water will remove the gross contamination from the sampling equipment.

- Use deionized water for the final rinse of sampling equipment that has direct contact to the sampling medium (e.g., the non-dedicated pumps used to sample monitoring wells).

3.2.9 Borehole Logging

During drilling, each boring will be fully described on the boring log form (Appendix F) in accordance with ASTM International D5434 and will include the following, when applicable:

- Identification number and location of each boring

- A general description of the drilling equipment used that includes such information as rod size, bit type, pump type, rig manufacturer, and model

- Date and time of start and completion of boring

- Name of contractor, driller, and drill site geologist

- Size and length of casing used in each borehole

- Soil classification in accordance with the United Soil Classification System, color, relative density and consistency, soil components, soil moisture, stratification, hardness, grain size and size distribution, and odor

- Mineralogical content of the core (for correlation)

- Depth to water as first encountered during drilling, along with method of determination

- Observations during drilling will be noted, such as bit chatter, rod binding, rod drops, and flowing or heaving sands (if drilling fluid is used, the fluid losses, interval over which they occur, and the quantity lost will be recorded)

- Depth limits, type, and number of each sample taken

- Observations of visible contamination for each sample or from cuttings that appear to be contaminated.

3.2.10 Photoionization Detector

PIDs will be used to determine the location of soil samples, if any soil samples will be collected for chemical analysis. The need for a PID for soil sampling will be determined once the drilling techniques are selected. The PID will be calibrated and tested as required in the QAPjP.

3.2.11 Headspace Screening

Headspace field screening will be performed in accordance with the following procedures.

1. Take PID measurements from cuttings/core with the frequency described in future revisions of this Work Plan.

2. Immediately upon the retrieval, collect a representative portion of the sample and place in a clean, dedicated (e.g., single sample) 1-gallon press-and-seal plastic food storage bag.

3. Vigorously agitate the bag for at least 15 seconds then allow a minimum of 10 minutes for the sample to adequately volatilize.

4. During cold weather, warm the samples to room temperature prior to taking the headspace measurement.

5. Re-shake the bag and quickly insert the vapor sampling probe and record the maximum meter response (this should be within the first 2-5 seconds).

6. Record headspace screening data on the boring log.

PID measurements will be recorded at a minimum of every 20 feet of core following the process below. Note that specific drilling tasks may have additional monitoring requirements.

1. Immediately upon the retrieval of the 2-4 feet of core, cut a small hole in the plastic core sleeve and insert the PID and record the highest reading.

2. Seal hole in a plastic core sleeve with tape.

3. Record headspace screening data on the boring log and core sleeve.

3.2.12 Sonic Core Handling and Photography

Core from sonic drilling will be extruded into plastic core sleeves at 2- to 4-foot increments over a 10-foot interval. Core sleeves will be labeled with the depth interval and the top of the core will be indicated. Once PID measurements and soil samples have been collected and the core has been logged by the geologist, the core will be placed in core boxes and photographed using a high resolution digital camera. The core boxes will be secured at the end of the project to the designated Kirtland AFB facility currently used to store project cores.

3.2.13 Well Construction Diagrams

Construction diagrams will be completed for the SVMP's KAFB-106V1, KAFB-106V2, and the air-lift well KAFB-106S1, as well as the dual completion vadose zone/groundwater monitoring wells. Well design will be approved in advance by NMED, and well construction will be documented on forms such as the one provided in Appendix B. Each form will include:

- Project and site names, well number, and total depth of the well

- Depth of any grouting or sealing, the amount of cement and/or bentonite used, and the total depth of the boring

- Depth and type of well casing

- Static water level upon completion of the well and after well development (except for SVMP's KAFB-106V1 and KAFB-106V2)
- Installation date or dates, and name of the driller and the geologist installing the well; each installation diagram will be signed by the preparer
- All pertinent construction details of the wells, such as depth to and description of backfill materials installed (i.e., gravel pack, bentonite, and grout); gradation of gravel pack, length, location, diameter, slot size, material and manufacturer of well screen(s); position of centralizers; and location of any blank pipe installed in the well
- Description of surface completion, including protective steel casing, protective pipes, and concrete surface seal
- A description of any difficulties encountered during well installation
- Survey coordinates and the elevation of the top of ground and top of well riser.

3.2.14 Soil Sampling

Soil samples will be collected to characterize the distribution of LNAPL in the identified subsurface target zones as related to the objectives of the borehole drilling. Soil samples will be collected as described below.

3.2.14.1 Soil Sampling for Chemical Analysis

Soil samples may be collected for chemical analysis during drilling of the continuous coring locations (Table 3-3). Once the sample depths have been determined, soil samples will be collected using EnCore® samplers for analysis of volatile-type compounds. Analyses performed for physical testing and/or biological testing have sampling specific container and handling requirements as outlined in Table 3-4 of the QAPjP.

3.2.14.2 Investigation-Derived Waste Sampling for Chemical Analysis

Samples submitted for solid IDW profiling will be collected as a five-point composite from each roll-off bin. A sampling scoop with a long handle will be used to collect each aliquot for homogenization from below the waste surface. The soil will be homogenized with a stainless steel sampling tool in a disposable container and aliquots will be collected to fill containers as per the QAPjP. Section 8 provides additional information for the chemical analyses to be performed on IDW samples.

3.2.14.3 Soil Sampling for Geotechnical Testing

Moisture content will be performed on selected core samples, when retrieved core represents different lithologic intervals. The samples will be sent to Daniel B. Stephens & Associates soil testing laboratory in Albuquerque, New Mexico for analysis by ASTM D2216. The soil will be collected by field staff donning nitrile gloves and using a stainless steel trowel and placed in 1-gallon plastic baggies. Samples will be collected, labeled, and handled as outlined in the QAPjP.

3.2.15 Well Development

KAFB-106S1 will be installed as a groundwater monitoring well, and KAFB-106S2 through KAFB-106S9 will be completed as dual-completion vadose zone/groundwater monitoring wells. KAFB-106S1 will be developed within 1 week after installation but no sooner than 48 hours after grout installation by bailing and surging. Wells KAFB-106S2 through KAFB-106S9 will be developed when there is sufficient water column available in the wells. Well development details are as follows:

- Initial development will consist of swabbing and bailing until little or no sediment enters the well (approximately 2-4 hours). Development and purge water will be contained in a temporary tank. If the addition of water is necessary to facilitate surging and bailing, only clean potable water will be used.

- A bailer fitted with a toggle valve will be lowered into the well and used to gently surge the screen interval to remove any accumulated sand, silt, and debris accumulated in the well bore. When the bailer is brought to the surface, an Imhoff cone will be used to collect water from the first bailer run to evaluate the amount of silt and sediment in the water. This process will be repeated after each cycle of surging development.

- A minimum of five casing volumes of water will be developed from the well.

- At the completion of well development, a sample will be collected and immediately photographed to document the results of the procedure.

The main goal of well development is to reduce the turbidity to less than 10 Nephelometric Turbidity Units (NTUs) (under 100 NTUs is acceptable). The site geologist will monitor field parameters including pH, temperature, and specific conductance, and record the results and other pertinent information on the well development record form (Appendix F).

3.2.16 Groundwater Gauging and Sampling

Following well development, groundwater and LNAPL (top and bottom) will be measured in KAFB-106S1, and all boreholes completed as dual completion vadose zone/groundwater monitoring wells. The wells will be allowed to recover a minimum of 24-hours following development prior to gauging, or water sampling. A baseline groundwater sample will be collected from the well utilizing a portable pump and dedicated tubing. Groundwater sampling will be performed in accordance with the procedures outlined in the Work Plan for Bulk Fuels Facility Expansion of the Dissolved-Phase Plume Groundwater Treatment System Design (USACE, 2017c). The new wells installed in this work plan will be incorporated into the groundwater monitoring program as soon as available (i.e. following proper development), and sampled as “newly-installed” wells quarterly during the one year baseline period. Following the baseline sampling, the wells will be proposed for a sampling frequency consistent with plume monitoring in each well location. If additional data are required, nearby wells may be sampled more frequently than the monitoring program in frequency provided in the Work Plan for Bulk Fuels Facility Expansion of the Dissolved-Phase Plume Groundwater Treatment System Design (USACE, 2017c). Future sampling and sample frequency of the air lift well, and any wells used in the pilot tests, will be described in the air-lift test plan. KAFB-106S1 will not be incorporated into the GWM network until completion of the air-lift pilot test and removal of downhole equipment.

3.2.17 Sample Packaging and Shipping

Sample packaging and shipping requirements are designed to maintain sample integrity from the time a sample is collected until it is received at the analytical laboratory. All chain-of-custody forms, sample labels, custody seals, and other sample documents will be completed as specified in the QAPjP. Specific procedures for packaging and shipping of environmental samples are presented below:

1. Complete sample label with indelible ink and attach to the sample bottle. Place sample bottles in a cooler for shipping.

2. In preparation for shipping samples, tape the drain plug shut so that no fluids, such as melted ice, will drain out of the cooler during shipment. A large plastic bag may be used as a liner for the cooler. Place packing material, such as bubble wrap, in the bottom of the liner. Place ice at the bottom of the cooler.

3. Place the containers in the lined cooler. Place cardboard separators or bubble wrap between the containers at the discretion of the shipper.

4. All samples for chemical analysis must be shipped cooled to ≤6 degrees Celsius with ice. Include a temperature blank in each sample container prior to shipment.

5. Tape the liner closed, if used, and use sufficient packing material to prevent sample containers from making contact or rolling around during shipment.

6. Place a copy of the chain-of-custody form inside the cooler.

7. Close and tape the cooler shut with strapping tape (filament-type).

8. Place custody seals on the cooler. Place clear tape over the custody seals to help prevent them from being accidentally torn or ripped off.

Ship the cooler of samples via an overnight carrier. A copy of the shipping bill will be retained with the field records and sent electronically to the Project Chemist.

3.2.18 Site Restoration

Site restoration will consist of backfilling and compaction, surface restoration/resurfacing, and landscaping restoration. Work areas will be restored to original conditions; and, in the residential areas, pavement of the type and thickness meeting COA Department of Municipal Development requirements will be replaced.

3.2.19 Survey

Land surveying activities will occur before, during, and after well installation activities. The surveys will be conducted at locations on Kirtland AFB, adjacent residential neighborhoods, and COA right-of-ways, as required. The surveys will establish northings, eastings, and elevations at all locations. All survey points will be verified, determined, marked, and documented per the provisions specified in the Definition of Land Survey Objective/Measuring Points and Land Survey Campaign among the Kirtland AFB Monitoring Well Network, which is included in draft form as Appendix G. This draft documentation includes an SOP and preliminary work plan for completing a survey of 400 existing monitoring wells within and nearby the Kirtland AFB in southeastern Albuquerque. For the purpose of the resurvey, wells have been divided into two categories, as follows: Category I wells include groups or clusters of wells within close proximity and which, therefore, represent minimal groundwater potentiometric surface gradients; and Category II wells include wells that are more distal to one another with larger groundwater potentiometric surface gradients. Datum specifications (refer to Appendix G for additional detail) are as follows for the two categories:

- New Mexico State Plane Coordinate System, Central Zone, North American Datum of 1983
- Category I and II horizontal uncertainty at the primary land survey objective point (PLSOP) = <0.03 feet
- North American Vertical Datum 1988
- Category I altitude uncertainty at the PLSOP = < 0.01 feet
- Category II altitude uncertainty at the PLSOP = < 0.15 feet.

A survey of horizontal positions (x-y coordinates) for existing wells will be completed in future years under a separate contract. For the survey of new wells to be installed under this Work Plan, the same procedures will be followed by a state of New Mexico-registered professional land surveyor or licensed Professional Engineer. Applicable requirements for uncertainty will also be used for excavation extents, temporary benchmarks as required for site controls, and as-built determination surveys.

Daily reports will consist of the following: a tabulation of the location, identification, coordinates, and elevations of each point surveyed that day. The elevations at junctions for all conveyance lines will be inverted.

As the documentation provided in Appendix G is still in draft form and further revisions are anticipated, survey work will be conducted throughout the duration of the project according to the version of these specifications current at the time work is being performed.

3.2.20 Analytical Services

Groundwater, drinking water, soil vapor, soil, and LNAPL samples will be collected, labeled, packaged, and shipped to the subcontractor laboratory as indicated below:

- ***Eurofins Lancaster Laboratories Environmental, LLC (ELLE), Lancaster, Pennsylvania*―**Groundwater monitoring samples and well installation soil samples. ELLE maintains a current DoD ELAP certification for the analyses required under this contract (Appendix A, Attachment 1).
- ***TestAmerica, Inc., Arvada, Colorado*―**Soil samples associated with the coring activities. Test America, Inc. maintains current DoD ELAP certification (Appendix A, Attachment 2).
- ***TestAmerica, Inc., Savannah, Georgia*―**Drinking water samples from supply wells and domestic irrigation wells. TestAmerica, Inc., Savannah maintains current State of New Mexico drinking water analysis certification (Appendix A, Attachment 2).

- ***TestAmerica, Inc., West Sacramento, California*–**Soil vapor samples associated with semiannual SVE monitoring. TestAmerica, Inc. maintains current DoD ELAP certification (Appendix A, Attachment 3).
- ***PTS Laboratories, Inc., Santa Fe Springs, California*—**Soil coring samples for LNAPL transmissivity and mobility (Appendix A, Attachment 4).
- ***Saybolt LP, Core Companies, Deer Park, Texas*—**LNAPL component testing associated with continuous coring activities (Appendix A, Attachment 5).
- ***IMR Metallurgical Services, Louisville, Kentucky*—**Soil sample testing for x-ray diffraction and energy dispersive x-ray spectrometry associated with continuous coring activities (Appendix A, Attachment 6).
- ***Microbial Insights, Inc., Knoxville, Tennessee*—**Soil samples for halorespiring bacteria to support vadose zone treatability studies (Appendix A, Attachment 7).
- ***Daniel B. Stephens & Associates*—**Soil samples collected for geotechnical analyses to determine soil properties associated with well installations (Appendix A, Attachment 8).

3.2.21 Data Validation

Analytical data generated in support of this contract will undergo data validation by the Project Chemist and an independent third party validation subcontractor to ensure compliance with data quality and project objectives per the QAPjP (Appendix A). All project data will undergo data verification by the Project Chemist or designee. For new data collection activities, 100% of the coring data and new well groundwater data will undergo EPA Stage 3 (formerly EPA Level 3) data validation for the criteria specified in the QAPjP. Due to the robust data set associated with SVM, 23 percent of analytical data for soil vapor is proposed for EPA Stage 3 data validation. Data qualifiers will be uploaded to the project database prior to finalizing data for use in project reports. Results of the data verification and validation efforts will be documented in the data validation report to be included with the Periodic Monitoring Reports. Data validation will be conducted in accordance with the requirements presented in the QAPjP.

3.2.22 Environmental Resources Program Information Management System Data Upload

Analytical and field data associated with the coring, drilling, and sampling activities will be managed and stored using EQuIS® Environmental Data Management System (Version 6.0). In addition to the EQuIS electronic deliverable, EA will receive Environmental Resources Program Information Management System 6.0 (ERPIMS) formatted deliverables from the laboratory for processing and submittal to the USAF Data Management ERPIMS support contractor on a semiannual basis for upload to the USAF Data Repository. ERPIMS submittals will include all soil vapor and groundwater data in addition to the chemical analysis of soil samples. IDW data will not be submitted to ERPIMS.

3.2.23 Public Notification

The public will be informed through door-to-door notifications at least seven days prior to mobilizing off-Base for intrusive activities, such as drilling.

4. PROJECT SCHEDULE

The project schedule is provided in Appendix H.

5. ORGANIZATIONAL PLAN

5.1 Organizational Structure

The organizational structure for this project is shown in Figure 5-1.

5.2 Responsibilities, Qualifications, and Authority of Key Personnel

Table 5-1 summarizes roles and responsibilities, qualifications, and authorities of project team members for the vadose zone treatability studies.

6. DATA MANAGEMENT

This section provides the data management process and procedures to be implemented for the field data and analytical laboratory data generated from work activities in support of the BFF pilot tests. The data management will satisfy the requirements of the QAPjP (Appendix A).

6.1 Personnel Roles and Responsibilities Specific to Data Management

Specific data management roles and responsibilities for the Data Management Lead and Field Team Lead are discussed below:

- ***Data Management Lead***—Responsible for oversight of transfer of field data to electronic data deliverable (EDD) format for loading to the project database, loading of laboratory EDDs, updating the database as required with current data pulls from the Environmental Resources Program Information Management System (ERPIMS) data repository, and running reports to provide current and historical data from the database. Also responsible for uploading the database with data validation qualifiers following validation, edits resulting from data validation, and delivering the ERPIMS data deliverable to the USAF data management contractor.

- ***Field Team Lead (responsibility will be assigned for each task to qualified staff)***—Responsible for the accuracy of all field activity-related documentation and records collected in support of project plan implementation including all information related to field sample collection; field instrumentation and measurements; equipment decontamination; and sample management and shipping documentation, field variance, and corrective action.

6.2 Project Data Types and Records

Field and analytical data will be collected as appropriate in support of activities associated with the BFF vadose zone treatability studies including coring, long-term SVM, well drilling and installation, drinking water supply well sampling, and irrigation well sampling. The following section describes the types of records and documentation that will be included for current and historical datasets, databases that will be used, database input requirements, and how data will be maintained and archived.

6.2.1 Project Data and Records

Project data will be documented and recorded using various methods as applicable. The following is a list of the various field and laboratory documentation and records that may be generated during project data gathering activities as applicable.

- Air bills and sample shipping documentation
- Analytical laboratory reports
- Chain-of-custody records
- Communication logs/e-mails
- Corrective action reports

- Documentation of corrective action results
- Documentation of deviations from methods (variances)
- Documentation of internal QA reviews
- Laboratory EDDs
- Field data collection forms, including boring logs, well construction logs, and field parameter logs
- Sampling notes in bound, waterproof field logbooks or on designated field forms
- Field instrumentation calibration logs
- Survey files for well location
- Identification of QC samples
- Photographs
- Sampling equipment decontamination records
- Sampling location figures (based on targeted and actual coordinates)
- Field variance request forms.

These records will be created in either written (e.g., sampling notes) or electronic formats (e.g., Global Positioning System files, measurement instrument/data-logger files, field databases, etc.). All records will undergo an independent review either at the laboratory or in the field by the technical leads, QA Officer, or the Project Manager. Additional information is provided in the QAPjP (Appendix A).

6.2.2 Laboratory Analytical Testing

Laboratory samples to be collected in support of the project include soil, soil vapor, and water for chemical analysis data and geotechnical soil testing data. Data deliverables to be provided by laboratories will be project- and data-type specific. Laboratory data will include:

- ***Chemical Analytical Data***—EPA Level IV-type data report (in portable document format [PDF]) and electronic data files in EQuIS® format and ERPIMS Version 6.0.
- ***Geotechnical Soil Data***—Electronic data file in Microsoft® Excel and summary report PDF.

6.2.3 Chemical Analytical Data

Chemical analytical data will include sample results from soil, soil vapor, and groundwater samples generated by the laboratory subcontractors. These data may include both routine and non-routine analytical testing. For all chemical analytical data, the laboratory will provide level 4 type data reports as defined in the QAPjP, EQuIS® 6 EDD for validation and loading into the project database and ERIPMS version 6.0 EDDs for processing and submittal of validated analytical data to the AFCEC data management contractor. The PDF data deliverable will be consistent with the requirements specified in the project-specific subcontractor statement of work.

The laboratories are responsible for ensuring that all analytical data reported in the electronic copy and level 4 type data report are consistent, accurate and complete in accordance with their scope. Verification of EDD formatting and completeness will be performed by the EA data management personnel during data review and upload of electronic data files. EDDs and data reports received from the laboratory that contain errors will be returned to the laboratory for correction and resubmittal. All chemical analytical data will be uploaded to the USAF data repository.

6.2.4 Geotechnical Data

Moisture content data will be generated by the subcontractor geotechnical testing laboratory. Testing results will be provided in Microsoft® Excel format and in a PDF data report. Geotechnical data results are not required to be submitted in ERPIMS format and will not be uploaded to the USAF data repository. This type of data will be reviewed by the Field Team Lead and the geotechnical data will be maintained in the electronic project files and provided in project reports.

6.3 Handling and Management of Project Generated Data

Data handling and management procedures are established to effectively process analytical and measurement data generated during field activities such that the relevant data are readily accessible and accurately maintained. There are multiple activities involved in the recording, storage, processing, and maintenance of project datasets and systems to manage these. In order to ensure that data are accurately recorded and stored, data tracking systems will be implemented. Automated and manual QC checks will be conducted to verify that data have been accurately recorded and appropriately stored. Corrective actions will be taken and documented in the event data have not been properly handled. General data handling and management as well as information on naming conventions, loading, and reporting of laboratory analytical data are discussed in this section.

The following subsections describe the data handling and management of data collected during field activities at Kirtland AFB, including onsite field and measurement data and offsite laboratory data. Field measurement and analytical data will be loaded into an EQuIS® database using Microsoft® Excel files and laboratory EDDs provided in the appropriate format per the templates provided by the data management team. These files will be saved and stored in Kirtland AFB project-specific folders located on the EA secure server.

6.3.1 Data Management Processes for Field-Related Data

Three general types of data will be collected and recorded in the field:

- Data to support sample collection and analysis
- Field measurements
- Field observations.

Project data collected during monitoring, investigation, and remediation sampling activities will be managed and stored using the EQuIS® Environmental Data Management System (Version 6.4). The types of field data to be managed in EQuIS® include field sampling parameters collected during well sampling and vapor monitoring, water level measurements, sampling observations, and sample location information such as coordinates, etc. Field data will be recorded on the appropriate forms or electronically, and reviewed and transferred to the field data electronic format as appropriate. The EDDs will be reviewed for accuracy and completeness against field records prior to being loaded into the EQuIS® database. The Data Management Lead will be responsible for ensuring that all field data files uploaded into EQuIS and ERPIMS are maintained on the corporate project server along with the ERPIMS submittal files and the project-specific database.

Field data that cannot be integrated into the database (i.e., site photographs, field logbooks, or field forms) will be stored electronically in the project-specific network folders and/or in the project files, along with supporting metadata such as author/creator of data, date, location, and a brief description. The Field Team Leads will be responsible for ensuring that all field data files are stored electronically in the project-specific network folders and all paper copies scanned and stored electronically in the project folders.

6.3.2 Analytical Data Management and Data Validation

Procedures for collecting field samples for laboratory analysis and the types of analyses to be conducted during the field activities are provided in Table 3-1 of the QAPjP (Appendix A). This section provides an overview of the EDD to be used for analytical data, the EDD loading process, field data verification, and analytical data validation. Record-by-record review of hard copy to electronic data transmittals from laboratories will be verified including validation qualifiers provided by the validation subcontractor.

Data management staff will review data and records received from the field team, subcontractor laboratories, and other subcontractors using the following process to ensure accuracy:

- Review field notes, logbooks, and field forms
- Verify field coordinates with the Geographic Information System group
- Record-by-record review of hard copy or electronic data transmittals from laboratories to data validators against the records loaded in the database for all validated results
- For data transmitted through subcontractors (not including the laboratories), 5-10 percent of loaded data records will be checked against data transmittals to verify import procedures
- For calculated or reported total analyte results, calculations will be performed on 100 percent of data to verify concentrations.

Laboratories will be required to submit their results in ERPIMS and EQuIS® EDD formats to be obtained from the laboratory secure website. Designated data management personnel will check and load the EDDs into the EQuIS® and ERPIMS database systems. Any errors in the EDD for a given sample delivery group will prevent loading of data from that sample delivery group and the issue will be communicated to the Laboratory Project Manager for correction and resubmission. Analytical data will be managed in EQuIS® for validation and reporting purposes. The ERPIMS data deliverables will be submitted to the USAF data management subcontractor and processed for upload to the USAF data repository.

One hundred percent of the analytical data generated by the subcontractor laboratories in support of the coring project and drinking water supply sampling will undergo EPA Stage 3 validation in accordance with the requirements in the project QAPJP. Soil vapor validation requirements for specific SVMPs are specified in Section 3.1.5. Validation qualifiers will be applied to the data results in the EQuIS® EDD and uploaded to the project database. Validation qualifiers will be included in the upload to the USAF data repository.

6.4 Data Security

The information systems that will house the BFF data, including field and analytical data as well as other electronic information, include systems maintained and managed within contractor offices. Servers located in contractor facilities are physically secured in locked buildings and rooms with access limited to authorized personnel.

Corporate servers are electronically secured behind firewalls with multiple layers of anti-malware software that protect the firewall, the local area network, and e-mail networks. The servers are backed up nightly. Corporate servers and networking equipment are connected to battery-based uninterruptable power supplies with automated shutdown procedures in the event of a power outage.

7. QUALITY ASSURANCE/QUALITY CONTROL

QA/QC activities for the soil and water sampling will be conducted in accordance with the processes and procedures documented in the QAPjP (Appendix A).

8. WASTE MANAGEMENT

IDW generated during the implementation of this project will be managed as specified in this Work Plan. Prior to initiation of field activities, EA will ensure that all waste management procedures have been refined and approved by NMED and that all waste streams and volumes have been properly planned for. This is especially important when large volumes of liquids from well drilling and development are produced at an off-Base drilling location. Waste volumes will be minimized to the extent practical and eliminate the potential for the local population's exposure to IDW during and after work hours. IDW will be stored for no longer than 90 days prior to disposal; refer to Figure 3-11 for the location of the IDW storage area.

8.1 Water Investigation-Derived Waste

All excess water generated during well development, sampling, or during drinking water supply sampling events will be 100% captured and contained during generation. The following categories of water are discussed in the paragraphs below:

- **Non-hazardous water** generated from:
  - Purging or development of wells prior to sampling for which the sampling data for two consecutive preceding sampling events document no contaminants are present at concentrations that met the definition of characteristic hazardous waste (40 Code of Federal Regulations [CFR] Part 261 [2015]).
  - Decontamination water from equipment cleaning across all site activities.
- **Hazardous/potentially hazardous water** generated from:
  - Purging or development of wells during sampling events for which any data from two consecutive preceding sampling events have documented that contamination is present at concentrations that exceed the characteristic hazardous waste toxicity criteria (40 CFR Part 261.24).
  - Purge water from wells for which historical data show water quality fluctuating between non-hazardous and hazardous classification.
  - Purge water that had concentrations relatively close to the regulatory standard in 40 CFR Part 261.24 (e.g., water that exhibited benzene above 0.4 milligrams per liter in at least one of the previous two events).
- **Water of unknown quality** generated from development and sampling of new wells (i.e. KAFB-106S1) will rely on actual sample results from the IDW for waste profiling.

The QAPjP in Appendix A presents additional information regarding analytical requirements.

8.1.1 Non-Hazardous Water

Non-hazardous water generated from groundwater sampling activities may contain concentrations of dissolved iron and manganese that exceed the influent acceptance limits specified in the GWTS O&M

Plan (USACE, 2017d). Non-hazardous water will be managed as described below depending on dissolved metals concentrations.

8.1.1.1 Non-Hazardous Water with Dissolved Metals Exceeding Groundwater Treatment System Influent Acceptance Limits

IDW water that contains dissolved iron and manganese exceeding the GWTS influent acceptance limits will be kept segregated by point of origin both during transport and in storage and will not be discharged directly to the GWTS. Upon generation, the water will be placed in dedicated drums and transported to "pending analysis" storage facility where the drums will be labeled and stored pending laboratory analytical results. The storage containers will not be left unattended at off-Base locations during work hours. This water will be profiled for offsite disposal based on the analytical data from the sample collected from the well purged.

8.1.1.2 Non-Hazardous Water with Dissolved Metals Less than the Groundwater Treatment System Influent Acceptance Limits

For IDW waste meeting the dissolved iron and manganese GWTS influent acceptance limits, the water will be segregated while in storage until waste profile analytical data are available. Fluids purged or generated at the wellheads will be placed, to the acceptable filling capacity, in 55-gallon drums or larger containers (totes) that are secured to a truck bed and, upon conclusion of the work day, transferred to the IDW storage area. The storage containers will not be left unattended at off-Base locations during work hours. The quantity of IDW water from each well and the total quantity of water transferred to the GWTS will be recorded. A minimal amount of fines is anticipated to be present in this water and pre-filtering before batching into the GWTS is not anticipated.

If, for any reason, the GWTS cannot accept the purge water as it is generated (e.g., shut down for maintenance), the water will be temporarily stored in the IDW storage area on pallets and properly labeled until it can be discharged to the GWTS.

8.1.2 Hazardous/Potentially Hazardous Water

Characteristically hazardous water generated from any well development or sampling activities will be kept segregated by point of origin both during transport and in storage. Upon generation, the water will be placed in dedicated drums and transported to the less than 90-day accumulation area where the drums will be labeled and stored pending laboratory analytical results. The storage containers will not be left unattended at the residential sites during work hours. This water will be profiled for disposal based on the analytical data from the sample collected from the well purged. A minimal amount of fines is anticipated to be present in this water. Water generated from purging of new wells due to undocumented water quality will be treated the same way as the hazardous water until proven non-hazardous. The quantity of water purged from each well will be recorded.

8.1.3 Water of Unknown Quality

Water of unknown quality associated with drilling activities will initially be placed in portable tanks located at the wellhead where it is produced. The fines will be allowed to settle before the water will be transported, on a daily basis, using vacuum trucks from the wellhead to a centralized storage area where it will be pumped in storage tanks. The quantity of water extracted during development of each well and the total quantity of water transferred into the storage tank will be recorded. Upon conclusion of the development or when the storage tank capacity is reached, one water sample will be collected from a spigot situated at the bottom of the tank; proper disposal will take place upon receipt of analytical results. The sample will be analyzed for the analytical suites presented in Table 8-1. Upon receipt of the analytical results confirming that the water is non-hazardous and that the dissolved iron and manganese meet the GWTS influent acceptance limits, the water will be batched through the GWTS. A pre-filter to capture fines is anticipated for well development water. If the water is hazardous based on toxicity characteristics, it will be disposed of offsite in accordance with NMED regulations. If the water does not meet the GWTS influent acceptance limits, the IDW water will be profiled for offsite disposal.

8.2 Soil Investigation-Derived Waste

Soil will be 100% captured and contained at the drill site during coring and/or well drilling. All necessary equipment will be provided to contain and transport soil IDW back to the IDW storage area for further handling (i.e., characterization, temporary storage, and disposal). IDW soil from drilling sites will be collected, secured, and transported in 20-cubic yard lined roll-off bins to the IDW storage area pending receipt of waste characterization profiling results.

For profiling of solid waste, each roll-off containing soil will be characterized for disposal at the Kirtland AFB Construction and Demolition (C&D) Landfill with a 5-point composite IDW sample. Depending on the type and provenance of the waste, the samples will be analyzed for the suites outlined in Table 8-1. Soil will have to meet the waste acceptance criteria for the Kirtland C&D Landfill (USAF, 2009). The suite for profiling soil originating at locations where extraction and observation wells are installed is reduced, as it is historically known that the waste from that general location is petroleum-based.

Once the analytical results for soil IDW are received and reviewed, a Request for Disposal letter will be provided to Kirtland AFB for approval to dispose of the contents of each container. All documentation regarding waste characterization and disposal will be provided in the appendices of the document describing the activities during which waste was generated.

Should the petroleum levels exceed what the Kirtland C&D Landfill is allowed to accept (benzene, toluene, ethylbenzene, and toluene >50 milligrams per kilogram [mg/kg], benzene >10 mg/kg, or total petroleum hydrocarbons >100 mg/kg), it will require characterization as “special waste” and disposed at an offsite permitted landfill. Samples will be handled per Section 3.2.17 of this Work Plan. The QAPjP (Appendix A) presents additional information regarding analytical requirements.

9. ACCIDENT PREVENTION PLAN/SITE SAFETY AND HEALTH PLAN

The safety requirements for the field implementation of this project are addressed in the companion document, *APP for the Kirtland AFB BFF Expansion of the GWTS and Vadose Zone Treatability Studies (Revision 5)* that also contains the SSHPs (EA, 2017). All field personnel associated with the project will be required to read and understand the elements of the APP, and the document will be available at the project location at all times.

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FIGURES

TABLES

APPENDIX A

Quality Assurance Project Plan

APPENDIX B

Bioventing Well Design, Air-Lift Enhanced Bioremediation Well Design, and Dual-Completion Soil Vapor/Groundwater Wells

APPENDIX C

Relevant Standard Operating Procedures from Kirtland AFB Basewide Plan (Appendix B; 2004)

APPENDIX D

Soil Vapor Sampling SOP

APPENDIX E

Water Supply Well Monitoring SOP

APPENDIX F

Field Forms

APPENDIX G

Definition of Land Survey Objective/Measuring Points and Land Survey Campaign among the Kirtland Air Force Base Monitoring Well Network

APPENDIX H

Project Schedule