KIRTLAND AIR FORCE BASE
ALBUQUERQUE, NEW MEXICO

SOURCE ZONE CHARACTERIZATION REPORT FOR THE BULK FUELS FACILITY SOLID WASTE MANAGEMENT UNITS ST-106/SS-111
REVISION 1

APRIL 2021

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ALBUQUERQUE, NEW MEXICO

Source Zone Characterization Report
Solid Waste Management Units ST-106/SS-111
Kirtland Air Force Base, New Mexico
Revision 1

April 2021

Prepared for
U.S. Army Corps of Engineers
Albuquerque District
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Contract No. W9128F-13-D-0006/Delivery Order DM02

NOTICE

This Source Zone Characterization Report Revision 1 summarizes an investigation to address data gaps in the horizontal and vertical extent of diffused and dispersed light non-aqueous phase liquid (LNAPL) both in the vadose zone and submerged in groundwater at Solid Waste Management Units ST-106/SS-111. This report was prepared for Kirtland Air Force Base under U.S. Army Corps of Engineers Contract Number W9128F-13-D-0006/Delivery Order DM02 by EA Engineering, Science, and Technology, Inc., PBC.

The source zone characterization included sonic coring at 11 locations and the collection of soil samples for chemical, physical, and biological analyses. Physical characterization was performed on diffused and dispersed LNAPL samples. All coring locations were completed as nested groundwater monitoring wells or vapor monitoring wells to augment the monitoring networks associated with the Kirtland Air Force Base Bulk Fuels Facility, Solid Waste Management Units ST-106/SS-111.

This work was performed under the U.S. Air Force Environmental Restoration Program, in general accordance with requirements set forth in the Resource Conservation and Recovery Act Permit Number NM9570024423, issued to Kirtland Air Force Base. The New Mexico Environment Department is the lead regulatory agency.

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This Source Zone Characterization Report Revision 1 summarizes an investigation to address data gaps in the horizontal and vertical extent of diffused and dispersed light non-aqueous phase liquid (LNAPL) both in the vadose zone and submerged in groundwater at Solid Waste Management Units ST-106/SS-111. The source zone characterization included sonic coring at 11 locations and the collection of soil samples for chemical, physical, and biological analyses. Physical characterization was performed on diffused and dispersed LNAPL samples. Results are tabulated and discussed in this report.

15. SUBJECT TERMS

Source zone, jet fuel, aviation gas, diffused and dispersed LNAPL, ethylene dibromide, sonic coring, ultraviolet fluorescence, core photography, x-ray diffraction, x-ray fluorescence, microbial analysis, LNAPL mobility, solute plume, vapor plume, intrinsic biodegradation, abiotic reactions, Bulk Fuels Facility, vadose zone

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This document has been approved for public release.

KIRTLAND AIR FORCE BASE
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PREFACE

This report has been prepared by EA Engineering, Science, and Technology, Inc., PBC (EA) for Kirtland Air Force Base (AFB) under the U.S. Army Corps of Engineers Contract Number W9128F-13-D-0006, Delivery Order DM02. This report summarizes an investigation to characterize the source zone associated with a historical fuel release at Solid Waste Management Units ST-106/SS-111, Bulk Fuels Facility at Kirtland AFB, New Mexico. This report was prepared in general accordance with the requirements of Part 6 of the Resource Conservation and Recovery Act Permit Number NM9570024423 issued to Kirtland AFB.

The source zone characterization was performed to address data gaps in the horizontal and vertical extent of diffused and dispersed light non-aqueous phase liquid (LNAPL) both in the vadose zone and submerged in groundwater. The source zone characterization included sonic coring at 11 locations and the collection of soil samples for chemical, physical, and biological analyses. Physical characterization was performed on diffused and dispersed LNAPL samples. All coring locations were completed as nested groundwater or vapor monitoring wells to augment the monitoring networks.

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(Provided Electronically via Compact Disc)

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ACRONYMS AND ABBREVIATIONS

°C	Degree Celsius
%	percent
AFB	Air Force Base
amsl	above mean sea level
API	American Petroleum Institute
ARCH	air rotary casing hammer
ASTM	ASTM International
AvGas	aviation gasoline
BFF	Bulk Fuels Facility
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and total xylenes
DRO	diesel range organics
EA	EA Engineering, Science, and Technology, Inc., PBC
EDB	ethylene dibromide (also known as 1,2-dibromoethane)
EPA	U.S. Environmental Protection Agency
FFOR	Former Fuel Offloading Rack
FOC	fractional organic carbon
ft	foot/feet
g	gram(s)
GRO	gasoline range organics
GWM	groundwater monitoring
IDW	investigation-derived waste
(J)	estimated detect
JP	jet propellant
KAFB	Kirtland Air Force Base
LNAPL	light non-aqueous phase liquid
mg/kg	milligram(s) per kilogram
mg/L	milligram(s) per liter
MRO	motor oil range organics
NMED	New Mexico Environment Department
PCR	polymerase chain reaction
PID	photoionization detector
Q1	first quarter
Q2	second quarter

RCRA	Resource Conservation and Recovery Act
REI	reference elevation interval
RP	Recommended Practice
SE	Southeast
SVM	soil vapor monitoring
SWMU	Solid Waste Management Unit
TPH	total petroleum hydrocarbons
(U)	Non-detect
(UJ)	Estimated non-detect
USACE	U.S. Army Corps of Engineers
USCS	Unified Soil Classification System
UV	ultraviolet
VOC	volatile organic compound
wt. %	weight percent
XRD	x-ray diffraction
XRF	x-ray fluorescence

EXECUTIVE SUMMARY

This report describes the source zone characterization activities that were performed from October 5, 2018 to March 7, 2019. The scope of work for this assessment was performed in accordance with the Work Plan for Vadose Zone Coring, Vapor Monitoring, and Water Supply Sampling (Kirtland Air Force Base, 2017a). The Work Plan was approved with conditions by the New Mexico Environment Department (NMED) on February 23, 2018 (NMED, 2018a). The submittal of this report was requested by NMED in a letter dated February 25, 2019 letter (NMED, 2019a). The submittal of this report satisfies that requirement.

The Bulk Fuels Facility area consisted of a tank holding area where bulk shipments of fuel were received and a fuel loading area where individual fuel trucks were filled. Underground piping was used to convey fuel between these locations. Kirtland Air Force Base removed the underground piping from service in 1999 due to the discovery of a release. The release area is referred to as the source area and is located in the northwest portion of the Base to the south of Randolph Road, Southeast within the installation boundary.

Continuous cores were drilled to the water table at nine locations and two were cored in the vadose zone near the source area to assess the horizontal and vertical extent of diffused and dispersed light non-aqueous phase liquid (LNAPL) at Solid Waste Management Units (SWMUs) ST-106/SS-111 (the Site). In addition to the diffused and dispersed LNAPL characterization, nested monitoring wells were constructed in each borehole with nine dual-completion groundwater monitoring (GWM) wells and two, six-well nest soil vapor monitoring (SVM) wells. The GWM wells were installed to address data gaps in the source zone created by the rising groundwater elevation. The SVM wells were installed as observation wells for the bioventing pilot study that was initiated in 2019. Soil core samples were collected to obtain contaminant concentrations in soil and diffused and dispersed LNAPL properties data.

Residual fuel remains in place in the subsurface in the source area soils and below the water table in areas where LNAPL was historically detected in monitoring wells. Laboratory analysis of soil properties indicate that the LNAPL is immobile. The highest concentrations of fuel-release related constituents in the vadose zone were found in the source area at a depth of 254 feet (ft) below ground surface (bgs). These concentrations then decrease significantly below a clay layer encountered at a depth of approximately 265 ft bgs.

LNAPL saturation in vadose zone samples was highest in the source area and none of the samples were found to contain mobile LNAPL, demonstrating that there is no drainage of LNAPL that could cause a continued LNAPL head in the source area that would be required to drive migration. A diffused and dispersed LNAPL smear zone is present below the water table and downgradient from the source area extending northeast under USS Bullhead Memorial Park. Laboratory analysis demonstrates that the LNAPL in this zone is immobile.

Additional findings based upon analysis of samples from the vadose zone include:

- Microbial analyses from vadose zone cores indicate a low potential for anaerobic degradation of EDB, but moderate potential for aerobic degradation of BTEX.
- Mineralogy analyses using x-ray diffraction, x-ray fluorescence, and magnetic susceptibility were used to assess the potential for abiotic remedial techniques. Based on the results of the data, abiotic attenuation of EDB with respect to iron-bearing minerals is not anticipated to be significant.

- Moisture content data were collected to assist with the bioventing pilot study. The moisture content ranged from 1.3 to 33.8 weight percent (wt. %) for the analyzed samples. In general, soil moisture averaged approximately 5 percent in well graded and poorly graded sand samples collected in the vadose zone. There also did not appear to be a significant difference in moisture contents in samples collected in the source area versus those collected off-Base.

The highest concentrations of fuel-release related constituents in the saturated zone were found in the source area at a depth of approximately 490 ft bgs. Concentrations decrease with distance from the source area, particularly off-Base. LNAPL saturation in saturated zone samples was highest in the source area and none of the samples were found to contain mobile LNAPL.

The data indicates that the fuel migrated vertically through mostly permeable non-cohesive soil by gravity drainage from the release point to a clay layer encountered around 260 to 270 ft bgs. Upon encountering the clay layer, the fuel saturated the soil above the clay, resulting in increased hydraulic head that eventually overcame the capillary pressure of pore water in the clay porosity. Once this pressure was overcome, LNAPL migrated into and through the clay layer (ITRC-3, 2018). Not only did the hydraulic head that built up drive the LNAPL into and through the clay, it spread LNAPL laterally on the clay layer as a saturated fluid. Laterally, LNAPL may have pooled with sufficient hydraulic head to penetrate the clay elsewhere.

Once the LNAPL entered the clay, structural changes to the clay facilitated greater permeability and ability to transmit the LNAPL through the clay to the underlying permeable soil. This mechanism is contrary to the concept that the clay formed an impermeable layer to the LNAPL, LNAPL migrated vertically through the clay, and laterally through the clay by capillarity. A “hole” or other discontinuity in the clay layer is not required to explain the deeper migration of LNAPL to the water table.

Vertical downward migration appears to have continued until the LNAPL intercepted the groundwater table. Dissolved-phase EDB and benzene plumes then developed and migrated northward according to the local historical groundwater gradient. The LNAPL migrated as far north as USS Bullhead Memorial Park. As the groundwater decreased in elevation, transport would have followed the LNAPL gradient created by the continued drainage and favored the groundwater gradient.

Locations where groundwater concentrations of fuel-related constituents exceed the calculated effective solubility of benzene may be indicative of the presence of LNAPL in the saturated zone. The effective solubility of benzene (1.43 milligrams per liter) was used as a conservative method for approximating the location of submerged LNAPL. The Q2 2019 isocontour plot for benzene shows that the BTEX plume attenuates within a relatively short distance (less than 500 ft) from the diffused and dispersed LNAPL source and is fully attenuated before it reaches Ridgecrest Drive.

1. INTRODUCTION

Solid Waste Management Units (SWMUs) ST-106/SS-111 are located at Kirtland Air Force Base (AFB) in Bernalillo County, New Mexico. Kirtland AFB is located southeast of, and adjacent to, the City of Albuquerque and the Albuquerque International Sunport (airport). The approximate area of the base is 52,287 acres. The Bulk Fuels Facility (BFF or Site) is located in the northwestern portion of Kirtland AFB (Figure 1-1). Environmental restoration efforts at the BFF are being performed pursuant to the corrective action provisions in Part 6 of the Resource Conservation and Recovery Act (RCRA) Permit Number NM9570024423 (RCRA Permit). The New Mexico Environment Department (NMED) is the lead regulatory agency (NMED, 2010). This work was performed under U.S. Army Corps of Engineers (USACE) Contract Number W9128F-13-D-0006/Delivery Order DM02. This report is the compliance deliverable for the Vadose Zone Work Plan per the February 25, 2019 NMED letter requirement (NMED, 2019a).

The coring program discussed in this report was performed in accordance with the Work Plan for Vadose Zone Coring, Vapor Monitoring, and Water Supply Sampling, Revision 2 (Kirtland AFB, 2017a), referred to throughout this report as the Work Plan. The Work Plan was approved with conditions by NMED on February 23, 2018 (NMED, 2018a). This Work Plan included several scopes of work in addition to vadose zone coring and sampling. These scopes of work included soil vapor monitoring (SVM), an air-lift well pilot study, maintenance of the SVM well network, and water supply sampling. Table A-1 in Appendix A provides the status for these various scopes of work. This report discusses the work performed to support the vadose zone coring, sampling, and monitoring well installation.

The approval conditions included the collection of photoionization detector (PID) readings, specified coring interval starting depths, mineral/microbial data collection zones, optional coring locations, a background coring location, the timing of lithologic log submittals, NMED authorization to proceed prior to the drilling, and construction of bioventing wells.

The following appendices accompany this report:

- Appendix A – Regulatory Correspondence (includes the Response to Comments Table)
- Appendix B – Daily Quality Control Reports
- Appendix C – Core Temperature Logs
- Appendix D – Lithologic Logs and Well Completion Diagrams
- Appendix E – Technical Memorandum for Vadose Zone Core Photography Logs
- Appendix F – Site Photographs
- Appendix G – Laboratory Data Packages for Soil Samples
- Appendix H – Data Quality Evaluation Report, TestAmerica, Inc.
- Appendix I – Well Completion Report

- Appendix J – Searchable Flat File of Volatile Organic Compounds (VOCs), Ethylene Dibromide (EDB), and Total Petroleum Hydrocarbon (TPH) Analytical Data
- Appendix K – Waste Management Documentation.

2. FACILITY HISTORY AND PROJECT BACKGROUND

The BFF at Kirtland AFB became operational in 1953 and has been used over time for the storage of aviation gasoline (AvGas), jet propellant (JP)-4, JP-8, and smaller amounts of diesel fuel and unleaded gasoline. Jet fuel was offloaded from railcars or tanker trucks to the Former Fuel Offloading Rack (FFOR), pumped through underground pipelines to the pump house, and then to large fuel storage tanks at the BFF. Releases were discovered in November 1999 when fuel staining was observed on the ground surface at the FFOR. Based on the chemical composition of the fuels stored and used at the BFF, the releases are estimated to have begun prior to 1975, when the BFF transitioned from AvGas to JP-4. Of the fuels stored and used at the BFF, only AvGas contained EDB as an additive. When the fuel release was discovered in November 1999, the FFOR was closed, and a temporary fuel offloading area was constructed and used during the construction of aboveground infrastructure. Replacement of the infrastructure was finished in March 2011 and includes aboveground storage tanks and pipeline with leak detection and containment measures (Kirtland AFB, 2018a). The current and former infrastructure for the BFF is shown on Figure 2-1.

Once released, jet fuel entered the ground as a light non-aqueous phase liquid (LNAPL). Discharged fuels are considered LNAPL because they are: (1) immiscible in water, (2) have low solubility in water (typically less than 1 percent [%] by weight), and (3) are buoyant in water (i.e., lighter or less dense than water). Aromatic compounds present in hydrocarbon fuels—including benzene, toluene, ethylbenzene, and total xylenes (BTEX)—and short-chain aliphatic compounds such as pentane, hexane, and octane, dissolve in groundwater and soil porewater at varying concentrations which is controlled by their molecular weight, compound geometry, vapor pressure, and aqueous solubility. Fuel hydrocarbon compounds and LNAPL over time partition in the subsurface: sorption onto soil, volatilization into soil gas, dissolution into soil moisture and groundwater, and mobile (still free draining) and immobile (trapped in capillary tension) LNAPL in pore space. As the fuel was released from the underground pipelines over time, it drained vertically downward due to the force of gravity through different parts of the subsurface. Lateral spreading occurred in response to soil tension and permeability variations (Kirtland AFB, 2018a).

LNAPL traveled downward through soil in the vadose zone. The vadose zone is the part of the earth between the ground surface and the water table. The vadose zone is also referred to in this Report as the unsaturated zone because this area is generally not saturated with water. The capillary fringe, where groundwater seeps up from the water table by capillary action, is also included in the vadose zone. At the Site, the vadose zone reaches a depth of approximately 480 feet (ft) below ground surface (bgs). LNAPL traveled through the vadose zone to groundwater (Kirtland AFB, 2018a).

As LNAPL traveled through the subsurface, constituents in the LNAPL partitioned to different phases. In the vadose zone, LNAPL constituents volatilized and contributed to soil vapor contamination in the spaces between sand grains. LNAPL also sorbed to materials in soil, or dissolved into water between sand grains, and was retained in the spaces between grains in the vadose zone due to viscosity and capillary forces. When LNAPL reached the water table, it spread laterally in response to buoyancy forces, selectively displaced groundwater from the interior of the larger pores in the aquifer media and began to dissolve into groundwater. Due to the age of the release and the rapid rise of the groundwater table, there is no longer a contiguous phase of fuel above the water table based on the last several years of gauging. The LNAPL is now discontinuously dispersed across the vadose zone and the upper portion of the aquifer.

LNAPL constituents (dissolved-phase fuel-related contamination) dissolved into groundwater and followed the flow of groundwater in a north–northeast direction. Interim measures were performed to remediate contamination in the vadose zone including excavating contaminated soil and performing soil vapor extraction. Approximately 3,000 cubic yards of contaminated soil was excavated from the source area at the site from 1999 to 2015 to a depth of 20 ft bgs. Soil vapor extraction systems operated at the site from 2003 to 2015 and removed approximately 775,000 equivalent gallons of jet fuel. Groundwater Monitoring (GWM) activities have been ongoing at the site since 2000. Groundwater interim measures historically included skimmers and a modified bioslurping system to remove floating LNAPL (Note that the removed LNAPL is included in the 775,000 gallons).

An understanding of the distribution and mobility of diffused and dispersed LNAPL in the vadose and saturated zones is critical to defining the nature and extent of contamination from the fuel release and preparing for the corrective measures evaluation. This is particularly important due to changes in the water table elevation and gradient resulting from reduced pumping by the Albuquerque Bernalillo County Water Utility Authority due to the San Juan-Chama Drinking Water Project. This surface water diversion has relieved the pumping stress of the aquifer system and groundwater elevation has been rebounding approximately 3-4 ft per year (Beman, 2013).

This investigation of the source area focused on the following objectives that are discussed in this report:

- Collection, field screening, and laboratory testing of soil cores from 11 boreholes to assess the current state of LNAPL, adsorbed-phase contaminants, microbiological, and mineralogical constituents in the vadose and saturated zones.

- Installation of nine GWM wells to fill data gaps caused by the rising water table.

- Installation of two SVM wells to assist with future bioventing pilot studies.

- Drilling of a soil borehole and conversion to a monitoring well to provide background data.

2.1 Regional Hydrogeology

In general, the site is underlain by approximately 200 ft of relatively fine-grained alluvial fan deposits, with some alternating and laterally discontinuous coarse-grained zones. Underlying these easterly derived alluvial fan deposits are relatively coarse-grained Ancestral Rio Grande deposits, with few laterally discontinuous fine-grained zones (Kirtland AFB, 2018a).

Coarse-grained, Ancestral Rio Grande deposits with northeast-southwest oriented channel axes are interbedded with fine-grained silt and clay units. These deposits have been structurally tilted to the east due to generally down-to-the east faulting along the Sandia Mountains. Braided deposits at the site are more restrictive in the transverse axis of the deposition channel (east-west), and less restrictive in the longitudinal axis (north-south). However, this geologic control is secondary to hydrologic controls on groundwater flow direction.

Two fine-grained clay-rich layers called A1 and A2 are present with the axial Ancestral Rio Grande fluvial deposits throughout the Albuquerque area (Kirtland AFB, 2018a). The A1 and A2 clay-rich layers are present at the site as laterally continuous fine-grained zones. The thicknesses of A1 and A2 range from approximately 50 to 200 ft and are observed across the site, extending north of the Ridgecrest well field. These A1 and A2 layers create confining conditions within the aquifer and, beneath these clays, groundwater occurs under confined conditions. Though these confining beds play a key role in the transport of dissolved-phased contaminants, flow direction of the dissolved-phase groundwater plumes is largely influenced by as the hydraulic gradient introduced by operation of the production wells.

3. SCOPE OF ACTIVITIES

The work associated with the source zone characterization included continuous coring at 11 locations in the vadose and saturated zones (Figure 3-1), installation of two nested SVM wells (KAFB-106V1 and KAFB-106V2), installation of eight dual-completion GWM wells (KAFB-106S1 through KAFB-106S5 and KAFB-106S7 through KAFB-106S9), and one background GWM well (KAFB-106247) (Kirtland AFB, 2017a). The two SVM wells (KAFB-106V1 and KAFB-106V2) were located in the source area near the two SVM wells (SVMW-10 and SVMW-11) that exhibited the highest total hydrocarbon concentration in soil vapor. The GWM wells (KAFB-106S1 through KAFB-106S7 and KAFB-106S9) were located next to GWM wells where LNAPL was historically present. Finally, the location for the background well (KAFB-106247) was chosen in an area to the south of the BFF that did not have any history of hydrocarbon impacts.

The elevation of the water table has varied over the years since the fuel release. In 1953 (the earliest possible beginning of the fuel release), the groundwater elevation at the top of the aquifer was approximately 60 ft higher than current elevations (Rice et al., 2014), which would be approximately 4,950 ft above mean sea level (amsl). The approximate groundwater elevation in the project area was 4,950 ft amsl in 1950, 4,940 ft amsl in 1960, and 4,930 ft amsl in 1970. The groundwater table elevation began dropping due to the development of the City of Albuquerque well fields and reached its lowest point of approximately 4,852 ft amsl at the end of 2009. Using KAFB-106S9 as an example, the depth to water was approximately 396 ft bgs in 1950, 406 ft bgs in 1960, 416 ft bgs in 1970, and 494 ft bgs in 2009. Because of this, the nine boreholes that were drilled and converted to GWM wells were constructed with well screens at the water table.

Soil cores collected from the boreholes were screened for the presence of LNAPL (using ultraviolet [UV] light flashlights) and hydrocarbons (using a PID with the heated headspace method). The ability of LNAPL to fluoresce in the presence of UV light was used to screen for its presence. This was performed in accordance with Figure 3-7 Decision Logic schematic for Sample Collection of the approved work plan (Kirtland AFB, 2017a) which provides a flow chart for sample analyses. Selected cores were frozen and then sent for laboratory UV analysis to further confirm or deny the presence of LNAPL. During the laboratory analysis, the frozen soil cores were saw-cut in half, length wise, and exposed to UV light. This provided an estimate of the location of LNAPL in the soil core. The intensity of the UV light provided an approximation of the relative amount of LNAPL present in the soil. This information was used to select sample locations for further laboratory LNAPL analysis (see below). However, in some cases, carbonate minerals also fluoresced under UV light. In these instances, the un-fluoresced and fluoresced photos were compared. Fluorescent minerals typically appear spherical or light-colored in the un-fluoresced photo. When these were observed to correspond to the same location in the UV light photo, these areas were not considered to have LNAPL present.

Soil cores and samples were submitted for laboratory analysis of:

- VOCs (U.S. Environmental Protection Agency [EPA] Method 8260C); EDB (EPA Method 8011), and TPH gasoline range organics (GRO)/diesel range organics (DRO)/motor oil range organics (MRO) (EPA Method 8015D). These data were used to assist with assessing the nature and extent of the LNAPL, EDB, and hydrocarbons in the subsurface.

- LNAPL transmissivity and mobility, grain size, fluid properties, capillary pressure air/water drainage, free product mobility, relative permeability, and hydraulic conductivity. These data were used to assess the relative amount and mobility of LNAPL in the subsurface.

- LNAPL physical properties including gravity, hydrocarbon component analysis, flash point, and viscosity. These data were used to assess LNAPL mobility in the subsurface.
- Mineralogy using x-ray diffraction (XRD) and energy dispersive x-ray spectrometry. These data were used to assess the potential for abiotic degradation.
- Microbial analysis using QuantArray-Chlor to identify and quantify halorespiring bacteria. These data were used to assess the potential for aerobic or anaerobic degradation of EDB and hydrocarbons.
- Moisture analyses (ASTM International [ASTM] D2216 [ASTM, 2005]). These data were collected to assess the potential for biodegradation in the vadose zone.
- Fractional organic carbon (FOC) (Walkley Black Method). These data were collected to assess the potential of bioavailability of organic contaminants.
- Thermal properties including specific heat, thermal resistivity, thermal conductivity, and thermal diffusivity.

The selected target sampling depths were 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 (Kirtland AFB, 2017a), or at historical or current water elevations. Target sample depths were 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. Deviations to soil collection procedures are noted in Section 4.3. Coring intervals and sample locations for each borehole discussed in this report are summarized in Table 3-1.

The bottom of the designated coring intervals (total depth of the borehole) extended approximately 10-20 ft below the lowest historical recorded water level (2009) to ensure that the deepest vertical LNAPL migration elevation was evaluated.

Seven boreholes (KAFB-106S1, KAFB-106S2, KAFB-106S8, KAFB-106S9, KAFB-106247, KAFB-106V1, and KAFB-106V2) were continuously cored from ground surface to total depth using sonic coring methodology exclusively. Four boreholes (KAFB-106S3, KAFB-106S4, KAFB-106S5, and KAFB-106S7) were advanced to the top of the approved coring interval with air rotary casing hammer (ARCH) and then sonic cored from the historical 1960 groundwater elevation, approximately 4,950 ft amsl, to the total depth of the borehole in order to delineate the LNAPL smear zone further away from the release area.

Two drilling methods were used to advance and sample the boreholes. Sonic coring was performed to obtain greater lithologic logging resolution than what could be obtained from logging soil cuttings from the ARCH drilling. The sonic coring also allowed the ability to collect discrete samples for submission to the analytical laboratory. All of the boreholes were reamed with ARCH to facilitate the installation of SVM and GWM wells.

Boreholes that reached total depth in the vadose zone (KAFB-106V1 and KAFB-106V2) were completed as nested SVM wells. Each SVM well is comprised of six nested vapor probes with 2 ft of screen each targeting different depths of the vadose zone (well construction diagrams are provided in Appendix D). Each vapor probe is isolated from the others using a hydrated bentonite chip seal. For GWM wells, following drilling and sampling, the boreholes that were drilled to depths below the groundwater table were constructed as two-well nested monitoring wells. The GWM wells were installed to assist with data gaps in the GWM network caused by the rising groundwater elevation.

One borehole (KAFB-106247) was drilled and sampled to provide background data. The location for this borehole was selected so that it would be far enough away from the source area that it would not be affected by the release (Figure 3-1). This borehole was converted to a monitoring well to assess future groundwater conditions.

4. FIELD INVESTIGATION

The methodology and rationale for soil sample selection from specific depth intervals and/or field screening results for hydrocarbons are discussed in Section 3 and are outlined in the Work Plan (Kirtland AFB, 2017a). Soil samples were submitted to the laboratory as described above in Section 3. The field geologist completed daily quality control reports documenting the tasks conducted during each day including any deviations from the Work Plan, which are discussed in Section 4.3. Data quality control reports are provided in Appendix B.

4.1 Assessment of Diffused and Dispersed Light Non-Aqueous Phase Liquids

4.1.1 Vadose Zone Coring

A total of nine continuous core locations (including one background location) were planned to characterize hydrocarbon concentrations within the vadose and saturated zones. Three additional optional coring locations were to be drilled if field screening observations made during the coring of the initial soil borings indicated a need for additional data at these locations. Optional coring locations were designated as KAFB-106S6, KAFB-106S7, and KAFB-106S8 (Figure 3-1).

KAFB-106S7 was drilled farther to the northeast from KAFB-106S4 and north, northwest from KAFB-106S3 based on screening data obtained during the coring of KAFB-106S3 and KAFB-106S4 (Table 4-1). The KAFB-106S8 location was drilled farther to the east based on screening data obtained from KAFB-106S1. KAFB-106S6, originally the farthest downgradient location, was not drilled since field screening via UV fluorescence screening for LNAPL did not indicate the presence of LNAPL in the soil samples collected from KAFB-106S5, indicating that the northern extent of LNAPL had been defined (NMED, 2019b).

The boreholes for KAFB-106S1, KAFB-106S2, KAFB-106S8, KAFB-106S9, KAFB-106247, KAFB-106V1, and KAFB-106V2 were cored continuously from ground surface to total depth. The coring methodology was selected to collect intact samples to screen for LNAPL using UV fluorescence and for volatile organics using a PID.

These boreholes were then over-reamed via ARCH methodology to a nominal 10-inch diameter to accommodate nested well installation. The boreholes for wells KAFB-106S3, KAFB-106S4, KAFB-106S5, and KAFB-106S7 were drilled using a combination of ARCH drilling to advance the borehole to the designated coring depth, followed by sonic drilling to obtain cores from the designated coring intervals. These wells were drilled using ARCH technique to depths of 400, 340, 400, and 401 ft bgs, respectively. Following core collection, the boreholes were reamed with ARCH drilling to total depth to facilitate nested monitoring well installation.

During coring, temperature controls were implemented to maintain the data quality for LNAPL and VOCs analytical results. Core barrels were cooled with dry ice immediately prior to deployment downhole. Cores collected from sonic drilling were extruded into plastic core sleeves at 1- to 2-ft increments over the selected coring interval. Coring intervals varied during drilling primarily to minimize core temperatures to prevent loss of volatile organic constituents. However, other downhole conditions required varying the coring intervals (typically due to caving).

Immediately following submittal of the core from the driller to the geologist for logging, a thermometer was placed within the core. The temperature of each core was measured with a National Institutes of

Standards and Technology Traceable® digital thermometer. Temperature data were recorded on the core sleeves and field forms. Core temperature data are presented in Tables 4-1 and 5-1 and Appendix C. Following temperature collection, core sleeves were labeled with the well number, depth interval, collection date, and the top of the core depth.

4.1.2 Soil Sample Handling

Soil cores were stored within a refrigerated truck after the coring and logging process was completed. The temperature in the refrigerated truck was maintained at approximately 4 degrees Celsius (°C). Core temperature measurements were never collected in the refrigerated truck. Samples were unopened and allowed to cool prior to soil sample collection. Lithologic logging and sample photography occurred after sample collection to minimize volatile constituent losses. Based on this process, it is unlikely that significant volatile constituent losses occurred. To maintain sample custody, the refrigerated truck was kept locked when no one was present. Cores that were selected for LNAPL properties analyses were placed in a freezer and shipped frozen via overnight delivery. All cores from the entire borehole were kept in refrigerated storage until soil sample intervals were selected for analyses. Once intervals were selected based on Work Plan selection criteria, the core was retrieved from a shelving system installed within the refrigerated truck and the soil sample was collected.

A box truck was also used to provide a mobile workspace. The box truck allowed for a darkened workspace to perform UV screening as well as a place for core photography and lithologic logging.

4.1.3 Field Screening for Light Non-Aqueous Phase Liquid and Hydrocarbons

Due to the ability of LNAPL to fluoresce in the presence of UV light, a UV flashlight was used to screen for its presence. Following collection, soil cores were placed within the darkened workspace of the box truck or refrigerated truck and screened for the presence of areas that may fluoresce. This was performed in accordance with Figure 3-7 Decision Logic schematic for Sample Collection of the approved work plan (Kirtland AFB, 2017a) which provides a flow chart for sample analyses. During screening, a UV light (Spectronics Optimax 365 UVA Inspection Flashlight) was shown on the core sample. Areas that were noted to fluoresce were marked on the core sleeve with either “UV” or “no UV.” Cores that were found to fluoresce are indicated on the lithologic logs included in Appendix D.

Soil samples were also field screened for the presence of VOCs with a PID by the heated headspace method. Field screening for VOCs was performed at a maximum of 20-ft intervals during ARCH drilling and 10-ft intervals during sonic coring. Heated headspace was performed with a calibrated PID using the method described in the Work Plan (Kirtland AFB, 2017a). Readings from the PID were recorded on the lithologic log at the appropriate depth. A summary of heated headspace measurements by coring location and depth is provided in Table 4-1 and documented on the lithologic logs in Appendix D.

4.1.4 Physical Properties of Light Non-Aqueous Phase Liquid from the Site

During drilling operations, it was observed (via UV fluorescence screening) that there was not enough LNAPL present within the soil samples to perform the physical properties analyses. Therefore, a sample of LNAPL was collected from KAFB-106079 (the well that had the most LNAPL in it at the time), and a groundwater sample was collected from well KAFB-106150 (a well that historically had LNAPL but did not at the time). These samples were submitted to PTS Laboratories, Inc. for transmissivity and mobility analyses. Results are summarized in Table 4-2 and the wells are shown on Figure 5-7.

4.1.5 Core and Project Photography

Individual cores were placed in a standard core box to allow for efficient cataloging, storage, and assist with core photography. Photographing of the core was performed using an onsite, high resolution digital camera (Nikon Coolpix B500). Each photograph was logged on a field form, noting the borehole number, depth, date, and time. Core photographs are presented in a Technical Memorandum for Vadose Zone Core Photography Logs provided in Appendix E. Photographs of work conducted during the coring program were also collected throughout the project. These photographs are provided in Appendix F.

4.1.6 Laboratory Analytical Samples

Selection of target sample depths followed the decision logic presented in the Work Plan (Kirtland AFB, 2017a), as discussed in Section 3, and was modified based on field observations and data collected. Sample collection, chain-of-custody, and shipping procedures were performed in accordance with the Quality Assurance Project Plan (Appendix A to the Work Plan). Laboratory analyses consisted of the following:

- VOCs (EPA Method 8260B), EDB (EPA Method 8011), and TPH-GRO/DRO/MRO (EPA Method 8015D) sent to TestAmerica**,** Inc., Arvada, Colorado (TestAmerica, Appendix G-1).

- LNAPL transmissivity and mobility (American Petroleum Institute [API] Recommended Practice [RP] 40, Dean-Stark), grain size (ASTM D422), fluid properties (API RP 40, EPA 9100), capillary pressure air/water drainage (API RP 40, EPA 9100), free product mobility (API RP 40, Dean-Stark), relative permeability (API RP 40, EPA 9100), and hydraulic conductivity (API RP 40, EPA 9100) sent to PTS Laboratories, Inc., Houston, Texas.

- Mineralogy using XRD and energy dispersive x-ray fluorescence (XRF) sent to Microbial Insights, Inc., Knoxville, Tennessee.

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

- Moisture analyses in conjunction with TestAmerica sample preparation and ASTM D2216 sent to Daniel B. Stephens and Associates Soil Testing Laboratory.

- FOC (Walkley Black Method). These samples were sent to Daniel B. Stephens and Associates Soil Testing Laboratory.

- Thermal properties by ASTM D5334 (ASTM, 2014) sent to Daniel B. Stephens and Associates Soil Testing Laboratory.

Soil cores that indicated the presence of UV fluorescence in the field were submitted to PTS Laboratories, Inc., Houston, Texas, for soil core photography to screen for the presence of LNAPL. Laboratory data packages are provided in Appendix G. A data quality evaluation report completed for TestAmerica chemical analyses of VOCs, TPH, and EDB data is provided in Appendix H.

4.1.7 Lithologic Logging

Two methods were utilized to drill the boreholes completed at the Site: ARCH and/or Sonic coring. The ARCH drilling method produced soil cuttings from a cyclone that were collected via a metal-screened basket deployed beneath the return area. These cuttings were collected from the cyclone at specific drilling depths and at observed changes in lithology and placed on a polyethylene liner with each drilled interval labeled for lithologic logging. Sonic coring typically produced 2-ft long, intact soil cores that were collected within a polyethylene bag. Each core bag was labeled and placed in a labeled cardboard core box. Photographic examples of each sample collection method are provided in Appendix E.

Soil or core samples collected from each drilling method were logged in accordance with the Unified Soil Classification System (USCS) by an experienced field geologist (ASTM D5434-12 [ASTM, 2012]). Information described in each lithologic log included the USCS classification; color as compared against the Munsell Soil Color Chart; sand, silt, or clay content; stiffness and plasticity of encountered clays; moisture content; percent gravel; minerology; and odor (if noted by the experienced field geologist). Additional information included in each lithologic log included field UV results, heated headspace results, core run length, and locations where the core was identified as disturbed. Lithologic borehole logs are presented in Appendix D.

4.2 Monitoring Well Installation

Monitoring well construction details were approved by NMED prior to the installation of each well nest (Appendix A). Monitoring well installation reports (and associated groundwater sampling data) were submitted under separate cover in the first quarter (Q1) and second quarter (Q2) 2019 Quarterly GWM Reports. The Q1 2019 GWM Report (Kirtland AFB, 2019b) included well installation reports for KAFB-106S2, KAFB-106S4, KAFB-106S5, KAFB-106S8, KAFB-106S9, KAFB-106V1, and KAFB-106V2. The Q2 2019 Quarterly GWM Report (Kirtland AFB, 2019c) included well installation reports for KAFB-106S1, KAFB-106S3, KAFB-106S7, and KAFB-106247. A Well Completion Report that includes all of the wells is provided in Appendix I. The two types of wells installed during the coring program are discussed in the following sections.

4.2.1 Groundwater Monitoring Wells

Following advancement of the borehole to total depth, proposed well completion diagrams were submitted to NMED and the boreholes were converted to dual-completion monitoring wells. Well construction approvals were received from NMED prior to construction for wells (in order of construction) KAFB-106S9 (NMED, 2018c), KAFB-106S5 (NMED, 2018d), KAFB-106S4 (NMED, 2018e), KAFB-106S2 (NMED, 2018f), KAFB-106S3 (NMED, 2018g), KAFB-106S1 (NMED, 2018h), KAFB-106S8 (NMED, 2019c), KAFB-106S7 (NMED, 2019d), and KAFB-106247 (NMED, 2019e). Dual-completion monitoring wells included one well with a screen interval that crossed the current water table and one well located above the water table. Both wells were collocated within the same borehole. The latter well was installed to function in the future with anticipated rising groundwater elevations (well construction diagrams are provided in Appendix D).

Both nested monitoring wells were constructed using 3.5-inch outside diameter Schedule 80 polyvinyl chloride casing. The water table wells were installed with a 40-ft screen length with approximately 15 ft of screen placed below the groundwater table. The wells completed above the water table (contingency wells) were completed with a 25-ft screen length. Each well is isolated from the other by a 5-ft long bentonite seal. Well screens with a 0.010-inch slot screen size were used and a 2-ft sump was installed at the base of each well. Well construction details for GWM wells are presented in Table 4-3 and Appendix D.

Following placement of the well casings, a 10/20 silica sand filter pack was placed in the borehole annulus from the bottom to approximately 2 ft above the deep well screen. A 5-ft thick bentonite chip seal was placed above the sand pack. Additional 10/20 silica sand was placed within the borehole annulus from the bottom of the vadose zone (or contingency) well to approximately 2 ft above the well screen. Approximately 30 ft of bentonite chips was placed within the borehole annulus above the upper silica sand filter pack. The bentonite chip seal was hydrated in lifts using a potable water source.

A high-solids bentonite grout was placed in the annulus that extended from the upper bentonite chip seal to approximately 30 ft bgs (any grout settling was filled with bentonite chips to a depth of 30 ft bgs). A neat cement surface seal was installed over the grout seal and extended vertically up the well annulus to approximately 1 ft bgs.

Wells KAFB-106S1, KAFB-106S5, KAFB-106S7, and KAFB-106S9 were completed as flush-mounted wells with an 18-inch diameter well vault surrounded by a 3-ft by 3-ft by 4-inch thick concrete pad at the ground surface. Well pads were sloped to direct rainwater away from the well. Wells KAFB-106S2, KAFB-106S3, KAFB-106S4, KAFB-106S8, and KAFB-106247 were completed as aboveground wells consisting of a 12-inch diameter steel surface casing placed to approximately 3 ft above ground surface to protect the inner well casings. Each aboveground well completion was placed within a 4-ft × 4-ft by 4-inch thick concrete pad with four protective steel bollards installed at the corners of the pad.

4.2.2 Groundwater Monitoring Well Gauging and Development

Upon completion of the wells, they were gauged and developed. After well construction was completed, the water table wells were developed in accordance with the Work Plan (Kirtland AFB, 2017a) and the completion dates are listed in the Well Completion Report in Appendix I. Well development was initiated no sooner than 48 hours from setting well seals.

Prior to development, water levels and total depths were gauged in the wells with an electronic water level indicator. Development was accomplished by surging and bailing to minimize fines in the filter pack. Wells were developed until a minimum of five casing volumes were removed. Development water was contained in 55-gallon steel drums with water-tight lids and transferred to the EA investigation-derived waste (IDW) yard located on Kirtland AFB for waste management. Monitoring well development records are provided in the Well Completion Report found in Appendix I. The analytical results for the first sampling event for each well is included in Table 4-4. Discussions of sampling procedures are discussed in the quarterly monitoring reports (Table 1 in Appendix A).

4.2.3 Soil Vapor Monitoring Wells

SVM wells KAFB-106V1 and KAFB-106V2 were cored via the sonic drilling method to depths prescribed in the Work Plan (275 ft bgs). As done for the GWM wells, the cored boreholes for these SVM wells were over-drilled using ARCH methodology to allow for well installation. An 11.75-inch outside diameter drive casing was installed following coring from ground surface to the total depth of each SVM well to facilitate construction.

Each SVM well is comprised of six 0.75-inch outside diameter nested vapor probes, each with 2 ft of screen targeting different depths of the vadose zone to a total depth of 275 ft bgs. Each vapor probe is isolated from the others using a bentonite chip seal. Well screens are 0.010-inch slot screen size. Well construction details for SVM wells are presented in Table 4-5 and Appendix D.

Following placement of each well string, a 10/20 silica sand filter pack was placed in the borehole annulus from the bottom to approximately 1 ft above the well screen as the drill casing was retrieved. A bentonite chip seal was placed above the sand pack. Approximately 96 ft of bentonite chips was placed within the borehole annulus above the upper silica sand filter pack. The bentonite chip seal was hydrated in lifts using a potable water source. A neat cement surface seal was installed over the grout seal and extended vertically up the well annulus to approximately 1 ft bgs.

The SVM wells were completed as flush-mount wells. The flush mount wells were completed with an 18-inch diameter well vault surrounded by a 4-ft by 4-ft by 4-inch thick concrete pad at the ground surface. The well pad was sloped to direct rainwater away from the well.

4.3 Deviations from Work Plan

Proposed sample depth intervals are described in the Work Plan and summarized in Section 3 (Kirtland AFB, 2017a). Deviations to any sample depth interval from the Work Plan were based on field-specific observations (i.e., UV fluorescence, PID measurements, etc.).

During the drilling process, there were occasions when the sample was unable to be retained within the core barrel. When this occurred, the driller would make another attempt at collecting the sample. When this occurred, the sample was reported on the core temperature log as disturbed and the driller made another attempt at sample collection. This occurred during the collection of the following samples:

- KAFB-106S2 at depths of 105, 278, and 404 ft bgs and KAFB-106S4 at a depth of 366 ft bgs. These samples were submitted because they indicated the highest heated headspace concentration of their sample interval. These samples were submitted for analysis of TPH, the results of which were non-detect. Sample disturbance for these samples is indicated on the appropriate tables and figures.

- At KAFB-106S9 the driller attempted to make a 10-ft long core run at a depth interval of 491 to 500 ft bgs (with 9 ft of recovery). During retrieval, the core fell out of the core barrel and was disturbed. Another attempt was made that successfully collected the core interval. A sample within this interval was collected at a depth of 496 ft bgs for analysis of TPH and VOCs. This sample was collected because it indicated the highest headspace concentration of the borehole. While the depth may be suspect due to the core disturbance, it is unlikely that the laboratory sample concentration was affected since the sample was collected based on the headspace concentration. In addition, the core temperature was 20.4°C (close to background temperatures) and unlikely to have been affected by overheating of the sample. Two cores were also collected from this core run at depths of 491-493 and 493-495 ft bgs. These samples were submitted to the laboratory for UV light analysis based on field screening (the possible presence of LNAPL based on in-field UV light screening). It is likely that these cores are disturbed. Sample disturbance for these samples is indicated on the appropriate tables and figures.

The driller periodically added small amounts of water to the borehole (1-7.5 gallons of water) to reduce sample temperatures and in one case, assist with getting the core barrel unstuck (KAFB-106V1 at 115 ft bgs). The addition of water was discussed in the Work Plan (Section 3.1.1.1 Drilling Approach and Methodology, Page 3-2, Kirtland AFB 2017a). The addition of water is not a deviation from the Work Plan and it is standard drilling operating procedure to reduce core temperatures. Whenever water was added to a borehole, it was noted on the temperature logs. The top of the core run where borehole slough was present (along with the added water) was discarded.

LNAPL was not present in sufficient quantities to be able to perform hydrocarbon component analysis.

Minerology was originally proposed to be performed by IMR Metallurgical Services of Louisville, Kentucky. However, once it was determined that Microbial Insights, Inc. of Knoxville, Tennessee could perform both microbial and mineralogy analyses, the decision was made to not send samples for mineralogy analysis to IMR Metallurgical Services of Louisville, Kentucky, as originally proposed. Using the same laboratory for both analyses simplified sample processing and shipping.

Soil coring was to be completed within set temperature parameters (≤20°C) regardless of whether a soil sample was planned for any given interval. As coring advanced to depth, temperature regulation became more complicated. Initial remedial efforts included cooling of the core barrel with wet and dry ice, and the reduction of coring run length from 6 to 4 ft long. Temperature regulation only occurred in cored intervals where VOCs analysis was to take place in selected wells (KAFB-106S1, KAFB-106S2, KAFB-106S3, KAFB-106S7, and KAFB-106S8). This variance was approved by NMED via email on November 5, 2018 (NMED, 2018i). Field temperature logs are provided in Appendix C.

Monitoring well KAFB-106247 was originally planned to be a background borehole located to the southeast of the source area where impacted soils were not expected to be encountered. However, conversion of this borehole to a monitoring well would also provide the opportunity to collect background groundwater samples. Based on this, it was later decided to convert the borehole into a monitoring well to assess future groundwater conditions (NMED, 2019e).

5. FIELD INVESTIGATION RESULTS

5.1 Subsurface Lithology

Lithologic information obtained from ARCH and Sonic drilling was used to create boring logs. The sonic coring data were used to provide higher lithologic resolution by continuously coring (sonic coring) as opposed to collecting soil samples every 10 ft from disturbed cuttings (ARCH drilling).

Lower permeability units (silt and clay) were found interbedded with lesser amounts of higher permeability units (sand) to a depth of approximately 160 ft bgs. Below 160 ft bgs, fine to coarse gravelly sand dominated to a depth of approximately 250 ft bgs. A lens of low permeability silt and clay was present between 250 and 300 ft bgs. This unit was classified in the field as very stiff to hard and contained up to 40% silt. Approximate 1-ft thick silt lenses were observed within the clay unit at KAFB-106V1. The thickness and continuity of this unit fluctuated at each borehole and ultimately pinched out completely to the north (i.e., absent at KAFB-106S5).

Below 300 ft bgs, fine to coarse gravelly sand dominated with minor interbedding (<10 ft) of lower permeability material to the total depth of drilling (515 ft bgs). A second lens of lower permeable silt and clay was present between 440 and 460 ft bgs. The thickness and continuity of this lens also fluctuated at each borehole and ultimately pinched out completely to the north (KAFB-106S5). Soils below 460 ft bgs primarily consisted of interbedded silty sand, well graded sand, and poorly graded sand. A clay layer was encountered in KAFB-106S1 from 490 to 495 ft bgs and in KAFB-106247 from 507 to 510 ft bgs. The groundwater table was observed at depths between 469 and 478 ft bgs. This is consistent with groundwater depths observed during the Q1 and Q2 GWM events (Kirtland AFB 2019b, 2019c).

5.1.1 Field Screening

Laboratory analysis of soil sample UV fluorescence was used as a tool to assess the possible presence or absence of LNAPL based on field screening that was discussed in Section 4.1.3. Appendix D provides lithologic logs for UV field screening results and Appendix G-2 provides photographs of laboratory UV fluorescence.

Heated headspace field screening values in the vadose zone are most significant at the source area (KAFB-106V1 and KAFB-106V2) from a depth of 10 ft bgs to a clay unit observed at a depth of approximately 265 ft bgs (Table 4-1). Below this depth, heated headspace concentrations decrease significantly. Analytical hydrocarbon concentrations were also observed to decrease through this clay layer at KAFB-106V2 (Section 5.2.1 below and Figures 5-1 through 5-3), correlating with the heated headspace data.

Heated headspace PID field screening was also performed on samples collected within the saturated zone. The heated headspace values observed below the water table were indicative of the relative presence of hydrocarbons and were used to guide sample collection. In general, elevated heated headspace values (greater than 100 milligrams per kilogram [mg/kg]) were observed predominately in the saturated zone (Table 4-1). In wells located closer to the source area (KAFB-106S1 and KAFB-106S9), elevated heated headspace concentrations were observed 35 and 15 ft above the water table, respectively. In boreholes located farther away from the source area, elevated heated headspace values were observed below the groundwater table.

Historical water levels (Rice et al., 2014) were added to Table 4-1 to correlate the water table depths to the heated headspace concentrations. In each of the borings for wells KAFB-106S1 through KAFB-106S5 and KAFB-106S7 through KAFB-106S9, the data indicates that the deepest historical water table (observed in 2009) correlates closely (within 13 ft or less) with the depths that the highest heated headspace concentration was recorded for each boring (Table 4-1). In these same monitoring wells, heated headspace concentrations increase with depth towards the historically deepest water level (observed in 2009) to concentrations greater than 1,000 ppmv, then decrease below this depth (Table 4-1).

5.2 Laboratory Analytical Results

This section reports and discusses pertinent analytical results for all laboratory analyses conducted on core samples taken during drilling activities.

5.2.1 Analytical Results for Organic Compounds

A total of 87 soil samples were submitted for laboratory analysis of organic compounds. Of these 87 samples, all were submitted for TPH-GRO/DRO/MRO analyses and 73 were submitted for VOCs and EDB analyses. The samples were collected based on field observations and at depths specified in the Work Plan. For the purposes of this report, only results for the primary contaminants of concern of BTEX, EDB, and TPH are discussed. Analytical data for organic compounds are presented on Figures 5-1 through 5-3 and provided in Table 5-1. A searchable flat file containing the VOCs, EDB, and TPH analytical results in Microsoft Excel format is included as Appendix J.

Vadose Zone Summary

The following summarizes the detected laboratory concentration ranges in the vadose zone by constituent (not including non-detected constituents):

- Detected concentrations of TPH in the vadose zone ranged from a low of 1.3 J mg/kg (KAFB-106S9 at 252 ft bgs) to a high of 32,000 mg/kg (KAFB-106V1 at 254 ft bgs) (Figure 5-3, Table 5-1).

- Detected benzene concentrations ranged from a low of 0.0061 mg/kg (KAFB-106S2 at 474 ft bgs) to a high of 110 mg/kg (KAFB-106V1 at 254 ft bgs) (Figure 5-1 and Table 5-1).

- Detected toluene concentrations ranged from a low of 0.00091 J mg/kg (KAFB-106S5 at 417 ft bgs) to a high of 3,100 mg/kg (KAFB-106V1 at 254 ft bgs) (Figure 5-1 and Table 5-1).

- Detected ethylbenzene concentrations ranged from a low of 0.045 J mg/kg (KAFB-106S8 at 475 ft bgs) to a high of 770 mg/kg (KAFB-106V1 at 254 ft bgs) (Figure 5-1 and Table 5-1).

- Detected xylenes concentrations ranged from a low of 0.0011 J mg/kg (KAFB-106S9 at 252 ft bgs) to a high of 3,690 mg/kg (KAFB-106V1 at 254 ft bgs) (Figure 5-1 and Table 5-1).

- Detected EDB concentrations ranged from a low of 0.0003 mg/kg (KAFB-106V1 at 161 ft bgs) to a high of 2.1 mg/kg (KAFB-106V1 at 254 ft bgs) (Figure 5-2, Table 5-1).

The highest hydrocarbon concentrations in the vadose zone were found in well KAFB-106V1 (Figures 5-1 through 5-3, Table 5-1). Both boreholes KAFB-106V1 and KAFB-106V2 are located within the source area and the observed concentrations are indicative of the release location. Elevated petroleum hydrocarbon concentrations were observed in a poorly graded sand at depths located above a clay layer located at 266 ft bgs (see KAFB-106V1 boring log located in Appendix D). The highest hydrocarbon concentrations were observed from the soil sample collected from borehole KAFB-106V1 at a depth of 254 ft bgs (Figures 5-1 through 5-3, Table 5-1). Petroleum hydrocarbon concentrations increase with depth in KAFB-106V1 until reaching a depth of approximately 266 ft bgs (Table 5-1). A clay layer is present at this depth (see KAFB-106V1 boring log located in Appendix D) whereby concentrations decrease significantly at depths of 271 and 285 ft bgs (Table 5-1).

The highest BTEX and EDB concentrations in KAFB-106V2 were observed at a depth of 103 ft bgs located within a poorly graded sand (see KAFB-106V2 boring log located in Appendix D). The highest TPH concentrations in KAFB-106V2 were observed at a depth of 80 ft bgs within a silt (see KAFB-106V2 Boring log located in Appendix D). Analytical results are presented in Figures 5-1 through 5-3, and Table 5-1. The TPH GRO concentrations generally decrease with depth from 21,000 to 5,900 mg/kg (Table 5-1) until reaching a clay unit at a depth of approximately 269 ft bgs (see KAFB-106V2 Boring log located in Appendix D). These concentrations decrease significantly at depths of 270 ft bgs (TPH GRO 8.2 mg/kg) and 287 ft bgs (TPH GRO 1.1 J mg/kg) in samples collected within and below the clay layer.

In wells located off-Base (KAFB-106S5 and KAFB-106S7), toluene was the only BTEX constituent detected in KAFB-106S5 (farthest from source area) at concentrations of 0.00091 mg/kg (417 ft bgs) and 0.00094 mg/kg (467 ft bgs). TPH was detected in this borehole at a concentration of 5.6 J mg/kg at a depth of 467 ft bgs.

Saturated Zone Summary

The following summarizes the detected laboratory concentration ranges in the saturated zone by constituent (not including non-detected constituents):

- Detected concentrations of TPH in the saturated zone ranged from a low of 1.8 mg/kg (KAFB-106S7 at 485 ft bgs) to a high of 3,600 mg/kg (KAFB-106S1 at 489 ft bgs).
- Detected benzene concentrations ranged from a low of 0.00054 J mg/kg (KAFB-106S3 at 512 ft bgs) to a high of 57 J mg/kg (KAFB-106S9 at 490 ft bgs).
- Detected toluene concentrations ranged from a low of 0.00081 J mg/kg (KAFB-106S3 at 512 ft bgs) to a high of 310 J mg/kg (KAFB-106S9 at 490 ft bgs).
- Detected ethylbenzene concentrations ranged from a low of 0.0024 J mg/kg (KAFB-106S4 at 504 ft bgs) to a high of 79 J mg/kg (KAFB-106S9 at 490 ft bgs).
- Detected xylenes concentrations ranged from a low of 0.0011 J mg/kg (KAFB-106S5 at 506 ft bgs) to a high of 271 J mg/kg (KAFB-106S9 at 490 ft bgs).
- Detected EDB concentrations ranged from a low of 0.00013 mg/kg (KAFB-106S5 at 506 ft bgs) to a high of 0.29 J mg/kg (KAFB-106S9 at 490 ft bgs).

The highest hydrocarbon concentrations in the saturated zone were found in wells KAFB-106S9 and KAFB-106S1 (Figures 5-1 through 5-3, Table 5-1) located to the east of the source area. The highest BTEX and EDB concentrations observed in the saturated zone were found in KAFB-106S9 at a depth of 490 ft bgs. The highest concentrations of TPH were observed in KAFB-106S9 at 490 ft bgs and KAFB-106S1 at a depth of 489 ft bgs.

Hydrocarbon concentrations decrease with distance from the source area as indicated in wells KAFB-106S5 and KAFB-106S7 (Figures 5-1 through 5-3, Table 5-1). The highest concentrations in these wells were observed in saturated soil samples collected at depths of 491 ft bgs (KAFB-106S5) and 495 ft bgs (KAFB-106S7).

Note that concentrations of TPH-DRO and TPH-GRO are more prevalent than TPH-MRO concentrations (Figure 5-3 and Table 5-1). This is likely due to the fuels being released consisting of aviation gasoline (which consist primarily of TPH-GRO) and jet fuels (which consist primarily of TPH-DRO).

There were no detections of BTEX, EDB, or TPH in the saturated soil samples analyzed from borehole KAFB-106247 (background well located historically downgradient from the source area).

5.2.2 Analytical Data Quality and Data Usability

Chemical analytical data for the source zone soil samples underwent EPA Stage 3 data validation on 100%) of the sample data by a third-party subcontractor, Environmental Data Services, Virginia Beach, Virginia. The following quality control criteria were included in the EPA Stage 3 validation per the Quality Assurance Project Plan, as applicable to the analytical method in order to evaluate precision, accuracy, representativeness, comparability, completeness and sensitivity for the data set.

- Sample preservation and extraction and analysis holding times
- Laboratory method blank contamination
- Surrogate spike and internal standard recoveries (organic analyses)
- Laboratory control sample and duplicate recoveries
- Matrix spike and matrix spike duplicate recoveries
- Initial and continuing calibrations
- Second column confirmation (for EDB only)
- Trip, rinse, and source water blank results
- Field duplicate sample precision.

Data quality exceedances that resulted in data qualification during validation include: (1) blank contamination for VOCs and TPH, (2) minimal hold time exceedances for VOCs and TPH, (3) matrix spike recovery exceedances for VOCs and TPH, (4) surrogate recovery exceedance for VOCs and TPH, (5) calibration criteria exceedance for VOCs, and (6) field duplicate relative percent difference exceedance for VOCs and TPH. Data were qualified as estimated detect (J), estimated non-detect (UJ), and non-detect (U). Estimated sample data are usable to achieve project objectives. The 95% technical completeness goal was achieved for all analytical methods for the source zone coring sampling event. Data are determined to be usable to achieve the project data quality objectives as qualified based on validation. Details regarding the analytical data validation and data usability are presented in the Appendix H – Data Quality Evaluation Report.

5.2.3 Light Non-Aqueous Phase Liquid Saturation, Mobility, and Effective Solubility

A total of 16 soil cores were analyzed for LNAPL, soil physical properties (grain size, density, porosity, and moisture content), soil type, LNAPL hydraulic conductivity, LNAPL retention curves under drainage, LNAPL saturation, and mobility.

The soil physical properties are necessary to understand the behavior of LNAPL in soil. In the vadose zone soil, pore space is occupied by pore water, air, and LNAPL. Grain size affects capillarity and retention of LNAPL and water phases, which is crucial to understanding if LNAPL is mobile or at residual saturation. The volume of LNAPL in a sample is determined by understanding total porosity, air-filled porosity, and water-filled porosity. LNAPL-filled porosity is then calculated by subtraction. In saturated soil, the air-filled porosity is zero, and the total pore space is occupied by water-filled porosity plus LNAPL filled porosity.

Soil grain distribution and mean grain size were analyzed on 16 soil samples (six vadose zone and 10 saturated zone), along with 16 interstitial analyses of soil samples (six vadose zone and 10 saturated zone). Sieve analyses are presented on Table 5-2. Interstitial properties are presented on Table 5-3. Soil grain density for all samples coincided with that of average soil (2.65 grams [g] per cubic centimeter) and averaged 2.61 g per cubic centimeter.

Soil cores were selected based on field screening of UV analysis in accordance with Figure 3-7 Decision Logic schematic for Sample Collection of the approved work plan (Kirtland AFB, 2017a) which provides a flow chart for sample analyses. A total of 30 core samples were analyzed in the laboratory for the presence of LNAPL via UV fluorescence. Photographs of UV analyses are shown in Appendix G-2 and are summarized below. If UV analysis identified a potential for LNAPL presence, further analyses were conducted on select samples to provide a quantitative analysis of the LNAPL. For example, the core from KAFB-106S9 (GUV-S9-171018-473) was collected from 473 to 475 ft bgs and showed fluorescence from 474.1 to 474.2 ft bgs. This portion of the core was selected for LNAPL hydraulic conductivity, LNAPL retention curves under drainage, LNAPL saturation, and mobility. The core collected from 484 to 486 ft bgs from KAFB-106S9 (GUV-S9-171018-484) showed fluorescence from 484.2 to 484.4 ft bgs and was also subsequently selected for LNAPL analysis.

LNAPL saturation in the selected samples was measured by API Method RP 40 (Recommended Practices for Core Analysis [API, 1998]). Method API RP 40 determines LNAPL saturation by the Dean-Stark distillation-extraction method and is a quantitative means of direct measurement of LNAPL-specific volume in a sample (Los Angeles LNAPL Working Group, 2011). The method is appropriate for plug samples. The method determines fluid saturation by distillation of the water fraction and solvent extraction of the oil fraction. The core sample is weighed, and the water fraction is vaporized by a boiling solvent. The boiled-off water is condensed and collected in a calibrated receiver to establish water weight. The vaporized solvent condenses, soaks the sample, and extracts the oil. Then, as with determining sample moisture content, the sample is oven dried, weighed, and the oil content determined by gravimetric difference. The result provides percent saturation of LNAPL as expressed as a percentage of the pore volume (Table 5-4). Higher saturations indicate more volume of LNAPL within the pore spaces.

For the vadose zone samples, LNAPL saturations ranged from 7.2 to 13.1% of pore volume (average of 10.0%) and 3.4 to 6.9% of total volume (average of 4.9%) (Table 5-4). The medium sand sample from KAFB-106V2 indicated LNAPL saturations of 10.7% relative to pore volume, 4.7% relative to total volume. The five fine sand samples averaged 9.9% pore volume and 4.8% total volume. The highest LNAPL pore volume saturation (13.1%) and LNAPL total volume saturation (6.9%) from the vadose zone samples were observed in KAFB-106V1 at a depth of 122 ft bgs (Table 5-4).

For the 10 samples collected from the saturated zone, LNAPL saturation ranged from 0.04 to 4.9% pore volume and from 0.02 to 2.01% total volume (Table 5-4, Figures 5-4 and 5-5). Average LNAPL saturation in gravel below the water table ranged from 1.9 to 3.5% pore volume and from 0.6 to 1.56% total volume. Average gravel LNAPL saturations were 2.6 and 0.9% relative to pore volume and total volume, respectively. For the medium sand sample from the saturated zone, LNAPL saturation was 4.9%

pore volume and 2.0% total volume, respectively. Average LNAPL saturation relative to pore volume and total volume for the three fine sand samples averaged 2.4 and 1.0%, respectively (Table 5-4).

The percentage of LNAPL saturation decreases away from the source area (KAFB-106V1 and KAFB-106V2). The highest LNAPL pore volume saturation, 4.9% and total volume LNAPL saturation, 2.01%, in the saturated zone was found in KAFB-106S9 at a depth of 484 ft bgs (Table 5-4). The lowest LNAPL saturations were found in wells KAFB-106S5 and KAFB-106S7, which are the farthest wells from the source area and located off-Base to the northeast (Table 5-4).

Mobility of LNAPL was evaluated for 14 samples using two residual saturation techniques: centrifuge and water drive. The centrifuge method is a modified ASTM D425 Standard Test Method for Centrifuge Moisture Equivalent of Soil. The method is modified to measure LNAPL drainage curves rather than water drainage curves. The residual saturation by water drive technique involves flushing the sample with multiple pore volumes of water, which will displace mobile LNAPL. By either method, the presence of fluids discharged from the sample demonstrates that the LNAPL is mobile. The results of both LNAPL mobility techniques demonstrated that LNAPL was not produced from any samples (Table 5-4). All residual LNAPL saturations were identical to initial LNAPL saturations, demonstrating the LNAPL was not mobile (Table 5-4). Since none of the samples demonstrated mobile LNAPL, neither the LNAPL retention curves nor the LNAPL hydraulic conductivity were used to calculate LNAPL mobility.

Effective solubility represents the concentration that may occur at equilibrium under ideal conditions. Locations where groundwater concentrations exceed the calculated effective solubility may indicate that LNAPL remains in the saturated zone in that area. LNAPL samples collected from KAFB-106006 (alias KAFB-1066) and KAFB-106076 (alias KAFB-10676) in 2011 were used to calculate the effective solubility of BTEX in both samples (Kirtland AFB, 2018a). Solubility values from NMED guidance (NMED, 2019g) were used to calculate the molar fractions for each constituent. The effective solubility of BTEX (average of ortho-, meta-, and para-xylenes) in KAFB-106006 was calculated to be:

- 6.44 milligrams per liter (mg/L) for benzene
- 17.25 mg/L for toluene
- 1.03 mg/L for ethylbenzene
- 1.37 mg/L for xylenes.

The effective solubility of BTEX in KAFB-106076 was calculated to be:

- 1.43 mg/L for benzene (Table 5-5)
- 6.89 mg/L for toluene
- 0.78 mg/L for ethylbenzene
- 0.94 mg/L for xylenes.

For the purpose of assessing the location of LNAPL in the saturated zone, the more conservative effective solubility concentration of 1.43 mg/L benzene is used as a line of evidence of potential LNAPL occurrence. It should be noted that this only represents two data points, and the effective solubility will vary depending on the original composition of the LNAPL and degree of degradation in the subsurface. The analysis of additional LNAPL samples may provide a better range of effective solubilities.

Molar fractions of total C4 through C12 carbon chains were also determined for these samples. In the LNAPL sample collected from KAFB-106006, the highest mole fraction percent was C8 (26.87%), while the highest mole fraction from the LNAPL sample collected from KAFB-106076 was from heavier (e.g., > C12) carbon chains (28.52%). Diesel and fuel oils typically range from C8 to C24, while kerosene and jet fuels range from C6 to C16. The carbon chain distribution found in these two samples indicated that the LNAPL collected was from a mixed aviation gasoline/jet fuel type source, as expected.

Because the LNAPL at the Site is a mixture of jet fuel and aviation gasoline, it was expected that BTEX solute would be present. In the source area at the BFF, this is exactly what was observed: detected benzene concentrations in the 4857 reference elevation interval (REI), the water table interval, during the Q2 2019 monitoring period exceeded the benzene standard of 5 µg/L ranging from 0.2 to 26,000 µg/L (Kirtland AFB, 2019c), Figure 5-6. A total of 50 wells were sampled for BTEX in Q2 2019; all 50 wells are located south of Ridgecrest Drive Southeast (SE). Benzene was detected in groundwater samples collected from 23 of the 50 GWM wells (Figure 5-6); 18 exceeded the 5.0 µg/L maximum contaminant level. Seventeen exceedances were in REI 4857 and one was in REI 4838. The highest benzene concentration was detected in KAFB-106149-484 (26,000 µg/L) in the source area.

Based on the three lines of evidence: direct measurement of LNAPL observed in current or historical monitoring wells, measurement of LNAPL by PTS Laboratory and the effective solubility concentration of 1.43 mg/L, the estimated extent of LNAPL was approximated. Using the effective solubility concentration of 1.43 mg/L, the location of submerged LNAPL was approximated by locating this concentration isocontour on the benzene concentration map. Figure 5-7 shows the approximate location of LNAPL as superimposed on the Q2 2019 benzene isocontour map (reference elevation interval 4857). Figure 5-7 indicates that the BTEX plume attenuates within a relatively short distance (less than 500 ft) from the diffused and dispersed LNAPL source and is fully attenuated before it reaches Ridgecrest Drive SE.

5.2.4 Mineralogy and Magnetic Susceptibility

Mineralogy analyses using XRD and XRF, and magnetic susceptibility were performed on a total of 30 samples collected from all 11 boreholes. XRD and XRF analyses were used to determine the presence of iron bearing minerals, particularly iron sulfide minerals. These minerals are capable of complete or nearly complete degradation of halogenated compounds. Magnetic susceptibility estimates the degree of magnetism of a material. Since there is no direct chemical test available for the quantification of magnetite, magnetic susceptibility provides an estimate of the quantity of magnetite in a sample.

Natural attenuation of halogenated organics by reductive dehalogenation occurs as a result of a reaction with naturally occurring ferrous iron-bearing minerals in contaminated aquifers (He et al., 2009). While EDB is a brominated organic, reductive dehalogenation occurs by the same mechanism as reductive dechlorination. Potentially reactive minerals that can decompose and supply ferrous iron for reductive dehalogenation include iron sulfides (e.g., pyrite, mackinowite), iron oxides (e.g., magnetite) and iron bearing clays and micas (e.g., biotite).

Representative core samples collected from the contaminated shallow aquifer zone boreholes at Kirtland AFB were submitted for XRD to determine if ferrous iron-bearing mineral species are present in the shallow aquifer that could attenuate EDB by reductive dehalogenation. The relevant results are summarized in Table 5-6 are summarized below:

- Pyrite = $Fe^{+2}S^{-2}$ where Fe^{+2} supplies electrons: $2Fe^{+2} = 2Fe^{+3} + 2e^{-}$ was not detected.
- Magnetite = $Fe^{+2}Fe_2^{+3}O_4^{-2}$ occurs in Kirtland AFB aquifer matrix, 1.5-7 weight percent (wt. %).
- Micas, illites, and clays occur in Kirtland AFB aquifer matrix, but the iron contents are not known.

Where:

- Fe = Iron.
- S = Sulfide
- O = Oxygen.
- e = Electrons.

The results show, in general, that the soil samples were dominated by quartz, feldspars, magnetite, and clays (Table 5-6). Ferrous sulfide minerals (Mackinawite, pyrite), which have the greatest ability to perform complete or nearly complete degradation of halogenated compounds, were not reported to be present. Magnetite was observed at 1.5-7 wt. % of soil samples by correlation of magnetic susceptibility. Magnetite can perform degradation of halogenated compounds; however, it reacts more slowly than pyrite. The rate of degradation for magnetite is approximately 20-40 times slower than ferrous sulfide minerals in laboratory experiments (Lee and Batchelor, 2019). Micas, illites, and clays were observed in samples. However, the amount of iron in their compositions is unknown and their potential effect on abiotic degradation is unclear. Based on this, abiotic attenuation of EDB is not anticipated to be significant.

5.2.5 Microbial Analysis

Both BTEX and EDB are amenable to biological degradation processes in the environment. BTEX compounds are biodegradable under oxic (El-Naas et al., 2014) and anoxic (Weelink, et al., 2010) conditions, where they serve as a carbon and energy source. EDB is also biodegradable under oxic (Pignatello, 1987) and anoxic (Yu et al., 2013) conditions. Under oxic conditions, EDB is degraded as a carbon and energy source whereas under anoxic conditions, EDB serves as a terminal electron acceptor during organohalide respiration (i.e., reductive dehalogenation).

Halorespiration is a process by which bacteria gain energy by transferring electrons to halogenated compounds (i.e., EDB), which then serve as a terminal electron acceptor during anaerobic respiration. Under oxic conditions, some enzymes associated with aerobic metabolism of aromatic compounds such as toluene have been shown to cometabolically degrade halogenated compounds. Unlike dehalorespiration, cometabolism of halogenated compounds does not provide bacteria with any energy or carbon. Instead, the enzymes associated with cometabolic processes are destroyed in the process (Vogel et al., 1987). Cometabolic processes have been shown to be useful for remediation of sites with low concentrations of EDB (Hatzinger et al., 2018).

Multiple lines of evidence suggest that fewer than 1% of microbial species in soil can be cultured in a laboratory setting (Amann et al., 1995) and molecular techniques, such as those included in the QuantArray analysis by Microbial Insights, may offer more useful information than traditional culture or direct count methods. Many of the bacteria and bacterial genes associated with these varied microbial processes have been well characterized and commercially available genetic analyses (i.e., QuantArray-Chlor®) are available to assess whether the bacterial community present at a given site is potentially capable of degrading a particular contaminant. QuantArray-Chlor® is a polymerase chain reaction (PCR) assay. This assay was used to identify bacteria and quantify a variety of functional bacterial genes associated with the biodegradation of BTEX and EDB, as well as genes specific to total Eubacteria and sulfate-reducing and methanogenic bacteria. The QuantArray Chlor® assay also quantifies genes associated with the aerobic degradation of some BTEX compounds, including toluene monooxygenase, two toluene monooxygenase, and toluene dioxygenase. In addition to providing a quantitative estimate of bacterial populations and gene copies of interest, Microbial Insights also provides a qualitative assessment of abundance relative to samples from other sites submitted to their laboratory for similar analyses. For example, if concentrations of toluene-degrading bacteria are reported as “low,” then compared to other samples analyzed by Microbial Insights, there are few toluene-degrading bacteria present and those relatively few bacteria are not likely to contribute significantly to toluene degradation at that location. Conversely, if the concentration of toluene monooxygenase genes is qualitatively “high” relative to other sites analyzed or to background concentrations, it is likely that significant toluene degradation may occur via that enzymatic reaction under the reported site conditions.

As there is no commercially available assay to test for the presence of genes that are specifically responsible for the degradation of EDB, an analysis of genes and bacterial species known to be responsible for reductive dechlorination is a potentially useful substitute. Significant numbers of sulfate-reducing and methanogenic bacteria indicate that organisms associated with anaerobic BTEX degradation and reductive dehalogenation of EDB are present at the site. Numbers of total Eubacteria provide an estimate of the overall health of the microbial community; low numbers may indicate that something may be inhibiting bacterial growth whereas high numbers indicate a healthy bacterial community. Note that Microbial Insights uses the qualitative terms “low”, “moderate”, and “high” or “significant” when describing numbers of gene copies and/or bacterial numbers. These qualitative terms are relative to results obtained from other samples submitted to Microbial Insights for analysis as described previously. Microbial Insights laboratory reports are presented in Appendix G-3 for more information.

In 2018, two soil samples each from six boreholes (KAFB-106S1, KAFB-106S2, KAFB-106S4, KAFB-106S5, KAFB-106V1, and KAFB-106V2) and three samples from two boreholes (KAFB-106S3 and KAFB-106S9) were collected from zones with observed LNAPL or where high concentrations of adsorbed hydrocarbons were measured. In 2019, 11 soil samples were collected from KAFB-106S7, KAFB-106S8, and in a background borehole (KAFB-106247). The samples collected from boreholes KAFB-106V1 and KAFB-106V2 and two samples collected from depths of 143 and 208 ft bgs in KAFB-106247 were collected in the vadose zone. The samples collected from boreholes KAFB-106S1 through KAFB-106S5, KAFB-106S7 through KAFB-106S9, and the samples collected from KAFB-106247 at depths of 474, 480, 489, and 499 ft bgs were collected in the saturated zone. All samples were submitted for QuantArray-Chlor® analysis. The laboratory results of the QuantArray-Chlor® analyses are presented in Appendix G-3 and discussed below.

None of the bacteria or functional genes associated with biodegradation of BTEX or EDB were detected in the January and February 2019 samples (sample identification BM-S8-180119-475, BM-S8-180119-499, BM-S7-220119-469, BM-S7-220119-485, and BM-S7-220119-495 or in the background borehole samples BM-247-300119-143, BM-247-310119-208, BM-247-040219-474, BM-247-050219-480, BM-247-050219-489, and BM-247-050219-499). In addition, Microbial Insights, Inc. indicated low numbers of total Eubacteria (2.08×10^3 to 1.54×10^6 cells/g) in these samples. Sulfate-reducing bacteria and methanogens were detected in three of the 29 samples submitted for analysis.

Based on these data, it does not appear that biodegradation of EDB or BTEX can occur at significant rates at these sample locations. However, the analytical laboratory indicated that the low results were likely due to an unidentified substance that appeared to inhibit the PCR. Inhibition of the PCR would cause the gene and bacterial population assays to report lower than what may be present. Based on this, it is not possible to determine whether these data are biased low due to an unknown compound present in the samples or if these organisms and functional genes are truly not widespread in significant numbers in the samples.

In October, November, and December 2018, Eubacterial genes associated with aerobic and anaerobic microbial populations were also quantified in all 18 samples. Total bacterial numbers, which include bacteria capable of BTEX and EDB degradation, ranged from 6.99×10^3 to 2.69×10^7 cells/g. These results are comparable to total bacterial numbers observed at other sites; however, total bacterial numbers were substantially lower in the sample collected from KAFB-106V2 at a depth of 215 ft bgs and in both samples from KAFB-106V1, with concentrations ranging between 2.31×10^4 and 9.96×10^4 cells/g. Microbial Insights, Inc. determined that these lower numbers were also likely due to inhibition of the PCR and may be biased low.

At borehole KAFB-106S9, several bacterial species capable of potential EDB reduction were detected, with concentrations ranging between 8.01×10^3(J) and 2.12×10^6 cells/g). The presence of these genes does not necessarily indicate that the bacteria are active; these bacteria are only active in anaerobic conditions, typically under sulfate-reducing and methanogenic conditions, and do not function in the presence of oxygen. At this same borehole KAFB-106S9, toluene monooxygenases were also detected, indicating that under aerobic conditions, bacteria capable of aerobic degradation of BTEX could be active.

Sulfate-reducing bacteria were only detected in two samples (BM-S1-051218-489 and BM-S9-171018-475) and methanogens were not detected above the laboratory practical quantitation limit in any samples. This may possibly indicate that oxygen concentrations in the areas where the samples were collected may be too high to support the growth of these obligate anaerobes, many of which cannot survive exposure to even low oxygen concentrations.

In general, concentrations of bacteria associated with potential EDB degradation in soil samples collected in 2018 were moderate (5.31×10^3(J) to 3.35×10^4 cells/g at KAFB-106S1 and 3.02×10^5 to 2.12×10^6 in KAFB-106S9) but were not detected above the practical quantitation limit (1.00×10^4 cells/g) in any other samples. Concentrations of various well-studied reductase enzymes (including ethylene dichloride reductase) were not detected in any samples, and enzymes associated with aerobic cometabolic degradation of EDB during aerobic metabolism of BTEX (phenol hydroxylase and two toluene monooxygenases) were detected in significant numbers in five samples (collected from KAFB-106S1, KAFB-106S2, KAFB-106S3, KAFB-106S4, and KAFB-106S9). It is difficult to determine if the low concentrations of these common aerobic BTEX degradation genes were the result of the inhibition of the PCR. However, their presence suggests that aerobic degradation of BTEX and potentially cometabolic biodegradation of EDB may be significant degradation processes in at least some locations in the source area.

Low numbers of the obligate anaerobes *Dehalobacter spp.* and *Desulfuromonas spp.* were identified in samples collected from KAFB-106S1 and KAFB-106S9; both species are capable of degrading halogenated ethenes and ethanes. The well-studied bacterium, *Dehalococcoides spp.*, which is capable of complete degradation of EDB, was not detected in any samples. As previously stated, the laboratory suggested that these samples contained a substance that inhibited the quantitative PCRs; therefore, it is not possible to determine whether these data are biased low due to some unknown compound present in the samples or if these organisms and functional genes are truly not widespread in significant numbers in the source area.

Genes associated with aerobic cometabolic degradation of EDB (e.g., toluene oxygenases) were detected in four samples collected at KAFB-106S1 (sample identification BM-S1-051218-480), KAFB106S2 (BM-S2-161118-474), KAFB-106S4 (BM-S4-041118-480), and KAFB-106S9 (BM-S9-171018-475). Concentrations from these samples ranged between 2.42×10^3(J) and 1.04×10^7 cells/g. If these enzymes are active, then aerobic metabolism is likely to occur.

Microbial analyses on cores show that microbial genes that are responsible for reductive dehalogenation were not observed in samples collected from the Site. Dehalococcoides, the only bacteria known to be capable of complete reductive dehalogenation to ethane, was not detected in any of the samples. Microbial genes responsible for aerobic co-metabolism of EDB were present in most samples analyzed.

These results indicate a low potential for anaerobic degradation of EDB, but moderate potential for aerobic degradation of BTEX. However, the analytical laboratory indicated that an unidentified substance was present that appeared to inhibit the PCR. Based on this, it is not possible to determine whether these data are biased low due to an unknown compound present in the samples or if these organisms and functional genes are truly not widespread in significant numbers in the samples.

5.2.6 Moisture Content

Vadose zone moisture content data were collected to review the state of moisture in the vadose zone to assist with the Bioventing Pilot Study and support the Corrective Measures Evaluation. The work plan for Bioventing Pilot study was submitted to NMED in November 2017 (Kirtland AFB, 2017b) and was approved with conditions on April 6, 2018 (NMED, 2018b). The Bioventing Respiration Pilot Testing Procedure was submitted to NMED on September 7, 2018 (Kirtland AFB, 2018b) and it was approved with conditions on February 25, 2019 (NMED, 2019f). The Bioventilation Construction and Initiation Report was submitted to NMED on January 21, 2020 (Kirtland AFB, 2020) and is currently being revised.

Moisture analyses were performed by ASTM D2216-90 (ASTM, 2005) by three different laboratories, PTS Laboratory, Daniel B. Stephens and Associates, and TestAmerica. The core samples submitted to PTS Laboratory were sealed in the plastic sleeves in which they were collected. The cores were frozen and then shipped in a cooler on ice for next day delivery to the laboratory. The samples submitted to Daniel B. Stephens and Associates were submitted in the plastic sleeves in which they were collected, and hand delivered to the laboratory. These procedures were performed to minimize potential moisture losses. The soil samples submitted to TestAmerica were containerized in glass jars and shipped overnight on ice to the laboratory. The moisture content is used by the laboratory to provide dry weights for the TPH, EDB, and VOCs analyses. It is likely that some moisture was lost in the repackaging of these samples, although it should be minimal.

Soil samples were collected using the sonic drilling method from various depths below ground surface under significant overburden pressures. As a result, the samples should be considered disturbed and may not be representative of the in-situ density of the sample. It is also likely that the moisture contents of saturated sand and gravel samples collected below the water table have been biased low due to gravity drainage of water from non-cohesive soils within the sample bags. Coarse-grained samples (sands and gravels) with high permeability collected below the water table may have experienced drainage where water drained to the bottom of the plastic sample sleeve and not collected during sample preparation. This would create a low bias toward the moisture content of samples collected below the water table. Water draining from permeable sand and gravel samples is more likely to occur in saturated samples collected below the water table than above the water table. Above the water table, the moisture is held in capillary tension and did not freely drain upon extrusion from the core barrel.

The results of the moisture analyses are shown in Tables 5-7 and 5-8 and in Appendix G-4. The results are summarized below:

- The moisture content ranged from 1.3 to 33.8 wt. % for the analyzed samples. The moisture content results and corresponding USCS classification and mean grain size, for the samples are summarized in Table 5-7.

- The moisture content ranged from 1.3 to 33.8 wt. % in the samples collected from the vadose zone. The highest and lowest moisture content results for each soil borehole are summarized in Table 5-8.

The highest moisture content results from soil samples collected from the vadose zone (28.8, 29.5, 31.1, and 33.8 wt. %) were recorded in samples collected in sandy clays, silts, or fine sands. The vadose zone samples containing the lowest moisture content (1.3, 1.9, and 2.4 wt. %) were recorded from samples collected in either poorly graded or well graded sand. In general, soil moisture averaged approximately 5% in well graded and poorly graded sand samples collected in the vadose zone (Table 5-7). There did not appear to be a significant difference in moisture contents between samples collected in the source area versus those collected off-Base (KAFB-106S5 and KAFB-106S7).

5.2.7 Fractional Organic Carbon

FOC analysis was performed for five select soil samples collected from KAFB-106247 were to assess the potential of bioavailability of organic contaminants. The analysis was performed using the Walkley Black Method. All five samples were found to be non-detect for FOC (Table 5-9 and Appendix G-4).

5.2.8 Thermal Properties

Thermal properties analyses including specific heat, thermal resistivity, thermal conductivity, and thermal diffusivity were performed on select samples by ASTM D5334-14 (ASTM, 2014). Summary results of these analyses can be found in Appendix G-4.

5.3 Light Non-Aqueous Phase Liquid and Fuel Hydrocarbon Spatial Distribution

As previously stated, BTEX, EDB, and TPH concentrations in the vadose zone from source area wells KAFB-106V1 and KAFB-106V2 are representative of the release location. The dominant control for the downward migration of the release was the continuous, extended release of fuel to the subsurface which provided gravity drainage and the hydraulic head necessary to drive migration. The dominant control for the contaminant migration pathway was the subsurface geology.

Fuel migrated vertically through mostly permeable non-cohesive soil by gravity drainage from the release point to the clay layer encountered around 260 to 270 ft bgs. Upon encountering the clay layer, the fuel saturated the soil above the clay, resulting in increased hydraulic head that eventually overcame the capillary pressure of pore water in the clay porosity. Once this pressure was overcome, LNAPL could migrate into and through the clay layer (ITRC-3, 2018) as evidenced in heated headspace readings from boring KAFB-106V1. Here, the lower clay extends from 266 to 281 ft bgs. Heated headspace readings in this borehole were 4,049 ppm at 260 ft bgs, just above the clay, representing former LNAPL saturation. In the clay layer the readings were 1,788 and 3,681 ppmv at 270 and 280 ft bgs, respectively. Finally, just below the clay layer, 1,439 ppmv was observed at 281 ft bgs (Table 4-1 and KAFB-106V1 lithological log, Appendix D). Not only did the hydraulic head that built up drive the LNAPL into and through the clay, it spread LNAPL laterally on the clay layer as a saturated fluid driven by Darcy's law and seepage. Laterally, LNAPL may have pooled with sufficient hydraulic head to penetrate the clay elsewhere.

Studies have shown that organic liquids can physically alter clay structure. Izdebska-Mucha, et. al. (2011) showed the influence of hydrocarbon contamination in clay soil resulted in more open porosity and larger voids. Mosavat and Nalbantoblu (2012) showed that pure toluene resulted in diminution in plasticity and considerable flocculation of clay particles causing granularity in the soil structure. Finally, Nasir (2011) showed contamination of clay with motor oil entailed substantial microstructural changes: looser packing of clay particles and grain surface detachment, reduction in Atterberg limits in the first 3 months, and substantial increase in coefficient of permeability.

Once the LNAPL entered the clay, structural changes to the clay facilitated greater permeability and ability to transmit the LNAPL through the clay to the underlying permeable soil. This mechanism is contrary to the concept that the clay formed an impermeable layer to the LNAP, LNAPL migrated vertically through the clay, and laterally through the clay by capillarity. A “hole” or other discontinuity in the clay layer is not required to explain the deeper migration of LNAPL to the water table.

At the water table, an LNAPL hydraulic head again formed as the LNAPL pooled. This hydraulic head caused the LNAPL to spread laterally at the water table, forming a substantial historical LNAPL plume extending to Bullhead Park. As the groundwater elevation decreased, LNAPL transport would have followed the LNAPL gradient created by the continued drainage, which favored the northerly groundwater gradient. The LNAPL migrated as far north as USS Bullhead Memorial Park, and this was observed in the LNAPL data collected. The lowest LNAPL saturations observed were near Bullhead Park in the distal portion of the historical LNAPL plume (in wells KAFB-106S7 and KAFB-106S5) (Figures 5-4 and 5-5), and the highest LNAPL saturations were observed closest to the source area in KAFB-106V1 and KAFB-106V2. This is also observed in the benzene concentrations which attenuate rapidly north of the off-Base portion of the benzene plume (Figure 5-6).

The highest LNAPL saturation percentage (pore volume and total volume) of the cores below the water table came from KAFB-106S9 at a depth of 484 ft bgs. This depth is very close to the former lowest groundwater elevation from 2009 (approximately 494 ft bgs, see Table 4-1). Diffused and dispersed LNAPL in the vadose zone was only observed in the immediate source area (KAFB-106V1 and KAFB-106V2).

At times when water table subsidence was slower, or ceased for a lengthy period of time, LNAPL would have remained, providing higher concentrations of diffused and dispersed hydrocarbons to exist interstitially. Laboratory results during coring operations indicate elevated concentrations of adsorbed hydrocarbons at elevations that most likely relate to the historical groundwater elevations. However, the remaining LNAPL is not a mappable continuous body of fluid. The remaining LNAPL is present as a discontinuous mass spread across the smear zone of the historical water tables and currently submerged. This diffuse distribution at LNAPL at depth is not completely accounted for even with the robust GWM network.

Mapping of every minute body of LNAPL is not required to define the nature and extent of contamination. LNAPL continues to provide a persistent source of benzene contamination to groundwater. In the vadose zone, LNAPL and soil contamination partition benzene into pore water, which in turn leaches to groundwater. At the current water table and LNAPL smear zone, benzene partitions directly from LNAPL to groundwater, sourcing the solute plume. As the water table rises, it places groundwater in direct communication with soil contamination and LNAPL in the lower vadose zone, again directly sourcing benzene to groundwater. Finally, submerged LNAPL in response to the rising water is a persistent source to benzene solute contamination by direct partitioning of benzene from LNAPL to groundwater. These LNAPL sources will continue to source solute plumes of all site contaminants of concern—EDB, toluene, ethylbenzene, and xylenes, until depleted by dissolution into pore water or groundwater, degradation by natural attenuation processes, or by active remediation.

6. INVESTIGATION-DERIVED WASTE

This section includes a general summary of waste that was generated and managed during the vadose zone drilling program. A detailed description is included in the Well Completion Report that can be found in Appendix I. Waste generated during vadose zone drilling activities included non-hazardous liquids, hazardous waste, special waste solids, and non-hazardous solids. Information regarding investigation-derived waste accumulation, utilization of the Kirtland AFB groundwater treatment system, and other investigation-derived waste processes are described in more detail in the following reports generated for the BFF: Quarterly Monitoring Report, October-December 2018, and Annual Report for 2018 (Kirtland AFB, 2019a); Quarterly Monitoring Report, January-March 2019 (Kirtland AFB, 2019b); and Quarterly Monitoring Report, April-June 2019 (Kirtland AFB, 2019c).

6.1 Non-Hazardous Liquids

Non-hazardous liquid waste consisted of containment pad rainwater, water pumped from roll-off bins, well development water, water utilized during hydro-knife activities prior to the start of drilling, decontamination pad water, and pressure wash water. A total of 9,103 gallons of non-hazardous liquids was generated with 8,983 gallons treated at the groundwater treatment system and discharged to the Kirtland AFB Tijeras Arroyo golf course. A total of 120 gallons of non-hazardous liquids did not meet the groundwater treatment system criteria and was disposed of by Advanced Chemical Treatment, Albuquerque, New Mexico. Summaries of the liquid waste disposal to the groundwater treatment system are provided in Appendix K-1, Tables K-1-1 through K-1-3.

6.2 Hazardous Waste

Hazardous waste consisted of water/sand mixtures generated from well development activities. A total of 694 gallons of hazardous waste was generated and disposed of offsite at ACT Chemical Transport in Albuquerque, New Mexico. Summaries of the waste disposal are provided in Appendix K-2, Tables K-2-1 and K-2-2.

6.3 Special Waste Solids

Special waste consisted of petroleum-contaminated soil that was found to have a TPH concentration greater than 100 mg/kg. Special waste was generated from drilling activities and from mud collected from the decontamination pad. A total of 44.2 cubic yards of special waste was generated and disposed of in the Waste Management Rio Rancho Landfill in Rio Rancho, New Mexico. Disposal is summarized in Appendix K-3, Tables K-3-1 and K-3-2.

6.4 Non-Hazardous Solids

Non-hazardous solids consisted of soil, mud, and sand generated during drilling. A total of 246 cubic yards of non-hazardous dry solids was generated and disposed of at the Kirtland AFB Construction and Demolition Landfill. An additional 28 cubic yards of non-hazardous mud was generated and disposed of at Twin Enviro Services in Penrose, Colorado. Disposal is summarized in Appendix K-4, Tables K-4-1 through K-4-3.

7. SUMMARY AND CONCLUSIONS

The source zone characterization included coring at 11 locations to assess the horizontal and vertical extent of LNAPL at the Site. The characterization included the collection of over 3,600 linear ft of core, chemical analysis of 87 soil samples, UV fluorescence of 30 cores, physical property testing of 16 cores, microbial analyses of 26 samples, and mineralogy and magnetic susceptibility analyses of 30 samples. Soil core samples were collected to obtain contaminant concentration and soil and LNAPL properties data.

In addition to the LNAPL characterization, nested monitoring wells were constructed in each borehole with nine dual-completion GWM wells and two, six-nest SVM wells. The GWM wells were installed to address data gaps in the source zone created by the rising groundwater elevation and to facilitate future sampling as the water table continues to rise. The SVM wells were installed as observation wells for the bioventing pilot study that initiated in 2018.

Borehole locations were selected based on their proximity to the source area (KAFB-106V1 and KAFB-106V2), and their proximity to historical LNAPL (KAFB-106S1 through KAFB-106S5, and KAFB-106S7 through KAFB-106S9). One borehole (KAFB-106247) was located outside of the known release area to collect background data). Two of the boreholes, KAFB-106S5 and KAFB-106S7, were located off-Base, north of Kirtland AFB. Continuous cores were collected next to existing boreholes using sonic drilling to provide higher resolution lithologic data in the source area. The logs from the new cores were then compared to the logs from the existing boreholes.

In general, the lithologic logs created using data from the continuous sonic cores correlated well with previously prepared borehole logs. The vadose zone is dominated by silt and clay units to a depth of approximately 160 ft bgs. These low-permeability units are interbedded with higher-permeability sand units. Below 160 ft bgs, fine to coarse gravelly sand dominated to a depth of approximately 250 ft bgs. A lens of low permeability silt and clay was present between 250 and 300 ft bgs. Below 300 ft bgs, fine to coarse sand and gravel dominate to the total depth of the boreholes advanced during this investigation (approximately 515 ft bgs). These higher-permeability units are interbedded with lower-permeability units of silt and clay. These soil units are indicative of Ancestral Rio Grande deposits.

Soil samples were collected from drill cuttings and soil cores and then submitted to an analytical laboratory for TPH-GRO/DRO/MRO, VOCs, and EDB analysis. Field screening (heated headspace) was performed to guide collection of soil samples for laboratory analysis. The laboratory analytical data were used to assess the magnitude and location of contaminants in the subsurface. Evaluation of the data collected from TPH-GRO/DRO/MRO, VOCs, and EDB testing provided the following conclusions:

- The highest concentrations of BTEX (110 mg/kg, 3,100 mg/kg, 770 mg/kg, and 3,690 mg/kg, respectively), TPH (32,000 mg/kg), and EDB (2.1 mg/kg) observed in the vadose zone were present in samples collected from KAFB-106V1 (Figures 5-1 through 5-3, Table 5-1). Both borehole KAFB-106V1 and KAFB-106V2 are located within the source area and the observed concentrations are representative of the release location. The laboratory analytical data indicated petroleum hydrocarbon concentrations generally increased with depth in KAFB-106V1 and decreased with depth in KAFB-106V2 (see Figures 5-1 through 5-3 for depths of soil sample concentrations and the lithologic logs in appendix D for soil descriptions). However, concentrations decreased significantly beneath the clay unit that was encountered at a depth of approximately 265 ft bgs (see soil boring logs in Appendix D and Figures 5-1 through 5-3 for depths of soil sample concentrations).

- The highest concentrations in the saturated zone are in wells KAFB-106S9 and KAFB-106S1 (Figures 5-1 through 5-3, Table 5-1) located to the east of the source area (KAFB-106V1 and KAFB-106V2).

- Concentrations of BTEX, EDB, and TPH decrease significantly in wells located off-Base (KAFB-106S5 and KAFB-106S7). The highest concentrations in these wells are in soil samples collected at depths of 491 ft bgs (KAFB-106S5) and 495 ft bgs (KAFB-106S7).

Soil cores were also used to assess the location and percentage of saturation of LNAPL in the subsurface. Field screening for the presence of LNAPL was performed using UV light. Soil cores that indicated the presence of LNAPL were submitted for laboratory UV analysis to confirm or deny the presence of LNAPL. Soil cores that were confirmed to have LNAPL present were submitted for laboratory testing for saturation and mobility. The evaluation of the data collected from LNAPL testing provided the following conclusions:

- The LNAPL in the vadose zone core samples is immobile. This demonstrates that there is no drainage of LNAPL that could cause a continued LNAPL head in the source area that would be required to drive migration (Interstate Technology and Regulatory Council, 2018).

- The percentage of LNAPL saturation decreases away from the source area (KAFB-106V1 and KAFB-106V2). The highest LNAPL saturation from the vadose zone is in KAFB-106V1 at a depth of 122 ft bgs (Table 5-4). The highest LNAPL saturation in the saturated zone was observed in KAFB-106S9 at a depth of 484 ft bgs (Table 5-4). The lowest LNAPL saturations are in wells KAFB-106S5 and KAFB-106S7, which are located off-Base, farthest from the source area (Table 5-4). The LNAPL pore volume percentages and LNAPL total volume saturation percentages are presented in Figures 5-4 and 5-5, respectively.

UV fluorescence of core samples from KAFB-106S9 identified LNAPL in the saturated zone at a depth that coincides with the former lowest groundwater elevation from 2009 (approximately 494 ft bgs). In addition, the highest PID concentrations collected from each of the borings advanced to the water table also generally correlate with this elevation.

A diffused and dispersed LNAPL smear zone is present below the water table and downgradient from the source area extending northeast under USS Bullhead Memorial Park. Laboratory analysis demonstrates that the LNAPL in this zone is immobile.

Diffused and dispersed LNAPL appears to coincide with the effective solubility of 1.43 mg/L benzene. Outside of this isocontour, dissolved-phase BTEX constituents are present. However, dissolved-phase BTEX attenuates to below the project screening levels less than 500 ft from the diffused and dispersed LNAPL (Figure 5-7).

Soil samples were also collected for microbiological and mineralogic analyses to provide data to support the future evaluation of abiotic and microbiological remedial techniques in the Corrective Measures Evaluation. The evaluation of the data collected from these analyses provided the following conclusions:

- No microbial genes responsible for reductive dehalogenation were found in samples collected.

- No Dehalococcoides, the only bacteria known to be capable of complete reductive dehalogenation to ethane *including dehalogenation of EDB to ethane*, were found in any of the samples.

- Microbial genes responsible for aerobic co-metabolism of chlorinated ethenes were present in most samples analyzed. These results indicate a low potential for anaerobic degradation of EDB, but moderate potential for aerobic degradation of BTEX.

- The analytical laboratory indicated that an unidentified substance was present that appeared to inhibit the PCR. Based on this, it is not possible to determine whether these data are biased low due to an unknown compound present in the samples or if these organisms and functional genes are truly not widespread in significant numbers in the samples.

- Abiotic attenuation of EDB with respect to iron-bearing minerals is not anticipated to be significant because no pyrite or other iron sulfide minerals were present in the aquifer that can catalyze reductive dehalogenation of EDB. Magnetite was observed at 1.5-7 wt. % of soil samples by correlation of magnetic susceptibility. Magnetite can perform degradation of halogenated compounds; however, it reacts more slowly than pyrite. The rate of degradation for magnetite is approximately 20-40 times slower than ferrous sulfide. Some other iron-bearing silicate minerals may be able to catalyze abiotic EDB attenuation, but these minerals could not be characterized in the samples by the methods used in this study.

The data indicates that the fuel migrated vertically through mostly permeable non-cohesive soil in the source zone by gravity drainage from the release point to the clay layer encountered around 260 to 270 ft bgs. Upon encountering the clay layer, the fuel saturated the soil above the clay, resulting in increased hydraulic head that eventually overcame the capillary pressure of pore water in the clay porosity. Once this pressure was overcome, LNAPL migrated into and through the clay layer (ITRC-3, 2018) as evidenced in heated headspace readings from boring KAFB-106V1. Not only did the hydraulic head that built up drive the LNAPL into and through the clay, it spread LNAPL laterally on the clay layer as a saturated fluid. Laterally, LNAPL may have pooled with sufficient hydraulic head to penetrate the clay elsewhere.

Once the LNAPL entered the clay, structural changes to the clay facilitated greater permeability and ability to transmit the LNAPL through the clay to the underlying permeable soil. This mechanism is contrary to the concept that the clay formed an impermeable layer to the LNAPL, but that it migrated vertically through the clay, and laterally through the clay by capillarity. A physical absence of the clay layer to facilitate LNAPL migration past the clay layer is not required to explain the deeper migration of LNAPL to the water table.

The data collected during this coring investigation have provided detailed lithologic information in the source area. This information, when incorporated with existing data collected from other investigations from 1999 to present, will be presented in the RCRA Facility Investigation Phase II. The monitoring wells installed as part of this investigation will continue to be monitored quarterly and incorporated into the GWM program.

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FIGURES

TABLES

APPENDICES

(Appendices Provided in Electronic Format via Compact Disc)

APPENDICES

(Provided Electronically via Compact Disc)

Appendix A Regulatory Correspondence

Appendix B Daily Quality Control Reports

Appendix C Core Temperature Logs

Appendix D Lithologic Logs and Well Completion Diagrams

Appendix E Technical Memorandum for Vadose Zone Core Photography Logs

Appendix F Site Photographs

Appendix G Laboratory Data Packages – Soil Samples

G-1 TestAmerica Laboratories, Inc.
G-2 PTS Laboratories, Houston, Texas
G-3 Microbial Insights, Inc., Knoxville, Tennessee
G-4 Daniel B. Stephens and Associates Soil Testing Laboratory, Albuquerque, New Mexico

Appendix H Data Quality Evaluation Report, Source Zone Characterization Report

Appendix I Well Completion Report

Appendix J Searchable Flat File of Volatile Organic Compounds, Ethylene Dibromide, and Total Petroleum Hydrocarbon Analytical Data

Appendix K Waste Management Documentation

K-1 Non-Hazardous Drilling and Extraction Well Liquid Investigation-Derived Waste Disposal in Q4 2018
K-2 Hazardous Waste Disposal, Q1 2019
K-3 Special Waste Drilling Solid Investigation-Derived Waste Disposal, Q1 2019
K-4 Non-Hazardous Solid Investigation-Derived Waste Profiling and Disposal Documentation

APPENDIX A

REGULATORY CORRESPONDENCE

APPENDIX B

DAILY QUALITY CONTROL REPORTS

APPENDIX C

CORE TEMPERATURE LOGS

APPENDIX D

LITHOLOGIC LOGS AND WELL COMPLETION DIAGRAMS

APPENDIX E

TECHNICAL MEMORANDUM FOR VADOSE ZONE CORE PHOTOGRAPHY LOGS

APPENDIX F

SITE PHOTOGRAPHS

APPENDIX G

LABORATORY DATA PACKAGES – SOIL SAMPLES

APPENDIX G-1

TESTAMERICA

APPENDIX G-2

PTS LABORATORIES, HOUSTON, TEXAS

APPENDIX G-3

MICROBIAL INSIGHTS, INC., KNOXVILLE, TENNESSEE

APPENDIX G-4

DANIEL B. STEPHENS AND ASSOCIATES SOIL TESTING LABORATORY, ALBUQUERQUE, NEW MEXICO

APPENDIX H

DATA QUALITY EVALUATION REPORT, TEST AMERICA

APPENDIX I

WELL COMPLETION REPORT

APPENDIX J

SEARCHABLE FLAT FILE OF VOCS, EDB, AND TPH ANALYTICAL

APPENDIX K

WASTE MANAGEMENT DOCUMENTATION

APPENDIX K-1

NON-HAZARDOUS LIQUIDS INVESTIGATION-DERIVED WASTE PROFILING AND DISPOSAL DOCUMENTATION

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APPENDIX K-2

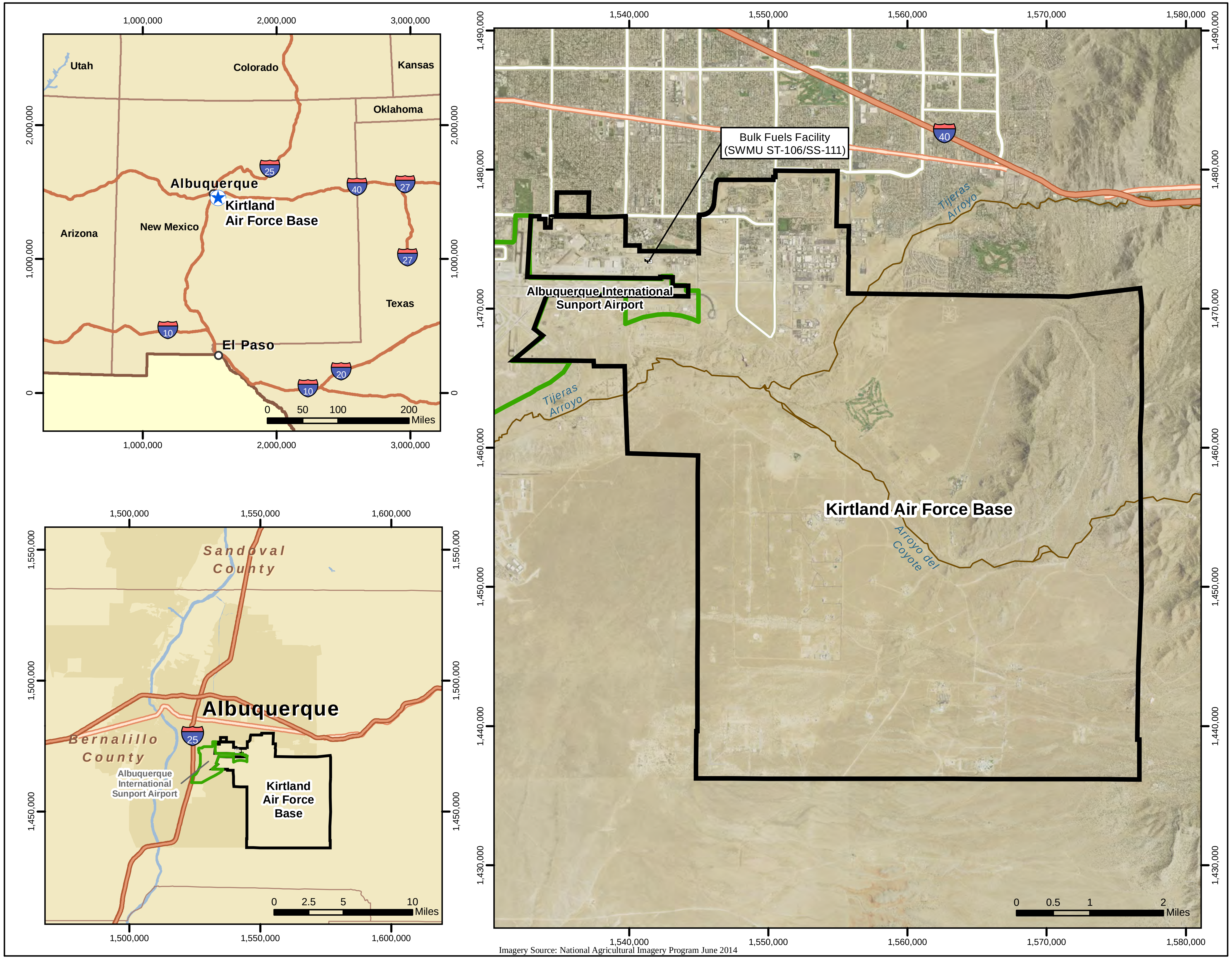
HAZARDOUS WASTE INVESTIGATION-DERIVED WASTE PROFILING AND DISPOSAL DOCUMENTATION APPENDIX K-3

APPENDIX K-3

SPECIAL WASTE SOLIDS INVESTIGATION-DERIVED WASTE PROFILING AND DISPOSAL DOCUMENTATION

APPENDIX K-4

NON-HAZARDOUS SOLIDS INVESTIGATION-DERIVED WASTE PROFILING AND DISPOSAL DOCUMENTATION



Imagery Source: National Agricultural Imagery Program June 2014

Legend

- ▭ Kirtland Air Force Base Installation Boundary
- ▭ Albuquerque International Sunport Airport
- — Major Highways
- — Highways
- — Major Roads
- — Arroyos
- — Rivers
- ⬚ Source Area

N

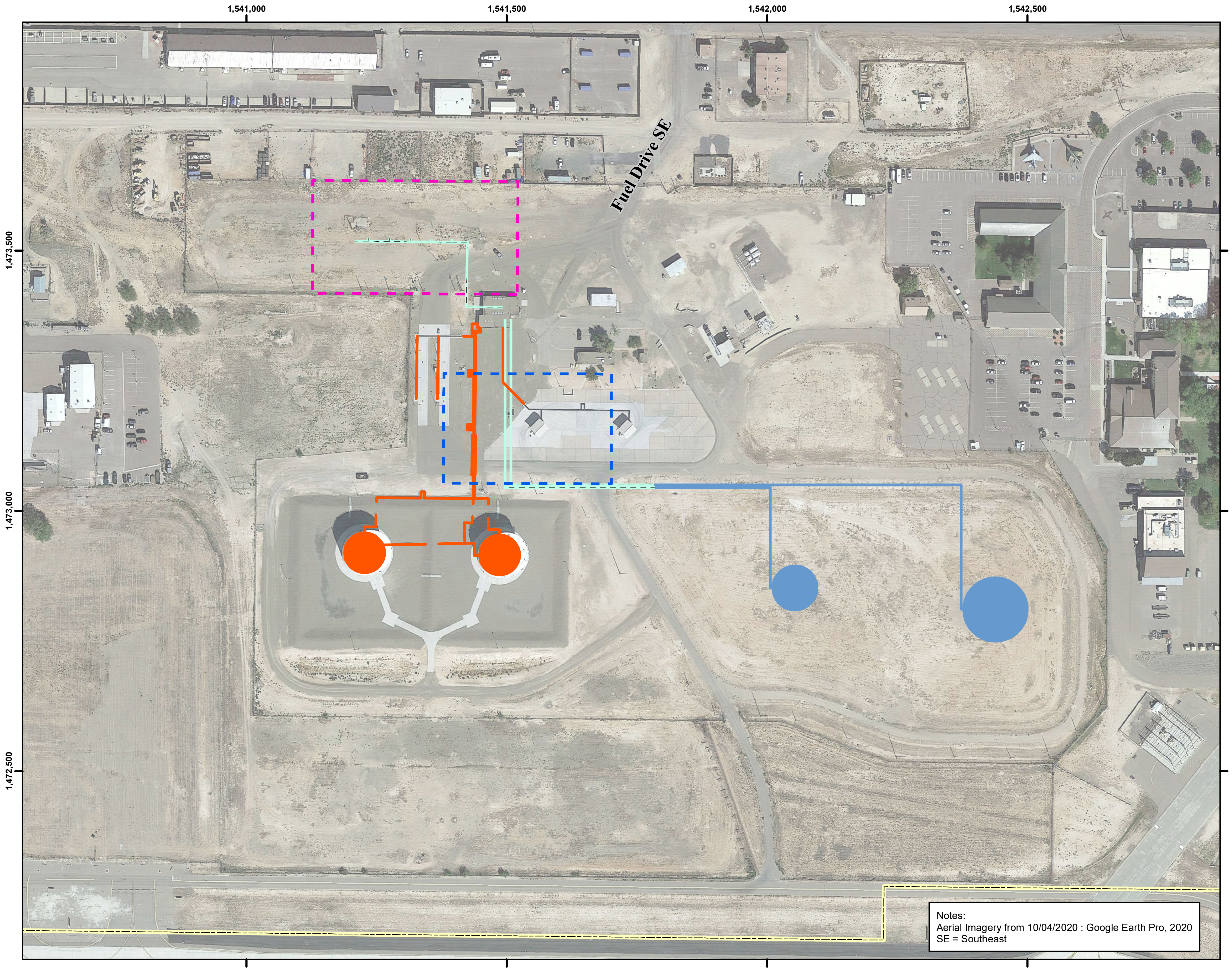
Projection: NAD83 State Plane New Mexico Central FIPS3002 Feet

SOURCE ZONE CHARACTERIZATION REPORT FOR
THE BULK FUELS FACILITY
REVISION 1
SOLID WASTE MANAGEMENT UNITS ST-106/SS-111
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 1-1

SITE LOCATION MAP

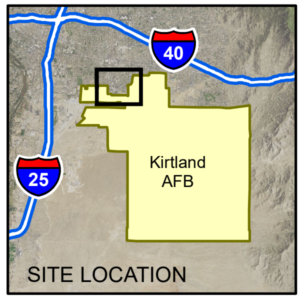
P:\Projects\Kirtland\Figures\VZ Coring Photo Report\1-1_VZ_SiteLocMap.mxd 10/1/2020 EA ecarpio



Notes:
Aerial Imagery from 10/04/2020 : Google Earth Pro, 2020
SE = Southeast

Legend

●	Former Aboveground Storage Tank
- - -	Former Buried Fuel Transfer Line
—	Former Aboveground Fuel Transfer Line
⬚	Former Fuel Offloading Rack
⬚	Former Temporary Fueling Pad
●	Current Above Ground Storage Tank
—	Current Aboveground Fuel Transfer Line
- - -	Installation Boundary



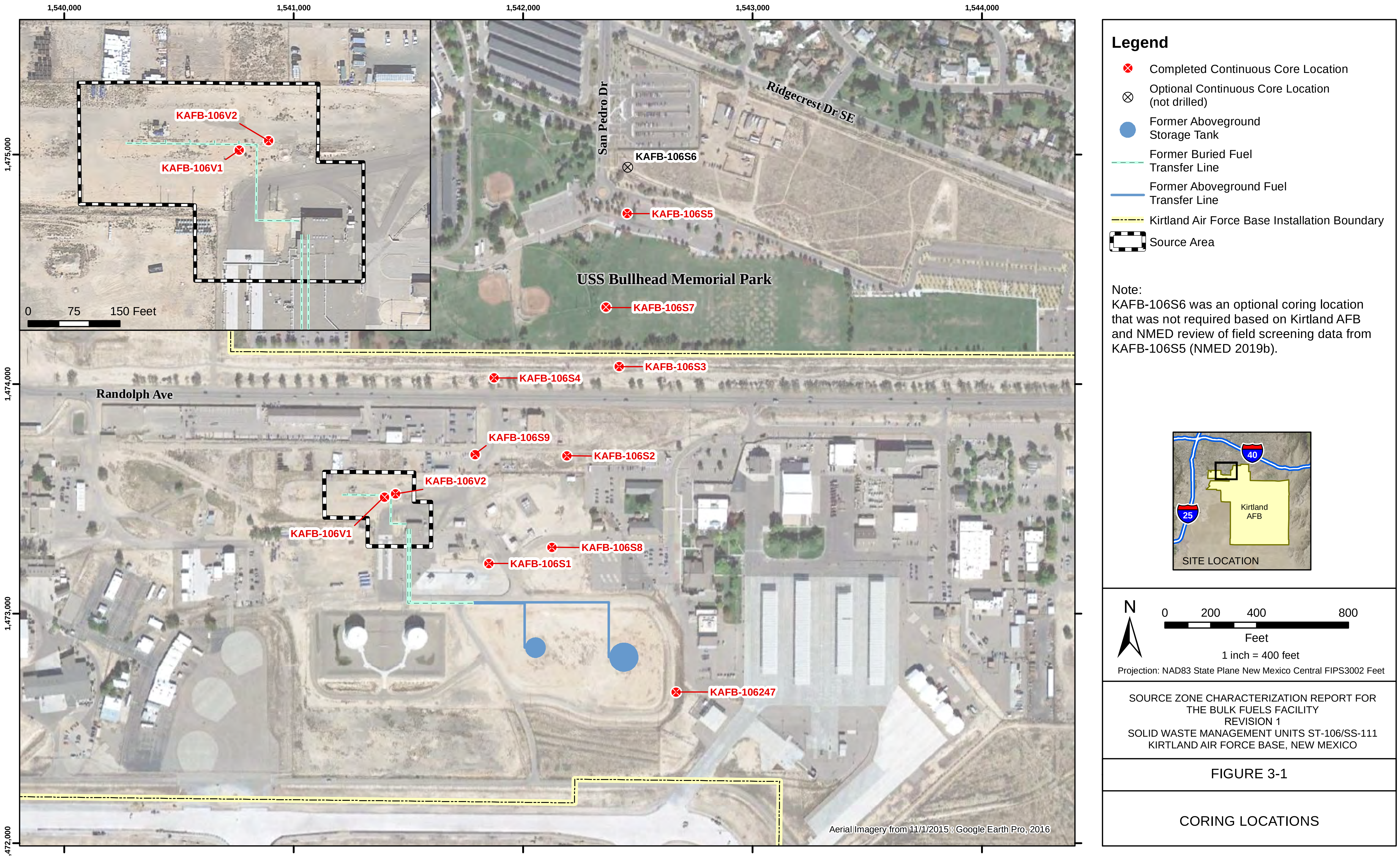
N
0 100 200 400
Feet
1 inch = 200 feet
Projection: NAD83 State Plane New Mexico Central FIPS3002 Feet

SOURCE ZONE CHARACTERIZATION REPORT
FOR THE BULK FUELS FACILITY
REVISION 1
SOLID WASTE MANAGEMENT UNITS ST-106/SS-111
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 2-1

CURRENT AND FORMER
SITE INFRASTRUCTURE

P:\Projects\Kirtland\Figures\VZ Coring Photo Report\2-1_VZ_Current and Former Site Infrastructure.mxd 2/22/2021 EA ecarpio



Legend

- ⊗ Completed Continuous Core Location
- ⊗ Optional Continuous Core Location (not drilled)
- ● Former Aboveground Storage Tank
- Former Buried Fuel Transfer Line
- Former Aboveground Fuel Transfer Line
- Kirtland Air Force Base Installation Boundary
- Source Area

Note:
KAFB-106S6 was an optional coring location that was not required based on Kirtland AFB and NMED review of field screening data from KAFB-106S5 (NMED 2019b).

1 inch = 400 feet

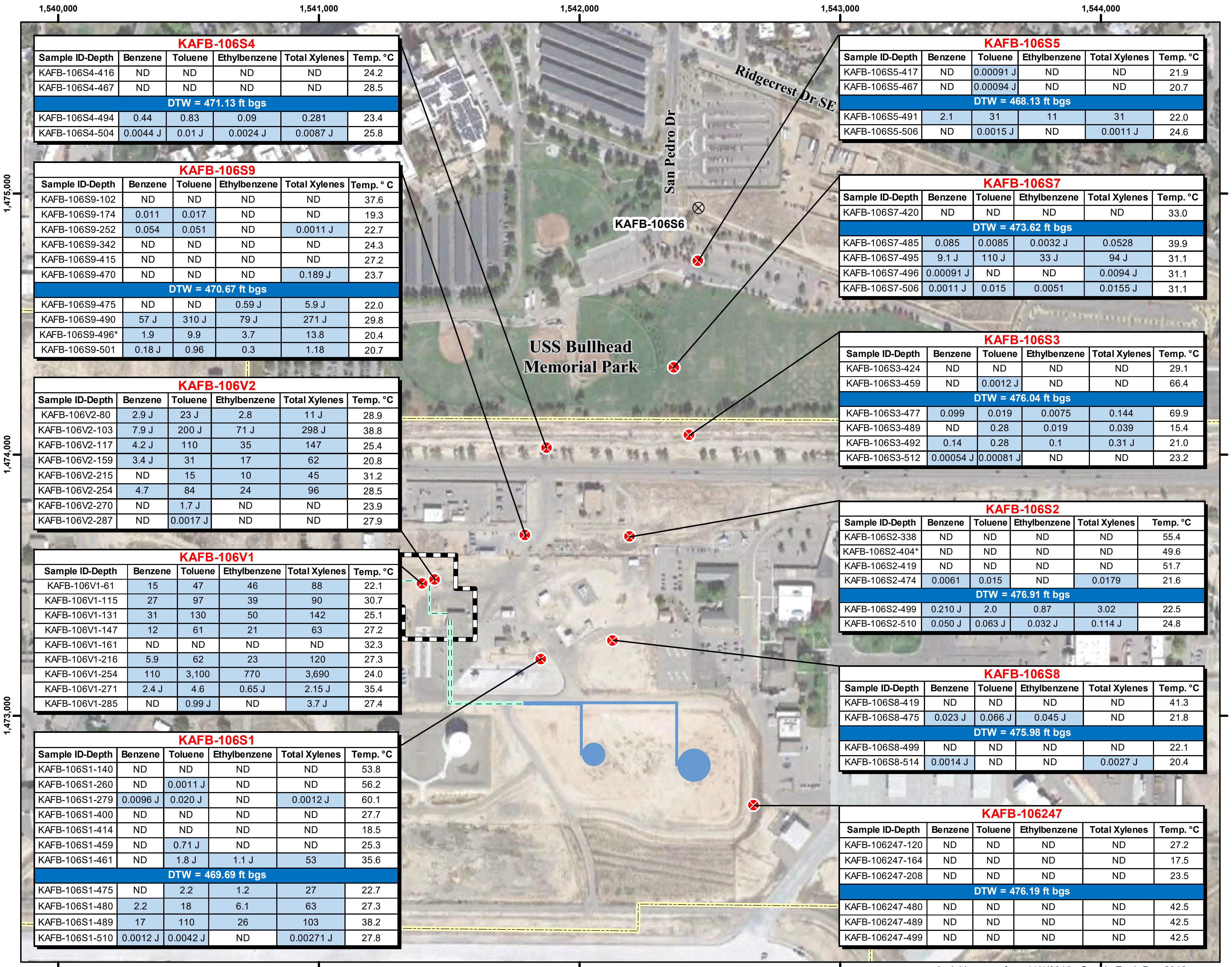
Projection: NAD83 State Plane New Mexico Central FIPS3002 Feet

SOURCE ZONE CHARACTERIZATION REPORT FOR
THE BULK FUELS FACILITY
REVISION 1
SOLID WASTE MANAGEMENT UNITS ST-106/SS-111
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 3-1

CORING LOCATIONS

P:\Projects\Kirtland\Figures\VZ Coring Photo Report\3-1_VZ_Completed_Coring_Locations.mxd 10/1/2020 EA ecarpio



KAFB-106S4

Sample ID-Depth	Benzene	Toluene	Ethylbenzene	Total Xylenes	Temp. °C
KAFB-106S4-416	ND	ND	ND	ND	24.2
KAFB-106S4-467	ND	ND	ND	ND	28.5
DTW = 471.13 ft bgs					
KAFB-106S4-494	0.44	0.83	0.09	0.281	23.4
KAFB-106S4-504	0.0044 J	0.01 J	0.0024 J	0.0087 J	25.8

KAFB-106S9

Sample ID-Depth	Benzene	Toluene	Ethylbenzene	Total Xylenes	Temp. ° C
KAFB-106S9-102	ND	ND	ND	ND	37.6
KAFB-106S9-174	0.011	0.017	ND	ND	19.3
KAFB-106S9-252	0.054	0.051	ND	0.0011 J	22.7
KAFB-106S9-342	ND	ND	ND	ND	24.3
KAFB-106S9-415	ND	ND	ND	ND	27.2
KAFB-106S9-470	ND	ND	ND	0.189 J	23.7
DTW = 470.67 ft bgs					
KAFB-106S9-475	ND	ND	0.59 J	5.9 J	22.0
KAFB-106S9-490	57 J	310 J	79 J	271 J	29.8
KAFB-106S9-496*	1.9	9.9	3.7	13.8	20.4
KAFB-106S9-501	0.18 J	0.96	0.3	1.18	20.7

KAFB-106V2

Sample ID-Depth	Benzene	Toluene	Ethylbenzene	Total Xylenes	Temp. °C
KAFB-106V2-80	2.9 J	23 J	2.8	11 J	28.9
KAFB-106V2-103	7.9 J	200 J	71 J	298 J	38.8
KAFB-106V2-117	4.2 J	110	35	147	25.4
KAFB-106V2-159	3.4 J	31	17	62	20.8
KAFB-106V2-215	ND	15	10	45	31.2
KAFB-106V2-254	4.7	84	24	96	28.5
KAFB-106V2-270	ND	1.7 J	ND	ND	23.9
KAFB-106V2-287	ND	0.0017 J	ND	ND	27.9

KAFB-106V1

Sample ID-Depth	Benzene	Toluene	Ethylbenzene	Total Xylenes	Temp. °C
KAFB-106V1-61	15	47	46	88	22.1
KAFB-106V1-115	27	97	39	90	30.7
KAFB-106V1-131	31	130	50	142	25.1
KAFB-106V1-147	12	61	21	63	27.2
KAFB-106V1-161	ND	ND	ND	ND	32.3
KAFB-106V1-216	5.9	62	23	120	27.3
KAFB-106V1-254	110	3,100	770	3,690	24.0
KAFB-106V1-271	2.4 J	4.6	0.65 J	2.15 J	35.4
KAFB-106V1-285	ND	0.99 J	ND	3.7 J	27.4

KAFB-106S1

Sample ID-Depth	Benzene	Toluene	Ethylbenzene	Total Xylenes	Temp. °C
KAFB-106S1-140	ND	ND	ND	ND	53.8
KAFB-106S1-260	ND	0.0011 J	ND	ND	56.2
KAFB-106S1-279	0.0096 J	0.020 J	ND	0.0012 J	60.1
KAFB-106S1-400	ND	ND	ND	ND	27.7
KAFB-106S1-414	ND	ND	ND	ND	18.5
KAFB-106S1-459	ND	0.71 J	ND	ND	25.3
KAFB-106S1-461	ND	1.8 J	1.1 J	53	35.6
DTW = 469.69 ft bgs					
KAFB-106S1-475	ND	2.2	1.2	27	22.7
KAFB-106S1-480	2.2	18	6.1	63	27.3
KAFB-106S1-489	17	110	26	103	38.2
KAFB-106S1-510	0.0012 J	0.0042 J	ND	0.00271 J	27.8

KAFB-106S5

Sample ID-Depth	Benzene	Toluene	Ethylbenzene	Total Xylenes	Temp. °C
KAFB-106S5-417	ND	0.00091 J	ND	ND	21.9
KAFB-106S5-467	ND	0.00094 J	ND	ND	20.7
DTW = 468.13 ft bgs					
KAFB-106S5-491	2.1	31	11	31	22.0
KAFB-106S5-506	ND	0.0015 J	ND	0.0011 J	24.6

KAFB-106S7

Sample ID-Depth	Benzene	Toluene	Ethylbenzene	Total Xylenes	Temp. °C
KAFB-106S7-420	ND	ND	ND	ND	33.0
DTW = 473.62 ft bgs					
KAFB-106S7-485	0.085	0.0085	0.0032 J	0.0528	39.9
KAFB-106S7-495	9.1 J	110 J	33 J	94 J	31.1
KAFB-106S7-496	0.00091 J	ND	ND	0.0094 J	31.1
KAFB-106S7-506	0.0011 J	0.015	0.0051	0.0155 J	31.1

KAFB-106S3

Sample ID-Depth	Benzene	Toluene	Ethylbenzene	Total Xylenes	Temp. °C
KAFB-106S3-424	ND	ND	ND	ND	29.1
KAFB-106S3-459	ND	0.0012 J	ND	ND	66.4
DTW = 476.04 ft bgs					
KAFB-106S3-477	0.099	0.019	0.0075	0.144	69.9
KAFB-106S3-489	ND	0.28	0.019	0.039	15.4
KAFB-106S3-492	0.14	0.28	0.1	0.31 J	21.0
KAFB-106S3-512	0.00054 J	0.00081 J	ND	ND	23.2

KAFB-106S2

Sample ID-Depth	Benzene	Toluene	Ethylbenzene	Total Xylenes	Temp. °C
KAFB-106S2-338	ND	ND	ND	ND	55.4
KAFB-106S2-404*	ND	ND	ND	ND	49.6
KAFB-106S2-419	ND	ND	ND	ND	51.7
KAFB-106S2-474	0.0061	0.015	ND	0.0179	21.6
DTW = 476.91 ft bgs					
KAFB-106S2-499	0.210 J	2.0	0.87	3.02	22.5
KAFB-106S2-510	0.050 J	0.063 J	0.032 J	0.114 J	24.8

KAFB-106S8

Sample ID-Depth	Benzene	Toluene	Ethylbenzene	Total Xylenes	Temp. °C
KAFB-106S8-419	ND	ND	ND	ND	41.3
KAFB-106S8-475	0.023 J	0.066 J	0.045 J	ND	21.8
DTW = 475.98 ft bgs					
KAFB-106S8-499	ND	ND	ND	ND	22.1
KAFB-106S8-514	0.0014 J	ND	ND	0.0027 J	20.4

KAFB-106247

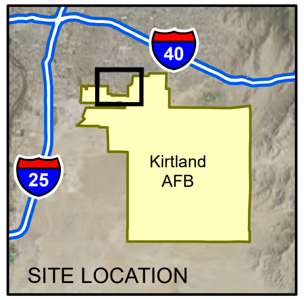
Sample ID-Depth	Benzene	Toluene	Ethylbenzene	Total Xylenes	Temp. °C
KAFB-106247-120	ND	ND	ND	ND	27.2
KAFB-106247-164	ND	ND	ND	ND	17.5
KAFB-106247-208	ND	ND	ND	ND	23.5
DTW = 476.19 ft bgs					
KAFB-106247-480	ND	ND	ND	ND	42.5
KAFB-106247-489	ND	ND	ND	ND	42.5
KAFB-106247-499	ND	ND	ND	ND	42.5

Aerial Imagery from 11/1/2015 : Google Earth Pro, 2016

Legend

⊗	Completed Continuous Core Location
⊗	Optional Continuous Core Location (not drilled)
●	Former Aboveground Storage Tank
– – –	Former Buried Fuel Transfer Line
—	Former Aboveground Fuel Transfer Line
–·–·–	Kirtland Air Force Base Installation Boundary
▭	Source Area

Notes:
KAFB-106S6 was an optional coring location that was not required based on Kirtland AFB and NMED review of field screening data from KAFB-106S5 (NMED 2019b).
Shaded values indicate laboratory detections of analytes.
All data was presented in μg/kg in laboratory reports; data converted to mg/kg for presentation.
All sample depths are in ft bgs.
* sample disturbed during collection
ft = foot/feet
bgs = below ground surface
DTW = Depth to water (measured July 2019)
J = Qualifier denotes the analyte was positively identified, but the associated numerical value is estimated.
mg/kg - milligrams per kilogram
ND - not detected
μg/kg = microgram per kilogram
Xylenes = Combined m, p, and o
°C = degrees celsius



1 inch = 400 feet

Projection: NAD83 State Plane New Mexico Central FIPS3002 Feet

SOURCE ZONE CHARACTERIZATION REPORT
FOR THE BULK FUELS FACILITY
REVISION 1
SOLID WASTE MANAGEMENT UNITS ST-106/SS-111
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 5-1

BENZENE, TOLUENE, ETHYLBENZENE, AND TOTAL XYLENES CONCENTRATIONS IN SOIL

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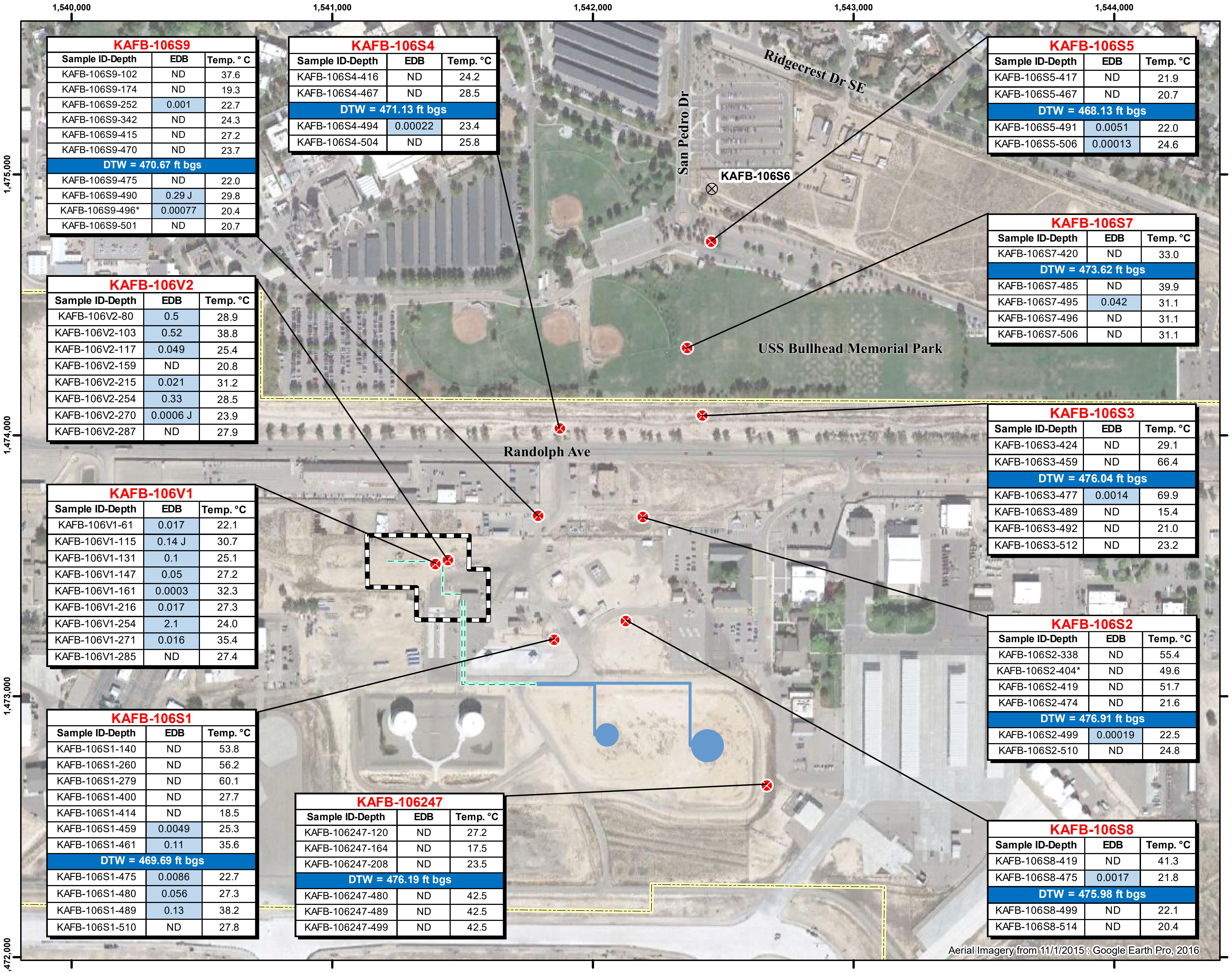


Aerial Imagery from 11/1/2015 : Google Earth Pro, 2016

KAFB-106S9

Sample ID-Depth	EDB	Temp. ° C
KAFB-106S9-102	ND	37.6
KAFB-106S9-174	ND	19.3
KAFB-106S9-252	0.001	22.7
KAFB-106S9-342	ND	24.3
KAFB-106S9-415	ND	27.2
KAFB-106S9-470	ND	23.7
DTW = 470.67 ft bgs		
KAFB-106S9-475	ND	22.0
KAFB-106S9-490	0.29 J	29.8
KAFB-106S9-496*	0.00077	20.4
KAFB-106S9-501	ND	20.7

KAFB-106S4

Sample ID-Depth	EDB	Temp. °C
KAFB-106S4-416	ND	24.2
KAFB-106S4-467	ND	28.5
DTW = 471.13 ft bgs		
KAFB-106S4-494	0.00022	23.4
KAFB-106S4-504	ND	25.8

KAFB-106S5

Sample ID-Depth	EDB	Temp. °C
KAFB-106S5-417	ND	21.9
KAFB-106S5-467	ND	20.7
DTW = 468.13 ft bgs		
KAFB-106S5-491	0.0051	22.0
KAFB-106S5-506	0.00013	24.6

KAFB-106V2

Sample ID-Depth	EDB	Temp. °C
KAFB-106V2-80	0.5	28.9
KAFB-106V2-103	0.52	38.8
KAFB-106V2-117	0.049	25.4
KAFB-106V2-159	ND	20.8
KAFB-106V2-215	0.021	31.2
KAFB-106V2-254	0.33	28.5
KAFB-106V2-270	0.0006 J	23.9
KAFB-106V2-287	ND	27.9

KAFB-106S7

Sample ID-Depth	EDB	Temp. °C
KAFB-106S7-420	ND	33.0
DTW = 473.62 ft bgs		
KAFB-106S7-485	ND	39.9
KAFB-106S7-495	0.042	31.1
KAFB-106S7-496	ND	31.1
KAFB-106S7-506	ND	31.1

KAFB-106S3

Sample ID-Depth	EDB	Temp. °C
KAFB-106S3-424	ND	29.1
KAFB-106S3-459	ND	66.4
DTW = 476.04 ft bgs		
KAFB-106S3-477	0.0014	69.9
KAFB-106S3-489	ND	15.4
KAFB-106S3-492	ND	21.0
KAFB-106S3-512	ND	23.2

KAFB-106V1

Sample ID-Depth	EDB	Temp. °C
KAFB-106V1-61	0.017	22.1
KAFB-106V1-115	0.14 J	30.7
KAFB-106V1-131	0.1	25.1
KAFB-106V1-147	0.05	27.2
KAFB-106V1-161	0.0003	32.3
KAFB-106V1-216	0.017	27.3
KAFB-106V1-254	2.1	24.0
KAFB-106V1-271	0.016	35.4
KAFB-106V1-285	ND	27.4

KAFB-106S2

Sample ID-Depth	EDB	Temp. °C
KAFB-106S2-338	ND	55.4
KAFB-106S2-404*	ND	49.6
KAFB-106S2-419	ND	51.7
KAFB-106S2-474	ND	21.6
DTW = 476.91 ft bgs		
KAFB-106S2-499	0.00019	22.5
KAFB-106S2-510	ND	24.8

KAFB-106S1

Sample ID-Depth	EDB	Temp. °C
KAFB-106S1-140	ND	53.8
KAFB-106S1-260	ND	56.2
KAFB-106S1-279	ND	60.1
KAFB-106S1-400	ND	27.7
KAFB-106S1-414	ND	18.5
KAFB-106S1-459	0.0049	25.3
KAFB-106S1-461	0.11	35.6
DTW = 469.69 ft bgs		
KAFB-106S1-475	0.0086	22.7
KAFB-106S1-480	0.056	27.3
KAFB-106S1-489	0.13	38.2
KAFB-106S1-510	ND	27.8

KAFB-106247

Sample ID-Depth	EDB	Temp. °C
KAFB-106247-120	ND	27.2
KAFB-106247-164	ND	17.5
KAFB-106247-208	ND	23.5
DTW = 476.19 ft bgs		
KAFB-106247-480	ND	42.5
KAFB-106247-489	ND	42.5
KAFB-106247-499	ND	42.5

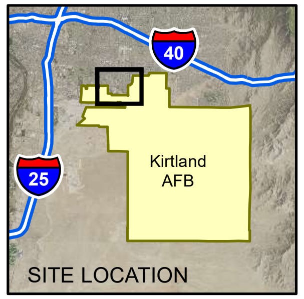
KAFB-106S8

Sample ID-Depth	EDB	Temp. °C
KAFB-106S8-419	ND	41.3
KAFB-106S8-475	0.0017	21.8
DTW = 475.98 ft bgs		
KAFB-106S8-499	ND	22.1
KAFB-106S8-514	ND	20.4

Legend

- ⊗ Completed Continuous Core Location
- ⊗ Optional Continuous Core Location (not drilled)
- ● Former Aboveground Storage Tank
- Former Buried Fuel Transfer Line
- Former Aboveground Fuel Transfer Line
- Kirtland Air Force Base Installation Boundary
- Source Area

Notes:
KAFB-106S6 was an optional coring location that was not required based on Kirtland AFB and NMED review of field screening data from KAFB-106S5 (NMED 2019b).
Shaded values indicate laboratory detections of analytes.
All data was presented in µg/kg in laboratory reports; data converted to mg/kg for presentation.
All sample depths are in ft bgs.
* sample disturbed during collection
Ave = avenue
Dr = drive
SE = southeast
ft = foot/feet
bgs = below ground surface
DTW = Depth to water (measured July 2019)
EDB = ethylene dibromide (1,2-Dibromoethane)
J = Qualifier denotes the analyte was positively identified, but the associated numerical value is estimated.
mg/kg = milligrams per kilogram
µg/kg = micrograms per kilogram
ND = not detected
°C = degrees celsius



N
0 200 400 800
Feet
1 inch = 400 feet

Projection: NAD83 State Plane New Mexico Central FIPS3002 Feet

SOURCE ZONE CHARACTERIZATION REPORT
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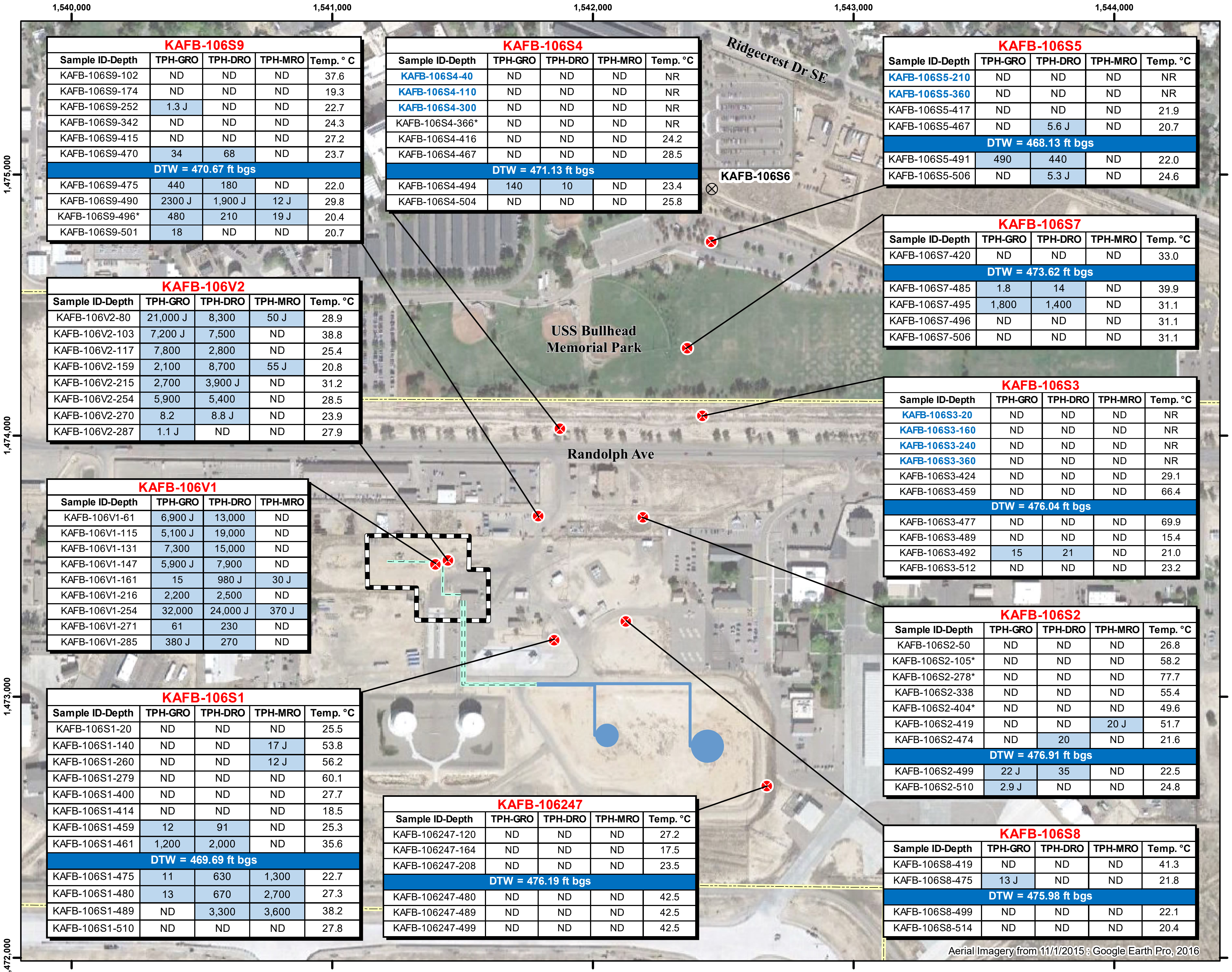
FIGURE 5-2

ETHYLENE DIBROMIDE
CONCENTRATIONS IN SOIL

P:\Projects\Kirtland\Figures\VZ Coring Photo Report\5-2_VZ_EDB_Concentrations_REV2.mxd 2/25/2021 EA ecarpio



KAFB-106S9

Sample ID-Depth	TPH-GRO	TPH-DRO	TPH-MRO	Temp. ° C
KAFB-106S9-102	ND	ND	ND	37.6
KAFB-106S9-174	ND	ND	ND	19.3
KAFB-106S9-252	1.3 J	ND	ND	22.7
KAFB-106S9-342	ND	ND	ND	24.3
KAFB-106S9-415	ND	ND	ND	27.2
KAFB-106S9-470	34	68	ND	23.7
DTW = 470.67 ft bgs				
KAFB-106S9-475	440	180	ND	22.0
KAFB-106S9-490	2300 J	1,900 J	12 J	29.8
KAFB-106S9-496*	480	210	19 J	20.4
KAFB-106S9-501	18	ND	ND	20.7

KAFB-106S4

Sample ID-Depth	TPH-GRO	TPH-DRO	TPH-MRO	Temp. °C
KAFB-106S4-40	ND	ND	ND	NR
KAFB-106S4-110	ND	ND	ND	NR
KAFB-106S4-300	ND	ND	ND	NR
KAFB-106S4-366*	ND	ND	ND	NR
KAFB-106S4-416	ND	ND	ND	24.2
KAFB-106S4-467	ND	ND	ND	28.5
DTW = 471.13 ft bgs				
KAFB-106S4-494	140	10	ND	23.4
KAFB-106S4-504	ND	ND	ND	25.8

KAFB-106S5

Sample ID-Depth	TPH-GRO	TPH-DRO	TPH-MRO	Temp. °C
KAFB-106S5-210	ND	ND	ND	NR
KAFB-106S5-360	ND	ND	ND	NR
KAFB-106S5-417	ND	ND	ND	21.9
KAFB-106S5-467	ND	5.6 J	ND	20.7
DTW = 468.13 ft bgs				
KAFB-106S5-491	490	440	ND	22.0
KAFB-106S5-506	ND	5.3 J	ND	24.6

KAFB-106V2

Sample ID-Depth	TPH-GRO	TPH-DRO	TPH-MRO	Temp. °C
KAFB-106V2-80	21,000 J	8,300	50 J	28.9
KAFB-106V2-103	7,200 J	7,500	ND	38.8
KAFB-106V2-117	7,800	2,800	ND	25.4
KAFB-106V2-159	2,100	8,700	55 J	20.8
KAFB-106V2-215	2,700	3,900 J	ND	31.2
KAFB-106V2-254	5,900	5,400	ND	28.5
KAFB-106V2-270	8.2	8.8 J	ND	23.9
KAFB-106V2-287	1.1 J	ND	ND	27.9

KAFB-106S7

Sample ID-Depth	TPH-GRO	TPH-DRO	TPH-MRO	Temp. °C
KAFB-106S7-420	ND	ND	ND	33.0
DTW = 473.62 ft bgs				
KAFB-106S7-485	1.8	14	ND	39.9
KAFB-106S7-495	1,800	1,400	ND	31.1
KAFB-106S7-496	ND	ND	ND	31.1
KAFB-106S7-506	ND	ND	ND	31.1

KAFB-106S3

Sample ID-Depth	TPH-GRO	TPH-DRO	TPH-MRO	Temp. °C
KAFB-106S3-20	ND	ND	ND	NR
KAFB-106S3-160	ND	ND	ND	NR
KAFB-106S3-240	ND	ND	ND	NR
KAFB-106S3-360	ND	ND	ND	NR
KAFB-106S3-424	ND	ND	ND	29.1
KAFB-106S3-459	ND	ND	ND	66.4
DTW = 476.04 ft bgs				
KAFB-106S3-477	ND	ND	ND	69.9
KAFB-106S3-489	ND	ND	ND	15.4
KAFB-106S3-492	15	21	ND	21.0
KAFB-106S3-512	ND	ND	ND	23.2

KAFB-106V1

Sample ID-Depth	TPH-GRO	TPH-DRO	TPH-MRO
KAFB-106V1-61	6,900 J	13,000	ND
KAFB-106V1-115	5,100 J	19,000	ND
KAFB-106V1-131	7,300	15,000	ND
KAFB-106V1-147	5,900 J	7,900	ND
KAFB-106V1-161	15	980 J	30 J
KAFB-106V1-216	2,200	2,500	ND
KAFB-106V1-254	32,000	24,000 J	370 J
KAFB-106V1-271	61	230	ND
KAFB-106V1-285	380 J	270	ND

KAFB-106S2

Sample ID-Depth	TPH-GRO	TPH-DRO	TPH-MRO	Temp. °C
KAFB-106S2-50	ND	ND	ND	26.8
KAFB-106S2-105*	ND	ND	ND	58.2
KAFB-106S2-278*	ND	ND	ND	77.7
KAFB-106S2-338	ND	ND	ND	55.4
KAFB-106S2-404*	ND	ND	ND	49.6
KAFB-106S2-419	ND	ND	20 J	51.7
KAFB-106S2-474	ND	20	ND	21.6
DTW = 476.91 ft bgs				
KAFB-106S2-499	22 J	35	ND	22.5
KAFB-106S2-510	2.9 J	ND	ND	24.8

KAFB-106S1

Sample ID-Depth	TPH-GRO	TPH-DRO	TPH-MRO	Temp. °C
KAFB-106S1-20	ND	ND	ND	25.5
KAFB-106S1-140	ND	ND	17 J	53.8
KAFB-106S1-260	ND	ND	12 J	56.2
KAFB-106S1-279	ND	ND	ND	60.1
KAFB-106S1-400	ND	ND	ND	27.7
KAFB-106S1-414	ND	ND	ND	18.5
KAFB-106S1-459	12	91	ND	25.3
KAFB-106S1-461	1,200	2,000	ND	35.6
DTW = 469.69 ft bgs				
KAFB-106S1-475	11	630	1,300	22.7
KAFB-106S1-480	13	670	2,700	27.3
KAFB-106S1-489	ND	3,300	3,600	38.2
KAFB-106S1-510	ND	ND	ND	27.8

KAFB-106247

Sample ID-Depth	TPH-GRO	TPH-DRO	TPH-MRO	Temp. °C
KAFB-106247-120	ND	ND	ND	27.2
KAFB-106247-164	ND	ND	ND	17.5
KAFB-106247-208	ND	ND	ND	23.5
DTW = 476.19 ft bgs				
KAFB-106247-480	ND	ND	ND	42.5
KAFB-106247-489	ND	ND	ND	42.5
KAFB-106247-499	ND	ND	ND	42.5

KAFB-106S8

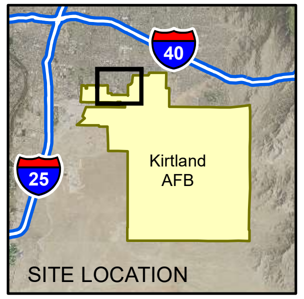
Sample ID-Depth	TPH-GRO	TPH-DRO	TPH-MRO	Temp. °C
KAFB-106S8-419	ND	ND	ND	41.3
KAFB-106S8-475	13 J	ND	ND	21.8
DTW = 475.98 ft bgs				
KAFB-106S8-499	ND	ND	ND	22.1
KAFB-106S8-514	ND	ND	ND	20.4

Aerial Imagery from 11/1/2015 : Google Earth Pro, 2016

Legend

⊗	Completed Continuous Core Location
⊗	Optional Continuous Core Location (not drilled)
●	Former Aboveground Storage Tank
- - -	Former Buried Fuel Transfer Line
—	Former Aboveground Fuel Transfer Line
- · -	Kirtland Air Force Base Installation Boundary
▨	Source Area

Notes:
Blue bold sample IDs were collected from soil cuttings.
KAFB-106S6 was an optional coring location that was not required based on Kirtland AFB and NMED review of field screening data from KAFB-106S5 (NMED 2019b).
Shaded values indicate laboratory detections of analytes
All results are in mg/kg.
All sample depths are in ft bgs.
* sample disturbed during collection
Ave = avenue
Dr = drive
SE = southeast
ft - foot/feet
bgs - below ground surface
DTW = Depth to water (measured July 2019)
DRO = diesel range organics
GRO = gasoline range organics
MRO = motor oil range organics
TPH = total petroleum hydrocarbons
J = Qualifier denotes the analyte was positively identified, but the associated numerical value is estimated.
mg/kg - milligrams per kilogram
ND - not detected
NR = no reading
°C = degrees celsius



SITE LOCATION

N
0 200 400 800
Feet
1 inch = 400 feet

Projection: NAD83 State Plane New Mexico Central FIPS3002 Feet

SOURCE ZONE CHARACTERIZATION REPORT
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FIGURE 5-3

TOTAL PETROLEUM HYDROCARBON
CONCENTRATIONS IN SOIL

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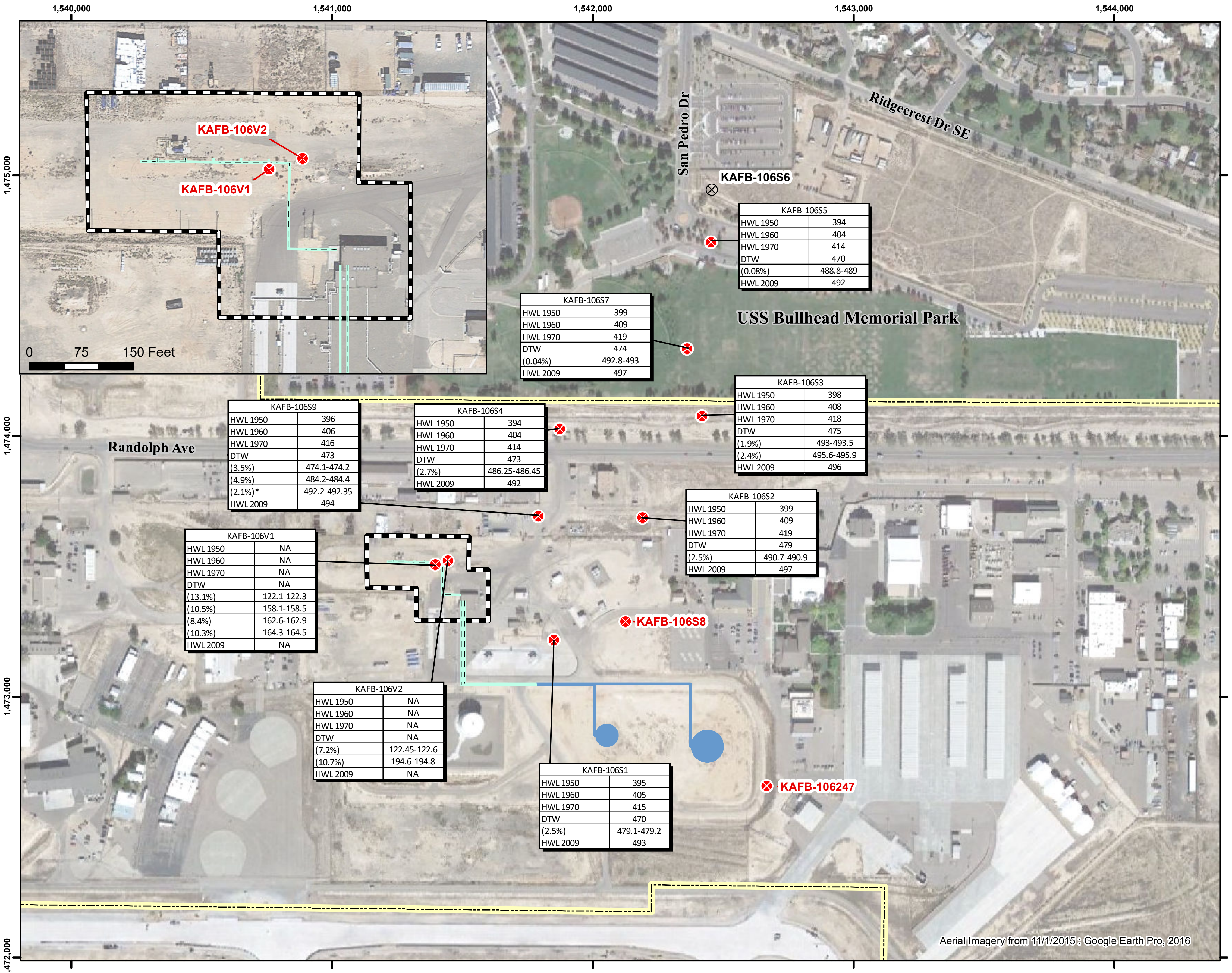


KAFB-106S5	
HWL 1950	394
HWL 1960	404
HWL 1970	414
DTW	470
(0.08%)	488.8-489
HWL 2009	492

KAFB-106S7	
HWL 1950	399
HWL 1960	409
HWL 1970	419
DTW	474
(0.04%)	492.8-493
HWL 2009	497

KAFB-106S3	
HWL 1950	398
HWL 1960	408
HWL 1970	418
DTW	475
(1.9%)	493-493.5
(2.4%)	495.6-495.9
HWL 2009	496

KAFB-106S9	
HWL 1950	396
HWL 1960	406
HWL 1970	416
DTW	473
(3.5%)	474.1-474.2
(4.9%)	484.2-484.4
(2.1%)*	492.2-492.35
HWL 2009	494

KAFB-106S4	
HWL 1950	394
HWL 1960	404
HWL 1970	414
DTW	473
(2.7%)	486.25-486.45
HWL 2009	492

KAFB-106S2	
HWL 1950	399
HWL 1960	409
HWL 1970	419
DTW	479
(2.5%)	490.7-490.9
HWL 2009	497

KAFB-106V1	
HWL 1950	NA
HWL 1960	NA
HWL 1970	NA
DTW	NA
(13.1%)	122.1-122.3
(10.5%)	158.1-158.5
(8.4%)	162.6-162.9
(10.3%)	164.3-164.5
HWL 2009	NA

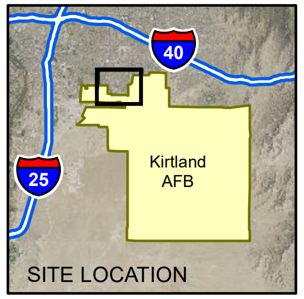
KAFB-106V2	
HWL 1950	NA
HWL 1960	NA
HWL 1970	NA
DTW	NA
(7.2%)	122.45-122.6
(10.7%)	194.6-194.8
HWL 2009	NA

KAFB-106S1	
HWL 1950	395
HWL 1960	405
HWL 1970	415
DTW	470
(2.5%)	479.1-479.2
HWL 2009	493

Legend

⊗	Completed Continuous Core Location
⊗	Optional Continuous Core Location (not drilled)
●	Former Aboveground Storage Tank
- - -	Former Buried Fuel Transfer Line
—	Former Aboveground Fuel Transfer Line
-·-·-	Kirtland Air Force Base Installation Boundary
▭	Source Area

Notes:
All depths are in feet below ground surface.
Depths to water and depths to the historic water levels are rounded to the nearest significant number.
KAFB-106S6 was an optional coring location that was not required based on Kirtland AFB and NMED review of field screening data from KAFB-106S5 (NMED 2019b).
* sample disturbed during collection
(2.5%) = LNAPL pore volume Saturation percent
479.1-479.2 = sample depth interval
% = percent
amsl = above mean sea level
ft bgs = feet below ground surface
DTW = depth to water at well completion
HWL = historic water level
LNAPL = light non-aqueous phase liquid
NA = not applicable



N
0 200 400 800
Feet
1 inch = 400 feet

Projection: NAD83 State Plane New Mexico Central FIPS3002 Feet

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FIGURE 5-4

LNAPL PORE VOLUME
SATURATION PERCENT

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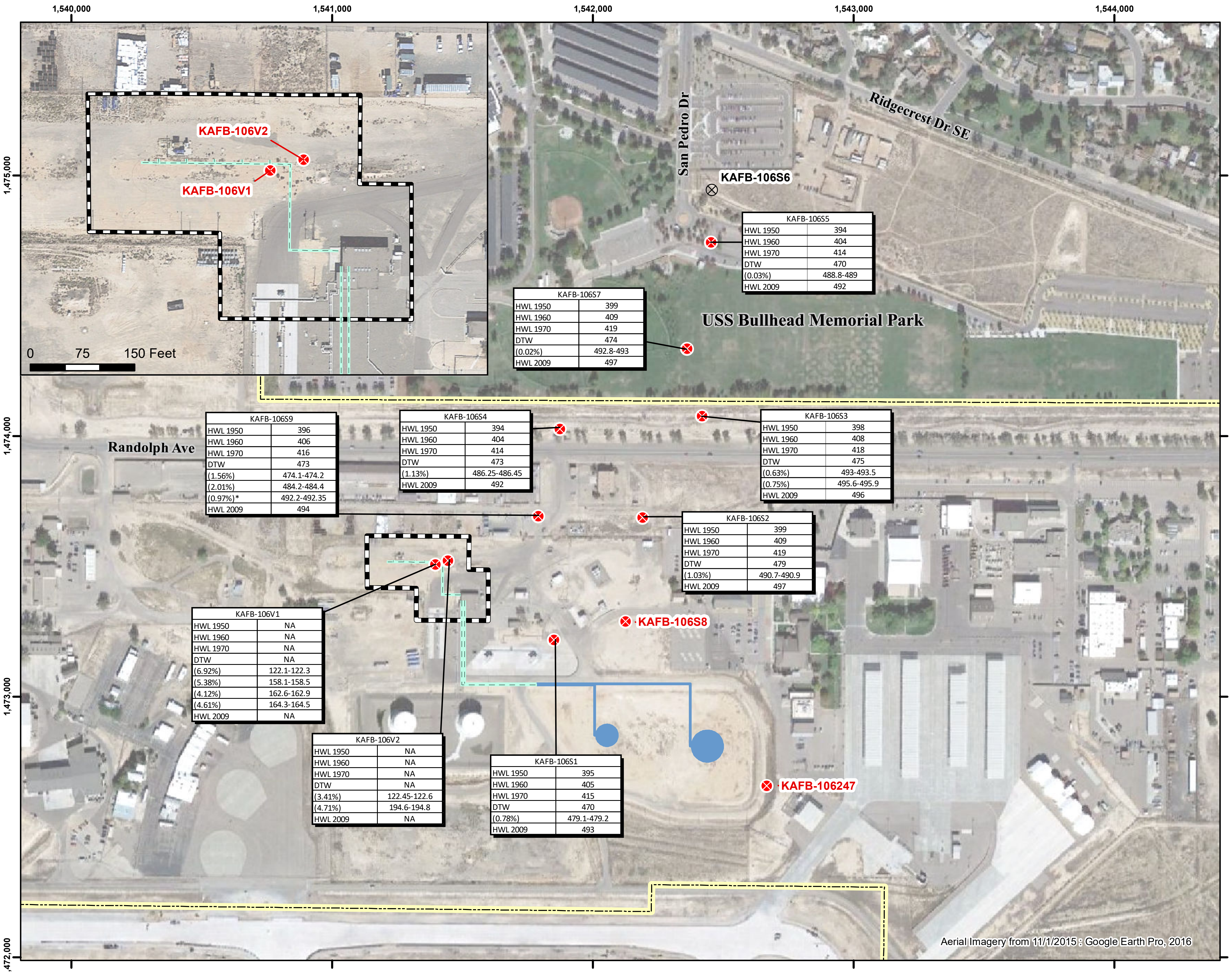


KAFB-106S5	
HWL 1950	394
HWL 1960	404
HWL 1970	414
DTW	470
(0.03%)	488.8-489
HWL 2009	492

KAFB-106S7	
HWL 1950	399
HWL 1960	409
HWL 1970	419
DTW	474
(0.02%)	492.8-493
HWL 2009	497

KAFB-106S9	
HWL 1950	396
HWL 1960	406
HWL 1970	416
DTW	473
(1.56%)	474.1-474.2
(2.01%)	484.2-484.4
(0.97%)*	492.2-492.35
HWL 2009	494

KAFB-106S4	
HWL 1950	394
HWL 1960	404
HWL 1970	414
DTW	473
(1.13%)	486.25-486.45
HWL 2009	492

KAFB-106S3	
HWL 1950	398
HWL 1960	408
HWL 1970	418
DTW	475
(0.63%)	493-493.5
(0.75%)	495.6-495.9
HWL 2009	496

KAFB-106S2	
HWL 1950	399
HWL 1960	409
HWL 1970	419
DTW	479
(1.03%)	490.7-490.9
HWL 2009	497

KAFB-106V1	
HWL 1950	NA
HWL 1960	NA
HWL 1970	NA
DTW	NA
(6.92%)	122.1-122.3
(5.38%)	158.1-158.5
(4.12%)	162.6-162.9
(4.61%)	164.3-164.5
HWL 2009	NA

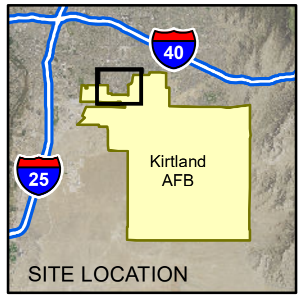
KAFB-106V2	
HWL 1950	NA
HWL 1960	NA
HWL 1970	NA
DTW	NA
(3.41%)	122.45-122.6
(4.71%)	194.6-194.8
HWL 2009	NA

KAFB-106S1	
HWL 1950	395
HWL 1960	405
HWL 1970	415
DTW	470
(0.78%)	479.1-479.2
HWL 2009	493

Legend

⊗	Completed Continuous Core Location
⊗	Optional Continuous Core Location (not drilled)
●	Former Aboveground Storage Tank
- - -	Former Buried Fuel Transfer Line
—	Former Aboveground Fuel Transfer Line
-·-·-	Kirtland Air Force Base Installation Boundary
▨	Source Area

Notes:
All depths are in feet below ground surface.
Depths to water and depths to the historic water levels are rounded to the nearest significant number.
KAFB-106S6 was an optional coring location that was not required based on Kirtland AFB and NMED review of field screening data from KAFB-106S5 (NMED 2019b).
* sample disturbed during collection
(2.5%) = LNAPL pore volume Saturation percent
479.1-479.2 = sample depth interval
% = percent
amsl = above mean sea level
ft bgs = feet below ground surface
DTW = depth to water at well completion
HWL = historic water level
LNAPL = light non-aqueous phase liquid
NA = not applicable



1 inch = 400 feet

Projection: NAD83 State Plane New Mexico Central FIPS3002 Feet

SOURCE ZONE CHARACTERIZATION REPORT
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FIGURE 5-5

LNAPL TOTAL VOLUME
SATURATION PERCENT

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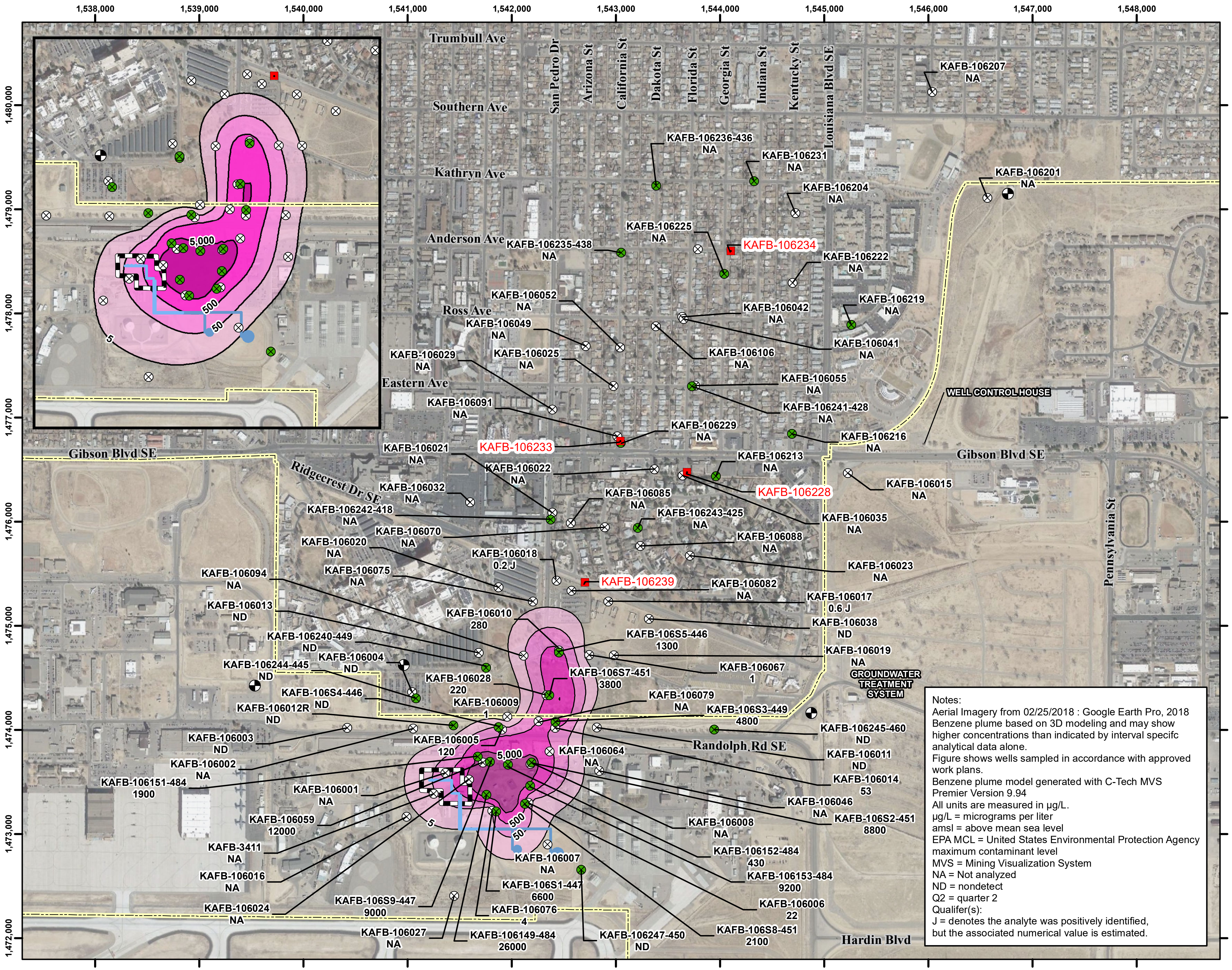


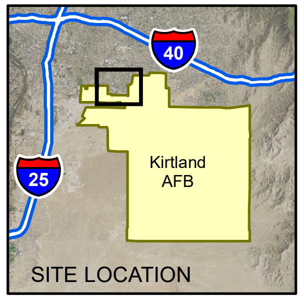
Notes:
Aerial Imagery from 02/25/2018 : Google Earth Pro, 2018
Benzene plume based on 3D modeling and may show higher concentrations than indicated by interval specifc analytical data alone.
Figure shows wells sampled in accordance with approved work plans.
Benzene plume model generated with C-Tech MVS Premier Version 9.94
All units are measured in µg/L.
µg/L = micrograms per liter
amsl = above mean sea level
EPA MCL = United States Environmental Protection Agency maximum contaminant level
MVS = Mining Visualization System
NA = Not analyzed
ND = nondetect
Q2 = quarter 2
Qualifier(s):
J = denotes the analyte was positively identified, but the associated numerical value is estimated.

Legend

- ● Monitoring Well (Screen Not Submerged)
- ⊗ Monitoring Well (Screen Submerged)
- ■ Extraction Well
- ◐ Drinking Water Supply Well
- ● Former Aboveground Storage Tank
- — Former Buried Fuel Transfer Line
- — Former Aboveground Fuel Transfer Line
- -·- Installation Fence Boundary
- — Benzene Concentration Isocontour
- ▨ Source Area

Q2 2019 Benzene Concentration Range

- ▨ 5.0 (EPA MCL) - 50 µg/L
- ▨ 50 - 500 µg/L
- ▨ 500 - 5,000 µg/L
- ▨ >5,000 µg/L



N

0 500 1,000 2,000
Feet
1 inch = 1,000 feet

Projection: NAD83 State Plane New Mexico Central FIPS3002 Feet

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FIGURE 5-6

BENZENE CONCENTRATION IN
GROUNDWATER REFERENCE ELEVATION
INTERVAL 4857, Q2 2019

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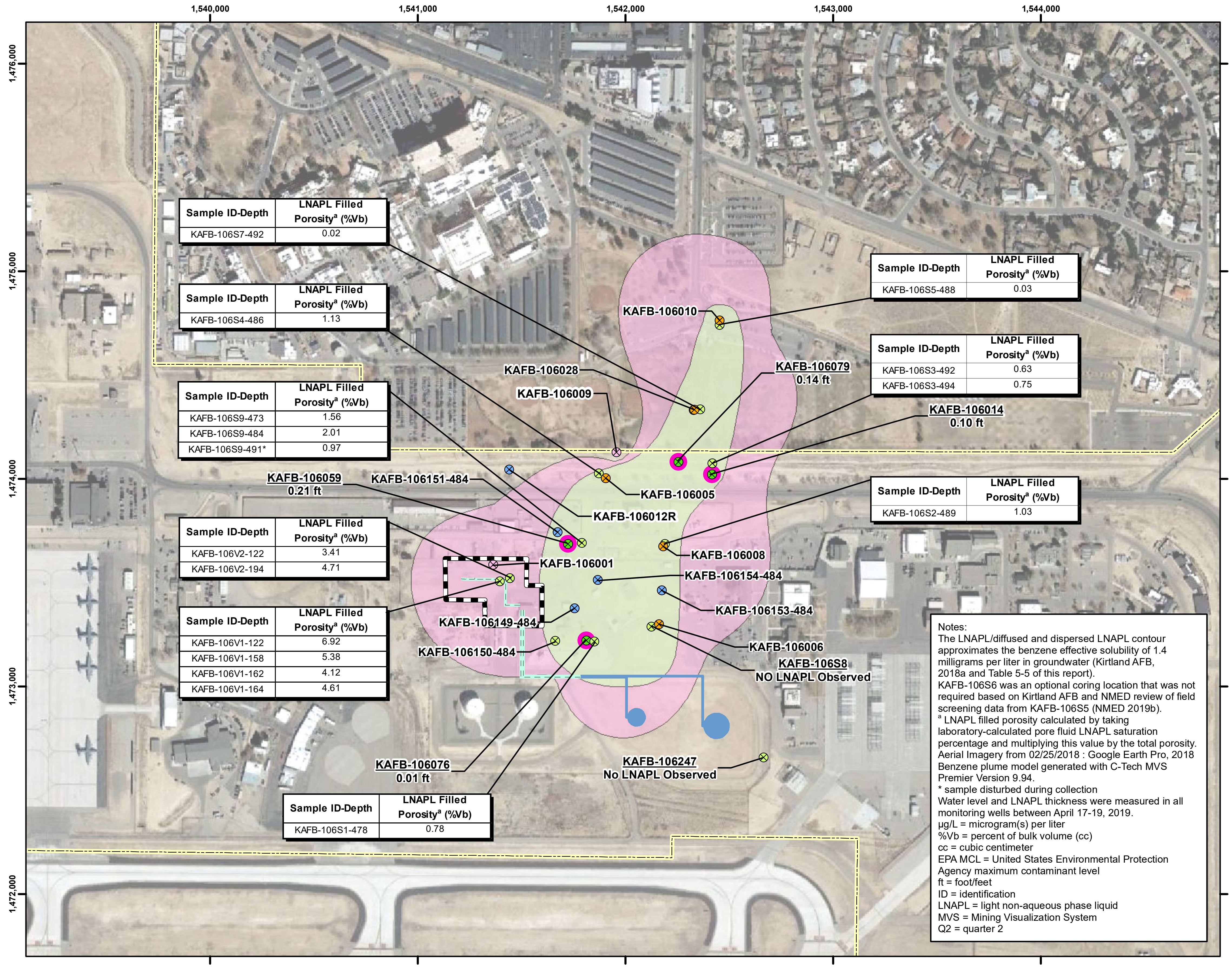


Sample ID-Depth	LNAPL Filled Porosity[a] (%Vb)
KAFB-106S7-492	0.02

Sample ID-Depth	LNAPL Filled Porosity[a] (%Vb)
KAFB-106S4-486	1.13

Sample ID-Depth	LNAPL Filled Porosity[a] (%Vb)
KAFB-106S9-473	1.56
KAFB-106S9-484	2.01
KAFB-106S9-491*	0.97

Sample ID-Depth	LNAPL Filled Porosity[a] (%Vb)
KAFB-106V2-122	3.41
KAFB-106V2-194	4.71

Sample ID-Depth	LNAPL Filled Porosity[a] (%Vb)
KAFB-106V1-122	6.92
KAFB-106V1-158	5.38
KAFB-106V1-162	4.12
KAFB-106V1-164	4.61

Sample ID-Depth	LNAPL Filled Porosity[a] (%Vb)
KAFB-106S1-478	0.78

Sample ID-Depth	LNAPL Filled Porosity[a] (%Vb)
KAFB-106S5-488	0.03

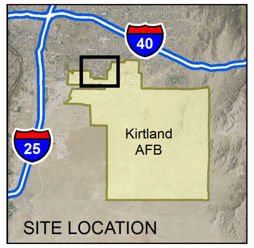
Sample ID-Depth	LNAPL Filled Porosity[a] (%Vb)
KAFB-106S3-492	0.63
KAFB-106S3-494	0.75

Sample ID-Depth	LNAPL Filled Porosity[a] (%Vb)
KAFB-106S2-489	1.03

Notes:
The LNAPL/diffused and dispersed LNAPL contour approximates the benzene effective solubility of 1.4 milligrams per liter in groundwater (Kirtland AFB, 2018a and Table 5-5 of this report).
KAFB-106S6 was an optional coring location that was not required based on Kirtland AFB and NMED review of field screening data from KAFB-106S5 (NMED 2019b).
[a] LNAPL filled porosity calculated by taking laboratory-calculated pore fluid LNAPL saturation percentage and multiplying this value by the total porosity.
Aerial Imagery from 02/25/2018 : Google Earth Pro, 2018
Benzene plume model generated with C-Tech MVS Premier Version 9.94.
* sample disturbed during collection
Water level and LNAPL thickness were measured in all monitoring wells between April 17-19, 2019.
µg/L = microgram(s) per liter
%Vb = percent of bulk volume (cc)
cc = cubic centimeter
EPA MCL = United States Environmental Protection Agency maximum contaminant level
ft = foot/feet
ID = identification
LNAPL = light non-aqueous phase liquid
MVS = Mining Visualization System
Q2 = quarter 2

Legend

- ◎ Monitoring Well with Confirmed LNAPL in Q2 2019
- ⊗ REI 4857 Groundwater Monitoring Wells with unsubmerged screens and no measureable LNAPL; presence of diffused and dispersed LNAPL indicated by solubility of benzene and presence of historical LNAPL
- ⊗ REI 4857 Groundwater Monitoring Well with fully submerged sceen and no measureable LNAPL; presence of diffused and dispersed LNAPL not indicated
- ⊗ REI 4857 Groundwater Monitoring Wells with fully submerged screens and no measureable LNAPL; presence of diffused and dispersed LNAPL indicated by solubility of benzene and presence of historical LNAPL
- ⊗ REI 4857 Groundwater Monitoring Wells with fully submerged screens and measureable LNAPL
- ⊗ Vadose Zone Coring Location
- ● Former Aboveground Storage Tank
- Former Buried Fuel Transfer Line
- Former Aboveground Fuel Transfer
- Kirtland Air Force Base Installation Boundary
- Dissolved Benzene Plume in Groundwater, Q2 2019 ≥5 µg/L (EPA MCL)
- Estimated Extent of LNAPL/Diffused and Dispersed LNAPL in Groundwater
- Source Area



N
0 250 500 1,000
Feet
1 inch = 500 feet
Projection: NAD83 State Plane New Mexico Central FIPS3002 Feet

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FIGURE 5-7

ESTIMATED EXTENT OF
LNAPL/DIFFUSED AND DISPERSED
LNAPL IN GROUNDWATER

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Table 3-1
Coring Intervals and Soil Sample Locations

Coring Location	Laboratory Analysis	Total Depth (ft bgs)	Drilling Method (ft bgs)		Soil Sample Depths (ft bgs)										
			ARCH	Sonic Coring	0-50	50-100	100-150	150-200	200-250	250-300	300-350	350-400	400-450	450-500	500+
KAFB-106S1	TPH and/or VOCs	510	NA	0-510	20	--	140	--		260, 279	--	--	400, 414	459, 461, 475, 480, 489	510
	Biologic and/or Mineralogic													480, 489	
	UV, LNAPL													476-478, 478-480, 480-482, 482-484, 484-486, 486-488	
KAFB-106S2	TPH and/or VOCs	510	NA	0-510	50	--	105*	--	--	278*	338	--	404*, 419	474, 499	510
	Biologic and/or Mineralogic													474, 499	
	UV, LNAPL													489 - 491, 491-493	
KAFB-106S3	TPH and/or VOCs	512	0-400	400-512	**20**	--	--	**160**	**240**	--	--	**360**	424	459, 477, 489, 492	512
	Biologic and/or Mineralogic													477, 489, 494	
	UV, LNAPL													492-494, 494-496	
KAFB-106S4	TPH and/or VOCs	504	0-340	340-504	**40**	--	**110**	--	--	**300**	--	366	416	467, 494	504
	Biologic and/or Mineralogic													480, 494	
	UV, LNAPL													476-478, 486-488, 492-493	
	Geotechnical													486	
KAFB-106S5	TPH and/or VOCs	506	0-400	400-506	--	--	--	--	**210**	--	--	**360**	417	467, 491	506
	Biologic and/or Mineralogic													491	506
	UV, LNAPL													488-490	
	Geotechnical													490	
KAFB-106S6[a]	Not Sampled	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--
KAFB-106S7	TPH and/or VOCs	506	0-400	400-506	--	--	--	--	--	--	--	--	420	469, 485, 495	506
	Biologic and/or Mineralogic													469, 485, 495	
	UV, LNAPL													492-494	
KAFB-106S8	TPH and/or VOCs	514	NA	0-514	--	--	--	--	--	--	--	--	419	475, 499	514
	Biologic and/or Mineralogic													475, 499	
KAFB-106S9	TPH and/or VOCs	510	NA	0-510	--	--	102	174	--	252	342	--	415	470, 475, 490, 496*	501
	Biologic and/or Mineralogic													475, 477, 483, 495, 496	
	UV, LNAPL													473-475, 484-486, 491-493*, 493-495*	
	Geotechnical												435	459, 464, 474, 484	
KAFB-106247	TPH and/or VOCs	515	NA	0-515	--	--	120	164	208	--	--	--	--	480, 489, 499	--
	Biologic and/or Mineralogic						143		208					474, 480, 489, 499	
	Geotechnical						120	164, 199						474, 480, 489, 490	
KAFB-106V1	TPH and/or VOCs	285	NA	0-285	--	61	115, 131, 147	161	216	254, 271, 285	--	--	--	--	--
	Biologic and/or Mineralogic						122	161							
	UV, LNAPL						120-122, 122-124	158-160, 162-164, 164-166	202-204						
KAFB-106V2	TPH and/or VOCs	287	NA	0-287	--	80	103, 117	159	215	254, 270, 287	--	--	--	--	--
	Biologic and/or Mineralogic						144		215						
	UV, LNAPL						120-122, 122-124	168-170, 194-196	214-215						
	Geotechnical						144								

Soil samples with depths shown in bold were collected from soil cuttings. All other samples were collected from sonic cores.

Samples collected from soil cuttings were analyzed for total petroleum hydrocarbons. All other analyses were performed on samples collected from sonic cores.

[a] Optional coring location KAFB-106S6 was not required and therefore not drilled based on Kirtland AFB and NMED joint review of field screening data from KAFB-106S5 (NMED, 2019b).

Table 3-1
Coring Intervals and Soil Sample Locations

* Indicates sample was disturbed during collection
AFB = Air Force Base
ARCH = air rotary casing hammer
bgs = below ground surface
EPA = U.S. Environmental Protection Agency
TPH = Total Petroleum Hydrocarbons. Indicates samples analyzed for gasoline, diesel, and motor oil range total petroleum hydrocarbons by EPA Method 8015.
VOCs - Volatile Organic Compounds. Indicates samples analyzed by EPA Method 8260.
UV = Ultraviolet Light Analysis. Indicates samples where utraviolet light analysis was performed by PTS Laboratories, Inc.
LNAPL - Light, Non-Aqueous Phase Liquids. Indicates samples analyzed for Pore Fluid Saturation Package by PTS Laboratories, Inc.
Biologic indicates samples analyzed for QuantArray-Chlor Study by Microbial Insights
Mineralogic indicates samples analyzed for X-ray diffraction (abiotic potential) and magnetic susceptibility.
Geotechnical indicates samples analyzed for either fraction organic carbon or thermal conductivity by Daniel B. Stevens and Associates.
ft = foot/feet
NA = not applicable
NMED = New Mexico Environment Department
-- = sample not collected

Table 4-1
Photoionization Detector and Core Temperature Field Screening Data

KAFB-106S1				
Historical DTW (Ft bgs)	**Drilling Method**	**Depth (ft bgs)**	**PID (ppm-v)**	**Temperature (°C)**
	SONIC CORING	10	3.1	28.2
		20	3.0	25.5
		30	2.8	47.9
		40	2.3	28.2
		50	1.8	37.5
		60	1.5	30.6
		70	1.3	40.5
		80	1.3	39.4
		90	2.0	54.1
		100	1.3	34.2
		110	1.6	42.2
		120	2.7	53.7
		130	2.2	53.8
		140	6.6	53.8
		150	1.7	39.5
		160	4.3	22.3
		170	4.2	32.2
		180	2.5	27.5
		190	2.2	33.3
		200	4.4	41.3
		210	2.1	33.9
		220	2.5	34.6
		230	2.4	45.4
		240	3.0	42.7
		250	22.7	46.4
		260	25.1	56.2
		270	11.2	48.8
		280	24.1	60.1
		290	2.7	41.7
		300	0.8	37.2
		310	1.9	44.6
		320	2.9	50.4
		330	3.6	28.3
		340	2.5	38.4
		350	3.8	32.0
		360	2.8	29.1
		370	3.2	38.2
		380	0.4	26.1
395[a]		390	0.5	37.5
405[b]		400	4.7	27.7
		410	12.2	44.7
415[c]		420	43.5	54.2
		430	21.7	32.9
		440	150.0	52.1
		450	452.8	70.4
		460	652.8	35.6
		470	**2398**	22.7
		480	**2572**	27.3
493[d]		490	**1784**	38.2
		500	14.3	27.8
		505	28.6	27.8
		510	215.8	27.8
		Max	**2572**	
		Min	0.4	

Table 4-1
Photoionization Detector and Core Temperature Field Screening Data

KAFB-106S2				
Historical DTW (Ft bgs)	**Drilling Method**	**Depth (ft bgs)**	**PID (ppm-v)**	**Temperature (°C)**
	SONIC CORING	9	8.6	31.7
		19	7.3	22.9
		29	6.7	30.6
		39	1.8	24.8
		49	14.0	26.8
		59	2.5	29.2
		66	1.8	50.8
		86	10.1	32.8
		95	1.1	33.2
		105*	15.7	58.2
		115	2.7	34.2
		125	6.2	25.9
		135	7.7	35.9
		147	11.4	84.6
		157	6.1	59.4
		167	5.3	37.3
		178	3.4	74.3
		188	1.3	42.8
		198	0.3	48.5
		208	0.7	50.9
		218	1.3	67.1
		228	1.3	62.1
		238	2.1	43.1
		248	0.0	52.9
		258	0.5	33.8
		268	2.2	51.1
		278*	2.9	77.7
		289	0.0	56.2
		294	0.3	44.9
		298	0.0	35.9
		308	0.0	56.1
		318	2.1	56.3
		328	2.1	55.4
		338	7.3	68.9
		348	4.7	54.7
		358	3.3	45.3
		368	8.1	55.5
		378	37.1	40.1
		388	17.0	52.8
399[a]		394	16.9	51.5
409[b]		404*	38.4	49.6
		410	19.5	73.3
419[c]		419	0.3	23.3
		430	0.0	49.1
		439	0.2	45.5
		450	0.7	42.2
		460	22.9	61.3
		470	31.7	31.9
		475	90.2	22.3
		480	362	23.2
		484	**1802**	24.2
		490	**1476**	26.9
497[d]		494	**3826**	25.1
		505	130.1	24.0
		509	346	24.8
		Max	**3826**	
		Min	0	

Table 4-1
Photoionization Detector and Core Temperature Field Screening Data

KAFB-106S3				
Historical DTW (Ft bgs)	**Drilling Method**	**Depth (ft bgs)**	**PID (ppm-v)**	**Temperature (°C)**
	ARCH	11	5.5	-
		21	8.0	-
		31	4.0	-
		41	2.1	-
		51	1.4	-
		61	2.8	-
		71	4.5	-
		81	5.9	-
		91	1.4	-
		101	5.9	-
		111	5.0	-
		121	5.6	-
		131	4.5	-
		141	6.0	-
		151	5.6	-
		161	10.2	-
		171	8.3	-
		181	8.0	-
		191	8.2	-
		201	5.6	-
		211	6.0	-
		221	7.9	-
		231	8.3	-
		241	8.4	-
		251	4.8	-
		261	3.8	-
		271	4.0	-
		281	3.5	-
		291	3.4	-
		301	5.5	-
		311	5.7	-
		321	5.0	-
		331	4.7	-
		341	3.6	-
		351	5.8	-
		361	6.9	-
		371	6.5	-
		381	6.0	-
398[a]		391	6.4	-
		401	2.3	-
408[b]	SONIC CORING	400	1.7	68.2
418[c]		410	6.4	60.7
		420	5.7	78.1
		425	0.4	32.8
		430	0.0	42.9
		435	1.2	82.8
		440	2.7	52.3
		444	1.6	52.3
		450	1.2	82.4
		455	15.6	66.4
		460	6.7	22.0
		461	15.2	22.0
		464	9.4	69.9
		470	7.3	50.4
		475	163	24.3
		480	285	27.3
		485	335	22.0
		489	85.9	15.45
		490	468	18.5
496[d]		496	**2569**	24.0
		500	260	24.5
		504	175	24.4
		510	35.1	23.2
		Max	**2569.0**	
		Min	0.0	

Table 4-1
Photoionization Detector and Core Temperature Field Screening Data

KAFB-106S4				
Historical DTW (Ft bgs)	**Drilling Method**	**Depth (ft bgs)**	**PID (ppm-v)**	**Temperature (°C)**
	ARCH	11	3.6	-
		21	2.3	-
		31	2.5	-
		41	5.0	-
		51	1.8	-
		61	0.6	-
		71	3.1	-
		81	3.8	-
		91	0.2	-
		101	0.3	-
		111	2.6	-
		121	0.0	-
		141	0.0	-
		151	0.1	-
		161	0.0	-
		171	0.0	-
		181	0.0	-
		191	0.0	-
		201	0.0	-
		211	1.8	-
		221	0.7	-
		231	0.8	-
		241	0.7	-
		251	0.7	-
		261	0.5	-
		271	0.6	-
		281	1.1	-
		291	0.8	-
		301	2.1	-
		311	0.7	-
		321	0.3	-
		331	0.7	-
		341	0.7	-
	SONIC CORING	340	3.1	25.9
		350	3.8	34.4
		359	2.1	22.4
		366*	6.8	56.6
		370	5.7	55.4
		380	6.7	23.9
394[a]		389	6.3	27.1
404[b]		404	8.7	45.3
		409	6.8	56.7
		412	6.9	28.8
414[c]		414	7.8	29.4
		420	7.7	49.6
		430	4.8	31.2
		466	15.6	28.5
		469	34.7	23.9
		470	52.8	23.9
		479	**1432**	21.9
		480	74.4	21.9
		484	**3271**	22.4
		486	**3028**	22.5
		490	**1608**	24.7
492[d]		492	**2141**	25.4
		493	**1322**	21.1
		500	174.2	24.4
		502	73.2	25.8
		Max	**3271**	
		Min	0	

Table 4-1
Photoionization Detector and Core Temperature Field Screening Data

KAFB-106S5				
Historical DTW (Ft bgs)	**Drilling Method**	**Depth (ft bgs)**	**PID (ppm-v)**	**Temperature (°C)**
	ARCH	21	8.1	-
		31	15.5	-
		41	9.5	-
		51	1.4	-
		71	31.9	-
		81	2.0	-
		91	3.0	-
		101	5.0	-
		111	2.9	-
		121	1.0	-
		131	1.0	-
		141	0.9	-
		151	0.8	-
		161	1.6	-
		171	2.6	-
		181	1.5	-
		191	1.3	-
		201	0.9	-
		211	10.7	-
		221	4.6	-
		231	1.9	-
		241	4.1	-
		251	6.2	-
		261	2.2	-
		271	4.9	-
		281	7.0	-
		301	2.2	-
		311	2.3	-
		321	2.5	-
		331	2.4	-
		341	2.6	-
		351	1.7	-
		361	4.0	-
		371	3.3	-
		381	2.9	-
394[a]		391	2.1	-
		401	1.1	-
404[b]	SONIC CORING	400	3.5	34.1
		405	2.5	40.5
		409	4.7	22.9
		412	3.7	45.8
414[c]		414	2.4	62.8
		415	3.2	71.7
		420	3.8	27.2
		429	2.9	24.0
		439	3.5	40.7
		449	1.7	25.9
		456	4.9	21.2
		459	3.2	21.9
		460	8.7	24.9
		467	27.8	20.7
		469	20.3	22.2
		470	44.2	23.2
		472	91.0	19.9
		475	77.3	19.5
		479	27.7	20.7
		483	21.8	22.4
		485	14.7	25.7
		487	**1942**	21.3
492[d]		491	**1957**	22.0
		493	557	25.0
		495	62.7	26.3
		497	21.0	20.8
		501	7.5	21.3
		503	12	22.5
		505	16.9	24.6
		Max	**1957**	
		Min	0.8	

Table 4-1
Photoionization Detector and Core Temperature Field Screening Data

KAFB-106S7				
Historical DTW (Ft bgs)	**Drilling Method**	**Depth (ft bgs)**	**PID (ppm-v)**	**Temperature (°C)**
	ARCH	11	25.4	-
		21	3.9	-
		31	6.8	-
		41	4.9	-
		51	4.0	-
		61	3.5	-
		71	4.0	-
		81	3.8	-
		91	3.3	-
		101	1.6	-
		111	3.2	-
		121	2.3	-
		131	3.3	-
		141	3.0	-
		151	3.8	-
		161	4.1	-
		171	19.8	-
		181	11.0	-
		191	13.8	-
		201	13.3	-
		211	1.7	-
		221	2.1	-
		231	2.4	-
		241	2.4	-
		251	2.5	-
		261	1.7	-
		271	1.6	-
		281	1.2	-
		291	1.7	-
		301	1.2	-
		311	1.4	-
		321	0.9	-
		331	1.3	-
		341	1.0	-
		351	69.0	-
		361	2.6	-
		371	5.1	-
		381	3.8	-
399[a]		391	9.8	-
409[b]		401	5.1	-
	SONIC CORING	410	0.3	39.0
419[c]		419	1.3	33.0
		430	2.1	68.9
		440	1.6	67.5
		450	0.1	34.3
		460	6.8	46.9
		470	6.3	23.6
		480	46.3	30.6
497[d]		490	**1499**	31.1
		500	418.3	31.1
		506	8.6	31.1
		Max	**1499**	
		Min	0.1	

Table 4-1
Photoionization Detector and Core Temperature Field Screening Data

KAFB-106S8				
Historical DTW (Ft bgs)	**Drilling Method**	**Depth (ft bgs)**	**PID (ppm-v)**	**Temperature (°C)**
	SONIC CORING	10	3.4	19.2
		20	2.4	19.7
		30	1.9	33.0
		40	0.4	19.4
		50	1.6	26.4
		60	5.3	28.6
		70	2.5	29.2
		80	3.9	46.8
		90	1.7	77.9
		100	2.1	23.3
		110	2.6	33.9
		120	2.0	51.1
		130	0.2	37.9
		140	3.9	40.5
		150	2.3	40.0
		160	1.6	41.4
		170	0.9	29.1
		180	3.7	33.2
		190	2.6	30.3
		210	0.7	25.6
		220	0.0	24.0
		230	2.5	41.1
		240	2.4	34.5
		260	5.2	41.2
		270	3.1	58.2
		280	1.0	31.2
		310	0.7	41.6
		320	0.4	34.7
		330	0.2	58.1
		340	0.6	36.5
		350	10.6	84.5
		360	0.4	35.3
		370	0.1	36.4
		380	0.6	38.6
398[a]		390	0.5	54.0
408[b]		400	0.4	60.4
418[c]		410	0.1	64.0
		419	1.5	40.5
		420	1.1	40.5
		422	2.1	40.5
		430	1.2	37.8
		440	1.4	26.6
		450	70.4	34.2
		460	124.6	51.8
		470	54.1	31.9
		480	844	27.3
496[d]		490	**1498**	25.9
		500	8.1	22.1
		510	3.7	20.4
		514	6.7	20.4
		Max	**1498**	
		Min	0	

Table 4-1
Photoionization Detector and Core Temperature Field Screening Data

KAFB-106S9

Historical DTW (Ft bgs)	Drilling Method	Depth (ft bgs)	PID (ppm-v)	Temperature (°C)
	SONIC CORING	9	0.0	24.6
		19	0.0	23.9
		29	0.0	20.2
		39	0.0	20.2
		49	0.0	20.8
		55	0.0	23.7
		59	0.0	20.6
		69	0.0	20.4
		79	0.0	19.7
		89	0.0	21.0
		99	0.0	25.3
		109	0.0	21.3
		119	0.0	21.8
		129	0.0	20.9
		139	0.0	24.9
		150	1.5	21.7
		159	0.0	26.0
		169	0.0	25.0
		175	1.8	19.3
		179	0.0	23.8
		190	0.0	49.3
		197	0.0	27.4
		209	0.0	26.9
		222	0.5	39.5
		229	5.8	34.8
		239	0.0	19.2
		243	1.6	25.9
		244	8.9	25.9
		247	1.4	21.3
		249	1.5	22.7
		252	6.0	22.7
		259	4.6	29.0
		269	7.7	24.8
		280	3.4	29.4
		289	1.1	20.2
		300	0.8	24.3
		309	0.6	24.2
		319	0.7	25.9
		329	1.4	25.1
		341	31.0	21.6
		350	0.8	31.6
		359	1.3	29.3
		369	2.1	31.5
		371	2.2	24.9
		379	1.2	31.7
396[a]		389	1.5	27.5
406[b]		399	1.4	49.5
		407	2.8	33.2
416[c]		409	1.9	33.4
		419	1.5	28.7
		429	1.8	32.7
		433	1.7	48.1
		443	1.2	31.9
		449	0.5	26.8
		459	12.2	25.1
		460	159.0	27.6
		461	96.1	27.6
		463	143.2	25.4
		465	305.0	26.5
		466	379.8	23.2
		470	519.4	23.7
		471	**1440**	21.3
		472	**2531**	21.3
		475	**2557**	22.0
		481	**1679**	34.4
		485	**1565**	25.8
494[d]		490	**1453**	29.8
		496*	**4880**	20.4
		498	**1496**	20.4
		500	230.8	20.5
		501	419.9	20.7
		Max	**4880**	
		Min	0.0	

Table 4-1
Photoionization Detector and Core Temperature Field Screening Data

KAFB-106247				
Historical DTW (Ft bgs)	**Drilling Method**	**Depth (ft bgs)**	**PID (ppm-v)**	**Temperature (°C)**
	SONIC CORING	10	0.3	26.8
		20	0.5	22.8
		30	0.2	22.2
		40	0.6	26.7
		50	0.4	19.9
		60	0.9	21.5
		70	1.1	22.4
		80	0.8	32.2
		90	0.9	34.5
		100	1.1	38.7
		110	0.8	38.5
		120	0.7	27.2
		130	1.1	34.8
		140	0.7	32.9
		150	0.6	35.6
		160	0.6	26.5
		170	0.6	24.7
		180	0.5	29.4
		190	0.1	28.5
		200	0.5	27.7
		210	0.8	23.5
		220	0.3	26.0
		230	0.5	26.7
		240	1.5	30.6
		250	0.8	34.5
		260	0.6	44.6
		270	0.7	35.8
		280	0.3	30.4
		290	1.2	46.4
		300	0.8	46.9
		310	0.5	53.0
		320	0.9	53.1
		330	0.9	36.1
		340	0.8	29.1
		350	1.1	48.2
		360	1.1	38.1
		370	1.1	40.1
		380	0.4	38.5
399[a]		390	1.5	36.3
409[b]		400	0.3	48.3
419[c]		410	0.2	41.1
		420	4.5	51.2
		430	4.7	65.3
		440	0.5	21.2
		450	0.3	55.5
		460	0.7	34.9
		470	1.4	27.4
		480	1.4	42.5
497[d]		490	1.3	34.7
		500	0.6	34.4
		510	2.7	34.4
		515	1.0	34.4
		Max	4.7	
		Min	0.1	

Table 4-1
Photoionization Detector and Core Temperature Field Screening Data

KAFB-106V1			
Drilling Method	**Depth (ft bgs)**	**PID (ppm-v)**	**Temperature (°C)**
SONIC CORING	10	36.1	24.5
	20	**2547**	24.9
	30	**2330**	22.1
	40	**2434**	21.6
	50	**2991**	21.9
	60	**3131**	22.1
	70	**2834**	22.5
	80	**2271**	22.5
	90	**2546**	22.2
	100	**3097**	23.2
	102	**2560**	30.8
	104	**2600**	30.8
	115	**3825**	30.7
	116	**3402**	31.1
	118	**2981**	28.7
	120	**2179**	29.3
	130	**3278**	25.1
	138	**3246**	26.5
	150	**3163**	24.9
	158	**4229**	29.6
	160	**5743**	32.3
	162	**4270**	32.3
	170	**4338**	28.6
	180	**3578**	33.4
	190	**3463**	37.6
	200	**3201**	27.2
	210	**2812**	28.4
	215	**2647**	27.3
	216	**2965**	27.3
	218	**1459**	27.3
	220	**3491**	26.1
	230	**2154**	34.4
	240	**6831**	32.7
	250	**4450**	24.0
	252	**7263**	24.0
	254	**8563**	24.0
	260	**4049**	28.1
	270	**1788**	35.4
	280	**3681**	28.3
	281	**1439**	27.4
	283	**1363**	27.4
	285	**1160**	27.4
	Max	**8563**	
	Min	36.1	

Table 4-1
Photoionization Detector and Core Temperature Field Screening Data

KAFB-106V2			
Drilling Method	**Depth (ft bgs)**	**PID (ppm-v)**	**Temperature (°C)**
SONIC CORING	10	173.0	23.0
	20	384.0	24.5
	30	221.9	24.4
	40	373.6	27.4
	50	**2701**	27.7
	60	**3239**	25.0
	70	**2359**	23.2
	80	**3254**	28.9
	90	**2288**	67.9
	100	**1778**	57.2
	110	**1972**	25.7
	115	**1805**	25.4
	116	**2075**	25.4
	118	**1609**	25.4
	120	**1724**	29.0
	130	**1904**	27.7
	140	**2230**	29.5
	150	**1806**	27.4
	158	**2264**	20.8
	160	**2040**	23.9
	162	**1944**	25.4
	170	**2706**	25.9
	180	**2385**	27.4
	190	**2687**	28.8
	200	**3331**	32.8
	210	**3351**	24.3
	215	**3023**	31.2
	216	**2552**	23.3
	218	**2233**	22.0
	220	**3087**	34.5
	230	**3633**	32.2
	250	**3033**	28.5
	254	**3507**	28.5
	255	**3334**	28.5
	260	**3707**	23.4
	270	963.3	23.9
	275	452.1	28.4
	278	122.8	28.4
	280	702.2	36.5
	280	231.3	36.5
	281	71.3	34.3
	283	25.5	23.3
	285	34.0	**27.9**
	Max	**3707**	
	Min	25.5	

Table 4-1
Photoionization Detector Field Screening Data

Historical depths to water reference "Rice, S., G. Oelsner, and C. Heywood. 2014. *Simulated and measured water levels and estimated water-level changes in the Albuquerque area, central New Mexico* . 1950–2012: U.S. Geological Survey Scientific Investigations Map 3305, 1 sheet."

[a] 1950 historical depth to water

[b] 1960 historical depth to water

[c] 1970 historical depth to water

[d] 2009 historical depth to water

* Indicates sample was disturbed during collection

Note - "-" indicates temperature readings were not collected due to ARCH drilling of that interval.

ARCH = air rotary casing hammer

bgs = below ground surface

°C = degrees Celsius

ft = foot/feet

DTW = depth to water

PID = photoionization detector

ppm-v = parts per million by volume

Bold print PID numbers indicate readings greater than 1000 ppm.

Table 4-2
Groundwater and LNAPL Properties

Well ID	Sample Date	Fluid Type	Temperature (˚F)	Specific Gravity (ASTM D1481)[a]	Density (ASTM D1481)[a] (g/cc)	Viscosity (ASTM D445)	
						Centistokes	Centipoise
KAFB-106079	11/26/2018	LNAPL	70	0.7593	0.7592	1.02	0.78
			100	0.7507	0.7455	0.83	0.62
			130	0.7421	0.7317	0.70	0.52
KAFB-106150	12/3/2018	GW	70	0.9983	0.9981	1.00	1.00
			100	1.0001	0.9931	0.70	0.69
			130	0.9982	0.9842	0.52	0.51

Phase Pair[b,c]		Temperature (˚F)	Interfacial Tension (ASTM D971) (Dynes/cm)
GW	Air	72.4	57.2
NAPL	Air	74.0	23.6
GW	NAPL	73.4	18.4

[a] Analysis performed by PTS Laboratories, Inc. (PTS File No. 48275).

[b] Data from: U.S. Army Corps of Engineers (USACE). 2012. "*Quarterly Pre-Remedy Monitoring and Site Investigation Report for October – December 2011. Units ST-106 and SS-111, Kirtland Air Force Base, New Mexico".* Prepared by Shaw Environmental & Infrastructure, Inc. for USACE-Albuquerque District under USACE Contract No. W912DY-10-D-0014, Delivery Order 0002. June.

[c] Samples collected from monitoring well KAFB-106076.

ASTM = ASTM International
cm = centimeter
°F = degrees Fahrenheit
g/cc = grams per cubic centimeter
GW = groundwater
LNAPL = light non-aqueous phase liquid
NAPL = non-aqueous phase liquid

Table 4-3
Well Construction Details for Groundwater Monitoring Wells

Well ID	DTW (ft bgs)	Install Date	Survey Data					Well Construction Details									
			State Plane Coordinate System (NAD83)		Elevations (NAVD88)							3.5-inch Outside Diameter, Schedule 80 PVC					
			Northing (ft)	Easting (ft)	Top of PVC Casing (ft amsl)	Ground Surface (ft amsl)	Measuring Point Elevation (ft amsl)	Bentonite Pellets		10/20 Silica Sand		Blank Casing		Screen[b]		Sump	
								Top (ft bgs)	Bottom (ft bgs)	Top (ft bgs)	Bottom (ft bgs)	Top[a] (ft bgs)	Bottom (ft bgs)	Top (ft bgs)	Bottom (ft bgs)	Top (ft bgs)	Bottom (ft bgs)
KAFB-106S1-447	472	18-Feb-19	1473216.755	1541850.937	5344.69	5345.20	5345.22	440	445	445	495	0.5	447	447	487	487	489
KAFB-106S1-413			1473216.855	1541851.285	5344.68			377.5	411	411	440	0.5	413	413	438	438	440
KAFB-106S2-451	476	21-Nov-18	1473687.54	1542191.48	5351.82	5349.20	5352.40	444	448.8	448.8	502	-2.5	451	451	491	491	493
KAFB-106S2-417			1473687.22	1542191.37	5351.82			384	415.1	415.1	444	-2.5	417	417	442	442	444
KAFB-106S3-449	474	29-Nov-18	1474075.66	1542418.88	5350.45	5347.84	5351.01	441.8	447	447	512	-2.4	449	449	489	489	491
KAFB-106S3-415			1474075.65	1542418.47	5350.45			380	412.5	412.5	441.8	-2.4	414.8	414.8	439.8	439.8	441.8
KAFB-106S4-446	471	16-Nov-18	1474026.65	1541872.75	5346.11	5343.36	5346.57	438.9	443.3	443.3	497	-2.5	446	446	486	486	488
KAFB-106S4-412			1474026.57	1541872.34	5346.11			375.9	409.9	409.9	438.9	-2.5	412	412	437	437	439
KAFB-106S5-446	471	5-Nov-18	1474742.59	1542453.32	5343.09	5343.52	5343.58	438.8	444.3	444.3	500	0.5	446	446	486	486	488
KAFB-106S5-412			1474742.29	1542453.71	5343.16			375.7	409.5	409.5	438.8	0.5	412	412	437	437	439
KAFB-106S7-451	476	4-Feb-19	1474334.55	1542361.21	5348.57	5348.93	5348.88	443.9	449	449	505	0.3	451	451	491	491	493
KAFB-106S7-417			1474334.77	1542360.92	5348.58			384.8	414.9	414.9	443.9	0.3	417	417	441.9	441.9	443.9
KAFB-106S8-451	476	1-Mar-19	1473288.32	1542125.67	5350.90	5348.23	5351.45	444	449.3	449.3	496	-2.45	451	451	491	491	493
KAFB-106S8-417			1473288.63	1542125.84	5350.95			384.7	414.6	414.6	444	-2.5	417	417	442	442	444
KAFB-106S9-447	472	8-Nov-18	1473692.77	1541783.29	5344.98	5345.71	5345.82	440.1	444.9	444.9	496	0.8	447	447	487	487	489
KAFB-106S9-413			1473692.91	1541782.91	5345.01			377	408.8	408.8	440.1	0.8	413	413	438	438	440
KAFB-106247-450	475	1-Mar-19	1472657.82	1542665.809	5350.72	5348.26	5351.60	442.8	448	448	500	-2.06	450	450	490	490	492
KAFB-106247-416			1472657.798	1542666.173	5350.78			378	413	413	442.8	-2	416	416	441	441	443

[a] Negative values are due to wells completed aboveground.

[b] Screen is 0.010-inch slot.

amsl = above mean sea level

bgs = below ground surface

DTW = depth to water at time of well construction

ft = foot/feet

ID = identification
NAD83 = North American Datum of 1983
NAVD88 = North American Vertical Datum of 1988
PVC = polyvinyl chloride

Table 4-4
Groundwater Analytical Results for First Sampling Event

						Well Location ID:	KAFB-106S1-447			KAFB-106S2-451			KAFB-106S2-451			KAFB-106S3-449		
						Field Sample ID:	GWS1-447-192			GWS2-451-191			GWS2-451-591			GWS3-449-191		
						Sample Date:	4/16/2019			1/15/2019			1/15/2019			1/15/2019		
						Sample Type:	REG			REG			Field Duplicate			REG		
						Sample Depth (ft bgs):	471.12											
						Reference Elevation Interval (ft AMSL):	471.12											
Parameter	**Analytic Method**	**Analyte**	**NMWQCC GW 2018**	**EPA MCL NOV18**	**EPA RSL**	**Project Screening Level**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
EDB	SW8011 (ug/L)	1,2-Dibromoethane	0.05	0.05	0.075	0.05	**250**	--	97	**240**	--	37	--	--	--	**0.13**	--	0.019
VOCs	SW8260C (ug/L)	Benzene	5	5	4.6	5	**6600**	--	100	**6400**	--	100	--	--	--	**4800**	--	10
		Ethylbenzene	700	700	15	700	580	--	160	**1200**	--	16	--	--	--	**1500**	--	16
		Toluene	1000	1000	1,100	1000	**8900**	--	100	**12000**	--	100	--	--	--	**10000**	--	100
		Xylenes, total	620	10000	190	620	**2400**	--	400	**5300**	--	40	--	--	--	**4600**	--	40
Metals	SW6010C (mg/L)	Calcium	NS	NS	NS	NS	75.9	--	0.1	95.8	--	0.1	--	--	--	150	--	0.1
		Iron, dissolved	1	NS	NS	NS	—	--	—	**1.57**	J	0.1	--	--	--	**1.38**	J	0.1
		Magnesium	NS	NS	NS	NS	12.5	--	0.05	16.2	--	0.05	--	--	--	25.3	--	0.05
		Manganese, dissolved	0.2	NS	NS	NS	—	--	—	**4.44**	--	0.0025	--	--	--	**5.46**	--	0.0025
		Potassium	NS	NS	NS	NS	3.26	--	0.375	3.67	--	0.375	--	--	--	4.76	--	0.375
		Sodium	NS	NS	NS	NS	28.8	--	0.5	34.1	--	0.5	--	--	--	45.1	--	0.5
	SW6020A (mg/L)	Arsenic	0.01	0.01	0.00052	0.01	0.002	--	0.0016	0.005	--	0.0016	--	--	--	0.0037	--	0.0016
		Lead	0.015	0.015	0.015	0.015	ND	U	0.0024	ND	U	0.0024	--	--	--	ND	U	0.0024
Anions	E300.0 (mg/L)	Bromide	NS	NS	NS	NS	—	--	—	ND	U	2	2.1	J	2	3	--	2
		Chloride	250	NS	NS	250	—	--	—	29.2	--	3	31.7	--	3	106	--	15
		Sulfate	600	NS	NS	250	—	--	—	4.7	J	4.5	4.7	J	4.5	ND	U	4.5
	E353.2 (mg/L)	Nitrogen as nitrate + nitrite	NS	NS	NS	10	—	--	—	ND	U	0.09	ND	U	0.09	ND	U	0.09
Alkalinity	SM2320B (mg/L)	Alkalinity, bicarbonate (as CaCO3)	NS	NS	NS	NS	—	--	—	260	--	4	--	--	--	370	--	4
		Alkalinity, carbonate (as CaCO3)	NS	NS	NS	NS	—	--	—	ND	U	4	--	--	--	ND	U	4
		Alkalinity, total (as CaCO3)	NS	NS	NS	NS	—	--	—	260	--	4	--	--	--	370	--	4
	RSK-175 (ug/L)	Carbon dioxide	NS	NS	NS	NS	24000	--	8000	--	--	--	--	--	--	--	--	--
		Methane	NS	NS	NS	NS	4.7	J	5.9	--	--	--	--	--	--	--	--	--

Table 4-4
Groundwater Analytical Results for First Sampling Event

						Well Location ID:	KAFB-106S3-449			KAFB-106S4-446			KAFB-106S4-446			KAFB-106S5-446		
						Field Sample ID:	GWS3-449-591			GWS4-446-191			GWS4-446-591			GWS5-446-191		
						Sample Date:	1/15/2019			1/15/2019			1/15/2019			1/15/2019		
						Sample Type:	Field Duplicate			REG			Field Duplicate			REG		
						Sample Depth (ft bgs):												
						Reference Elevation Interval (ft AMSL):												
Parameter	**Analytic Method**	**Analyte**	**NMWQCC GW 2018**	**EPA MCL NOV18**	**EPA RSL**	**Project Screening Level**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
EDB	SW8011 (ug/L)	1,2-Dibromoethane	0.05	0.05	0.075	0.05	--	--	--	0.039	--	0.019	--	--	--	**17**	--	1.9
VOCs	SW8260C (ug/L)	Benzene	5	5	4.6	5	--	--	--	ND	U	0.5	--	--	--	**1600**	--	5
		Ethylbenzene	700	700	15	700	--	--	--	ND	U	0.8	--	--	--	**1400**	--	8
		Toluene	1000	1000	1,100	1000	--	--	--	ND	U	0.5	--	--	--	**3500**	J	50
		Xylenes, total	620	10000	190	620	--	--	--	ND	U	2	--	--	--	**2200**	--	20
Metals	SW6010C (mg/L)	Calcium	NS	NS	NS	NS	--	--	--	192	--	0.1	191	--	0.1	70.3	--	0.1
		Iron, dissolved	1	NS	NS	NS	**1.85**	J	0.1	ND	U	0.1	--	--	--	**2.65**	J	0.1
		Magnesium	NS	NS	NS	NS	--	--	--	30.1	--	0.05	29.7	--	0.05	11.3	--	0.05
		Manganese, dissolved	0.2	NS	NS	NS	**5.8**	--	0.0025	0.0014	J	0.0025	--	--	--	**2.03**	--	0.0025
		Potassium	NS	NS	NS	NS	--	--	--	5.2	--	0.375	5.99	--	0.375	3.13	--	0.375
		Sodium	NS	NS	NS	NS	--	--	--	68.7	--	0.5	69.2	--	0.5	31.5	--	0.5
	SW6020A (mg/L)	Arsenic	0.01	0.01	0.00052	0.01	--	--	--	0.00075	J	0.0016	0.002	J	0.0016	0.005	--	0.0016
		Lead	0.015	0.015	0.015	0.015	--	--	--	ND	U	0.0024	0.0011	J	0.0024	ND	U	0.0024
Anions	E300.0 (mg/L)	Bromide	NS	NS	NS	NS	--	--	--	3.3	--	2	--	--	--	1.5	J	2
		Chloride	250	NS	NS	250	--	--	--	188	--	30	--	--	--	22.2	J	1.5
		Sulfate	600	NS	NS	250	--	--	--	347	J	90	--	--	--	2.3	J	4.5
	E353.2 (mg/L)	Nitrogen as nitrate + nitrite	NS	NS	NS	10	--	--	--	7.6	--	0.45	--	--	--	ND	U	0.09
Alkalinity	SM2320B (mg/L)	Alkalinity, bicarbonate (as CaCO3)	NS	NS	NS	NS	--	--	--	102	--	4	--	--	--	246	--	4
		Alkalinity, carbonate (as CaCO3)	NS	NS	NS	NS	--	--	--	ND	U	4	--	--	--	ND	U	4
		Alkalinity, total (as CaCO3)	NS	NS	NS	NS	--	--	--	102	--	4	--	--	--	246	--	4
	RSK-175 (ug/L)	Carbon dioxide	NS	NS	NS	NS	--	--	--	--	--	--	--	--	--	--	--	--
		Methane	NS	NS	NS	NS	--	--	--	--	--	--	--	--	--	--	--	--

Table 4-4
Groundwater Analytical Results for First Sampling Event

			Well Location ID:				KAFB-106S5-446			KAFB-106S7-451			KAFB-106S8-451			KAFB-106S9-447		
			Field Sample ID:				GWS5-446-591			GWS7-491-192			GWS8-491-192			GWS9-447-191		
			Sample Date:				1/15/2019			4/16/2019			4/16/2019			1/15/2019		
			Sample Type:				Field Duplicate			REG			REG			REG		
			Sample Depth (ft bgs):							475.1								
			Reference Elevation Interval (ft AMSL):							475.1								
Parameter	**Analytic Method**	**Analyte**	**NMWQCC GW 2018**	**EPA MCL NOV18**	**EPA RSL**	**Project Screening Level**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
EDB	SW8011 (ug/L)	1,2-Dibromoethane	0.05	0.05	0.075	0.05	**17**	--	3.8	**8.7**	--	0.95	**96**	--	19	**120**	--	38
VOCs	SW8260C (ug/L)	Benzene	5	5	4.6	5	**1700**	--	5	**3800**	--	25	**2100**	--	100	**8800**	--	100
		Ethylbenzene	700	700	15	700	**1400**	--	8	450	--	40	550	--	160	**1400**	--	16
		Toluene	1000	1000	1,100	1000	**6700**	J	50	**3600**	--	25	**10000**	--	100	**14000**	--	100
		Xylenes, total	620	10000	190	620	**2200**	--	20	**2200**	--	100	**2700**	--	400	**4600**	--	40
Metals	SW6010C (mg/L)	Calcium	NS	NS	NS	NS	--	--	--	122	--	0.1	82.7	--	0.1	97.3	--	0.1
		Iron, dissolved	1	NS	NS	NS	--	--	--	—	--	—	—	--	—	**4**	J	0.1
		Magnesium	NS	NS	NS	NS	--	--	--	21.4	--	0.05	13.3	--	0.05	17.4	--	0.05
		Manganese, dissolved	0.2	NS	NS	NS	--	--	--	—	--	—	—	--	—	**2.07**	--	0.0025
		Potassium	NS	NS	NS	NS	--	--	--	4.12	--	0.375	3.27	--	0.375	4.28	--	0.375
		Sodium	NS	NS	NS	NS	--	--	--	40	--	0.5	31.6	--	0.5	36.1	--	0.5
	SW6020A (mg/L)	Arsenic	0.01	0.01	0.00052	0.01	--	--	--	0.0026	--	0.0016	0.0011	J	0.0016	0.0042	--	0.0016
		Lead	0.015	0.015	0.015	0.015	--	--	--	ND	U	0.0024	ND	U	0.0024	ND	U	0.0024
Anions	E300.0 (mg/L)	Bromide	NS	NS	NS	NS	--	--	--	—	--	—	—	--	—	1.8	J	2
		Chloride	250	NS	NS	250	--	--	--	—	--	—	—	--	—	26.9	--	1.5
		Sulfate	600	NS	NS	250	--	--	--	—	--	—	—	--	—	21.5	J	4.5
	E353.2 (mg/L)	Nitrogen as nitrate + nitrite	NS	NS	NS	10	--	--	--	—	--	—	—	--	—	ND	U	0.09
Alkalinity	SM2320B (mg/L)	Alkalinity, bicarbonate (as CaCO3)	NS	NS	NS	NS	--	--	--	—	--	—	—	--	—	291	--	4
		Alkalinity, carbonate (as CaCO3)	NS	NS	NS	NS	--	--	--	—	--	—	—	--	—	ND	U	4
		Alkalinity, total (as CaCO3)	NS	NS	NS	NS	--	--	--	—	--	—	—	--	—	291	--	4
	RSK-175 (ug/L)	Carbon dioxide	NS	NS	NS	NS	--	--	--	63000	--	8000	13000	--	8000	--	--	--
		Methane	NS	NS	NS	NS	--	--	--	ND	U	5.9	ND	U	5.9	--	--	--

Table 4-4
Groundwater Analytical Results for First Sampling Event

						Well Location ID:	KAFB-106S9-447			KAFB-106247-450			KAFB-106S7-451		
						Field Sample ID:	GWS9-447-591			GW247-490-192			GWS7-491-192		
						Sample Date:	1/15/2019			4/16/2019			4/16/2019		
						Sample Type:	Field Duplicate			REG			REG		
						Sample Depth (ft bgs):				477.42			475.1		
						Reference Elevation Interval (ft AMSL):				477.42			475.1		
Parameter	**Analytic Method**	**Analyte**	**NMWQCC GW 2018**	**EPA MCL NOV18**	**EPA RSL**	**Project Screening Level**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
EDB	SW8011 (ug/L)	1,2-Dibromoethane	0.05	0.05	0.075	0.05	--	--	--	ND	U	0.019	**8.7**	--	0.95
VOCs	SW8260C (ug/L)	Benzene	5	5	4.6	5	--	--	--	ND	U	0.5	**3800**	--	25
		Ethylbenzene	700	700	15	700	--	--	--	ND	U	0.8	450	--	40
		Toluene	1000	1000	1,100	1000	--	--	--	ND	U	0.5	**3600**	--	25
		Xylenes, total	620	10000	190	620	--	--	--	ND	U	2	**2200**	--	100
Metals	SW6010C (mg/L)	Calcium	NS	NS	NS	NS	--	--	--	38.1	--	0.1	122	--	0.1
		Iron, dissolved	1	NS	NS	NS	--	--	--	—	--	—	—	--	—
		Magnesium	NS	NS	NS	NS	--	--	--	6.14	--	0.05	21.4	--	0.05
		Manganese, dissolved	0.2	NS	NS	NS	--	--	--	—	--	—	—	--	—
		Potassium	NS	NS	NS	NS	--	--	--	2.87	--	0.375	4.12	--	0.375
		Sodium	NS	NS	NS	NS	--	--	--	25.3	--	0.5	40	--	0.5
	SW6020A (mg/L)	Arsenic	0.01	0.01	0.00052	0.01	--	--	--	0.00084	J	0.0016	0.0026	--	0.0016
		Lead	0.015	0.015	0.015	0.015	--	--	--	ND	U	0.0024	ND	U	0.0024
Anions	E300.0 (mg/L)	Bromide	NS	NS	NS	NS	--	--	--	—	--	—	—	--	—
		Chloride	250	NS	NS	250	--	--	--	—	--	—	—	--	—
		Sulfate	600	NS	NS	250	--	--	--	—	--	—	—	--	—
	E353.2 (mg/L)	Nitrogen as nitrate + nitrite	NS	NS	NS	10	--	--	--	—	--	—	—	--	—
Alkalinity	SM2320B (mg/L)	Alkalinity, bicarbonate (as CaCO3)	NS	NS	NS	NS	287	--	4	—	--	—	—	--	—
		Alkalinity, carbonate (as CaCO3)	NS	NS	NS	NS	ND	U	4	—	--	—	—	--	—
		Alkalinity, total (as CaCO3)	NS	NS	NS	NS	287	--	4	—	--	—	—	--	—
	RSK-175 (ug/L)	Carbon dioxide	NS	NS	NS	NS	--	--	--	4600	J	8000	63000	--	8000
		Methane	NS	NS	NS	NS	--	--	--	ND	U	5.9	ND	U	5.9

Table 4-4
Groundwater Analytical Results for First Sampling Event

[a] Full suite of analytes was collected over two sample dates.

[b] NMWQCC numeric standards per the NMAC Title 20.6.2.3101A, Standards for Ground Water of 10,000 mg/L Total Dissolved Solids Concentration or Less (NMAC 2018). For metals, the NMWQCC numeric standard applies to dissolved metals.

[c] EPA National Primary Drinking Water Regulations, MCLs and Secondary MCLs, Title 40CFR Part 141, 143 (May 2018).

[d] EPA Region 6 RSL for Tapwater (May 2019) for hazard index = 1.0 for noncarcinogens and a 10-5 cancer risk level for carcinogens.

[e] The project screening level was selected to satisfy the requirements of the Kirtland AFB Hazardous Waste Permit Number NM9570024423 as the lowest of (1) NMWQCC numeric standard or (2) EPA MCL. If no NMQWCC standard or MCL exists for any analyte, then the project screening level will be the EPA RSL.

[f] Based on the geochemical equilibrium of the site groundwater and previous site data analyses, nitrate/nitrite results represent nitrate concentrations.

µg/L = microgram per liter
AFB = Air Force Base
AMSL = above mean sea level
BFF = Bulk Fuels Facility
bgs = beloww ground surface
$CaCO_3$ = calcium carbonate
CFR = Code of Federal Regulations
EDB = ethylene dibromide (1,2-dibromoethane)
EPA = U.S. Environmental Protection Agency
ft = foot/feet
ID = identification
KAFB = Kirtland Air Force Base
LOD = limit of detection
MCL = maximum contaminant level
mg/L = milligram per liter
ND = not detected
NMAC = New Mexico Administrative Code
NMWQCC = New Mexico Water Quality Control Commission
NS = not specified
REG = normal field sample
RSL = regional screening level
SWMU = Solid Waste Management Unit
Val Qual = validation qualifier
VOC = volatile organic compound
Shading = detected concentrations above the detection limit
Bold/Shading = reported concentrations exceed the project screening level
Val Quals based on independent data validation

J = Qualifier denotes the analyte was positively identified, but the associated numerical value is estimated.

U = Qualifier denotes the analyte was analyzed but not detected above the detection limit. The value associated with the U-qualifier is the LOD.
-- = Validation qualifier not assigned.
— = Compound not analyzed for.

Table 4-5
Well Construction Details for Soil Vapor Monitoring Wells

		Survey Data					Well Construction Details									
		State Plane Coordinate System (NAD83)		Elevations (NAVD88)							3/4-inch Outside Diameter, Schedule 80 PVC					
							Bentonite Pellets		10/20 Silica Sand		Blank Casing		Screen[a]		Sump	
Well ID	Install Date	Northing (ft)	Easting (ft)	Top of PVC Casing (ft amsl)	Ground Surface (ft amsl)	Point Elevation (ft amsl)	Top (ft bgs)	Bottom (ft bgs)	Top (ft bgs)	Bottom (ft bgs)	Top (ft bgs)	Bottom (ft bgs)	Top (ft bgs)	Bottom (ft bgs)	Top (ft bgs)	Bottom (ft bgs)
KAFB-106V1-102	24-Jan-19	1473505.97	1541395.12	5343.26	5343.31	5343.57	3	99	99	103.5	0.5	100.1	100.1	102.1	102.1	102.5
KAFB-106V1-113		1473505.62	1541395.62	5343.24			103.5	109.5	109.5	114.6	0.5	110.6	110.6	112.6	112.6	113
KAFB-106V1-160		1473505.39	1541395.28	5343.26			114.6	156.5	156.5	161.2	0.5	157.6	157.6	159.6	159.6	160
KAFB-106V1-217		1473505.76	1541394.95	5343.25			161.2	214	214	218	0.5	215.1	215.1	217.1	217.1	217.5
KAFB-106V1-252		1473505.59	1541395.22	5343.25			218	248.8	248.8	253	0.5	250.1	250.1	252.1	252.1	252.5
KAFB-106V1-263		1473505.75	1541395.29	5343.26			253	260	260	266	0.5	260.6	260.6	262.6	262.6	263
KAFB-106V2-102	24-Jan-19	1473521.12	1541443.66	5343.47	5343.65	5343.91	3	98.5	98.5	103.5	0.5	100.2	100.2	102.2	102.2	102.6
KAFB-106V2-117		1473520.95	1541443.51	5343.46			103.5	113.9	113.9	118.5	0.5	115.1	115.1	117.1	117.1	117.5
KAFB-106V2-160		1473521.18	1541443.45	5343.5			118.5	156.1	156.1	161.5	0.5	157.9	157.9	159.9	159.9	160.3
KAFB-106V2-217		1473521.03	1541443.27	5343.49			161.5	213.2	213.2	218.7	0.5	215.1	215.1	217.1	217.1	217.5
KAFB-106V2-252		1473521.09	1541443.06	5343.51			218.7	249.5	249.5	253.5	0.5	250.2	250.2	252.2	252.2	252.6
KAFB-106V2-270		1473521.28	1541443.28	5343.49			253.5	266.4	266.4	270.2	0.5	267.55	267.55	269.55	269.55	269.95

[a] Screen is 0.010-inch slot.

amsl = above mean sea level

bgs = below ground surface

ft = foot/feet

ID = identification

NAD83 = North American Datum of 1983

NAVD88 = North American Vertical Datum on 1988

PVC = polyvinyl chloride

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

			Boring ID:	KAFB-106S1			KAFB-106S1			KAFB-106S1			KAFB-106S1			KAFB-106S1		
			Sample Date:	11/27/2018			11/27/2018			11/29/2018			11/29/2018			12/1/2018		
			Sample Depth (ft bgs):	20			140			260			279			400		
			Sample Type:	REG			REG			REG			REG			REG		
			Core Temperature (°C)		**25.5**			**53.8**			**56.2**			**60.1**			**27.7**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
Total Petroleum Hydrocarbons	Method SW8015 (mg/kg)	Motor Oil (C20-C38)	MOIL	ND	U	23	17	J	26	12	J	26	ND	UJ	27	ND	U	23
		TPH-DRO (C10-C28)	TPH-DRO	ND	U	3.9	ND	U	4.5	ND	U	4.5	ND	UJ	4.7	ND	U	4
		TPH-GRO (C6-C10)	TPH-GRO	ND	U	1.5	ND	U	1.5	ND	U	1.4	ND	U	1.6	ND	U	1.3
Moisture	Percent Moisture (%) TPH	NA	NA	8.2	--	--	11.5	--	--	12.7	--	--	19	--	--	3.6	--	--
EDB	Method SW8011 (mg/kg)[a]	1,2-Dibromoethane	106-93-4	—	—	—	ND	U	0.000044	ND	U	0.000044	ND	U	0.000045	ND	U	4E-05
Moisture	Percent Moisture (%) EDB	NA	NA	—	—	—	13.4	--	--	13.6	--	--	16.1	--	--	3.8	--	--
VOCs	Method SW8260B (mg/kg)[a]	1,1,1,2-Tetrachloroethane	630-20-6	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		1,1,1-Trichloroethane	71-55-6	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		1,1,2,2-Tetrachloroethane	79-34-5	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		1,1,2-Trichloroethane	79-00-5	—	—	—	ND	U	0.0044	ND	U	0.0038	ND	UJ	0.0035	ND	U	0.0032
		1,1-Dichloroethane	75-34-3	—	—	—	ND	U	0.0011	ND	U	0.00096	ND	UJ	0.00088	ND	U	0.0008
		1,1-Dichloroethene	75-35-4	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		1,1-Dichloropropene	563-58-6	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		1,2,3-Trichlorobenzene	87-61-6	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		1,2,3-Trichloropropane	96-18-4	—	—	—	ND	U	0.0044	ND	U	0.0038	ND	UJ	0.0035	ND	U	0.0032
		1,2,4-Trichlorobenzene	120-82-1	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		1,2,4-Trimethylbenzene	95-63-6	—	—	—	ND	U	0.0044	ND	U	0.0038	ND	UJ	0.0035	ND	U	0.0032
		1,2-Dibromo-3-Chloropropane	96-12-8	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		1,2-Dibromoethane	106-93-4	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		1,2-Dichlorobenzene	95-50-1	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		1,2-Dichloroethane	107-06-2	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		1,2-Dichloroethene	540-59-0	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		1,2-Dichloropropane	78-87-5	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		1,3,5-Trimethylbenzene	108-67-8	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		1,3-Dichlorobenzene	541-73-1	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		1,3-Dichloropropane	142-28-9	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		1,4-Dichlorobenzene	106-46-7	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		2,2-Dichloropropane	594-20-7	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		2-Butanone	78-93-3	—	—	—	ND	U	0.0089	ND	U	0.0077	ND	UJ	0.0071	0.013	J	0.0063
		2-Chlorotoluene	95-49-8	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		2-Hexanone	591-78-6	—	—	—	ND	U	0.018	0.0067	J	0.015	ND	UJ	0.014	ND	U	0.013
		4-Chlorotoluene	106-43-4	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		4-Isopropyltoluene	99-87-6	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		4-Methyl-2-Pentanone	108-10-1	—	—	—	ND	U	0.018	0.0054	J	0.015	ND	UJ	0.014	ND	U	0.013
		Acetone	67-64-1	—	—	—	ND	U	0.018	0.22	--	0.015	--	UJ	0.014	0.028	--	0.013
		Benzene	71-43-2	—	—	—	ND	U	0.0022	ND	U	0.0019	0.0096	J	0.0018	ND	U	0.0016

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

			Boring ID:	KAFB-106S1			KAFB-106S1			KAFB-106S1			KAFB-106S1			KAFB-106S1		
			Sample Date:	11/27/2018			11/27/2018			11/29/2018			11/29/2018			12/1/2018		
			Sample Depth (ft bgs):	20			140			260			279			400		
			Sample Type:	REG			REG			REG			REG			REG		
			Core Temperature (°C)		**25.5**			**53.8**			**56.2**			**60.1**			**27.7**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
VOCs	Method SW8260B (mg/kg)[a]	Bromobenzene	108-86-1	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		Bromochloromethane	74-97-5	—	—	—	ND	U	0.0011	ND	U	0.00096	ND	UJ	0.00088	ND	U	0.0008
		Bromodichloromethane	75-27-4	—	—	—	ND	U	0.0011	ND	U	0.00096	ND	UJ	0.00088	ND	U	0.0008
		Bromoform	75-25-2	—	—	—	ND	U	0.0011	ND	U	0.00096	ND	UJ	0.00088	ND	U	0.0008
		Bromomethane	74-83-9	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		Carbon Disulfide	75-15-0	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		Carbon Tetrachloride	56-23-5	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		Chlorobenzene	108-90-7	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		Chloroethane	75-00-3	—	—	—	ND	U	0.0044	ND	U	0.0038	ND	UJ	0.0035	ND	U	0.0032
		Chloroform	67-66-3	—	—	—	ND	U	0.0011	ND	U	0.00096	ND	UJ	0.00088	ND	U	0.0008
		Chloromethane	74-87-3	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		Cis-1,2-Dichloroethene	156-59-2	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		Cis-1,3-Dichloropropene	10061-01-5	—	—	—	ND	U	0.0044	ND	U	0.0038	ND	UJ	0.0035	ND	U	0.0032
		Dibromochloromethane	124-48-1	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		Dibromomethane	74-95-3	—	—	—	ND	U	0.0044	ND	U	0.0038	ND	UJ	0.0035	ND	U	0.0032
		Dichlorodifluoromethane	75-71-8	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		Ethylbenzene	100-41-4	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		Hexachloro-1,3-Butadiene	87-68-3	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		Isopropylbenzene	98-82-8	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		m- & p-Xylenes	179601-23-1	—	—	—	ND	U	0.0044	ND	U	0.0038	0.0012	J	0.0035	ND	U	0.0032
		Methyl tert-Butyl Ether	1634-04-4	—	—	—	ND	U	0.0011	ND	U	0.00096	ND	UJ	0.00088	ND	U	0.0008
		Methylene Chloride	75-09-2	—	—	—	0.0061	J	0.0044	0.0053	J	0.0038	ND	UJ	0.0035	ND	U	0.0032
		Naphthalene	91-20-3	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		n-Butylbenzene	104-51-8	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		n-Propylbenzene	103-65-1	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		o-Xylene	95-47-6	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		sec-Butylbenzene	135-98-8	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		Styrene	100-42-5	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		tert-Butylbenzene	98-06-6	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		Tetrachloroethene	127-18-4	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		Toluene	108-88-3	—	—	—	ND	U	0.0022	0.0011	J	0.0019	0.02	J	0.0018	ND	U	0.0016
		Trans-1,2-Dichloroethene	156-60-5	—	—	—	ND	U	0.0011	ND	U	0.00096	ND	UJ	0.00088	ND	U	0.0008
		Trans-1,3-Dichloropropene	10061-02-6	—	—	—	ND	U	0.0022	ND	U	0.0019	ND	UJ	0.0018	ND	U	0.0016
		Trichloroethene	79-01-6	—	—	—	0.00066	J	0.0011	0.00033	J	0.00096	ND	UJ	0.00088	ND	U	0.0008
		Trichlorofluoromethane	75-69-4	—	—	—	ND	U	0.0044	ND	U	0.0038	ND	UJ	0.0035	ND	U	0.0032
		Vinyl Chloride	75-01-4	—	—	—	ND	U	0.0044	ND	U	0.0038	ND	UJ	0.0035	ND	U	0.0032
Moisture	Percent Moisture (%) VOCs	NA	NA	—	—	—	13.4	--	--	13.6	--	--	16.1	--	--	3.8	--	--

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

			Boring ID:	KAFB-106S1			KAFB-106S1			KAFB-106S1			KAFB-106S1			KAFB-106S1		
			Sample Date:	12/3/2018			12/4/2018			12/4/2018			12/5/2018			12/5/2018		
			Sample Depth (ft bgs):	414			459			461			475			480		
			Sample Type:	REG			REG			REG			REG			REG		
			Core Temperature (°C)		18.5			**25.3**			**35.6**			**22.7**			**27.3**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
Total Petroleum Hydrocarbons	Method SW8015 (mg/kg)	Motor Oil (C20-C38)	MOIL	ND	U	24	ND	U	27	ND	U	45	11	J	23	13	J	24
		TPH-DRO (C10-C28)	TPH-DRO	ND	U	4.2	91	--	4.6	2,000	--	7.7	630	--	4	670	--	4.1
		TPH-GRO (C6-C10)	TPH-GRO	ND	U	1.5	12	--	2	1,200	--	72	1,300	--	61	2,700	--	240
Moisture	Percent Moisture (%) TPH	NA	NA	8.6	--	--	18.1	--	--	8	--	--	9.4	--	--	9.1	--	--
EDB	Method SW8011 (mg/kg)[a]	1,2-Dibromoethane	106-93-4	ND	U	0.000041	0.0049	--	0.0024	0.11	--	0.0042	0.0086	--	0.44	0.056	--	2.1
Moisture	Percent Moisture (%) EDB	NA	NA	7.7	--	--	19.2	--	--	10.2	--	--	12.2	--	--	10.8	--	--
VOCs	Method SW8260B (mg/kg)[a]	1,1,1,2-Tetrachloroethane	630-20-6	ND	U	0.097	ND	U	1.2	ND	U	0.98	ND	U	0.89	ND	U	0.83
		1,1,1-Trichloroethane	71-55-6	ND	U	0.048	ND	U	0.6	ND	U	0.49	ND	U	0.45	ND	U	0.42
		1,1,2,2-Tetrachloroethane	79-34-5	ND	U	0.097	ND	U	1.2	ND	U	0.98	ND	U	0.89	ND	U	0.83
		1,1,2-Trichloroethane	79-00-5	ND	U	0.097	ND	U	1.2	ND	U	0.98	ND	U	0.89	ND	U	0.83
		1,1-Dichloroethane	75-34-3	ND	U	0.19	ND	U	2.4	ND	U	2	ND	U	1.8	ND	U	1.7
		1,1-Dichloroethene	75-35-4	ND	U	0.19	ND	U	2.4	ND	U	2	ND	U	1.8	ND	U	1.7
		1,1-Dichloropropene	563-58-6	ND	U	0.19	ND	U	2.4	ND	U	2	ND	U	1.8	ND	U	1.7
		1,2,3-Trichlorobenzene	87-61-6	ND	U	0.097	ND	U	1.2	ND	U	0.98	ND	U	0.89	ND	U	0.83
		1,2,3-Trichloropropane	96-18-4	ND	U	0.19	ND	U	2.4	ND	U	2	ND	U	1.8	ND	U	1.7
		1,2,4-Trichlorobenzene	120-82-1	ND	U	0.19	ND	U	2.4	ND	U	2	ND	U	1.8	ND	U	1.7
		1,2,4-Trimethylbenzene	95-63-6	ND	U	0.097	ND	U	1.2	24	--	0.98	14	--	0.89	17	--	0.83
		1,2-Dibromo-3-Chloropropane	96-12-8	ND	U	0.39	ND	U	4.8	ND	U	3.9	ND	U	3.6	ND	U	3.3
		1,2-Dibromoethane	106-93-4	ND	U	0.097	ND	U	1.2	ND	U	0.98	ND	U	0.89	ND	U	0.83
		1,2-Dichlorobenzene	95-50-1	ND	U	0.39	ND	U	4.8	ND	U	3.9	ND	U	3.6	ND	U	3.3
		1,2-Dichloroethane	107-06-2	ND	U	0.097	ND	U	1.2	ND	U	0.98	ND	U	0.89	ND	U	0.83
		1,2-Dichloroethene	540-59-0	ND	U	0.097	ND	U	1.2	ND	U	0.98	ND	U	0.89	ND	U	0.83
		1,2-Dichloropropane	78-87-5	ND	U	0.19	ND	U	2.4	ND	U	2	ND	U	1.8	ND	U	1.7
		1,3,5-Trimethylbenzene	108-67-8	ND	U	0.097	ND	U	1.2	15	--	0.98	7.3	--	0.89	7.7	--	0.83
		1,3-Dichlorobenzene	541-73-1	ND	U	0.19	ND	U	2.4	ND	U	2	ND	U	1.8	ND	U	1.7
		1,3-Dichloropropane	142-28-9	ND	U	0.097	ND	U	1.2	ND	U	0.98	ND	U	0.89	ND	U	0.83
		1,4-Dichlorobenzene	106-46-7	ND	U	0.097	ND	U	1.2	ND	U	0.98	ND	U	0.89	ND	U	0.83
		2,2-Dichloropropane	594-20-7	ND	U	0.097	ND	U	1.2	ND	U	0.98	ND	U	0.89	ND	U	0.83
		2-Butanone	78-93-3	ND	U	0.77	ND	U	9.7	ND	U	7.8	ND	U	7.2	ND	U	6.7
		2-Chlorotoluene	95-49-8	ND	U	0.097	ND	U	1.2	ND	U	0.98	ND	U	0.89	ND	U	0.83
		2-Hexanone	591-78-6	ND	U	0.77	ND	U	9.7	ND	U	7.8	ND	U	7.2	ND	U	6.7
		4-Chlorotoluene	106-43-4	ND	U	0.097	ND	U	1.2	ND	U	0.98	ND	U	0.89	ND	U	0.83
		4-Isopropyltoluene	99-87-6	ND	U	0.097	ND	U	1.2	3	--	0.98	1.7	J	0.89	1.3	J	0.83
		4-Methyl-2-Pentanone	108-10-1	ND	U	0.77	ND	U	9.7	ND	U	7.8	ND	U	7.2	ND	U	6.7
		Acetone	67-64-1	ND	U	1.5	ND	U	19	ND	U	16	ND	U	14	ND	U	13
		Benzene	71-43-2	ND	U	0.19	ND	U	2.4	ND	U	2	ND	U	1.8	2.2	J	1.7

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

		Boring ID:		KAFB-106S1			KAFB-106S1			KAFB-106S1			KAFB-106S1			KAFB-106S1		
		Sample Date:		12/3/2018			12/4/2018			12/4/2018			12/5/2018			12/5/2018		
		Sample Depth (ft bgs):		414			459			461			475			480		
		Sample Type:		REG			REG			REG			REG			REG		
		Core Temperature (°C)			18.5			**25.3**			**35.6**			**22.7**			**27.3**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
VOCs	Method SW8260B (mg/kg)[a]	Bromobenzene	108-86-1	ND	U	0.048	ND	U	0.6	ND	U	0.49	ND	U	0.45	ND	U	0.42
		Bromochloromethane	74-97-5	ND	U	0.19	ND	U	2.4	ND	U	2	ND	U	1.8	ND	U	1.7
		Bromodichloromethane	75-27-4	ND	U	0.097	ND	U	1.2	ND	U	0.98	ND	U	0.89	ND	U	0.83
		Bromoform	75-25-2	ND	U	0.19	ND	U	2.4	ND	U	2	ND	U	1.8	ND	U	1.7
		Bromomethane	74-83-9	ND	U	0.19	ND	U	2.4	ND	U	2	ND	U	1.8	ND	U	1.7
		Carbon Disulfide	75-15-0	ND	U	0.19	ND	U	2.4	ND	U	2	ND	U	1.8	ND	U	1.7
		Carbon Tetrachloride	56-23-5	ND	U	0.048	ND	U	0.6	ND	U	0.49	ND	U	0.45	ND	U	0.42
		Chlorobenzene	108-90-7	ND	U	0.097	ND	U	1.2	ND	U	0.98	ND	U	0.89	ND	U	0.83
		Chloroethane	75-00-3	ND	U	0.19	ND	U	2.4	ND	U	2	ND	U	1.8	ND	U	1.7
		Chloroform	67-66-3	ND	U	0.19	ND	U	2.4	ND	U	2	ND	U	1.8	ND	U	1.7
		Chloromethane	74-87-3	ND	U	0.19	ND	U	2.4	ND	U	2	ND	U	1.8	ND	U	1.7
		Cis-1,2-Dichloroethene	156-59-2	ND	U	0.097	ND	U	1.2	ND	U	0.98	ND	U	0.89	ND	U	0.83
		Cis-1,3-Dichloropropene	10061-01-5	ND	U	0.097	ND	U	1.2	ND	U	0.98	ND	U	0.89	ND	U	0.83
		Dibromochloromethane	124-48-1	ND	U	0.097	ND	U	1.2	ND	U	0.98	ND	U	0.89	ND	U	0.83
		Dibromomethane	74-95-3	ND	U	0.097	ND	U	1.2	ND	U	0.98	ND	U	0.89	ND	U	0.83
		Dichlorodifluoromethane	75-71-8	ND	U	0.097	ND	U	1.2	ND	U	0.98	ND	U	0.89	ND	U	0.83
		Ethylbenzene	100-41-4	ND	U	0.097	ND	U	1.2	1.1	J	0.98	1.2	J	0.89	6.1	--	0.83
		Hexachloro-1,3-Butadiene	87-68-3	ND	U	0.19	ND	U	2.4	ND	U	2	ND	U	1.8	ND	U	1.7
		Isopropylbenzene	98-82-8	ND	U	0.097	ND	U	1.2	2.9	J	0.98	1.5	J	0.89	3.4	--	0.83
		m- & p-Xylenes	179601-23-1	ND	U	0.19	ND	U	2.4	28	--	2	17	--	1.8	47	--	1.7
		Methyl tert-Butyl Ether	1634-04-4	ND	U	0.19	ND	U	2.4	ND	U	2	ND	U	1.8	ND	U	1.7
		Methylene Chloride	75-09-2	ND	U	0.19	ND	U	2.4	ND	U	2	ND	U	1.8	ND	U	1.7
		Naphthalene	91-20-3	ND	U	0.097	ND	U	1.2	8.8	--	0.98	4.7	J	0.89	3.4	J	0.83
		n-Butylbenzene	104-51-8	ND	UJ	0.097	ND	U	1.2	4.6	--	0.98	3	--	0.89	2.9	--	0.83
		n-Propylbenzene	103-65-1	ND	U	0.19	ND	U	2.4	1.9	J	2	1.8	J	1.8	5.2	--	1.7
		o-Xylene	95-47-6	ND	U	0.097	ND	U	1.2	25	--	0.98	10	--	0.89	16	--	0.83
		sec-Butylbenzene	135-98-8	ND	U	0.097	ND	U	1.2	6.7	--	0.98	3.7	--	0.89	4.5	--	0.83
		Styrene	100-42-5	ND	U	0.097	ND	U	1.2	ND	U	0.98	ND	U	0.89	ND	U	0.83
		tert-Butylbenzene	98-06-6	ND	U	0.097	ND	U	1.2	ND	U	0.98	ND	U	0.89	ND	U	0.83
		Tetrachloroethene	127-18-4	ND	U	0.097	ND	U	1.2	ND	U	0.98	ND	U	0.89	ND	U	0.83
		Toluene	108-88-3	ND	U	0.097	0.71	J	1.2	1.8	J	0.98	2.2	J	0.89	18	--	0.83
		Trans-1,2-Dichloroethene	156-60-5	ND	U	0.19	ND	U	2.4	ND	U	2	ND	U	1.8	ND	U	1.7
		Trans-1,3-Dichloropropene	10061-02-6	ND	U	0.19	ND	U	2.4	ND	U	2	ND	U	1.8	ND	U	1.7
		Trichloroethene	79-01-6	ND	U	0.097	ND	U	1.2	ND	U	0.98	ND	U	0.89	ND	U	0.83
		Trichlorofluoromethane	75-69-4	ND	U	0.19	ND	U	2.4	ND	U	2	ND	U	1.8	ND	U	1.7
		Vinyl Chloride	75-01-4	ND	U	0.097	ND	U	1.2	ND	U	0.98	ND	U	0.89	ND	U	0.83
Moisture	Percent Moisture (%) VOCs	NA	NA	7.7	--	--	19.2	--	--	10.2	--	--	12.2	--	--	10.8	--	--

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

		Boring ID:		KAFB-106S1			KAFB-106S1			KAFB-106S1			KAFB-106S2			KAFB-106S2		
		Sample Date:		12/5/2018			12/5/2018			12/5/2018			11/6/2018			11/6/2018		
		Sample Depth (ft bgs):		489			510			510			50			105*		
		Sample Type:		REG			REG			Field Duplicate			REG			REG		
		Core Temperature (°C)			**38.2**			**27.8**			**27.8**			**26.8**			**58.2**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
Total Petroleum Hydrocarbons	Method SW8015 (mg/kg)	Motor Oil (C20-C38)	MOIL	ND	U	97	ND	U	24	ND	U	24	ND	U	24	ND	U	24
		TPH-DRO (C10-C28)	TPH-DRO	3,300	--	17	ND	U	4.1	ND	U	4.2	ND	U	4	ND	U	4.1
		TPH-GRO (C6-C10)	TPH-GRO	3,600	--	280	ND	U	1.2	ND	U	1.6	ND	U	1.4	ND	U	1.4
Moisture	Percent Moisture (%) TPH	NA	NA	9.9	--	--	10.9	--	--	11.2	--	--	11.6	--	--	2.4	--	--
EDB	Method SW8011 (mg/kg)[a]	1,2-Dibromoethane	106-93-4	0.13	J	4.2	ND	U	0.000043	ND	U	0.000042	—	—	—	—	—	—
Moisture	Percent Moisture (%) EDB	NA	NA	10.2	--	--	11.2	--	--	9.3	--	--	—	—	—	—	—	—
VOCs	Method SW8260B (mg/kg)[a]	1,1,1,2-Tetrachloroethane	630-20-6	ND	U	0.88	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		1,1,1-Trichloroethane	71-55-6	ND	U	0.44	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		1,1,2,2-Tetrachloroethane	79-34-5	ND	U	0.88	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		1,1,2-Trichloroethane	79-00-5	ND	U	0.88	ND	U	0.0035	ND	U	0.003	—	—	—	—	—	—
		1,1-Dichloroethane	75-34-3	ND	U	1.8	ND	U	0.00087	ND	U	0.00075	—	—	—	—	—	—
		1,1-Dichloroethene	75-35-4	ND	U	1.8	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		1,1-Dichloropropene	563-58-6	ND	U	1.8	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		1,2,3-Trichlorobenzene	87-61-6	ND	U	0.88	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		1,2,3-Trichloropropane	96-18-4	ND	U	1.8	ND	U	0.0035	ND	U	0.003	—	—	—	—	—	—
		1,2,4-Trichlorobenzene	120-82-1	ND	U	1.8	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		1,2,4-Trimethylbenzene	95-63-6	33	--	0.88	ND	U	0.0035	ND	U	0.003	—	—	—	—	—	—
		1,2-Dibromo-3-Chloropropane	96-12-8	ND	U	3.5	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		1,2-Dibromoethane	106-93-4	ND	U	0.88	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		1,2-Dichlorobenzene	95-50-1	ND	U	3.5	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		1,2-Dichloroethane	107-06-2	ND	U	0.88	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		1,2-Dichloroethene	540-59-0	ND	U	0.88	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		1,2-Dichloropropane	78-87-5	ND	U	1.8	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		1,3,5-Trimethylbenzene	108-67-8	14	--	0.88	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		1,3-Dichlorobenzene	541-73-1	ND	U	1.8	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		1,3-Dichloropropane	142-28-9	ND	U	0.88	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		1,4-Dichlorobenzene	106-46-7	ND	U	0.88	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		2,2-Dichloropropane	594-20-7	ND	U	0.88	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		2-Butanone	78-93-3	ND	U	7	ND	U	0.0069	ND	U	0.006	—	—	—	—	—	—
		2-Chlorotoluene	95-49-8	ND	U	0.88	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		2-Hexanone	591-78-6	ND	U	7	ND	U	0.014	ND	U	0.012	—	—	—	—	—	—
		4-Chlorotoluene	106-43-4	ND	U	0.88	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		4-Isopropyltoluene	99-87-6	2.9	--	0.88	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		4-Methyl-2-Pentanone	108-10-1	ND	U	7	ND	U	0.014	ND	U	0.012	—	—	—	—	—	—
		Acetone	67-64-1	40	--	14	ND	U	0.014	ND	U	0.012	—	—	—	—	—	—
		Benzene	71-43-2	17	--	1.8	0.0012	J	0.0017	0.00063	J	0.0015	—	—	—	—	—	—

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

			Boring ID:	KAFB-106S1			KAFB-106S1			KAFB-106S1			KAFB-106S2			KAFB-106S2		
			Sample Date:	12/5/2018			12/5/2018			12/5/2018			11/6/2018			11/6/2018		
			Sample Depth (ft bgs):	489			510			510			50			105*		
			Sample Type:	REG			REG			Field Duplicate			REG			REG		
			Core Temperature (°C)		**38.2**			**27.8**			**27.8**			**26.8**			**58.2**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
VOCs	Method SW8260B (mg/kg)[a]	Bromobenzene	108-86-1	ND	U	0.44	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		Bromochloromethane	74-97-5	ND	U	1.8	ND	U	0.00087	ND	U	0.00075	—	—	—	—	—	—
		Bromodichloromethane	75-27-4	ND	U	0.88	ND	U	0.00087	ND	U	0.00075	—	—	—	—	—	—
		Bromoform	75-25-2	ND	U	1.8	ND	U	0.00087	ND	U	0.00075	—	—	—	—	—	—
		Bromomethane	74-83-9	ND	U	1.8	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		Carbon Disulfide	75-15-0	ND	U	1.8	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		Carbon Tetrachloride	56-23-5	ND	U	0.44	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		Chlorobenzene	108-90-7	ND	U	0.88	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		Chloroethane	75-00-3	ND	U	1.8	ND	U	0.0035	ND	U	0.003	—	—	—	—	—	—
		Chloroform	67-66-3	ND	U	1.8	ND	U	0.00087	ND	U	0.00075	—	—	—	—	—	—
		Chloromethane	74-87-3	ND	U	1.8	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		Cis-1,2-Dichloroethene	156-59-2	ND	U	0.88	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		Cis-1,3-Dichloropropene	10061-01-5	ND	U	0.88	ND	U	0.0035	ND	U	0.003	—	—	—	—	—	—
		Dibromochloromethane	124-48-1	ND	U	0.88	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		Dibromomethane	74-95-3	ND	U	0.88	ND	U	0.0035	ND	U	0.003	—	—	—	—	—	—
		Dichlorodifluoromethane	75-71-8	ND	U	0.88	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		Ethylbenzene	100-41-4	26	--	0.88	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		Hexachloro-1,3-Butadiene	87-68-3	ND	U	1.8	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		Isopropylbenzene	98-82-8	6	--	0.88	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		m- & p-Xylenes	179601-23-1	77	--	1.8	0.0019	J	0.0035	0.0011	J	0.003	—	—	—	—	—	—
		Methyl tert-Butyl Ether	1634-04-4	ND	U	1.8	ND	U	0.00087	ND	U	0.00075	—	—	—	—	—	—
		Methylene Chloride	75-09-2	ND	U	1.8	ND	U	0.0035	0.0025	J	0.003	—	—	—	—	—	—
		Naphthalene	91-20-3	7.5	--	0.88	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		n-Butylbenzene	104-51-8	5.2	--	0.88	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		n-Propylbenzene	103-65-1	11	--	1.8	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		o-Xylene	95-47-6	26	--	0.88	0.00081	J	0.0017	ND	U	0.0015	—	—	—	—	—	—
		sec-Butylbenzene	135-98-8	7.3	--	0.88	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		Styrene	100-42-5	ND	U	0.88	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		tert-Butylbenzene	98-06-6	ND	U	0.88	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		Tetrachloroethene	127-18-4	ND	U	0.88	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		Toluene	108-88-3	110	--	0.88	0.0042	J	0.0017	0.0022	J	0.0015	—	—	—	—	—	—
		Trans-1,2-Dichloroethene	156-60-5	ND	U	1.8	ND	U	0.00087	ND	U	0.00075	—	—	—	—	—	—
		Trans-1,3-Dichloropropene	10061-02-6	ND	U	1.8	ND	U	0.0017	ND	U	0.0015	—	—	—	—	—	—
		Trichloroethene	79-01-6	ND	U	0.88	ND	U	0.00087	ND	U	0.00075	—	—	—	—	—	—
		Trichlorofluoromethane	75-69-4	ND	U	1.8	ND	U	0.0035	ND	U	0.003	—	—	—	—	—	—
		Vinyl Chloride	75-01-4	ND	U	0.88	ND	U	0.0035	ND	U	0.003	—	—	—	—	—	—
Moisture	Percent Moisture (%) VOCs	NA	NA	10.2	--	--	11.2	--	--	9.3	--	--	—	—	—	—	—	—

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

			Boring ID:	KAFB-106S2			KAFB-106S2			KAFB-106S2			KAFB-106S2			KAFB-106S2		
			Sample Date:	11/8/2018			11/13/2018			11/14/2018			11/15/2018			11/16/2018		
			Sample Depth (ft bgs):	278*			338			404*			419			474		
			Sample Type:	REG			REG			REG			REG			REG		
			Core Temperature (°C)		**77.7**			**68.9**			**49.6**			**23.3**			**21.6**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
Total Petroleum Hydrocarbons	Method SW8015 (mg/kg)	Motor Oil (C20-C38)	MOIL	ND	U	23	ND	U	23	ND	U	23	20	J	23	ND	U	27
		TPH-DRO (C10-C28)	TPH-DRO	ND	U	3.9	ND	U	4	ND	U	3.9	ND	UJ	4	20	--	4.6
		TPH-GRO (C6-C10)	TPH-GRO	ND	U	1.4	ND	U	1.3	ND	U	1.3	ND	U	1.2	ND	U	1.3
Moisture	Percent Moisture (%) TPH	NA	NA	3.9	--	--	4.6	--	--	2.6	--	--	4.6	--	--	12.7	--	--
EDB	Method SW8011 (mg/kg)[a]	1,2-Dibromoethane	106-93-4	—	—	—	ND	U	3.9E-05	ND	U	3.9E-05	ND	U	0	ND	U	0.01
Moisture	Percent Moisture (%) EDB	NA	NA	—	—	—	3.8	--	--	2.6	--	--	4.1	--	--	11.8	--	--
VOCs	Method SW8260B (mg/kg)[a]	1,1,1,2-Tetrachloroethane	630-20-6	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		1,1,1-Trichloroethane	71-55-6	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		1,1,2,2-Tetrachloroethane	79-34-5	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		1,1,2-Trichloroethane	79-00-5	—	—	—	ND	U	0.0034	ND	U	0.0036	ND	U	0	ND	U	0
		1,1-Dichloroethane	75-34-3	—	—	—	ND	U	0.00085	ND	U	0.00091	ND	U	0	ND	U	0
		1,1-Dichloroethene	75-35-4	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		1,1-Dichloropropene	563-58-6	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		1,2,3-Trichlorobenzene	87-61-6	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		1,2,3-Trichloropropane	96-18-4	—	—	—	ND	U	0.0034	ND	U	0.0036	ND	U	0	ND	U	0
		1,2,4-Trichlorobenzene	120-82-1	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		1,2,4-Trimethylbenzene	95-63-6	—	—	—	ND	U	0.0034	ND	U	0.0036	ND	U	0	ND	U	0
		1,2-Dibromo-3-Chloropropane	96-12-8	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		1,2-Dibromoethane	106-93-4	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	0.014	--	0
		1,2-Dichlorobenzene	95-50-1	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		1,2-Dichloroethane	107-06-2	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		1,2-Dichloroethene	540-59-0	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		1,2-Dichloropropane	78-87-5	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		1,3,5-Trimethylbenzene	108-67-8	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	0.0033	J	0
		1,3-Dichlorobenzene	541-73-1	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		1,3-Dichloropropane	142-28-9	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		1,4-Dichlorobenzene	106-46-7	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		2,2-Dichloropropane	594-20-7	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		2-Butanone	78-93-3	—	—	—	ND	U	0.0068	ND	U	0.0073	ND	U	0.01	ND	U	0.01
		2-Chlorotoluene	95-49-8	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		2-Hexanone	591-78-6	—	—	—	ND	U	0.014	ND	U	0.015	ND	U	0.01	ND	U	0.01
		4-Chlorotoluene	106-43-4	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		4-Isopropyltoluene	99-87-6	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		4-Methyl-2-Pentanone	108-10-1	—	—	—	ND	U	0.014	ND	U	0.015	ND	U	0.01	0.021	--	0.01
		Acetone	67-64-1	—	—	—	ND	U	0.014	ND	U	0.015	ND	U	0.01	ND	U	0.01
		Benzene	71-43-2	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	0.0061	--	0

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

		Boring ID:		KAFB-106S2			KAFB-106S2			KAFB-106S2			KAFB-106S2			KAFB-106S2		
		Sample Date:		11/8/2018			11/13/2018			11/14/2018			11/15/2018			11/16/2018		
		Sample Depth (ft bgs):		278*			338			404*			419			474		
		Sample Type:		REG			REG			REG			REG			REG		
		Core Temperature (°C)			**77.7**			**68.9**			**49.6**			**23.3**			**21.6**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
VOCs	Method SW8260B (mg/kg)[a]	Bromobenzene	108-86-1	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		Bromochloromethane	74-97-5	—	—	—	ND	U	0.00085	ND	U	0.00091	ND	U	0	ND	U	0
		Bromodichloromethane	75-27-4	—	—	—	ND	U	0.00085	ND	U	0.00091	ND	U	0	ND	U	0
		Bromoform	75-25-2	—	—	—	ND	U	0.00085	ND	U	0.00091	ND	U	0	ND	U	0
		Bromomethane	74-83-9	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		Carbon Disulfide	75-15-0	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		Carbon Tetrachloride	56-23-5	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		Chlorobenzene	108-90-7	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		Chloroethane	75-00-3	—	—	—	ND	U	0.0034	ND	U	0.0036	ND	U	0	ND	U	0
		Chloroform	67-66-3	—	—	—	ND	U	0.00085	ND	U	0.00091	ND	U	0	ND	U	0
		Chloromethane	74-87-3	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		Cis-1,2-Dichloroethene	156-59-2	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		Cis-1,3-Dichloropropene	10061-01-5	—	—	—	ND	U	0.0034	ND	U	0.0036	ND	U	0	ND	U	0
		Dibromochloromethane	124-48-1	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		Dibromomethane	74-95-3	—	—	—	ND	U	0.0034	ND	U	0.0036	ND	U	0	ND	U	0
		Dichlorodifluoromethane	75-71-8	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		Ethylbenzene	100-41-4	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		Hexachloro-1,3-Butadiene	87-68-3	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		Isopropylbenzene	98-82-8	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		m- & p-Xylenes	179601-23-1	—	—	—	ND	U	0.0034	ND	U	0.0036	ND	U	0	0.0079	--	0
		Methyl tert-Butyl Ether	1634-04-4	—	—	—	ND	U	0.00085	ND	U	0.00091	ND	U	0	ND	U	0
		Methylene Chloride	75-09-2	—	—	—	0.0031	J	0.0034	0.005	J	0.0036	ND	U	0	ND	U	0
		Naphthalene	91-20-3	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		n-Butylbenzene	104-51-8	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		n-Propylbenzene	103-65-1	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		o-Xylene	95-47-6	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	0.01	--	0
		sec-Butylbenzene	135-98-8	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		Styrene	100-42-5	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		tert-Butylbenzene	98-06-6	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		Tetrachloroethene	127-18-4	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		Toluene	108-88-3	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	0.015	--	0
		Trans-1,2-Dichloroethene	156-60-5	—	—	—	ND	U	0.00085	ND	U	0.00091	ND	U	0	ND	U	0
		Trans-1,3-Dichloropropene	10061-02-6	—	—	—	ND	U	0.0017	ND	U	0.0018	ND	U	0	ND	U	0
		Trichloroethene	79-01-6	—	—	—	ND	U	0.00085	ND	U	0.00091	ND	U	0	ND	U	0
		Trichlorofluoromethane	75-69-4	—	—	—	ND	U	0.0034	ND	U	0.0036	ND	U	0	ND	U	0
		Vinyl Chloride	75-01-4	—	—	—	ND	U	0.0034	ND	U	0.0036	ND	U	0	ND	U	0
Moisture	Percent Moisture (%) VOCs	NA	NA	—	—	—	3.8	--	--	2.6	--	--	4.1	--	--	11.8	--	--

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

			Boring ID:	KAFB-106S2			KAFB-106S2			KAFB-106S2			KAFB-106S3			KAFB-106S3		
			Sample Date:	11/16/2018			11/16/2018			11/16/2018			10/19/2018			10/19/2018		
			Sample Depth (ft bgs):	499			510			510			20			160		
			Sample Type:	REG			REG			Field Duplicate			REG			REG		
			Core Temperature (°C)		**22.5**			**24.8**			**24.8**		Not Cored			Not Cored		
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
Total Petroleum Hydrocarbons	Method SW8015 (mg/kg)	Motor Oil (C20-C38)	MOIL	ND	U	24	ND	U	25	ND	U	23	ND	U	25	ND	U	23
		TPH-DRO (C10-C28)	TPH-DRO	35	--	4.2	ND	U	4.2	ND	U	3.9	ND	U	4.3	ND	U	4
		TPH-GRO (C6-C10)	TPH-GRO	22	J	1.3	2.9	J	1.2	7.6	J	1.2	ND	U	1.1	ND	U	1.3
Moisture	Percent Moisture (%) TPH	NA	NA	11.1	--	--	10.9	--	--	9.1	--	--	8.4	--	--	4	--	--
EDB	Method SW8011 (mg/kg)[a]	1,2-Dibromoethane	106-93-4	0.00019	--	4.3E-05	ND	U	4.2E-05	ND	U	4.3E-05	—	—	—	—	—	—
Moisture	Percent Moisture (%) EDB	NA	NA	11.9	--	--	10.1	--	--	11.3	--	--	—	—	—	—	—	—
VOCs	Method SW8260B (mg/kg)[a]	1,1,1,2-Tetrachloroethane	630-20-6	ND	U	0.1	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		1,1,1-Trichloroethane	71-55-6	ND	U	0.05	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		1,1,2,2-Tetrachloroethane	79-34-5	ND	U	0.1	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		1,1,2-Trichloroethane	79-00-5	ND	U	0.1	ND	U	0.0046	ND	U	0.0034	—	—	—	—	—	—
		1,1-Dichloroethane	75-34-3	ND	U	0.2	ND	U	0.0012	ND	U	0.00084	—	—	—	—	—	—
		1,1-Dichloroethene	75-35-4	ND	U	0.2	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		1,1-Dichloropropene	563-58-6	ND	U	0.2	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		1,2,3-Trichlorobenzene	87-61-6	ND	U	0.1	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		1,2,3-Trichloropropane	96-18-4	ND	U	0.2	ND	U	0.0046	ND	U	0.0034	—	—	—	—	—	—
		1,2,4-Trichlorobenzene	120-82-1	ND	U	0.2	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		1,2,4-Trimethylbenzene	95-63-6	1.2	--	0.1	0.051	J	0.0046	0.0034	J	0.0034	—	—	—	—	—	—
		1,2-Dibromo-3-Chloropropane	96-12-8	ND	U	0.4	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		1,2-Dibromoethane	106-93-4	ND	U	0.1	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		1,2-Dichlorobenzene	95-50-1	ND	U	0.4	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		1,2-Dichloroethane	107-06-2	ND	U	0.1	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		1,2-Dichloroethene	540-59-0	ND	U	0.1	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		1,2-Dichloropropane	78-87-5	ND	U	0.2	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		1,3,5-Trimethylbenzene	108-67-8	0.51	--	0.1	0.024	J	0.0023	0.0014	J	0.0017	—	—	—	—	—	—
		1,3-Dichlorobenzene	541-73-1	ND	U	0.2	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		1,3-Dichloropropane	142-28-9	ND	U	0.1	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		1,4-Dichlorobenzene	106-46-7	ND	U	0.1	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		2,2-Dichloropropane	594-20-7	ND	U	0.1	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		2-Butanone	78-93-3	ND	U	0.8	ND	U	0.0093	0.017	J	0.0067	—	—	—	—	—	—
		2-Chlorotoluene	95-49-8	ND	U	0.1	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		2-Hexanone	591-78-6	ND	U	0.8	ND	U	0.019	ND	U	0.013	—	—	—	—	—	—
		4-Chlorotoluene	106-43-4	ND	U	0.1	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		4-Isopropyltoluene	99-87-6	0.15	J	0.1	0.0059	J	0.0023	0.00077	J	0.0017	—	—	—	—	—	—
		4-Methyl-2-Pentanone	108-10-1	ND	U	0.8	ND	U	0.019	ND	U	0.013	—	—	—	—	—	—
		Acetone	67-64-1	1.5	J	1.6	0.091	--	0.019	0.077	--	0.013	—	—	—	—	—	—
		Benzene	71-43-2	0.21	J	0.2	0.05	J	0.0023	0.076	J	0.0017	—	—	—	—	—	—

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

			Boring ID:	KAFB-106S2			KAFB-106S2			KAFB-106S2			KAFB-106S3			KAFB-106S3		
			Sample Date:	11/16/2018			11/16/2018			11/16/2018			10/19/2018			10/19/2018		
			Sample Depth (ft bgs):	499			510			510			20			160		
			Sample Type:	REG			REG			Field Duplicate			REG			REG		
			Core Temperature (°C)		**22.5**			**24.8**			**24.8**		Not Cored			Not Cored		
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
VOCs	Method SW8260B (mg/kg)[a]	Bromobenzene	108-86-1	ND	U	0.05	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		Bromochloromethane	74-97-5	ND	U	0.2	ND	U	0.0012	ND	U	0.00084	—	—	—	—	—	—
		Bromodichloromethane	75-27-4	ND	U	0.1	ND	U	0.0012	ND	U	0.00084	—	—	—	—	—	—
		Bromoform	75-25-2	ND	U	0.2	ND	U	0.0012	ND	U	0.00084	—	—	—	—	—	—
		Bromomethane	74-83-9	ND	U	0.2	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		Carbon Disulfide	75-15-0	ND	U	0.2	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		Carbon Tetrachloride	56-23-5	ND	U	0.05	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		Chlorobenzene	108-90-7	ND	U	0.1	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		Chloroethane	75-00-3	ND	U	0.2	ND	U	0.0046	ND	U	0.0034	—	—	—	—	—	—
		Chloroform	67-66-3	ND	U	0.2	ND	U	0.0012	ND	U	0.00084	—	—	—	—	—	—
		Chloromethane	74-87-3	ND	U	0.2	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		Cis-1,2-Dichloroethene	156-59-2	ND	U	0.1	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		Cis-1,3-Dichloropropene	10061-01-5	ND	U	0.1	ND	U	0.0046	ND	U	0.0034	—	—	—	—	—	—
		Dibromochloromethane	124-48-1	ND	U	0.1	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		Dibromomethane	74-95-3	ND	U	0.1	ND	U	0.0046	ND	U	0.0034	—	—	—	—	—	—
		Dichlorodifluoromethane	75-71-8	ND	U	0.1	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		Ethylbenzene	100-41-4	0.87	--	0.1	0.032	J	0.0023	0.005	J	0.0017	—	—	—	—	—	—
		Hexachloro-1,3-Butadiene	87-68-3	ND	U	0.2	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		Isopropylbenzene	98-82-8	0.25	J	0.1	0.011	--	0.0023	ND	U	0.0017	—	—	—	—	—	—
		m- & p-Xylenes	179601-23-1	2.3	--	0.2	0.083	J	0.0046	0.0056	J	0.0034	—	—	—	—	—	—
		Methyl tert-Butyl Ether	1634-04-4	ND	U	0.2	ND	U	0.0012	ND	U	0.00084	—	—	—	—	—	—
		Methylene Chloride	75-09-2	ND	U	0.2	0.008	J	0.0046	0.0027	J	0.0034	—	—	—	—	—	—
		Naphthalene	91-20-3	0.2	J	0.1	0.0083	--	0.0023	0.0018	J	0.0017	—	—	—	—	—	—
		n-Butylbenzene	104-51-8	0.22	J	0.1	0.013	J	0.0023	0.00087	J	0.0017	—	—	—	—	—	—
		n-Propylbenzene	103-65-1	0.42	--	0.2	0.018	J	0.0023	0.0013	J	0.0017	—	—	—	—	—	—
		o-Xylene	95-47-6	0.72	--	0.1	0.031	J	0.0023	0.003	J	0.0017	—	—	—	—	—	—
		sec-Butylbenzene	135-98-8	0.27	J	0.1	0.012	--	0.0023	0.00098	J	0.0017	—	—	—	—	—	—
		Styrene	100-42-5	ND	U	0.1	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		tert-Butylbenzene	98-06-6	ND	U	0.1	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		Tetrachloroethene	127-18-4	ND	U	0.1	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		Toluene	108-88-3	2	--	0.1	0.063	J	0.0023	0.0079	J	0.0017	—	—	—	—	—	—
		Trans-1,2-Dichloroethene	156-60-5	ND	U	0.2	ND	U	0.0012	ND	U	0.00084	—	—	—	—	—	—
		Trans-1,3-Dichloropropene	10061-02-6	ND	U	0.2	ND	U	0.0023	ND	U	0.0017	—	—	—	—	—	—
		Trichloroethene	79-01-6	ND	U	0.1	ND	U	0.0012	ND	U	0.00084	—	—	—	—	—	—
		Trichlorofluoromethane	75-69-4	ND	U	0.2	ND	U	0.0046	ND	U	0.0034	—	—	—	—	—	—
		Vinyl Chloride	75-01-4	ND	U	0.1	ND	U	0.0046	ND	U	0.0034	—	—	—	—	—	—
Moisture	Percent Moisture (%) VOCs	NA	NA	11.9	--	--	10.1	--	--	11.3	--	--	—	—	—	—	—	—

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

			Boring ID:	KAFB-106S3			KAFB-106S3			KAFB-106S3			KAFB-106S3			KAFB-106S3		
			Sample Date:	11/4/2018			11/5/2018			11/19/2018			11/20/2018			11/20/2018		
			Sample Depth (ft bgs):	240			360			424			459			459		
			Sample Type:	REG			REG			REG			REG			Field Duplicate		
			Core Temperature (°C)	Not Cored			Not Cored				**29.1**			19.6			19.6	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
Total Petroleum Hydrocarbons	Method SW8015 (mg/kg)	Motor Oil (C20-C38)	MOIL	ND	U	26	ND	U	21	ND	U	22	ND	U	22	ND	U	22
		TPH-DRO (C10-C28)	TPH-DRO	ND	U	4.5	ND	U	3.6	ND	U	3.8	ND	U	3.8	ND	U	3.8
		TPH-GRO (C6-C10)	TPH-GRO	ND	U	2.1	ND	U	1.2	ND	U	1.4	ND	U	1.4	ND	U	1.3
Moisture	Percent Moisture (%) TPH	NA	NA	16.1	--	--	1.3	--	--	2.4	--	--	3.2	--	--	2.9	--	--
EDB	Method SW8011 (mg/kg)[a]	1,2-Dibromoethane	106-93-4	—	—	—	—	—	—	ND	U	4E-05	ND	UJ	4E-05	ND	U	4E-05
Moisture	Percent Moisture (%) EDB	NA	NA	—	—	—	—	—	—	2.7	--	--	3.6	--	--	3.6	--	--
VOCs	Method SW8260B (mg/kg)[a]	1,1,1,2-Tetrachloroethane	630-20-6	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	ND	U	0.002
		1,1,1-Trichloroethane	71-55-6	—	—	—	—	—	—	ND	U	0.045	ND	U	0.002	ND	U	0.002
		1,1,2,2-Tetrachloroethane	79-34-5	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	ND	U	0.002
		1,1,2-Trichloroethane	79-00-5	—	—	—	—	—	—	ND	U	0.09	ND	U	0.004	ND	U	0.004
		1,1-Dichloroethane	75-34-3	—	—	—	—	—	—	ND	U	0.18	ND	U	9E-04	ND	U	9E-04
		1,1-Dichloroethene	75-35-4	—	—	—	—	—	—	ND	U	0.18	ND	U	0.002	ND	U	0.002
		1,1-Dichloropropene	563-58-6	—	—	—	—	—	—	ND	U	0.18	ND	U	0.002	ND	U	0.002
		1,2,3-Trichlorobenzene	87-61-6	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	ND	U	0.002
		1,2,3-Trichloropropane	96-18-4	—	—	—	—	—	—	ND	U	0.18	ND	U	0.004	ND	U	0.004
		1,2,4-Trichlorobenzene	120-82-1	—	—	—	—	—	—	ND	U	0.18	ND	U	0.002	ND	U	0.002
		1,2,4-Trimethylbenzene	95-63-6	—	—	—	—	—	—	ND	U	0.09	ND	U	0.004	ND	U	0.004
		1,2-Dibromo-3-Chloropropane	96-12-8	—	—	—	—	—	—	ND	U	0.36	ND	U	0.002	ND	U	0.002
		1,2-Dibromoethane	106-93-4	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	ND	U	0.002
		1,2-Dichlorobenzene	95-50-1	—	—	—	—	—	—	ND	U	0.36	ND	U	0.002	ND	U	0.002
		1,2-Dichloroethane	107-06-2	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	ND	U	0.002
		1,2-Dichloroethene	540-59-0	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	ND	U	0.002
		1,2-Dichloropropane	78-87-5	—	—	—	—	—	—	ND	U	0.18	ND	U	0.002	ND	U	0.002
		1,3,5-Trimethylbenzene	108-67-8	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	ND	U	0.002
		1,3-Dichlorobenzene	541-73-1	—	—	—	—	—	—	ND	U	0.18	ND	U	0.002	ND	U	0.002
		1,3-Dichloropropane	142-28-9	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	ND	U	0.002
		1,4-Dichlorobenzene	106-46-7	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	ND	U	0.002
		2,2-Dichloropropane	594-20-7	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	ND	U	0.002
		2-Butanone	78-93-3	—	—	—	—	—	—	ND	U	0.72	0.035	J	0.007	0.02	J	0.007
		2-Chlorotoluene	95-49-8	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	ND	U	0.002
		2-Hexanone	591-78-6	—	—	—	—	—	—	ND	U	0.72	ND	U	0.015	ND	U	0.014
		4-Chlorotoluene	106-43-4	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	ND	U	0.002
		4-Isopropyltoluene	99-87-6	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	ND	U	0.002
		4-Methyl-2-Pentanone	108-10-1	—	—	—	—	—	—	ND	U	0.72	ND	U	0.015	ND	U	0.014
		Acetone	67-64-1	—	—	—	—	—	—	ND	U	1.4	0.021	J	0.015	0.017	J	0.014
		Benzene	71-43-2	—	—	—	—	—	—	ND	U	0.18	ND	U	0.002	ND	U	0.002

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

		Boring ID:		KAFB-106S3			KAFB-106S3			KAFB-106S3			KAFB-106S3			KAFB-106S3		
		Sample Date:		11/4/2018			11/5/2018			11/19/2018			11/20/2018			11/20/2018		
		Sample Depth (ft bgs):		240			360			424			459			459		
		Sample Type:		REG			REG			REG			REG			Field Duplicate		
		Core Temperature (°C)		Not Cored			Not Cored				**29.1**			19.6			19.6	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
VOCs	Method SW8260B (mg/kg)^{a}	Bromobenzene	108-86-1	—	—	—	—	—	—	ND	U	0.045	ND	U	0.002	ND	U	0.002
		Bromochloromethane	74-97-5	—	—	—	—	—	—	ND	U	0.18	ND	U	9E-04	ND	U	9E-04
		Bromodichloromethane	75-27-4	—	—	—	—	—	—	ND	U	0.09	ND	U	9E-04	ND	U	9E-04
		Bromoform	75-25-2	—	—	—	—	—	—	ND	U	0.18	ND	U	9E-04	ND	U	9E-04
		Bromomethane	74-83-9	—	—	—	—	—	—	ND	U	0.18	ND	U	0.002	ND	U	0.002
		Carbon Disulfide	75-15-0	—	—	—	—	—	—	ND	U	0.18	ND	U	0.002	ND	U	0.002
		Carbon Tetrachloride	56-23-5	—	—	—	—	—	—	ND	U	0.045	ND	U	0.002	ND	U	0.002
		Chlorobenzene	108-90-7	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	ND	U	0.002
		Chloroethane	75-00-3	—	—	—	—	—	—	ND	U	0.18	ND	U	0.004	ND	U	0.004
		Chloroform	67-66-3	—	—	—	—	—	—	ND	U	0.18	ND	U	9E-04	ND	U	9E-04
		Chloromethane	74-87-3	—	—	—	—	—	—	ND	U	0.18	ND	U	0.002	ND	U	0.002
		Cis-1,2-Dichloroethene	156-59-2	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	ND	U	0.002
		Cis-1,3-Dichloropropene	10061-01-5	—	—	—	—	—	—	ND	U	0.09	ND	U	0.004	ND	U	0.004
		Dibromochloromethane	124-48-1	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	ND	U	0.002
		Dibromomethane	74-95-3	—	—	—	—	—	—	ND	U	0.09	ND	U	0.004	ND	U	0.004
		Dichlorodifluoromethane	75-71-8	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	ND	U	0.002
		Ethylbenzene	100-41-4	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	ND	U	0.002
		Hexachloro-1,3-Butadiene	87-68-3	—	—	—	—	—	—	ND	U	0.18	ND	U	0.002	ND	U	0.002
		Isopropylbenzene	98-82-8	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	ND	U	0.002
		m- & p-Xylenes	179601-23-1	—	—	—	—	—	—	ND	U	0.18	ND	U	0.004	ND	U	0.004
		Methyl tert-Butyl Ether	1634-04-4	—	—	—	—	—	—	ND	U	0.18	ND	U	9E-04	ND	U	9E-04
		Methylene Chloride	75-09-2	—	—	—	—	—	—	ND	U	0.18	0.0036	J	0.004	0.0028	J	0.004
		Naphthalene	91-20-3	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	0.001	J	0.002
		n-Butylbenzene	104-51-8	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	ND	U	0.002
		n-Propylbenzene	103-65-1	—	—	—	—	—	—	ND	U	0.18	ND	U	0.002	ND	U	0.002
		o-Xylene	95-47-6	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	ND	U	0.002
		sec-Butylbenzene	135-98-8	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	ND	U	0.002
		Styrene	100-42-5	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	ND	U	0.002
		tert-Butylbenzene	98-06-6	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	ND	U	0.002
		Tetrachloroethene	127-18-4	—	—	—	—	—	—	ND	U	0.09	ND	U	0.002	ND	U	0.002
		Toluene	108-88-3	—	—	—	—	—	—	ND	U	0.09	0.0012	J	0.002	ND	U	0.002
		Trans-1,2-Dichloroethene	156-60-5	—	—	—	—	—	—	ND	U	0.18	ND	U	9E-04	ND	U	9E-04
		Trans-1,3-Dichloropropene	10061-02-6	—	—	—	—	—	—	ND	U	0.18	ND	U	0.002	ND	U	0.002
		Trichloroethene	79-01-6	—	—	—	—	—	—	ND	U	0.09	ND	U	9E-04	ND	U	9E-04
		Trichlorofluoromethane	75-69-4	—	—	—	—	—	—	ND	U	0.18	ND	U	0.004	ND	U	0.004
		Vinyl Chloride	75-01-4	—	—	—	—	—	—	ND	U	0.09	ND	U	0.004	ND	U	0.004
Moisture	Percent Moisture (%) VOCs	NA	NA	—	—	—	—	—	—	2.7	--	--	3.3	--	--	3.6	--	--

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

		Boring ID:		KAFB-106S3			KAFB-106S3			KAFB-106S3			KAFB-106S3			KAFB-106S4		
		Sample Date:		11/20/2018			11/20/2018			11/21/2018			11/21/2018			10/17/2018		
		Sample Depth (ft bgs):		477			489			492			512			40		
		Sample Type:		REG			REG			REG			REG			REG		
		Core Temperature (°C)			**23,5**			15.5			**21**			**23.2**		Not Cored		
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
Total Petroleum Hydrocarbons	Method SW8015 (mg/kg)	Motor Oil (C20-C38)	MOIL	ND	U	25	ND	U	24	ND	U	26	ND	U	26	ND	U	27
		TPH-DRO (C10-C28)	TPH-DRO	ND	U	4.3	ND	U	4.1	21	--	4.5	ND	U	4.4	ND	U	4.7
		TPH-GRO (C6-C10)	TPH-GRO	ND	U	1.5	ND	U	1.4	15	--	1.2	ND	U	1.2	ND	U	1
Moisture	Percent Moisture (%) TPH	NA	NA	14.9	--	--	8.7	--	--	10.7	--	--	8.9	--	--	14.8	--	--
EDB	Method SW8011 (mg/kg)[a]	1,2-Dibromoethane	106-93-4	0.0014	--	5E-05	ND	U	4E-05	ND	U	4E-05	ND	U	4E-05	—	—	—
Moisture	Percent Moisture (%) EDB	NA	NA	16.2	--	--	7	--	--	9.3	--	--	8	--	--	—	—	—
VOCs	Method SW8260B (mg/kg)[a]	1,1,1,2-Tetrachloroethane	630-20-6	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		1,1,1-Trichloroethane	71-55-6	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		1,1,2,2-Tetrachloroethane	79-34-5	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		1,1,2-Trichloroethane	79-00-5	ND	U	0.003	ND	U	0.003	ND	U	0.003	ND	U	0.003	—	—	—
		1,1-Dichloroethane	75-34-3	ND	U	8E-04	ND	U	8E-04	ND	U	8E-04	ND	U	7E-04	—	—	—
		1,1-Dichloroethene	75-35-4	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		1,1-Dichloropropene	563-58-6	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		1,2,3-Trichlorobenzene	87-61-6	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		1,2,3-Trichloropropane	96-18-4	ND	U	0.003	ND	U	0.003	ND	U	0.003	ND	U	0.003	—	—	—
		1,2,4-Trichlorobenzene	120-82-1	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		1,2,4-Trimethylbenzene	95-63-6	0.009	--	0.003	0.0071	--	0.003	0.15	--	0.003	ND	U	0.003	—	—	—
		1,2-Dibromo-3-Chloropropane	96-12-8	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		1,2-Dibromoethane	106-93-4	0.024	--	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		1,2-Dichlorobenzene	95-50-1	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		1,2-Dichloroethane	107-06-2	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		1,2-Dichloroethene	540-59-0	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		1,2-Dichloropropane	78-87-5	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		1,3,5-Trimethylbenzene	108-67-8	0.0081	--	0.002	0.0025	J	0.002	0.067	--	0.002	ND	U	0.001	—	—	—
		1,3-Dichlorobenzene	541-73-1	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		1,3-Dichloropropane	142-28-9	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		1,4-Dichlorobenzene	106-46-7	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		2,2-Dichloropropane	594-20-7	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		2-Butanone	78-93-3	0.0084	J	0.006	ND	U	0.006	0.039	--	0.006	0.13	--	0.006	—	—	—
		2-Chlorotoluene	95-49-8	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		2-Hexanone	591-78-6	ND	U	0.013	0.016	J	0.013	ND	U	0.012	ND	U	0.011	—	—	—
		4-Chlorotoluene	106-43-4	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		4-Isopropyltoluene	99-87-6	ND	U	0.002	ND	U	0.002	0.013	--	0.002	ND	U	0.001	—	—	—
		4-Methyl-2-Pentanone	108-10-1	0.025	--	0.013	0.012	J	0.013	ND	U	0.012	ND	U	0.011	—	—	—
		Acetone	67-64-1	0.043	--	0.013	0.04	--	0.013	0.12	--	0.012	0.028	--	0.011	—	—	—
		Benzene	71-43-2	0.099	--	0.002	ND	U	0.002	0.14	--	0.002	0.00054	J	0.001	—	—	—

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

			Boring ID:	KAFB-106S3			KAFB-106S3			KAFB-106S3			KAFB-106S3			KAFB-106S4		
			Sample Date:	11/20/2018			11/20/2018			11/21/2018			11/21/2018			10/17/2018		
			Sample Depth (ft bgs):	477			489			492			512			40		
			Sample Type:	REG			REG			REG			REG			REG		
			Core Temperature (°C)		**23,5**			15.5			**21**			**23.2**		Not Cored		
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
VOCs	Method SW8260B (mg/kg)^{a}	Bromobenzene	108-86-1	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		Bromochloromethane	74-97-5	ND	U	8E-04	ND	U	8E-04	ND	U	8E-04	ND	U	7E-04	—	—	—
		Bromodichloromethane	75-27-4	ND	U	8E-04	ND	U	8E-04	ND	U	8E-04	ND	U	7E-04	—	—	—
		Bromoform	75-25-2	ND	U	8E-04	ND	U	8E-04	ND	U	8E-04	ND	U	7E-04	—	—	—
		Bromomethane	74-83-9	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		Carbon Disulfide	75-15-0	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		Carbon Tetrachloride	56-23-5	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		Chlorobenzene	108-90-7	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		Chloroethane	75-00-3	ND	U	0.003	ND	U	0.003	ND	U	0.003	ND	U	0.003	—	—	—
		Chloroform	67-66-3	ND	U	8E-04	ND	U	8E-04	ND	U	8E-04	ND	U	7E-04	—	—	—
		Chloromethane	74-87-3	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		Cis-1,2-Dichloroethene	156-59-2	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		Cis-1,3-Dichloropropene	10061-01-5	ND	U	0.003	ND	U	0.003	ND	U	0.003	ND	U	0.003	—	—	—
		Dibromochloromethane	124-48-1	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		Dibromomethane	74-95-3	ND	U	0.003	ND	U	0.003	ND	U	0.003	ND	U	0.003	—	—	—
		Dichlorodifluoromethane	75-71-8	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		Ethylbenzene	100-41-4	0.0075	--	0.002	0.019	--	0.002	0.1	--	0.002	ND	U	0.001	—	—	—
		Hexachloro-1,3-Butadiene	87-68-3	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		Isopropylbenzene	98-82-8	0.001	J	0.002	0.0012	J	0.002	0.025	--	0.002	ND	U	0.001	—	—	—
		m- & p-Xylenes	179601-23-1	0.034	--	0.003	0.039	--	0.003	0.19	J	0.16	ND	U	0.003	—	—	—
		Methyl tert-Butyl Ether	1634-04-4	ND	U	8E-04	ND	U	8E-04	ND	U	8E-04	ND	U	7E-04	—	—	—
		Methylene Chloride	75-09-2	ND	U	0.003	ND	U	0.003	ND	U	0.003	ND	U	0.003	—	—	—
		Naphthalene	91-20-3	0.0052	--	0.002	0.0065	--	0.002	0.047	--	0.002	0.00063	J	0.001	—	—	—
		n-Butylbenzene	104-51-8	ND	U	0.002	ND	U	0.002	0.035	--	0.002	ND	U	0.001	—	—	—
		n-Propylbenzene	103-65-1	0.0007	J	0.002	0.0015	J	0.002	0.043	--	0.002	ND	U	0.001	—	—	—
		o-Xylene	95-47-6	0.11	--	0.002	ND	U	0.002	0.12	--	0.002	ND	U	0.001	—	—	—
		sec-Butylbenzene	135-98-8	ND	U	0.002	ND	U	0.002	0.052	--	0.002	ND	U	0.001	—	—	—
		Styrene	100-42-5	ND	U	0.002	0.00064	J	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		tert-Butylbenzene	98-06-6	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		Tetrachloroethene	127-18-4	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.001	—	—	—
		Toluene	108-88-3	0.019	--	0.002	0.28	--	0.08	0.28	--	0.08	0.00081	J	0.001	—	—	—
		Trans-1,2-Dichloroethene	156-60-5	ND	U	8E-04	ND	U	8E-04	ND	U	8E-04	ND	U	7E-04	—	—	—
		Trans-1,3-Dichloropropene	10061-02-6	ND	U	0.002	ND	U	0.002	ND	UJ	0.002	ND	UJ	0.001	—	—	—
		Trichloroethene	79-01-6	ND	U	8E-04	ND	U	8E-04	ND	U	8E-04	ND	U	7E-04	—	—	—
		Trichlorofluoromethane	75-69-4	ND	U	0.003	ND	U	0.003	ND	U	0.003	ND	U	0.003	—	—	—
		Vinyl Chloride	75-01-4	ND	U	0.003	ND	U	0.003	ND	U	0.003	ND	U	0.003	—	—	—
Moisture	Percent Moisture (%) VOCs	NA	NA	16.2	--	--	7	--	--	9.3	--	--	8	--	--	—	—	—

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

			Boring ID:	KAFB-106S4			KAFB-106S4			KAFB-106S4			KAFB-106S4			KAFB-106S4		
			Sample Date:	10/17/2018			10/17/2018			11/1/2018			11/2/2018			11/4/2018		
			Sample Depth (ft bgs):	110			300			366			416			467		
			Sample Type:	REG			REG			REG			REG			REG		
			Core Temperature (°C)	Not Cored			Not Cored				**50.9**			**24.2**			**28.5**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
Total Petroleum Hydrocarbons	Method SW8015 (mg/kg)	Motor Oil (C20-C38)	MOIL	ND	U	24	ND	U	22	ND	U	22	ND	U	22	ND	U	22
		TPH-DRO (C10-C28)	TPH-DRO	ND	U	4.2	ND	U	3.8	ND	U	3.7	ND	U	3.8	ND	U	3.8
		TPH-GRO (C6-C10)	TPH-GRO	ND	U	1.4	ND	U	1.3	ND	U	1.2	ND	U	1.2	ND	U	1.3
Moisture	Percent Moisture (%) TPH	NA	NA	10.2	--	--	2.6	--	--	3.5	--	--	1.9	--	--	5.4	--	--
EDB	Method SW8011 (mg/kg)[a]	1,2-Dibromoethane	106-93-4	—	—	—	—	—	—	—	—	—	ND	U	4E-05	ND	U	0
Moisture	Percent Moisture (%) EDB	NA	NA	—	—	—	—	—	—	—	—	—	2.7	--	--	5.4	--	--
VOCs	Method SW8260B (mg/kg)[a]	1,1,1,2-Tetrachloroethane	630-20-6	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		1,1,1-Trichloroethane	71-55-6	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		1,1,2,2-Tetrachloroethane	79-34-5	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		1,1,2-Trichloroethane	79-00-5	—	—	—	—	—	—	—	—	—	ND	U	0.004	ND	U	0
		1,1-Dichloroethane	75-34-3	—	—	—	—	—	—	—	—	—	ND	U	9E-04	ND	U	0
		1,1-Dichloroethene	75-35-4	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		1,1-Dichloropropene	563-58-6	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		1,2,3-Trichlorobenzene	87-61-6	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		1,2,3-Trichloropropane	96-18-4	—	—	—	—	—	—	—	—	—	ND	U	0.004	ND	U	0
		1,2,4-Trichlorobenzene	120-82-1	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		1,2,4-Trimethylbenzene	95-63-6	—	—	—	—	—	—	—	—	—	ND	U	0.004	ND	U	0
		1,2-Dibromo-3-Chloropropane	96-12-8	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		1,2-Dibromoethane	106-93-4	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		1,2-Dichlorobenzene	95-50-1	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		1,2-Dichloroethane	107-06-2	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		1,2-Dichloroethene	540-59-0	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		1,2-Dichloropropane	78-87-5	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		1,3,5-Trimethylbenzene	108-67-8	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		1,3-Dichlorobenzene	541-73-1	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		1,3-Dichloropropane	142-28-9	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		1,4-Dichlorobenzene	106-46-7	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		2,2-Dichloropropane	594-20-7	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		2-Butanone	78-93-3	—	—	—	—	—	—	—	—	—	ND	U	0.007	ND	U	0.01
		2-Chlorotoluene	95-49-8	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		2-Hexanone	591-78-6	—	—	—	—	—	—	—	—	—	ND	U	0.014	ND	U	0.01
		4-Chlorotoluene	106-43-4	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		4-Isopropyltoluene	99-87-6	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		4-Methyl-2-Pentanone	108-10-1	—	—	—	—	—	—	—	—	—	ND	U	0.014	ND	U	0.01
		Acetone	67-64-1	—	—	—	—	—	—	—	—	—	ND	U	0.014	ND	U	0.01
		Benzene	71-43-2	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

			Boring ID:	KAFB-106S4			KAFB-106S4			KAFB-106S4			KAFB-106S4			KAFB-106S4		
			Sample Date:	10/17/2018			10/17/2018			11/1/2018			11/2/2018			11/4/2018		
			Sample Depth (ft bgs):	110			300			366			416			467		
			Sample Type:	REG			REG			REG			REG			REG		
			Core Temperature (°C)	Not Cored			Not Cored				**50.9**			**24.2**			**28.5**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
VOCs	Method SW8260B (mg/kg)[a]	Bromobenzene	108-86-1	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		Bromochloromethane	74-97-5	—	—	—	—	—	—	—	—	—	ND	U	9E-04	ND	U	0
		Bromodichloromethane	75-27-4	—	—	—	—	—	—	—	—	—	ND	U	9E-04	ND	U	0
		Bromoform	75-25-2	—	—	—	—	—	—	—	—	—	ND	U	9E-04	ND	U	0
		Bromomethane	74-83-9	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		Carbon Disulfide	75-15-0	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		Carbon Tetrachloride	56-23-5	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		Chlorobenzene	108-90-7	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		Chloroethane	75-00-3	—	—	—	—	—	—	—	—	—	ND	U	0.004	ND	U	0
		Chloroform	67-66-3	—	—	—	—	—	—	—	—	—	ND	U	9E-04	ND	U	0
		Chloromethane	74-87-3	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		Cis-1,2-Dichloroethene	156-59-2	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		Cis-1,3-Dichloropropene	10061-01-5	—	—	—	—	—	—	—	—	—	ND	U	0.004	ND	U	0
		Dibromochloromethane	124-48-1	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		Dibromomethane	74-95-3	—	—	—	—	—	—	—	—	—	ND	U	0.004	ND	U	0
		Dichlorodifluoromethane	75-71-8	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		Ethylbenzene	100-41-4	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		Hexachloro-1,3-Butadiene	87-68-3	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		Isopropylbenzene	98-82-8	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		m- & p-Xylenes	179601-23-1	—	—	—	—	—	—	—	—	—	ND	U	0.004	ND	U	0
		Methyl tert-Butyl Ether	1634-04-4	—	—	—	—	—	—	—	—	—	ND	U	9E-04	ND	U	0
		Methylene Chloride	75-09-2	—	—	—	—	—	—	—	—	—	0.0039	J	0.004	ND	U	0
		Naphthalene	91-20-3	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		n-Butylbenzene	104-51-8	—	—	—	—	—	—	—	—	—	ND	UJ	0.002	ND	U	0
		n-Propylbenzene	103-65-1	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		o-Xylene	95-47-6	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		sec-Butylbenzene	135-98-8	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		Styrene	100-42-5	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		tert-Butylbenzene	98-06-6	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		Tetrachloroethene	127-18-4	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		Toluene	108-88-3	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		Trans-1,2-Dichloroethene	156-60-5	—	—	—	—	—	—	—	—	—	ND	U	9E-04	ND	U	0
		Trans-1,3-Dichloropropene	10061-02-6	—	—	—	—	—	—	—	—	—	ND	U	0.002	ND	U	0
		Trichloroethene	79-01-6	—	—	—	—	—	—	—	—	—	ND	U	9E-04	ND	U	0
		Trichlorofluoromethane	75-69-4	—	—	—	—	—	—	—	—	—	ND	U	0.004	ND	U	0
		Vinyl Chloride	75-01-4	—	—	—	—	—	—	—	—	—	ND	U	0.004	ND	U	0
Moisture	Percent Moisture (%) VOCs	NA	NA	—	—	—	—	—	—	—	—	—	2.7	--	--	5.4	--	--

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

		Boring ID:		KAFB-106S4			KAFB-106S4			KAFB-106S4			KAFB-106S5			KAFB-106S5		
		Sample Date:		11/5/2018			11/5/2018			11/5/2018			10/9/2018			10/9/2018		
		Sample Depth (ft bgs):		494			504			504			210			360		
		Sample Type:		REG			REG			Field Duplicate			REG			REG		
		Core Temperature (°C)			**23.4**			**25.8**			**25.8**		Not Cored			Not Cored		
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
Total Petroleum Hydrocarbons	Method SW8015 (mg/kg)	Motor Oil (C20-C38)	MOIL	ND	U	26	ND	UJ	26	ND	U	25	ND	U	23	ND	U	22
		TPH-DRO (C10-C28)	TPH-DRO	10	--	4.4	ND	U	4.4	ND	U	4.3	ND	U	3.9	ND	U	3.8
		TPH-GRO (C6-C10)	TPH-GRO	140	--	10	ND	UJ	1.2	ND	U	1.1	ND	UJ	1.1	ND	UJ	1.1
Moisture	Percent Moisture (%) TPH	NA	NA	11.4	--	--	11.3	--	--	11.3	--	--	4	--	--	3.6	--	--
EDB	Method SW8011 (mg/kg)[a]	1,2-Dibromoethane	106-93-4	0.00022	--	4E-05	ND	U	5E-05	ND	U	4E-05	—	—	—	—	—	—
Moisture	Percent Moisture (%) EDB	NA	NA	11.9	--	--	19.7	--	--	11.3	--	--	—	—	—	—	—	—
VOCs	Method SW8260B (mg/kg)[a]	1,1,1,2-Tetrachloroethane	630-20-6	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		1,1,1-Trichloroethane	71-55-6	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		1,1,2,2-Tetrachloroethane	79-34-5	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		1,1,2-Trichloroethane	79-00-5	ND	U	0.003	ND	UJ	0.003	ND	U	0.003	—	—	—	—	—	—
		1,1-Dichloroethane	75-34-3	ND	U	8E-04	ND	UJ	8E-04	ND	U	7E-04	—	—	—	—	—	—
		1,1-Dichloroethene	75-35-4	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		1,1-Dichloropropene	563-58-6	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		1,2,3-Trichlorobenzene	87-61-6	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		1,2,3-Trichloropropane	96-18-4	ND	U	0.003	ND	UJ	0.003	ND	U	0.003	—	—	—	—	—	—
		1,2,4-Trichlorobenzene	120-82-1	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		1,2,4-Trimethylbenzene	95-63-6	0.044	--	0.003	0.0032	J	0.003	0.0029	J	0.003	—	—	—	—	—	—
		1,2-Dibromo-3-Chloropropane	96-12-8	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		1,2-Dibromoethane	106-93-4	0.0091	--	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		1,2-Dichlorobenzene	95-50-1	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		1,2-Dichloroethane	107-06-2	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		1,2-Dichloroethene	540-59-0	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		1,2-Dichloropropane	78-87-5	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		1,3,5-Trimethylbenzene	108-67-8	0.017	--	0.002	0.0014	J	0.002	0.0013	J	0.001	—	—	—	—	—	—
		1,3-Dichlorobenzene	541-73-1	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		1,3-Dichloropropane	142-28-9	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		1,4-Dichlorobenzene	106-46-7	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		2,2-Dichloropropane	594-20-7	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		2-Butanone	78-93-3	ND	U	0.006	ND	UJ	0.006	ND	U	0.005	—	—	—	—	—	—
		2-Chlorotoluene	95-49-8	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		2-Hexanone	591-78-6	ND	U	0.013	ND	UJ	0.012	ND	U	0.01	—	—	—	—	—	—
		4-Chlorotoluene	106-43-4	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		4-Isopropyltoluene	99-87-6	0.0032	J	0.002	ND	UJ	0.002	0.00043	J	0.001	—	—	—	—	—	—
		4-Methyl-2-Pentanone	108-10-1	ND	U	0.013	ND	UJ	0.012	ND	U	0.01	—	—	—	—	—	—
		Acetone	67-64-1	0.025	--	0.013	0.09	J	0.012	0.089	--	0.01	—	—	—	—	—	—
		Benzene	71-43-2	0.44	--	0.13	0.0044	J	0.002	0.0033	J	0.001	—	—	—	—	—	—

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

		Boring ID:		KAFB-106S4			KAFB-106S4			KAFB-106S4			KAFB-106S5			KAFB-106S5		
		Sample Date:		11/5/2018			11/5/2018			11/5/2018			10/9/2018			10/9/2018		
		Sample Depth (ft bgs):		494			504			504			210			360		
		Sample Type:		REG			REG			Field Duplicate			REG			REG		
		Core Temperature (°C)			**23.4**			**25.8**			**25.8**		Not Cored			Not Cored		
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
VOCs	Method SW8260B (mg/kg)[a]	Bromobenzene	108-86-1	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		Bromochloromethane	74-97-5	ND	U	8E-04	ND	UJ	8E-04	ND	U	7E-04	—	—	—	—	—	—
		Bromodichloromethane	75-27-4	ND	U	8E-04	ND	UJ	8E-04	ND	U	7E-04	—	—	—	—	—	—
		Bromoform	75-25-2	ND	U	8E-04	ND	UJ	8E-04	ND	U	7E-04	—	—	—	—	—	—
		Bromomethane	74-83-9	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		Carbon Disulfide	75-15-0	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		Carbon Tetrachloride	56-23-5	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		Chlorobenzene	108-90-7	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		Chloroethane	75-00-3	ND	U	0.003	ND	UJ	0.003	ND	U	0.003	—	—	—	—	—	—
		Chloroform	67-66-3	ND	U	8E-04	ND	UJ	8E-04	ND	U	7E-04	—	—	—	—	—	—
		Chloromethane	74-87-3	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		Cis-1,2-Dichloroethene	156-59-2	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		Cis-1,3-Dichloropropene	10061-01-5	ND	U	0.003	ND	UJ	0.003	ND	U	0.003	—	—	—	—	—	—
		Dibromochloromethane	124-48-1	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		Dibromomethane	74-95-3	ND	U	0.003	ND	UJ	0.003	ND	U	0.003	—	—	—	—	—	—
		Dichlorodifluoromethane	75-71-8	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		Ethylbenzene	100-41-4	0.09	--	0.002	0.0024	J	0.002	0.0022	J	0.001	—	—	—	—	—	—
		Hexachloro-1,3-Butadiene	87-68-3	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		Isopropylbenzene	98-82-8	0.011	--	0.002	0.00088	J	0.002	0.0007	J	0.001	—	—	—	—	—	—
		m- & p-Xylenes	179601-23-1	0.19	--	0.003	0.0062	J	0.003	0.0058	--	0.003	—	—	—	—	—	—
		Methyl tert-Butyl Ether	1634-04-4	ND	U	8E-04	ND	UJ	8E-04	ND	U	7E-04	—	—	—	—	—	—
		Methylene Chloride	75-09-2	ND	U	0.003	ND	UJ	0.003	ND	U	0.003	—	—	—	—	—	—
		Naphthalene	91-20-3	0.0097	--	0.002	ND	UJ	0.002	0.001	J	0.001	—	—	—	—	—	—
		n-Butylbenzene	104-51-8	0.0051	--	0.002	0.00093	J	0.002	0.00085	J	0.001	—	—	—	—	—	—
		n-Propylbenzene	103-65-1	0.014	--	0.002	0.00093	J	0.002	0.00095	J	0.001	—	—	—	—	—	—
		o-Xylene	95-47-6	0.091	--	0.002	0.0025	J	0.002	0.0022	J	0.001	—	—	—	—	—	—
		sec-Butylbenzene	135-98-8	0.0087	--	0.002	0.0011	J	0.002	0.00077	J	0.001	—	—	—	—	—	—
		Styrene	100-42-5	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		tert-Butylbenzene	98-06-6	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		Tetrachloroethene	127-18-4	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		Toluene	108-88-3	0.83	--	0.063	0.01	J	0.002	0.0091	--	0.001	—	—	—	—	—	—
		Trans-1,2-Dichloroethene	156-60-5	ND	U	8E-04	ND	UJ	8E-04	ND	U	7E-04	—	—	—	—	—	—
		Trans-1,3-Dichloropropene	10061-02-6	ND	U	0.002	ND	UJ	0.002	ND	U	0.001	—	—	—	—	—	—
		Trichloroethene	79-01-6	ND	U	8E-04	ND	UJ	8E-04	ND	U	7E-04	—	—	—	—	—	—
		Trichlorofluoromethane	75-69-4	ND	U	0.003	ND	UJ	0.003	ND	U	0.003	—	—	—	—	—	—
		Vinyl Chloride	75-01-4	ND	U	0.003	ND	UJ	0.003	ND	U	0.003	—	—	—	—	—	—
Moisture	Percent Moisture (%) VOCs	NA	NA	11.9	--	--	19.7	--	--	11.3	--	--	—	—	—	—	—	—

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

			Boring ID:	KAFB-106S5			KAFB-106S5			KAFB-106S5			KAFB-106S5			KAFB-106S5		
			Sample Date:	10/21/2018			10/23/2018			10/23/2018			10/23/2018			10/23/2018		
			Sample Depth (ft bgs):	417			467			467			491			506		
			Sample Type:	REG			REG			Field Duplicate			REG			REG		
			Core Temperature (°C)		**21.9**			**20.7**			**20.7**			**22**			**24.6**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
Total Petroleum Hydrocarbons	Method SW8015 (mg/kg)	Motor Oil (C20-C38)	MOIL	ND	U	23	ND	U	22	ND	U	23	ND	U	27	ND	U	23
		TPH-DRO (C10-C28)	TPH-DRO	ND	U	3.9	5.6	J	3.8	4.7	J	4	440	--	4.6	5.3	J	4
		TPH-GRO (C6-C10)	TPH-GRO	ND	UJ	1.2	ND	U	1.6	ND	UJ	1.3	490	--	20	ND	U	1.5
Moisture	Percent Moisture (%) TPH	NA	NA	2.6	--	--	3.8	--	--	3.7	--	--	18.3	--	--	8.7	--	--
EDB	Method SW8011 (mg/kg)[a]	1,2-Dibromoethane	106-93-4	ND	U	4E-05	ND	U	4E-05	ND	U	0	0.0051	--	0.0009	0.00013	--	4E-05
Moisture	Percent Moisture (%) EDB	NA	NA	2.6	--	--	4.1	--	--	4.2	--	--	11.9	--	--	13.9	--	--
VOCs	Method SW8260B (mg/kg)[a]	1,1,1,2-Tetrachloroethane	630-20-6	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	0.68	ND	U	0.002
		1,1,1-Trichloroethane	71-55-6	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	0.34	ND	U	0.002
		1,1,2,2-Tetrachloroethane	79-34-5	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	0.68	ND	U	0.002
		1,1,2-Trichloroethane	79-00-5	ND	U	0.003	ND	U	0.003	ND	U	0	ND	U	0.68	ND	U	0.003
		1,1-Dichloroethane	75-34-3	0.00038	J	6E-04	ND	U	9E-04	ND	U	0	ND	U	1.4	ND	U	7E-04
		1,1-Dichloroethene	75-35-4	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	1.4	ND	U	0.002
		1,1-Dichloropropene	563-58-6	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	1.4	ND	U	0.002
		1,2,3-Trichlorobenzene	87-61-6	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	0.68	ND	U	0.002
		1,2,3-Trichloropropane	96-18-4	ND	U	0.003	ND	U	0.003	ND	U	0	ND	U	1.4	ND	U	0.003
		1,2,4-Trichlorobenzene	120-82-1	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	1.4	ND	U	0.002
		1,2,4-Trimethylbenzene	95-63-6	ND	U	0.003	ND	U	0.003	ND	U	0	8.7	--	0.68	0.0015	J	0.003
		1,2-Dibromo-3-Chloropropane	96-12-8	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	2.7	ND	U	0.002
		1,2-Dibromoethane	106-93-4	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	0.68	ND	U	0.002
		1,2-Dichlorobenzene	95-50-1	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	2.7	ND	U	0.002
		1,2-Dichloroethane	107-06-2	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	0.68	ND	U	0.002
		1,2-Dichloroethene	540-59-0	0.0091	--	0.001	ND	U	0.002	ND	U	0	ND	U	0.68	ND	U	0.002
		1,2-Dichloropropane	78-87-5	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	1.4	ND	U	0.002
		1,3,5-Trimethylbenzene	108-67-8	ND	U	0.001	ND	U	0.002	ND	U	0	3.5	--	0.68	0.00083	J	0.002
		1,3-Dichlorobenzene	541-73-1	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	1.4	ND	U	0.002
		1,3-Dichloropropane	142-28-9	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	0.68	ND	U	0.002
		1,4-Dichlorobenzene	106-46-7	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	0.68	ND	U	0.002
		2,2-Dichloropropane	594-20-7	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	0.68	ND	U	0.002
		2-Butanone	78-93-3	ND	U	0.005	ND	U	0.007	0.0042	J	0.01	ND	U	5.4	ND	U	0.006
		2-Chlorotoluene	95-49-8	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	0.68	ND	U	0.002
		2-Hexanone	591-78-6	ND	U	0.01	ND	U	0.014	ND	U	0.01	ND	U	5.4	ND	U	0.012
		4-Chlorotoluene	106-43-4	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	0.68	ND	U	0.002
		4-Isopropyltoluene	99-87-6	ND	U	0.001	ND	U	0.002	ND	U	0	0.79	J	0.68	ND	U	0.002
		4-Methyl-2-Pentanone	108-10-1	ND	U	0.01	ND	U	0.014	ND	U	0.01	ND	U	5.4	ND	U	0.012
		Acetone	67-64-1	0.0052	J	0.01	ND	U	0.014	ND	U	0.01	11	J	11	ND	U	0.012
		Benzene	71-43-2	ND	U	0.001	ND	U	0.002	0.0006	J	0	2.1	--	1.4	ND	U	0.002

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

			Boring ID:	KAFB-106S5			KAFB-106S5			KAFB-106S5			KAFB-106S5			KAFB-106S5		
			Sample Date:	10/21/2018			10/23/2018			10/23/2018			10/23/2018			10/23/2018		
			Sample Depth (ft bgs):	417			467			467			491			506		
			Sample Type:	REG			REG			Field Duplicate			REG			REG		
			Core Temperature (°C)		**21.9**			**20.7**			**20.7**			**22**			**24.6**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
VOCs	Method SW8260B (mg/kg)[a]	Bromobenzene	108-86-1	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	0.34	ND	U	0.002
		Bromochloromethane	74-97-5	ND	U	6E-04	ND	U	9E-04	ND	U	0	ND	U	1.4	ND	U	7E-04
		Bromodichloromethane	75-27-4	ND	U	6E-04	ND	U	9E-04	ND	U	0	ND	U	0.68	ND	U	7E-04
		Bromoform	75-25-2	ND	U	6E-04	ND	U	9E-04	ND	U	0	ND	U	1.4	ND	U	7E-04
		Bromomethane	74-83-9	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	1.4	ND	U	0.002
		Carbon Disulfide	75-15-0	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	1.4	ND	U	0.002
		Carbon Tetrachloride	56-23-5	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	0.34	ND	U	0.002
		Chlorobenzene	108-90-7	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	0.68	ND	U	0.002
		Chloroethane	75-00-3	ND	U	0.003	ND	U	0.003	ND	U	0	ND	U	1.4	ND	U	0.003
		Chloroform	67-66-3	ND	U	6E-04	ND	U	9E-04	ND	U	0	ND	U	1.4	ND	U	7E-04
		Chloromethane	74-87-3	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	1.4	ND	U	0.002
		Cis-1,2-Dichloroethene	156-59-2	0.0091	--	0.001	ND	U	0.002	ND	U	0	ND	U	0.68	ND	U	0.002
		Cis-1,3-Dichloropropene	10061-01-5	ND	U	0.003	ND	U	0.003	ND	U	0	ND	U	0.68	ND	U	0.003
		Dibromochloromethane	124-48-1	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	0.68	ND	U	0.002
		Dibromomethane	74-95-3	ND	U	0.003	ND	U	0.003	ND	U	0	ND	U	0.68	ND	U	0.003
		Dichlorodifluoromethane	75-71-8	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	0.68	ND	U	0.002
		Ethylbenzene	100-41-4	ND	U	0.001	ND	U	0.002	ND	U	0	11	--	0.68	ND	U	0.002
		Hexachloro-1,3-Butadiene	87-68-3	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	1.4	ND	U	0.002
		Isopropylbenzene	98-82-8	ND	U	0.001	ND	U	0.002	ND	U	0	2.1	--	0.68	ND	U	0.002
		m- & p-Xylenes	179601-23-1	ND	U	0.003	ND	U	0.003	ND	U	0	23	--	1.4	0.0011	J	0.003
		Methyl tert-Butyl Ether	1634-04-4	ND	U	6E-04	ND	U	9E-04	ND	U	0	ND	U	1.4	ND	U	7E-04
		Methylene Chloride	75-09-2	ND	U	0.003	ND	U	0.003	ND	U	0	ND	U	1.4	ND	U	0.003
		Naphthalene	91-20-3	ND	U	0.001	ND	U	0.002	ND	U	0	1.6	J	0.68	ND	U	0.002
		n-Butylbenzene	104-51-8	ND	U	0.001	ND	U	0.002	ND	U	0	1.6	J	0.68	0.00089	J	0.002
		n-Propylbenzene	103-65-1	ND	U	0.001	ND	U	0.002	ND	U	0	3.8	--	1.4	ND	U	0.002
		o-Xylene	95-47-6	ND	U	0.001	ND	U	0.002	ND	U	0	8	--	0.68	ND	U	0.002
		sec-Butylbenzene	135-98-8	ND	U	0.001	ND	U	0.002	ND	U	0	1.5	J	0.68	0.00087	J	0.002
		Styrene	100-42-5	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	0.68	ND	U	0.002
		tert-Butylbenzene	98-06-6	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	0.68	ND	U	0.002
		Tetrachloroethene	127-18-4	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	0.68	ND	U	0.002
		Toluene	108-88-3	0.00091	J	0.001	0.00094	J	0.002	0.0021	J	0	31	--	0.68	0.0015	J	0.002
		Trans-1,2-Dichloroethene	156-60-5	ND	U	6E-04	ND	U	9E-04	ND	U	0	ND	U	1.4	ND	U	7E-04
		Trans-1,3-Dichloropropene	10061-02-6	ND	U	0.001	ND	U	0.002	ND	U	0	ND	U	1.4	ND	U	0.002
		Trichloroethene	79-01-6	ND	U	6E-04	ND	U	9E-04	ND	U	0	ND	U	0.68	ND	U	7E-04
		Trichlorofluoromethane	75-69-4	ND	U	0.003	ND	U	0.003	ND	U	0	ND	U	1.4	ND	U	0.003
		Vinyl Chloride	75-01-4	ND	U	0.003	ND	U	0.003	ND	U	0	ND	U	0.68	ND	U	0.003
Moisture	Percent Moisture (%) VOCs	NA	NA	2.6	--	--	4.1	--	--	4.2	--	--	11.9	--	--	13.9	--	--

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

		Boring ID:		KAFB-106S7			KAFB-106S7			KAFB-106S7			KAFB-106S7			KAFB-106S7		
		Sample Date:		1/21/2019			1/22/2019			1/22/2019			1/22/2019			1/22/2019		
		Sample Depth (ft bgs):		420			485			495			496			506		
		Sample Type:		REG			REG			REG			REG			REG		
		Core Temperature (°C)			**33**			**39.9**			**31.1**			**31.1**			**31.1**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
Total Petroleum Hydrocarbons	Method SW8015 (mg/kg)	Motor Oil (C20-C38)	MOIL	ND	U	22	ND	U	23	ND	U	24	ND	U	24	ND	U	23
		TPH-DRO (C10-C28)	TPH-DRO	ND	U	3.8	14	--	4	1,400	--	4.1	ND	U	4.1	ND	U	4
		TPH-GRO (C6-C10)	TPH-GRO	ND	U	1.4	1.8	--	1.2	1,800	--	330	ND	U	1.2	ND	U	1.3
Moisture	Percent Moisture (%) TPH	NA	NA	3.6	--	--	9.1	--	--	10.4	--	--	2.8	--	--	9.4	--	--
EDB	Method SW8011 (mg/kg)[a]	1,2-Dibromoethane	106-93-4	ND	U	0	ND	U	0	0.042	--	0.0084	ND	U	4E-05	ND	U	4E-05
Moisture	Percent Moisture (%) EDB	NA	NA	4.6	--	--	8.3	--	--	10.8	--	--	3	--	--	10.3	--	--
VOCs	Method SW8260B (mg/kg)[a]	1,1,1,2-Tetrachloroethane	630-20-6	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		1,1,1-Trichloroethane	71-55-6	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		1,1,2,2-Tetrachloroethane	79-34-5	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		1,1,2-Trichloroethane	79-00-5	ND	U	0	ND	U	0	ND	UJ	0.0034	ND	U	0.003	ND	U	0.003
		1,1-Dichloroethane	75-34-3	ND	U	0	ND	U	0	ND	UJ	0.00084	ND	U	8E-04	ND	U	8E-04
		1,1-Dichloroethene	75-35-4	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		1,1-Dichloropropene	563-58-6	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		1,2,3-Trichlorobenzene	87-61-6	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		1,2,3-Trichloropropane	96-18-4	ND	U	0	ND	U	0	ND	UJ	0.0034	ND	U	0.003	ND	U	0.003
		1,2,4-Trichlorobenzene	120-82-1	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		1,2,4-Trimethylbenzene	95-63-6	ND	U	0	0.0095	--	0	23	J	9.5	0.0021	J	0.003	0.009	--	0.003
		1,2-Dibromo-3-Chloropropane	96-12-8	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		1,2-Dibromoethane	106-93-4	ND	U	0	ND	U	0	ND	UJ	0.0017	0.00083	J	0.002	ND	U	0.002
		1,2-Dichlorobenzene	95-50-1	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		1,2-Dichloroethane	107-06-2	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		1,2-Dichloroethene	540-59-0	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		1,2-Dichloropropane	78-87-5	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		1,3,5-Trimethylbenzene	108-67-8	ND	U	0	0.0055	J	0	11	J	9.5	0.00085	J	0.002	0.0033	J	0.002
		1,3-Dichlorobenzene	541-73-1	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		1,3-Dichloropropane	142-28-9	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		1,4-Dichlorobenzene	106-46-7	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		2,2-Dichloropropane	594-20-7	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		2-Butanone	78-93-3	ND	U	0.01	0.14	--	0.01	ND	UJ	0.0067	ND	U	0.007	ND	U	0.006
		2-Chlorotoluene	95-49-8	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		2-Hexanone	591-78-6	ND	U	0.02	0.13	--	0.02	ND	UJ	0.013	0.0071	J	0.013	ND	U	0.012
		4-Chlorotoluene	106-43-4	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		4-Isopropyltoluene	99-87-6	ND	U	0	0.044	--	0	ND	UJ	9.5	ND	U	0.002	0.0011	J	0.002
		4-Methyl-2-Pentanone	108-10-1	ND	U	0.02	0.052	--	0.02	ND	UJ	0.013	ND	U	0.013	ND	U	0.012
		Acetone	67-64-1	ND	U	0.02	0.46	--	0.02	ND	UJ	150	0.082	--	0.013	0.038	--	0.012
		Benzene	71-43-2	ND	U	0	0.085	--	0	9.1	J	19	0.00091	J	0.002	0.0011	J	0.002

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

			Boring ID:	KAFB-106S7			KAFB-106S7			KAFB-106S7			KAFB-106S7			KAFB-106S7		
			Sample Date:	1/21/2019			1/22/2019			1/22/2019			1/22/2019			1/22/2019		
			Sample Depth (ft bgs):	420			485			495			496			506		
			Sample Type:	REG			REG			REG			REG			REG		
			Core Temperature (°C)		**33**			**39.9**			**31.1**			**31.1**			**31.1**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
VOCs	Method SW8260B (mg/kg)[a]	Bromobenzene	108-86-1	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		Bromochloromethane	74-97-5	ND	U	0	ND	U	0	ND	UJ	0.00084	ND	U	8E-04	ND	U	8E-04
		Bromodichloromethane	75-27-4	ND	U	0	ND	U	0	ND	UJ	0.00084	ND	U	8E-04	ND	U	8E-04
		Bromoform	75-25-2	ND	U	0	ND	U	0	ND	UJ	0.00084	ND	U	8E-04	ND	U	8E-04
		Bromomethane	74-83-9	ND	U	0	ND	U	0	0.025	J	0.0017	ND	U	0.002	ND	U	0.002
		Carbon Disulfide	75-15-0	ND	U	0	ND	U	0	0.0054	J	0.0017	ND	U	0.002	ND	U	0.002
		Carbon Tetrachloride	56-23-5	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		Chlorobenzene	108-90-7	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		Chloroethane	75-00-3	ND	U	0	ND	U	0	ND	UJ	0.0034	ND	U	0.003	ND	U	0.003
		Chloroform	67-66-3	ND	U	0	ND	U	0	ND	UJ	0.00084	ND	U	8E-04	ND	U	8E-04
		Chloromethane	74-87-3	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		Cis-1,2-Dichloroethene	156-59-2	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		Cis-1,3-Dichloropropene	10061-01-5	ND	U	0	ND	U	0	ND	UJ	0.0034	ND	U	0.003	ND	U	0.003
		Dibromochloromethane	124-48-1	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		Dibromomethane	74-95-3	ND	U	0	ND	U	0	ND	UJ	0.0034	ND	U	0.003	ND	U	0.003
		Dichlorodifluoromethane	75-71-8	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		Ethylbenzene	100-41-4	ND	U	0	0.0032	J	0	33	J	9.5	ND	U	0.002	0.0051	--	0.002
		Hexachloro-1,3-Butadiene	87-68-3	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		Isopropylbenzene	98-82-8	ND	U	0	0.0095	--	0	6.5	J	9.5	ND	U	0.002	0.00086	J	0.002
		m- & p-Xylenes	179601-23-1	ND	U	0	0.0088	--	0	69	J	19	0.0047	--	0.003	0.011	--	0.003
		Methyl tert-Butyl Ether	1634-04-4	ND	U	0	ND	U	0	ND	UJ	0.00084	ND	U	8E-04	ND	U	8E-04
		Methylene Chloride	75-09-2	0.0039	J	0	ND	U	0	ND	UJ	0.0034	ND	U	0.003	ND	U	0.003
		Naphthalene	91-20-3	ND	U	0	0.021	--	0	ND	UJ	9.5	ND	U	0.002	0.0096	--	0.002
		n-Butylbenzene	104-51-8	ND	U	0	ND	U	0	4.5	J	9.5	ND	U	0.002	0.0025	J	0.002
		n-Propylbenzene	103-65-1	ND	U	0	0.00067	J	0	11	J	19	ND	U	0.002	0.0027	J	0.002
		o-Xylene	95-47-6	ND	U	0	0.044	--	0	25	J	9.5	0.0047	J	0.002	0.0045	J	0.002
		sec-Butylbenzene	135-98-8	ND	U	0	0.0012	J	0	ND	UJ	9.5	ND	U	0.002	0.0018	J	0.002
		Styrene	100-42-5	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		tert-Butylbenzene	98-06-6	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		Tetrachloroethene	127-18-4	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		Toluene	108-88-3	ND	U	0	0.0085	--	0	110	J	9.5	ND	U	0.002	0.015	--	0.002
		Trans-1,2-Dichloroethene	156-60-5	ND	U	0	ND	U	0	ND	UJ	0.00084	ND	U	8E-04	ND	U	8E-04
		Trans-1,3-Dichloropropene	10061-02-6	ND	U	0	ND	U	0	ND	UJ	0.0017	ND	U	0.002	ND	U	0.002
		Trichloroethene	79-01-6	ND	U	0	ND	U	0	ND	UJ	0.00084	ND	U	8E-04	ND	U	8E-04
		Trichlorofluoromethane	75-69-4	ND	U	0	ND	U	0	ND	UJ	0.0034	ND	U	0.003	ND	U	0.003
		Vinyl Chloride	75-01-4	ND	U	0	ND	U	0	ND	UJ	0.0034	ND	U	0.003	ND	U	0.003
Moisture	Percent Moisture (%) VOCs	NA	NA	4.6	--	--	8.3	--	--	10.8	--	--	3	--	--	10.3	--	--

Table 5-1

Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

		Boring ID:		KAFB-106S7			KAFB-106S8			KAFB-106S8			KAFB-106S8			KAFB-106S8		
		Sample Date:		1/22/2019			1/16/2019			1/18/2019			1/18/2019			1/18/2019		
		Sample Depth (ft bgs):		506			419			475			499			514		
		Sample Type:		Field Duplicate			REG			REG			REG			REG		
		Core Temperature (°C)			**31.1**			**41.3**			**21.8**			**22.1**			**20.4**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
Total Petroleum Hydrocarbons	Method SW8015 (mg/kg)	Motor Oil (C20-C38)	MOIL	ND	U	24	ND	U	24	ND	U	23	ND	U	25	ND	U	26
		TPH-DRO (C10-C28)	TPH-DRO	ND	U	4.1	ND	U	4.1	ND	U	4	ND	U	4.3	ND	U	4.4
		TPH-GRO (C6-C10)	TPH-GRO	ND	U	1.1	ND	U	1.3	13	J	1.3	ND	U	1.4	ND	U	1.4
Moisture	Percent Moisture (%) TPH	NA	NA	8.8	--	--	2.6	--	--	9.5	--	--	12.8	--	--	11.6	--	--
EDB	Method SW8011 (mg/kg)[a]	1,2-Dibromoethane	106-93-4	ND	U	4E-05	ND	U	0	0.0017	--	0.0004	ND	U	4E-05	ND	U	5E-05
Moisture	Percent Moisture (%) EDB	NA	NA	10.2	--	--	2.2	--	--	11.7	--	--	10.8	--	--	16.5	--	--
VOCs	Method SW8260B (mg/kg)[a]	1,1,1,2-Tetrachloroethane	630-20-6	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		1,1,1-Trichloroethane	71-55-6	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		1,1,2,2-Tetrachloroethane	79-34-5	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	0.002	J	0.002
		1,1,2-Trichloroethane	79-00-5	ND	U	0.003	ND	U	0	ND	U	0.0032	ND	U	0.003	ND	U	0.003
		1,1-Dichloroethane	75-34-3	ND	U	9E-04	ND	U	0	ND	U	0.0008	ND	U	7E-04	ND	U	8E-04
		1,1-Dichloroethene	75-35-4	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		1,1-Dichloropropene	563-58-6	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		1,2,3-Trichlorobenzene	87-61-6	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		1,2,3-Trichloropropane	96-18-4	ND	U	0.003	ND	U	0	ND	U	0.0032	ND	U	0.003	0.00099	J	0.003
		1,2,4-Trichlorobenzene	120-82-1	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		1,2,4-Trimethylbenzene	95-63-6	0.003	J	0.003	ND	U	0	ND	U	0.87	ND	U	0.003	ND	U	0.003
		1,2-Dibromo-3-Chloropropane	96-12-8	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		1,2-Dibromoethane	106-93-4	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		1,2-Dichlorobenzene	95-50-1	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		1,2-Dichloroethane	107-06-2	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		1,2-Dichloroethene	540-59-0	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		1,2-Dichloropropane	78-87-5	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		1,3,5-Trimethylbenzene	108-67-8	ND	U	0.002	ND	U	0	0.15	J	0.0016	ND	U	0.001	ND	U	0.002
		1,3-Dichlorobenzene	541-73-1	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		1,3-Dichloropropane	142-28-9	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		1,4-Dichlorobenzene	106-46-7	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		2,2-Dichloropropane	594-20-7	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		2-Butanone	78-93-3	ND	U	0.007	ND	U	0.01	ND	U	7	0.0035	J	0.006	ND	U	0.007
		2-Chlorotoluene	95-49-8	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		2-Hexanone	591-78-6	ND	U	0.014	ND	U	0.02	0.26	J	0.013	ND	U	0.011	0.015	J	0.013
		4-Chlorotoluene	106-43-4	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		4-Isopropyltoluene	99-87-6	0.00091	J	0.002	ND	U	0	0.017	J	0.0016	ND	U	0.001	ND	U	0.002
		4-Methyl-2-Pentanone	108-10-1	ND	U	0.014	ND	U	0.02	0.13	J	0.013	ND	U	0.011	ND	U	0.013
		Acetone	67-64-1	0.036	--	0.014	ND	U	0.02	ND	U	14	ND	U	0.011	ND	U	0.013
		Benzene	71-43-2	0.00088	J	0.002	ND	U	0	0.023	J	0.0016	ND	U	0.001	0.0014	J	0.002

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

		Boring ID:		KAFB-106S7			KAFB-106S8			KAFB-106S8			KAFB-106S8			KAFB-106S8		
		Sample Date:		1/22/2019			1/16/2019			1/18/2019			1/18/2019			1/18/2019		
		Sample Depth (ft bgs):		506			419			475			499			514		
		Sample Type:		Field Duplicate			REG			REG			REG			REG		
		Core Temperature (°C)			**31.1**			**41.3**			**21.8**			**22.1**			**20.4**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
VOCs	Method SW8260B (mg/kg)[a]	Bromobenzene	108-86-1	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		Bromochloromethane	74-97-5	ND	U	9E-04	ND	U	0	ND	U	0.0008	ND	U	7E-04	ND	U	8E-04
		Bromodichloromethane	75-27-4	ND	U	9E-04	ND	U	0	ND	U	0.0008	ND	U	7E-04	ND	U	8E-04
		Bromoform	75-25-2	ND	U	9E-04	ND	U	0	ND	U	0.0008	ND	U	7E-04	ND	U	8E-04
		Bromomethane	74-83-9	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		Carbon Disulfide	75-15-0	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		Carbon Tetrachloride	56-23-5	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		Chlorobenzene	108-90-7	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		Chloroethane	75-00-3	ND	U	0.003	ND	U	0	ND	U	0.0032	ND	U	0.003	ND	U	0.003
		Chloroform	67-66-3	ND	U	9E-04	ND	U	0	ND	U	0.0008	ND	U	7E-04	ND	U	8E-04
		Chloromethane	74-87-3	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		Cis-1,2-Dichloroethene	156-59-2	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		Cis-1,3-Dichloropropene	10061-01-5	ND	U	0.003	ND	U	0	ND	U	0.0032	ND	U	0.003	ND	U	0.003
		Dibromochloromethane	124-48-1	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		Dibromomethane	74-95-3	ND	U	0.003	ND	U	0	ND	U	0.0032	ND	U	0.003	ND	U	0.003
		Dichlorodifluoromethane	75-71-8	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		Ethylbenzene	100-41-4	0.002	J	0.002	ND	U	0	0.045	J	0.0016	ND	U	0.001	ND	U	0.002
		Hexachloro-1,3-Butadiene	87-68-3	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		Isopropylbenzene	98-82-8	ND	U	0.002	ND	U	0	0.029	J	0.0016	ND	U	0.001	0.00081	J	0.002
		m- & p-Xylenes	179601-23-1	0.0039	--	0.003	ND	U	0	ND	U	1.7	ND	U	0.003	0.002	J	0.003
		Methyl tert-Butyl Ether	1634-04-4	ND	U	9E-04	ND	U	0	ND	U	0.0008	ND	U	7E-04	ND	U	8E-04
		Methylene Chloride	75-09-2	ND	U	0.003	0.003	J	0	ND	U	0.0032	0.0024	J	0.003	0.0033	J	0.003
		Naphthalene	91-20-3	0.0022	J	0.002	ND	U	0	0.44	J	0.87	ND	U	0.001	ND	U	0.002
		n-Butylbenzene	104-51-8	ND	U	0.002	ND	U	0	0.15	J	0.0016	ND	U	0.001	ND	U	0.002
		n-Propylbenzene	103-65-1	0.0015	J	0.002	ND	U	0	0.13	J	0.0016	ND	U	0.001	0.00074	J	0.002
		o-Xylene	95-47-6	0.0012	J	0.002	ND	U	0	ND	U	0.87	ND	U	0.001	0.0007	J	0.002
		sec-Butylbenzene	135-98-8	0.00088	J	0.002	ND	U	0	ND	U	0.87	ND	U	0.001	ND	U	0.002
		Styrene	100-42-5	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		tert-Butylbenzene	98-06-6	ND	U	0.002	ND	U	0	0.015	J	0.0016	ND	U	0.001	ND	U	0.002
		Tetrachloroethene	127-18-4	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		Toluene	108-88-3	0.0092	--	0.002	ND	U	0	0.066	J	0.0016	ND	U	0.001	ND	U	0.002
		Trans-1,2-Dichloroethene	156-60-5	ND	U	9E-04	ND	U	0	ND	U	0.0008	ND	U	7E-04	ND	U	8E-04
		Trans-1,3-Dichloropropene	10061-02-6	ND	U	0.002	ND	U	0	ND	U	0.0016	ND	U	0.001	ND	U	0.002
		Trichloroethene	79-01-6	ND	U	9E-04	ND	U	0	ND	U	0.0008	ND	U	7E-04	ND	U	8E-04
		Trichlorofluoromethane	75-69-4	ND	U	0.003	ND	U	0	ND	U	0.0032	ND	U	0.003	ND	U	0.003
		Vinyl Chloride	75-01-4	ND	U	0.003	ND	U	0	ND	U	0.0032	ND	U	0.003	ND	U	0.003
Moisture	Percent Moisture (%) VOCs	NA	NA	10.2	--	--	2.2	--	--	11.7	--	--	10.8	--	--	16.5	--	--

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

		Boring ID:		KAFB-106S8			KAFB-106S9			KAFB-106S9			KAFB-106S9			KAFB-106S9		
		Sample Date:		1/18/2019			10/6/2018			10/7/2018			10/9/2018			10/11/2018		
		Sample Depth (ft bgs):		514			102			174			252			342		
		Sample Type:		Field Duplicate			REG			REG			REG			REG		
		Core Temperature (°C)			**20.4**			**37.6**			19.3			**22.7**			**24.3**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
Total Petroleum Hydrocarbons	Method SW8015 (mg/kg)	Motor Oil (C20-C38)	MOIL	ND	U	27	ND	U	25	ND	U	34	ND	U	32	ND	U	26
		TPH-DRO (C10-C28)	TPH-DRO	ND	U	4.5	ND	U	4.2	ND	U	5.8	ND	U	5.5	ND	U	4.5
		TPH-GRO (C6-C10)	TPH-GRO	ND	U	1.4	ND	U	1.7	ND	U	2	1.3	J	2	ND	U	1.5
Moisture	Percent Moisture (%) TPH	NA	NA	12.5	--	--	5.9	--	--	33.8	--	--	29.5	--	--	14	--	--
EDB	Method SW8011 (mg/kg)[a]	1,2-Dibromoethane	106-93-4	ND	U	4E-05	ND	UJ	0	ND	U	6E-05	0.001	--	4E-05	ND	U	5E-05
Moisture	Percent Moisture (%) EDB	NA	NA	14.6	--	--	5.9	--	--	33.8	--	--	0	--	--	16.3	--	--
VOCs	Method SW8260B (mg/kg)[a]	1,1,1,2-Tetrachloroethane	630-20-6	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		1,1,1-Trichloroethane	71-55-6	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		1,1,2,2-Tetrachloroethane	79-34-5	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		1,1,2-Trichloroethane	79-00-5	ND	U	0.003	ND	U	0	ND	U	0.005	ND	U	0.003	ND	U	0.004
		1,1-Dichloroethane	75-34-3	ND	U	7E-04	ND	U	0	ND	U	0.001	ND	U	9E-04	ND	U	1E-03
		1,1-Dichloroethene	75-35-4	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		1,1-Dichloropropene	563-58-6	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		1,2,3-Trichlorobenzene	87-61-6	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		1,2,3-Trichloropropane	96-18-4	ND	U	0.003	ND	U	0	ND	U	0.005	ND	U	0.003	ND	U	0.004
		1,2,4-Trichlorobenzene	120-82-1	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		1,2,4-Trimethylbenzene	95-63-6	ND	U	0.003	ND	U	0	ND	U	0.005	ND	U	0.003	ND	U	0.004
		1,2-Dibromo-3-Chloropropane	96-12-8	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		1,2-Dibromoethane	106-93-4	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		1,2-Dichlorobenzene	95-50-1	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		1,2-Dichloroethane	107-06-2	ND	U	0.001	ND	U	0	ND	U	0.002	0.0052	J	0.002	ND	U	0.002
		1,2-Dichloroethene	540-59-0	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		1,2-Dichloropropane	78-87-5	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		1,3,5-Trimethylbenzene	108-67-8	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		1,3-Dichlorobenzene	541-73-1	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		1,3-Dichloropropane	142-28-9	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		1,4-Dichlorobenzene	106-46-7	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		2,2-Dichloropropane	594-20-7	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		2-Butanone	78-93-3	ND	U	0.006	ND	U	0.01	ND	U	0.009	0.055	--	0.007	ND	U	0.008
		2-Chlorotoluene	95-49-8	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		2-Hexanone	591-78-6	ND	U	0.012	ND	U	0.02	ND	U	0.018	ND	U	0.014	ND	U	0.016
		4-Chlorotoluene	106-43-4	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		4-Isopropyltoluene	99-87-6	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		4-Methyl-2-Pentanone	108-10-1	ND	U	0.012	ND	U	0.02	ND	U	0.018	ND	U	0.014	ND	U	0.016
		Acetone	67-64-1	ND	U	0.012	ND	U	0.02	0.75	--	0.018	0.53	--	0.014	ND	U	0.016
		Benzene	71-43-2	0.0014	J	0.001	ND	U	0	0.011	--	0.002	0.054	--	0.002	ND	U	0.002

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

		Boring ID:		KAFB-106S8			KAFB-106S9			KAFB-106S9			KAFB-106S9			KAFB-106S9		
		Sample Date:		1/18/2019			10/6/2018			10/7/2018			10/9/2018			10/11/2018		
		Sample Depth (ft bgs):		514			102			174			252			342		
		Sample Type:		Field Duplicate			REG			REG			REG			REG		
		Core Temperature (°C)			**20.4**			**37.6**			19.3			**22.7**			**24.3**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
VOCs	Method SW8260B (mg/kg)[a]	Bromobenzene	108-86-1	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		Bromochloromethane	74-97-5	ND	U	7E-04	ND	U	0	ND	U	0.001	ND	U	9E-04	ND	U	1E-03
		Bromodichloromethane	75-27-4	ND	U	7E-04	ND	U	0	ND	U	0.001	ND	U	9E-04	ND	U	1E-03
		Bromoform	75-25-2	ND	U	7E-04	ND	U	0	ND	U	0.001	ND	U	9E-04	ND	U	1E-03
		Bromomethane	74-83-9	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		Carbon Disulfide	75-15-0	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		Carbon Tetrachloride	56-23-5	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		Chlorobenzene	108-90-7	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		Chloroethane	75-00-3	ND	U	0.003	ND	U	0	ND	U	0.005	ND	U	0.003	ND	U	0.004
		Chloroform	67-66-3	ND	U	7E-04	ND	U	0	ND	U	0.001	ND	U	9E-04	ND	U	1E-03
		Chloromethane	74-87-3	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		Cis-1,2-Dichloroethene	156-59-2	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		Cis-1,3-Dichloropropene	10061-01-5	ND	U	0.003	ND	U	0	ND	U	0.005	ND	U	0.003	ND	U	0.004
		Dibromochloromethane	124-48-1	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		Dibromomethane	74-95-3	ND	U	0.003	ND	U	0	ND	U	0.005	ND	U	0.003	ND	U	0.004
		Dichlorodifluoromethane	75-71-8	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		Ethylbenzene	100-41-4	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		Hexachloro-1,3-Butadiene	87-68-3	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		Isopropylbenzene	98-82-8	0.00068	J	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		m- & p-Xylenes	179601-23-1	0.0021	J	0.003	ND	U	0	ND	U	0.005	ND	U	0.003	ND	U	0.004
		Methyl tert-Butyl Ether	1634-04-4	ND	U	7E-04	ND	U	0	ND	U	0.001	ND	U	9E-04	ND	U	1E-03
		Methylene Chloride	75-09-2	ND	U	0.003	ND	U	0	ND	U	0.005	ND	U	0.003	ND	U	0.004
		Naphthalene	91-20-3	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		n-Butylbenzene	104-51-8	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		n-Propylbenzene	103-65-1	0.00065	J	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		o-Xylene	95-47-6	0.00071	J	0.001	ND	U	0	ND	U	0.002	0.0011	J	0.002	ND	U	0.002
		sec-Butylbenzene	135-98-8	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		Styrene	100-42-5	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		tert-Butylbenzene	98-06-6	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		Tetrachloroethene	127-18-4	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		Toluene	108-88-3	ND	U	0.001	ND	U	0	0.017	--	0.002	0.051	--	0.002	ND	U	0.002
		Trans-1,2-Dichloroethene	156-60-5	ND	U	7E-04	ND	U	0	ND	U	0.001	ND	U	9E-04	ND	U	1E-03
		Trans-1,3-Dichloropropene	10061-02-6	ND	U	0.001	ND	U	0	ND	U	0.002	ND	U	0.002	ND	U	0.002
		Trichloroethene	79-01-6	ND	U	7E-04	ND	U	0	ND	U	0.001	ND	U	9E-04	ND	U	1E-03
		Trichlorofluoromethane	75-69-4	ND	U	0.003	ND	U	0	ND	U	0.005	ND	U	0.003	ND	U	0.004
		Vinyl Chloride	75-01-4	ND	U	0.003	ND	U	0	ND	U	0.005	ND	U	0.003	ND	U	0.004
Moisture	Percent Moisture (%) VOCs	NA	NA	14.6	--	--	5.9	--	--	33.8	--	--	0	--	--	16.3	--	--

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

			Boring ID:	KAFB-106S9			KAFB-106S9			KAFB-106S9			KAFB-106S9			KAFB-106S9		
			Sample Date:	10/16/2018			10/17/2018			10/17/2018			10/19/2018			10/19/2018		
			Sample Depth (ft bgs):	415			470			475			490			490		
			Sample Type:	REG			REG			REG			REG			Field Duplicate		
			Core Temperature (°C)		**27.2**			**23.7**			**22**			**25.2**			**33.6**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
Total Petroleum Hydrocarbons	Method SW8015 (mg/kg)	Motor Oil (C20-C38)	MOIL	ND	U	22	ND	U	23	ND	U	26	12	J	24	12	J	25
		TPH-DRO (C10-C28)	TPH-DRO	ND	U	3.8	68	--	3.9	180	--	4.5	1,900	J	4.1	1,900	--	4.3
		TPH-GRO (C6-C10)	TPH-GRO	ND	U	1.4	34	--	1.3	440	--	13	2,300	J	210	1,400	J	120
Moisture	Percent Moisture (%) TPH	NA	NA	3.8	--	--	3.3	--	--	16.5	--	--	9.9	--	--	9.6	--	--
EDB	Method SW8011 (mg/kg)[a]	1,2-Dibromoethane	106-93-4	ND	U	0	ND	U	4E-05	ND	U	5E-05	0.29	J	0.0084	0.13	J	0.0085
Moisture	Percent Moisture (%) EDB	NA	NA	4.6	--	--	3.5	--	--	18.5	--	--	9.9	--	--	10.4	--	--
VOCs	Method SW8260B (mg/kg)[a]	1,1,1,2-Tetrachloroethane	630-20-6	ND	U	0	ND	U	0.11	ND	UJ	0.9	ND	U	4.3	ND	U	1.3
		1,1,1-Trichloroethane	71-55-6	ND	U	0	ND	U	0.057	ND	UJ	0.45	ND	U	2.2	ND	U	0.67
		1,1,2,2-Tetrachloroethane	79-34-5	ND	U	0	ND	U	0.11	ND	UJ	0.9	ND	U	4.3	ND	U	1.3
		1,1,2-Trichloroethane	79-00-5	ND	U	0	ND	U	0.11	ND	UJ	0.9	ND	U	4.3	ND	U	1.3
		1,1-Dichloroethane	75-34-3	ND	U	0	ND	U	0.23	ND	UJ	1.8	ND	U	8.6	ND	U	2.7
		1,1-Dichloroethene	75-35-4	ND	U	0	ND	U	0.23	ND	UJ	1.8	ND	U	8.6	ND	U	2.7
		1,1-Dichloropropene	563-58-6	ND	U	0	ND	U	0.23	ND	UJ	1.8	ND	U	8.6	ND	U	2.7
		1,2,3-Trichlorobenzene	87-61-6	ND	U	0	ND	U	0.11	ND	UJ	0.9	ND	U	4.3	ND	U	1.3
		1,2,3-Trichloropropane	96-18-4	ND	U	0	ND	U	0.23	ND	UJ	1.8	ND	U	8.6	ND	U	2.7
		1,2,4-Trichlorobenzene	120-82-1	ND	U	0	ND	U	0.23	ND	UJ	1.8	ND	U	8.6	ND	U	2.7
		1,2,4-Trimethylbenzene	95-63-6	ND	U	0	0.12	J	0.11	1.6	J	0.9	68	J	4.3	42	J	1.3
		1,2-Dibromo-3-Chloropropane	96-12-8	ND	U	0	ND	U	0.46	ND	UJ	3.6	ND	U	17	ND	U	5.4
		1,2-Dibromoethane	106-93-4	ND	U	0	ND	U	0.11	ND	UJ	0.9	ND	U	4.3	ND	U	1.3
		1,2-Dichlorobenzene	95-50-1	ND	U	0	ND	U	0.46	ND	UJ	3.6	ND	U	17	ND	U	5.4
		1,2-Dichloroethane	107-06-2	ND	U	0	ND	U	0.11	ND	UJ	0.9	ND	U	4.3	ND	U	1.3
		1,2-Dichloroethene	540-59-0	ND	U	0	ND	U	0.11	ND	UJ	0.9	ND	U	4.3	ND	U	1.3
		1,2-Dichloropropane	78-87-5	ND	U	0	ND	U	0.23	ND	UJ	1.8	ND	U	8.6	ND	U	2.7
		1,3,5-Trimethylbenzene	108-67-8	ND	U	0	0.079	J	0.11	1.2	J	0.9	31	J	4.3	17	J	1.3
		1,3-Dichlorobenzene	541-73-1	ND	U	0	ND	U	0.23	ND	UJ	1.8	ND	U	8.6	ND	U	2.7
		1,3-Dichloropropane	142-28-9	ND	U	0	ND	U	0.11	ND	UJ	0.9	ND	U	4.3	ND	U	1.3
		1,4-Dichlorobenzene	106-46-7	ND	U	0	ND	U	0.11	ND	UJ	0.9	ND	U	4.3	ND	U	1.3
		2,2-Dichloropropane	594-20-7	ND	U	0	ND	U	0.11	ND	UJ	0.9	ND	U	4.3	ND	U	1.3
		2-Butanone	78-93-3	ND	U	0.01	ND	U	0.92	ND	UJ	7.2	ND	U	34	ND	U	11
		2-Chlorotoluene	95-49-8	ND	U	0	ND	U	0.11	ND	UJ	0.9	ND	U	4.3	ND	U	1.3
		2-Hexanone	591-78-6	ND	U	0.02	ND	U	0.92	ND	UJ	7.2	ND	U	34	ND	U	11
		4-Chlorotoluene	106-43-4	ND	U	0	ND	U	0.11	ND	UJ	0.9	ND	U	4.3	ND	U	1.3
		4-Isopropyltoluene	99-87-6	ND	U	0	ND	U	0.11	ND	UJ	0.9	5.4	J	4.3	3.4	J	1.3
		4-Methyl-2-Pentanone	108-10-1	ND	U	0.02	ND	U	0.92	ND	UJ	7.2	ND	U	34	ND	U	11
		Acetone	67-64-1	ND	U	0.02	2.2	J	1.8	ND	UJ	14	ND	U	69	50	--	22
		Benzene	71-43-2	ND	U	0	ND	U	0.23	ND	UJ	1.8	57	J	8.6	27	J	2.7

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

			Boring ID:	KAFB-106S9			KAFB-106S9			KAFB-106S9			KAFB-106S9			KAFB-106S9		
			Sample Date:	10/16/2018			10/17/2018			10/17/2018			10/19/2018			10/19/2018		
			Sample Depth (ft bgs):	415			470			475			490			490		
			Sample Type:	REG			REG			REG			REG			Field Duplicate		
			Core Temperature (°C)		**27.2**			**23.7**			**22**			**25.2**			**33.6**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
VOCs	Method SW8260B (mg/kg)[a]	Bromobenzene	108-86-1	ND	U	0	ND	U	0.057	ND	UJ	0.45	ND	U	2.2	ND	U	0.67
		Bromochloromethane	74-97-5	ND	U	0	ND	U	0.23	ND	UJ	1.8	ND	U	8.6	ND	U	2.7
		Bromodichloromethane	75-27-4	ND	U	0	ND	U	0.11	ND	UJ	0.9	ND	U	4.3	ND	U	1.3
		Bromoform	75-25-2	ND	U	0	ND	U	0.23	ND	UJ	1.8	ND	U	8.6	ND	U	2.7
		Bromomethane	74-83-9	ND	U	0	ND	U	0.23	ND	UJ	1.8	ND	U	8.6	ND	U	2.7
		Carbon Disulfide	75-15-0	ND	U	0	ND	U	0.23	ND	UJ	1.8	ND	U	8.6	ND	U	2.7
		Carbon Tetrachloride	56-23-5	ND	U	0	ND	U	0.057	ND	UJ	0.45	ND	U	2.2	ND	U	0.67
		Chlorobenzene	108-90-7	ND	U	0	ND	U	0.11	ND	UJ	0.9	ND	U	4.3	ND	U	1.3
		Chloroethane	75-00-3	ND	U	0	ND	U	0.23	ND	UJ	1.8	ND	U	8.6	ND	U	2.7
		Chloroform	67-66-3	ND	U	0	ND	U	0.23	ND	UJ	1.8	ND	U	8.6	ND	U	2.7
		Chloromethane	74-87-3	ND	U	0	ND	U	0.23	ND	UJ	1.8	ND	U	8.6	ND	U	2.7
		Cis-1,2-Dichloroethene	156-59-2	ND	U	0	ND	U	0.11	ND	UJ	0.9	ND	U	4.3	ND	U	1.3
		Cis-1,3-Dichloropropene	10061-01-5	ND	U	0	ND	U	0.11	ND	UJ	0.9	ND	U	4.3	ND	U	1.3
		Dibromochloromethane	124-48-1	ND	U	0	ND	U	0.11	ND	UJ	0.9	ND	U	4.3	ND	U	1.3
		Dibromomethane	74-95-3	ND	U	0	ND	U	0.11	ND	UJ	0.9	ND	U	4.3	ND	U	1.3
		Dichlorodifluoromethane	75-71-8	ND	U	0	ND	U	0.11	ND	UJ	0.9	ND	U	4.3	ND	U	1.3
		Ethylbenzene	100-41-4	ND	U	0	ND	U	0.11	0.59	J	0.9	79	J	4.3	44	J	1.3
		Hexachloro-1,3-Butadiene	87-68-3	ND	U	0	ND	U	0.23	ND	UJ	1.8	ND	U	8.6	ND	U	2.7
		Isopropylbenzene	98-82-8	ND	U	0	ND	U	0.11	0.48	J	0.9	15	J	4.3	9.2	J	1.3
		m- & p-Xylenes	179601-23-1	ND	U	0	0.12	J	0.23	4.3	J	1.8	200	J	8.6	110	J	2.7
		Methyl tert-Butyl Ether	1634-04-4	ND	U	0	ND	U	0.23	ND	UJ	1.8	ND	U	8.6	ND	U	2.7
		Methylene Chloride	75-09-2	0.0034	J	0	ND	U	0.23	ND	UJ	1.8	ND	U	8.6	ND	U	2.7
		Naphthalene	91-20-3	ND	U	0	--	U	0.11	0.89	J	0.9	11	J	4.3	7.7	J	1.3
		n-Butylbenzene	104-51-8	ND	U	0	ND	U	0.11	ND	UJ	0.9	7.9	J	4.3	4.9	J	1.3
		n-Propylbenzene	103-65-1	ND	U	0	ND	U	0.23	1.1	J	1.8	25	J	8.6	14	J	2.7
		o-Xylene	95-47-6	ND	U	0	0.069	J	0.11	1.6	J	0.9	71	J	4.3	41	J	1.3
		sec-Butylbenzene	135-98-8	ND	U	0	ND	U	0.11	1.1	J	0.9	10	J	4.3	8	--	1.3
		Styrene	100-42-5	ND	U	0	ND	U	0.11	ND	UJ	0.9	ND	U	4.3	ND	U	1.3
		tert-Butylbenzene	98-06-6	ND	U	0	ND	U	0.11	ND	UJ	0.9	ND	U	4.3	ND	U	1.3
		Tetrachloroethene	127-18-4	ND	U	0	ND	U	0.11	ND	UJ	0.9	ND	U	4.3	ND	U	1.3
		Toluene	108-88-3	ND	U	0	ND	U	0.11	ND	UJ	0.9	310	J	4.3	160	J	1.3
		Trans-1,2-Dichloroethene	156-60-5	ND	U	0	ND	U	0.23	ND	UJ	1.8	ND	U	8.6	ND	U	2.7
		Trans-1,3-Dichloropropene	10061-02-6	ND	U	0	ND	U	0.23	ND	UJ	1.8	ND	U	8.6	ND	U	2.7
		Trichloroethene	79-01-6	ND	U	0	ND	U	0.11	ND	UJ	0.9	ND	U	4.3	ND	U	1.3
		Trichlorofluoromethane	75-69-4	ND	U	0	ND	U	0.23	ND	UJ	1.8	ND	U	8.6	ND	U	2.7
		Vinyl Chloride	75-01-4	ND	U	0	ND	U	0.11	ND	UJ	0.9	ND	U	4.3	ND	U	1.3
Moisture	Percent Moisture (%) VOCs	NA	NA	4.6	--	--	3.5	--	--	18.5	--	--	9.9	--	--	10.4	--	--

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

			Boring ID:	KAFB-106S9			KAFB-106S9			KAFB-106247			KAFB-106247			KAFB-106247		
			Sample Date:	10/30/2018			10/30/2018			1/30/2019			1/31/2019			1/31/2019		
			Sample Depth (ft bgs):	496*			501			120			164			208		
			Sample Type:	REG			REG			REG			REG			REG		
			Core Temperature (°C)		**20.4**			**20.7**			**27.2**			17.5			**23.5**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
Total Petroleum Hydrocarbons	Method SW8015 (mg/kg)	Motor Oil (C20-C38)	MOIL	19	J	25	ND	U	25	ND	U	26	ND	U	24	ND	U	23
		TPH-DRO (C10-C28)	TPH-DRO	210	--	4.2	ND	U	4.2	ND	U	4.4	ND	U	4.1	ND	U	4
		TPH-GRO (C6-C10)	TPH-GRO	480	--	13	18	--	1.4	ND	U	1.4	ND	U	1.5	ND	U	1.9
Moisture	Percent Moisture (%) TPH	NA	NA	9.9	--	--	12.5	--	--	11.9	--	--	4.3	--	--	3.4	--	--
EDB	Method SW8011 (mg/kg)[a]	1,2-Dibromoethane	106-93-4	0.00077	--	4E-05	ND	U	4E-05	ND	U	4E-05	ND	U	0	ND	U	0
Moisture	Percent Moisture (%) EDB	NA	NA	12.3	--	--	12.7	--	--	11.1	--	--	4	--	--	3.6	--	--
VOCs	Method SW8260B (mg/kg)[a]	1,1,1,2-Tetrachloroethane	630-20-6	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		1,1,1-Trichloroethane	71-55-6	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		1,1,2,2-Tetrachloroethane	79-34-5	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		1,1,2-Trichloroethane	79-00-5	ND	U	0.002	ND	U	0.002	ND	U	0.004	ND	U	0	ND	U	0
		1,1-Dichloroethane	75-34-3	ND	U	5E-04	ND	U	5E-04	ND	U	9E-04	ND	U	0	ND	U	0
		1,1-Dichloroethene	75-35-4	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		1,1-Dichloropropene	563-58-6	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		1,2,3-Trichlorobenzene	87-61-6	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		1,2,3-Trichloropropane	96-18-4	ND	U	0.002	ND	U	0.002	ND	U	0.004	ND	U	0	ND	U	0
		1,2,4-Trichlorobenzene	120-82-1	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		1,2,4-Trimethylbenzene	95-63-6	5.3	--	0.078	0.45	--	0.084	ND	U	0.004	ND	U	0	ND	U	0
		1,2-Dibromo-3-Chloropropane	96-12-8	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		1,2-Dibromoethane	106-93-4	ND	U	1E-03	0.0026	J	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		1,2-Dichlorobenzene	95-50-1	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		1,2-Dichloroethane	107-06-2	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		1,2-Dichloroethene	540-59-0	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		1,2-Dichloropropane	78-87-5	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		1,3,5-Trimethylbenzene	108-67-8	2.2	--	0.078	0.082	J	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		1,3-Dichlorobenzene	541-73-1	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		1,3-Dichloropropane	142-28-9	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		1,4-Dichlorobenzene	106-46-7	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		2,2-Dichloropropane	594-20-7	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		2-Butanone	78-93-3	ND	U	0.63	ND	U	0.004	ND	U	0.007	ND	U	0.01	ND	U	0.01
		2-Chlorotoluene	95-49-8	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		2-Hexanone	591-78-6	ND	U	0.008	ND	U	0.007	ND	U	0.014	ND	U	0.01	ND	U	0.01
		4-Chlorotoluene	106-43-4	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		4-Isopropyltoluene	99-87-6	0.48	--	0.078	0.019	J	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		4-Methyl-2-Pentanone	108-10-1	ND	U	0.008	ND	U	0.007	ND	U	0.014	ND	U	0.01	ND	U	0.01
		Acetone	67-64-1	ND	U	0.008	0.02	J	0.007	ND	U	0.014	ND	U	0.01	ND	U	0.01
		Benzene	71-43-2	1.9	--	0.16	0.18	J	0.17	ND	U	0.002	ND	U	0	ND	U	0

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

		Boring ID:		KAFB-106S9			KAFB-106S9			KAFB-106247			KAFB-106247			KAFB-106247		
		Sample Date:		10/30/2018			10/30/2018			1/30/2019			1/31/2019			1/31/2019		
		Sample Depth (ft bgs):		496*			501			120			164			208		
		Sample Type:		REG			REG			REG			REG			REG		
		Core Temperature (°C)			**20.4**			**20.7**			**27.2**			17.5			**23.5**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
VOCs	Method SW8260B (mg/kg)[a]	Bromobenzene	108-86-1	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		Bromochloromethane	74-97-5	ND	U	5E-04	ND	U	5E-04	ND	U	9E-04	ND	U	0	ND	U	0
		Bromodichloromethane	75-27-4	ND	U	5E-04	ND	U	5E-04	ND	U	9E-04	ND	U	0	ND	U	0
		Bromoform	75-25-2	ND	U	5E-04	ND	U	5E-04	ND	U	9E-04	ND	U	0	ND	U	0
		Bromomethane	74-83-9	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		Carbon Disulfide	75-15-0	0.00071	J	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		Carbon Tetrachloride	56-23-5	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		Chlorobenzene	108-90-7	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		Chloroethane	75-00-3	ND	U	0.002	ND	U	0.002	ND	U	0.004	ND	U	0	ND	U	0
		Chloroform	67-66-3	ND	U	5E-04	ND	U	5E-04	ND	U	9E-04	ND	U	0	ND	U	0
		Chloromethane	74-87-3	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		Cis-1,2-Dichloroethene	156-59-2	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		Cis-1,3-Dichloropropene	10061-01-5	ND	U	0.002	ND	U	0.002	ND	U	0.004	ND	U	0	ND	U	0
		Dibromochloromethane	124-48-1	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		Dibromomethane	74-95-3	ND	U	0.002	ND	U	0.002	ND	U	0.004	ND	U	0	ND	U	0
		Dichlorodifluoromethane	75-71-8	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		Ethylbenzene	100-41-4	3.7	--	0.078	0.3	--	0.084	ND	U	0.002	ND	U	0	ND	U	0
		Hexachloro-1,3-Butadiene	87-68-3	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		Isopropylbenzene	98-82-8	0.96	--	0.078	0.043	J	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		m- & p-Xylenes	179601-23-1	9.9	--	0.16	0.87	--	0.17	ND	U	0.004	ND	U	0	ND	U	0
		Methyl tert-Butyl Ether	1634-04-4	ND	U	5E-04	ND	U	5E-04	ND	U	9E-04	ND	U	0	ND	U	0
		Methylene Chloride	75-09-2	ND	U	0.002	ND	U	0.002	0.0042	J	0.004	ND	U	0	ND	U	0
		Naphthalene	91-20-3	0.05	J	1E-03	0.038	J	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		n-Butylbenzene	104-51-8	0.87	--	0.078	0.03	J	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		n-Propylbenzene	103-65-1	1.6	--	0.16	0.068	J	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		o-Xylene	95-47-6	3.9	--	0.078	0.31	--	0.084	ND	U	0.002	ND	U	0	ND	U	0
		sec-Butylbenzene	135-98-8	1.1	--	0.078	0.045	J	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		Styrene	100-42-5	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		tert-Butylbenzene	98-06-6	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		Tetrachloroethene	127-18-4	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		Toluene	108-88-3	9.9	--	0.078	0.96	--	0.084	ND	U	0.002	ND	U	0	ND	U	0
		Trans-1,2-Dichloroethene	156-60-5	ND	U	5E-04	ND	U	5E-04	ND	U	9E-04	ND	U	0	ND	U	0
		Trans-1,3-Dichloropropene	10061-02-6	ND	U	1E-03	ND	U	9E-04	ND	U	0.002	ND	U	0	ND	U	0
		Trichloroethene	79-01-6	ND	U	5E-04	ND	U	5E-04	ND	U	9E-04	ND	U	0	ND	U	0
		Trichlorofluoromethane	75-69-4	ND	U	0.002	ND	U	0.002	ND	U	0.004	ND	U	0	ND	U	0
		Vinyl Chloride	75-01-4	ND	U	0.002	ND	U	0.002	ND	U	0.004	ND	U	0	ND	U	0
Moisture	Percent Moisture (%) VOCs	NA	NA	12.3	--	--	12.7	--	--	11.1	--	--	--	--	--	3.6	U	--

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

		Boring ID:		KAFB-106247			KAFB-106247			KAFB-106247			KAFB-106V1			KAFB-106V1		
		Sample Date:		2/5/2019			2/5/2019			2/5/2019			12/16/2018			12/16/2018		
		Sample Depth (ft bgs):		480			489			499			61			115		
		Sample Type:		REG			REG			REG			REG			REG		
		Core Temperature (°C)			**42.5**			**34.7**			**34.3**			**22.1**			**30.7**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
Total Petroleum Hydrocarbons	Method SW8015 (mg/kg)	Motor Oil (C20-C38)	MOIL	ND	U	26	ND	U	25	ND	U	24	ND	U	220	ND	U	240
		TPH-DRO (C10-C28)	TPH-DRO	ND	U	8.8	ND	U	8.5	ND	U	8	13,000	--	38	19,000	--	42
		TPH-GRO (C6-C10)	TPH-GRO	ND	U	2.5	ND	U	2.4	ND	U	2.2	6,900	J	270	5,100	J	310
Moisture	Percent Moisture (%) TPH	NA	NA	13.2	--	--	12.7	--	--	8.5	--	--	5.3	--	--	14.3	--	--
EDB	Method SW8011 (mg/kg)[a]	1,2-Dibromoethane	106-93-4	ND	U	4E-05	ND	U	4E-05	ND	U	4E-05	0.017	--	0.0008	0.14	J	0.0044
Moisture	Percent Moisture (%) EDB	NA	NA	13.1	--	--	12.8	--	--	9.6	--	--	5.7	--	--	13.7	--	--
VOCs	Method SW8260B (mg/kg)[a]	1,1,1,2-Tetrachloroethane	630-20-6	ND	U	0.005	ND	U	0.005	ND	U	0.005	ND	U	1.4	ND	U	1
		1,1,1-Trichloroethane	71-55-6	ND	U	0.005	ND	U	0.005	ND	U	0.005	ND	U	0.69	ND	U	0.51
		1,1,2,2-Tetrachloroethane	79-34-5	ND	U	8E-04	ND	U	8E-04	ND	U	8E-04	ND	U	1.4	ND	U	1
		1,1,2-Trichloroethane	79-00-5	ND	U	0.003	ND	U	0.003	ND	U	0.003	ND	U	1.4	ND	U	1
		1,1-Dichloroethane	75-34-3	ND	U	8E-04	ND	U	8E-04	ND	U	8E-04	ND	U	2.8	ND	U	2
		1,1-Dichloroethene	75-35-4	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	2.8	ND	U	2
		1,1-Dichloropropene	563-58-6	ND	U	4E-04	ND	U	4E-04	ND	U	4E-04	ND	U	2.8	ND	U	2
		1,2,3-Trichlorobenzene	87-61-6	ND	U	0.003	ND	U	0.003	ND	U	0.003	ND	U	1.4	ND	U	1
		1,2,3-Trichloropropane	96-18-4	ND	U	8E-04	ND	U	8E-04	ND	U	8E-04	ND	U	2.8	ND	U	2
		1,2,4-Trichlorobenzene	120-82-1	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	2.8	ND	U	2
		1,2,4-Trimethylbenzene	95-63-6	ND	U	0.005	ND	U	0.005	ND	U	0.005	160	--	1.4	120	--	1
		1,2-Dibromo-3-Chloropropane	96-12-8	ND	U	0.009	ND	U	0.01	ND	U	0.01	ND	U	5.5	ND	U	4.1
		1,2-Dibromoethane	106-93-4	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	1.4	ND	U	1
		1,2-Dichlorobenzene	95-50-1	ND	U	0.005	ND	U	0.005	ND	U	0.005	ND	U	5.5	ND	U	4.1
		1,2-Dichloroethane	107-06-2	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	1.4	ND	U	1
		1,2-Dichloroethene	540-59-0	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	1.4	ND	U	1
		1,2-Dichloropropane	78-87-5	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	2.8	ND	U	2
		1,3,5-Trimethylbenzene	108-67-8	ND	U	0.005	ND	U	0.005	ND	U	0.005	46	--	1.4	32	--	1
		1,3-Dichlorobenzene	541-73-1	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	2.8	ND	U	2
		1,3-Dichloropropane	142-28-9	ND	U	4E-04	ND	U	4E-04	ND	U	4E-04	ND	U	1.4	ND	U	1
		1,4-Dichlorobenzene	106-46-7	ND	U	8E-04	ND	U	8E-04	ND	U	8E-04	ND	U	1.4	ND	U	1
		2,2-Dichloropropane	594-20-7	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	1.4	ND	U	1
		2-Butanone	78-93-3	ND	U	0.012	ND	U	0.013	ND	U	0.013	ND	U	11	120	--	8.1
		2-Chlorotoluene	95-49-8	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	1.4	ND	U	1
		2-Hexanone	591-78-6	ND	U	0.012	ND	U	0.013	ND	U	0.013	ND	U	11	ND	U	8.1
		4-Chlorotoluene	106-43-4	ND	U	8E-04	ND	U	8E-04	ND	U	8E-04	ND	U	1.4	ND	U	1
		4-Isopropyltoluene	99-87-6	ND	U	0.003	ND	U	0.003	ND	U	0.003	23	--	1.4	19	--	1
		4-Methyl-2-Pentanone	108-10-1	ND	U	0.012	ND	U	0.013	ND	U	0.013	ND	U	11	ND	U	8.1
		Acetone	67-64-1	ND	U	0.067	ND	U	0.071	ND	U	0.074	88	--	22	200	--	16
		Benzene	71-43-2	ND	U	4E-04	ND	U	4E-04	ND	U	4E-04	15	--	2.8	27	--	2

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

			Boring ID:	KAFB-106247			KAFB-106247			KAFB-106247			KAFB-106V1			KAFB-106V1		
			Sample Date:	2/5/2019			2/5/2019			2/5/2019			12/16/2018			12/16/2018		
			Sample Depth (ft bgs):	480			489			499			61			115		
			Sample Type:	REG			REG			REG			REG			REG		
			Core Temperature (°C)		**42.5**			**34.7**			**34.3**			**22.1**			**30.7**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
VOCs	Method SW8260B (mg/kg)[a]	Bromobenzene	108-86-1	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	0.69	ND	U	0.51
		Bromochloromethane	74-97-5	ND	U	0.005	ND	U	0.005	ND	U	0.005	ND	U	2.8	ND	U	2
		Bromodichloromethane	75-27-4	ND	U	0.005	ND	U	0.005	ND	U	0.005	ND	U	1.4	ND	U	1
		Bromoform	75-25-2	ND	U	0.005	ND	U	0.005	ND	U	0.005	ND	U	2.8	ND	U	2
		Bromomethane	74-83-9	ND	U	0.003	ND	U	0.003	ND	U	0.003	ND	U	2.8	ND	U	2
		Carbon Disulfide	75-15-0	ND	U	0.005	ND	U	0.005	ND	U	0.005	ND	U	2.8	ND	U	2
		Carbon Tetrachloride	56-23-5	ND	U	0.005	ND	U	0.005	ND	U	0.005	ND	U	0.69	ND	U	0.51
		Chlorobenzene	108-90-7	ND	U	0.005	ND	U	0.005	ND	U	0.005	ND	U	1.4	ND	U	1
		Chloroethane	75-00-3	ND	U	0.006	ND	U	0.006	ND	U	0.007	ND	U	2.8	ND	U	2
		Chloroform	67-66-3	ND	U	8E-04	ND	U	8E-04	ND	U	8E-04	ND	U	2.8	ND	U	2
		Chloromethane	74-87-3	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	2.8	ND	U	2
		Cis-1,2-Dichloroethene	156-59-2	ND	U	8E-04	ND	U	8E-04	ND	U	8E-04	ND	U	1.4	ND	U	1
		Cis-1,3-Dichloropropene	10061-01-5	ND	U	4E-04	ND	U	4E-04	ND	U	4E-04	ND	U	1.4	ND	U	1
		Dibromochloromethane	124-48-1	ND	U	0.005	ND	U	0.005	ND	U	0.005	ND	U	1.4	ND	U	1
		Dibromomethane	74-95-3	ND	U	8E-04	ND	U	8E-04	ND	U	8E-04	ND	U	1.4	ND	U	1
		Dichlorodifluoromethane	75-71-8	ND	U	0.006	ND	U	0.006	ND	U	0.007	ND	U	1.4	ND	U	1
		Ethylbenzene	100-41-4	ND	U	8E-04	ND	U	8E-04	ND	U	8E-04	46	--	1.4	39	--	1
		Hexachloro-1,3-Butadiene	87-68-3	ND	U	0.005	ND	U	0.005	ND	U	0.005	ND	U	2.8	ND	U	2
		Isopropylbenzene	98-82-8	ND	U	0.005	ND	U	0.005	ND	U	0.005	16	--	1.4	12	--	1
		m- & p-Xylenes	179601-23-1	ND	U	0.003	ND	U	0.003	ND	U	0.003	58	--	2.8	63	--	2
		Methyl tert-Butyl Ether	1634-04-4	ND	U	0.006	ND	U	0.006	ND	U	0.007	ND	U	2.8	ND	U	2
		Methylene Chloride	75-09-2	0.0026	J	0.003	ND	U	0.003	0.0019	J	0.003	ND	U	2.8	ND	U	2
		Naphthalene	91-20-3	ND	U	0.006	ND	U	0.007	ND	U	0.007	58	--	1.4	55	--	1
		n-Butylbenzene	104-51-8	ND	U	0.002	ND	U	0.002	ND	U	0.002	67	--	1.4	51	--	1
		n-Propylbenzene	103-65-1	ND	U	0.002	ND	U	0.002	ND	U	0.002	45	--	2.8	31	--	2
		o-Xylene	95-47-6	ND	U	8E-04	ND	U	8E-04	ND	U	8E-04	30	--	1.4	27	--	1
		sec-Butylbenzene	135-98-8	ND	U	0.002	ND	U	0.002	ND	U	0.002	66	--	1.4	41	--	1
		Styrene	100-42-5	ND	U	8E-04	ND	U	8E-04	ND	U	8E-04	ND	U	1.4	ND	U	1
		tert-Butylbenzene	98-06-6	ND	U	0.002	ND	U	0.002	ND	U	0.002	ND	U	1.4	ND	U	1
		Tetrachloroethene	127-18-4	ND	U	0.005	ND	U	0.005	ND	U	0.005	ND	U	1.4	ND	U	1
		Toluene	108-88-3	ND	U	8E-04	ND	U	8E-04	ND	U	8E-04	47	--	1.4	97	--	1
		Trans-1,2-Dichloroethene	156-60-5	ND	U	8E-04	ND	U	8E-04	ND	U	8E-04	ND	U	2.8	ND	U	2
		Trans-1,3-Dichloropropene	10061-02-6	ND	U	2E-04	ND	U	2E-04	ND	U	2E-04	ND	U	2.8	ND	U	2
		Trichloroethene	79-01-6	ND	U	0.005	ND	U	0.005	ND	U	0.005	ND	U	1.4	ND	U	1
		Trichlorofluoromethane	75-69-4	ND	U	0.009	ND	U	0.01	ND	U	0.01	ND	U	2.8	ND	U	2
		Vinyl Chloride	75-01-4	ND	U	0.003	ND	U	0.003	ND	U	0.003	ND	U	1.4	ND	U	1
Moisture	Percent Moisture (%) VOCs	NA	NA	13.1	--	--	12.8	--	--	9.6	--	--	5.7	--	--	13.7	--	--

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

			Boring ID:	KAFB-106V1			KAFB-106V1			KAFB-106V1			KAFB-106V1			KAFB-106V1		
			Sample Date:	12/16/2018			12/17/2018			12/17/2018			12/18/2018			12/19/2018		
			Sample Depth (ft bgs):	131			147			161			216			254		
			Sample Type:	REG			REG			REG			REG			REG		
			Core Temperature (°C)		**25.1**			**27.2**			**32.3**			**27.3**			**24**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
Total Petroleum Hydrocarbons	Method SW8015 (mg/kg)	Motor Oil (C20-C38)	MOIL	ND	U	220	ND	U	110	30	J	30	ND	U	46	370	J	580
		TPH-DRO (C10-C28)	TPH-DRO	15,000	--	37	7,900	--	20	980	J	5.2	2,500	--	7.8	24,000	J	99
		TPH-GRO (C6-C10)	TPH-GRO	7,300	--	290	5,900	J	360	15	--	3.7	2,200	--	330	32,000	--	1,600
Moisture	Percent Moisture (%) TPH	NA	NA	3.5	--	--	3.9	--	--	24.1	--	--	3.4	--	--	22.2	--	--
EDB	Method SW8011 (mg/kg)[a]	1,2-Dibromoethane	106-93-4	0.1	--	0.0039	0.05	--	0.002	0.0003	--	0.0001	0.017	--	0.0008	2.1	--	0.26
Moisture	Percent Moisture (%) EDB	NA	NA	3.1	--	--	3.9	--	--	24.1	--	--	3.3	--	--	27.7	--	--
VOCs	Method SW8260B (mg/kg)[a]	1,1,1,2-Tetrachloroethane	630-20-6	ND	U	1.3	ND	U	1.2	ND	U	1.2	ND	U	0.88	ND	U	3.5
		1,1,1-Trichloroethane	71-55-6	ND	U	0.63	ND	U	0.58	ND	U	0.62	ND	U	0.44	ND	U	1.7
		1,1,2,2-Tetrachloroethane	79-34-5	ND	U	1.3	ND	U	1.2	ND	U	1.2	ND	U	0.88	ND	U	3.5
		1,1,2-Trichloroethane	79-00-5	ND	U	1.3	ND	U	1.2	ND	U	1.2	ND	U	0.88	ND	U	3.5
		1,1-Dichloroethane	75-34-3	ND	U	2.5	ND	U	2.3	ND	U	2.5	ND	U	1.8	ND	U	6.9
		1,1-Dichloroethene	75-35-4	ND	U	2.5	ND	U	2.3	ND	U	2.5	ND	U	1.8	ND	U	6.9
		1,1-Dichloropropene	563-58-6	ND	U	2.5	ND	U	2.3	ND	U	2.5	ND	U	1.8	ND	U	6.9
		1,2,3-Trichlorobenzene	87-61-6	ND	U	1.3	ND	U	1.2	ND	U	1.2	ND	U	0.88	ND	U	3.5
		1,2,3-Trichloropropane	96-18-4	ND	U	2.5	ND	U	2.3	ND	U	2.5	ND	U	1.8	ND	U	6.9
		1,2,4-Trichlorobenzene	120-82-1	ND	U	2.5	ND	U	2.3	ND	U	2.5	ND	U	1.8	ND	U	6.9
		1,2,4-Trimethylbenzene	95-63-6	160	--	1.3	53	--	1.2	ND	U	1.2	42	--	0.88	790	--	35
		1,2-Dibromo-3-Chloropropane	96-12-8	ND	U	5	ND	U	4.6	ND	U	5	ND	U	3.5	ND	U	14
		1,2-Dibromoethane	106-93-4	ND	U	1.3	ND	U	1.2	ND	U	1.2	ND	U	0.88	18	--	3.5
		1,2-Dichlorobenzene	95-50-1	ND	U	5	ND	U	4.6	ND	U	5	ND	U	3.5	ND	U	14
		1,2-Dichloroethane	107-06-2	ND	U	1.3	ND	U	1.2	ND	U	1.2	ND	U	0.88	ND	U	3.5
		1,2-Dichloroethene	540-59-0	ND	U	1.3	ND	U	1.2	ND	U	1.2	ND	U	0.88	ND	U	3.5
		1,2-Dichloropropane	78-87-5	ND	U	2.5	ND	U	2.3	ND	U	2.5	ND	U	1.8	ND	U	6.9
		1,3,5-Trimethylbenzene	108-67-8	45	--	1.3	16	--	1.2	ND	U	1.2	18	--	0.88	300	--	3.5
		1,3-Dichlorobenzene	541-73-1	ND	U	2.5	ND	U	2.3	ND	U	2.5	ND	U	1.8	ND	U	6.9
		1,3-Dichloropropane	142-28-9	ND	U	1.3	ND	U	1.2	ND	U	1.2	ND	U	0.88	ND	U	3.5
		1,4-Dichlorobenzene	106-46-7	ND	U	1.3	ND	U	1.2	ND	U	1.2	ND	U	0.88	ND	U	3.5
		2,2-Dichloropropane	594-20-7	ND	U	1.3	ND	U	1.2	ND	U	1.2	ND	U	0.88	ND	U	3.5
		2-Butanone	78-93-3	87	--	10	ND	U	9.3	ND	U	9.9	ND	U	7.1	ND	U	28
		2-Chlorotoluene	95-49-8	ND	U	1.3	ND	U	1.2	ND	U	1.2	ND	U	0.88	ND	U	3.5
		2-Hexanone	591-78-6	ND	U	10	ND	U	9.3	ND	U	9.9	ND	U	7.1	ND	U	28
		4-Chlorotoluene	106-43-4	ND	U	1.3	ND	U	1.2	ND	U	1.2	ND	U	0.88	ND	U	3.5
		4-Isopropyltoluene	99-87-6	25	--	1.3	7.7	--	1.2	ND	U	1.2	3.7	--	0.88	51	--	3.5
		4-Methyl-2-Pentanone	108-10-1	ND	U	10	ND	U	9.3	ND	U	9.9	ND	U	7.1	ND	U	28
		Acetone	67-64-1	53	--	20	ND	U	19	1,100	--	99	98	--	14	430	--	55
		Benzene	71-43-2	31	--	2.5	12	--	2.3	ND	U	2.5	5.9	--	1.8	110	--	6.9

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

			Boring ID:	KAFB-106V1			KAFB-106V1			KAFB-106V1			KAFB-106V1			KAFB-106V1		
			Sample Date:	12/16/2018			12/17/2018			12/17/2018			12/18/2018			12/19/2018		
			Sample Depth (ft bgs):	131			147			161			216			254		
			Sample Type:	REG			REG			REG			REG			REG		
			Core Temperature (°C)		**25.1**			**27.2**			**32.3**			**27.3**			**24**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
VOCs	Method SW8260B (mg/kg)[a]	Bromobenzene	108-86-1	ND	U	0.63	ND	U	0.58	ND	U	0.62	ND	U	0.44	ND	U	1.7
		Bromochloromethane	74-97-5	ND	U	2.5	ND	U	2.3	ND	U	2.5	ND	U	1.8	ND	U	6.9
		Bromodichloromethane	75-27-4	ND	U	1.3	ND	U	1.2	ND	U	1.2	ND	U	0.88	ND	U	3.5
		Bromoform	75-25-2	ND	U	2.5	ND	U	2.3	ND	U	2.5	ND	U	1.8	ND	U	6.9
		Bromomethane	74-83-9	ND	U	2.5	ND	U	2.3	ND	U	2.5	ND	U	1.8	ND	U	6.9
		Carbon Disulfide	75-15-0	ND	U	2.5	ND	U	2.3	ND	U	2.5	ND	U	1.8	ND	U	6.9
		Carbon Tetrachloride	56-23-5	ND	U	0.63	ND	U	0.58	ND	U	0.62	ND	U	0.44	ND	U	1.7
		Chlorobenzene	108-90-7	ND	U	1.3	ND	U	1.2	ND	U	1.2	ND	U	0.88	ND	U	3.5
		Chloroethane	75-00-3	ND	U	2.5	ND	U	2.3	ND	U	2.5	ND	U	1.8	ND	U	6.9
		Chloroform	67-66-3	ND	U	2.5	ND	U	2.3	ND	U	2.5	ND	U	1.8	ND	U	6.9
		Chloromethane	74-87-3	ND	U	2.5	ND	U	2.3	ND	U	2.5	ND	U	1.8	ND	U	6.9
		Cis-1,2-Dichloroethene	156-59-2	ND	U	1.3	ND	U	1.2	ND	U	1.2	ND	U	0.88	ND	U	3.5
		Cis-1,3-Dichloropropene	10061-01-5	ND	U	1.3	ND	U	1.2	ND	U	1.2	ND	U	0.88	ND	U	3.5
		Dibromochloromethane	124-48-1	ND	U	1.3	ND	U	1.2	ND	U	1.2	ND	U	0.88	ND	U	3.5
		Dibromomethane	74-95-3	ND	U	1.3	ND	U	1.2	ND	U	1.2	ND	U	0.88	ND	U	3.5
		Dichlorodifluoromethane	75-71-8	ND	U	1.3	ND	U	1.2	ND	U	1.2	ND	U	0.88	ND	U	3.5
		Ethylbenzene	100-41-4	50	--	1.3	21	--	1.2	ND	U	1.2	23	--	0.88	770	--	35
		Hexachloro-1,3-Butadiene	87-68-3	ND	U	2.5	ND	U	2.3	ND	U	2.5	ND	U	1.8	ND	U	6.9
		Isopropylbenzene	98-82-8	15	--	1.3	6.3	--	1.2	ND	U	1.2	6.3	--	0.88	110	--	3.5
		m- & p-Xylenes	179601-23-1	100	--	2.5	45	--	2.3	ND	U	2.5	88	--	1.8	2,800	--	69
		Methyl tert-Butyl Ether	1634-04-4	ND	U	2.5	ND	U	2.3	ND	U	2.5	ND	U	1.8	ND	U	6.9
		Methylene Chloride	75-09-2	ND	U	2.5	ND	U	2.3	ND	U	2.5	ND	U	1.8	ND	U	6.9
		Naphthalene	91-20-3	48	--	1.3	21	--	1.2	ND	U	1.2	10	--	0.88	150	--	3.5
		n-Butylbenzene	104-51-8	57	--	1.3	20	--	1.2	ND	U	1.2	5.7	--	0.88	100	--	3.5
		n-Propylbenzene	103-65-1	37	--	2.5	14	--	2.3	ND	U	2.5	11	--	1.8	200	--	6.9
		o-Xylene	95-47-6	42	--	1.3	18	--	1.2	ND	U	1.2	32	--	0.88	890	--	35
		sec-Butylbenzene	135-98-8	50	--	1.3	18	--	1.2	ND	U	1.2	7	--	0.88	150	--	3.5
		Styrene	100-42-5	ND	U	1.3	ND	U	1.2	ND	U	1.2	ND	U	0.88	ND	U	3.5
		tert-Butylbenzene	98-06-6	ND	U	1.3	ND	U	1.2	ND	U	1.2	ND	U	0.88	ND	U	3.5
		Tetrachloroethene	127-18-4	ND	U	1.3	ND	U	1.2	ND	U	1.2	ND	U	0.88	ND	U	3.5
		Toluene	108-88-3	130	--	1.3	61	--	1.2	ND	U	1.2	62	--	0.88	3,100	--	35
		Trans-1,2-Dichloroethene	156-60-5	ND	U	2.5	ND	U	2.3	ND	U	2.5	ND	U	1.8	ND	U	6.9
		Trans-1,3-Dichloropropene	10061-02-6	ND	U	2.5	ND	U	2.3	ND	U	2.5	ND	U	1.8	ND	U	6.9
		Trichloroethene	79-01-6	ND	U	1.3	ND	U	1.2	ND	U	1.2	ND	U	0.88	ND	U	3.5
		Trichlorofluoromethane	75-69-4	ND	U	2.5	ND	U	2.3	ND	U	2.5	ND	U	1.8	ND	U	6.9
		Vinyl Chloride	75-01-4	ND	U	1.3	ND	U	1.2	ND	U	1.2	ND	U	0.88	ND	U	3.5
Moisture	Percent Moisture (%) VOCs	NA	NA	3.1	--	--	3.9	--	--	24.1	--	--	3.3	--	--	27.7	--	--

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

			Boring ID:	KAFB-106V1			KAFB-106V1			KAFB-106V1			KAFB-106V2			KAFB-106V2		
			Sample Date:	12/19/2018			12/19/2018			12/19/2018			12/12/2018			12/12/2018		
			Sample Depth (ft bgs):	271			285			285			80			103		
			Sample Type:	REG			REG			Field Duplicate			REG			REG		
			Core Temperature (°C)		**35.4**			**27.4**			**27.4**			**28.9**			**38.8**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
Total Petroleum Hydrocarbons	Method SW8015 (mg/kg)	Motor Oil (C20-C38)	MOIL	ND	U	27	ND	U	24	ND	U	22	50	J	130	ND	U	110
		TPH-DRO (C10-C28)	TPH-DRO	230	--	4.6	270	--	4.1	290	--	3.8	8,300	--	21	7,500	--	18
		TPH-GRO (C6-C10)	TPH-GRO	61	--	3.6	380	J	140	75	J	2.6	21,000	J	1,400	7,200	J	2,800
Moisture	Percent Moisture (%) TPH	NA	NA	19.6	--	--	3.3	--	--	3.8	--	--	9.2	--	--	2.9	--	--
EDB	Method SW8011 (mg/kg)^a	1,2-Dibromoethane	106-93-4	0.016	--	0.001	ND	U	0.0004	ND	UJ	0.0008	0.5	--	0.021	0.52	--	0.02
Moisture	Percent Moisture (%) EDB	NA	NA	21.4	--	--	3.3	--	--	3.6	--	--	8.9	--	--	3.1	--	--
VOCs	Method SW8260B (mg/kg)^a	1,1,1,2-Tetrachloroethane	630-20-6	ND	U	1.2	ND	U	1.4	ND	U	0.95	ND	UJ	0.93	ND	UJ	1.5
		1,1,1-Trichloroethane	71-55-6	ND	U	0.59	ND	U	0.7	ND	U	0.48	ND	UJ	0.47	ND	UJ	0.76
		1,1,2,2-Tetrachloroethane	79-34-5	ND	U	1.2	ND	U	1.4	ND	U	0.95	ND	UJ	0.93	ND	UJ	1.5
		1,1,2-Trichloroethane	79-00-5	ND	U	1.2	ND	U	1.4	ND	U	0.95	3.8	J	0.93	ND	UJ	1.5
		1,1-Dichloroethane	75-34-3	ND	U	2.4	ND	U	2.8	ND	U	1.9	ND	UJ	1.9	ND	UJ	3.1
		1,1-Dichloroethene	75-35-4	ND	U	2.4	ND	U	2.8	ND	U	1.9	ND	UJ	1.9	ND	UJ	3.1
		1,1-Dichloropropene	563-58-6	ND	U	2.4	ND	U	2.8	ND	U	1.9	ND	UJ	1.9	ND	UJ	3.1
		1,2,3-Trichlorobenzene	87-61-6	ND	U	1.2	ND	U	1.4	ND	U	0.95	ND	UJ	0.93	ND	UJ	1.5
		1,2,3-Trichloropropane	96-18-4	ND	U	2.4	ND	U	2.8	ND	U	1.9	ND	UJ	1.9	ND	UJ	3.1
		1,2,4-Trichlorobenzene	120-82-1	ND	U	2.4	ND	U	2.8	ND	U	1.9	ND	UJ	1.9	ND	UJ	3.1
		1,2,4-Trimethylbenzene	95-63-6	0.62	J	1.2	1.7	J	1.4	0.87	J	0.95	1.7	J	0.93	120	J	1.5
		1,2-Dibromo-3-Chloropropane	96-12-8	ND	U	4.7	ND	U	5.6	ND	U	3.8	ND	UJ	3.7	ND	UJ	6.1
		1,2-Dibromoethane	106-93-4	ND	U	1.2	ND	U	1.4	ND	U	0.95	0.48	J	0.93	1.4	J	1.5
		1,2-Dichlorobenzene	95-50-1	ND	U	4.7	ND	U	5.6	ND	U	3.8	ND	UJ	3.7	ND	UJ	6.1
		1,2-Dichloroethane	107-06-2	ND	U	1.2	ND	U	1.4	ND	U	0.95	ND	UJ	0.93	ND	UJ	1.5
		1,2-Dichloroethene	540-59-0	ND	U	1.2	ND	U	1.4	ND	U	0.95	ND	UJ	0.93	ND	UJ	1.5
		1,2-Dichloropropane	78-87-5	6	--	2.4	ND	U	2.8	ND	U	1.9	ND	UJ	1.9	ND	UJ	3.1
		1,3,5-Trimethylbenzene	108-67-8	ND	U	1.2	0.94	J	1.4	0.53	J	0.95	0.65	J	0.93	44	J	1.5
		1,3-Dichlorobenzene	541-73-1	ND	U	2.4	ND	U	2.8	ND	U	1.9	ND	UJ	1.9	ND	UJ	3.1
		1,3-Dichloropropane	142-28-9	ND	U	1.2	ND	U	1.4	ND	U	0.95	ND	UJ	0.93	ND	UJ	1.5
		1,4-Dichlorobenzene	106-46-7	ND	U	1.2	ND	U	1.4	ND	U	0.95	ND	UJ	0.93	ND	UJ	1.5
		2,2-Dichloropropane	594-20-7	ND	U	1.2	ND	U	1.4	ND	U	0.95	ND	UJ	0.93	ND	UJ	1.5
		2-Butanone	78-93-3	37	--	9.5	ND	U	11	ND	U	7.6	23	J	7.5	ND	UJ	12
		2-Chlorotoluene	95-49-8	ND	U	1.2	ND	U	1.4	ND	U	0.95	ND	UJ	0.93	ND	UJ	1.5
		2-Hexanone	591-78-6	ND	U	9.5	ND	U	11	ND	U	7.6	ND	UJ	7.5	ND	UJ	12
		4-Chlorotoluene	106-43-4	ND	U	1.2	ND	U	1.4	ND	U	0.95	ND	UJ	0.93	ND	UJ	1.5
		4-Isopropyltoluene	99-87-6	ND	U	1.2	ND	U	1.4	ND	U	0.95	ND	UJ	0.93	13	J	1.5
		4-Methyl-2-Pentanone	108-10-1	ND	U	9.5	ND	U	11	ND	U	7.6	ND	UJ	7.5	ND	UJ	12
		Acetone	67-64-1	34	--	19	ND	U	22	ND	U	15	160	J	15	41	J	24
		Benzene	71-43-2	2.4	J	2.4	ND	U	2.8	ND	U	1.9	2.9	J	1.9	7.9	J	3.1

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

			Boring ID:	KAFB-106V1			KAFB-106V1			KAFB-106V1			KAFB-106V2			KAFB-106V2		
			Sample Date:	12/19/2018			12/19/2018			12/19/2018			12/12/2018			12/12/2018		
			Sample Depth (ft bgs):	271			285			285			80			103		
			Sample Type:	REG			REG			Field Duplicate			REG			REG		
			Core Temperature (°C)		**35.4**			**27.4**			**27.4**			**28.9**			**38.8**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
VOCs	Method SW8260B (mg/kg)[a]	Bromobenzene	108-86-1	ND	U	0.59	ND	U	0.7	ND	U	0.48	ND	UJ	0.47	ND	UJ	0.76
		Bromochloromethane	74-97-5	ND	U	2.4	ND	U	2.8	ND	U	1.9	ND	UJ	1.9	ND	UJ	3.1
		Bromodichloromethane	75-27-4	ND	U	1.2	ND	U	1.4	ND	U	0.95	ND	UJ	0.93	ND	UJ	1.5
		Bromoform	75-25-2	ND	U	2.4	ND	U	2.8	ND	U	1.9	ND	UJ	1.9	ND	UJ	3.1
		Bromomethane	74-83-9	ND	U	2.4	ND	U	2.8	ND	U	1.9	ND	UJ	1.9	ND	UJ	3.1
		Carbon Disulfide	75-15-0	ND	U	2.4	ND	U	2.8	ND	U	1.9	ND	UJ	1.9	ND	UJ	3.1
		Carbon Tetrachloride	56-23-5	ND	U	0.59	ND	U	0.7	ND	U	0.48	ND	UJ	0.47	ND	UJ	0.76
		Chlorobenzene	108-90-7	ND	U	1.2	ND	U	1.4	ND	U	0.95	ND	UJ	0.93	ND	UJ	1.5
		Chloroethane	75-00-3	ND	U	2.4	ND	U	2.8	ND	U	1.9	ND	UJ	1.9	ND	UJ	3.1
		Chloroform	67-66-3	ND	U	2.4	ND	U	2.8	ND	U	1.9	ND	UJ	1.9	ND	UJ	3.1
		Chloromethane	74-87-3	ND	U	2.4	ND	U	2.8	ND	U	1.9	ND	UJ	1.9	ND	UJ	3.1
		Cis-1,2-Dichloroethene	156-59-2	ND	U	1.2	ND	U	1.4	ND	U	0.95	ND	UJ	0.93	ND	UJ	1.5
		Cis-1,3-Dichloropropene	10061-01-5	ND	U	1.2	ND	U	1.4	ND	U	0.95	ND	UJ	0.93	ND	UJ	1.5
		Dibromochloromethane	124-48-1	ND	U	1.2	ND	U	1.4	ND	U	0.95	ND	UJ	0.93	ND	UJ	1.5
		Dibromomethane	74-95-3	ND	U	1.2	ND	U	1.4	ND	U	0.95	ND	UJ	0.93	ND	UJ	1.5
		Dichlorodifluoromethane	75-71-8	ND	U	1.2	ND	U	1.4	ND	U	0.95	ND	UJ	0.93	ND	UJ	1.5
		Ethylbenzene	100-41-4	0.65	J	1.2	ND	U	1.4	ND	U	0.95	2.8	J	0.93	71	J	1.5
		Hexachloro-1,3-Butadiene	87-68-3	ND	U	2.4	ND	U	2.8	ND	U	1.9	ND	UJ	1.9	ND	UJ	3.1
		Isopropylbenzene	98-82-8	ND	U	1.2	ND	U	1.4	ND	U	0.95	0.35	J	0.93	17	J	1.5
		m- & p-Xylenes	179601-23-1	1.5	J	2.4	2.5	J	2.8	1.3	J	1.9	7.8	J	1.9	220	J	3.1
		Methyl tert-Butyl Ether	1634-04-4	ND	U	2.4	ND	U	2.8	ND	U	1.9	ND	UJ	1.9	ND	UJ	3.1
		Methylene Chloride	75-09-2	ND	U	2.4	ND	U	2.8	ND	U	1.9	ND	UJ	1.9	ND	UJ	3.1
		Naphthalene	91-20-3	0.68	J	1.2	1.9	J	1.4	1.4	J	0.95	0.65	J	0.93	40	J	1.5
		n-Butylbenzene	104-51-8	ND	U	1.2	ND	U	1.4	ND	U	0.95	ND	UJ	0.93	21	J	1.5
		n-Propylbenzene	103-65-1	ND	U	2.4	ND	U	2.8	ND	U	1.9	0.5	J	1.9	29	J	3.1
		o-Xylene	95-47-6	0.65	J	1.2	1.2	J	1.4	0.69	J	0.95	3.2	J	0.93	78	J	1.5
		sec-Butylbenzene	135-98-8	ND	U	1.2	ND	U	1.4	0.5	J	0.95	ND	UJ	0.93	25	J	1.5
		Styrene	100-42-5	ND	U	1.2	ND	U	1.4	ND	U	0.95	ND	UJ	0.93	ND	UJ	1.5
		tert-Butylbenzene	98-06-6	ND	U	1.2	ND	U	1.4	ND	U	0.95	ND	UJ	0.93	ND	UJ	1.5
		Tetrachloroethene	127-18-4	ND	U	1.2	ND	U	1.4	ND	U	0.95	ND	UJ	0.93	ND	UJ	1.5
		Toluene	108-88-3	4.6	--	1.2	0.99	J	1.4	0.51	J	0.95	23	J	0.93	200	J	1.5
		Trans-1,2-Dichloroethene	156-60-5	ND	U	2.4	ND	U	2.8	ND	U	1.9	ND	UJ	1.9	ND	UJ	3.1
		Trans-1,3-Dichloropropene	10061-02-6	ND	U	2.4	ND	U	2.8	ND	U	1.9	ND	UJ	1.9	8.6	J	3.1
		Trichloroethene	79-01-6	ND	U	1.2	ND	U	1.4	ND	U	0.95	ND	UJ	0.93	ND	UJ	1.5
		Trichlorofluoromethane	75-69-4	ND	U	2.4	ND	U	2.8	ND	U	1.9	ND	UJ	1.9	ND	UJ	3.1
		Vinyl Chloride	75-01-4	ND	U	1.2	ND	U	1.4	ND	U	0.95	ND	UJ	0.93	ND	UJ	1.5
Moisture	Percent Moisture (%) VOCs	NA	NA	21.4	--	--	3.3	--	--	3.6	--	--	8.9	--	--	3.1	--	--

Table 5-1

Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

		Boring ID:		KAFB-106V2			KAFB-106V2			KAFB-106V2			KAFB-106V2			KAFB-106V2		
		Sample Date:		12/13/2018			12/13/2018			12/14/2018			12/14/2018			12/14/2018		
		Sample Depth (ft bgs):		117			159			215			254			270		
		Sample Type:		REG			REG			REG			REG			REG		
		Core Temperature (°C)			**25.4**			**20.8**			**31.2**			**28.5**			**23.9**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
Total Petroleum Hydrocarbons	Method SW8015 (mg/kg)	Motor Oil (C20-C38)	MOIL	ND	U	51	55	J	110	ND	U	120	ND	U	110	ND	UJ	29
		TPH-DRO (C10-C28)	TPH-DRO	2,800	--	8.7	8,700	--	19	3,900	J	20	5,400	--	19	8.8	J	4.9
		TPH-GRO (C6-C10)	TPH-GRO	7,800	--	310	2,100	--	320	2,700	--	270	5,900	--	390	8.2	--	1.7
Moisture	Percent Moisture (%) TPH	NA	NA	11.8	--	--	8.4	--	--	3.1	--	--	4.4	--	--	19.9	--	--
EDB	Method SW8011 (mg/kg)[a]	1,2-Dibromoethane	106-93-4	0.049	--	0.0022	ND	U	0.0008	0.021	--	0.0008	0.33	--	0.021	0.0006	J	0.0005
Moisture	Percent Moisture (%) EDB	NA	NA	11.8	--	--	3.9	--	--	3	--	--	7.5	--	--	20.8	--	--
VOCs	Method SW8260B (mg/kg)[a]	1,1,1,2-Tetrachloroethane	630-20-6	ND	U	3.6	0.81	J	1.3	ND	U	0.8	ND	U	1	ND	U	1.1
		1,1,1-Trichloroethane	71-55-6	ND	U	1.8	ND	U	0.67	ND	U	0.4	ND	U	0.52	ND	U	0.53
		1,1,2,2-Tetrachloroethane	79-34-5	ND	U	3.6	ND	U	1.3	ND	U	0.8	ND	U	1	ND	U	1.1
		1,1,2-Trichloroethane	79-00-5	ND	U	3.6	ND	U	1.3	ND	U	0.8	ND	U	1	ND	U	1.1
		1,1-Dichloroethane	75-34-3	ND	U	7.2	ND	U	2.7	ND	U	1.6	ND	U	2.1	ND	U	2.1
		1,1-Dichloroethene	75-35-4	ND	U	7.2	ND	U	2.7	ND	U	1.6	ND	U	2.1	ND	U	2.1
		1,1-Dichloropropene	563-58-6	ND	U	7.2	ND	U	2.7	ND	U	1.6	ND	U	2.1	ND	U	2.1
		1,2,3-Trichlorobenzene	87-61-6	ND	U	3.6	ND	U	1.3	ND	U	0.8	ND	U	1	ND	U	1.1
		1,2,3-Trichloropropane	96-18-4	ND	U	7.2	ND	U	2.7	ND	U	1.6	ND	U	2.1	ND	U	2.1
		1,2,4-Trichlorobenzene	120-82-1	ND	U	7.2	ND	U	2.7	ND	U	1.6	ND	U	2.1	ND	U	2.1
		1,2,4-Trimethylbenzene	95-63-6	62	--	3.6	63	--	1.3	35	--	0.8	59	--	1	ND	U	1.1
		1,2-Dibromo-3-Chloropropane	96-12-8	ND	U	14	ND	U	5.3	ND	U	3.2	ND	U	4.2	ND	U	4.2
		1,2-Dibromoethane	106-93-4	ND	U	3.6	ND	U	1.3	ND	U	0.8	ND	U	1	ND	U	1.1
		1,2-Dichlorobenzene	95-50-1	ND	U	14	ND	U	5.3	ND	U	3.2	ND	U	4.2	ND	U	4.2
		1,2-Dichloroethane	107-06-2	ND	U	3.6	ND	U	1.3	ND	U	0.8	ND	U	1	ND	U	1.1
		1,2-Dichloroethene	540-59-0	ND	U	3.6	ND	U	1.3	ND	U	0.8	ND	U	1	ND	U	1.1
		1,2-Dichloropropane	78-87-5	ND	U	7.2	ND	U	2.7	ND	U	1.6	ND	U	2.1	ND	U	2.1
		1,3,5-Trimethylbenzene	108-67-8	21	--	3.6	21	--	1.3	11	--	0.8	18	--	1	ND	U	1.1
		1,3-Dichlorobenzene	541-73-1	ND	U	7.2	ND	U	2.7	ND	U	1.6	ND	U	2.1	ND	U	2.1
		1,3-Dichloropropane	142-28-9	ND	U	3.6	ND	U	1.3	ND	U	0.8	ND	U	1	ND	U	1.1
		1,4-Dichlorobenzene	106-46-7	ND	U	3.6	ND	U	1.3	ND	U	0.8	ND	U	1	ND	U	1.1
		2,2-Dichloropropane	594-20-7	ND	U	3.6	ND	U	1.3	ND	U	0.8	ND	U	1	ND	U	1.1
		2-Butanone	78-93-3	ND	U	29	ND	U	11	ND	U	6.4	ND	U	8.3	ND	U	8.4
		2-Chlorotoluene	95-49-8	ND	U	3.6	ND	U	1.3	ND	U	0.8	ND	U	1	ND	U	1.1
		2-Hexanone	591-78-6	ND	U	29	ND	U	11	ND	U	6.4	ND	U	8.3	ND	U	8.4
		4-Chlorotoluene	106-43-4	ND	U	3.6	ND	U	1.3	ND	U	0.8	ND	U	1	ND	U	1.1
		4-Isopropyltoluene	99-87-6	7.2	J	3.6	8.2	--	1.3	4.4	--	0.8	8.2	--	1	ND	U	1.1
		4-Methyl-2-Pentanone	108-10-1	ND	U	29	ND	U	11	ND	U	6.4	ND	U	8.3	ND	U	8.4
		Acetone	67-64-1	ND	U	58	32	--	21	28	--	13	67	--	17	76	--	17
		Benzene	71-43-2	4.2	J	7.2	3.4	J	2.7	ND	U	1.6	4.7	--	2.1	ND	U	2.1

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

		Boring ID:		KAFB-106V2			KAFB-106V2			KAFB-106V2			KAFB-106V2			KAFB-106V2		
		Sample Date:		12/13/2018			12/13/2018			12/14/2018			12/14/2018			12/14/2018		
		Sample Depth (ft bgs):		117			159			215			254			270		
		Sample Type:		REG			REG			REG			REG			REG		
		Core Temperature (°C)			**25.4**			**20.8**			**31.2**			**28.5**			**23.9**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
VOCs	Method SW8260B (mg/kg)[a]	Bromobenzene	108-86-1	ND	U	1.8	ND	U	0.67	ND	U	0.4	ND	U	0.52	ND	U	0.53
		Bromochloromethane	74-97-5	ND	U	7.2	ND	U	2.7	ND	U	1.6	ND	U	2.1	ND	U	2.1
		Bromodichloromethane	75-27-4	ND	U	3.6	ND	U	1.3	ND	U	0.8	ND	U	1	ND	U	1.1
		Bromoform	75-25-2	ND	U	7.2	ND	U	2.7	ND	U	1.6	ND	U	2.1	ND	U	2.1
		Bromomethane	74-83-9	ND	U	7.2	ND	U	2.7	ND	U	1.6	ND	U	2.1	ND	U	2.1
		Carbon Disulfide	75-15-0	ND	U	7.2	ND	U	2.7	ND	U	1.6	ND	U	2.1	ND	U	2.1
		Carbon Tetrachloride	56-23-5	ND	U	1.8	ND	U	0.67	ND	U	0.4	ND	U	0.52	ND	U	0.53
		Chlorobenzene	108-90-7	ND	U	3.6	ND	U	1.3	ND	U	0.8	ND	U	1	ND	U	1.1
		Chloroethane	75-00-3	ND	U	7.2	ND	U	2.7	ND	U	1.6	ND	U	2.1	ND	U	2.1
		Chloroform	67-66-3	ND	U	7.2	ND	U	2.7	ND	U	1.6	ND	U	2.1	ND	U	2.1
		Chloromethane	74-87-3	ND	U	7.2	ND	U	2.7	ND	U	1.6	ND	U	2.1	ND	U	2.1
		Cis-1,2-Dichloroethene	156-59-2	ND	U	3.6	ND	U	1.3	ND	U	0.8	ND	U	1	ND	U	1.1
		Cis-1,3-Dichloropropene	10061-01-5	ND	U	3.6	ND	U	1.3	ND	U	0.8	ND	U	1	ND	U	1.1
		Dibromochloromethane	124-48-1	ND	U	3.6	ND	U	1.3	ND	U	0.8	ND	U	1	ND	U	1.1
		Dibromomethane	74-95-3	ND	U	3.6	ND	U	1.3	ND	U	0.8	ND	U	1	ND	U	1.1
		Dichlorodifluoromethane	75-71-8	ND	U	3.6	ND	U	1.3	ND	U	0.8	ND	U	1	ND	U	1.1
		Ethylbenzene	100-41-4	35	--	3.6	17	--	1.3	10	--	0.8	24	--	1	ND	U	1.1
		Hexachloro-1,3-Butadiene	87-68-3	ND	U	7.2	ND	U	2.7	ND	U	1.6	ND	U	2.1	ND	U	2.1
		Isopropylbenzene	98-82-8	8.3	J	3.6	6.9	--	1.3	3.5	--	0.8	6.2	--	1	ND	U	1.1
		m- & p-Xylenes	179601-23-1	110	--	7.2	43	--	2.7	32	--	1.6	71	--	2.1	ND	U	2.1
		Methyl tert-Butyl Ether	1634-04-4	ND	U	7.2	ND	U	2.7	ND	U	1.6	ND	U	2.1	ND	U	2.1
		Methylene Chloride	75-09-2	ND	U	7.2	ND	U	2.7	ND	U	1.6	ND	U	2.1	ND	U	2.1
		Naphthalene	91-20-3	19	J	3.6	38	--	1.3	15	--	0.8	23	--	1	0.69	J	1.1
		n-Butylbenzene	104-51-8	12	--	3.6	22	--	1.3	8.3	--	0.8	16	--	1	ND	U	1.1
		n-Propylbenzene	103-65-1	16	--	7.2	15	--	2.7	7.2	--	1.6	13	--	2.1	ND	U	2.1
		o-Xylene	95-47-6	37	--	3.6	19	--	1.3	13	--	0.8	25	--	1	ND	U	1.1
		sec-Butylbenzene	135-98-8	13	--	3.6	22	--	1.3	7.8	--	0.8	15	--	1	ND	U	1.1
		Styrene	100-42-5	ND	U	3.6	ND	U	1.3	ND	U	0.8	ND	U	1	ND	U	1.1
		tert-Butylbenzene	98-06-6	ND	U	3.6	ND	U	1.3	ND	U	0.8	ND	U	1	ND	U	1.1
		Tetrachloroethene	127-18-4	ND	U	3.6	ND	U	1.3	ND	U	0.8	ND	U	1	ND	U	1.1
		Toluene	108-88-3	110	--	3.6	31	--	1.3	15	--	0.8	84	--	1	1.7	J	1.1
		Trans-1,2-Dichloroethene	156-60-5	ND	U	7.2	ND	U	2.7	ND	U	1.6	ND	U	2.1	ND	U	2.1
		Trans-1,3-Dichloropropene	10061-02-6	ND	U	7.2	ND	U	2.7	ND	U	1.6	ND	U	2.1	ND	U	2.1
		Trichloroethene	79-01-6	ND	U	3.6	ND	U	1.3	ND	U	0.8	ND	U	1	ND	U	1.1
		Trichlorofluoromethane	75-69-4	ND	U	7.2	ND	U	2.7	ND	U	1.6	ND	U	2.1	ND	U	2.1
		Vinyl Chloride	75-01-4	ND	U	3.6	ND	U	1.3	ND	U	0.8	ND	U	1	ND	U	1.1
Moisture	Percent Moisture (%) VOCs	NA	NA	11.8	--	--	3.9	--	--	--	--	--	7.5	--	--	20.8	--	--

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

			Boring ID:	KAFB-106V2			KAFB-106V2		
			Sample Date:	12/14/2018			12/15/2018		
			Sample Depth (ft bgs):	270			287		
			Sample Type:	Field Duplicate			REG		
			Core Temperature (°C)		**23.9**			**27.9**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
Total Petroleum Hydrocarbons	Method SW8015 (mg/kg)	Motor Oil (C20-C38)	MOIL	ND	UJ	29	ND	U	24
		TPH-DRO (C10-C28)	TPH-DRO	7.5	J	5	ND	U	4.1
		TPH-GRO (C6-C10)	TPH-GRO	6.5	--	1.8	1.1	J	1.4
Moisture	Percent Moisture (%) TPH	NA	NA	20.3	--	--	6.5	--	--
EDB	Method SW8011 (mg/kg)[a]	1,2-Dibromoethane	106-93-4	0.00046	--	0.000047	ND	U	0
Moisture	Percent Moisture (%) EDB	NA	NA	19.6	--	--	4.7	--	--
VOCs	Method SW8260B (mg/kg)[a]	1,1,1,2-Tetrachloroethane	630-20-6	ND	U	0.11	ND	U	0
		1,1,1-Trichloroethane	71-55-6	ND	U	0.055	ND	U	0
		1,1,2,2-Tetrachloroethane	79-34-5	ND	U	0.11	ND	U	0
		1,1,2-Trichloroethane	79-00-5	0.043	J	0.11	ND	U	0
		1,1-Dichloroethane	75-34-3	ND	U	0.22	ND	U	0
		1,1-Dichloroethene	75-35-4	ND	U	0.22	ND	U	0
		1,1-Dichloropropene	563-58-6	ND	U	0.22	ND	U	0
		1,2,3-Trichlorobenzene	87-61-6	0.055	J	0.11	ND	U	0
		1,2,3-Trichloropropane	96-18-4	ND	U	0.22	ND	U	0
		1,2,4-Trichlorobenzene	120-82-1	ND	U	0.22	ND	U	0
		1,2,4-Trimethylbenzene	95-63-6	0.048	J	0.11	ND	U	0
		1,2-Dibromo-3-Chloropropane	96-12-8	ND	U	0.44	ND	U	0
		1,2-Dibromoethane	106-93-4	0.046	J	0.11	ND	U	0
		1,2-Dichlorobenzene	95-50-1	ND	U	0.44	ND	U	0
		1,2-Dichloroethane	107-06-2	ND	U	0.11	ND	U	0
		1,2-Dichloroethene	540-59-0	0.03	J	0.11	ND	U	0
		1,2-Dichloropropane	78-87-5	ND	U	0.22	ND	U	0
		1,3,5-Trimethylbenzene	108-67-8	ND	U	0.11	ND	U	0
		1,3-Dichlorobenzene	541-73-1	ND	U	0.22	ND	U	0
		1,3-Dichloropropane	142-28-9	ND	U	0.11	ND	U	0
		1,4-Dichlorobenzene	106-46-7	0.034	J	0.11	ND	U	0
		2,2-Dichloropropane	594-20-7	ND	U	0.11	ND	U	0
		2-Butanone	78-93-3	7.3	--	0.87	ND	U	0.01
		2-Chlorotoluene	95-49-8	ND	U	0.11	ND	U	0
		2-Hexanone	591-78-6	ND	U	0.87	ND	U	0.01
		4-Chlorotoluene	106-43-4	0.031	J	0.11	ND	U	0
		4-Isopropyltoluene	99-87-6	ND	U	0.11	ND	U	0
		4-Methyl-2-Pentanone	108-10-1	0.34	J	0.87	ND	U	0.01
		Acetone	67-64-1	78	--	17	0.22	--	0.01
		Benzene	71-43-2	0.26	J	0.22	ND	U	0

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

			Boring ID:	KAFB-106V2			KAFB-106V2		
			Sample Date:	12/14/2018			12/15/2018		
			Sample Depth (ft bgs):	270			287		
			Sample Type:	Field Duplicate			REG		
			Core Temperature (°C)		**23.9**			**27.9**	
Parameter	**Analytical Method**	**Chemical Name**	**CAS**	**Result**	**Val Qual**	**LOD**	**Result**	**Val Qual**	**LOD**
VOCs	Method SW8260B (mg/kg)[a]	Bromobenzene	108-86-1	0.039	J	0.055	ND	U	0
		Bromochloromethane	74-97-5	ND	U	0.22	ND	U	0
		Bromodichloromethane	75-27-4	ND	U	0.11	ND	U	0
		Bromoform	75-25-2	ND	U	0.22	ND	U	0
		Bromomethane	74-83-9	ND	U	0.22	ND	U	0
		Carbon Disulfide	75-15-0	ND	U	0.22	ND	U	0
		Carbon Tetrachloride	56-23-5	0.026	J	0.055	ND	U	0
		Chlorobenzene	108-90-7	ND	U	0.11	ND	U	0
		Chloroethane	75-00-3	ND	U	0.22	ND	U	0
		Chloroform	67-66-3	ND	U	0.22	ND	U	0
		Chloromethane	74-87-3	ND	U	0.22	ND	U	0
		Cis-1,2-Dichloroethene	156-59-2	0.03	J	0.11	ND	U	0
		Cis-1,3-Dichloropropene	10061-01-5	ND	U	0.11	ND	U	0
		Dibromochloromethane	124-48-1	ND	U	0.11	ND	U	0
		Dibromomethane	74-95-3	ND	U	0.11	ND	U	0
		Dichlorodifluoromethane	75-71-8	ND	U	0.11	ND	U	0
		Ethylbenzene	100-41-4	0.06	J	0.11	ND	U	0
		Hexachloro-1,3-Butadiene	87-68-3	ND	U	0.22	ND	U	0
		Isopropylbenzene	98-82-8	ND	U	0.11	ND	U	0
		m- & p-Xylenes	179601-23-1	ND	U	0.22	ND	U	0
		Methyl tert-Butyl Ether	1634-04-4	ND	U	0.22	ND	U	0
		Methylene Chloride	75-09-2	ND	U	0.22	ND	U	0
		Naphthalene	91-20-3	ND	U	0.11	ND	U	0
		n-Butylbenzene	104-51-8	ND	U	0.11	ND	U	0
		n-Propylbenzene	103-65-1	ND	U	0.22	ND	U	0
		o-Xylene	95-47-6	0.057	J	0.11	ND	U	0
		sec-Butylbenzene	135-98-8	ND	U	0.11	ND	U	0
		Styrene	100-42-5	ND	U	0.11	ND	U	0
		tert-Butylbenzene	98-06-6	0.039	J	0.11	ND	U	0
		Tetrachloroethene	127-18-4	ND	U	0.11	ND	U	0
		Toluene	108-88-3	0.69	J	0.11	0.0017	J	0
		Trans-1,2-Dichloroethene	156-60-5	ND	U	0.22	ND	U	0
		Trans-1,3-Dichloropropene	10061-02-6	ND	U	0.22	ND	U	0
		Trichloroethene	79-01-6	ND	U	0.11	ND	U	0
		Trichlorofluoromethane	75-69-4	ND	U	0.22	ND	U	0
		Vinyl Chloride	75-01-4	ND	U	0.11	ND	U	0
Moisture	Percent Moisture (%) VOCs	NA	NA	19.6	--	--	4.7	--	--

Table 5-1
Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

°C = degrees Celsius

[a] Data presented in units of micrograms per kilogram (μg/kg) in laboratory reports; data converted to mg/kg for presentation.

* Indicates sample was disturbed during collection.

AFB = Air Force Base
BFF = Bulk Fuels Facility
bgs = below ground surface
CAS = chemical abstract service number
DRO = diesel range organics
EDB = ethylene dibromide (1,2-dibromoethane)
ft = foot/feet
GRO = gasoline range organics
ID = identification
KAFB = Kirtland Air Force Base
LOD = limit of detection
mg/kg = milligram per kilogram
MRO = motor oil organics
NA = not applicable
ND = not detected
NS = not specified
REG = normal field sample
SWMU = Solid Waste Management Unit
TPH = total petroleum hydrocarbons
Val Qual = validation qualifier
VOC = volatile organic compound
% = percent

Val Quals based on independent data validation
J = Qualifier denotes the analyte was positively identified, but the associated numerical value is estimated.
U = Qualifier denotes the analyte was analyzed but not detected above the detection limit. The value associated with the U-qualifier is the LOD.
-- = Validation qualifier not assigned.
— = Compound not analyzed for.

Core temperatures in bold exceeded ≤ 20° C

Table 5-2
Soil Grain Size Distribution

Coring Location	Sample ID	PTS Lab File No.	Depth (ft bgs)	Particle Size Distribution (wt.%)[a]					Total	Mean Grain Size
				Silt/Clay	Fine Sand	Medium Sand	Coarse Sand	Gravel		
KAFB-106S1	GUV-S1-051218-478	48276	479.10 - 479.20	4.87	17.24	20.73	10.00	47.15	99.99	Gravel
KAFB-106S2	GUV-S2-161118-489	48255	490.7 - 490.9	7.63	63.69	19.67	2.66	6.35	100.00	Fine Sand
KAFB-106S3	GUV-S3-211118-492	48262	493.0 - 493.5	1.84	7.36	15.59	6.75	68.46	100.00	Gravel
	GUV-S3-211118-494	48262	495.6 - 495.9	2.05	9.21	19.57	12.86	56.32	100.01	Gravel
KAFB-106S4	GUV-S4-041118-486	48244	486.25 - 486.45	5.89	25.31	45.40	11.91	11.50	100.01	Fine Sand
KAFB-106S9	GUV-S9-171018-473	48218	474.1 - 474.2	3.07	18.97	17.29	4.00	56.67	100.00	Gravel
	GUV-S9-181018-484	48218	484.2 - 484.4	6.00	29.19	37.62	4.20	22.98	99.99	Medium Sand
	UV-S9-301018-491*	48236	491.7 - 491.9	2.80	68.98	28.03	0.18	0.00	99.99	Fine Sand
	UV-S9-301018-491*	48236	492.1 - 492.35	1.98	56.10	41.40	0.29	0.23	100.00	Fine Sand
	UV-S9-301018-493*	48236	493.0 - 493.4	2.00	28.07	62.81	6.47	0.65	100.00	Medium Sand
KAFB-106V1	GUV-V1-171218-122	48286	122.10-123.30	26.45	49.82	21.59	2.14	0.00	100.00	Fine Sand
	GUV-V1-161218-158	48292	158.10-158.50	12.81	45.97	21.06	9.53	10.63	100.00	Fine Sand
	GUV-V1-161218-162	48292	162.60-162.90	35.80	62.73	1.47	0.00	0.00	100.00	Fine Sand
	GUV-V1-161218-164	48292	164.30-164.50	8.51	90.77	0.73	0.00	0.00	100.01	Fine Sand
KAFB-106V2	GUV-V2-131218-122	48284	122.45 - 122.60	34.62	41.64	22.10	1.65	0.00	100.01	Fine Sand
	GUV-V2-131218-194	48284	194.60 - 194.80	6.06	30.58	31.54	12.64	19.18	100.00	Medium Sand

* Indicates sample was disturbed during collection.

[a] Grain Size Description (ASTM International-USCS Scale - D422)

% = percent

bgs = below ground surface

ft = foot/feet

ID = identification

USCS = Unified Soil Classification System (logged in the field)

wt. = weight

Table 5-3
Mean Grain Size and Interstitial Properties of Selected Core Samples

Coring Location	Sample ID	PTS Lab File Number	Depth (ft bgs)	Mean Grain Size	Density (g/cc)		Total Porosity (%Vb)	Air Filled Porosity (%Vb)	Pore Fluid Water Saturation (% Pv)	Pore Fluid LNAPL Saturation (% Pv)	Effective Permeability (millidarcy)	Hydraulic Conductivity (cm/s)	Intrinsic Permeability (cm^2)	Water Filled Porosity[a] (%Vb)	LNAPL Filled Porosity[b] (%Vb)
					Dry Bulk	Grain									
KAFB-106S1	GUV-S1-051218-478	48276	479.10 - 479.20	Gravel	1.80	2.61	31.00	13.00	55.40	2.50	261.489	3.21E-04	2.58E-09	17.17	0.78
KAFB-106S2	GUV-S2-161118-489	48255	490.7 - 490.9	Fine Sand	1.55	2.62	41.10	19.30	50.60	2.50	206.772	2.53E-04	2.04E-09	20.80	1.03
KAFB-106S3	GUV-S3-211118-492	48262	493.2 - 493.5	Gravel	1.77	2.65	33.00	16.00	49.60	1.90	306.105	3.76E-04	3.02E-09	16.37	0.63
	GUV-S3-211118-494	48262	495.6 - 495.9	Gravel	1.80	2.62	31.30	14.10	52.60	2.40	46.160	5.74E-05	4.56E-10	16.46	0.75
KAFB-106S4	GUV-S4-041118-486	48244	486.25 - 486.45	Fine Sand	1.54	2.65	41.80	24.10	39.50	2.70	1201.567	1.49E-03	1.19E-08	16.51	1.13
KAFB-106S5	GUV-S5-231018-488	48222	488.8 - 489	NA	1.80	2.64	31.50	16.10	48.80	0.08	NA	NA	NA	15.37	0.03
KAFB-106S7	GUV-S7-220119-492	49005	492.8 - 493	NA	1.58	2.64	40.10	28.40	29.20	0.04	NA	NA	NA	11.71	0.02
KAFB-106S9	GUV-S9-171018-473	48218	474.1 - 474.2	Gravel	1.49	2.69	44.60	15.40	62.00	3.50	1719.885	2.14E-03	1.70E-08	27.65	1.56
	GUV-S9-181018-484	48218	484.2 - 484.4	Medium Sand	1.57	2.67	41.10	16.90	53.90	4.90	583.230	7.27E-04	5.76E-09	22.15	2.01
	UV-S9-301018-491*	48236	492.2 - 493.4	Fine Sand	1.43	2.66	46.20	20.00	54.60	2.10	648.045	8.08E-04	6.40E-09	25.23	0.97
KAFB-106V1	GUV-V1-171218-122	48286	122.10-123.30	Fine Sand	1.22	2.58	52.80	13.20	61.90	13.10	0.173	2.17E-07	1.71E-12	32.68	6.92
	GUV-V1-161218-158	48292	158.10-158.50	Fine Sand	1.21	2.48	51.20	32.60	25.80	10.50	361.998	4.54E-04	3.57E-09	13.21	5.38
	GUV-V1-161218-162	48292	162.60-162.90	Fine Sand	1.32	2.59	49.00	31.00	28.40	8.40	261.386	3.27E-04	2.58E-09	13.92	4.12
	GUV-V1-161218-164	48292	164.30-164.50	Fine Sand	1.43	2.59	44.80	31.60	19.00	10.30	342.485	4.29E-04	3.38E-09	8.51	4.61
KAFB-106V2	GUV-V2-131218-122	48284	122.45 - 122.6	Fine Sand	1.37	2.59	47.30	7.10	77.70	7.20	46.505	5.75E-05	4.59E-10	36.75	3.41
	GUV-V2-131218-194	48284	194.60 - 194.8	Medium Sand	1.40	2.60	44.00	21.40	40.60	10.70	414.410	5.14E-04	4.09E-09	17.86	4.71

Pore fluid saturations performed by American Petroleum Institute Method RP 40.

[a] Value calculated by taking the pore fluid water saturation percentage and multiplying this value by the total porosity percentage.

[b] Value calculated by taking the pore fluid NAPL saturation percentage and multiplying this value by the total porosity percentage.

* Indicates sample was disturbed during collection

% = percent

bgs - below ground surface

cc = cubic centimeter

cm = centimeter(s)

ft = foot/feet

g = gram(s)

ID = identification

LNAPL = light non-aqueous phase liquid

NA - Parameter not analyzed for.

Pv = pore volume (cc)

s = second

Vb = bulk volume (cc)

Table 5-4
Summary of LNAPL Saturation and Mobility for Select Core Samples

Coring Location	Sample Identification	PTS Lab File No.	Sample Interval	Mean Grain Size	Physical Properties				Sample Saturations				
					Bulk Density[a]	Porosity[a]	Moisture Content[a,b]	LNAPL Hydraulic Conductivity[a,c]	Air Filled Porosity[a]	Water Saturation[a]	Water Saturation[d]	LNAPL Pore Volume Saturation[a]	LNAPL Total Volume Saturation
					g/cm^3	(%)	(% Weight)	cm/sec	(%)	(% PV)	(% TV)	(% PV)	(% TV)
KAFB-106S1	GUV-S1-051218-478	48276	479.1-479.2	Gravel	1.80	31.0	9.8	3.21E-04	13.0	55.4	17.2	2.5	0.78
KAFB-106S2	GUV-S2-161118-489	48255	490.7-490.9	Fine Sand	1.55	41.1	13.9	2.53E-04	19.3	50.6	20.8	2.5	1.03
KAFB-106S3	GUV-S3-211118-492	48262	493.0-493.5	Gravel	1.77	33.0	9.5	3.76E-04	16.0	49.6	16.4	1.9	0.63
	GUV-S3-211118-494	48262	495.6-495.9	Gravel	1.80	31.3	11.1	5.74E-05	14.1	52.6	16.5	2.4	0.75
KAFB-106S4	GUV-S4-041118-486	48244	486.25-486.45	Fine Sand	1.54	41.8	11.4	1.49E-03	24.1	39.5	16.5	2.7	1.13
KAFB-106S5	GUV-S5-231018-488	48222	488.8 - 489	NA	1.80	31.5	8.2	--	16.1	48.8	15.4	0.08	0.03
KAFB-106S7	GUV-S7-220119-492	49005	492.8 - 493	NA	1.58	40.1	6.9	--	28.4	29.2	11.7	0.04	0.02
KAFB-106S9	GUV-S9-171018-473	48218	474.10-474.20	Gravel	1.49	44.6	19.3	2.14E-03	15.4	62	27.7	3.5	1.56
	GUV-S9-171018-484	48218	484.20-484.40	Medium Sand	1.57	41.1	15.1	7.27E-04	16.9	53.9	22.2	4.9	2.01
	GUV-S9-301018-491*	48236	492.10 -492.35	Fine Sand	1.43	46.2	18.3	8.08E-04	20.0	54.6	25.2	2.1	0.97
KAFB-106V1	**GUV-V1-171218-122**	48286	122.1-122.3	Fine Sand	1.22	52.8	31.1	2.17E-07	13.2	61.9	32.7	13.1	6.92
	GUV-V1-161218-158	48292	158.1-158.5	Fine Sand	1.21	51.2	14.3	4.54E-04	32.6	25.8	13.2	10.5	5.38
	GUV-V1-161218-162	48292	162.6-162.9	Fine Sand	1.32	49.0	12.9	3.27E-04	31.0	28.4	13.9	8.4	4.12
	GUV-V1-161218-164	48292	164.3-164.5	Fine Sand	1.43	44.8	8.5	4.29E-04	31.6	19.0	8.5	10.3	4.61
KAFB-106V2	**GUV-V2-131218-122**	48284	122.45-122.6	Fine Sand	1.37	47.3	28.8	5.75E-05	7.1	77.7	36.8	7.2	3.41
	GUV-V2-131218-194	48284	194.6-194.8	Medium Sand	1.40	44.0	14.9	5.14E-04	21.4	40.6	17.9	10.7	4.71

Table 5-4
Summary of LNAPL Saturation and Mobility for Select Core Samples

Coring Location	Sample Identification	PTS Lab File No.	Sample Interval	LNAPL Mobility Analyses					
				Centrifuge Method[e]			Water Drive Method[a,c]		
				Initial LNAPL Saturation	Residual LNAPL Saturation	Observed LNAPL	Initial LNAPL Saturation	Residual LNAPL Saturation	Observed LNAPL
KAFB-106S1	GUV-S1-051218-478	48276	479.1-479.2	1.52	1.52	None	2.6	2.6	None
KAFB-106S2	GUV-S2-161118-489	48255	490.7-490.9	0.02	0.02	None	2.8	2.8	None
KAFB-106S3	GUV-S3-211118-492	48262	493.0-493.5	0.7	0.7	None	6.0	6.0	None
	GUV-S3-211118-494	48262	495.6-495.9	1.2	1.2	None	9.4	9.4	None
KAFB-106S4	GUV-S4-041118-486	48244	486.25-486.45	0.18	0.18	None	0.8	0.8	None
KAFB-106S5	GUV-S5-231018-488	48222	488.8 - 489	--	--	--	--	--	--
KAFB-106S7	GUV-S7-220119-492	49005	492.8 - 493	--	--	--	--	--	--
KAFB-106S9	GUV-S9-171018-473	48218	474.10-474.20	0.35	0.35	None	4.1	4.1	None
	GUV-S9-171018-484	48218	484.20-484.40	1.99	1.99	None	5.7	5.7	None
	GUV-S9-301018-491*	48236	492.10 -492.35	2.26	2.26	None	4.1	4.1	None
KAFB-106V1	**GUV-V1-171218-122**	48286	122.1-122.3	16.2	16.2	None	13.3	13.3	None
	GUV-V1-161218-158	48292	158.1-158.5	8.8	8.8	None	11.5	11.5	None
	GUV-V1-161218-162	48292	162.6-162.9	5.3	5.3	None	7.6	7.6	None
	GUV-V1-161218-164	48292	164.3-164.5	8.3	8.3	None	7.8	7.8	None
KAFB-106V2	**GUV-V2-131218-122**	48284	122.45-122.6	9.72	9.72	None	6.5	6.5	None
	GUV-V2-131218-194	48284	194.6-194.8	12.3	12.3	None	7.3	7.3	None

Table 5-4
Summary of LNAPL Saturation and Mobility for Select Core Samples

[a] Performed by American Petroleum Institute Method RP 40

[b] Performed by ASTM International Method D2216

[c] Performed by Environn PTS Lab File No.

[d] Calculated using pore volume saturation.

[e] Performed by ASTM International Method D425M (Dean Stark)

* Indicates sample was disturbed during collection.

Sample identifications in bold were collected from the vadose zone all others were collected from the saturated zone.

% = percent

cm^3 = cubic centimeters

g = gram

LNAPL = light non-aqueous phase liquid

NA = Parameter not analyzed for

NO. = number

PTS Lab = PTS Laboratories, Inc.

PV = pore volume

sec = second(s)

TV = total volume

-- = not analyzed

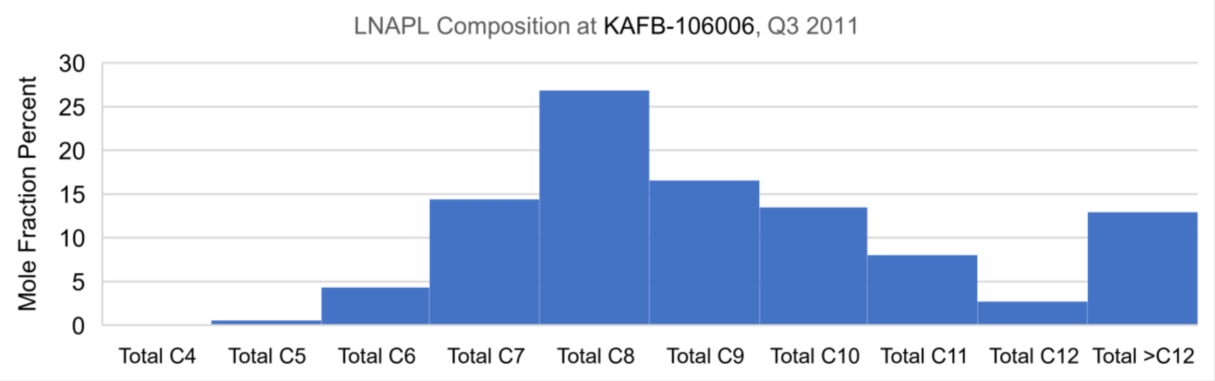
LNAPL Saturation (%TV) =LNAPL Saturation (%PV) * Porosity / 100

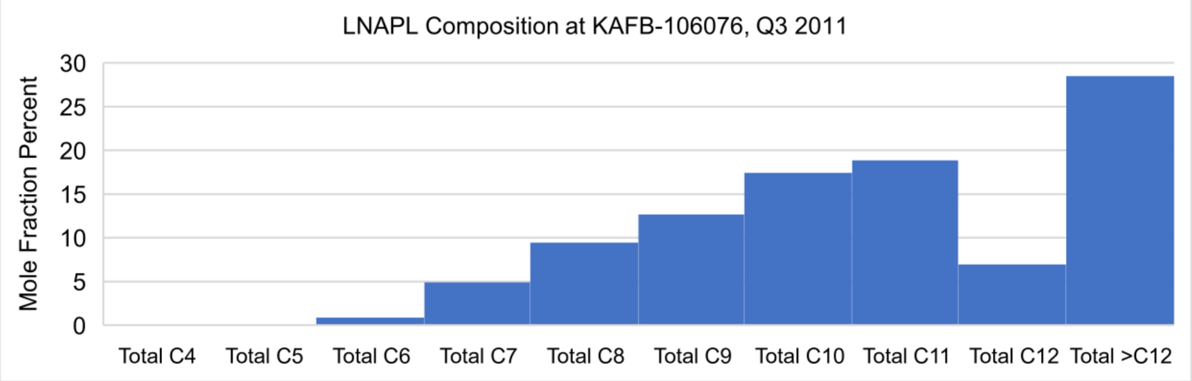
Table 5-5
LNAPL Chemical Properties Collected from the BFF Site

Analyte	Solubility in Water[a] (mg/L)	KAFB-1066-LNAPL-GEO [b] (KAFB-106006, Q3 2011)		KAFB-10676-LNAPL-GEO-1 [b] (KAFB-106076,Q3 2011)	
		Mole Fraction (percent)	Effective Solubility (mg/L)	Mole Fraction (percent)	Effective Solubility (mg/L)
Benzene	1,790	0.36	6.44	0.08	1.43
Toluene	526	3.28	17.25	1.31	6.89
Ethylbenzene	169	0.61	1.03	0.46	0.78
ortho-Xylene	106	0.84	0.89	0.59	0.63
meta-Xylene	161	1.59	2.56	1.05	1.69
para-Xylene	160	0.42	0.67	0.31	0.50
Xylene average	--	--	1.37	--	0.94
Total C4	--	0.06	--	0.06	--
Total C5	--	0.55	--	0.12	--
Total C6	--	4.35	--	0.89	--
Total C7	--	14.42	--	4.93	--
Total C8	--	26.87	4	9.48	--
Total C9	--	16.56	--	12.67	--
Total C10	--	13.49	--	17.45	--
Total C11	--	8.04	--	18.89	--
Total C12	--	2.72	--	6.99	--
Total >C12	--	12.94	--	28.52	--
Total Carbon Mole Fraction	--	100		100	

Ethylene Dibromide Data

Analyte	Solubility in Water[1] (mg/L)	PPM	Percent Solubility at 0.99 mg/L	PPM	Percent Solubility at 4.99 mg/L
Ethylene dibromide	3,910	<1	0.025	<5	0.13


LNAPL Composition at KAFB-106006, Q3 2011


LNAPL Composition at KAFB-106076, Q3 2011

[a] New Mexico Environment Department, Risk Assessment Guidance for Site Investigations and Remediation, Volume I, March 2019. Table B-2, Physical and Chemical Properties

[b] Samples collected for the Phase I RCRA Facility Investigation Report, Bulk Fuels Facility Release, Solid Waste Management Unit ST-106/SS-111 (Sundance, 2018).

BFF = Bulk Fuels Facility

KAFB = Kirtland Air Force Base

LNAPL = light non-aqueous phase liquid

mg/L = milligrams per liter

PPM = parts per million

Typical carbon chain signatures of fuel sources are C8-C24 for diesel/fuel oils and C6-C16 for kerosene/jet fuel.

Q3 = July - September

Table 5-6
Analytical Results for Soil Mineralogy and Magnetic Susceptibility

Sample Location	KAFB-106S1-480	KAFB-106S1-489	KAFB-106S2-474	KAFB-106S2-499	KAFB-106S3-477	KAFB-106S3-489	KAFB-106S3-494	KAFB-106S4-480
	X-Ray Diffraction Results							
	Relative Abundance (%)							
Mineral Constituent								
Quartz	47	40	35	46	34	32	29	36
Cristobalite	ND	ND	ND	ND	2	3	ND	ND
Oligoclase	ND	ND	ND	ND	ND	ND	ND	ND
Plagioclase Feldspar	30	34.5	33	32	33	41	43	21
Microcline	10	14	6	8	7	11	10	5
Calcite	1	ND	ND	ND	ND	ND	1	ND
Dolomite	ND	ND	ND	ND	ND	ND	ND	ND
Magnetite	4	2.5	7	3.5	4	5	5	5
Hematite	ND	ND	1	0.5	1	ND	ND	ND
Rutile	ND	ND	ND	ND	ND	ND	ND	ND
Heulandite	ND	ND	ND	ND	ND	ND	ND	ND
Hornblende	ND	ND	ND	ND	ND	ND	ND	ND
Clinoptilolite	ND	ND	ND	<0.5	ND	ND	0.5	ND
Goethite	ND	ND	ND	ND	ND	ND	ND	ND
Kaolinite	0.5	0.5	1	0.5	0.5	0.5	0.5	1
Chlorite	ND	ND	ND	ND	<0.5	ND	ND	ND
Illite/Mica	0.5	0.5	1	1	1.5	0.5	1	1
Montmorillonite	7	8	16	8.5	17	7	10	31
Mixed-layered Illite/Smectite	ND	ND	ND	ND	ND	ND	ND	ND
Total	100	100	100	100	100	100	100	100
% Illite Layers in ML (Illite/Smectite)	ND	ND	ND	ND	ND	ND	ND	ND

Table 5-6
Analytical Results for Soil Mineralogy and Magnetic Susceptibility

Sample Location	**KAFB-106S1-480**	**KAFB-106S1-489**	**KAFB-106S2-474**	**KAFB-106S2-499**	**KAFB-106S3-477**	**KAFB-106S3-489**	**KAFB-106S3-494**	**KAFB-106S4-480**
	X-Ray Fluorescence Results							
Compound	**Results (mass %)**							
MgO	0.2096	0.2686	0.2856	ND	0.2307	0.3615	0.1955	0.6241
Al_2O_3	8.6217	8.0828	8.9350	7.941	8.8761	9.4752	9.9017	10.2034
SiO_2	74.6048	76.7199	70.905	77.2565	75.9737	73.5919	72.5321	72.4060
P_2O_5	0.9668	0.9646	0.9873	1.005	0.9390	0.9608	1.0373	1.0487
SO_3	ND	ND	0.0485	ND	0.0339	0.0590	ND	ND
Cl	ND	ND	0.0154	0.0159	0.0412	0.0108	ND	ND
K_2O	6.338	5.9193	4.7379	5.6548	4.9802	5.4124	5.6524	4.7968
CaO	3.6131	3.9177	3.5409	2.8252	3.1696	3.6045	3.6527	2.9698
TiO_2	0.4273	0.4601	1.3590	0.5312	0.569	0.6124	0.6062	0.7515
MnO	0.0944	0.0661	0.1178	0.1002	0.066	0.1083	0.1282	0.1901
Fe_2O_3	4.5467	3.1964	8.8067	4.5199	4.952	5.6333	5.8372	6.8266
CuO	ND	ND	ND	ND	ND	ND	0.0253	ND
ZnO	ND	ND	0.0267	ND	ND	ND	0.0220	0.0202
Rb_2O	0.0227	0.0195	0.0291	0.0219	0.0205	0.0210	0.0264	0.0273
SrO	0.0742	0.0842	0.1062	0.0961	0.0900	0.0948	0.0927	0.0701
Y_2O_3	ND	ND	ND	ND	ND	0.0027	ND	ND
ZrO_2	0.0352	0.0191	0.0989	0.0323	0.0581	0.0512	0.0315	0.0653
Nb_2O_5	ND	ND	ND	ND	ND	ND	ND	ND
Ag_2O	ND	ND	ND	ND	ND	ND	ND	ND
BaO	ND	0.2817	ND	ND	ND	ND	0.2587	ND
Cr_2O_3	ND	ND	ND	ND	ND	ND	ND	ND
Magnetic Susceptibility (m^3/kg)	2.5E-6 ± 4.4E-8	1.9E-6 ± 4.0E-8	6.0E-6 ± 9.7E-8	2.6E-6 ± 9.3E-8	3.1E-6 ± 3.3E-8	2.0E-6 ± 2.4E-7	2.5E-6 ± 1.9E-7	1.9E-6 ± 8.4E-8

Table 5-6
Analytical Results for Soil Mineralogy and Magnetic Susceptibility

Sample Location	KAFB-106S4-494	KAFB-106S5-491	KAFB-106S5-506	KAFB-106S7-469	KAFB-106S7-485	KAFB-106S7-495	KAFB-106S8-475	KAFB-106S8-499
	X-Ray Diffraction Results							
	Relative Abundance (%)							
Mineral Constituent								
Quartz	44	28	40	52	42	53	46	51
Cristobalite	ND	ND	ND	ND	ND	ND	ND	ND
Oligoclase	ND	ND	ND	23	29	25	17	21
Plagioclase Feldspar	32	39	40	ND	ND	ND	ND	ND
Microcline	8	8	7	17.5	17	17.5	27	23
Calcite	ND	1	--	ND	ND	0.5	1	ND
Dolomite	ND	ND	ND	ND	ND	ND	ND	ND
Magnetite	4	5	5	2	3	2	2	2
Hematite	ND	ND	ND	ND	ND	ND	ND	ND
Rutile	ND	ND	ND	0.5	0.5	ND	0.5	0.5
Heulandite	ND	ND	ND	ND	ND	ND	ND	ND
Hornblende	ND	ND	ND	ND	ND	ND	ND	ND
Clinoptilolite	ND	ND	<0.5	ND	ND	ND	ND	ND
Goethite	ND	1	ND	ND	ND	ND	ND	ND
Kaolinite	1	<0.5	0.5	<0.5	<0.5	ND	<0.5	<0.5
Chlorite	ND	ND	0.5	ND	ND	ND	ND	ND
Illite/Mica	1	0.5	1	<0.5	0.5	<0.5	0.5	<0.5
Montmorillonite	10	17.5	6	5	8	2	6	2.5
Mixed-layered Illite/Smectite	ND	ND	ND	ND	ND	ND	ND	ND
Total	100	100	100	100	100	100	100	100
% Illite Layers in ML (Illite/Smectite)	ND	ND	ND	ND	ND	ND	ND	ND

Table 5-6
Analytical Results for Soil Mineralogy and Magnetic Susceptibility

Sample Location	**KAFB-106S4-494**	**KAFB-106S5-491**	**KAFB-106S5-506**	**KAFB-106S7-469**	**KAFB-106S7-485**	**KAFB-106S7-495**	**KAFB-106S8-475**	**KAFB-106S8-499**
	X-Ray Fluorescence Results							
Compound	**Results (mass %)**							
MgO	0.3689	0.5018	0.2765	0.2366	0.2725	0.2168	0.3798	ND
Al_2O_3	8.8896	8.7385	8.3363	7.6373	9.3256	7.8973	8.7800	7.6620
SiO_2	75.3079	74.2316	75.9823	77.8895	72.2035	77.8303	74.3213	78.1395
P_2O_5	1.0403	0.9459	0.9571	1.0144	1.1023	1.0206	1.0963	1.0902
SO_3	0.0371	ND	0.0392	0.0335	ND	0.0736	0.0647	ND
Cl	ND	0.0288	ND	ND	ND	ND	ND	0.0317
K_2O	5.6238	5.1344	5.2099	5.2647	5.6372	5.6476	5.3489	5.4289
CaO	3.2911	3.4171	3.1390	2.7783	3.8011	2.7388	3.5964	2.8848
TiO_2	0.5222	0.5983	0.5586	0.5266	0.6671	0.3938	0.6119	0.5193
MnO	0.0834	0.1063	0.0832	0.0911	0.1336	0.0752	0.1094	0.0839
Fe_2O_3	4.5973	5.9017	5.2802	4.4032	6.6252	3.9675	5.2429	4.0196
CuO	ND	ND	ND	ND	ND	ND	ND	ND
ZnO	ND	ND	ND	ND	0.0233	ND	ND	ND
Rb_2O	0.0234	0.0264	0.0243	0.0244	0.0332	0.0213	0.0268	0.0218
SrO	0.0975	0.0974	0.0831	0.0771	0.1027	0.0903	0.1060	0.0928
Y_2O_3	0.0564	ND	ND	ND	ND	0.0027	ND	0.0007
ZrO_2	0.0612	0.0380	0.0303	0.0233	0.0728	0.0242	0.0294	0.0249
Nb_2O_5	ND	ND	ND	ND	ND	ND	ND	ND
Ag_2O	ND	ND	ND	ND	ND	ND	ND	ND
BaO	ND	0.2338	ND	ND	ND	ND	0.2861	ND
Cr_2O_3	ND	ND	ND	ND	ND	ND	ND	ND
Magnetic Susceptibility (m^3/kg)	2.0E-6 ± 2.6E-8	1.9E-6 ± 4.0E-8	2.4E-6 ± 1.1E-7	2.0E-6 ± 9.8E-8	2.8E-6 ± 1.3E-7	1.7E-6 ± 3.6E-8	3.0E-6 ± 8.0E-8	2.1E-6 ± 10.0E-8

Table 5-6
Analytical Results for Soil Mineralogy and Magnetic Susceptibility

Sample Location	KAFB-106S9-475	KAFB-106S9-477	KAFB-106S9-483		KAFB-106V1-122	KAFB-106V1-161	KAFB-106V2-144	KAFB-106V2-215
	X-Ray Diffraction Results							
	Relative Abundance (%)							
Mineral Constituent								
Quartz	44	27	31	34	32	19	26.5	39
Cristobalite	ND	ND	ND	ND	ND	ND	ND	ND
Oligoclase	ND	ND	ND	ND	ND	ND	ND	ND
Plagioclase Feldspar	39	23	16	48	10	3	13	34
Microcline	6	4	4	9	6	3	6	13
Calcite	ND	5	44	ND	4	12	34	ND
Dolomite	ND	ND	ND	ND	ND	ND	ND	ND
Magnetite	5	6	3.5	4	4	6	2.5	5
Hematite	<0.5	ND	ND	ND	ND	ND	ND	ND
Rutile	ND	ND	ND	ND	ND	ND	ND	ND
Heulandite	ND	ND	ND	ND	ND	ND	ND	ND
Hornblende	<0.5	ND	ND	ND	ND	ND	ND	ND
Clinoptilolite	ND	0.5	ND	ND	ND	ND	ND	ND
Goethite	ND	ND	ND	ND	ND	ND	ND	ND
Kaolinite	0.5	1	<0.5	0.5	ND	10	1	<0.5
Chlorite	<0.5	0.5	<0.5	ND	ND	ND	<0.5	ND
Illite/Mica	0.5	1	<0.5	0.5	3	5	3	<0.5
Montmorillonite	5	32	1.5	4	ND	ND	ND	ND
Mixed-layered Illite/Smectite	ND	ND	ND	ND	41	42	14	9
Total	100	100	100	100	100	100	100	100
% Illite Layers in ML (Illite/Smectite)	ND	ND	ND	ND	30%	30%	60%	30%

Table 5-6
Analytical Results for Soil Mineralogy and Magnetic Susceptibility

Sample Location	**KAFB-106S9-475**	**KAFB-106S9-477**	**KAFB-106S9-483**		**KAFB-106V1-122**	**KAFB-106V1-161**	**KAFB-106V2-144**	**KAFB-106V2-215**
	X-Ray Fluorescence Results							
Compound	**Results (mass %)**							
MgO	0.4032	0.7938	0.2179	0.2769	1.2093	1.0533	0.9677	0.4076
Al_2O_3	8.4816	10.4114	5.1776	8.1006	11.9004	14.7724	6.3591	8.3962
SiO_2	74.8852	67.2286	50.5207	72.7651	68.4083	57.4354	49.7724	75.4545
P_2O_5	1.0978	0.9791	0.7796	1.0564	1.1017	1.0820	0.8553	1.1154
SO_3	ND	0.1093	ND	ND	0.0834	ND	0.1172	0.0565
Cl	ND	ND	ND	ND	ND	ND	ND	ND
K_2O	4.5492	5.1831	3.6163	5.5193	5.2766	5.1542	3.9246	5.2092
CaO	3.7306	6.7662	34.966	6.1292	5.6122	10.0372	32.5081	3.1812
TiO_2	0.5864	0.9050	0.3818	0.6463	0.8061	1.3946	0.5222	0.4674
MnO	0.0863	0.1278	0.0795	ND	.01384	0.2202	0.2670	0.0986
Fe_2O_3	6.0153	6.8537	4.1215	5.1149	5.1679	8.6051	4.4103	5.2604
CuO	ND	ND	ND	ND	ND	ND	ND	ND
ZnO	ND	0.0288	ND	ND	0.0242	ND	ND	ND
Rb_2O	0.0183	0.0326	0.0184	0.0243	0.0257	0.0371	0.0287	0.0164
SrO	0.1089	0.1206	0.0859	0.1142	0.0870	0.0608	0.1562	0.0802
Y_2O_3	0.0034	0.0002	ND	ND	ND	ND	ND	ND
ZrO_2	0.0339	0.0793	0.0347	0.0222	0.1460	0.0398	0.1111	0.0281
Nb_2O_5	ND	ND	ND	ND	0.0127	ND	ND	ND
Ag_2O	ND	ND	ND	ND	ND	0.1080	ND	ND
BaO	ND	0.3805	ND	0.2305	ND	ND	ND	0.2283
Cr_2O_3	ND	ND	ND	ND	ND	ND	ND	ND
Magnetic Susceptibility (m^3/kg)	3.2E-6 ± 6.4E-8	1.3E-6 ± 2.2E-8	1.7E-6 ± 4.2E-8	2.2E-6 ± 8.4E-9	1.0E-6 ± 1.2E-8	1.5E-7 ± 3.2E-9	5.5E-7 ± 1.1E-8	3.1E-6 ± 7.2E-8

Table 5-6
Analytical Results for Soil Mineralogy and Magnetic Susceptibility

Sample Location	**KAFB-106247-143**	**KAFB-106247-208**	**KAFB-106247-474**	**KAFB-106247-480**	**KAFB-106247-489**	**KAFB-106247-499**
	X-Ray Diffraction Results					
	Relative Abundance (%)					
Mineral Constituent						
Quartz	46.5	52	60.5	61	61	36
Cristobalite	ND	ND	ND	ND	ND	ND
Oligoclase	19	27	21	20	20	37
Plagioclase Feldspar	ND	ND	ND	ND	ND	ND
Microcline	9	17	14	13	15	20
Calcite	3	ND	ND	0.5	0.5	0.5
Dolomite	ND	ND	ND	0.5	ND	ND
Magnetite	3	2	2	2	1.5	2
Hematite	ND	ND	ND	ND	ND	ND
Rutile	0.5	ND	0.5	ND	ND	0.5
Heulandite	ND	ND	<0.5	ND	ND	ND
Hornblende	ND	ND	ND	ND	ND	ND
Clinoptilolite	ND	ND	ND	ND	ND	ND
Goethite	ND	ND	ND	ND	ND	ND
Kaolinite	1	<0.5	0.5	0.5	<0.5	<0.5
Chlorite	ND	<0.5	<0.5	ND	ND	ND
Illite/Mica	1	0.5	0.5	0.5	0.5	0.5
Montmorillonite	ND	ND	ND	ND	ND	3.5
Mixed-layered Illite/Smectite	17	1.5	1	2	1.5	ND
Total	100	100	100	100	100	100
% Illite Layers in ML (Illite/Smectite)	10%	10%	10%	10%	10%	10%

Table 5-6
Analytical Results for Soil Mineralogy and Magnetic Susceptibility

Sample Location	KAFB-106247-143	KAFB-106247-208	KAFB-106247-474	KAFB-106247-480	KAFB-106247-489	KAFB-106247-499
	X-Ray Fluorescence Results					
Compound	Results (mass %)					
MgO	0.6637	ND	0.2061	0.2604	ND	0.2376
Al_2O_3	10.3432	7.7642	6.8164	6.6194	7.5282	9.8080
SiO_2	67.3376	79.5446	79.7081	81.0614	80.2252	72.5567
P_2O_5	0.9950	0.8449	0.8362	0.9519	0.9672	1.0858
SO_3	0.0933	ND	0.0679	ND	0.0586	0.0628
Cl	0.0141	0.0187	ND	ND	ND	ND
K_2O	5.7476	5.2114	4.7075	4.4687	4.8606	6.5113
CaO	4.8093	2.0557	2.3251	2.2370	2.5981	3.4109
TiO_2	1.2686	0.4004	0.3771	0.4547	0.3901	0.5894
MnO	0.1189	0.0930	0.0792	0.0603	0.0654	0.0882
Fe_2O_3	8.0953	3.9716	4.7442	3.7480	3.1866	5.4745
CuO	ND	ND	ND	ND	ND	ND
ZnO	0.0275	ND	ND	ND	ND	ND
Rb_2O	0.0428	0.0213	0.0180	0.0194	0.0192	0.0288
SrO	0.1061	0.0534	0.0756	0.0728	0.0807	0.1146
Y_2O_3	0.0982	0.0012	ND	0.0019	ND	0.0081
ZrO_2	0.1721	0.0197	0.0387	0.0440	0.0201	0.0233
Nb_2O_5	ND	ND	ND	ND	ND	ND
Ag_2O	ND	ND	ND	ND	ND	ND
BaO	ND	ND	ND	ND	ND	ND
Cr_2O_3	0.0667	ND	ND	ND	ND	ND
Magnetic Susceptibility (m^3/kg)	8.8E-7 ± 1.1E-8	2.0E-6 ± 9.3E-8	2.3E-6 ± 5.3E-8	1.5E-6 ± 2.8E-9	1.5E-6 ± 1.8E-8	2.6E-6 ± 4.2E-8

Table 5-6
Analytical Results for Soil Mineralogy and Magnetic Susceptibility

* Indicates sample was disturbed during collection.
% = percent
ND = not detected
m^3/kg = cubic meters per kilogram

Table 5-7
Summary of Soil Analytical Moisture Content

Moisture Content[a] (USCS[b])											
Depth (ft bgs)	KAFB-106S1	KAFB-106S2	KAFB-106S3	KAFB-106S4	KAFB-106S5	KAFB-106S7	KAFB-106S8	KAFB-106S9	KAFB-106247	KAFB-106V1	KAFB-106V2
20	8.2 (ML)		8.4 (ML)								
40				14.8 (SM)							
50		11.6 (ML)									
61										5.3 (ML)	
80											9.2 (ML)
102								5.9 (SP)			
103											2.9 (SP)
105		2.4 (SP)*									
110				10.2 (ML)							
115										14.3 (CL)	
117											11.8 (ML)
120									11.9 (ML)		
122										31.1 (FS)[c]	28.8 (FS)[c]
131										3.5 (SP)	
140	11.5 (CL)										
144											20.3[d]
147										3.9 (SW)	
158										14.3 (FS)[c]	
159											8.4 (SW)
160			4.0 (SW)								
161										24.1 (CL)	
162										12.9 (FS)[c]	
164									4.3 (SW)	8.5 (FS)[c]	
174								33.8 (CL)			
194											14.9 (MS)[c]
199									16.4[d]		
208									3.4 (SP)		
210					4.0 (SW)						
215											3.1 (SP)
216										3.4 (SW)	
240			16.1 (SM)								
252								29.5 (CL/ML)			
254										22.2 (SP)	4.4 (SP)
260	12.7 (ML)										
270											19.9 (CL)
271										19.6 (CL)	
278		3.9 (SW)*									
279	19.0 (CL)										
285										3.3 (SP/SM)	
287											6.5 (SP/SM)
300				2.6 (SW)							
338		4.6 (SW)									
342								14.0 (SW)			
360			1.3 (SP/SM)		3.6 (SW)						
366				3.5 (SW)*							
400	3.6 (SW)										
404		2.6 (SW)*									
414	8.6 (SP)										
415								3.8 (SW)			
416				1.9 (SW)							
417					2.6 (SP)						
419		4.6 (SW)					2.6 (SW)				
420						3.6 (SP/SM)					
424			2.4 (SP)								
435								4.4[d]			
459	18.1 (CL)		3.2 (SW)					24.5[d]			
461	8.0 (SM)										
464								3.8[d]			
467				5.4 (SW)	3.8 (SP)						
468.13					DTW						
469.69	DTW										
470								3.3 (SW)			
470.67								DTW			
471.13				DTW							
473								19.3 (G)			
473.62						DTW					
474		12.7 (SP)									
475	9.4 (SW)						9.5 (SP)	16.5 (SP)			
475.98							DTW				
476.04			DTW								
476.19									DTW		
476.91		DTW									
477			14.9 (SW)								
478	9.8 (G)[c]										
480	9.1[c]								13.2 (SP)		
484								15.1 (MS)[c]			
485						9.1 (GW)					
486				11.4 (FS)[c]							
488					8.2 (CS)[c]						
489	9.9 (SM)	16.9[c] (FS)	8.7 (SW)						12.7 (SP)		

Table 5-7
Summary of Soil Analytical Moisture Content

Moisture Content[a] (USCS[b])											
Depth (ft bgs)	KAFB-106S1	KAFB-106S2	KAFB-106S3	KAFB-106S4	KAFB-106S5	KAFB-106S7	KAFB-106S8	KAFB-106S9	KAFB-106247	KAFB-106V1	KAFB-106V2
490					13.1[d]			9.9 (SP)	9.3[d]		
491					18.3 (SW)			18.3 (FS)[c]*			
492			10.7/9.5 (G)			6.9 (MS)[c]					
494			11.1 (G)	11.4 (SW)							
495						10.4 (SW)					
496						2.8 (SP)		9.9 (SW)*			
499		11.1 (SW)					12.8 (SW)		8.5 (GW)		
501								12.5 (SW)			
504				11.3 (SW)							
506					8.7 (SW)	9.4 (SW)					
510	10.9 (SP)	10.9 (SC)									
512			8.9 (SP)								
514							11.6 (SW)				

Note: Soil samples were collected using the sonic drilling method from various depths below ground surface under significant overburden pressures. As a result, the samples should be considered disturbed and may not be representative of the in-situ density of the sample. It is also likely that the moisture contents of saturated sand and gravel samples collected below the water table have been biased low due to gravity drainage within the sample bags.

[a] Moisture content is gravimetric moisture content (mass of water /mass of solids) expressed in percent.
[b] Classification taken from Lithologic Well Logs.

[c] Core interval was not logged in the field. Core bag was kept sealed before being sent directly to the laboratory for ultraviolet analysis. Mean grain size is shown.

[d] Core interval was not logged in the field. Core bag was kept sealed before being sent directly to the laboratory for analysis. USCS/Mean grain size not shown.

* Indicates sample was disturbed during collection.

Color Code:	
	TestAmerica, Inc. (analysis performed by ASTM International D2216-90)
	PTS Laboratories, Inc. (analysis performed by ASTM 2216-90)
	Daniel B. Stephens and Associates (analysis performed by ASTM International D2216-90)

CL = clayey sand
CS = coarse sand
DTW = Depth to water (feet below ground surface) measured to the nearest 0.01 foot.
G = gravel
LNAPL = light non-aqueous phase liquid
ML = silt
MS = medium sand
bgs = below ground surface
ft = foot/feet
FS = fine sand
SM = silty sand
SP = porely graded sand
SW = well graded sand
USCS = Unified Soil Classification System

Table 5-8
Summary of Soil Moisture Measurements

Sample ID	Borehole Range of Values	Percent Moisture (%)	Depth (ft bgs)
KAFB-106S1-279	Highest Recorded Percent Moisture	19.0	279
KAFB-106S1-400	Lowest Recorded Percent Moisture	3.6	400
KAFB-106S2-489	Highest Recorded Percent Moisture	13.9	489
KAFB-106S2-105	Lowest Recorded Percent Moisture	2.4*	105
KAFB-106S3-240	Highest Recorded Percent Moisture	16.1	240
KAFB-106S3-360	Lowest Recorded Percent Moisture	1.3	360
KAFB-106S4-40	Highest Recorded Percent Moisture	14.8	40
KAFB-106S4-416	Lowest Recorded Percent Moisture	1.9	416
KAFB-106S5-491	Highest Recorded Percent Moisture	18.3	491
KAFB-106S5-417	Lowest Recorded Percent Moisture	2.6	417
KAFB-106S7-495	Highest Recorded Percent Moisture	10.4	495
KAFB-106S7-496	Lowest Recorded Percent Moisture	2.8	496
KAFB-106S8-499	Highest Recorded Percent Moisture	12.8	499
KAFB-106S8-419	Lowest Recorded Percent Moisture	2.6	419
KAFB-106S9-174	Highest Recorded Percent Moisture	33.8	174
KAFB-106S9-470	Lowest Recorded Percent Moisture	3.3	470
KAFB-106247-199	Highest Recorded Percent Moisture	16.4	199
KAFB-106247-208	Lowest Recorded Percent Moisture	3.4	208
KAFB-106V1-122	Highest Recorded Percent Moisture	31.1	122
KAFB-106V1-285	Lowest Recorded Percent Moisture	3.3	285
KAFB-106V2-122	Highest Recorded Percent Moisture	28.8	122
KAFB-106V2-103	Lowest Recorded Percent Moisture	2.9	103

* Indicates sample was disturbed during collection.

% = percent

ID = Identification

bgs - below ground surface

ft = foot/feet

Table 5-9
Summary of Fractional Organic Carbon Results

Well Location ID	Sample Number	(ft bgs)	Fraction Organic Carbon Result (Percent Carbon)
KAFB-106247	FOC-247-300119-120	120	ND
	FOC-247-310119-164	164	ND
	FOC-247-040219-474	474	ND
	FOC-247-050219-480	480	ND
	FOC-247-050219-489	489	ND

Analysis performed by Walkley Black; Nelson, D and L. Sommers. 1996. Total Carbon, Organic Carbon, and Organic Matter. Chapter 34, pages 995-1001, Walkley Black Method, in D. Sparks (ed.), Methods of Soil Analysis. Part 3. American Society of Agronomy, Madison, WI

bgs = below ground surface

ft = foot/feet

ID = identification

Comment and Response Worksheet (Version 3)

Date	**Reviewer**	**Document Title (version)**		**Contract/TO Number**
17-Aug-20	**NMED HWB**	**Source Zone Characterization Report for the Bulk Fuels Facility Solid Waste Management Units ST-106/SS-111**		**EPA ID# NM9570024423**
Item	**NMED NOD Comment Number**	**Page**	**Comment**	**Response**
			Direction in letter from NMED: Requires the report to be submitted no later than December 31, 2020.	A request for extension of time to submit the revisions for this report was submitted to the NMED on December 4, 2020. Approval for the extension of time was provided in a letter from the NMED on December 16, 2020. The submittal of the report was extended to April 30, 2021.
1	1	1	**1. Quality Control of document submittals** **NMED Comment:** Quality control issues identified by NMED in documents previously submitted by the Permittee have also been identified in this Report. Examples include the lack of proper numbering of pages and tables, inconsistencies in the titles of related documents, and the lack of labeling of site features on figures. The Permittee must review its quality control procedures and address these issues to assist the public in better understanding the documents that are submitted by the Permittee. This general topic and several examples of the following general comments were discussed during the NMED/KAFB conference call on June 18, 2020.	The document has been revised to meet these requirements.
2	2a	1	**2. Document titles and reporting for remaining scopes of work which were included in the Work Plan.** **NMED Comment:** Several scopes were included in the approved Work Plan but not all were addressed in this Report: **a.** The NMED approved June 2017 *Work Plan for Vadose Zone Coring, Vapor Monitoring, and Water Supply Sampling, Bulk Fuels Facility, Solid Waste Management Unit ST-106/SS-111* (Work Plan) provides: i. the technical approach for the continuous coring for subsurface sample collection, installation of soil vapor monitoring wells for future pilot testing at two of the coring locations, dual-completion of soil vapor/groundwater monitoring wells in eight of the coring locations; ii. soil vapor network monitoring and maintenance; iii. sampling of the newly installed groundwater monitoring wells and water supply wells; and iv. details for the air-lift enhanced bioremediation pilot test The *Source Zone Characterization Report for the Bulk Fuels Facility Solid Waste Management Unit ST-106/SS- 111,* dated October 2019, (Report) presents the results of item i and elements of items ii and iii above: no information on item iv was provided. The Permittee is advised that, in order to avoid confusion, all future work plans must be written for one specific scope of work. No revision necessary.	Future work plans will be written for one specific scope of work. A written request to defer the air-lift enhanced bioremediation pilot test was submitted the NMED on July 23, 2018 based on discussions with NMED. A meeting was held on June 7, 2018 with NMED to discuss technical issues with the in-situ bioremediation pilot test and how these same issues would affect the air-lift enhanced bioremediation pilot test. These issues included a limited radius of influence and biofouling of the wells that would impede water flow and cause significant maintenance and redevelopment of the wells. A formal response to the request has not been received from the NMED. Further discussions will be provided in the In-Situ Bioremediation Report to be submitted to NMED in the future.
3	2b	1/2	**2. Document titles and reporting for remaining scopes of work which were included in the Work Plan.** **NMED Comment**: Several scopes were included in the approved Work Plan but not all were addressed in this Report: **b.** The title of the Report does not match the name of the relevant scope of work in the Work Plan. This letter pertains solely to the vadose zone coring and associated well installation activities as described in the Report. In order to maintain a clear administrative record, the names of all future documents and scopes of work must not change during the Resource Conservation and Recovery Act (RCRA) corrective action process (i.e., work plans through reports); however, the revised Report must retain its current title to avoid further confusion. No revision necessary. This issue was discussed during the NMED/KAFB conference call on June 18, 2020.	Future document names will be retained from work plans through reports.
4	2c	2	**2. Document titles and reporting for remaining scopes of work which were included in the Work Plan.** **NMED Comment:** Several scopes were included in the approved Work Plan but not all were addressed in this Report: **c.** Future submittals that report on the activities performed under the Work Plan, must reference the Work Plan in the cover letter and executive summary of the document. Additionally, all future document titles and cover pages must include all major scope activities incorporated within that document, including those presented in appendices. No revision necessary. This issue was discussed during the NMED/KAFB conference call on June 18, 2020.	Work plans will be referenced in cover letters and executive summaries for future documents.
5	2d	2	**2. Document titles and reporting for remaining scopes of work which were included in the Work Plan.** **NMED Comment:** Several scopes were included in the approved Work Plan but not all were addressed in this Report: **d.** Report revision required. The workplan for the source zone characterization contained multiple scopes of work for various aspects of the study. The Report must clarify where the information regarding the other scopes of work presented in the Work Plan can be found (e.g., data associated with groundwater well gauging and sampling, drinking water and irrigation supply well sampling, and soil vapor monitoring data). The Work Plan discusses data collection for various scopes of work: i. Section 3.1.5, pages 3-6, 2nd paragraph of the Work Plan states: "Semiannual monitoring of the SVM network was approved...and will include sampling of the entire 284 SVMP network...". ii. Section 6.2 Project Data Types and Records, page 6-1, 1st paragraph, line 1 of the Work Plan states: "Field data will be collected...in support of field activities associated with the BFF vadose zone treatability studies including coring, long term SVM, well drilling and installation, drinking water supply... [and]...irrigation well sampling." iii. Section 6.2.3 Chemical Analytical Data: page 6-2, 1st paragraph, line 1 of the Work Plan states: "Chemical analytical data will include sample results from soil, soil vapor, and groundwater samples generated by the lab subcontractors." The revised report must include a section describing the status of the remaining scopes of work included in the approved Work Plan. Include the date the work was performed and the specific document(s) where the information was reported.	Created Table A-1 in Appendix A to cross walk the items in the Work Plan to status of items. Added the following text to the introduction (new text in italics), "The coring program discussed in this report was *performed* in accordance with the Work Plan for Vadose Zone Coring, Vapor Monitoring, and Water Supply Sampling, Revision 2 (Kirtland AFB, 2017a), referred to throughout this report as the Work Plan. The Work Plan was approved with conditions by NMED on February 23, 2018 (NMED, 2018a). *This Work Plan included several scopes of work in addition to vadose zone coring and sampling. These scopes of work included soil vapor monitoring, an air-lift well pilot study, maintenance of the soil vapor monitoring well network, and water supply sampling. Table A-1 in Appendix A provides the status for these various scopes of work. This report discusses the work performed to support the vadose zone coring, sampling, and monitor well installation."*

Comment and Response Worksheet (Version 3)				
Date	**Reviewer**	**Document Title (version)**		**Contract/TO Number**
17-Aug-20	**NMED HWB**	**Source Zone Characterization Report for the Bulk Fuels Facility Solid Waste Management Units ST-106/SS-111**		**EPA ID# NM9570024423**
Item	**NMED NOD Comment Number**	**Page**	**Comment**	**Response**
6	3	2/3	**3. Historic high and low water levels at the site** **NMED Comment:** Report revision required. The historic groundwater levels and present groundwater levels referenced by the Permittee in the Report are not consistently or clearly described in the text. For example: **a.** The Work Plan states in Section 3.1.1, page 3-3, 1st paragraph, line 2: "The bottom of the designated coring interval extends approximately 10-20 feet (ft) below the lowest historic water level (2009) to ensure that the deepest vertical LNAPL migration is evaluated. **b.** In the Report, Section 5.3, page 5-10, 3rd paragraph, 1st line states: "The highest LNAPL saturation percentage of the collected cores came from KAFB-106S9 at a depth of 484 feet below ground surface (ft bgs). This is very close to the former lowest groundwater elevation from 2009 (approximately 500 ft bgs)." **c.** Section 7, page 7-2, 2nd paragraph, 3rd bullet, 2nd line: "...at a depth that coincides with the former lowest groundwater elevation from 2009 (approximately 500 ft bgs)." **d.** The approved Work Plan states: "Coring intervals will begin at least ten (10) feet above the 1970s high water mark, which is equivalent to the 1960s high water mark." Please revise the Report to provide a discussion of groundwater elevation changes over time at the site that includes the dates (month/year) of both the historical high and historical low water levels. Present the historic water levels in both depth below ground surface (ft bgs) and elevation relative to mean sea level (ft amsl) to the nearest 0.01 foot.	Added the following text to Section 3 (new text in italics), "*The approximate groundwater elevation in the project area was 4,950 ft above mean sea (amsl) level in 1950, 4,940 ft amsl in 1960, and 4,930 ft amsl in 1970. The groundwater table* elevation began dropping due to the development of the City of Albuquerque well fields and reached its lowest point *of approximately 4,852 ft amsl* at the end of 2009. *Using KAFB-106S9 as an example, the depth to water was approximately 396 ft bgs in 1950, 406 ft bgs in 1960, 416 ft bgs in 1970, and 494 ft bgs in 2009.*" The text in Section 5.3, 3rd paragraph, 1st line was revised to the following, "The highest LNAPL saturation percentage (pore volume and total volume) of the cores below the water table came from KAFB-106S9 at a depth of 484 ft bgs. This depth is very close to the former lowest groundwater elevation from 2009 (approximately *494* ft bgs, see Table 4-1)." The following text was changed in Section 7 (new text in italics), "UV fluorescence of core samples from KAFB-106S9 identified LNAPL in the saturated zone at a depth that coincides with the former lowest groundwater elevation from 2009 (approximately *494* ft bgs)." Note that the historical data available (Rice, et. al., 2014) does not provide data with an accuracy of 0.01 foot.
7	4a	3	**4. Laboratory data, laboratory qualifiers, and data presentation** **NMED Comment:** Report revision required. Quality Assurance (QA) and Quality Control (QC) of laboratory data **a.** The 2010 KAFB Hazardous Waste Facility Permit (Permit), Section 6.5.18, Laboratory Analyses Requirements for all Environmental Media, states, "All analytical data (including non-detects, estimated values, and detects) shall be included in the electronic copy of the Investigation Report or other report in Microsoft™ Excel format with any qualifiers as attached from the analytical laboratory." The majority of the laboratory results for soil sampling at the facility presented in Table 5-1 were analyzed by Test America Laboratory. The associated laboratory reports are included as Appendix G-1, however, there are over 50 PDF laboratory reports, each consisting of 600 to 1,200+ individual pages. This format is inconsistent with the Permit requirements which makes it difficult to find specific data and information (e.g., a specific soil sample from a specific boring, at a specific depth, or specific data quality issues for samples associated with a particular laboratory report). The Permittee must revise the Report to provide a Microsoft™ Excel spreadsheet that includes the laboratory data in a searchable format. This spreadsheet must include a specific field which indicates the laboratory report file name for each sample.	A searchable, sortable flat file has been provided in Appendix J in Microsoft™ Excel format. The flat file contains a column for boring number, sample depth, lab report file name, and laboratory qualifiers are included.
8	4b	4	**4. Laboratory data, laboratory qualifiers, and data presentation** **NMED Comment:** Report revision required. Quality Assurance (QA) and Quality Control (QC) of laboratory data **b.** Permit, Section 6.5.18.2, Laboratory Deliverables, states, "[l]aboratory analytical data packages shall be prepared in accordance with United States Environmental Protection Agency (EPA)-established Level III or IV analytical support protocols" and "[t]he Permittee shall present summary tables of these data and Level II QC results to the Department in reports or other documents...Raw analytical data, including calibration curves, instrument calibration data, data calculation work sheets, and other laboratory supporting data for samples from this project, shall be compiled and kept on file at the Facility for reference." The Permittee must revise Appendix G-1, Laboratory Data Packages - Soil Samples, Test America, Inc., to present level II laboratory report data packages instead of Level IV laboratory report data packages.	In the original report, the level IV lab reports included all of the requirements of Part 6.5.18.2. However, the Level IV reports contained additional information that in accordance with Part 6.5.18.2 can be maintained by the Permittee and not necessary to be included with reporting. Level II lab reports are included with this report and include all of the requirements of Part 6.5.18.2. In addition, the level IV report are maintained on file by USAF and ae available for review at NMED request.

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9	4c	4	**4. Laboratory data, laboratory qualifiers, and data presentation** **NMED Comment:** Report revision required. Quality Assurance (QA) and Quality Control (QC) of laboratory data **c.** The December 2017 *Quality Assurance Project Plan for Bulk Fuels Facility Vadose Zone Treatability Studies Solid Waste Management Unit ST-106/SS-111, Revision 1,* (QAPP) was included as an appendix to the Work Plan. Section 4.2 of the QAPP states that data will be validated and flagged with the following data qualifiers: J+, J-, U, UJ, and R. Laboratory case narratives outline numerous concerns resulting in a variety of laboratory data qualifiers which are not included on Table 5-1 or mentioned in text of the Report. For example, the case narrative for associated soil sample V-V2-131218-117 identified three laboratory qualifiers (i.e., J, D, and Q) for the ethylene dibromide (EDB) results for that sample, however, Table 5-1 of the Report shows only a J qualifier. In another example, the case narrative of the laboratory report for total petroleum hydrocarbon (TPH) gasoline range organics (GRO) results for P-V2-121218-080 and P-V2-121218-103 indicates that these samples have been reported with "Q" laboratory data qualifiers which indicate that "One or more quality control criteria failed", however, Table 5-1 of the Report shows only a J qualifier. Please revise the Report to include all laboratory- assigned data qualifiers, including dilution, with footnotes that adequately define the qualifier codes. Data qualifiers must be presented in Table 5-1, and elsewhere in the report as appropriate.	The data qualifiers presented on Table 5-1 of the report are the final data qualifiers applied to the analytical data once the data has undergone the formal third-party validation process documented in Appendix H-DQER. During the formal data validation process, the laboratory assigned qualifiers that are reported in the lab data package (D, Q, etc.) are reviewed through the data quality indicator criteria and revised to the appropriate EPA/DoD qualifiers identified in the project QAPP (J, UJ, U, R). The qualifiers reported by the laboratory will always be maintained in the final data package. The validation qualifiers will be added to the project database and supersedes the lab qualifiers when reporting project data in tables etc. Both the lab assigned qualifiers and the validation qualifiers are maintained in the project database.
10	4d	4/5	**4. Laboratory data, laboratory qualifiers, and data presentation** **NMED Comment:** Report revision required. Quality Assurance (QA) and Quality Control (QC) of laboratory data **d.** Section 6.5.18.3.1 of the Permit, Laboratory Analyses Requirements for all Environmental Media, states that "[a] full review and discussion of QC data and all data qualifiers shall be submitted with Investigation Reports...” Section 4.2 of the QAPP, Analytical Data Verification and Validation, states "data review findings will be summarized and documented in task-specific data reports, completion reports, or with each quarterly monitoring report." The Permittee must include a new section in the revised Report that discusses all data quality concerns and how these concerns may affect the data quality.	Data usability issues determined by the third-party validator are discussed in Section 5.2.2 that includes a discussion of data quality exceedances that resulted in data qualification during validation and a reference to Appendix H for details. A full review and discussion of the formal third-party data validation process and final applied data qualifiers, including potential impact to data quality and usability of analytical results is provided in the report, Appendix H – Data Quality Evaluation Report.
11	4e	5	**4. Laboratory data, laboratory qualifiers, and data presentation** **NMED Comment:** Report revision required. Quality Assurance (QA) and Quality Control (QC) of laboratory data **e.** Table 5-1 indicates that several results are J-coded as a result of the laboratory having to dilute numerous samples prior to analysis due to high contaminant concentrations (e.g.: V-V2-131218-159). The Permittee is reminded that per 6.5.18 of the Permit "[t]he Department will not accept J-coded (estimated) results for samples requiring dilution prior to laboratory analysis." Please revise the report to indicate that samples diluted prior to analysis will not be used as decision level data but may be used qualitatively.	The “J” qualifier for sample results on Table 5-1 does not indicate samples were diluted prior to analysis. The “J” qualifier is not applied to data for that purpose. The “J” qualifier is used to indicate either 1) the result is below the limit of quantitation or reporting limit and therefore considered an estimated value, or 2) the value is estimated based on data validation criteria such as lab control sample recovery, matrix spike recovery, calibration verification exceedance, minor hold time exceedance, field duplicate sample relative percent difference, etc. as documented in Appendix H-DQER. Project samples are not diluted prior to analysis and only diluted during analysis to bring elevated concentrations of target analytes into the calibration range or if matrix interferences are present. Sample dilution is performed per the EPA SW846 analytical methods. The sample specific dilution factor is included in the Appendix J flat file, column Q (dilution factor). Through review of the Appendix J flat file one can see that the sample analyses where the dilution factor is greater than 1X are associated with high levels of BTEX, EDB or TPH in sample results.
12	4f	5	**4. Laboratory data, laboratory qualifiers, and data presentation** **NMED Comment:** Report revision required. Quality Assurance (QA) and Quality Control (QC) of laboratory data **f.** Laboratory reports indicate that some samples were analyzed outside of the holding time. As a result, the laboratory reports document data validation concerns for these samples. This important information is not included in the Report. The Permittee must revise Table 5-1 to note which samples exceeded holding times and include the applicable laboratory qualifiers on the revised table. Additionally, the Permittee must include an explanation of the issue causing the analysis outside of the holding time and the effect it may have on the data quality, an explanation of any steps taken to resolve the matter, and the results of those efforts in the revised Report. See comment 4c above [Item 9] regarding laboratory qualifiers.	There were exceedances of holding time by the laboratory for some samples and results presented on Table 5-1. A thorough discussion of the holding time exceedances and the resulting data qualifiers are included in Appendix H – DQER. As a result of the formal validation process as discussed in Item #9, the results associated with the hold time exceedances have been qualified per EPA and DoD guidelines including “J” for detects and “UJ” for non-detects. If there are data usability issues determined by the third-party validator, those concerns would be discussed in Section 5.2.2 and a reference included to Appendix H for details.
13	4g	5	**4. Laboratory data, laboratory qualifiers, and data presentation** **NMED Comment:** Report revision required. Quality Assurance (QA) and Quality Control (QC) of laboratory data **g.** Table 5-1 only presents analytical results under the column heading for the limit of detection (LOD). The LOD is the lowest analyte concentration at which an analyte can be detected, however, precision and accuracy are not achieved. The limit of quantitation (LOQ) is the lowest concentration at which an analyte can be reliably detected with precision and accuracy. Section 4.3.2, Project-Required Reporting Limits - Sensitivity, in the QAPP of the approved Work Plan indicates that LOQs will be calculated. Laboratory reports show that data is presented with the detection limit (DL), LOD, and LOQ for all analyses performed. Table 5-1 only includes the LOD and is therefore not acceptable as presented for the purposes of data reporting. The Permittee must revise the Report to add columns to Table 5-1 to report the DL, LOD, and LOQ for each analysis presented.	The lowest analyte concentration detected per the DoD QSM methods is the DL. There are 3 DoD reporting limits (DL, LOD, LOQ). The LOD is the lowest for reporting of a non-detect analyte with a 99% confidence. Results reported below the LOQ and above the DL are flagged “J” for estimated data. Non-detects are reported at the LOD which is why that column and value are included on the table 5-1. A flat file of the data was provided in Appendix J that includes the 3 DOD reporting limits for each analyte reported.

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14	5	5/6	**5. Notice Page** **Permittee Statement:** "Physical and chemical characterization was performed on residual LNAPL samples." **NMED Comment:** Report revision required. The results of chemical characterization of residual LNAPL from samples collected in 2011 for the Phase I RCRA Facility Investigation Report, Bulk Fuels Facility Release, Solid Waste Management Unit ST-106/SS-111 are presented in the Report rather than from samples collected as part of the field work implemented under the Work Plan. Please revise the statement for accuracy and revise Table 5- 5 to include chemical characterization data performed on residual LNAPL samples collected as part of the field activities covered in this Report or provide an explanation in the revised Report justifying why these data were not collected. The purpose of collecting samples in 2018 was to allow for evaluation of the changing chemical composition of LNAPL in groundwater over time and to calculate new values for the effective solubility of benzene and EDB for estimating the current extent of LNAPL in groundwater. This is important information to obtain due to rising water levels.	The approved scope of work did not include an evaluation of changing chemical composition of LNAPL in groundwater over time nor an analysis of the effective solubility of the LNAPL. LNAPL was not present in sufficient quantities for the analytical laboratory to perform chemical composition analysis. The following was added to Section 4.3, Deviations from Work Plan, “LNAPL was not present in sufficient quantities to be able to perform hydrocarbon component analysis.” The statement on the notice page was revised to state, “Physical characterization was performed on residual LNAPL samples.” The Air Force agrees that it is important to understand the nature and extent of LNAPL to the extent necessary to support the Corrective Measures Evaluation. Please note additional source area wells were installed in accordance with the NMED approved Work Plan (Work Plan for Data Gap Monitoring Well Installation KAFB-106248 to KAFB-106252, Bulk Fuels Facility, SWMUs ST-106/SS-111, (Kirtland AFB, 2020a) that included the installation of KAFB-106V3, KAFB-106S10, and KAFB-106248 to KAFB-106252.
15	6	6	**6. Executive Summary, page ES-1** **Permittee Statement:** "The results of this investigation indicate that the presence of fuel has been significantly reduced in the vadose zone by remedial actions and natural processes." **NMED Comment:** Report revision required. The Report does not include historical data from source area characterization to compare to the 2018 and 2019 soil, soil vapor, light non-aqueous phase liquid (LNAPL), and groundwater data presented in this Report that would support this statement. The Permittee must include historical data and provide a discussion to support this statement or remove it from the narrative.	Narrative was deleted.
16	7	6	**7. Executive Summary, page ES-1** **Permittee Statement:** "LNAPL saturation in vadose zone samples was highest in the source area and none of the samples were found to contain mobile LNAPL. This demonstrates that there is no drainage of LNAPL that could cause continued LNAPL head in the source area that would be required to drive migration." **NMED Comment:** Report revision required. Analysis of multiple geophysical and lithologic logs at the site indicate it is likely that a discontinuous clay layer in the source area may have altered the pathway for the migration of fuels related contamination to groundwater. This potential migration pathway is likely to contain hydrocarbon saturated soils that, while not mobile under current conditions, would likely serve as a significant source of dissolved phase petroleum hydrocarbon contamination as groundwater levels continue to rise and come into contact with them. The lithologic cross sections and the discussion of the site hydrogeology presented in the Report do not address this issue. Revise the Report to address this possibility by identifying the top and bottom surfaces of both the upper and lower clay units beneath the site using cross sections and isopach maps.	The Air Force agrees that there is residual source fuel in the saturated zone as well as in the vadose zone above the capillary fringe. Each monitoring well is gauged on a quarterly basis and minor amounts of LNAPL are observed in only a few wells that are located within the boundary of benzene effective solubilities (see Figure 5-7). In addition, LNAPL mobility analysis performed on samples collected above and below the clay in the vadose all indicated that the residual LNAPL is no longer mobile. Creating cross sections and a site-wide clay isopach map was beyond the scope of this investigation and not included in the approved work plan. Additional information regarding the clay pathway will also be included in the forthcoming Data Gap Report. The Air Force agrees that it is important to understand the historic LNAPL migration pathway to the extent necessary to support the Corrective Measures Evaluation. The Air Force will summarize the data concerning the historic LNAPL migration pathway in an updated Conceptual Site Model in the RFI Phase II once the investigation phase of the RCRA process has been completed.
17	8	7	**8. Section 2 Facility History and Project Background, page 2-1** **NMED Comment:** Report revision required. The Permittee must revise the Report to include a comprehensive general overview of the site history per reporting requirements outlined in Permit Section 6.2.4.3, Investigation Reports, item number 5, Background information.	Project background was revised. See Section 2, Facility History and Project Background for the revised text.
18	9	7	**9. Section 3 Scope of Activities Page 3-2 NMED Comment:** Report revision required. Laboratory reports included in Appendix G-4 (DBSA Soil Testing Laboratory) include results for Fraction Organic Carbon (FOC). Revise the report to add an additional bullet to the list on this page that states that FOC testing was conducted and provide the purpose of the tests. Include a table that summarizes the analytical results for FOC, as this is valuable information for use in in valuating risk.	Added to bullets in Section 3, “*Fractional organic carbon (FOC) (Walkley Black Method). These data were collected to assess the potential of bioavailability of organic contaminants.”* In addition, added the following text (bullet to Section 3) to discuss thermal conductivity, “*Thermal properties including specific heat, thermal resistivity, thermal conductivity, and thermal diffusivity*.” Added Section 5.2.7, “*FOC analysis was performed for five select soil samples collected from KAFB-106247. The analysis was performed using the Walkley Black Method. All five samples were found to be non-detect for FOC. All five samples were found to be non-detect for FOC (Table 5-9 and Appendix G-4).”* Added Section 5.2.8, “*Thermal properties analyses including specific heat, thermal resistivity, thermal conductivity, and thermal diffusivity were performed on select samples by ASTM International D5334-14 (ASTM International, 2014). The results of these analyses can be found in Appendix G-4*.”

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19	10	7	**10. Section 4.2.1 Groundwater Monitoring Wells, page 4-4** **NMED Comment:** Report revision required. The Permittee does not discuss well development, gauging, or sampling performed on new groundwater monitoring wells after well installation was complete. This information is essential for a comprehensive characterization of the source area. Revise the Report to include this information in accordance with Permit Sections 6.2.4.3 (Investigation Reports) and 6.5.17.10.8 Well and Piezometer Completion Reports, see Comment 58, below.	Well development and gauging information was provided in the well completion reports that were included as an appendix within the appropriate Quarterly Groundwater Monitoring Report. A Well Completion report is included as Appendix I of this revised report. Sampling information was also provided in the appropriate Quarterly Groundwater Monitoring Report. The analytical results for the first sampling event for each well are included in Table 4-4 of the included Well Completion Report (Appendix I). In addition, Section 4.2.2 Groundwater Monitoring Well Gauging and development was added to the text.
20	11	7	**11. Section 5.1 Subsurface Lithology, page 5-1** **Permittee Statement:** "Soil descriptions from the lithologic logs created during coring activities were used to create detailed geologic models of the subsurface." **NMED Comment:** Report revision required. It appears that an incomplete data set was used to generate the model. Cross sections, fence diagrams, and models must be generated using lithologic, soil vapor, and water level data from all the available boreholes and monitoring locations. Failing to do so creates an incomplete picture of subsurface site conditions and may lead to erroneous conclusions regarding the nature and extent of the contaminants. Please revise the figures to incorporate both the data collected during the vadose zone coring project and previously collected data.	See response to Item #16.
21	12	7/8	**12. Section 5.1 Subsurface Lithology, page 5-1** **Permittee Statements:** "Data supplied to this module are based on Unified Soil Classification System (USCS) classifications logged during drilling that were simplified into nine categories reflecting observed grain-size distribution and inferred permeability." and "The data used to construct the model are provided in Appendix J." **NMED Comment:** Report revision required. The table provided in Appendix J, EVS Model Data does not appear to include most of the model inputs described in the Report. The column headers are not aligned with the data columns and the only units provided (feet and ppb) are both included in a single column. Revise the Report to define all of the parameters in the table and provide appropriate units for each column. NMED notes that Table 5-2, Soil Grain Size Distribution and Classification, contains only eight rather than nine grain-size distribution categories. Please resolve this discrepancy. Additionally, please revise Appendix J to include the complete data set, data sources, and data quality assurance evaluation used to create the model presented in the Report. This information must include calibrated targets and estimated parameters, parameter distributions and sources of variability, and how each parameter is used in the model. Also include information on model boundary/source conditions, vadose zone and aquifer material properties, and contaminant transport properties. Identify all model assumptions and uncertainties and present the results of the uncertainty and sensitivity analyses in the revised report.	The model was provided as a visualization to supplement understanding of the data collected and was not required by the approved work plan. As the model is not necessary to support the data interpretation in this report the model and all associated tables and figures were deleted from the report.
22	13a	8	**13. Section 5.1 Subsurface Lithology, page 5-1** **Permittee Statement:** "The subsurface in the area of the Source Zone Characterization project is shown on a west-to-east transect (A-A') and a north-to-south transect (B-B') (Figures 5-1 and 5-2)." **NMED Comments:** Report revision required. **a.** The Permittee must revise the Report to include a brief discussion of the regional geology and how it is expressed locally at the site.	A discussion of regional geology was added as Section 2.1.
23	13b	8	**13. Section 5.1 Subsurface Lithology, page 5-1** **Permittee Statement:** "The subsurface in the area of the Source Zone Characterization project is shown on a west-to-east transect (A-A') and a north-to-south transect (B-B') (Figures 5-1 and 5-2)." **NMED Comments:** Report revision required. **b.** Figures 5-1 and 5-2 contain errors. Please revise the report to correct the following errors: i. The X-axis on Figure 5-2 should read "1,474,500" rather than "1,475,500" ii. The inset aerial photograph in the Key incorrectly shows the scale of the axes as 2:1 while the scale of the photograph is shown as 1:1	Cross sections were removed from the revised report. Updated cross sections that will include the data from this investigation as well as the recently installed data gap wells (Including wells KAFB-106S10 and KAFB-106V3) will be presented in the upcoming Data Gap report submittal.

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24	13c	8	**13. Section 5.1 Subsurface Lithology, page 5-1** **Permittee Statement:** "The subsurface in the area of the Source Zone Characterization project is shown on a west-to-east transect (A-A') and a north-to-south transect (B-B') (Figures 5-1 and 5-2)." **NMED Comments:** Report revision required. **c.** The Permittee must include copies of the field lithologic logs and well completion diagrams as an appendix to the Report.	Cross sections were removed from the revised report. Updated cross sections that will include the data from this investigation as well as the recently installed data gap wells (Including wells KAFB-106S10 and KAFB-106V3) will be presented in the upcoming Data Gap report submittal.
25	14	9	**14. Section 5.1.1 Field Screening, page 5-2** **Permittee Statement:** "The heated headspace values observed below the water table were indicative of the relative presence of hydrocarbons and were used to guide sample collection. In general, elevation heated headspace values (greater than 100 milligrams per kilogram) were observed predominately in the saturated zone (Table 4-1)." **NMED Comment:** Report revision required. The Permittee's summary of heated headspace field screening lacks the necessary level of detail given its use in guiding sample collection for laboratory analyses. Please revise the discussion to provide a more complete summary of the heated headspace field screening results, including the increasing and decreasing trend in heated headspace readings followed by another increase at depth in heated headspace readings, which correspond to historical water levels at the Site. Additionally, PIDs typically give a response in units of parts per million by volume (ppmv). In heated headspace screening, the concentration in the headspace, measured in ppmv, does not equal the soil or water concentration, measured in mg/kg or mg/L. Correct the units in the revised report.	Current and historic high and low water levels are presented on Table 4-1 in accordance with Section 3.1.1.2 of the approved work plan, Rationale for Sample Depth Intervals. Text was revised to remove milligrams per kilogram and changed to *parts per million by volume.* The following text was added to Section 5.1.1, "Historical water levels (Rice et al., 2014) were added to Table 4-1 to correlate the water table depths to the heated headspace concentrations. In each of the borings for wells KAFB-106S1 through KAFB-106S5 and KAFB-106S7 through KAFB-106S9, the data indicates that the deepest historical water table (observed in 2009) correlates closely (within 13 feet or less) with the depths that the highest heated headspace concentration was recorded for each boring (Table 4-1). In these same monitoring wells, heated headspace concentrations increase with depth towards the historically deepest water level (observed in 2009) to concentrations greater than 1,000 ppmv, then decrease below this depth (Table 4-1)."
26	15	9	**15. Section 5.2.1 Analytical Results for Organic Compounds, Vadose Zone, page 5-2:** **Permittee Statement:** "Concentrations of TPH, BTEX, and EDB are below the laboratory reporting limit in the vadose zone in all other boreholes (Figures 5-3 through 5-5, Table 5-1)." **NMED Comment:** Report revision required. Soil coring was to be completed within set temperature parameters (≤ 20˚ Celsius) regardless of whether collection of a soil sample was planned for any given interval. On November 2, 2018 the Permittee requested via electronic mail a variance from meeting the temperature requirement for sample collected above 450 ft bgs for borings KAFB-106S2, KAFB-106S3, KAFB-106S6, KAFB-106S7, KAFB-106S8, and for samples above 400 ft bgs for boring KAFB-106S1. NMED approved the request on November 5, 2018 without comment. The Permittee's presentation of the analytical results for organic compounds in Section 5.2.1 fails to address their inability to meet the Work Plan requirement for completing sonic coring within set temperature parameters (≤ 20˚ Celsius). The Report must be revised to include a description of the process for measuring the core temperature and a discussion on the uncertainties associated with the temperature measurements. The Permittee must discuss the impact of elevated core temperatures on PID readings, sample integrity, and representativeness of the laboratory analytical results. The Permittee must include temperature data in appropriate tables. For example, Table 4-1 and Table 5-1 must have a column that displays the core temperature for each PID result or analytical sample. Lab analytical samples must be flagged for any sample that was collected above ≤ 20˚ Celsius. This issue was discussed during the NMED/KAFB conference call on June 18, 2020.	The request for the variance on coring temperatures during drilling was based on the lack of significant hydrocarbon concentrations being observed within the specified depths of the vadose zone. The request included continued heated headspace monitoring of these depths. If concentrations above 100 ppm were detected, temperature control would be implemented. However, heated headspace concentrations in these zones did not exceed 100 ppm for any of the samples collected within these depths. Due to this, increasing drilling speeds did not present an impact to the quality of the data being collected and is why the NMED approved the request. A discussion of the precautions taken to minimize volatilization was included in Sections 4.1.2 and 4.1.3. The text was revised in section 4.1.2 as follows (new text in italics), "Soil cores were stored within a refrigerated truck after the coring and logging process was completed. The temperature in the refrigerated truck was maintained at approximately 4 degrees Celsius. Core temperature measurements were never collected in the refrigerated truck. *Samples were unopened and allowed to cool prior to soil sample collection. Lithologic logging and sample photography occurred after sample collection to minimize volatile constituent losses. Based on this process, it is unlikely that significant volatile constituent losses occurred.* To maintain sample custody, the refrigerated truck was kept locked when no one was present. Cores that were selected for LNAPL properties analyses were placed in a freezer and shipped frozen via overnight delivery. All cores from the entire borehole were kept in refrigerated storage until soil sample intervals were selected for analyses. Once intervals were selected based on Work Plan selection criteria, the core was retrieved from a shelving system installed within the refrigerated truck and the soil sample was collected." Core temperatures were added to tables 4-1 and 5-1.
27	16	10	**16. 5.2.1 Analytical Results for Organic Compounds, page 5-2** **Permittee Statement:** "for the purposes of this report, only results for the primary contaminants of concern BTEX, EDB, and TPH are discussed." **NMED Comment:** Report revision required. Clarify why analyses for 61 other constituents is not discussed in the Report. Revise the Report to include a discussion of the other constituents listed in Table 5-1 and provide an explanation for excluding certain analytes.	As stated in the approved work plan, "*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*." Addressing other constituents of potential concern was not part of the approved work plan and would detract from the focus of the investigation. Other Constituents of Potential Concern will be discussed in the RFI Phase II report.

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28	17	10	**17. 5.2.1 Vadose Zone Summary, page 5-2** **Permittee Statement:** "Concentrations of BTEX, TPH, and EDB were elevated in the samples collected from KAFB-106V1 and KAFB-106V2 (Figures 5-3 through 5-5, Table 5-1)." **NMED Comment:** Report revision required. The Permittee's subsequent discussion addresses only KAFB-106V1. The Vadose Zone Summary must also include a discussion of organic compound trends in well KAFB-106V2. A discussion of the physical and interstitial properties of the stratigraphic intervals that control the migration and occurrence of the organic compounds in the vadose zone must also be included in the revised report.	The following text was added to Section 5.2.1 (new text in italics), *The following summarizes the detected laboratory concentration ranges in the vadose zone by constituent (not including non-detected constituents):* • *Detected concentrations of TPH in the vadose zone ranged from a low of 1.3 J mg/kg (KAFB-106S9 at 252 ft bgs) to a high of 32,000 mg/kg (KAFB-106V1 at 254 ft bgs) (Figures 5-1 through 5-3, Table 5-1).* • *Detected benzene concentrations ranged from a low of 0.0061 mg/kg (KAFB-106S2 at 474 ft bgs) to a high of 110 mg/kg (KAFB-106V1 at 254 ft bgs).* • *Detected toluene concentrations ranged from a low of 0.00091 J mg/kg (KAFB-106S5 at 417 ft bgs) to a high of 3,100 mg/kg (KAFB-106V1 at 254 ft bgs).* • *Detected ethylbenzene concentrations ranged from a low of 0.045 J mg/kg (KAFB-106S8 at 475 ft bgs) to a high of 770 mg/kg (KAFB-106V1 at 254 ft bgs).* • *Detected xylenes concentrations ranged from a low of 0.0011 J mg/kg (KAFB-106S9 at 252 ft bgs) to a high of 3,690 mg/kg (KAFB-106V1 at 254 ft bgs).* • *Detected EDB concentrations ranged from a low of 0.0003 mg/kg (KAFB-106V1 at 161 ft bgs) to a high of 2.1 mg/kg (KAFB-106V1 at 254 ft bgs). (Figures 5-1 through 5-3, Table 5-1).* The *highest hydrocarbon concentrations* in the vadose zone were found in well KAFB-106V1 (Figures 5-1 through 5-3, Table 5-1). Both boreholes *KAFB-106V1 and KAFB-106V2* are located within the source area and the observed concentrations are indicative of the release location. *Elevated petroleum hydrocarbon concentrations were observed in a poorly graded sand at depths located above a clay layer located at 266 ft bgs (See KAFB-106V1 boring log located in Appendix D).* The highest *hydrocarbon* concentrations were observed from the soil sample collected from borehole KAFB-106V1 at a depth of 254 ft bgs (Figures 5-*1* through 5-*3*, Table 5-1). *Petroleum hydrocarbon* concentrations increase with depth in *KAFB-106V1* until reaching a depth of approximately 266 ft bgs (Table 5-1). *A clay layer is present at this depth (See KAFB-106V1 boring log located in Appendix D) whereby concentrations decrease significantly at depths of 271 and 285 ft bgs (Table 5-1).*
29	18	10	**18. 5.2.1 Vadose Zone Summary, page 5-2** **Permittee Statement:** "The clay unit at these wells [KAFB-106V1 and KAFB-106V2] is very stiff to hard and contained up to 40 percent (%) silt." **NMED Comment:** Report revision required. The source of the data for Permittee's statement must be included. The boring lithologic log for KAFB-106V2 indicates a maximum silt content of 40% in the clay layer. Analytical data in Table 5-2 Soil Grain Size Distribution and Classification does not provide particle size distribution data for the clay layer at any of the boring locations. None of the analytical data presented in the Report includes measurements of sample stiffness or hardness. If the source of the data in the Permittee's statement is from the field borehole and lithologic logs, the data must be reported in Section 5.1, Subsurface Lithology, rather than in Section 5.2, Laboratory Analytical Results. Please revise the Report for accuracy.	Moved the text to Section 5.1 (second paragraph) from Section 5.2 as requested. Text revised as follows, "Lower permeability units (silt and clay) were found interbedded with lesser amounts of higher permeability units (sand) to a depth of approximately 160 ft bgs. Below 160 ft bgs, fine to coarse gravelly sand dominated to a depth of approximately 250 ft bgs. A lens of low permeability silt and clay was present between 250 and 300 ft bgs. *This unit was classified in the field as very stiff to hard and contained up to 40 percent (%) silt. Approximate 1-ft thick silt lenses were observed within the clay unit at KAFB-106V1*. The thickness and continuity of this *unit* fluctuated at each borehole and ultimately pinched out completely to the north (i.e., absent at KAFB-106S5)."

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30	19	10/11	**19. 5.2.1 Vadose Zone Summary, page 5-2** **Permittee Statement:** "Concentrations of BTEX, TPH, and EDB decrease significantly below the clay to the total depth of KAFB-106V1 at 285 ft bgs. Concentrations of TPH, BTEX, and EDB are below the laboratory reporting limit within the vadose zone in all other boreholes. " **NMED Comment:** Report revision required. The Permittee's statement is not supported by the data reported in Table 5.1. The table indicates elevated total petroleum hydrocarbons-diesel range organics (TPH DRO) and TPH GRO concentrations starting at a depth of 459' bgs in well KAFB-106S1. Concentrations for both analytes increase with depth to over 3000 milligrams per kilogram (mg/kg) at a depth of 489' bgs. Depth to water (DTW) for KAFB-106S1 is recorded at 492' bgs in the boring log header and well construction diagram. Based on a DTW of 492' bgs, the elevated concentrations are within the vadose zone and both screened intervals of the well are above the water table. NMED notes that the reported DTW at KAFB-106S1 is substantially greater than at any other groundwater monitoring well. For instance, at nearby well KAFB-106S8, DTW is approximately 476' bgs. The anomalous DTW measurement at KAFB-106S1 must be corrected or explained. The Permittee must review the water level data and all related analytical data for all boreholes and revise the Report for accuracy.	KAFB-106S1 soil boring log and well construction schematic has been revised. Changed water level to 469.8' bgs. The statement, "Concentrations of BTEX, TPH, and EDB decrease significantly below the clay to the total depth of KAFB-106V1 at 285 ft bgs. Concentrations of TPH, BTEX, and EDB are below the laboratory reporting limit within the vadose zone in all other boreholes." Has been removed.
31	20	11	**20. 5.2.1 Saturated Zone Summary, page 5-3** **Permittee Statement:** "In wells located off-Base, toluene was the only constituent detected in KAFB-106S5 (farthest from source area) at concentrations of 0.00091 milligrams per kilogram (mg/kg) (417 ft bgs) and 0.00094 mg/kg (467 ft bgs)." **NMED Comment:** Report revision required. The Permittee must identify the off-base wells. Additionally, Table 5- 1 indicates that TPH DRO was detected at 5.6 mg/kg at a depth of 467 ft bgs at boring KAFB-106S5. Please revise the statement for accuracy.	The following text was added to Section 5.2.1 (revised text in italics), "In wells located off-*Base (KAFB-106S5 and KAFB-106S7)*, toluene was the only BTEX constituent detected in KAFB-106S5 (farthest from source area) at concentrations of 0.00091 milligrams per kilogram (mg/kg) (417 ft bgs) and 0.00094 mg/kg (467 ft bgs). *TPH was detected in this borehole at a concentration of 5.6 J mg/kg at a depth of 467 ft bgs*.
32	21	11	**21. 5.2.2 Light Non-Aqueous Phase Liquid Saturation, Mobility, and Effective Solubility, page 5-4 Permittee Statement:** "The highest LNAPL saturation from the vadose zone sample was observed in KAFB- 106V1 at a depth of 122 ft bgs…". **NMED Comment:** Report revision required. No percentage is provided to compare with the range of LNAPL saturation results stated in previous paragraphs. The Permittee must add the value for percent pore volume for KAFB-106V1 at 122 ft bgs to this sentence.	Changed text to (new) Section 5.2.3 (revised text in italics, **"**The highest LNAPL *pore volume* saturation*, 13.1%, and LNAPL total volume saturation, 6.92%,* from the vadose zone sample was observed in KAFB-106V1 at a depth of 122 ft bgs *(Table 5-4*)."
33	22	11	**22. 5.2.2 Light Non-Aqueous Phase Liquid Saturation, Mobility, and Effective Solubility, page 5-4** **Permittee Statement:** "The percentage of LNAPL saturation decreases away from the source area (KAFB-106V1 and KAFB-106V2). The highest LNAPL saturation in the saturated zone was found in KAFB-106S9 at a depth of 484 ft bgs (Table 5-4). The lowest LNAPL saturations KAFB 106S5 and KAFB-106S7, which are the farthest wells from the source area..." **NMED Comment:** Report revision required. The Permittee must add the percentages of LNAPL saturation to this sentence for comparison purposes and reference the table that presents this information.	Added the following to (new) Section 5.2.3 (revised text in italics), "The highest LNAPL *pore volume* saturation, *4.9%, and total LNAPL volume saturation, 2.01%...,"*
34	23a	12	**23. 5.2.2 Light Non-Aqueous Phase Liquid Saturation, Mobility, and Effective Solubility, page 5-4 Permittee Statement:** "Soil grain distribution and classification was analyzed on 16 soil samples (six vadose zone and 10 saturated zone), along with 14 interstitial analyses of soil samples (six vadose zone and eight saturated zone)." **NMED Comment:** Report revision required. NMED identified multiple problems with the data and discussion for Section 5.2.2 that make it difficult to evaluate the information presented by the Permittee. The tables and associated discussions must be revised for accuracy and the section rewritten. This issue was discussed during the NMED/KAFB conference call on June 18, 2020. **a.** Table 5-3, Lithology and Interstitial Properties of Selected Core Samples, indicates that interstitial properties (total porosity, air filled porosity, pore fluid water saturation, and pore fluid LNAPL saturation) were determined for 16 rather than 14 samples. Resolve the discrepancy	The number of samples was revised to 16 to be consistent with Table 5-3. Text was revised as follows (now found in Section 5.2.3), "Soil grain distribution and mean grain size were analyzed on 16 soil samples (six vadose zone and 10 saturated zone), along with *16* interstitial analyses of soil samples (six vadose zone and 10 saturated zone)."

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35	23b	12	**23. 5.2.2 Light Non-Aqueous Phase Liquid Saturation, Mobility, and Effective Solubility, page 5-4 Permittee Statement:** "Soil grain distribution and classification was analyzed on 16 soil samples (six vadose zone and 10 saturated zone), along with 14 interstitial analyses of soil samples (six vadose zone and eight saturated zone)." **NMED Comment:** Report revision required. NMED identified multiple problems with the data and discussion for Section 5.2.2 that make it difficult to evaluate the information presented by the Permittee. The tables and associated discussions must be revised for accuracy and the section rewritten. This issue was discussed during the NMED/KAFB conference call on June 18, 2020. **b.** The sample depth column for Table 5-2 reports a depth range for some samples and a single depth for other samples. Explain the difference in the reported sampling intervals and explain how a representative particle size distribution for a 2-foot-long core sample was determined for samples where only a single depth is given. Explain why sample sizes listed in Table 5-4 range from 1/10 foot to 2 feet.	PTS Laboratory updated reports 48218, 48222, 48236, and 49005 to show a range of sample intervals versus a single point. Tables 5-2, 5-3, and 5-4 have been revised.
36	23c	12	**23. 5.2.2 Light Non-Aqueous Phase Liquid Saturation, Mobility, and Effective Solubility, page 5-4 Permittee Statement:** "Soil grain distribution and classification was analyzed on 16 soil samples (six vadose zone and 10 saturated zone), along with 14 interstitial analyses of soil samples (six vadose zone and eight saturated zone)." **NMED Comment:** Report revision required. NMED identified multiple problems with the data and discussion for Section 5.2.2 that make it difficult to evaluate the information presented by the Permittee. The tables and associated discussions must be revised for accuracy and the section rewritten. This issue was discussed during the NMED/KAFB conference call on June 18, 2020. **c.** A description of the rationale for selecting discreet samples from core samples and at least two examples of the process must be provided in the discussion in Section 5.2.2. Compare the rationale for selecting a discreet sample from cores that fluoresced under ultraviolet (UV) light to cores that did not fluoresce.	Revised text in (new) Section 5.2.3 as follows (new text in italics), "*Soil cores were selected based on field screening of UV analysis in accordance with Figure 3-7 Decision Logic schematic for Sample Collection of the approved work plan (Kirtland AFB, 2017a) which provides a flow chart for sample analyses.* A total of 30 core samples were analyzed in the laboratory for the presence of LNAPL via UV fluorescence. Photographs of UV analyses are shown in Appendix G-2 and are summarized below. If UV analysis identified a potential for LNAPL presence, further analyses were conducted on select samples to provide a quantitative analysis of the LNAPL. *For example, the core from KAFB-106S9 (GUV-S9-171018-473) was collected from 473 to 475 ft bgs and showed fluorescence from 474.1 to 474.2 ft bgs. This portion of the core was selected for LNAPL hydraulic conductivity, LNAPL retention curves under drainage, LNAPL saturation, and mobility. The core collected from 484 to 486 ft bgs from KAFB-106S9 (GUV-S9-171018-484) showed fluorescence from 484.2 to 484.4 ft bgs and was also subsequently selected for LNAPL analysis*."
37	23d	12	**23. 5.2.2 Light Non-Aqueous Phase Liquid Saturation, Mobility, and Effective Solubility, page 5-4 Permittee Statement:** "Soil grain distribution and classification was analyzed on 16 soil samples (six vadose zone and 10 saturated zone), along with 14 interstitial analyses of soil samples (six vadose zone and eight saturated zone)." **NMED Comment:** Report revision required. NMED identified multiple problems with the data and discussion for Section 5.2.2 that make it difficult to evaluate the information presented by the Permittee. The tables and associated discussions must be revised for accuracy and the section rewritten. This issue was discussed during the NMED/KAFB conference call on June 18, 2020. **d.** Table 5-2 reports particle size distribution data and a corresponding United Soil Classification System (USCS) name. Sample GUV-S9-171018-473 is given a USCS classification of well graded sand. The particle size distribution data reports the sample as having 56.67 weight percent (wt. %) gravel 4.0 wt% coarse sand, 17.29 wt% medium sand, 18.97 wt% fine sand, and 3.07 wt% silt/clay. According to the USCS code the sample should be classified as a sandy gravel rather than a well graded sand. All such discrepancies in Tables 5-2 must be identified and corrected.	The USCS classifications in the table were initially included from the boring logs and were based on what the geologist observed in the field. The table was revised to only include the mean grain size as performed by grain size analysis by PTS Laboratory and not USCS classification. The USCS classifications on the table were removed to reduce confusion.
38	23e	12/13	**23. 5.2.2 Light Non-Aqueous Phase Liquid Saturation, Mobility, and Effective Solubility, page 5-4 Permittee Statement:** "Soil grain distribution and classification was analyzed on 16 soil samples (six vadose zone and 10 saturated zone), along with 14 interstitial analyses of soil samples (six vadose zone and eight saturated zone)." **NMED Comment:** Report revision required. NMED identified multiple problems with the data and discussion for Section 5.2.2 that make it difficult to evaluate the information presented by the Permittee. The tables and associated discussions must be revised for accuracy and the section rewritten. This issue was discussed during the NMED/KAFB conference call on June 18, 2020. **e.** Issues were identified with the PTS Laboratories Physical Properties Data presented in Appendix G-2. For example, PTS File No. 48218 includes two samples, identified on some pages of the data sheets as GUV-S9- 171018-473 and GUV-S9-181018-484 and on other pages as GUV-S9-171018-473 and GUV-S9-181018-474. Review the PTS lab data for accuracy. The Report must be revised to remove data, discussions, conclusions, and recommendations that are based on lab data that fails to meet data quality objectives.	The laboratory report has been revised to clarify the sample identification as GUV-S9-171018-484. Lab reports numbers 48218, 48236, and 49005 were edited to provide the correct sample depth intervals.

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39	23f	13	**23. 5.2.2 Light Non-Aqueous Phase Liquid Saturation, Mobility, and Effective Solubility, page 5-4 Permittee Statement:** "Soil grain distribution and classification was analyzed on 16 soil samples (six vadose zone and 10 saturated zone), along with 14 interstitial analyses of soil samples (six vadose zone and eight saturated zone)." **NMED Comment:** Report revision required. NMED identified multiple problems with the data and discussion for Section 5.2.2 that make it difficult to evaluate the information presented by the Permittee. The tables and associated discussions must be revised for accuracy and the section rewritten. This issue was discussed during the NMED/KAFB conference call on June 18, 2020. **f.** NMED has identified discrepancies in the lithologic descriptions for samples reported in Tables 5-2, 5-3, and 5-4. For example, sample GUV-S5-231018-488 is described in Table 5-3 as a well graded sand with gravel while in Table 5-4 it is described as coarse sand. Aside from the descriptions being different, a well graded sand should contain a range of sand sizes rather than coarse sand only. All such discrepancies in Tables 5-2, 5-3, and 5-4 must be identified and the Report revised accordingly. The following are examples of some of the discrepancies identified: i. The PTS Laboratories sieve analysis results in Appendix G-2 report that sample GUV-S4-041118-486 is classified as a medium sand. Table 5-4 lists the soil type for the sample as fine sand. Resolve the discrepancy. ii. The PTS Laboratories sieve analysis results in Appendix G-2 report that sample GUV-S2-161118-489 is classified as fine sand. Table 5-4 lists the soil type for the sample as fine sand. Table 5-2 lists the sample as well graded gravel with sand. Resolve the discrepancy. iii. The PTS Laboratories sieve analysis results in Appendix G-2 report that sample GUV-S3-211118-494 is classified as gravel. Table 5-4 lists the soil type for the sample as gravel. Table 5-2 lists the sample as clay. Resolve the discrepancy. iv. The PTS Laboratories sieve analysis results in Appendix G-2 report that sample GUV-V1-161219-164 is 91 wt% fine sand. Table 5-2 lists the sample as clay. Resolve the discrepancy.	USCS descriptions were removed from the tables except Table 5-7. The USCS classifications in the tables were initially included from the boring logs and were based on what the geologist observed in the field. The tables were revised to only include the mean grain size as performed by grain size analysis by PTS Laboratory and not USCS classification. The USCS classifications on the tables were removed to reduce confusion.
40	23g	13	**23. 5.2.2 Light Non-Aqueous Phase Liquid Saturation, Mobility, and Effective Solubility, page 5-4 Permittee Statement:** "Soil grain distribution and classification was analyzed on 16 soil samples (six vadose zone and 10 saturated zone), along with 14 interstitial analyses of soil samples (six vadose zone and eight saturated zone)." **NMED Comment:** Report revision required. NMED identified multiple problems with the data and discussion for Section 5.2.2 that make it difficult to evaluate the information presented by the Permittee. The tables and associated discussions must be revised for accuracy and the section rewritten. This issue was discussed during the NMED/KAFB conference call on June 18, 2020. **g.** Appendix G-2 appears to contain duplicate Chain of Custody Record forms for individual samples. Remove the duplicate forms from Appendix G-2 or provide an explanation for retaining them.	Redundant/duplicate Chain of Custody records were removed.
41	23h	13	**23. 5.2.2 Light Non-Aqueous Phase Liquid Saturation, Mobility, and Effective Solubility, page 5-4 Permittee Statement:** "Soil grain distribution and classification was analyzed on 16 soil samples (six vadose zone and 10 saturated zone), along with 14 interstitial analyses of soil samples (six vadose zone and eight saturated zone)." **NMED Comment:** Report revision required. NMED identified multiple problems with the data and discussion for Section 5.2.2 that make it difficult to evaluate the information presented by the Permittee. The tables and associated discussions must be revised for accuracy and the section rewritten. This issue was discussed during the NMED/KAFB conference call on June 18, 2020. **h.** Sample GUV-S7-220119-492 is attributed to coring location KAFB-106S7 in Table 5-3, but it is attributed to coring location KAFB-105S7 in Table 5-4. Resolve the discrepancy.	KAFB-105S7 was changed to KAFB-106S7 in Table 5-4.

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42	23i	13/14	**23. 5.2.2 Light Non-Aqueous Phase Liquid Saturation, Mobility, and Effective Solubility, page 5-4 Permittee Statement:** "Soil grain distribution and classification was analyzed on 16 soil samples (six vadose zone and 10 saturated zone), along with 14 interstitial analyses of soil samples (six vadose zone and eight saturated zone)." **NMED Comment**: Report revision required. NMED identified multiple problems with the data and discussion for Section 5.2.2 that make it difficult to evaluate the information presented by the Permittee. The tables and associated discussions must be revised for accuracy and the section rewritten. This issue was discussed during the NMED/KAFB conference call on June 18, 2020. **i.** The PTS Laboratories Chain of Custody Record for sample GUV-S5-231018-488 indicates that grain size distribution data was one of the analyses requested. Grain size distribution data for the sample is not presented in Table 5-2 of the Report and the footnotes for Table 5-3 indicate that the lithology description for the sample was obtained from logs. Explain why the log description was used rather than the laboratory analysis. Also, the PTS Laboratories data sheets for grain size distribution, interstitial properties, and fluid properties for the sample could not be located in Appendix G-2. All of the laboratory data for the sample must be provided in the revised Report or the sample must be excluded from the report.	The USCS classifications in the tables were initially included from the boring logs and were based on what the geologist observed in the field. The tables were revised to only include the mean grain size as performed by grain size analysis by PTS Laboratory and not USCS classification. In addition, the samples sent to PTS for analysis were contained in sealed core bags and not opened to preserve sample moisture and LNAPL. Because of this, the PTS samples were not logged by the field geologist and USCS classifications of the samples are not available. The USCS classifications on the tables (except Table 5-7) were removed to reduce confusion.
43	23j	14	**23. 5.2.2 Light Non-Aqueous Phase Liquid Saturation, Mobility, and Effective Solubility, page 5-4 Permittee Statement:** "Soil grain distribution and classification was analyzed on 16 soil samples (six vadose zone and 10 saturated zone), along with 14 interstitial analyses of soil samples (six vadose zone and eight saturated zone)." **NMED Comment:** Report revision required. NMED identified multiple problems with the data and discussion for Section 5.2.2 that make it difficult to evaluate the information presented by the Permittee. The tables and associated discussions must be revised for accuracy and the section rewritten. This issue was discussed during the NMED/KAFB conference call on June 18, 2020. **j.** The Permittee states in Section 3 that the intensity of core sample response to UV light provided an approximation of the relative amount of LNAPL present in the soil and that this was used to select sample locations for further laboratory LNAPL analysis. The photo of core sample GUV-V2-131218 at a depth of 214-215 ft bgs appears to display the most intense response to UV light of any of the samples evaluated yet the Permittee did not select the sample for LNAPL analysis. Provide justification for not conducting LNAPL analysis on this sample.	Calcium carbonate minerals also fluoresce under UV light. A comparison of the fluoresced photo with the non-fluoresced photo for core sample GUV-V2-131218 shows the fluorescence in these photographs is caused primarily from calcium carbonate minerals and not from LNAPL (spherical objects and light colored sediments in the non-fluoresced photo). The following text was added to Section 3, "*However, in some cases, carbonate minerals also fluoresced under UV light. In these instances, the unfluoresced and fluoresced photos were compared. Fluorescent minerals typically appear spherical or light-colored in the unfluoresced photo. When these were observed to correspond to the same location in the UV light photo, these areas were not considered to have LNAPL present*."
44	24	14	**24. 5.2.2 Light Non-Aqueous Phase Liquid Saturation, Mobility, and Effective Solubility, page 5-4 Permittee Statement:** "For the purpose of assessing the location of LNAPL in the saturated zone, the more conservative effective solubility concentration of 1.43 milligrams per liter (mg/L) benzene is used as a line of evidence of potential LNAPL occurrence." and "Using the effective solubility concentration of 1.43 mg/L, the location of submerged LNAPL was approximated by locating this concentration isocontour on the benzene concentration map. Figure 5-7 shows the approximate location of LNAPL as superimposed on the [second quarter of 2019 sampling event] Q2 2019 benzene isocontour map (reference elevation interval 4857)." **NMED Comment:** Report revision required. Figure 5-7, LNAPL-Filled Porosity from Continuous Coring, depicts the outline of the dissolved benzene plume where concentrations exceed the EPA maximum contaminant level (MCL) of 5 ug/L in groundwater rather than the contour for the effective solubility concentration of benzene 1.43 mg/L. Also depicted in the figure is an outline of the estimated extent of LNAPL/residual LNAPL in groundwater. The Permittee must clarify in the legend of Figure 5-7 if this contour is equivalent to the effective solubility of benzene (1.43 mg/L), if it is not, revise Figure 5-7 to show the isocontour for 1.43 mg/L benzene. Furthermore, it is not clear what data was used to create the LNAPL outline. The Permittee's statement refers to using the effective solubility concentration of 1.43 mg/L to construct the LNAPL isocontour however, the well identification numbers and analytical data used to construct the contour have not been provided. The Permittee must also revise the legend of Figure 5-7 to indicate the source of the data used to create the LNAPL isocontour and provide a table that identifies the wells, date of collection, and concentration data used to create the LNAPL isocontour.	The data used to create the estimated extent of LNAPL/residual LNAPL can be found in the following text (Section 5.2.3, paragraph 11), "Effective solubility represents the concentration that may occur at equilibrium under ideal conditions. Locations where groundwater concentrations exceed the calculated effective solubility may indicate that LNAPL remains in the saturated zone in that area. LNAPL samples collected from KAFB-106006 (alias KAFB-1066) and KAFB-106076 (alias KAFB-10676) in 2011 were used to calculate the effective solubility of BTEX in both samples (Kirtland AFB, 2018a). Solubility values from NMED guidance (NMED, 2019g) were used to calculate the molar fractions for each constituent. The effective solubility of BTEX (average of ortho-, meta-, and para-xylenes) in KAFB-106006 was calculated to be 6.44, 17.25, 1.03, and 1.37 milligrams per liter (mg/L), respectively. The effective solubility of BTEX in KAFB-106076 was calculated to be 1.43, 6.89, 0.78, and 0.94 mg/L, respectively (Table 5-5). For the purpose of assessing the location of LNAPL in the saturated zone, the more conservative effective solubility concentration of 1.43 mg/L benzene is used as a line of evidence of potential LNAPL occurrence." The identification of the wells, dates of collection (Q3 2011), and concentration data can be found in Table 5-5. The data was obtained from the Phase I RFI Report which was recently approved. Table 5-5 and the Phase I RFI Report are referenced on Figure 5-7. Text has been added to the notes of Figure 5-7 to indicate that the contour is approximate to the effective solubility of benzene.

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45	25	15	**25. 5.2.2 Light Non-Aqueous Phase Liquid Saturation, Mobility, and effective Solubility, page 5-5 and 5-7 Permittee Statement:** "Figure 5-7 indicates that the BTEX plume biodegrades within a relatively short distance (less than 500 ft) from the residual source and is fully attenuated before it reaches Ridgecrest Drive." and "Based on these data, it does not appear that biodegradation of EDB or BTEX can occur at significant rates at these sample locations [KAFB-106S7, KAFB-106S8, KAFB-106247]." **NMED Comment:** Report revision required. The Permittee must revise the Report to include lines of evidence to demonstrate that biodegradation is the mechanism by which the BTEX plume is attenuated and resolve the discrepancy between the two conclusions presented in the statements above regarding biodegradation of the BTEX plume.	The text has been revised as follows (changed text in italics): "Figure 5-7 indicates that the BTEX plume *attenuates* within a relatively short distance (less than 500 ft) from the diffused and dispersed LNAPL source and is fully attenuated before it reaches Ridgecrest Drive *SE*."
46	26a	15	**26. 5.2.2 Light Non-Aqueous Phase Liquid Saturation, Mobility, and Effective Solubility, page 5-4** **Permittee Statement:** "LNAPL samples collected from KAFB-106006 (alias KAFB-1066) and KAFB-106076 (alias KAFB-10676) in 2011 were used to calculate the effective solubility of BTEX in both samples (Kirtland AFB, 2018a). Solubility values from NMED guidance (NMED, 2019f) were used to calculate the molar fractions for each constituent. The effective solubility of BTEX (average of ortho-, meta-, and para-xylenes) in KAFB-106006 was calculated to be 6.44, 17.25, 1.03, and 1.37 milligrams per liter (mg/L), respectively. The effective solubility of BTEX in KAFB-106076 was calculated to be 1.43, 6.89, 0.78, and 0.94 mg/L, respectively (Table 5-5)." **NMED Comment:** Report revision required. This issue was discussed during the NMED/KAFB conference call on June 18, 2020. **a.** The Permittee states that the solubility in water and effective solubility values for benzene are taken from the 2018 *Phase I RCRA Investigation Report, Bulk Fuels Facility Release, Solid Waste Management Unit ST- 106/SS-111* (2018 RFI), a document that has not been approved by NMED. The 2018 RFI, page 5-4, lines 24-27, reports the following values for benzene: solubility in water = 1,780 mg/L; effective solubility = 1.494 mg/L at KAFB-106006; and effective solubility = 6.408 mg/L at KAFB-106076. These values are different than what is presented in the discussion and in Table 5-5. Resolve the discrepancy.	Table 5-5 was calculated using a solubility of benzene in water of 1,790 mg/L as published in New Mexico Environment Department, Risk Assessment Guidance for Site Investigations and Remediation, Volume I, March 2019, Table B-2, Physical and Chemical Properties as stated in footnote a of the table. The Phase 1 RFI Report used a solubility of benzene in water of 1,780 mg/L. The difference in these values stems from the difference in the solubilities in water that was used to calculate the effective solubilities. However, the difference between the two are negligible.
47	26b	16	**26. 5.2.2 Light Non-Aqueous Phase Liquid Saturation, Mobility, and Effective Solubility, page 5-4** **Permittee Statement:** "LNAPL samples collected from KAFB-106006 (alias KAFB-1066) and KAFB-106076 (alias KAFB-10676) in 2011 were used to calculate the effective solubility of BTEX in both samples (Kirtland AFB, 2018a). Solubility values from NMED guidance (NMED, 2019f) were used to calculate the molar fractions for each constituent. The effective solubility of BTEX (average of ortho-, meta-, and para-xylenes) in KAFB-106006 was calculated to be 6.44, 17.25, 1.03, and 1.37 milligrams per liter (mg/L), respectively. The effective solubility of BTEX in KAFB-106076 was calculated to be 1.43, 6.89, 0.78, and 0.94 mg/L, respectively (Table 5-5)." **NMED Comment:** Report revision required. This issue was discussed during the NMED/KAFB conference call on June 18, 2020. **b.** NMED notes that the 2018 RFI, page 5-4, lines 28-31, states, "It is important to note that additional LNAPL samples may yield additional effective solubilities for benzene that could be higher or lower than those yielded by the two collected LNAPL samples. The original composition of the LNAPL, and the degree of degradation, will both affect the mole fraction of benzene in each sample. These effective solubilities represent only one line of evidence indicating where residual LNAPL remains in the saturated zone." This statement identifies important uncertainties regarding the use of LNAPL samples from 2011 to calculate the effective solubility of benzene and, in turn, to estimate the current extent of LNAPL/residual LNAPL in water. The Permittee must revise the Report to identify the uncertainties associated with using LNAPL samples from 2011.	Added the following text to Section 5.2.3, "*It should be noted that this only represents two data points, and the effective solubility will vary depending on the original composition of the LNAPL and degree of degradation in the subsurface. The analysis of additional LNAPL samples may provide a better range of effective solubility*."
48	27	16	**27. 5.2.2 Light Non-Aqueous Phase Liquid Saturation, Mobility, and Effective Solubility, page 5-5** **Permittee Statement: "**…exceeded the benzene standard of 5 µg/L ranging from 0.2 to 26,000 µg/L… Figure 5-6." **NMED Comment:** Report revision required. The Permittee must add additional text to this section describing how many wells were sampled and where the wells with the highest concentrations are located.	The following text was added To Section 5.2.3, "*A total of 50 wells were sampled for BTEX in Q2 2019; all 50 wells are located south of Ridgecrest Drive SE. Benzene was detected in groundwater samples collected from 23 of the 50 groundwater monitoring wells (Figure 5-6); 18 exceeded the 5.0 µg/L maximum contaminant level. Seventeen exceedances were in REI 4857 and one was in REI 4838. The highest benzene concentration was detected in KAFB-106149-484 (26,000 µg/L) in the source area.*"

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49	28	16	**28. 5.2.4 Microbial Analysis pages 5-7 and 5-8** **Permittee Statement:** "In general, concentrations of bacteria associated with potential EDB degradation in soil samples collected in 2018 were moderate… Concentrations of various well-studied reductase enzymes (including ethylene dichloride reductase) were not detected in any samples, and enzymes associated with aerobic cometabolic degradation of EDB during aerobic metabolism of BTEX (phenol hydroxylase and two toluene monooxygenases) were detected in significant numbers in five samples (collected from KAFB-106S1, KAFB-106S2, KAFB-106S3, KAFB-106S4, and KAFB-106S9)." **NMED Comment:** Report revision required. Provide information or context on what constitutes "moderate" concentrations of bacteria or "significant number" of enzymes associated with aerobic cometabolic degradation of EDB during aerobic metabolism of BTEX. Revise the Report to include a table and discussions that provide a quantitative comparison of the data presented in the Report to an appropriate standard. Incorporate information on sample depth relative to water table, lithology, and location relative to the submerged LNAPL plume.	Because there are a number of variables that affect the population growth of bacteria, standards of bacterial populations have not been established and cannot be included in a table or the text. The following text has been added to section 5.2.5, "*Note that Microbial Insights uses the qualitative terms "low", "moderate", and "high" or "significant" when describing numbers of gene copies and/or bacterial numbers. These qualitative terms are relative to results obtained from other samples submitted to Microbial Insights for analysis as described previously. Microbial Insights laboratory reports are presented in Appendix G-3 for more information.*" Please note that the term "LNAPL Plume" is not appropriate since the data in the report supports the fact that the LNAPL is residual.
50	29a	17	**29. Section 5.2.5 Moisture Content, page 5-8** **Permittee Statement:** "The results of the moisture analyses are shown in Tables 5-7 and 5-8 and in Appendix G- 4." **a. NMED Comment:** Report revision required. Table 5-7, Summary of Soil Analytical Moisture Content, lists the USCS lithology classification for each sample. It is unclear how the soil data in the USCS column corresponds to the data in the other columns. Revise the table to clearly attribute the appropriate soil type to each individual sample. The issues identified with the reporting of PTS Laboratories soil data in Tables 5-2, 5-3, and 5-4 also affects Table 5-7. Please revise all Tables containing USCS data to consistently report accurate USCS classifications for the samples.	The USCS classifications in the tables were initially included from the boring logs and were based on what the geologist observed in the field. For the samples analyzed by TestAmerica, USCS classifications were taken from the soil boring logs. However, the samples sent to PTS laboratory and Daniel B. Stephens and Associates for analysis were contained in sealed core bags and not opened to preserve sample moisture and LNAPL. Because of this, the samples sent to both laboratories were not logged by the field geologist and USCS classifications of the samples are not available. The USCS classifications on the tables were removed (except Table 5-7) to reduce confusion. Mean grain size was available from PTS data and the following note was added to Table 5-7, "*Core interval was not logged in the field. Core bag was kept sealed before being sent directly to the laboratory for ultraviolet analysis. Mean grain size is shown*." This information was not available for Daniel B. Stephens and Associates data and the following note was added to Table 5-7, "*Core interval was not logged in the field. Core bag was kept sealed before being sent directly to the laboratory for analysis. USCS/Mean grain size not shown.*"
51	29b	17	**29. Section 5.2.5 Moisture Content, page 5-8** **Permittee Statement:** "The results of the moisture analyses are shown in Tables 5-7 and 5-8 and in Appendix G- 4." **b. NMED Comment:** Report revision required. Table 5-7 reports percent moisture content and percent LNAPL for soil samples but provides no information as to what the percentage values refer to, such as percent pore volume or percent bulk volume. Revise Table 5-7 to indicate what the percentage values refer to.	The following note was included in Table 5-7, "*Moisture content is gravimetric moisture content (mass of water /mass of solids) expressed in percent.*"
52	30	17	**30. Section 5.2.5 Moisture Content, page 5-8** **Permittee Statement:** "Moisture analyses were performed by American Society for Testing and Materials (ASTM) International D2216 (ASTM International, 2005) for geotechnical, TPH, EDB, and [volatile organic compounds] VOC analyses." **NMED Comment:** Report revision required. ASTM International D2216 is a test for determination of the water (moisture) content by mass of soil, rock, and similar materials, not a test method used for geotechnical, TPH, EDB, and VOC analyses. Please revise the statement for accuracy.	Text revised as follows, "Moisture analyses were performed by ASTM International D2216-90 (ASTM International, 2005)."
53	31	17	**31. Section 5.2.5 Moisture Content, page 5-8** **Permittee Statement:** "The moisture content ranged from 1.3 to 33.8 wt% for the analyzed samples. The moisture content results and corresponding USCS classification for the samples are summarized in Table 5-7." **NMED Comment:** Report revision required. Table 5-7 reports percent moisture content and percent LNAPL for soil samples but does not provide information as to what the percentage values refer to, such as percent pore volume or percent bulk volume. Please revise Table 5-7 accordingly.	LNAPL Percentages were removed from the Table to focus only on moisture contents. Laboratory methods and descriptions were added to the notes by laboratory. Note added, "*Moisture content is gravimetric moisture content (mass of water /mass of solids) expressed in percent.*"

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54	32	18	**32. 5.3 Light Non-Aqueous Phase Liquid and Fuel Hydrocarbon Spatial Distribution, page 5-9** **Permittee Statement:** "The vapor plume model was interpolated using a kriging method assuming a very low horizontal to vertical anisotropy (3 to 1). The very low anisotropy range (typical is 30 to 1) was selected because of the gravity dominated flow of the release. A lower value was not used because it resulted in isolated plumes with no constraint in between borehole locations, which is not considered reasonable." **NMED Comment:** Report revision required. Model assumptions such as horizontal to vertical anisotropy and gravity dominated flow must be based on empirical data acquired from the site. Please revise the Report to provide justification for the anisotropy ratio and for the modeling assumption that gravity dominated flow is consistent throughout the vadose zone. Discuss differences in anisotropy that may exist between the alluvial piedmont deposits and the Upper Santa Fe Group deposits.	As discussed in comment 21, the model and the associated discussion was removed from the report.
55	33	18	**33. 5.3 Light Non-Aqueous Phase Liquid and Fuel Hydrocarbon Spatial Distribution, page 5-9** **Permittee Statement:** "The vapor plume was then illustrated using an arbitrary iso-shell value of 100,000 micrograms per cubic meter. Model results are presented on Figures 5-8 through 5-14 and are discussed below." **NMED Comment:** Report revision required. The term "iso-shell" must be defined. Based on the color bar representing BTEX concentrations in soil vapor and the depictions of the BTEX vapor plume in Figure 5-8 through 5-14, it appears that the Permittee used an "iso-shell" value of 10,000 micrograms per cubic meter rather than 100,000 micrograms per cubic meter as a cutoff value to define the boundary of the BTEX plume. Revise the figures and discussion to resolve the discrepancy.	As discussed in comment 21, the model and the associated discussion was removed from the report.

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56	34	18	**34. 5.3 Light Non-Aqueous Phase Liquid and Fuel Hydrocarbon Spatial Distribution, page 5-9** **Permittee Statement:** "Subsurface geology (sands and gravels) was the dominant control for the downward migration of the release." **NMED Comment:** Report revision required. The dominant control for the downward migration of the release was the continuous, extended release of fuel to the subsurface which provided the hydraulic head necessary to drive migration. The dominant control for the contaminant migration pathway was the subsurface geology. Please revise the statement for accuracy.	Text has been revised as follows (revised text in italics), "As previously stated, BTEX, EDB, and TPH concentrations in the vadose zone from source area wells KAFB-106V1 and KAFB-106V2 are representative of the release location. *The dominant control for the downward migration of the release was the continuous, extended release of fuel to the subsurface which provided gravity drainage and the hydraulic head necessary to drive migration. The dominant control for the contaminant migration pathway was the subsurface geology.* *Fuel migrated vertically through mostly permeable non-cohesive soil by gravity drainage from the release point to the clay layer encountered around 260 to 270 feet bgs. Upon encountering the clay layer, the fuel saturated the soil above the clay, resulting in increased hydraulic head that eventually overcame the capillary pressure of pore water in the clay porosity. Once this pressure was overcome, LNAPL could migrate into and through the clay layer (ITRC-3, 2018) as evidenced in heated headspace readings from boring KAFB-106V1. Here, the lower clay extends from 266to 281 ft bgs. Heated headspace readings in this borehole were 4,049 ppm at 260' bgs, just above the clay, representing former LNAPL saturation. In the clay layer the readings were 1,788 and 3,681 ppmv at 270 and 280 feet bgs, respectively. Finally, just below the clay layer, 1,439 ppmv was observed at 281 ft bgs (Table 4-1 and KAFB-106V1lithologic log, Appendix D). Not only did the hydraulic head that built up drive the LNAPL into and through the clay, it spread LNAPL laterally on the clay layer as a saturated fluid driven by Darcy's law and seepage. Laterally, LNAPL may have pooled with sufficient hydraulic head to penetrate the clay elsewhere.* *Studies have shown that organic liquids can physically alter clay structure. Izdebska-Mucha, et. al. (2011) showed the influence of hydrocarbon contamination in clay soil resulted in more open porosity and larger voids. Mosavat and Nalbantoblu (2012) showed that pure toluene resulted in diminution in plasticity and considerable flocculation of clay particles causing granularity in the soil structure. Finally, Nasir (2011) showed contamination of clay with motor oil entailed substantial microstructural changes: looser packing of clay particles and grain surface detachment, reduction in Atterberg limits in the first 3 months, and substantial increase in coefficient of permeability.* *Once the LNAPL entered the clay, structural changes to the clay facilitated greater permeability and ability to transmit the LNAPL through the clay to the underlying permeable soil. This mechanism is contrary to the concept that the clay formed an impermeable layer to the LNAP, LNAPL migrated vertically through the clay, and laterally through the clay by capillarity. A "hole" or other discontinuity in the clay layer is not required to explain the deeper migration of LNAPL to the water table.* *At the water table, an LNAPL hydraulic head again formed as the LNAPL pooled. This hydraulic head caused the LNAPL to spread laterally at the water table, forming a substantial historical LNAPL plume extending to Bullhead Park. As the groundwater elevation decreased, LNAPL transport would have followed the LNAPL gradient created by the continued drainage, which favored the northerly groundwater gradient. The LNAPL migrated as far north as USS Bullhead Memorial Park, and this was observed in the LNAPL data collected. The lowest LNAPL saturations observed were near Bullhead Park in the distal portion of the historical LNAPL plume (in wells KAFB-106S7 and KAFB-106S5) (Figures 5-4 and 5-5), and the highest LNAPL saturations were observed closest to the source area in KAFB-106V1 and KAFB-106V2. This is also observed in the benzene concentrations which attenuate rapidly north of the off-Base portion of the benzene plume (Figure 5-6).*

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57	35a	18/19	**35. 5.3 Light Non-Aqueous Phase Liquid and Fuel Hydrocarbon Spatial Distribution, page 5-9** **Permittee Statement:** "The lack of significant soil vapor hydrocarbon results directly above these shallow clay units laterally from the source area suggests that LNAPL maintained a near vertical migration pathway through higher permeable areas around, as well as through, the clays. This indicates that LNAPL migration was dominated by gravity drainage rather than horizontal migration along low permeability (i.e., clay or silt) zones." **a. NMED Comment:** Report revision required. The Permittee makes a comparison of a physical process (gravity drainage) relative to horizontal migration. It is not clear how gravity drainage, migration direction, and permeability relate to one another in this example or why gravity drainage is considered the dominant factor for LNAPL migration. Revise the statement for clarity.	The model and the associated discussion were removed from the report. However, as discussed above, gravity was the force that caused the fuel to move downwards through the vadose zone through higher permeability units (sands/gravels). Lower permeability units (clays/silts) likely caused lateral migration of the fuel in the subsurface, but the investigation did not uncover direct evidence of this. For example, the lower clay layer in KAFB-106S9 (the closest well to the release area) was observed from 270 to 283 ft bgs. Heated headspace concentrations at 269, 280, and 289 ft bgs (above, within, and below the lower clay) were less than 10 ppmv. If lateral migration occurred along the lower clay unit identified in KAFB-106S9, it did not migrate as far east as the well location. Additional information regarding the lower clay unit will be presented in the upcoming Data Gap report that will include information for wells KAFB-106S10 and KAFB-106V3 that are located closer to the release area.
58	35b	19	**35. 5.3 Light Non-Aqueous Phase Liquid and Fuel Hydrocarbon Spatial Distribution, page 5-9** **Permittee Statement:** "The lack of significant soil vapor hydrocarbon results directly above these shallow clay units laterally from the source area suggests that LNAPL maintained a near vertical migration pathway through higher permeable areas around, as well as through, the clays. This indicates that LNAPL migration was dominated by gravity drainage rather than horizontal migration along low permeability (i.e., clay or silt) zones." **b. NMED Comment:** Report revision required. In the discussion of downward migration of the contaminant plume the Permittee refers to shallow clay layers and deeper clay layers but provides no information on the different characteristics of the shallow versus deep clay layers to support the conclusions presented in the discussion. The Permittee must differentiate between the shallow and deeper clay layers by including in the discussion, at a minimum, information on the depositional environment, bed geometry and thickness, lateral continuity, and physical and interstitial properties.	The model and the associated discussion were removed from the report. However, information on the depositional environment can be found in Section 2.1. Bed thickness can be found in the lithologic logs. Sufficient samples to distinguish physical and interstitial properties between the two clay layers were not collected from the borings. This, and the assessment of the clay bed geometry, was not one of the objectives of the approved work plan. The lateral continuity of the clay beds will be provided in cross sections in the upcoming Data Gap Report. These cross sections will include additional information regarding these clay layers obtained from newly installed wells KAFB-106S10 and KAFB-106V3.
59	36	19	**36. 5.3 Light Non-Aqueous Phase Liquid and Fuel Hydrocarbon Spatial Distribution, page 5-10** **Permittee Statement:** "At that point, mobile LNAPL migrated northward on the groundwater in response to LNAPL head resulting from continued loading from the ongoing release (Figure 5-10)." **NMED Comment:** Report revision required. Figure 5-10 does not clearly depict LNAPL. Revise Figure 5-10 to clearly depict LNAPL.	Figure 5-10 was removed with the model.
60	37	19	**37. 5.3 Light Non-Aqueous Phase Liquid and Fuel Hydrocarbon Spatial Distribution, page 5-10** **Permittee Statement:** "Figure 5-11 shows the residual LNAPL (smear zone) to be approximately 40 ft thick in the source area (KAFB-106S9) and thins to approximately 25 ft thick toward the south (KAFB-106S1) and less than 10 ft thick to the north (KAFB-106S5)." **NMED Comment:** Report revision required. Figure 5-11 must be modified to include a north arrow. Also, the figure depicts multiple isolated LNAPL bodies below the water table without explanation. Revise the Report to add a north arrow to all figures and include a discussion on the significance of the isolated LNAPL bodies depicted in Figure 5-11. Clarify whether all the LNAPL bodies are included in the estimation of the LNAPL smear zone thickness.	Figure 5-11 was removed with the model.
61	38	20	**38. 5.3 Light Non-Aqueous Phase Liquid and Fuel Hydrocarbon Spatial Distribution, page 5-10 Permittee Statement:** "Laboratory results during coring operations indicate elevated concentrations of adsorbed hydrocarbons at elevations that most likely relate to the local groundwater elevation steps." **NMED Comment:** Report revision required. Provide lines of evidence to support this statement. Revise the discussion and provide a table that describes the number and depths of the elevation steps, the source of the data, the related laboratory results, and corresponding lithologies.	The model and the associated discussion were removed from the report. However, historic groundwater levels were added to Table 4-1. A review of this table indicates that the highest PID readings generally correlate with the deepest water levels. The approximate water table depth for each 10-year period and source of data can be found on Table 4-1. The related laboratory results can be found on Table 5-1 and the corresponding lithologies can be found in the lithologic logs in Appendix D.

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62	39	20	**39. 5.3 Light Non-Aqueous Phase Liquid and Fuel Hydrocarbon Spatial Distribution, page 5-10** **Permittee Statement:** "Partitioning of benzene from residual LNAPL where the vadose zone source intersected the groundwater table serves as a continuing source of dissolved contamination." **NMED Comment:** Report revision required. This statement must differentiate between past, current, and predicted vadose zone/groundwater table intersection. Please revise the statement for clarity and address submerged LNAPL in the discussion of continuing sources of dissolved contamination.	Revised statement as follows (revised text in italics), “*LNAPL continues to provide a persistent source of benzene contamination to groundwater. In the vadose zone, LNAPL and soil contamination partition benzene into pore water, which in turn leaches to groundwater. At the current water table and LNAPL smear zone, benzene partitions directly from LNAPL to groundwater, sourcing the solute plume. As the water table rises, it places groundwater in direct communication with soil contamination and LNAPL in the lower vadose zone, again directly sourcing benzene to groundwater. Finally, submerged LNAPL in response to the rising water is a persistent source to benzene solute contamination by direct partitioning of benzene from LNAPL to groundwater. These LNAPL sources will continue to source solute plumes of all site contaminants of concern – EDB, toluene, ethylbenzene, and xylenes, until depleted by dissolution into pore water or groundwater, degradation by natural attenuation processes, or by active remediation*.”
63	40	20	**40. 5.3 Light Non-Aqueous Phase Liquid and Fuel Hydrocarbon Spatial Distribution, page 5-10 Permittee Statement:** "The dissolved phase benzene plume is shown in map view on Figure 5-12." **NMED Comment:** Report revision required. The referenced figure must include clear contaminant contour lines. Also, please clarify if this figure represents soil vapor or groundwater data. The Legend and Notes contradict each other. Revise Figure 5-12 for clarity.	As discussed in comment 21, the model and the associated discussion was removed from the report.
64	41	20	**41. 5.3 Light Non-Aqueous Phase Liquid and Fuel Hydrocarbon Spatial Distribution, page 5-10 Permittee Statement:** "The soil vapor plume in the vadose zone is shown on Figure 5-13.**"** **NMED Comment:** Report revision required. Figure 5-13 depicts a lone pocket of BTEX vapor to the west of KAFB- 106S3 with no associated monitoring points to identify the source of these data. It is difficult to estimate the concentration of this pocket of BTEX soil vapor with the scale provided in the Legend of the figure. Discuss this anomaly, including its concentration and depth in the text of the revised Report.	This anomaly was a relic from the EVS model and did not apply to any specific data point. The model and the associated discussion have been removed from the report.
65	42	21	**42. 5.3 Light Non-Aqueous Phase Liquid and Fuel Hydrocarbon Spatial Distribution, page 5-1** **Permittee Statement:** "Figure 5-14 shows that the highest dissolved phase benzene concentrations are located where the soil vapor plume intersects the groundwater plume, demonstrating that the soil vapor and dissolved vapor data are in alignment." **NMED Comment:** Report revision required. Figure 5-14 does not clearly illustrate this concept as data points appear to be omitted from the figure. Please revise the figure to clearly depict the relationship between the soil vapor plume and groundwater plume.	As discussed in comment 21, the model and the associated discussion was removed from the report.
66	43	21	**43. Section 6 Investigation Derived Waste, page 6-1** **Permittee Statement:** "Information regarding investigation-derived waste accumulation and storage, utilization of the Kirtland AFB groundwater treatment system, and other investigation-derived waste processes are described in more detail in the following reports generated for the BFF..." **NMED Comment:** The Report contains no information on how the IDW was containerized, transported, characterized, stored, or disposed of. Appendices F-1 through F-4 contain tables but no descriptions of procedures. The Permittee may not refer to separate documents and must include all IDW information relevant to this scope of work as an appendix in the revised Report.	These descriptions were included in the Well Completion Reports. The Well Completion Report is included as Appendix I of this revised report.
67	44	21	**44. Section 7 Summary and Conclusions, page 7-1** **Permittee Statement:** "The source zone characterization included coring at 11 locations to assess the horizontal and vertical extent of LNAPL at the Site… the collection of over 3,600 linear ft of core, chemical analysis of 87 soil samples, UV fluorescence of 30 cores...” Soil core samples were collected to obtain contaminant concentration and soil and LNAPL properties data." **NMED Comment:** Report revision required. Please provide the results of these data on cross sections or fence diagrams so that a direct comparison can be made of the lithology and the locations of samples, LNAPL, and UV detections found through field screening and laboratory analyses.	Creating an updated cross section with information presented in this report was not part of the scope in the approved work plan. In addition, the cross section has been removed from the revised report. The Air Force agrees that it is important to compare the data presented in this report with other historical information/cross sections. Updated cross sections that will include the data from this investigation as well as the recently installed data gap wells (Including wells KAFB-106S10 and KAFB-106V3) will be presented in the upcoming Data Gap Report submittal.

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68	45	21/22	**45. Section 7 Summary and Conclusion, page 7-1** **Permittee Statement:** "Continuous cores were collected next to existing boreholes using sonic drilling to provide higher resolution lithologic data in the source area. The logs from the new cores were then compared to the logs from the existing boreholes." **NMED Comment:** Report revision required. The cross sections in the Report do not reflect this higher resolution data and are presented in a different style than those presented in the Work Plan. Please revise the Report to present the data in a format that allows a comparison of the data from the new cores to the data from the pre- existing boreholes.	See response to Item #67.
69	46	22	**46. Section 7 Summary and Conclusions, page 7-1** **Permittee Statement:** "The SVM wells were installed as observation wells for the bioventing pilot study that initiated in 2018." **NMED Comment:** Report revision required. Please cite and reference the specific documents in which the information related to the bioventing pilot study was submitted to NMED.	Citations are included in Section 5.2.6 of the revised report. The following was added to the text. "The work plan for Bioventing Pilot study was submitted to NMED in November 2017 (Kirtland AFB, 2017b) and was approved with conditions on April 6, 2018 (NMED, 2018a). The Bioventing Respiration Pilot Testing Procedure was submitted to NMED on September 7, 2018 (Kirtland AFB, 2018b) and it was approved with conditions on February 25, 2019 (NMED, 2019f). The Bioventilation Construction and Initiation Report was submitted to NMED on January 21, 2020 (Kirtland AFB, 2020) and is currently being revised.
70	47	22	**47. Section 7 Summary and Conclusions, page 7-1** **Permittee Statement:** "Soil samples were collected from drill cuttings and soil cores and then submitted to an analytical laboratory for TPH GRO/DRO/MRO, VOC, and EDB analysis." **NMED Comment:** Report revision required. Please identify which soil samples were collected from drill cuttings and sent to analytical laboratories for analysis. Samples collected for investigation derived waste (IDW) analyses may be excluded.	Figure 5-3 and Table 3-1 depict which samples were collected from soil cuttings during ARCH drilling and which were collected from Sonic drilling cores.
71	48	22	**48. Section 7 Summary and Conclusions, page 7-1** **Permittee Statement:** "Evaluation of the data collected from LNAPL testing provided the following conclusions:" **NMED Comment:** Report revision required. This statement appears to be a typographical error. Concentrations of TPH, BTEX, and EDB rather than LNAPL are discussed in the bulleted paragraphs that follow. LNAPL is discussed in a separate section on page 7-2. Please revise the Report to correct the discrepancy.	Changed text in paragraph 5, Section 7 as follows (revised text in italics), "Evaluation of the data collected from *TPH-GRO/DRO/MRO, VOCs, and EDB* testing provided the following conclusions:"
72	49	22	**49. Section 7 Summary and Conclusions, page 7-1** **Permittee Statement:** "These concentrations increased with depth until a clay unit that was encountered at a depth of approximately 265 ft bgs. Below this clay unit, concentrations decrease significantly (Figure 5-3 through 5-5)." **NMED Comment:** Report revision required. Figures 5-3 through 5-5- do not depict lithology and the cross sections provided in Figures 5-1 and 5-2 are insufficient for correlating this information. Please revise this Report to provide adequate cross sections that depict the information presented in this discussion.	Revised text as follows (revised text in italics), "*The laboratory analytical data indicated petroleum hydrocarbon concentrations generally increased with depth in KAFB-106V1 and decreased with depth in KAFB-106V2 (see Figures 5-1 through 5-3 for depths of soil sample concentrations and the lithologic logs in appendix D for soil descriptions). However*, concentrations *decreased significantly* beneath the clay unit that was encountered at a depth of approximately 265 ft bgs (*see soil boring logs in Appendix D and Figures 5-1 through 5-3 for depths of soil sample concentrations)*."
73	50	23	**50. Section 7 Summary and Conclusions, page 7-2** **Permittee Statement:** "The highest LNAPL saturation from the vadose zone is in KAFB-106V1 at a depth of 122 ft bgs (Table 5-4). The highest LNAPL saturation in the saturated zone was observed in KAFB-106S9 at a depth of 484 ft bgs (Table 5-4). The lowest LNAPL saturations are in wells KAFB-106S5 and KAFB-106S7, which are located off-Base, farthest from the source area (Table 5-4)." **NMED Comment:** The revised report must include a figure and/or cross section that illustrates this statement. The figure must clearly depict lithology, LNAPL saturation, current and former groundwater levels, and clearly identify relevant boring locations. See Comment 14.	Created Figures 5-4 LNAPL Pore Volume Saturation Percent and 5-5 LNAPL Total Volume Saturation Percent that have this information. Added the following text. *The LNAPL pore volume percentages and LNAPL total volume saturation percentages are presented in Figures 5-4 and 5-5, respectively.*
74	51	23	**51. Section 7 Summary and Conclusions, page 7-2** **Permittee Statement:** "The LNAPL migrated as far north as Bullhead Park, and this was observed in the residual saturation data." **NMED Comment:** Report revision required. Bullhead Park is not identified on any of the figures presented in the Report. Please revise the Report to ensure all geographical features and locations referenced in the text of the Report are identified on all relevant figures.	The figures, where applicable, were updated with USS Bullhead Memorial Park and streets.

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75	52	23	**52. Section 7 Summary and Conclusions, page 7-2** **Permittee Statement:** "The highest LNAPL saturation from the vadose zone is in KAFB-106V1 at a depth of 122 ft bgs (Table 5-4). The highest LNAPL saturation in the saturated zone was observed in KAFB-106S9 at a depth of 484 ft bgs (Table 5-4). The lowest LNAPL saturations are in wells KAFB-106S5 and KAFB-106S7, which are located off-Base, farthest from the source area (Table 5-4)." **NMED Comment:** Report revision required: Please review the Report to add a figure that clearly depicts the spatial context of LNAPL saturation within the site and identify all relevant boring identification numbers, sample depths, groundwater depths at the times of investigation, and historical low and high groundwater depths.	Added the following text, *"The LNAPL pore volume percentages and LNAPL total volume saturation percentages are presented in Figures 5-4 and 5-5, respectively."*
76	53	23/24	**53. Section 7 Summary and Conclusions, pages 7-2 and 7-3** **Permittee Statement:** "No microbial genes responsible for reductive dehalogenation were found in samples collected." "No Dehalococcoides, the only bacteria known to be capable of complete reductive dehalogenation to ethane, were found in any of the samples." and "Abiotic attenuation of EDB with respect to iron-bearing minerals is not anticipated to be significant." **NMED Comment:** Report revision required. Please revise the Report to discuss the presence or absence of bacteria and/or minerals that could have affected the degradation of site-specific contaminants of concern. This will serve to simplify Sections 5.2.3, Minerology and Magnetic Susceptibility and 5.2.4, Microbial Analysis, for the general public and stakeholders.	Revised bullet as follows (new text in italics), "Abiotic attenuation of EDB with respect to iron-bearing minerals is not anticipated to be significant *because no pyrite or other iron sulfide minerals were present in the aquifer that can catalyze reductive dehalogenation of EDB. Magnetite was observed at 1.5-7 wt.% of soil samples by correlation of magnetic susceptibility. Magnetite can perform degradation of halogenated compounds; however, it reacts more slowly than pyrite. The rate of degradation for magnetite is approximately 20-40 times slower than ferrous sulfide and has resulted in undetectable EDB attenuation. Some other iron-bearing silicate minerals may be able to catalyze abiotic EDB attenuation, but these minerals could not be characterized in the samples by the methods used in this study."* Revised bullet as follows (new text in italics), "No Dehalococcoides, the only bacteria known to be capable of complete reductive dehalogenation to ethane, *including dehalogenation of EDB to ethane*, were found in any of the samples."
77	54	24	**54. Section 7 Summary and Conclusions, page 7-3** **Permittee Statement:** "In general, soil moisture was less than 5% in vadose zone samples (Table 5-7)." **NMED Comment:** Report revision required. According to Table 5-7, soil moisture in vadose zone samples were greater than 10% in many samples, and greater than 15% in approximately one dozen samples, while soil moisture was significantly lower, on average, in the saturated zone. The Permittee must revise the Report to correct this statement and explain why soil moisture levels are higher in the vadose zone relative to the saturated zone, particularly in the area where SVE systems have been operated (KAFB-106V1 and KAFB-106V2).	Moisture contents (e.g., water content expressed as weight of water divided by weight of solid) of the most prevalent soil types, well graded and poorly graded sands (SW and SP) were averaged above and below the water table. The average moisture contents for SW and SP above the water table were 5.05% and 4.67% respectively. The average moisture contents for SW and SP below the water table were 11.58% and 10.35%, respectively. This only includes samples with a USCS classification and not the samples analyzed by PTS Laboratory that includes mean grain size. Note that moisture contents were calculated on a gravimetric and not volumetric basis. Gravimetric moisture content is calculated as the mass of water divided by the mass of the solids times 100. An example of this can be provided from Sample GUV-S9-181018-484 (Table 5.3) collected from borehole KAFB-106S9 at a depth of 484 feet below the water table: Mass of water = (Pore Water Saturation)(Total Porosity)(Water Density) Mass of solids Dry Bulk Density = (53.9 %)(41.1 %)(1 gram/cubic centimeter) 1.57 gram/cubic centimeter = 14.1% The laboratory calculated moisture content for this sample was 15.1% which is very similar and slightly higher than the calculated moisture content. However, the potential for moisture losses exists and the following text was added to Section 5.3.5, "*Soil samples were collected using the sonic drilling method from various depths below ground surface under significant overburden pressures. As a result, the samples should be considered disturbed and may not be representative of the in-situ density of the sample. It is also likely that the moisture contents of saturated sand and gravel samples collected below the water table have been biased low due to gravity drainage of water from non-cohesive soils within the sample bags. Coarse-grained samples (sands and gravels) with high permeability collected below the water table may have experienced drainage where water drained to the bottom of plastic sample sleeve and not collected during sample preparation. This would create a low bias towards the moisture content of samples collected below the water table. Water draining from permeable sand and gravel samples is more likely to occur in saturated samples collected below the water table than above the water table. Above the water table, the moisture is held in capillary tension and did not freely drain upon extrusion from the core barrel.*"

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78	55	24	**55. Section 7 Summary and Conclusions, page 7-3** **Permittee Statement:** " The clays do not appear to have significantly affected lateral migration of the LNAPL. LNAPL migration was primarily by gravity drainage rather than horizontal migration along low permeability (i.e., clay or silt) zones." **NMED Comment:** Report revision required. The conclusion that clays do not appear to have significantly affected lateral migration of the LNAPL minimizes the importance of the impact of the clays at the site. The vapor and LNAPL plumes depicted in Figures 5-8 through 5-14 indicate that the clay layer at approximately 265 ft bgs caused lateral migration of the contaminant plume. The statement must be revised for clarity.	As discussed in comment 21, the model and the associated discussion was removed from the report. The following text was removed, “The clays do not appear to have significantly affected lateral migration of the LNAPL.” As previously discussed in comments 56 and 57 if lateral migration occurred, it is bounded on the east by KAFB-106S9, Additional information regarding the lower clay unit will be presented in the upcoming Data Gap report that will include information for wells KAFB-106S10 and KAFB-106V3 that are located closer to the release area.
79	56	24/25	**56. Section 7 Summary and Conclusions, page 7-3** **Permittee Statement:** "Average gravel LNAPL saturations were 2.57 and 0.9% relative to pore volume and total volume, respectively. For the medium sand samples from the saturated zone, LNAPL saturation ranged from 0.04 to 4.9% pore volume and from 0.02 to 2.0% total volume, respectively. The coarse sand sample from the saturated zone had a LNAPL saturation of 0.08% pore volume and 0.03% total volume. Average LNAPL saturation relative to pore volume and total volume for the three fine sand samples averaged 2.4 and 1.0%, respectively." **NMED Comment:** Report revision required. The statement must be revised for accuracy once the issues identified by NMED related to the classification of soil types have been resolved.	Text was not in Section 7. Text was changed in 5.2.3 (Revised text in italics), “For the medium sand sample from the saturated zone, LNAPL saturation was *4.9% pore volume and 2.0% total volume*, respectively. Average LNAPL saturation relative to pore volume and total volume for the three fine sand samples averaged 2.4 and 1.0%, respectively (*Table 5-4*).”
80	57	25	**57. Section 8 References, page 8-1** **NMED Comment:** Monitoring well completion reports are listed as individual references but were not submitted to NMED as individual documents. The reports were submitted as appendices in other documents and the title and cover pages of those documents did not identify the presence of the monitoring well completion reports. The Permittee must revise the Report to cite the document, section, and page numbers in which each of the monitoring well completion reports is presented. Additionally, the Permittee must revise the Report to include all of the well completion reports for the well installations associated with this scope of work as an appendix.	A well completion report has been included in Appendix I in the revised report. Individual report references have been removed.
81	58	25	**58. Section 8 References, page 8-1** **NMED Comment:** Report revision required. The document "NMED. 2019b. *Approval to Not Install KAFB-106S6 and Relocate KAFB-106247* by Mr. Dennis McQuillan, Chief Scientist. January 25." is not included in Appendix A, Regulatory Correspondence. Please revise the Report to include the reference in Appendix A.	The correspondence is included in Appendix A.
82	59a	25	**59. Figure 5-1 Cross Section A-A' and 5-2 , Cross Section B-B' NMED Comment:** Report revision required. **a.** Figures 5-1 and 5-2 are not true cross sections or fence diagrams. They appear to be an interpolation of subsurface geology across the site. Some of the wells used to create the figures are offset too far from the transects to accurately depict subsurface geology. Please revise Figure 5-1 and 5-2 with more reasonable cross section lines. The Permittee must also depict the actual elevation/depth to water on the figure.	Cross sections were removed from the revised report. Updated cross sections that will include the data from this investigation as well as the recently installed data gap wells (Including wells KAFB-106S10 and KAFB-106V3) will be presented in the upcoming Data Gap report submittal.
83	59b	25/26	**59. Figure 5-1 Cross Section A-A' and 5-2 , Cross Section B-B' NMED Comment:** Report revision required. **b.** The cross-sections presented in Figures 5-1 and 5-2 are inadequate in depicting the subsurface conditions across the site, particularly in the source area, because they are inconsistent with much of the lithologic data previously obtained at the site. Revise the Report to include cross sections that appropriately incorporate existing lithologic and geophysical data from other nearby wells in the area and include depth to water and historic high and low water levels. The cross sections must also depict key stratigraphic surfaces such as the top of the ancestral Rio Grande sediments and the top and bottom of the fine grained, low permeability intervals that occur between 250 and 300 feet bgs. Multiple straight line transects must be presented rather than a single transect with multiple directional changes. The cross sections must be presented in a large enough format to allow the details to be discernable. This issue was discussed during the NMED/KAFB conference call on June 18, 2020.	See response to Item #82.

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84	60	26	**60. Figures 5-3 BTEX Concentrations in Soil, 5-4, EDB Concentrations in Soil, and 5-5, TPH Concentrations in Soil** **NMED Comment:** Report revision required. Soil screening levels are not included on Figures 5-3, 5-4, and 5-5. Please revise these figures to include the soil screening levels used for each contaminant of concern and reference which screening levels were used (e.g., NMED, EPA, etc.) in the "Notes" section of the figure.	NMED Soil Screening Levels (SSL) were not added to Figures 5-3, 5-4, and 5-5 because site conditions depart substantially from the conceptual model used to derive the soil leaching to groundwater SSLs. The depth of most soil samples makes the soil leachate pathway the appropriate SSLs; however, limitations in Section 4.5 of NMED's Risk Assessment Guidance for Site Investigations and Remediation (NMED 2019) are not all satisfied, including: 1) the significant vadose zone thickness provides potential significant attenuation for leaching and 2) NAPL is present. For the Corrective Measure Evaluation development of Site-Specific SSLs for protection of groundwater may be developed in accordance with Section 4.7 (NMED 2019). For the Corrective Measure Evaluation, SSLs for protection of groundwater will be evaluated in accordance NMED's Risk Assessment Guidance for Site Investigations and Remediation (NMED 2019).
85	61	26	**61. Figure 5-5 TPH Concentrations in Soil** **NMED Comment:** Report revision required. There is no unit of measurement for the TPH data in the figure. Please revise Figure 5-5 to indicate a unit of measurement for TPH concentration data.	Figure number is now Figure 5-3. The figure was revised to include TPH units in the legend.
86	62	26	**62. Figure 5-6 Benzene Concentrations in Groundwater Reference Elevation Interval 4857, Q2 2019** **NMED Comment:** Report revision required. The "Notes" section of Figure 5-6 refers to two abbreviations, MVS and REI, that are not defined in the Report. Please revise the Report to define the abbreviations. Additionally, the title of the figure refers to Reference Elevation Interval 4857. This term is not defined in the Report. Revise the Report to provide an explanation of the term and the significance of the associated value. Add a figure similar to Figure 3-2, Reference Elevation Capture and Containment Intervals, of the Q2 2019 Quarterly Report to provide a point of reference for understanding the concept of reference elevations.	A definition of the abbreviation "MVS" has been added to the notes section of the figure. A discussion of reference elevation intervals is not appropriate since the focus of the investigation was the assessment of LNAPL and not deeper REIs that are used for semiannual plume capture modeling. Due to this, a discussion of REIs would add confusion. References to the REIs were removed from the figure.
87	63	26	**63. Figure 5-6 Benzene Concentrations in Groundwater Reference Elevation Interval 4857, Q2 2019** **NMED Comment:** Report revision required. A large portion of the figure depicts wells north of Ridgecrest Drive which were not sampled for benzene. Please provide an explanation in the relevant section of the revised Report as to why these wells were not sampled for benzene. In addition, provide the date when benzene was last detected north of Ridgecrest Drive, the wells in which it was last detected, and which wells currently provide evidence of lateral containment of the benzene plume. These wells must be easily identifiable in the revised Report.	See response to Item #48 for the wells sampled for benzene. A discussion of historic benzene in groundwater is not appropriate since the focus of the investigation was the assessment of LNAPL in the vadose and saturated zones. Due to this, a discussion of historic benzene in the groundwater north of Ridgecrest Drive SE would add confusion. The wells north of Ridgecrest Drive SE were left on the figure to show wells within the groundwater monitoring well network. A note was added to the figure, "*Figure shows wells sampled in accordance with approved work plans*".
88	64	26/27	**64. Figure 5-7 LNAPL-Filled Porosity from Continuous Coring** **NMED Comments:** Report revision required. The legend indicates that the ≥5 ug/L isocontour for benzene is shown rather than the effective solubility concentration for benzene of 1.43 mg/L. The Permittee must depict the effective solubility concentration for benzene of 1.43 mg/L on Figure 5-7. Furthermore, the legend indicates that the green shaded area of the figure depicts the estimated extent of LNAPL/Residual LNAPL in groundwater while the title block of the figure indicates that the figure presents LNAPL filled porosity from continuous coring. Revise the Figure 5-7 to resolve the discrepancy. Finally, while Figure 5-7 shows wells that contain free phase LNAPL on groundwater, it is difficult to compare this with the submerged LNAPL in soil porosity that is also presented in the figure. Please revise Figure 5-7 to include contours for confirmed free phase LNAPL.	Changed the figure title to "Estimated Extent of LNAPL/Diffused and Dispersed LNAPL in Groundwater". Added "*The LNAPL/diffused and dispersed LNAPL contour is approximate to the effective solubility of benzene, 1.43 milligrams per liter (Kirtland AFB, 2018a and Table 5-5 of this report)*" to the notes of the figure. Diffused and dispersed LNAPL present in wells is discontinuous and typically only found periodically in specific wells, and therefore it is not possible to provide a contour of the free phase LNAPL found in wells. However, Figures 5-4 LNAPL Pore Volume Saturation Percent and 5-5 LNAPL Total Volume Saturation Percent were created that show location and depth LNAPL found in soil samples in the saturated zone.
89	65a	27	**65. Figure 5-8 EVS Model 3-Dimensional Views South to North and East to West Figure 5-9 EVS Model 3-Dimensional View Showing Clays at 265 Feet Depth** **Figure 5-10 EVS Model of Historical Groundwater Elevations Relative to the Vadose Zone Plume and the Dissolved Benzene Plume in Groundwater** **Figure 5-11 3-Dimensional View Showing Estimated Location of LNAPL in the Saturated Zone** **NMED Comment:** Report revision required. NMED has identified the following issues with Figures 5-8 through 5- 11: **a:** Revise all figures to include a North arrow.	As discussed in comment 21, the model and the associated discussion was removed from the report.
90	65b	27	**65. Figure 5-8 EVS Model 3-Dimensional Views South to North and East to West Figure 5-9 EVS Model 3-Dimensional View Showing Clays at 265 Feet Depth** **Figure 5-10 EVS Model of Historical Groundwater Elevations Relative to the Vadose Zone Plume and the Dissolved Benzene Plume in Groundwater** **Figure 5-11 3-Dimensional View Showing Estimated Location of LNAPL in the Saturated Zone** **NMED Comment:** Report revision required. NMED has identified the following issues with Figures 5-8 through 5- 11: **b.** Revise the figures to include well identification numbers and pertinent site features (e.g.: source area, former loading racks, former and current above ground storage tanks, any visible KAFB boundaries, Ridgecrest Drive).	As discussed in comment 21, the model and the associated discussion was removed from the report.

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91	65c	27	**65. Figure 5-8 EVS Model 3-Dimensional Views South to North and East to West Figure 5-9 EVS Model 3-Dimensional View Showing Clays at 265 Feet Depth** **Figure 5-10 EVS Model of Historical Groundwater Elevations Relative to the Vadose Zone Plume and the Dissolved Benzene Plume in Groundwater** **Figure 5-11 3-Dimensional View Showing Estimated Location of LNAPL in the Saturated Zone** **NMED Comment:** Report revision required. NMED has identified the following issues with Figures 5-8 through 5- 11: **c.** The plume depiction does not appear to match the data because there are several red and yellow soil vapor monitoring well (SVMW) points with elevated contaminant concentrations that are not incorporated into the plume. Explain this discrepancy and identify anomalous data on the figures in the revised Report.	As discussed in comment 21, the model and the associated discussion was removed from the report.
92	65d	27	**65. Figure 5-8 EVS Model 3-Dimensional Views South to North and East to West Figure 5-9 EVS Model 3-Dimensional View Showing Clays at 265 Feet Depth** **Figure 5-10 EVS Model of Historical Groundwater Elevations Relative to the Vadose Zone Plume and the Dissolved Benzene Plume in Groundwater** **Figure 5-11 3-Dimensional View Showing Estimated Location of LNAPL in the Saturated Zone** **NMED Comment:** Report revision required. NMED has identified the following issues with Figures 5-8 through 5- 11: **d.** Revise the Report to enable the reader to cross reference the lithologic data points for the intricate edges of the clay lenses with the other data presented in the report.	As discussed in comment 21, the model and the associated discussion was removed from the report.
93	66	28	**66. Figure 5-8 EVS Model 3-Dimensional Views South to North and East to West** **Figure 5-10 EVS Model of Historical Groundwater Elevations Relative to the Vadose Zone Plume and the Dissolved Benzene Plume in Groundwater** **NMED Comment:** Report revision required. It is difficult to interpret what represents BTEX in soil vapor and what represents dissolved benzene in groundwater because the same color scale is used for both data sets. Please revise Figures 5-8 and 5-10 to utilize contrasting color scales for BTEX concentrations in soil vapor and dissolved benzene concentrations in groundwater.	As discussed in comment 21, the model and the associated discussion was removed from the report.
94	66	28	**67. Figure 5-10 EVS Model of Historical Groundwater Elevations Relative to the Vadose zone Plume and the Dissolved Benzene Plume in Groundwater** **NMED Comment:** Report revision required. The figure is difficult to interpret because it is unclear if LNAPL thickness is represented and it is difficult to determine the compass orientation. Revise the figure to include well identification numbers and a north arrow for the purpose of orienting the features depicted in the figure. Also, the figure should be representative of the statements made in Section 5-2.	As discussed in comment 21, the model and the associated discussion was removed from the report.
95	68	28	**68. Figure 5-9 EVS Model 3-Dimensional View Showing Clays at 265 Feet Depth** **Figure 5-10 EVS Model of Historical Groundwater Elevations Relative to the Vadose Zone Plume and the Dissolved Benzene Plume in Groundwater** **Figure 5-11 3-Dimensional View Showing Estimated Location of LNAPL in the Saturated Zone** **NMED Comment:** Report revision required. The explanation of "Depth" in the legends in inaccurate. For example, on Figure 5-9, the legend states "(250) = Depth 100 feet below ground surface". Please revise the figures to accurately indicated depth.	As discussed in comment 21, the model and the associated discussion was removed from the report.
96	69	28	**69. Figure 5-8 EVS Model 3-Dimensional Views South to North and East to West** **Figure 5-11 3-Dimensional View Showing Estimated Location of LNAPL in the Saturated Zone** **NMED Comment:** Report revision required. Both figures appear to be missing key soil vapor data from Q2 2019. For example, Q2 019 soil vapor data from soil vapor monitoring point SVMW-09-266 shows a BTEX concentration of 3,398,000 parts per billion (ppb), which is not included in the figure. Please revise the figures to clearly depict all relevant Q2 2019 soil vapor data. Also, ensure that all monitoring points are labeled on all figures.	As discussed in comment 21, the model and the associated discussion was removed from the report.
97	70a	29	**70. Figure 5-11 3-Dimensional View Showing Estimated Location of LNAPL in the Saturated Zone** **NMED Comment:** Report revision required. Figure 5-11 is very difficult to read and interpret. There is no information on the figure which allows the reader to place the information presented within a spatial context for the BFFS: **a.** The figure depicts multiple isolated LNAPL bodies below the water table without explanation. Please revise the Report to include a discussion of the significance of the isolated LNAPL bodies depicted on Figure 5-11 and clarify whether all of the LNAPL bodies are included in the estimation of LNAPL smear zone thickness.	As discussed in comment 21, the model and the associated discussion was removed from the report.
98	70b	29	**70. Figure 5-11 3-Dimensional View Showing Estimated Location of LNAPL in the Saturated Zone** **NMED Comment:** Report revision required. Figure 5-11 is very difficult to read and interpret. There is no information on the figure which allows the reader to place the information presented within a spatial context for the BFFS: **b.** It is difficult to correlate high levels of BTEX in soil vapor (<10,000 ug/m3) in the representation of the subsurface of the site. Add well identification numbers to the figure.	As discussed in comment 21, the model and the associated discussion was removed from the report.

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99	70c	29	**70. Figure 5-11 3-Dimensional View Showing Estimated Location of LNAPL in the Saturated Zone** **NMED Comment:** Report revision required. Figure 5-11 is very difficult to read and interpret. There is no information on the figure which allows the reader to place the information presented within a spatial context for the BFFS: **c.** The legend indicates that "LNAPL in Groundwater" is depicted in the figure as a concentration ranging from 1,000 to 19,068 mg/kg. LNAPL is not usually presented as a concentration. Additionally, it is difficult to identify LNAPL in the figure. Please explain the presentation of LNAPL in units of mg/kg and revise Figure 5-11 so that LNAPL is readily identified.	As discussed in comment 21, the model and the associated discussion was removed from the report.
100	70d	29	**70. Figure 5-11 3-Dimensional View Showing Estimated Location of LNAPL in the Saturated Zone NMED Comment:** Report revision required. Figure 5-11 is very difficult to read and interpret. There is no information on the figure which allows the reader to place the information presented within a spatial context for the BFFS: **d.** Indicate which quarterly measurements (e.g., Q2 2019) were used to generate the depiction of LNAPL shown in the figure.	As discussed in comment 21, the model and the associated discussion was removed from the report.
101	70e	29	**70. Figure 5-11 3-Dimensional View Showing Estimated Location of LNAPL in the Saturated Zone NMED Comment:** Report revision required. Figure 5-11 is very difficult to read and interpret. There is no information on the figure which allows the reader to place the information presented within a spatial context for the BFFS: **e.** The area of interest on this figure is the submerged LNAPL in the saturated zone; however, the part of the figure in which the submerged LNAPL is illustrated is only a small portion of the total area available in the figure. Revise the Report to provide an additional figure focusing on the area of submerged LNAPL in the saturated zone which includes a way to identify the location beneath the BFFS site, appropriate scale indicators, and well identification numbers.	As discussed in comment 21, the model and the associated discussion was removed from the report. Added Figures 5-4 and 5-5 that show LNAPL Pore Volume Saturation Percent and LNAPL Total Volume Saturation Percent, respectively, at the location and depth of soil samples collected from the saturated zone.
102	71a	29	**71. Figure 5-12 Dissolved Benzene in the Saturated Zone** **NMED Comment:** Report revision required. NMED has identified multiple issues with this figure: **a.** It is difficult to interpret concentration data without clear contaminant contour lines. Please revise the figure to include contour lines.	As discussed in comment 21, the model and the associated discussion was removed from the report.
103	71b	29/30	**71. Figure 5-12 Dissolved Benzene in the Saturated Zone** **NMED Comment:** Report revision required. NMED has identified multiple issues with this figure: **b.** It is unclear what data were used to create this plume image. If the data for all groundwater monitoring wells sampled during Q2 2019 were included, these wells must be identified in the figure. If not, the Permittee must justify that the limited data set is representative of the site conditions. The Permittee must clarify and provide an explanation in the appropriate section of the revised Report.	As discussed in comment 21, the model and the associated discussion was removed from the report.
104	71c	29/30	**71. Figure 5-12 Dissolved Benzene in the Saturated Zone** **NMED Comment:** Report revision required. NMED has identified multiple issues with this figure: **c.** The legend shows a color scale for dissolved benzene in groundwater but the notes reference Q2 2019 soil vapor data. Please resolve the discrepancy.	As discussed in comment 21, the model and the associated discussion was removed from the report.
105	72a	30	**72. Figure 5-13 Total BTEX in Soil Vapor in the Vadose Zone** **NMED Comment:** Report revision required. NMED has identified the following issues with the figure: **a.** The area of interest is very small compared to size of the background aerial photograph, and therefore approximately 80% of the figure is non-relevant imagery of the surrounding area. Please revise the figure scale to clearly depict area of interest.	As discussed in comment 21, the model and the associated discussion was removed from the report.
106	72b	30	**72. Figure 5-13 Total BTEX in Soil Vapor in the Vadose Zone** **NMED Comment:** Report revision required. NMED has identified the following issues with the figure: **b.** It is unclear what data was used to create the figure. Revise the figure to identify the wells from which data was used to create the figure.	As discussed in comment 21, the model and the associated discussion was removed from the report.
107	72c	30	**72. Figure 5-13 Total BTEX in Soil Vapor in the Vadose Zone** **NMED Comment:** Report revision required. NMED has identified the following issues with the figure: **c.** It is unclear what subsurface sampling elevations were used to create the depiction of the soil vapor plume. Revise the figure to include the subsurface elevations represented on the figure	As discussed in comment 21, the model and the associated discussion was removed from the report.
108	72d	30	**72. Figure 5-13 Total BTEX in Soil Vapor in the Vadose Zone** **NMED Comment:** Report revision required. NMED has identified the following issues with the figure: **d.** The color gradient scale in the legend is very subtle in its differentiation between values over several orders of magnitude; furthermore, the colors in the legend do not match the colors in the figure. Revise the figure using a more detailed color gradient that matches the colors used in the figure and add contaminant contour lines.	As discussed in comment 21, the model and the associated discussion was removed from the report.

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109	72e	30	**72. Figure 5-13 Total BTEX in Soil Vapor in the Vadose Zone** **NMED Comment:** Report revision required. NMED has identified the following issues with the figure: **e.** The figure depicts an isolated pocket of elevated BTEX vapor to the west of KAFB-106S3 with no associated soil vapor wells or data points in the vicinity to identify the source of the data used to create the figure. Also, it is difficult to estimate the concentration of this pocket of BTEX soil vapor using the scale provided in the legend of the figure. The Permittee must discuss this pocket of BTEX in the relevant portions of the Report and add associated data points to the revised Figure.	As discussed in comment 21, the model and the associated discussion was removed from the report. Added Figures 5-4 and 5-5 that show LNAPL Pore Volume Saturation Percent and LNAPL Total Volume Saturation Percent, respectively, in soil samples collected from the saturated zone.
110	73a	30/31	**73. Figure 5-14 Total BTEX in Soil Vapor in the Vadose Zone, and Dissolved Benzene in the Saturated Zone NMED Comment:** Report revision required. NMED has identified multiple issues with the figure: **a.** It is not clear to which depth/elevations the depicted soil vapor data correspond. Please revise the figure to add depths/elevations.	As discussed in comment 21, the model and the associated discussion was removed from the report.
111	73b	30/31	**73. Figure 5-14 Total BTEX in Soil Vapor in the Vadose Zone, and Dissolved Benzene in the Saturated Zone NMED Comment:** Report revision required. NMED has identified multiple issues with the figure: **b.** The figure portrays groundwater data and soil vapor data with the same color scheme making it difficult to precisely interpret the data presented on the figure. Revise the figure with different color schemes for each data set depicted on the figure.	As discussed in comment 21, the model and the associated discussion was removed from the report.
112	73c	30/31	**73. Figure 5-14 Total BTEX in Soil Vapor in the Vadose Zone, and Dissolved Benzene in the Saturated Zone NMED Comment:** Report revision required. NMED has identified multiple issues with the figure: **c.** The color gradient panel for BTEX in soil vapor does not match the color presented on the figure. Revise the figure to use a color scale that matches both the key and the data.	As discussed in comment 21, the model and the associated discussion was removed from the report.
113	73d	30/31	**73. Figure 5-14 Total BTEX in Soil Vapor in the Vadose Zone, and Dissolved Benzene in the Saturated Zone** **NMED Comment:** Report revision required. NMED has identified multiple issues with the figure: **d.** It is unclear which data were used to create Figure 5-14. Wells KAFB-106V1 and KAFB-106V2 are not included on Figure 5-14. Revise the figure notes to explain which data sets were used to create Figure 5-14 and include all data points in the revised figure.	As discussed in comment 21, the model and the associated discussion was removed from the report.
114	73e	30/31	**73. Figure 5-14 Total BTEX in Soil Vapor in the Vadose Zone, and Dissolved Benzene in the Saturated Zone** **NMED Comment:** Report revision required. NMED has identified multiple issues with the figure: **e.** A large portion of Figure 5-14 depicts non-relevant surrounding satellite imagery. Revise the scale of the figure to provide greater detail for the area of interest.	As discussed in comment 21, the model and the associated discussion was removed from the report.
115	74	31	**74. Table 3-1 Coring Intervals and Soil Sample Locations** **NMED Comment:** Report revision required. Many different types of soil samples were collected for this field effort. Revise Table 3-1 to include any samples that may have been collected with drilling methods other than sonic (e.g., air rotary casing hammer). Additionally, please revise Table 3-1 to indicate which types of samples were collected at the depths presented on the revised table.	Table 3-1 was revised to show samples collected from ARCH cuttings in bold. The table notes were revised with the following note: "*Samples collected from soil cuttings were analyzed for total petroleum hydrocarbons. All other analyses were performed on samples collected from sonic cores."* Figure 5-3 and Table 3-1 have been revised to depict which samples were collected from soil cuttings.
116	75	31	**75. Table 4-1 Photoionization Detector Field Screening Data** **NMED Comment:** Report revision required. The depth for KAFB-106S8 is incorrectly expressed as a PID reading of 70.4 ppm rather than a depth of 450 ft bgs. Please revise the table to correct the error.	Depth was corrected to 450 ft bgs.
117	76	31	**76. Table 4-1 Photoionization Detector Field Screening Data** **NMED Comment:** Report revision required. Table 3-3 of the Work Plan, along with Table 3-1 and Table 4-1 of the Report indicate that KAFB-106247, the 'background' boring, was only sampled at 5 of the 10 proposed sample intervals defined by the Work Plan. In Section 4.3 (Deviations from Work Plan) of the revised Report, please explain why laboratory samples for KAFB-106247 were not collected according to the approved Work Plan.	Table 3-1 of the report originally only reported samples collected for TPH and VOC analysis. The table has been revised to include all samples. The sampling intervals for KAFB-106247, the background boring, were revised to better match the site-specific samples that were collected during the field investigation. The revised sample table was approved by NMED in an email dated January 28, 2019 and required nine sample locations. A copy of the email and the sample table can be found in Appendix A.
118	77	32	**77. Table 5-1 Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil** **NMED Comment:** Report revision required. All laboratory results are presented in Table 5-1 with the LOD only. Add a column to Table 5-1 to report the DL, LOD, and LOQ for each analysis presented. See General Comment 4.g.	A flat file of the data is provided as Appendix J and includes the three DOD reporting limits for each analyte reported.

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119	78	32	**78. Table 5-1 Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil** **NMED Comment:** The table footnotes refer to "RSL = regional screening level". The regional screening levels (RSLs) are not included in Table 5-1. Revise Table 5-1 to include a column for the appropriate screening levels used for the Report and reference the screening levels correctly in the table footnotes (e.g., NMED, NMWQCC, EPA, etc.).	The footnote has been removed from Table 5-1. NMED Soil Screening Levels (SSL) were not added to Table 5-1 because site conditions depart substantially from the conceptual model used to derive the soil leaching to groundwater SSLs. The depth of most soil samples makes the soil leachate pathway the appropriate SSLs; however, limitations in Section 4.5 of NMED's Risk Assessment Guidance for Site Investigations and Remediation (NMED 2019) are not all satisfied, including: 1) the significant vadose zone thickness provides potential significant attenuation for leaching and 2) NAPL is present. For the Corrective Measure Evaluation development of Site-Specific SSLs for protection of groundwater may be developed in accordance with Section 4.7 (NMED 2019). For the Corrective Measure Evaluation, SSLs for protection of groundwater will be evaluated in accordance NMED's Risk Assessment Guidance for Site Investigations and Remediation (NMED 2019).
120	79	32	**79. Table 5-2, Soil Grain Distribution and Classification** **NMED Comment:** Report revision required. The USCS Classification appears to be based on the lithologic logs rather than the particle size distribution presented in the table. See Comment 25. The Permittee must also include a table which compares the lithologic log descriptions to the laboratory particle size distribution in the revised Report.	The sample core bags were submitted to the laboratory unopened from the field. The soil borings were logged based on the lithology above and below the sample intervals. The actual sample intervals were not logged and thus a comparison to the laboratory data cannot be made.
121	80	32	**80. Table 5-3 Lithology and Interstitial Properties of Selected Core Samples** **NMED Comment:** Report revision required. Table 5-3 presents data quantifying porosity, permeability, and saturation of cores based on lithology and analyses of individual cores. In the relevant section of the Report, the Permittee must discuss fluid losses that may have occurred to cores during retrieval of the cores from boreholes during the drilling process and how this may affect sample integrity, data representativeness, and the representativeness of estimates of soil moisture in the vadose and saturated zones.	The text in Section 5.2.6 was revised as follows (new text in italics); "Moisture analyses were performed by ASTM International D2216-90 (ASTM International, 2005*) by three different laboratories, PTS Laboratory, Daniel B. Stephens and Associates, and TestAmerica. The core samples submitted to PTS Laboratory were sealed in the plastic sleeves in which they were collected. The cores were frozen and then shipped in a cooler on ice for next day delivery to the laboratory. The samples submitted to Daniel B. Stephens and Associates were submitted in the plastic sleeves in which they were collected, and hand delivered to the laboratory. These procedures were performed to minimize potential moisture losses. The soil samples submitted to TestAmerica were containerized in glass jars and shipped overnight on ice to the laboratory. The moisture content is used by the laboratory to provide dry weights for the TPH, EDB, and VOCs analyses. It is likely that some moisture was lost in the repackaging of these samples, although it should be minimal.* *Soil samples were collected using the sonic drilling method from various depths below ground surface under significant overburden pressures. As a result, the samples should be considered disturbed and may not be representative of the in-situ density of the sample. It is also likely that the moisture contents of saturated sand and gravel samples collected below the water table have been biased low due to gravity drainage within the sample bags. Coarse-grained samples (sands and gravels) with high permeability collected below the water table may have experienced drainage where water drained to the bottom of plastic sample sleeve and not collected during sample preparation. This would create a low bias towards the moisture content of samples collected below the water table. Water draining from permeable sand and gravel samples is more likely to occur in samples collected below the water table than above the water table. Above the water table, the moisture is held in capillary tension and did not freely drain upon extrusion from the core barrel."*
122	81	32	**81. Table 5-4 Summary of LNAPL Saturation and Mobility for Select Core Samples** **NMED Comment:** Report revision required. Please revise the table to add a footnote explaining how LNAPL Saturation (%TV) was calculated for this table.	The following note was added to the footnotes of Table 5-4: "LNAPL Saturation (%TV) =LNAPL Saturation (%PV) * Porosity / 100".
123	82a	32/33	**82. Table 5-7 Summary of Soil Analytical Moisture Content** **NMED Comment:** Report revision required. Table 5-7 contains inconsistencies, errors, and omissions. a: Add a footnote to indicate what impact fluid loss, due to core retrieval and sample shipping and handling, may had on soil moisture content in samples.	Added the following footnote: "*Soil samples were collected using the sonic drilling method from various depths below ground surface under significant overburden pressures. As a result, the samples should be considered disturbed and may not be representative of the in-situ density of the sample. It is also likely that the moisture contents of saturated sand and gravel samples collected below the water table have been biased low due to gravity drainage within the sample bags."*
124	82b	32/33	**82. Table 5-7 Summary of Soil Analytical Moisture Content** **NMED Comment:** Report revision required. Table 5-7 contains inconsistencies, errors, and omissions. The Permittee must correct the following in the revised report: **b**: The manner in which the LNAPL data is presented is unclear. For example, the result of 7.2% LNAPL at 122 ft bgs could belong to either V1 or V2, or both, and the result of 2.1% LNAPL at 490 ft bgs could belong to either S5 or S9. Provide clarification on which borings and sample depth correspond to the percentages of LNAPL.	Column with LNAPL data has been removed for clarity.

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125	82c	32/33	**82. Table 5-7 Summary of Soil Analytical Moisture Content** **NMED Comment:** Report revision required. Table 5-7 contains inconsistencies, errors, and omissions. The Permittee must correct the following in the revised report: **c:** The manner in which the lithologic data is presented is misleading. It is not accurate to assume that lithologies remain consistent at any given depth across the area of investigation. Some cells in the "USCS" column of the table have more than one lithology listed, some are separated by dashes, slashes, and or/spaces and some are presented in different colored fonts. For example, at the depth of 360 ft bgs there are two readings for soil moisture (for S3 and S5), and the USCS is presented as "SW-SP/SM" on the left side of the cell and "SW" on the right side of the cell. It is unclear which lithology is associated with S3 and which is associated with S5. Furthermore, the color coding of the font to represent different laboratories that performed analysis does not always correlate with the order of presentation of data at any given depth. Revise Table 5-7 to accurately present soil moisture data and lithology at the site.	The USCS classifications from the soil boring logs and/or the mean grain size from the PTS Laboratory data were moved next to their respective moisture content results in the table.
126	82d	32/33	**82. Table 5-7 Summary of Soil Analytical Moisture Content** **NMED Comment:** Report revision required. Table 5-7 contains inconsistencies, errors, and omissions. The Permittee must correct the following in the revised report: **d**: The Permittee must add the DBS lab results for KAFB-106247 at 490 ft bgs.	The DBS&A laboratory result of 9.3 percent was added for KAFB-106247 at a depth of 490 feet below ground surface.
127	82e	32/33	**82. Table 5-7 Summary of Soil Analytical Moisture Content** **NMED Comment:** Report revision required. Table 5-7 contains inconsistencies, errors, and omissions. The Permittee must correct the following in the revised report: **e**: The Permittee must add the PTS laboratory results for KAFB-106S5 at 488 ft bgs and KAFB-106S7 at 492 ft bgs.	The PTS Laboratory results of 8.2 and 6.9 percent were added for KAFB-106S5 at 488 feet below ground surface and 6.9 was added for KAFB-106S7 at 492 feet below ground surface.
128	82f	32/33	**82. Table 5-7 Summary of Soil Analytical Moisture Content** **NMED Comment:** Report revision required. Table 5-7 contains inconsistencies, errors, and omissions. The Permittee must correct the following in the revised report: **f**: The result for S9 at 342 ft bgs is presented as 14%, whereas the TA laboratory results present the value as 16.3%. Correct this discrepancy in the revised Report.	The TestAmerica moisture content results in Table 5-7 are associated with TPH results. The 14% moisture content result is associated with the TPH analysis. The 16.3% moisture content is associated with the EDB analysis. The TPH results were used because TPH was collected for every hydrocarbon sample and represented the most complete moisture content data set.
129	82g	32/33	**82. Table 5-7 Summary of Soil Analytical Moisture Content** **NMED Comment:** Report revision required. Table 5-7 contains inconsistencies, errors, and omissions. The Permittee must correct the following in the revised report: **g**: Adjust the font color for results for V1 at 158 ft bgs to blue to indicate that the analysis was performed by PTS laboratory	Font color was changed to blue.
130	82h	32/33	**82. Table 5-7 Summary of Soil Analytical Moisture Content** **NMED Comment:** Report revision required. Table 5-7 contains inconsistencies, errors, and omissions. The Permittee must correct the following in the revised report: **h**: Data in the Table is presented with inconsistent significant figures. The Permittee must use consistent significant figures in all data presented in the revised report	Significant figures were edited.
131	83	33/34	**83. Table 5-8, Table 5-8** **NMED comment:** The results for percent moisture for five of the 22 samples presented do not match the results for percent moisture presented on Table 5-7. Please correct these discrepancies in the revised Report.	Table was revised accordingly.

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132	84	34	**84. Appendix C - Temperature Logs** **NMED Comment:** The Core Temperature Log indicates many instances where intervals of core were dropped from the core barrel into the borehole during the process of bringing the core to the surface. In some cases, the partial sections of disturbed core were retrieved by the driller. The driller also reports the addition of water to the borehole during drilling. The driller's comments must be addressed in Section 4.3, Deviations from Work Plan. The impact on sample integrity of dropped and/or lost core, and data representativeness must be addressed in the appropriate sections and tables of the Report. Revise the Report accordingly.	The following text has been added to Section 4.3, "*During the drilling process, there were occasions when the sample was unable to be retained within the core barrel.* When this occurred, the driller would make another attempt at collecting the sample. When this occurred, the sample was reported on the core temperature log as disturbed and the driller made another attempt at sample collection. This occurred during the collection of the following samples: • *KAFB-106S2 at depths of 105, 278, and 404 ft bgs and KAFB-106S4 at a depth of 366 ft bgs. All of these samples were submitted because they indicated the highest heated headspace concentration of their sample interval. These samples were submitted for analysis of TPH, the results of which were non-detect. These samples were collected within the vadose at wells that are located outside of the BFF. Due to this it is unlikely that these samples would contain significant concentrations of TPH and little to no impact from the disturbance is expected for these samples. Sample disturbance for these samples will be indicated on the appropriate tables and figures.* • At KAFB-106S9 the driller attempted to make a 10-foot long core run at a depth interval of 491 to 500 ft bgs (with nine ft of recovery). During retrieval, the core fell out of the core barrel and was disturbed. Another attempt was made that successfully collected the core interval. A sample within this interval was collected at a depth of 496 ft bgs for analysis of TPH and VOCs. This sample was collected because it indicated the highest headspace concentration of the borehole. While the depth may be suspect due to the core disturbance, it is unlikely that the laboratory sample concentration was affected since the sample was collected based on the headspace concentration. In addition, the core temperature was 20.4 ºC (close to background temperatures) and unlikely to have been affected by overheating of the sample. Two cores were also collected from this core run at depths of 491 to 493 ft bgs and 493 to 495 ft bgs. These samples were submitted to the laboratory for UV light analysis based on field screening (the possible presence of LNAPL based on in-field UV light screening). It is likely that these cores are disturbed. Sample disturbance for these samples will be indicated on the appropriate tables and figures. *The driller periodically added small amounts of water to the borehole (one to 7.5 gallons of water) to reduce sample temperatures and in one case, assist with getting the core barrel unstuck (KAFB-106V1 at 115 ft bgs). The addition of water was discussed in the Work Plan (Section 3.1.1.1 Drilling Approach and Methodology, Page 3-2, Kirtland AFB 2017a). The addition of water is not a deviation from the Work Plan and it is standard drilling operation procedure to preserve data and minimize loss of VOCs. Whenever water was added to borehole, it was noted on the temperature logs. The top of the core run where borehole slough was present (along with the added water) was discarded. Due to this, the addition of water is unlikely to impact sample integrity."*

References

All references listed in the above RTC table are provide in the Reference section of the report expect for the following:

Kirtland Air Force Base. 2020a. *Work Plan for Data Gap Monitoring Well Installation KAFB-106248 to KAFB106252 and KAFB-106S10, Bulk Fuels Facility, Solid Waste Management Unit St-106/SS-111.* Prepared by Sundance Consulting, Inc., for the USACE-Albuquerque District. September.

KIRTLAND AIR FORCE BASE
ALBUQUERQUE, NEW MEXICO

SOURCE ZONE CHARACTERIZATION REPORT
Revision 1
FOR THE BULK FUELS FACILITY
SOLID WASTE MANAGEMENT UNITS~~s~~ ST-106/SS-111

APRIL~~OCTOBER~~ 2021~~19~~

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KIRTLAND AIR FORCE BASE
ALBUQUERQUE, NEW MEXICO

Source Zone Characterization Report Revision 1
Solid Waste Management Units ST-106/SS-111
Kirtland Air Force Base, New Mexico

April~~October~~ 2021~~19~~

Prepared for
U.S. Army Corps of Engineers
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Contract No. W9128F-13-D-0006/Delivery Order DM02

NOTICE

This Source Zone Characterization Report Revision 1 summarizes an investigation to address data gaps in the horizontal and vertical extent of diffused and dispersed~~residual~~ light non-aqueous phase liquid (LNAPL) both in the vadose zone and submerged in groundwater at Solid Waste Management Units ST-106/SS-111. This report was prepared for Kirtland Air Force Base under U.S. Army Corps of Engineers Contract Number W9128F-13-D-0006/Delivery Order DM02 by EA Engineering, Science, and Technology, Inc., PBC.

The source zone characterization included sonic coring at 11 locations and collection of soil samples for chemical, physical, and biological analyses. Physical ~~and chemical~~ characterization was performed on diffused and dispersed~~residual~~ LNAPL samples. All coring locations were completed as nested groundwater monitoring wells or vapor monitoring wells to augment the monitoring networks associated with the Kirtland Air Force Base Bulk Fuels Facility, Solid Waste Management Units ST-106/SS-111.

This work was performed under the U.S. Air Force Environmental Restoration Program, in general accordance with requirements set forth in the Resource Conservation and Recovery Act Permit Number NM9570024423, issued to Kirtland Air Force Base. The New Mexico Environment Department is the lead regulatory agency.

Government agencies and their contractors registered with the Defense Technical Information Center should direct requests for copies of this report to: Defense Technical Information Center, Cameron Station, Alexandria, Virginia 22304-6145.

Non-government agencies may obtain a copy of this document from: U.S. Air Force Civil Engineer Center Administrative Record web page.

REPORT DOCUMENTATION PAGE	*Form Approved* *OMB No. 0704-0188*

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4. TITLE AND SUBTITLE Source Zone Characterization Report Revision 1 for the Bulk Fuels Facility Solid Waste Management Units ST-106/SS-111, Kirtland Air Force Base, Albuquerque, New Mexico	**5a. CONTRACT NUMBER** W9128F-13-D-0006 **5b. GRANT NUMBER** **5c. PROGRAM ELEMENT NUMBER**
6. AUTHOR(S) EA Engineering, Science, and Technology, Inc., PBC	**5d. PROJECT NUMBER** 62735DM02 **5e. TASK NUMBER** DM02 **5f. WORK UNIT NUMBER** Not applicable
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) AND ADDRESS(ES) EA Engineering, Science, and Technology, Inc., PBC 320 Gold Avenue SW, Suite 1300 Albuquerque, New Mexico 87102	**8. PERFORMING ORGANIZATION REPORT NUMBER** Not assigned
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Corps of Engineers–Albuquerque District 4101 Jefferson Plaza NE Albuquerque, New Mexico 87109-3435	**10. SPONSOR/MONITOR'S ACRONYM(S)** **11. SPONSOR/MONITOR'S REPORT NUMBER(S)**

12. DISTRIBUTION / AVAILABILITY STATEMENT

13. SUPPLEMENTARY NOTES

14. ABSTRACT

This Source Zone Characterization Report Revision 1 summarizes an investigation to address data gaps in the horizontal and vertical extent of diffused and dispersed~~residual~~ light non-aqueous phase liquid (LNAPL) both in the vadose zone and submerged in groundwater at Solid Waste Management Units ST-106/SS-111. The source zone characterization included sonic coring at 11 locations and collection of soil samples for chemical, physical, and biological analyses. Physical ~~and chemical~~ characterization was performed on diffused and dispersed~~residual~~ LNAPL samples. Results are tabulated and discussed in this report.

15. SUBJECT TERMS

Source zone, jet fuel, aviation gas, diffused and dispersed ~~residual light non-aqueous phase liquid,~~ LNAPL, ethylene dibromide~~,~~ (EDB), sonic coring, ultraviolet fluorescence, core photography, x-ray diffraction, x-ray fluorescence, microbial analysis, LNAPL mobility, solute plume, vapor plume, intrinsic biodegradation, abiotic reactions, Bulk Fuels Facility, vadose zone, ~~Earth Volumetric Software modeling, EVS~~.

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40 CFR 270.11
DOCUMENT CERTIFICATION

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

____	____________________
DAVID S MILLER, Colonel, U.S. Air Force Commander, 377th Air Base Wing	Date

This document has been approved for public release.

____	____________________
KIRTLAND AIR FORCE BASE 377th Air Base Wing Public Affairs	Date

PREFACE

This report has been prepared by EA Engineering, Science, and Technology, Inc., PBC (EA) for Kirtland Air Force Base (AFB) under the U.S. Army Corps of Engineers Contract Number W9128F-13-D-0006, Delivery Order DM02. This report summarizes an investigation to characterize the source zone associated with a historic fuel release at Solid Waste Management Units ST-106/SS-111, Bulk Fuels Facility at Kirtland AFB, New Mexico. This report was prepared in general accordance with the requirements of Part 6 of the Resource Conservation and Recovery Act Permit Number NM9570024423 issued to Kirtland AFB.

The source zone characterization was performed to address data gaps in the horizontal and vertical extent of diffused and dispersed~~residual~~ light non-aqueous phase liquid (LNAPL) both in the vadose zone and submerged in groundwater. The source zone characterization included sonic coring at 11 locations and collection of soil samples for chemical, physical, and biological analyses. Physical ~~and chemical~~ characterization was performed on diffused and dispersed~~residual~~ LNAPL samples. All coring locations were completed as nested groundwater or vapor monitoring wells to augment the monitoring networks.

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TABLES

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ACRONYMS AND ABBREVIATIONS

%	percent
AFB	Air Force Base
amsl	above mean sea level
API	American Petroleum Institute
ARCH	air rotary casing hammer
Avgas	aviation gasoline
BFF	Bulk Fuels Facility
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and total xylenes
DRO	diesel range organics
e	electron
EA	EA Engineering, Science, and Technology, Inc., PBC
EDB	ethylene dibromide (also known as 1,2-dibromoethane)
EPA	U.S. Environmental Protection Agency
EVS	Earth Volumetric Software
Fe	iron
FFOR	Former Fuel Offloading Rack
FOC	fractional organic carbon
ft	foot/feet
g	gram(s)
GRO	gasoline range organics
GWM	groundwater monitoring
IDW	investigation-derived waste
ITRC	Interstate Technology Regulatory Council
(J)	estimated concentration below the practical quantitation limit but above the lower quantitation limit
JP	jet propellant
KAFB	Kirtland Air Force Base
LNAPL	light non-aqueous phase liquid
mg/kg	Milligrams per kilogram
mg/L	milligram(s) per liter
MRO	motor oil range organics
NMED	New Mexico Environment Department
O	oxygen

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PCR	polymerase chain reaction
PID	photoionization detector
Q1	first quarter
Q2	second quarter

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RCRA	Resource Conservation and Recovery Act
REI	reference elevation interval
RP	Recommended Practice
S	Sulfide
SVM	soil vapor monitoring
SWMU	Solid Waste Management Unit
TPH	total petroleum hydrocarbons
USACE	U.S. Army Corps of Engineers
USCS	Unified Soil Classification System
UV	ultraviolet
VOCs	volatile organic compounds
wt.%	weight percent
XRD	x-ray diffraction
XRF	x-ray fluorescence

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EXECUTIVE SUMMARY

This report describes the source zone characterization activities that were performed from October 5, 2018 to March 7, 2019. The scope of work for this assessment was performed in accordance with the Work Plan for Vadose Zone Coring, Vapor Monitoring, and Water Supply Sampling (Kirtland Air Force Base, 2017a). The Work Plan was approved with conditions by the New Mexico Environment Department (NMED) on February 23, 2018(NMED, 2018a). The submittal of this report was requested by NMED in a letter dated February 25, 2019 letter (NMED, 2019a). The submittal of this report satisfies that requirement.~~. The submittal of this report to NMED satisfies the requirement in NMED's February 25, 2019 letter (NMED 2019a).~~

The Bulk Fuels Facility area consisted of a tank holding area where bulk shipments of fuel were received and a fuel loading area where individual fuel trucks were filled. Underground piping was used to convey fuel between these locations. Kirtland Air Force Base removed the underground piping from service in 1999 due to the discovery of a release~~leakage~~. The release area is referred to as the source area and it is located in the northwest portion of the Base to the south of Randolph Road, Southeast within the installation boundary.

Continuous cores were drilled to the water table at ~~11~~nine locations and two were cored in the vadose zone near the source area to ~~define~~ assess the horizontal and vertical extent of light non-aqueous phase liquid (LNAPL) at Solid Waste Management Units (SWMUs) ST-106/SS-111 (the Site). In addition to the LNAPL characterization, nested monitoring wells were constructed in each borehole with nine dual-completion groundwater monitoring wells and two, six-well- nest soil vapor monitoring wells. The groundwater monitoring wells were installed to address data gaps in the source zone created by the rising groundwater elevation. The soil vapor monitoring wells were installed as observation wells for the bioventing pilot study that was initiated in 2019~~8~~. Soil core samples were collected to obtain contaminant concentration and soil and LNAPL properties data.

~~The results of this investigation indicate that the presence of fuel has been significantly reduced in the vadose zone by remedial actions and natural processes.~~ Residual fuel remains in place in the subsurface in the source area soils and below the water table in areas where LNAPL was historically detected in monitoring wells. Laboratory analysis ~~for~~o soil properties indicate that the LNAPL is immobile. ~~The results of the investigation are discussed in more detail below.~~

The highest concentrations of fuel-release~~leak~~ related constituents in the vadose zone were found in the source area at a depth of 254 feet (ft) below ground surface (bgs). These concentrations then decrease significantly below a clay layer at a depth of approximately 265 ft bgs. ~~The concentrations of total petroleum hydrocarbons; benzene, toluene, ethylbenzene, and total xylenes (BTEX); and ethylene dibromide (EDB) in all other vadose zone samples were below applicable laboratory reporting limits.~~

LNAPL saturation in vadose zone samples was highest in the source area and none of the samples were found to contain mobile LNAPL,~~. This~~ demonstrating~~es~~ that there is no drainage of LNAPL that could cause a continued LNAPL head in the source area that would be required to drive migration.

A diffused and residual~~residual~~ LNAPL smear zone is present below the water table and downgradient from the source area extending northeast under USS Bullhead Memorial Park. Laboratory analysis demonstrates that the LNAPL in this zone is immobile.

Additional findings based upon analysis of samples from the vadose zone include:

- Microbial analyses from vadose zone cores ~~indicate that microbial genes responsible for biological degradation were not observed in analytical results. These results~~ indicate a low potential for anaerobic degradation of EDB, but moderate potential for aerobic degradation of BTEX.

- Mineralogy analyses using x-ray diffraction, x-ray fluorescence, and magnetic susceptibility were used to assess the potential for abiotic remedial techniques. Based on the results of the data, abiotic attenuation of EDB with respect to iron-bearing minerals is not anticipated to be significant.

- Moisture content data were collected to assist with the bioventing pilot study. The moisture content ranged from 1.3 to 33.8 wt.% for the analyzed samples. ~~The moisture content ranged from 1.3 to 33.8 wt.% in the samples collected from the vadose zone.~~ In general, soil moisture averaged approximately 5% in well graded and poorly graded sand samples collected in the vadose zone. ~~Moisture content data were collected to assist with the bioventing pilot study. In general, soil moisture was less than 5 percent in vadose zone samples.~~ There also did not appear to be a significant difference in moisture contents in samples collected in the source area versus those collected off-Base.

The highest concentrations of fuel-release~~leak~~ related constituents in the saturated zone were found in the source area at a depth of approximately 490 ft bgs. Concentrations decrease with distance from the source area, particularly off-Base. LNAPL saturation in saturated zone samples was highest in the source area and none of the samples were found to contain mobile LNAPL.

The data indicates that the fuel migrated vertically through mostly permeable non-cohesive soil by gravity drainage from the release point to a clay layer encountered around 260 to 270 feet bgs. Upon encountering the clay layer, the fuel saturated the soil above the clay, resulting in increased hydraulic head that eventually overcame the capillary pressure of pore water in the clay porosity. Once this pressure was overcome, LNAPL migrated into and through the clay layer (ITRC-3, 2018). Not only did the hydraulic head that built up drive the LNAPL into and through the clay, it spread LNAPL laterally on the clay layer as a saturated fluid. Laterally, LNAPL may have pooled with sufficient hydraulic head to penetrate the clay elsewhere.

Once the LNAPL entered the clay, structural changes to the clay facilitated greater permeability and ability to transmit the LNAPL through the clay to the underlying permeable soil. This mechanism is contrary to the concept that the clay formed an impermeable layer to the LNAPL, LNAPL migrated vertically through the clay, and laterally through the clay by capillarity. A "hole" or other discontinuity in the clay layer is not required to explain the deeper migration of LNAPL to the water table.

~~The lithologic and LNAPL data from this investigation were combined with soil vapor data collected in the second quarter (Q2) 2019 to create a subsurface lithological model of the current state of the vadose and groundwater plumes. The primary path for the migration of mobile LNAPL was gravity drainage through sands and gravels~~. ~~, not along low permeability layers (i.e., clay or silt) as previously thought.~~ Vertical downward migration appears to have continued until the LNAPL intercepted the groundwater table. Dissolved-phase EDB and benzene plumes then developed and migrated northward according to the local historical groundwater gradient. The LNAPL migrated as far north as USS Bullhead Memorial Park. As the groundwater decreased in elevation, transport would have followed the LNAPL gradient created by the continued drainage and favored the groundwater gradient.~~.~~

Locations where groundwater concentrations of fuel-related constituents exceed the calculated effective solubility of benzene may be indicative of the presence of LNAPL in the saturated zone. The effective solubility of benzene (1.43 milligrams per liter) was used as a conservative method for approximating the location of submerged LNAPL. The Q2 2019 isocontour plot for benzene shows that the BTEX plume biodegrades within a relatively short distance (less than 500 ft) from the diffused and dispersed~~residual~~ LNAPL source and is fully attenuated before it reaches Ridgecrest Drive.

1. INTRODUCTION

Solid Waste Management Units (SWMU) ST-106/SS-111 is located at Kirtland Air Force Base (AFB) in Bernalillo County, New Mexico. Kirtland AFB is located southeast of, and adjacent to, the City of Albuquerque and the Albuquerque International Sunport (airport). The approximate area of the base is 52,287 acres. The Bulk Fuels Facility (BFF or Site) is located in the northwestern portion of Kirtland AFB (Figure 1-1). Environmental restoration efforts at the BFF are being performed pursuant to the corrective action provisions in Part 6 of the Resource Conservation and Recovery Act (RCRA) Permit Number NM9570024423 (RCRA Permit). The New Mexico Environment Department (NMED) is the lead regulatory agency (NMED, 2010). This work ~~has been~~was performed under U.S. Army Corps of Engineers (USACE) Contract Number W9128F-13-D-0006/Delivery Order DM02. This report is the compliance deliverable for the Vadose Zone Work Plan per the February 25, 2019 NMED letter requirement (NMED, 2019a).

The coring program discussed in this report was performed~~completed~~ in accordance with the Work Plan for Vadose Zone Coring, Vapor Monitoring, and Water Supply Sampling, Revision 2 (Kirtland AFB, 2017a), referred to throughout this report as the Work Plan. The Work Plan was approved with conditions by NMED on February 23, 2018 (NMED, 2018a). This Work Plan included several scopes of work in addition to vadose zone coring and sampling. These scopes of work included soil vapor monitoring, an air-lift well pilot study, maintenance of the soil vapor monitoring well network, and water supply sampling. ~~Appendix A~~ Table A-1 in Appendix A provides the status for these various scopes of work. This report discusses the work performed to support the vadose zone coring, sampling, and monitor well installation.

The approval conditions included the collection of photoionization detector (PID) readings, specified coring interval starting depths, mineral/microbial data collection zones, optional coring locations, a background coring location, the timing of lithologic log submittals, NMED authorization to proceed prior to the drilling, and construction of bioventing wells.

The following 10 appendices accompany this report:

- Appendix A – Regulatory ~~c~~Correspondence including the Response to Comments Table.~~from the coring program.~~
- Appendix B – Daily ~~q~~Quality ~~c~~Control ~~r~~Reports.
- Appendix C – Core ~~Field t~~Temperature ~~l~~Logs~~screening reports~~.
- Appendix D – Lithologic ~~l~~Logs and ~~w~~Well ~~c~~Completion ~~d~~Diagrams.
- Appendix E~~D~~ – Technical Memorandum for Vadose Zone Core Photography Logs ~~A core photography technical memorandum.~~ .
- Appendix F~~E~~ – Site ~~and operational p~~Photographs.
- Appendix G – Laboratory ~~d~~Data ~~p~~Packages for ~~s~~Soil ~~s~~Samples.

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- Appendix H – Data Quality Evaluation Report, TestAmerica, Inc.
- Appendix I – Compiled Well Completion Report.
- Appendix J – Searchable Flat File of VOCs, EDB, and TPH Analytical Data.
- Appendix K~~F~~ – Waste ~~m~~Management ~~d~~Documentation ~~for hazardous and non-hazardous liquid and solid waste disposal.~~
- ~~Appendix G – Laboratory data packages for soil samples.~~
- ~~Appendix H – A Data Quality Evaluation Report for TestAmerica, Inc. data packages.~~
- ~~Appendix I – Lithologic logs and well completion diagrams.~~
- ~~Appendix J – Data used to construct the lithologic contaminant model.~~

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2. FACILITY HISTORY AND PROJECT BACKGROUND

The BFF at Kirtland AFB became operational in 1953 and has been used over time for the storage of aviation gasoline (AvGas), jet propellant 4 (JP-4), jet propellant 8 (JP-8), and smaller amounts of diesel fuel and unleaded gasoline. Jet fuel was offloaded from railcars or tanker trucks to the Former Fuel Offloading Rack (FFOR), pumped through underground pipelines to the pump house, and then to large fuel storage tanks~~akns~~ at the BFF. Releases~~. Leaks~~ were discovered in November 1999 when fuel staining was observed on the ground surface at the FFOR. Based on the chemical composition of the fuels stored and used at the BFF, the releases are estimated to have begun prior to 1975, when the BFF transitioned from AvGas to JP-4. Of the fuels stored and used at the BFF, only AvGas contained EDB as an additive. When the fuel release was discovered in November 1999, the FFOR was closed and a temporary fuel offloading area was constructed and used during the construction of~~while~~ aboveground infrastructure~~ was construction~~. Replacement of the infrastructure was finished in March 2011 and includes aboveground storage tanks and pipeline with leak detection and containment measures (Kirtland AFB, 2018a). The current and former~~former and current~~ infrastructure for the BFF is shown on Figure 2-1.

Once released, jet fuel entered~~s~~ the ground as a light non-aqueous phase liquid (LNAPL). Discharged fuels are considered LNAPL because they are 1) immiscible in water, 2) have low solubility in water (typically less than 1 percent by weight), and 3) are buoyant in water (i.e., lighter or less dense than water). Aromatic compounds present in hydrocarbon fuels—including benzene, toluene, ethylbenzene, and xylenes (BTEX)—and short-chain aliphatic compounds such as pentane, hexane and octane, dissolve in groundwater and soil porewater at varying concentrations~~,~~ which is controlled by their molecular weight, compound geometry, vapor pressure, and aqueous solubility. Fuel hydrocarbon compounds and LNAPL over time partition in the subsurface – sorption onto soil, volatilization into soil gas, dissolution into soil moisture and groundwater, and mobile (still free draining) and immobile (trapped in capillary tension) LNAPL in pore space. As the fuel was released from the underground pipelines over time, it drained vertically downward due to the force of gravity through different parts of the subsurface. Lateral spreading occurred in response to soil tension and permeability variations (Kirtland AFB, 2018a).

LNAPL traveled downward through soil in the vadose zone. The vadose zone is the part of the earth between the ground surface and the water table. The vadose zone is also referred to in this Report as the unsaturated zone, because this area is generally not saturated with water. The capillary fringe—where groundwater seeps up from the water table by capillary action—is also included in the vadose zone. At the Site, the vadose zone reaches to a depth of approximately 480 feet (ft) below ground surface (bgs). LNAPL traveled through the vadose zone to groundwater (Kirtland AFB, 2018a).

As LNAPL traveled through the subsurface, constituents in the LNAPL partitioned to different phases. In the vadose zone, LNAPL constituents volatilized and contributed to soil vapor contamination in the spaces between sand grains. LNAPL also sorbed to materials in soil, or dissolved into water between sand grains, and was retained in the spaces between grains in the vadose zone due to viscosity and capillary forces. When LNAPL reached the water table it spread laterally in response to buoyancy forces, selectively displaced groundwater from the interior of the larger pores in the aquifer media and began to dissolve into groundwater. Due to the age of the release and the rapid rise of the groundwater table, there is no longer a contiguous phase of fuel above the water table based on the last several years of gauging. The LNAPL is now discontinuously dispersed across the vadose zone and the upper portion of the aquifer.

LNAPL ~~Some~~ constituents (dissolved- phase fuel-related contamination) ~~of LNAPL~~ dissolved into groundwater ~~—also known as the dissolved-phase fuel-related contamination—~~and followed the flow of groundwater in a north–northeast direction.

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~~The BFF and associated infrastructure operated from 1953 until 1999. During this time, the fueling area consisted of a tank holding area where bulk shipments of fuel were received and a fuel loading area where individual fuel trucks were filled. Underground piping was used to convey fuel between these locations. Kirtland AFB removed the underground piping from service in 1999 due to the discovery of leakage. Details of the historical BFF operations, investigations, and interim measures are presented in the Phase I RCRA Facility Investigation Report (Kirtland AFB, 2018a), which summarizes data and site activities from November 1999 through December 2015. Current groundwater and soil vapor sampling data are presented in Quarterly Reports.~~

Interim measures were performed to remediate contamination in the vadose zone including excavating contaminated soil and performing SVE. Approximately 3,000 cubic yards of contaminated soil were excavated from the source area at the site from 1999 to 2015 to a depth of 20 feet below ground surface. Soil Vapor Extraction systems operated at the site from 2003 to 2015 and removed approximately 775,000 equivalent gallons of jet fuel. GWM activities have been ongoing at the site since 2000. Groundwater interim measures historically included skimmers and a modified bioslurping system to remove floating LNAPL (Note that the removed LNAPL is included in the 775,000 gallons).

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An understanding of the distribution and mobility of diffused and dispersed ~~andresidual light non-aqueous phase liquid (~~LNAPL~~)~~ in the vadose and saturated zones is critical to defining the nature and extent of contamination from the fuel release~~leak,~~ ~~evaluating the mobility of this diffused and dispersedresidual LNAPL,~~ and preparing for the corrective measures evaluation. This is particularly important due to changes in the water table elevation and gradient resulting from reduced pumping by the Albuquerque Bernalillo County Water Utility Authority due to the San Juan-Chama Drinking Water Project. This surface water diversion has relieved the pumping stress of the aquifer system and groundwater elevation has been rebounding approximately 3-4 ~~feet (~~ft~~)~~ per year (Beman, 2013).

This investigation of the source area focused on the following objectives that are discussed in this report:

- Collection, field screening, and laboratory testing of soil cores from 11 boreholes to assess the current state of LNAPL, adsorbed-phase contaminants, microbiological, and mineralogical constituents in the vadose and saturated zones.
- Installation of nine groundwater monitoring (GWM) wells to fill data gaps caused by the rising water table.
- Installation of two soil vapor monitoring (SVM) wells to assist with future bioventing pilot studies.
- Drilling of a soil borehole and conversion to a monitoring well to provide background data.

2.1 Regional Hydrogeology

In general, the site is underlain by approximately 200 ft of relatively fine-grained alluvial fan deposits, with some alternating and laterally discontinuous coarse-grained zones. Underlying these easterly derived alluvial fan deposits are relatively coarse-grained Ancestral Rio Grande deposits, with few laterally discontinuous fine-grained zones (Kirtland AFB, 2018a).

Coarse-grained, Ancestral Rio Grande deposits with northeast-southwest oriented channel axes are interbedded with fine-grained silt and clay units. These deposits have been structurally tilted to the east due to generally down-to-the east faulting along the Sandia Mountains. Braided deposits at the site are more restrictive in the transverse axis of the deposition channel (east-west), and less restrictive in the longitudinal axis (north-south). However, this geologic control is secondary to hydrologic controls on groundwater flow direction.

Two fine-grained clay-rich layers called A1 and A2 are present with the axial Ancestral Rio Grande fluvial deposits throughout the Albuquerque area (Kirtland AFB, 2018a). The A1 and A2 clay-rich layers are present at the site as laterally continuous fine-grained zones. The thicknesses of A1 and A2 range from approximately 50 ft to 200 ft and are observed across the site, extending north of the Ridgecrest well field. These A1 and A2 layers create confining conditions within the aquifer, and beneath these clays, groundwater occurs under confined conditions. Though these confining beds play a key role in the transport of dissolved-phased contaminants, flow direction of the dissolved-phase groundwater plumes is largely influenced by as the hydraulic gradient introduced by operation of the production wells.

3. SCOPE OF ACTIVITIES

The work associated with the source zone characterization included continuous coring at 11 locations in the vadose and saturated zones (Figure 3-1), installation of two nested SVM wells (KAFB-106V1 and KAFB-106V2), installation of eight dual-completion GWM wells (KAFB-106S1 through KAFB-106S5 and KAFB-106S7 through KAFB-106S9), and one background GWM well (KAFB-106247) (Kirtland AFB, 2017a). The two SVM wells (KAFB-106V1 and KAFB-106V2) were located in the source area near the two SVM wells (SVMW-10 and SVMW-11) that exhibited the highest total hydrocarbon concentration in soil vapor. The GWM wells (KAFB-106S1 through KAFB-106S7 ~~and KAFB-106S9~~ and KAFB-106S9) were located next to GWM wells where LNAPL was historically present. Finally, the location for the background well (KAFB-106247) was chosen in an area to the south of the BFF that did not have any history of hydrocarbon impacts.

The elevation of the water table has varied over the years since the fuel release~~leak~~. In 1953 (the earliest possible beginning of the fuel release~~leak~~), the groundwater elevation at the top of the aquifer was approximately 60 ft higher than current elevations (Rice et al., 2014). which would be approximately 4,950 ft AMSL. -The approximate groundwater elevation in the project area was 4,950 ft above mean sea (AMSL) level in 1950, 4,940 ft AMSL in 1960, ft AMSL and 4,930 ft AMSL in 1970. ~~Using KAFB-106S9 as an example, the depth to water was approximately 396 ft bgs in 1950, 406 ft bgs in 1960, 416 ft bgs in 1970, and 494 ft bgs in 2009.~~ The groundwater table elevation began dropping due to the development of the City of Albuquerque well fields and reached its lowest point of approximately 4,852 ft AMSL at the end of 2009. Using KAFB-106S9 as an example, the depth to water was approximately 396 ft bgs in 1950, 406 ft bgs in 1960, 416 ft bgs in 1970, and 494 ft bgs in 2009. Because of this, the nine boreholes that were drilled were converted to GWM wells with well screens at the water table. ~~in areas where existing GWM wells contained historic measurements of LNAPL.~~

Soil cores collected from the boreholes were screened for the presence of LNAPL (using ultraviolet [UV] light flashlights) and hydrocarbons (using the heated headspace method). The ability of LNAPL to fluoresce in the presence of UV light was used to screen for its presence. This was performed in accordance with Figure 3-7 Decision Logic schematic for Sample Collection of the approved work plan (Kirtland AFB, 2017a) which provides a flow chart for sample analyses. Selected cores were frozen and then sent for laboratory UV analysis to further confirm or deny the presence of LNAPL. During the laboratory analysis, the frozen soil cores were saw-cut in half and exposed to UV light. This provided an estimate of the location of LNAPL in the soil core. The intensity of the UV light provided an approximation of the relative amount of LNAPL present in the soil. This information was used to select sample locations for further laboratory LNAPL analysis (see below). However, in some cases, carbonate minerals also fluoresced under UV light. In these instances, the unfluoresced and fluoresced photos were compared. Fluorescent minerals typically appear spherical or light-colored in the unfluoresced photo. When these were observed to correspond to the same location in the UV light photo, these areas were not considered to have LNAPL present.

Soil cores and samples were submitted for laboratory analysis of:

- Volatile organic compounds (VOCs) (U.S. Environmental Protection Agency [EPA] Method 8260C); ethylene dibromide (EDB) (EPA Method 8011), and total petroleum hydrocarbons (TPH) gasoline range organics (GRO)/diesel range organics (DRO)/motor oil range organics (MRO) (EPA Method 8015D). These data were used to assist with assessing the nature and extent of the LNAPL, EDB, and hydrocarbons in the subsurface.

- LNAPL transmissivity and mobility, grain size, fluid properties, capillary pressure air/water drainage, free product mobility, relative permeability, and hydraulic conductivity. These data were used to assess the relative amount and mobility of LNAPL in the subsurface.
- LNAPL physical properties including gravity, hydrocarbon component analysis, flash point, and viscosity. These data were used to assess LNAPL mobility in the subsurface.
- Mineralogy using x-ray diffraction (XRD) and energy dispersive x-ray spectrometry. These data were used to assess the potential for abiotic degradation.
- Microbial analysis using QuantArray-Chlor to identify and quantify halorespiring bacteria. These data were used to assess the potential for aerobic or anaerobic degradation of EDB and hydrocarbons.
- Moisture analyses (ASTM International D2216). These data were collected to assess the potential for biodegradation in the vadose zone.

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- Fractional organic carbon (FOC) (Walkley Black Method). These data were collected to assess the potential of bioavailability of organic contaminants.

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- Thermal properties including specific heat, thermal resistivity, thermal conductivity, and thermal diffusivity.

The selected target sampling depths were 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 (Kirtland AFB, 2017a), or at historical or current water elevations. Target sample depths were 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. Deviations to soil collection procedures are noted in Section 4.3. Coring intervals and sample locations for each borehole discussed in this report are summarized in Table 3-1.

The bottom of the designated coring intervals (total depth of the borehole) extended approximately 10-20 ft below the lowest historic recorded water level (2009) to ensure that the deepest vertical LNAPL migration elevation was evaluated.

Seven boreholes (KAFB-106S1, KAFB-106S2, KAFB-106S8, KAFB-106S9, KAFB-106247, KAFB-106V1, and KAFB-106V2) were continuously cored from ground surface to total depth using sonic coring methodology exclusively. Four boreholes (KAFB-106S3, KAFB-106S4, KAFB-106S5, and KAFB-106S7) were advanced to the top of the approved coring interval with air rotary casing hammer (ARCH) and then sonic cored from the historic 1960 groundwater elevation, approximately 4,950 ft AMSL, to the total depth of the borehole in order to delineate the LNAPL smear zone further away from the release area.

Two drilling methods were used to advance and sample the boreholes. Sonic coring was performed to obtain greater lithologic logging resolution than what could be obtained from logging soil cuttings from the ARCH drilling. The sonic coring also allowed the ability to collect discrete samples for submission to the analytical laboratory. All of the boreholes were reamed with ARCH to facilitate the installation of SVM and GWM wells.

Boreholes that reached total depth in the vadose zone (KAFB-106V1 and KAFB-106V2) were completed as nested SVM wells. ~~.~~ Each SVM well is comprised of six nested vapor probes with 2 ft of screen each targeting different depths of the vadose zone (well construction diagrams are provided in Appendix D). Each vapor probe is isolated from the others using a hydrated bentonite chip seal. ~~—~~For groundwater monitoring wells, f~~F~~ollowing drilling and sampling, the boreholes that were drilled to depths below the groundwater table were constructed as ~~converted to~~ two-well nested monitoring wells. The GWM wells were installed to assist with data gaps in the GWM network caused by the rising groundwater elevation.

One borehole (KAFB-106247) was drilled and sampled to provided background ~~geochemistry~~data. The location for this borehole was selected so that it would be far enough away from the source area that it would not be affected by the release (Figure 3-1). This borehole was converted to a monitoring well to assess future groundwater conditions.

4. FIELD INVESTIGATION

The methodology and rationale for soil sample selection from specific depth intervals and/or field screening results for hydrocarbons are discussed in Section 3 and are outlined in the Work Plan (Kirtland AFB, 2017a). Soil samples were submitted to the laboratory as described above in Section 3. The field geologist completed daily quality control reports documenting the tasks conducted during each day including any deviations from the Work Plan, which are discussed in Section 4.3. Data quality control reports are provided in Appendix B.

4.1 Assessment of Diffused and Dispersed~~Residual~~ Light Non-Aqueous Phase Liquids

4.1.1 Vadose Zone Coring

A total of nine continuous core locations (including one background location) were planned to characterize hydrocarbon concentrations within the vadose and saturated zones. Three additional optional coring locations were to be drilled if field screening observations made during the coring of the initial soil borings indicated a need for additional data at these locations. Optional coring locations were designated as KAFB-106S6, KAFB-106S7, and KAFB-106S8 (Figure 3-1).

KAFB-106S7 was drilled farther to the northeast from KAFB-106S4 and north, northwest from KAFB-106S3 based on screening data obtained during the coring of KAFB-106S3 and KAFB-106S4 (Table 4-1). The KAFB-106S8 location was drilled farther to the east based on screening data obtained from KAFB-106S1. KAFB-106S6, originally the farthest downgradient location, was not drilled since field screening via UV fluorescence screening for LNAPL did not indicate the presence of LNAPL in the soil samples collected from KAFB-106S5, indicating that the northern extent of LNAPL had been defined (NMED, 2019b).

The boreholes for KAFB-106S1, KAFB-106S2, KAFB-106S8, KAFB-106S9, KAFB-106247, KAFB-106V1, and KAFB-106V2 were cored continuously from ground surface to total depth. The coring methodology was selected to collect intact samples to screen for LNAPL using UV fluorescence and for volatile organics using a PID.

These boreholes were then over-reamed via ARCH methodology to a nominal 10-inch diameter to accommodate nested well installation. The boreholes for wells KAFB-106S3, KAFB-106S4, KAFB-106S5, and KAFB-106S7 were drilled using a combination of ARCH drilling to advance the borehole to the designated coring depth, followed by sonic drilling to obtain cores from the designated coring intervals. These wells were drilled using ARCH technique to depths of 400, 340, 400, and 401 ft below ground surface (bgs), respectively. Following core collection, the boreholes were reamed with ARCH drilling to total depth to facilitate nested monitoring well installation.

During coring, temperature controls were implemented to ensure the data quality for LNAPL and VOCs analytical results. Cores barrels were cooled with dry ice immediately prior to deployment downhole. Cores collected from sonic drilling were extruded into plastic core sleeves at 1- to 2-ft increments over the selected coring interval. Coring intervals varied during drilling primarily to minimize core temperatures to prevent loss of volatile constituents. However, other downhole conditions required varying the coring intervals (typically due to caving).

Immediately following submittal of the core from the driller to the geologist for logging, a thermometer was placed within the core. The temperature of each core was measured with a National Institutes of Standards and Technology Traceable® digital thermometer. Temperature data were recorded on the core sleeves and field forms. Core temperature data are presented in Table 4-1 and Appendix C. Following temperature collection, core sleeves were labeled with the well number, depth interval, collection date, and the top of the core depth.

4.1.2 Soil Sample Handling

Soil cores were stored within a refrigerated truck after the coring and logging process was completed. The temperature in the refrigerated truck was maintained at approximately 4 degrees Celsius. Core temperature measurements were never collected in the refrigerated truck. Samples were unopened and allowed to cool prior to soil sample collection. Lithologic logging and sample photography occurred after sample collection to minimize volatile constituent losses. Based on this process, it is unlikely that significant volatile constituent losses occurred. To maintain sample custody, the refrigerated truck was kept locked when no one was present. Cores that were selected for LNAPL properties analyses were placed in a freezer and shipped frozen via overnight delivery. All cores from the entire borehole were kept in refrigerated storage until soil sample intervals were selected for analyses. Once intervals were selected based on Work Plan selection criteria, the core was retrieved from a shelving system installed within the refrigerated truck and the soil sample was collected.

A box truck was also used to provide a mobile workspace. The box truck allowed for a darkened workspace to perform UV screening as well as a place for core photography and lithologic logging.

4.1.3 Field Screening for Light Non-Aqueous Phase Liquid and Hydrocarbons

The ability of LNAPL to fluoresce in the presence of UV light was used to screen for its presence. Following collection, a soil core was placed within the darkened workspace of the box truck or refrigerated truck and screened for the presence of areas that may fluoresce. This was performed in accordance with Figure 3-7 Decision Logic schematic for Sample Collection of the approved work plan (Kirtland AFB, 2017a) which provides a flow chart for sample analyses. During screening, a UV light (Spectronics Optimax 365 UVA Inspection Flashlight) was showwn~~ne~~ on the core sample. Areas that were noted to fluoresce were marked on the core sleeve with either "UV" or "no UV." Cores that were found to fluoresce ~~were~~ are indicated on the lithologic logs included in Appendix ~~I~~D.

Soil samples were also field screened for the presence of VOCs by the heated headspace method. Field screening for VOCs was performed at a maximum of 20-ft intervals during ARCH drilling and 10-ft intervals during sonic coring. Heated headspace was performed with a calibrated PID using the method described in the Work Plan (Kirtland AFB, 2017a). Readings from the PID were recorded on the lithologic log at the appropriate depth. A summary of heated headspace measurements by coring location and depth is provided in Table 4-1 and documented on the lithologic logs in Appendix ~~I~~D.

4.1.4 Physical Properties of Light Non-Aqueous Phase Liquid from the Site

During drilling operations, it was observed (via UV fluorescence screening) that there was not enough LNAPL present within the soil samples to perform the physical properties analyses. Therefore, a sample of LNAPL was collected from KAFB-106079 (the well that had the most LNAPL in it at the time), and a groundwater sample was collected from well KAFB-106150 (a well that historically had LNAPL but did not at the time). These samples were submitted to PTS Laboratories, Inc., for transmissivity and mobility analyses. Results are summarized in Table 4-2 and the wells are shown on Figure 5-7.~~.~~

4.1.5 Core and Project Photography

Core was placed in a standard core box to allow for efficient cataloging, storage, and assist with core photography. Photos of the core was preformed ~~for photography~~ using an onsite, high resolution digital camera (Nikon Coolpix B500). Each photograph was logged on a field form, noting the borehole number, depth, date, and time. Core photographs are presented in a Technical Memorandum for Vadose Zone Core Photography Logs provided in Appendix E~~D~~. Photographs of work conducted during the coring program were also collected throughout the project. These photographs are provided in Appendix ~~E~~F.

4.1.6 Laboratory Analytical Samples

Selection of target sample depths followed the decision logic presented in the Work Plan (Kirtland AFB, 2017a), as discussed in Section 3, and was modified based on field observations and data collected. Sample collection, chain-of-custody, and shipping procedures were performed in accordance with the Quality Assurance Project Plan (Appendix A to the Work Plan). Laboratory analyses consisted of the following:

- VOCs (EPA Method 8260B), EDB (EPA Method 8011), and TPH-GRO/DRO/MRO (EPA Method 8015D) sent to TestAmerica**,** Inc., Arvada, Colorado

- LNAPL transmissivity and mobility (American Petroleum Institute [API] Recommended Practice [RP] 40, Dean-Stark), grain size (ASTM International D422), fluid properties (API RP 40, EPA 9100), capillary pressure air/water drainage (API RP 40, EPA 9100), free product mobility (API RP 40, Dean-Stark), relative permeability (API RP 40, EPA 9100), and hydraulic conductivity (API RP 40, EPA 9100) sent to PTS Laboratories, Inc., Houston, Texas

- Mineralogy using XRD and energy dispersive x-ray fluorescence (XRF) sent to Microbial Insights, Inc., Knoxville, Tennessee

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

- Moisture analyses in conjunction with TestAmerica, Inc. sample preparation and ASTM International D2216 sent to Daniel B. Stephens and Associates Soil Testing Laboratory.

- FOC (Walkley Black Method). These samples were sent to Daniel B. Stephens and Associates Soil Testing Laboratory.
- These data were collected to assess the potential of bioavailability of organic contaminants.

- Thermal properties by ASTM International D5334 sent to Daniel B. Stephens and Associates Soil Testing Laboratory.

Soil cores that indicated the presence of UV fluorescence were submitted to PTS Laboratories, Inc., Houston, Texas for soil core photography to screen for the presence of LNAPL. Laboratory data packages are provided in Appendix G. A data quality evaluation report completed for TestAmerica, Inc. chemical analyses of VOCs, TPH, and EDB data is provided in Appendix H.

4.1.7 Lithologic Logging

Two methods were utilized to drill the boreholes completed at the Site: ARCH and/or Sonic coring. The ARCH drilling method produced soil cuttings from a cyclone that were collected via a metal-screened basket deployed beneath the return area. These cuttings were collected from the cyclone at specific drilling depths and at observed changes in lithology and placed on a polyethylene liner with each drilled interval labeled for lithologic logging. Sonic coring typically produced 2-ft long, intact soil cores that were collected within a polyethylene bag. Each core bag was labeled and placed in a labeled cardboard core box. Photographic examples of each sample collection method are provided in Appendix E.

Soil or core sampless collected from each drilling method were logged in accordance with the Unified Soil Classification System (USCS) by an experienced field geologist (ASTM International D5434-12). Information described in each lithologic log included the USCS classification; color as compared against the Munsell Soil Color Chart; sand, silt, or clay content; stiffness and plasticity of encountered clays; moisture content; percent gravel; minerology; and odor (if noted by the experienced field geologist). Additional information included in each lithologic log included field UV results, heated headspace results, core run length, and locations where the core was identified as disturbed. Lithologic borehole logs are presented in Appendix D~~I~~.

4.2 Monitoring Well Installation

Monitoring well construction details were approved by NMED prior to the installation of each well nest (Appendix A). Monitoring well installation reports (and associated groundwater sampling data) were submitted under separate cover in the first quarter (Q1) and second quarter (Q2) 2019 Quarterly GWM Reports. The Q1 2019 GWM Report (Kirtland AFB, 2019b) included well installation reports for KAFB-106S2, KAFB-106S4, KAFB-106S5, KAFB-106S8, KAFB-106S9, KAFB-106V1, and KAFB-106V2. ~~(Kirtland AFB, 2019c, 2019d).~~ The Q2 2019 Quarterly GWM Report (Kirtland AFB, 2019~~e~~c) included well installation reports for KAFB-106S1, KAFB-106S3, KAFB-106S7, and KAFB-106247. ~~(Kirtland AFB, 2019f, 2019g).~~ A Well Completion Report that includes all of the wells is provided in Appendix I. The two types of wells installed during the coring program are discussed in the following sections.

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4.2.1 Groundwater Monitoring Wells

Following advancement of the borehole to total depth, proposed well completion diagrams were submitted to NMED and the boreholes were converted to dual-completion monitoring wells. Well construction approvals were received from NMED prior to construction for wells (in order of construction) KAFB-106S9 (NMED, 2018c~~b~~), KAFB-106S5 (NMED, 2018d~~e~~), KAFB-106S4 (NMED, 2018e~~d~~), KAFB-106S2 (NMED, 2018f~~e~~), KAFB-106S3 (NMED, 2018g~~f~~), KAFB-106S1 (NMED, 2018h~~g~~), KAFB-106S8 (NMED, 2019c), KAFB-106S7 (NMED, 2019d), and KAFB-106247 (NMED, 2019e). Dual-completion monitoring wells included one well with a screen interval that crossed the current water table and one well located above the water table. Both wells were collocated within the same borehole. The latter well was installed to function in the future with anticipated rising groundwater elevations (well construction diagrams are provided in Appendix D~~I~~).

Both nested monitoring wells were constructed using 3.5-inch outside diameter Schedule 80 polyvinyl chloride casing. The water table wells were installed with a 40-ft screen length with approximately 15 ft of screen placed below the groundwater table. The wells completed above the water table were completed with a 25-ft screen length. Each well is isolated from the other by a 5-ft long bentonite seal. Well screens with a 0.010-inch slot screen size were used and a 2-ft sump was installed at the base of each well. Well construction details for GWM wells are presented in Table 4-3 and Appendix ~~I~~D.

Following placement of the well casings, a 10/20 silica sand filter pack was placed in the borehole annulus from the bottom to approximately 2 ft above the deep well screen. A 5-ft thick bentonite chip seal was placed above the sand pack. Additional 10/20 silica sand was placed within the borehole annulus from the bottom of the vadose zone (or contingency) well to approximately 2 ft above the well screen. Approximately 30 ft of bentonite chips was placed within the borehole annulus above the upper silica sand filter pack. The bentonite chip seal was hydrated in lifts using a potable water source.

A high-solids bentonite grout was placed in the annulus that extended from the upper bentonite chip seal to approximately 30 ft bgs (any grout settling was filled with bentonite chips to a depth of 30 ft bgs). A neat cement surface seal was installed over the grout seal and extended vertically up the well annulus to approximately 1 ft bgs.

Wells KAFB-106S1, KAFB-106S5, KAFB-106S7, and KAFB-106S9 were completed as flush-mounted wells with an 18-inch diameter well vault surrounded by a 3-ft × 3-ft × 4-inch thick concrete pad at the ground surface. Well pads were sloped to direct rainwater away from the well. Wells KAFB-106S2, KAFB-106S3, KAFB-106S4, KAFB-106S8, and KAFB-106247 were completed as aboveground wells consisting of a 12-inch diameter steel surface casing placed to approximately 3 ft above ground surface to protect the inner well casings. Each aboveground well completion was placed within a 4-ft × 4-ft × 4-inch thick concrete pad with four protective steel bollards installed at the corners of the pad.

4.2.2 Groundwater Monitoring Well Gauging and Development

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Upon completion of the wells, they were gauged and developed. After well construction was completed, the water table wells were developed in accordance with the Work Plan (Kirtland AFB, 2017a) and the completion dates are listed in the compiled completion report in Appendix I. Well development was initiated no sooner than 48 hours from setting well seals.

Prior to development, water levels and total depths were gauged in the wells with an electronic water level indicator. Development was accomplished by surging and bailing to minimize fines in the filter pack. Wells were developed until a minimum of five casing volumes were removed. Development water was contained in 55-gallon steel drums with water-tight lids and transferred to the EA investigation-derived waste (IDW) yard located on Kirtland AFB for waste management ~~characterization~~. Monitoring well development records are provided in the compiled Well Completion Report found in Appendix I. The analytical results for the first sampling event for each well is included in Table 4-4~~XX~~. Discussions of sampling procedures are discussed in the quarterly monitoring reports (Table 1 in Appendix A in Appendix A).

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~~4.2.2~~4.2.3 Soil Vapor Monitoring Wells

SVM wells KAFB-106V1 and KAFB-106V2 were cored via the sonic drilling method to depths prescribed in the Work Plan (275 ft bgs). As done for the GWM wells, the cored boreholes for these SVM wells were over-drilled using ARCH methodology to allow for well installation. An 11.75-inch outside diameter drive casing was installed following coring from ground surface to the total depth of each SVM well to facilitate construction.

Each SVM well is comprised of six 0.75-inch outside diameter nested vapor probes, each with 2 ft of screen targeting different depths of the vadose zone to a total depth of 275 ft bgs. Each vapor probe is isolated from the others using a bentonite chip seal. Well screens are 0.010-inch slot screen size. Well construction details for SVM wells are presented in Table 4-5~~4~~ and Appendix ~~I~~D.

Following placement of each well string, a 10/20 silica sand filter pack was placed in the borehole annulus from the bottom to approximately 1 ft above the well screen as the drill casing was retrieved. A bentonite chip seal was placed above the sand pack. Approximately 96 ft of bentonite chips was placed within the borehole annulus above the upper silica sand filter pack. The bentonite chip seal was hydrated in lifts using a potable water source. A neat cement surface seal was installed over the grout seal and extended vertically up the well annulus to approximately 1 ft bgs.

The SVM wells were completed as flush-mount wells. The flush mount wells were completed with an 18-inch diameter well vault surrounded by a 4-ft × 4-ft × 4-inch thick concrete pad at the ground surface. The well pad was sloped to direct rainwater away from the well.

4.3 Deviations from Work Plan

Proposed sample depth intervals ~~for LNAPL physical properties including specific gravity, hydrocarbon analysis, flashpoint, viscosity, and LNAPL components~~ are described in the Work Plan and summarized in Section 3 (Kirtland AFB, 2017a). Deviations to any sample depth interval from the Work Plan were based on field-specific observations (i.e., UV fluorescence, PID measurements, etc.).

During the drilling process, there were occasions when the sample was unable to be retained within the core barrel. When this occurred, the driller would make another attempt at collecting the sample. When this occurred, the sample was reported on the core temperature log as disturbed ~~on the core temperature logs~~and the driller made another attempt at sample collection. This occurred during the collection of the following samples~~. Sometimes, this occurred at intervals where samples were proposed to be collected hHowever, when this occurred, the sample would oftentimes become disturbed. This occurred to the following samples~~:

- KAFB-106S2 at depths of 105, 278, and 404 ft bgs and KAFB-106S4 at a depth of 366 ft bgs. These samples were submitted because they indicated the highest heated headspace concentration of their sample interval. These samples were submitted for analysis of TPH, the results of which were non-detect. ~~,~~Sample disturbance for these samples is indicated on the appropriate tables and figures.
- At KAFB-106S9 t~~T~~he driller attempted to make a 10-foot long core run at a depth interval of 49~~0~~1 to 500 ft bgs (with nine f~~eet~~ of recovery) ~~in KAFB-106S9~~. During retrieval, the core fell out of the core barrel and was disturbed. Another attempt was made that successfully collected the core interval. A sample within this interval was collected at a depth of 496 ft bgs for analysis of TPH and VOCs. This sample was collected because it indicated the highest headspace concentration of the borehole. While the depth may be suspect due to the core disturbance, it is unlikely that the laboratory sample concentration was affected since the sample was collected based on the headspace concentration. In addition, the core temperature was 20.4 ºC (close to background temperatures) and unlikely to have been affected by overheating of the sample. Two cores were also collected from this core run at depths of 491 to 493 ft bgs and 493 to 495 ft bgs. These samples were submitted to the laboratory for UV light analysis based on field screening (the possible presence of LNAPL based on in-field UV light screening). It is likely that these cores are disturbed. Sample disturbance for these samples is indicated on the appropriate tables and figures.

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The driller periodically added small amounts of water to the borehole (one to 7.5 gallons of water) to reduce sample temperatures and in one case, assist with getting the core barrel unstuck (KAFB-106V1 at 115 ft bgs). The addition of water was discussed in the Work Plan (Section 3.1.1.1 Drilling Approach and Methodology, Page 3-2, Kirtland AFB 2017a). The addition of water is not a deviation from the Work Plan and it is standard drilling operating procedure to ~~preserve data an minimize the loss of VOCs~~reduce core temperatures.~~Although not a deviation from the Work Plan, the addition of water has the potential to impact sample quality~~. Whenever water was added to a borehole, it was noted on the temperature logs. The top of the core run where ~~a~~ borehole slough was present (along with the added water) was discarded.

LNAPL was not present in sufficient quantities to be able to perform hydrocarbon component analysis.

Minerology was originally proposed to be performed by IMR Metallurgical Services of Louisville, Kentucky. However, once it was determined that Microbial Insights, Inc. of Knoxville, Tennessee could perform both microbial and mineralogy analyses, the decision was made to not send samples for mineralogy analysis to IMR Metallurgical Services of Louisville, Kentucky, as originally proposed. Using the same laboratory for both analyses simplified sample processing and shipping.

Soil coring was to be completed within set temperature parameters (≤ 20 degrees Celsius) regardless of whether a soil sample was planned for any given interval. As coring advanced to depth, temperature regulation became more complicated. Initial remedial efforts included cooling of the core barrel with wet and dry ice, and the reduction of coring run length from 6 to 4 ft long. Temperature regulation only occurred in cored intervals where VOCs analysis was to take place in selected wells (KAFB-106S1, KAFB-106S2, KAFB-106S3, KAFB-106S7, and KAFB-106S8). This variance was approved by NMED via email on November 5, 2018 (NMED, 2018h). Field temperature logs are provided in Appendix C.

Monitoring well KAFB-106247 was originally planned to be a background borehole located to the southeast of the source area where impacted soils were not expected to be encountered. However, conversion of this borehole to a monitoring well would also provide the opportunity to collect background groundwater samples. Based on this, it was later decided to convert the borehole into a monitoring well to assess future groundwater conditions (NMED, 2019e).

5. FIELD INVESTIGATION RESULTS

~~5.1 Subsurface Lithology~~

~~Soil descriptions from the lithologic logs created during coring activities were used to create detailed geologic models of the subsurface. The lithological models were developed by applying the technique of indicator kriging using Earth Volumetric Software (EVS) Version 2019.7.1.~~

~~The algorithm used to apply this technique is proprietary to the software and is represented by the “Indicator Kriging” module. Data supplied to this module are based on USCS classifications logged during drilling that were simplified into nine categories reflecting observed grain-size distribution and inferred permeability. Spherical kriging was then used to develop lithological probabilities for cells on a grid with x, y, and z resolutions of 42, 38, and 5 ft, respectively, at a horizontal/vertical anisotropy of 3 to 1. The representation shows maximum material probabilities for the nodes of this grid structure, inclusive of all wells in the dataset.~~

5.1 Subsurface Lithology

~~The subsurface in the area of the Source Zone Characterization project is shown on a the soil boring west-to-east transect (A-A’) and a north-to-south transect (B-B’) (Figures 5-1and 5-2). The lithology of the subsurface at each borehole location was consistent with the closest existing borehole that was used as a guide during drilling as described in the Work Plan.~~ Lithologic information obtained from ARCH and Sonic drilling was used to create boring logs. The sonic coring data were used ~~primarily to create the cross sections due~~ to ~~the~~provide higher lithologic resolution ~~provided~~ by continuously coring (sonic coring) as opposed to collecting soil samples every 10 ft from disturbed cuttings (ARCH drilling).

Lower permeability units (silt and clay) were found interbedded with lesser amounts of higher permeability units (sand) to a depth of approximately 160 ft bgs. Below 160 ft bgs, fine to coarse gravelly sand dominated to a depth of approximately 250 ft bgs. A lens of low permeability silt and clay was present between 250 and 300 ft bgs. This unit was classified in the field as very stiff to hard and contained up to 40 percent (%) silt. Approximate 1-ft thick silt lenses were observed within the clay unit at KAFB-106V1. The thickness and continuity of this ~~lens~~ unit fluctuated at each borehole and ultimately pinched out completely to the north (i.e., absent at KAFB-106S5).

Below 300 ft bgs, fine to coarse gravelly sand dominated with minor interbedding (<10 ft) of lower permeability material to the total depth of drilling (515 ft bgs). A second lens of lower permeable silt and clay was present between 440 and 460 ft bgs. The thickness and continuity of this lens also fluctuated at each borehole and ultimately pinched out completely to the north (KAFB-106S5). Soils below 460 ft bgs primarily consisted of interbedded silty sand, well graded sand, and poorly graded sand. A clay layer was encountered in KAFB-106S1 from 490 to 495 ft bgs and in KAFB-106247 from 507 to 510 ft bgs. The groundwater table was observed at depths between 469 and 478 ft bgs. This is consistent with groundwater depths observed during the Q1 and Q2 GWM events (Kirtland AFB 2019b, 2019e).

5.1.1 Field Screening

Laboratory analysis of soil sample UV fluorescence was used as a tool to assess the possible presence or absence of LNAPL based on field screening that was discussed in Section 4.1.3. Appendix ~~I~~D provides lithologic logs for UV field screening results and Appendix G-2 provides photographs of laboratory UV fluorescence.

Heated headspace field screening values in the vadose zone are most significant at the source area (KAFB-106V1 and KAFB-106V2) from a depth of 10 ft bgs to a clay unit observed at a depth of approximately 265 ft bgs (Table 4-1). Below this depth, heated headspace concentrations decrease significantly. Analytical ~~Measured TPH; EDB; and BTEX, EDB, and TPHbenzene~~hydrocarbon~~, toluene, ethylbenzene, and total xylenes (BTEX)~~ concentrations were also observed to decrease through this clay layer at KAFB-106V2 (Section 5.2.1 below and Figures 5-1~~3~~ through 5-3~~5~~), correlating with the heated headspace data.

Heated headspace field screening was also performed on samples collected within the saturated zone. The heated headspace values observed below the water table were indicative of the relative presence of hydrocarbons and were used to guide sample collection. In general, elevated heated headspace values (greater than 100 milligrams per kilogram) were observed predominately in the saturated zone (Table 4-1). In wells located closer to the source area (KAFB-106S1 and KAFB-106S9), elevated heated headspace concentrations were observed 35 and 15 ft above the water table, respectively. In boreholes located farther away from the source area, elevated heated headspace values were observed below the groundwater table.

Historical water levels (Rice et al., 2014) were added to Table 4-1 to correlate the water table depths to the heated headspace concentrations. In each of the borings the data indicates that the deepest water table correlates closely with the depths that elevated PID concentrations are observed below the current water table.

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5.2 Laboratory Analytical Results

This section reports and discusses pertinent analytical results for all laboratory analyses conducted on core samples taken during drilling activities.

5.2.1 Analytical Results for Organic Compounds

A total of 87 soil samples were submitted for laboratory analysis of organic compounds. Of these 87 samples, all were submitted for TPH-GRO/DRO/MRO analyses and 73 were submitted for VOCs and EDB analyses. The samples were collected based on field observations and at depths specified in the Work Plan~~ and field observations~~. For the purposes of this report, only results for the primary contaminants of concern of BTEX, EDB, and TPH are discussed. Analytical data for organic compounds are presented on Figures 5-1~~3~~ through 5-3~~5~~ and provided in Table 5-1. A searchable flat file containing the VOCs, EDB, and TPH analytical results in Microsoft Excel™ format is included as Appendix J.

Vadose Zone Summary

The following summarizes the detected laboratory concentration ranges in the vadose zone by constituent (not including non-detected constituents):

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- Detected concentrations of TPH in the vadose zone ranged from a low of 1.3 J mg/kg (KAFB-106S9 at 252 ft bgs) to a high of 32,000 mg/kg (KAFB-106V1 at 254 ft bgs) (Figure 5-3, Table 5-1).
- Detected benzene concentrations ranged from a low of 0.0061 mg/kg (KAFB-106S2 at 474 ft bgs) to a high of 110 mg/kg (KAFB-106V1 at 254 ft bgs). See Figure 5-1 and Table 5-1.
- Detected toluene concentrations ranged from a low of 0.00091 J mg/kg (KAFB-106S5 at 417 ft bgs) to a high of 3,100 mg/kg (KAFB-106V1 at 254 ft bgs). See Figure 5-1 and Table 5-1.
- Detected ethylbenzene concentrations ranged from a low of 0.045 J mg/kg (KAFB-106S8 at 475 ft bgs) to a high of 770 mg/kg (KAFB-106V1 at 254 ft bgs). See Figure 5-1 and Table 5-1.
- Detected xylenes concentrations ranged from a low of 0.0011 J mg/kg (KAFB-106S9 at 252 ft bgs) to a high of 3,690 mg/kg (KAFB-106V1 at 254 ft bgs). See Figure 5-1 and Table 5-1.
- Detected EDB concentrations ranged from a low of 0.0003 mg/kg (KAFB-106V1 at 161 ft bgs) to a high of 2.1 mg/kg (KAFB-106V1 at 254 ft bgs). (Figure 5-2, Table 5-1).

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The highest hydrocarbon concentrations in the vadose zone were found in well KAFB-106V1 (Figures 5-1 through 5-3, Table 5-1). ~~Concentrations of BTEX, EDBTPH, and TPHEDB were elevated in the samples collected from KAFB-106V1 and KAFB-106V2 (Figures 5-13 through 5-35, Table 5-1).~~ Both boreholes KAFB-106V1 and KAFB-106V2 are located within the source area and the observed concentrations are indicative of the release location. Elevated petroleum hydrocarbon concentrations were observed in a poorly graded sand at depths located above a clay layer located at 266 ft bgs (See KAFB-106V1 b~~B~~oring log located in Appendix ~~I~~D). The highest hydrocarbon concentrations were observed from the soil sample collected from borehole KAFB-106V1 at a depth of 254 ft bgs (Figures 5-1 through 5-3, Table 5-1). ~~The highest BTEX, TPH, and EDB concentrations were observed from the soil sample collected from borehole KAFB-106V1 at a depth of 254 ft bgs (Figures 5-13 through 5-35, Table 5-1). These~~ Petroleum hydrocarbon concentrations increase with depth in KAFB-106V1 until reaching ~~a clay unit at~~ a depth of approximately 266~~5~~ ft bgs (Table 5-1). A clay layer is present at this depth (See KAFB-106V1 boring log located in Appendix D) whereby c~~CThese c~~oncentrations ~~below the clay layer~~ decrease significantly at depths of 271 and 285 ft bgs (Table 5-1).~~, collected within and below the clay layer~~

The highest BTEX and EDB concentrations in KAFB-106V2 were observed at a depth of 103 ft bgs located within a poorly graded sand (see KAFB-106V2 boring log located in Appendix D). The highest TPH concentrations in KAFB-106V2 were observed at a depth of 80 ft bgs within a silt (See KAFB-106V2 Boring log located in Appendix D). Analytical results are presented in Figures 5-1 through 5-3, and Table 5-1. The TPH GRO concentrations generally decrease with depth from 21,000 milligrams per kilogram (mg/kg) to 5,900 mg/kg (Table 5-1) until reaching a clay unit at a depth of approximately 269 ft bgs (See KAFB-106V2 Boring log located in Appendix D). These concentrations decrease significantly at depths of 270 ft bgs (TPH GRO 8.2 mg/kg) and 287 ft bgs (TPH GRO 1.1 J mg/kg) in samples collected within and below the clay layer.

~~The clay unit at these wells is very stiff to hard and contained up to 40 percent (%) silt. Approximate 1-ft thick silt lenses were observed within the clay unit at KAFB-106V1. Concentrations of BTEX, TPH, and EDB decrease significantly below the clay to the total depth of KAFB-106V1 at 285 ft bgs (Figures 5-3 through 5-5, and Table 5-1).~~

~~Concentrations of TPH, BTEX, and EDB are below the laboratory reporting limit within the vadose zone in all other boreholes (Figures 5-3 through 5-5, Table 5-1).~~ In wells located off-Base (KAFB-106S5 and KAFB-106S7), toluene was ~~-~~the only BTEX constituent detected in KAFB-106S5 (farthest from source area) at ~~-~~concentrations of 0.00091 mg/kg~~milligrams per kilogram (mg/kg)~~ (417 ft bgs) and 0.00094 mg/kg (467 ft bgs). TPH was detected in this borehole at a concentration of 5.6 J mg/~~m~~kg at a depth of 467 ft bgs. ~~However, allboth of these concentrations are estimated (J-flagged).~~

Saturated Zone Summary

The following summarizes the detected laboratory concentration ranges in the saturated zone by constituent (not including non-detected constituents):

- Detected concentrations of TPH in the saturated zone ranged from a low of 1.8 mg/kg (KAFB-106S7 at 485 ft bgs) to a high of 3,600 mg/kg (KAFB-106S1 at 489 ft bgs).
- Detected benzene concentrations ranged from a low of 0.00054 J mg/kg (KAFB-106S3 at 512 ft bgs) to a high of 57 J mg/kg (KAFB-106S9 at 490 ft bgs).
- Detected toluene concentrations ranged from a low of 0.00081 J mg/kg (KAFB-106S3 at 512 ft bgs) to a high of 310 J mg/kg (KAFB-106S9 at 490 ft bgs).
- Detected ethylbenzene concentrations ranged from a low of 0.0024 J mg/kg (KAFB-106S4 at 504 ft bgs) to a high of 79 J mg/kg (KAFB-106S9 at 490 ft bgs).
- Detected xylenes concentrations ranged from a low of 0.0011 J mg/kg (KAFB-106S5 at 506 ft bgs) to a high of 271 J mg/kg (KAFB-106S9 at 490 ft bgs).
- Detected EDB concentrations ranged from a low of 0.00013 mg/kg (KAFB-106S5 at 506 ft bgs) to a high of 0.29 J mg/kg (KAFB-106S9 at 490 ft bgs).

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The highest hydrocarbon concentrations in the saturated zone were found in wells KAFB-106S9 and KAFB-106S1 (Figures 5-1~~3~~ through 5-3~~5~~, Table 5-1) located to the east of the source area~~ (KAFB-106V1 and KAFB-106V2)~~. The highest BTEX and EDB concentrations observed in the saturated zone were found in KAFB-106S9 at a depth of 490 ft bgs. The highest concentrations of TPH were observed in KAFB-106S9 at 490 ft bgs and KAFB-106S1 at a depth of 489 ft bgs.

~~ Concentrations of BTEX, TPH, and EDB~~Hydrocarbon concentrations decrease with distance from the source area as indicated in wells KAFB--106S5 and KAFB-106-S7 (Figures 5-1~~3~~ through 5-3~~5~~, Table 5-1).

~~Concentrations of BTEX, TPH, and EDB decrease significantly in wells located off-Base (KAFB-106S5 and KAFB-106S7).~~ The highest concentrations in these wells were observed in saturated soil samples collected at depths of 491 ft bgs (KAFB-106S5) and 495 ft bgs (KAFB-106S7).

Note that concentrations of TPH-DRO and TPH-GRO are more prevalent than TPH-MRO concentrations (Figure 5-3~~5~~ and Table 5-1). This is likely due to the fuels being released consisting of aviation gasoline (which consist primarily of TPH-GRO) and jet fuels (which consist primarily of TPH-DRO). ~~Concentrations of TPH-MRO are typically not associated with either fuel type.~~

There were no detections of BTEX, EDB, or TPH in the saturated soil samples analyzed from borehole KAFB-106247 (background well located historically downgradient from the source area).

5.2.2 Analytical Data Quality and Data Usability

Chemical analytical data for the source zone soil samples underwent EPA Stage 3 data validation on 100 percent (%) of the sample data by a third-party subcontractor, Environmental Data Services, Virginia Beach, Virginia. The following QC criteria were included in the EPA Stage 3 validation per the QAPjP, as applicable to the analytical method in order to evaluate precision, accuracy, representativeness, comparability, completeness and sensitivity for the data set.

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- Sample preservation and extraction and analysis holding times
- Laboratory method blank contamination
- Surrogate spike and internal standard recoveries (organic analyses)
- Laboratory control sample and duplicate recoveries
- Matrix spike and matrix spike duplicate recoveries
- Initial and continuing calibrations
- Second column confirmation (for EDB only)
- Trip, rinse, and source water blank results
- Field duplicate sample precision.

Data quality exceedances that resulted in data qualification during validation include: 1) blank contamination for VOCs and TPH, 2) minimal hold time exceedances for VOCs and TPH, 3) matrix spike recovery exceedances for VOCs and TPH, 4) surrogate recovery exceedance for VOCs and TPH, 5) calibration criteria exceedance for VOCs, and 6) field duplicate relative percent difference exceedance for VOCs and TPH. Data were qualified as estimated detect (J), estimated non-detect (UJ), and non-detect (U). Estimated sample data are usable to achieve project objectives. The 95% technical completeness goal was achieved for all analytical methods for the source zone coring sampling event. Data are determined to be usable to achieve the project data quality objectives as qualified based on validation. Details regarding the analytical data validation and data usability are presented in the Appendix H – Data Quality Evaluation Report.

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~~5.2.2~~5.2.3 Light Non-Aqueous Phase Liquid Saturation, Mobility, and Effective Solubility

A total of 16 soil cores were analyzed for LNAPL, soil physical properties (grain size, density, porosity, and moisture content), soil type, LNAPL hydraulic conductivity, LNAPL retention curves under drainage, LNAPL saturation, and mobility.

The soil physical properties are necessary to understand the behavior of LNAPL in soil. In the vadose zone soil, pore space is occupied by pore water, air, and LNAPL. Grain size affects capillarity and retention of LNAPL and water phases, which is crucial to understanding if LNAPL is mobile or at residual saturation. The volume of LNAPL in a sample is determined by understanding total porosity, air-filled porosity, and water-filled porosity. LNAPL-filled porosity is then calculated by subtraction. In saturated soil, the air-filled porosity is zero, and the total pore space is occupied by water-filled porosity plus LNAPL filled porosity.

Soil grain distribution and mean grain size~~classification~~ was analyzed on 16 soil samples (six vadose zone and 10 saturated zone), along with 16~~4~~ interstitial analyses of soil samples (six vadose zone and 10~~eight~~ saturated zone). Sieve analyses ~~and USCS classifications~~ are presented on Table 5-2. ~~Lithology and~~ ~~i~~Interstitial properties are presented on Table 5-3. Soil grain density for all samples coincided with that of average soil (2.65 g per cubic centimeter) and averaged 2.61 g per cubic centimeter.

Soil cores were selected based on field screening of UV analysis in accordance with Figure 3-7 Decision Logic schematic for Sample Collection of the approved work plan (Kirtland AFB, 2017a) which provides a flow chart for sample analyses. A total of 30 core samples were analyzed in the laboratory for the presence of LNAPL via UV fluorescence. Photographs of UV analyses are shown in Appendix G-2 and are summarized below. If UV analysis identified a potential for LNAPL presence, further analyses were conducted on select samples to provide a quantitative analysis of the LNAPL. For example, the core from KAFB-106S9 (GUV-S9-171018-473) was collected from 473 to 475 ft bgs and showed fluorescence from 474.1 to 474.2 ft bgs.- This portion of the core was selected for LNAPL hydraulic conductivity, LNAPL retention curves under drainage, LNAPL saturation, and mobility. The core collected from 484 to 486 ft bgs from KAFB-106S9 (GUV-S9-171018-484) showed fluorescence from 484.2 to 484.4 ft bgs and was also subsequently selected for LNAPL analysis.

LNAPL saturation in the selected samples was measured by API Method RP 40 (Recommended Practices for Core Analysis [API, 1998]). Method API RP 40 determines LNAPL saturation by the Dean-Stark distillation-extraction method and is a quantitative means of direct measurement of LNAPL-specific volume in a sample (Los Angeles LNAPL Working Group, 2011). The method is appropriate for plug samples. The method determines fluid saturation by distillation of the water fraction~~,~~ and ~~the~~ solvent extraction of the oil fraction ~~from the sample~~. The core sample is weighed, and the water fraction is vaporized by a boiling solvent. The boiled-off water is condensed and collected in a calibrated receiver to establish water weight. The vaporized solvent condenses, soaks the sample, and extracts the oil. Then, as with determining sample moisture content, the sample is oven dried, weighed, and the oil content determined by gravimetric difference. The result provides percent saturation of LNAPL as expressed as a percentage of the pore volume (Table 5-4). Higher saturations indicate more volume of LNAPL within the pore spaces.

For the vadose zone samples, LNAPL saturations ranged from ~~7.2~~ 7.2 to 13.1% of pore volume (average of 10.0%) and 3.4 to 6.9% of total volume (average of 4.9%) (Table 5-4). The medium sand sample from KAFB- 106V2 indicated LNAPL saturations of 10.7% relative to pore volume, 4.7% relative to total volume. The five fine sand samples averaged 9.9% pore volume and 4.8% total volume. The highest LNAPL pore volume saturation, 13.1%, - and LNAPL total volume saturation, 6.9~~2~~%, from the vadose zone samples was observed in KAFB-106V1 at a depth of 122 ft bgs (Table 5-4).

For the 10 samples collected from the saturated zone, LNAPL saturation ranged from 0.04 to 4.9% pore volume and from 0.02 to 2.01% total volume (Table 5-4, Figures 5-4~~6~~ and 5-5~~7~~). Average LNAPL saturation in gravel below the water table ranged from 1.9 to 3.5% pore volume and from 0.6 to 1.56% total volume. Average gravel LNAPL saturations were 2.6~~57~~ and 0.9% relative to pore volume and total volume, respectively. For the medium sand sample~~s~~ from the saturated zone, LNAPL saturation was~~ranged from 0.04 to~~ 4.9% pore volume~~ and from~~ and ~~0.02 to~~ 2.0% total volume, respectively. ~~The coarse sand sample from the saturated zone had a LNAPL saturation of 0.08% pore volume and 0.03% total volume.~~ Average LNAPL saturation relative to pore volume and total volume for the three fine sand samples averaged 2.4 and 1.0%, respectively (Table 5-4).

The percentage of LNAPL saturation decreases away from the source area (KAFB-106V1 and KAFB-106V2). The highest LNAPL pore volume saturation, 4.9%~~,~~ and total volume LNAPL saturation, 2.01%, in the saturated zone was found in KAFB-106S9 at a depth of 484 ft bgs (Table 5-4). The lowest LNAPL saturations were found in wells KAFB-106S5 and KAFB-106S7, which are the farthest wells from the source area and located off-Base to the northeast (Table 5-4).

Mobility of LNAPL was evaluated for 14 samples using two residual saturation techniques: centrifuge and water drive. The centrifuge method is a modified ASTM International D425 Standard Test Method for Centrifuge Moisture Equivalent of Soil. The method is modified to measure LNAPL drainage curves rather than water drainage curves. The residual saturation by water drive technique involves flushing the sample with multiple pore volumes of water, which will displace mobile LNAPL. By either method, the presence of fluids discharged from the sample demonstrates that the LNAPL is mobile. The results of ~~the~~ both LNAPL mobility techniques demonstrated that LNAPL was not produced from any samples (Table 5-4). All residual LNAPL saturations were identical to initial LNAPL saturations, demonstrating the LNAPL was not mobile (Table 5-4). Since none of the samples demonstrated mobile LNAPL, neither the LNAPL retention curves nor the LNAPL hydraulic conductivity were used to calculate LNAPL mobility.

Effective solubility represents the concentration that may occur at equilibrium under ideal conditions. Locations where groundwater concentrations exceed the calculated effective solubility may indicate that LNAPL remains in the saturated zone in that area. LNAPL samples collected from KAFB-106006 (alias KAFB-1066) and KAFB-106076 (alias KAFB-10676) in 2011 were used to calculate the effective solubility of BTEX in both samples (Kirtland AFB, 2018a). Solubility values from NMED guidance (NMED, 2019f) were used to calculate the molar fractions for each constituent. The effective solubility of BTEX (average of ortho-, meta-, and para-xylenes) in KAFB-106006 was calculated to be:

- 6.44 ~~,~~ milligrams per liter (mg/L) for benzene,
- 17.25 mg/L for toluene,
- 1.03 mg/L for ethylbenzene, and
- ~~and~~ 1.37 mg/L for xylenes ~~milligrams per liter (mg/L), respectively.~~

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The effective solubility of BTEX in KAFB-106076 was calculated to be:

- 1.43 mg/L for benzene (Table 5-5)~~,~~
- 6.89 mg/L for toluene,
- 0.78 mg/L for ethylbenzene, and
- 0.94 mg/L for xylenes.~~, respectively (Table 5-5)~~.

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For the purpose of assessing the location of LNAPL in the saturated zone, the more conservative effective solubility concentration of 1.43 mg/L benzene is used as a line of evidence of potential LNAPL occurrence. It should be noted that this only represents two data points, and the effective solubility will vary depending on the original composition of the LNAPL and degree of degradation in the subsurface. The analysis of additional LNAPL samples may provide a better range of effective solubilities.

Molar fractions of total C4 through C12 carbon chains were also determined for these samples. In the LNAPL sample collected from KAFB-106006, the highest mole fraction percent was C8 (26.87%), while the highest mole fraction from the LNAPL sample collected from KAFB-106076 was from heavier (e.g., > C12) carbon chains (28.52%). Diesel and fuel oils typically range from C8 to C24, while kerosene and jet fuels range from C6 to C16. The carbon chain distribution found in these two samples indicated that the LNAPL collected was from a mixed aviation gasoline/jet fuel type source, as expected.

Because the LNAPL at the Site is a mixture of jet fuel and aviation gasoline, it was expected that BTEX solute would be present. In the source area at BFF, this is exactly what was observed: detected benzene concentrations in the 4857 reference elevation interval (REI), the ~~(~~water table interval,~~)~~ during the Q2 2019 monitoring period exceeded the benzene standard of 5 µg/L ranging from 0.2 to 26,000 µg/L (Kirtland AFB, 2019e), Figure 5-68~~6~~. A total of 50 wells were sampled for BTEX in Q2 2019; all 50 wells are located south of Ridgecrest Drive SE. Benzene was detected in groundwater samples collected from 23 of the 50 groundwater monitoring wells (Figure 5-6); 18 exceeded the 5.0 µg/L maximum contaminant level. Seventeen exceedances were in REI 4857 and one was in REI 4838. The highest benzene concentration was detected in KAFB-106149-484 (26,000 µg/L) in the source area.

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Based on the three lines of evidence: direct measurement of LNAPL observed in current or historic monitoring wells, measurement of LNAPL by PTS Laboratory and the effective solubility concentration of 1.43 mg/L, the estimated extent of LNAPL was approximated. Using the effective solubility concentration of 1.43 mg/L, the location of submerged LNAPL was approximated by locating this concentration isocontour on the benzene concentration map. Figure 5-79~~7~~ shows the approximate location of LNAPL as superimposed on the Q2 2019 benzene isocontour map (reference elevation interval 4857). Figure 5-79~~7~~ indicates that the BTEX plume ~~biodegrades~~ attenuates within a relatively short distance (less than 500 ft) from the diffused and dispersed~~residual~~ LNAPL source and is fully attenuated before it reaches Ridgecrest Drive SE. ~~The LNAPL pore volume percentages and LNAPL total volume saturation percentages a presented in Figures XX and XX, respectively~~

~~5.2.3~~5.2.4 Mineralogy and Magnetic Susceptibility

Mineralogy analyses using XRD and XRF, and magnetic susceptibility were performed on a total of 30 samples collected from all 11 boreholes. XRD and XRF analyses were used to determine the presence of iron bearing minerals, particularly iron sulfide minerals. These minerals are capable of complete or nearly complete degradation of halogenated compounds. Magnetic susceptibility estimates the degree of magnetism of a material. Since there is no direct chemical test available for the quantification of magnetite, magnetic susceptibility provides an estimate of the quantity of magnetite in a sample.

Natural attenuation of halogenated organics by reductive dehalogenation occurs as a result of a reaction with naturally occurring ferrous iron-bearing minerals in contaminated aquifers (He et al., 2009). While EDB is a brominated organic, reductive dehalogenation occurs by the same mechanism as reductive dechlorination. Potentially reactive minerals that can decompose and supply ferrous iron for reductive dehalogenation include iron sulfides (e.g., pyrite, mackinowite), iron oxides (e.g., magnetite) and iron bearing clays and micas (e.g., biotite).

Representative core samples collected from the contaminated shallow aquifer zone boreholes at Kirtland AFB were submitted for XRD to determine if ferrous iron-bearing mineral species are present in the shallow aquifer that could attenuate EDB by reductive dehalogenation. The relevant results ~~in~~are summarized in Table 5-6. are summarized below:

- Pyrite = $Fe^{+2}S^{-2}$ where Fe^{+2} supplies electrons: $2Fe^{+2} = 2Fe^{+3} + 2e^{-}$ was not detected.
- Magnetite = $Fe^{+2}Fe_2^{+3}O_4^{-2}$ occurs in Kirtland AFB aquifer matrix, 1.5-7 weight percent (wt.%).
- Micas, illites, and clays occur in Kirtland AFB aquifer matrix but the iron contents are not known.

Where:

- Fe = Iron.
- S = Sulfide
- O = Oxygen.
- e = Electrons.

The results show, in general, that the soil samples were dominated by quartz, feldspars, magnetite, and clays (Table 5-6). Ferrous sulfide minerals (Mackinawite, pyrite), which have the greatest ability to perform complete or nearly complete degradation of halogenated compounds, were not reported to be present. Magnetite was observed at 1.5-7 wt.% of soil samples by correlation of magnetic susceptibility. Magnetite can perform degradation of halogenated compounds; however, it reacts more slowly than pyrite. The rate of degradation for magnetite is approximately 20-40 times slower than ferrous sulfide minerals in laboratory experiments (Lee and Batchelor, 2019). Micas, illites, and clays were observed in samples. However, the amount of iron in their compositions is unknown and their potential effect on abiotic degradation is unclear. Based on this, abiotic attenuation of EDB is not anticipated to be significant.

~~5.2.4~~5.2.5 Microbial Analysis

Both BTEX and EDB are amenable to biological degradation processes in the environment. BTEX compounds are biodegradable under oxic (El-Naas et al., 2014) and anoxic (Weelink, et al., 2010) conditions, where they serve as a carbon and energy source. EDB is also biodegradable under oxic (Pignatello, 1987) and anoxic (Yu, et al., 2013) conditions. Under oxic conditions, EDB is degraded as a carbon and energy source whereas under anoxic conditions, EDB serves as a terminal electron acceptor during organohalide respiration (i.e., reductive dehalogenation).

Halorespiration is a process by which bacteria gain energy by transferring electrons to halogenated compounds (i.e., EDB), which then serve as a terminal electron acceptor during anaerobic respiration. Under oxic conditions, some enzymes associated with aerobic metabolism of aromatic compounds such as toluene have been shown to cometabolically degrade halogenated compounds. Unlike dehalorespiration, cometabolism of halogenated compounds does not provide bacteria with any energy or carbon. Instead, the enzymes associated with cometabolic processes are destroyed in the process (Vogel et al., 1987). Cometabolic processes have been shown to be useful for remediation of sites with low concentrations of EDB (Hatzinger, et al., 2018).

Multiple lines of evidence suggest that fewer than 1% of microbial species in soil can be cultured in a laboratory setting (Amann, et al, 1995) and molecular techniques, such as those included in the QuantArray analysis by Microbial Insights, may offer more useful information than traditional culture or direct count methods. Many of the bacteria and bacterial genes associated with these varied microbial processes have been well characterized and commercially available genetic analyses (i.e., QuantArray-Chlor®) are available to assess whether the bacterial community present at a given site is potentially capable of degrading a particular contaminant. QuantArray-Chlor® is a polymerase chain reaction (PCR) assay. This assay was used to identify bacteria and quantify a variety of functional bacterial genes associated with the biodegradation of BTEX and EDB, as well as genes specific to total Eubacteria and sulfate-reducing and methanogenic bacteria. The QuantArray Chlor® assay also quantifies genes associated with the aerobic degradation of some BTEX compounds, including toluene monooxygenase, two toluene monooxygenase, and toluene dioxygenase. In addition to providing a quantitative estimate of bacterial populations and gene copies of interest, Microbial Insights also provides a qualitative assessment of abundance relative to samples from other sites submitted to their laboratory for similar analyses. For example, if concentrations of toluene-degrading bacteria are reported as “low”, then compared to other samples analyzed by Microbial Insights, there are few toluene-degrading bacteria present and those relatively few bacteria are not likely to contribute significantly to toluene degradation at that location. Conversely, if the concentration of toluene monooxygenase genes is qualitatively “high” relative to other sites analyzed or to background concentrations, it is likely that significant toluene degradation may occur via that enzymatic reaction under the reported site conditions.

As there is no commercially available assay to test for the presence of genes that are specifically responsible for the degradation of EDB, an analysis of genes and bacterial species known to be responsible for reductive dechlorination is a potentially useful substitute. Significant numbers of sulfate-reducing and methanogenic bacteria indicate that organisms associated with anaerobic BTEX degradation and reductive dehalogenation of EDB are present at the site. Numbers of total Eubacteria provide an estimate of the overall health of the microbial community; low numbers may indicate that something may be inhibiting bacterial growth whereas high numbers indicate a healthy bacterial community. Note that Microbial Insights uses the qualitative terms “low”, “moderate”, and “high” or “significant” when describing numbers of gene copies and/or bacterial numbers. These qualitative terms are relative to results obtained from other samples submitted to Microbial Insights for analysis as described previously. Microbial Insights laboratory reports are presented in Appendix G-3 for more information.

In 2018, two soil samples each from six boreholes (KAFB-106S1, KAFB-106S2, KAFB-106S4, KAFB-106S5, KAFB-106V1, and KAFB-106V2) and three samples from two boreholes (KAFB-106S3 and KAFB-106S9) were collected from zones with observed LNAPL or where high concentrations of adsorbed hydrocarbons were measured. In 2019, 11 soil samples were collected from KAFB-106S7, KAFB-106S8, and in a background borehole (KAFB-106247). The samples collected from boreholes KAFB-106V1 and KAFB-106V2 and two samples collected from depths of 143 and 208 ft bgs in KAFB-106247 were collected in the vadose zone. The samples collected from boreholes KAFB-106S1 through KAFB-106S5, KAFB-106S7 through KAFB-106S9, and the samples collected from KAFB-106247 at depths of 474, 480, 489, and 499 ft bgs were collected in the saturated zone. All samples were submitted for QuantArray-Chlor® analysis. The laboratory results of the QuantArray-Chlor® analyses are presented in Appendix G-3 and discussed below.

None of the bacteria or functional genes associated with biodegradation of BTEX or EDB were detected in the January and February 2019 samples (sample identification BM-S8-180119-475, BM-S8-180119-499, BM-S7-220119-469, BM-S7-220119-485, and BM-S7-220119-495 or in the background borehole samples BM-247-300119-143, BM-247-310119-208, BM-247-040219-474, BM-247-050219-480, BM-247-050219-489, and BM-247-050219-499). In addition, Microbial Insights, Inc. indicated low numbers of total Eubacteria (2.08×10^3 to 1.54×10^6 cells/gram[g]) in these samples. Sulfate-reducing bacteria and methanogens were detected in three of the 29 samples submitted for analysis.

Based on these data, it does not appear that biodegradation of EDB or BTEX can occur at significant rates at these sample locations. However, the analytical laboratory indicated that the low results were likely due to an unidentified substance that appeared to inhibit the PCR. Inhibition of the PCR would cause the gene and bacterial population assays to report lower than what may be present. Based on this, it is not possible to determine whether these data are biased low due to an unknown compound present in the samples or if these organisms and functional genes are truly not widespread in significant numbers in the samples.

In October, November, and December 2018, Eubacterial genes associated with aerobic and anaerobic microbial populations were also quantified in all 18 samples. Total bacterial numbers, which include bacteria capable of BTEX and EDB degradation, ranged from 6.99×10^3 to 2.69×10^7 cells/g. These results are comparable to total bacterial numbers observed at other sites; however, total bacterial numbers were substantially lower in the sample collected from KAFB-106V2 at a depth of 215 ft bgs and in both samples from KAFB-106V1, with concentrations ranging between 2.31×10^4 and 9.96×10^4 cells/g. Microbial Insights, Inc. determined that these lower numbers were also likely due to inhibition of the PCR and may be biased low.

At borehole KAFB-106S9, several bacterial species capable of potential EDB reduction were detected, with concentrations ranging between 8.01×10^3(J) and 2.12×10^6 cells/g). The presence of these genes does not necessarily indicate that the bacteria are active; these bacteria are only active in anaerobic conditions, typically under sulfate-reducing and methanogenic conditions, and do not function in the presence of oxygen. At this same borehole KAFB-106S9, toluene monooxygenases were also detected, indicating that under aerobic conditions, bacteria capable of aerobic degradation of BTEX could be active.

Sulfate-reducing bacteria were only detected in two samples (BM-S1-051218-489 and BM-S9-171018-475) and methanogens were not detected above the laboratory practical quantitation limit in any samples. This may possibly indicate that oxygen concentrations in the areas where the samples were collected may be too high to support the growth of these obligate anaerobes, many of which cannot survive exposure to even low oxygen concentrations.

In general, concentrations of bacteria associated with potential EDB degradation in soil samples collected in 2018 were moderate (5.31×10^3(J) to 3.35×10^4 cells/g at KAFB-106S1 and 3.02×10^5 to 2.12×10^6 in KAFB-106S9) but were not detected above the practical quantitation limit (1.00×10^4 cells/g) in any other samples. Concentrations of various well-studied reductase enzymes (including ethylene dichloride reductase) were not detected in any samples, and enzymes associated with aerobic cometabolic degradation of EDB during aerobic metabolism of BTEX (phenol hydroxylase and two toluene monooxygenases) were detected in significant numbers in five samples (collected from KAFB-106S1, KAFB-106S2, KAFB-106S3, KAFB-106S4, and KAFB-106S9). It is difficult to determine if the low concentrations of these common aerobic BTEX degradation genes were the result of the inhibition of the PCR. However, their presence suggests that aerobic degradation of BTEX and potentially cometabolic biodegradation of EDB may be significant degradation processes in at least some locations in the source area.

Low numbers of the obligate anaerobes *Dehalobacter spp.* and *Desulfuromonas spp.* were identified in samples collected from KAFB-106S1 and KAFB-106S9; both species are capable of degrading halogenated ethenes and ethanes. The well-studied bacterium, *Dehalococcoides spp.*, which is capable of complete degradation of EDB, was not detected in any samples. As previously stated, the laboratory suggested that these samples contained a substance that inhibited the quantitative PCRs; therefore, it is not possible to determine whether these data are biased low due to some unknown compound present in the samples or if these organisms and functional genes are truly not widespread in significant numbers in the source area.

Genes associated with aerobic cometabolic degradation of EDB (e.g., toluene oxygenases) were detected in four samples collected at KAFB-106S1 (sample identification BM-S1-051218-480), KAFB106S2 (BM-S2-161118-474), KAFB-106S4 (BM-S4-041118-480), and KAFB-106S9 (BM-S9-171018-475). Concentrations from these samples ranged between 2.42×10^3(J) and 1.04×10^7 cells/g. If these enzymes are active, then aerobic metabolism is likely to occur.

Microbial analyses on cores show that microbial genes that are responsible for reductive dehalogenation were not observed in samples collected from the Site. Dehalococcoides, the only bacteria known to be capable of complete reductive dehalogenation to ethane, was not detected in any of the samples. Microbial genes responsible for aerobic co-metabolism of EDB were present in most samples analyzed. These results indicate a low potential for anaerobic degradation of EDB, but moderate potential for aerobic degradation of BTEX. However, the analytical laboratory indicated that an unidentified substance was present that appeared to inhibit the PCR. Based on this, it is not possible to determine whether these data are biased low due to an unknown compound present in the samples or if these organisms and functional genes are truly not widespread in significant numbers in the samples.

~~5.2.5~~5.2.6 Moisture Content

Vadose zone moisture content data were collected to review the state of moisture in the vadose zone to assist with the Bioventing Pilot Study and support the Corrective Measures Evaluation. The work plan for Bioventing Pilot study was submitted to NMED in November 2017 (Kirtland AFB, 2017b) and was approved with conditions on April 6, 2018 (NMED, 2018b). The Bioventing Respiration Pilot Testing Procedure was submitted to NMED on September 7, 2018 (Kirtland AFB, 2018b) and it was approved with conditions on February 25, 2019 (NMED, 2019f~~a~~). The Bioventilation Construction and Initiation Report was submitted to NMED on January 21, 2020 (Kirtland AFB, 2020) and is currently being revised.

Moisture analyses were performed by ASTM International D2216-90 (ASTM International, 2005) by three different laboratories, PTS Laboratory, Daniel B. Stephens and Associates, and TestAmerica. The core samples submitted to PTS Laboratory were sealed in the plastic sleeves in which they were collected. The cores were frozen and then shipped in a cooler on ice for next day delivery to the laboratory. The samples submitted to Daniel B. Stephens and Associates were submitted in the plastic sleeves in which they were collected and hand delivered to the laboratory. These procedures were performed to minimize potential moisture losses. The soil samples submitted to TestAmerica were containerized in glass jars and shipped overnight on ice to the laboratory. The moisture content is used by the laboratory to provide dry weights for the TPH, EDB, and VOCs analyses. It is likely that some moisture was lost in the repackaging of these samples, although it should be minimal. ~~for geotechnical, TPH, EDB, and VOC analyses.~~

Soil samples were collected using the sonic drilling method from various depths below ground surface under significant overburden pressures. As a result, the samples should be considered disturbed and may not be representative of the in-situ density of the sample. It is also likely that the moisture contents of saturated sand and gravel samples collected below the water table have been biased low due to gravity drainage of water from non-cohesive soils within the sample bags. Coarse-grained samples (sands and gravels) with high permeability collected below the water table may have experienced drainage where water drained to the bottom of plastic sample sleeve and not collected during sample preparation. This would create a low bias towards the moisture content of samples collected below the water table. Water draining from permeable sand and gravel samples is more likely to occur in saturated samples collected below the water table than above the water table. Above the water table, the moisture is held in capillary tension and did not freely drain upon extrusion from the core barrel.

~~Soil samples were collected from various depths below ground surface under significant overburden pressures. As the samples were removed from the core barrel and extruded into the plastic sample sleeve that overburden pressure was relieved. This changed the sample density and reduced the water saturation of the sample. This process, which is a function of the sample collection process, likely caused a low bias to the moisture content of samples collected below the water table low. In addition, coarse-grained samples (sands and gravels) collected below the water table may have experienced drainage once collected in the plastic sample sleeve. This may also have created a low bias towards the moisture content of samples collected below the water table. It is not expected that either of these phenomena would affect samples collected in the vadose zone.~~

The results of the moisture analyses are shown in Tables 5-7 and 5-8 and in Appendix G-4. The results are summarized below:

- The moisture content ranged from 1.3 to 33.8 wt.% for the analyzed samples. The moisture content results and corresponding~~-~~ USCS classification and me~~di~~an grain size, for the samples are summarized in Table 5-7.

- The moisture content ranged from 1.3 to 33.8 wt.% in the samples collected from the vadose zone. The highest and lowest moisture content results for each soil borehole are summarized in Table 5-8.

The highest moisture content results from soil samples collected from the vadose zone (28.8, 29.5, 31.1, and 33.8 wt.%) were recorded in samples collected in sandy clays, ~~or~~ silts, or fine sands. The vadose zone samples containing the lowest moisture content (1.3, 1.9, and 2.4 wt.%) were recorded from samples collected in either poorly graded or well graded sand. In general, soil moisture ~~was less than~~averaged approximately 5% in well graded and poorly graded sand samples collected in the vadose zone ~~samples~~ (Table 5-7). There did not appear to be a significant difference in moisture contents between samples collected in the source area versus those collected off-Base (KAFB-106S5 and KAFB-106S7).

5.2.7 Fractional Organic Carbon

FOC analysis was performed for five select soil samples collected from KAFB-106247 were to assess the potential of bioavailability of organic contaminants. The analysis was performed using the Walkley Black Method. All five samples were found to be non-detect for FOC (Table 5-9 and Appendix G-4).

5.2.8 Thermal Properties

Thermal properties analyses including specific heat, thermal resistivity, thermal conductivity, and thermal diffusivity were performed on select samples by ASTM International D5334-14 (ASTM International, 2014). Summary results of these analyses can be found in Appendix G-4.

5.3 Light Non-Aqueous Phase Liquid and Fuel Hydrocarbon Spatial Distribution

~~Sufficient data exist to support the development of a three-dimensional geologic and contaminant distribution model. Three-dimensional data visualization is a common method of analyzing and presenting Site information. For this report, the EVS Version 2019.7.1 geological model was used to provide a comprehensive three-dimensional model of lithology. The Interstate Technology and Regulatory Council (ITRC) recommends that an LNAPL conceptual site model be developed and be presented in plan and cross-sectional views (ITRC, 2009).~~

~~The vadose zone model was constructed using 271 soil vapor measurements collected between April 22 and May 7, 2019 from the SVM network (Kirtland AFB 2019e). The SVM network consists screen intervals at seven different depths (25, 50, 100, 150, 250, 350, and 450 ft bgs) in 57 different wells. Total BTEX concentrations were used as analyzed by EPA Method TO-15. The data used to construct the model are provided in Appendix J. The total BTEX concentration was calculated by summing the reported concentrations for BTEX. Concentrations that were reported as below the detection limit were assumed to be equal to one-half the detection limit concentration. These points were then three-dimensionally modeled using the EVS software. The vapor plume model was interpolated using a kriging method assuming a very low horizontal to vertical anisotropy (3 to 1). The very low anisotropy range (typical is 30 to 1) was selected because of the gravity dominated flow of the release. A lower value was not used because it resulted in isolated plumes with no constraint in between borehole locations, which is not considered reasonable. The vapor model had a grid resolution of 47 ft in the X-direction, 47 ft in the Y-direction, and 5 ft in the Z-direction. The vapor plume was then illustrated using an arbitrary iso-shell value of 100,000 micrograms per cubic meter. Model results are presented on Figures 5-8 through 5-14 and are discussed below.~~

As previously stated, BTEX, TPH, and EDB concentrations in the vadose zone from source area wells KAFB-106V1 and KAFB-106V2 are representative of the release location. ~~Subsurface geology (sands and gravels),~~The dominant control for the downward migration of the release was the continuous, extended release of fuel to the subsurface which provided ~~the~~ gravity drainage and the hydraulic head necessary to drive migration. The dominant control for the contaminant migration pathway was the subsurface geology.

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Fuel migrated vertically through mostly permeable non-cohesive soil by gravity drainage from the release point to the clay layer encountered around 260 to 270 feet bgs. Upon encountering the clay layer, the fuel saturated the soil above the clay, resulting in increased hydraulic head that eventually overcame the capillary pressure of pore water in the clay porosity. Once this pressure was overcome, LNAPL could migrate into and through the clay layer (ITRC-3, 2018) as evidenced in heated headspace readings from boring KAFB-106V1. Here, the lower clay extends from 266 to 281 ft bgs. Heated headspace readings in this borehole were 4,049 ppm at 260' bgs, just above the clay, representing former LNAPL saturation. In the clay layer the readings were 1,788 and 3,681 ppmv at 270 and 280 feet bgs, respectively. Finally, just below the clay layer, 1,439 ppmv was observed at 281 ft bgs (Table 4-1 and KAFB-106V1 lithological log, Appendix D). Not only did the hydraulic head that built up drive the LNAPL into and through the clay, it spread LNAPL laterally on the clay layer as a saturated fluid driven by Darcy's law and seepage. Laterally, LNAPL may have pooled with sufficient hydraulic head to penetrate the clay elsewhere.

Studies have shown that organic liquids can physically alter clay structure. Izdebska-Mucha, et. al. (2011) showed the influence of hydrocarbon contamination in clay soil resulted in more open porosity and larger voids. Mosavat and Nalbantoblu (2012) showed that pure toluene resulted in diminution in plasticity and considerable flocculation of clay particles causing granularity in the soil structure. Finally, Nasir (2011) showed contamination of clay with motor oil entailed substantial microstructural changes:

looser packing of clay particles and grain surface detachment, reduction in Atterberg limits in the first 3 months, and substantial increase in coefficient of permeability.

Once the LNAPL entered the clay, structural changes to the clay facilitated greater permeability and ability to transmit the LNAPL through the clay to the underlying permeable soil. This mechanism is contrary to the concept that the clay formed an impermeable layer to the LNAP, LNAPL migrated vertically through the clay, and laterally through the clay by capillarity. A “hole” or other discontinuity in the clay layer is not required to explain the deeper migration of LNAPL to the water table.

At the water table, an LNAPL hydraulic head again formed as the LNAPL pooled. This hydraulic head caused the LNAPL to spread laterally at the water table, forming a substantial historical LNAPL plume extending to Bullhead Park. As the groundwater elevation decreased, LNAPL transport would have followed the LNAPL gradient created by the continued drainage, which favored the northerly groundwater gradient. The LNAPL migrated as far north as USS Bullhead Memorial Park, and this was observed in the LNAPL data collected. The lowest LNAPL saturations observed were near Bullhead Park in the distal portion of the historical LNAPL plume (in wells KAFB-106S7 and KAFB-106S5) (Figures 5-4 and 5-5), and the highest LNAPL saturations were observed closest to the source area in KAFB-106V1 and KAFB-106V2. This is also observed in the benzene concentrations which attenuate rapidly north of the off-Base portion of the benzene plume (Figure 5-6).

~~was the dominant control for the downward migration of the release. The EVS model indicates that the shallow clay layers did very little to prevent vertical migration of the contaminants (Figure 5-8). The lack of significant soil vapor hydrocarbon results directly above these shallow clay units laterally from the source area suggests that LNAPL maintained a near vertical migration pathway through higher permeable areas around, as well as through the clays. This indicates that LNAPL migration was dominated by gravity drainage rather than horizontal migration along low permeability (i.e., clay or silt) zones. This is most evident at the clay layer located approximately 265 ft bgs where laboratory analytical concentrations of BTEX and EDB were the highest. These data indicate that LNAPL migration was suspended for a period of time above the clay unit until a favorable pathway through the clay (very close to the initial intersection) was established (Figure 5-9).~~

~~Downward vertical migration appears to have continued until LNAPL intercepted the groundwater. At that point, mobile LNAPL migrated northward on the groundwater in response to LNAPL head resulting from continued loading from the ongoing release (Figure 5-10). Dissolved-phase EDB and benzene plumes developed and migrated northward according to the local historical water gradient.~~

~~As the groundwater elevation decreased, LNAPL transport would have followed the LNAPL gradient created by the continued drainage, which favored the northerly groundwater gradient. The LNAPL migrated as far north as USS Bullhead Memorial Park, and this was observed in the diffused and dispersedresidual saturation data. The highest diffused and dispersedresidual saturation was observed closest to the source area while the lowest was observed at the northern edge of the benzene plume (KAFB-106S5) (see below).~~

The highest LNAPL saturation percentage (pore volume and total volume) of the ~~collected~~ cores below the water table came from KAFB-106S9 at a depth of 484 ft bgs. This depth is very close to the former lowest groundwater elevation from 2009 (approximately ~~500~~494 ft bgs, see Table 4-1). ~~Figure 5-11 shows the residual LNAPL (smear zone) to be approximately 40 ft thick in the source area (KAFB-106S9) and thins to approximately 25 ft thick toward the south (KAFB-106S1) and less than 10 ft thick to the north (KAFB-106S5).~~ Diffused and dispersed~~Residual~~ LNAPL in the vadose zone was only observed in the immediate source area (KAFB-106V1 and KAFB-106V2).

At times when water table subsidence was slower, or ceased for a lengthy period of time, LNAPL would have remained, providing higher concentrations of diffused and dispersed~~residual~~ hydrocarbons to exist interstitially. Laboratory results during coring operations indicate elevated concentrations of adsorbed hydrocarbons at elevations that most likely relate to the ~~local~~ historical groundwater elevations However, the remaining LNAPL ~~bodies are~~is not a mappable continuous body of fluid. The remaining LNAPL is present as a discontinuous mass spread across the smear zone of the historical water tables and currently submerged. This diffuse distribution at LNAPL at depth~~s~~ is not completely accounted for even with the robust groundwater monitoring network.

Mapping of every minute body of LNAPL is not required to define the nature and extent of contamination. ~~steps~~. ~~Further evidence comes from the presence of immobile interstitial LNAPL observed in laboratory results at locations between the current and the historic low groundwater elevation in the upgradient direction (Figure 5-11).~~

LNAPL continues to provide a persistent source of benzene contamination to groundwater. In the vadose zone, LNAPL and soil contamination partition benzene into pore water, which in turn leaches to groundwater. At the current water table and LNAPL smear zone, benzene partitions directly from LNAPL to groundwater, sourcing the solute plume. As the water table rises, it places groundwater in direct communication with soil contamination and LNAPL in the lower vadose zone, again directly sourcing benzene to groundwater. Finally, submerged LNAPL in response to the rising water is a persistent source to benzene solute contamination by direct partitioning of benzene from LNAPL to groundwater. These LNAPL sources will continue to source solute plumes of all site contaminants of concern – EDB, toluene, ethylbenzene, and xylenes, until depleted by dissolution into pore water or groundwater, degradation by natural attenuation processes, or by active remediation.

~~Partitioning of benzene from diffused and dispersedresidual LNAPL where the vadose zone source intersected the groundwater table serves as a continuing source of dissolved contamination. The dissolved phase benzene plume is shown in map view on Figure 5-12. The soil vapor plume in the vadose zone is shown on Figure 5-13. Figure 5-14 shows that the highest dissolved phase benzene concentrations are located where the soil vapor plume intersects the groundwater plume, demonstrating that the soil vapor and dissolved vapor data are in alignment.~~

6. INVESTIGATION-DERIVED WASTE

This section includes a general summary of waste that was generated and managed during the vadose zone drilling program. A detailed description is included in the compiled Well Completion Report that can be found in Appendix I. Waste generated during vadose zone drilling activities included non-hazardous liquids, hazardous waste, special waste solids, and non-hazardous solids. Information regarding investigation-derived waste accumulation~~, and storage~~, utilization of the Kirtland AFB groundwater treatment system, and other investigation-derived waste processes are described in more detail in the following reports generated for the BFF: Quarterly Monitoring Report, October-December 2018, and Annual Report for 2018 (Kirtland AFB, 2019a); Quarterly Monitoring Report, January-March 2019 (Kirtland AFB, 2019b); and Quarterly Monitoring Report, April-June 2019 (Kirtland AFB, 2019e).

6.1 Non-Hazardous Liquids

Non-hazardous liquid waste consisted of containment pad rainwater, water pumped from roll-off bins, well development water, water utilized during hydro-knife activities prior to the start of drilling, decontamination pad water, and pressure wash water. A total of 9,103 gallons of non-hazardous liquids was generated with 8,983 gallons treated at the groundwater treatment system and discharged to the Kirtland AFB Tijeras Arroyo golf course. A total of 120 gallons of non-hazardous liquids did not meet the groundwater treatment system criteria and was disposed of by Advanced Chemical Treatment, Albuquerque, New Mexico. Summaries of the liquid waste disposal to the GWTS are provided in Appendix ~~F~~K-1, Tables K~~F~~-1-1 through ~~F~~K-1-3.

6.2 Hazardous Waste

Hazardous waste consisted of ~~a~~ water/sand mixtures generated from well development~~drilling~~ activities. A total of 694 gallons of hazardous waste was generated and disposed of offsite at ACT Chemical Transport in Albuquerque, New Mexico. Summaries of the waste disposal are provided in Appendix K~~F~~-2, Tables K~~F~~-2-1 and ~~F~~K-2-2.

6.3 Special Waste Solids

Special waste consisted of petroleum-contaminated soil that was found to have a TPH concentration greater than 100 milligrams per kilogram. Special waste was generated from drilling activities and from mud collected from the decontamination pad. A total of 44.2 cubic yards of special waste was generated and disposed of in the Waste Management Rio Rancho Landfill in Rio Rancho, New Mexico~~a Special Waste cell~~. Disposal is summarized in Appendix K~~F~~-3, Tables K~~F~~-3-1 and K~~F~~-3-2.

6.4 Non-Hazardous Solids

Non-hazardous solids consisted of soil, mud, and sand generated during drilling. A total of 246 cubic yards of non-hazardous dry solids was generated and disposed of at the Kirtland AFB Construction and Demolition Landfill. An additional 28 cubic yards of non-hazardous mud was generated and disposed of at Twin Enviro Services in Penrose, Colorado. Disposal is summarized in Appendix K~~F~~-4, Tables K~~F~~-4-1 through K~~F~~-4-3.

7. SUMMARY AND CONCLUSIONS

The source zone characterization included coring at 11 locations to assess the horizontal and vertical extent of LNAPL at the Site. The characterization included the collection of over 3,600 linear ft of core, chemical analysis of 87 soil samples, UV fluorescence of 30 cores, physical property testing of 16 cores, microbial analyses of 26 samples, and mineralogy and magnetic susceptibility analyses of 30 samples. Soil core samples were collected to obtain contaminant concentration and soil and LNAPL properties data.

In addition to the LNAPL characterization, nested monitoring wells were constructed in each borehole with nine dual-completion GWM wells and two, six-nest SVM wells. The GWM wells were installed to address data gaps in the source zone created by the rising groundwater elevation and to facilitate future sampling as the water table continues to rise. The SVM wells were installed as observation wells for the bioventing pilot study that initiated in 2018.

Borehole locations were selected based on their proximity to the source area (KAFB-106V1 and KAFB-106V2), and their proximity to historical LNAPL (KAFB-106S1 through KAFB-106S5, and KAFB-106S7 through KAFB-106S9). One borehole (KAFB-106247) was located outside of the known release area to collect background data). Two of the b~~B~~oreholes, KAFB-106S5 and KAFB-106S7, were located off-Base, north of Kirtland AFB. Continuous cores were collected next to existing boreholes using sonic drilling to provide higher resolution lithologic data in the source area. The logs from the new cores were then compared to the logs from the existing boreholes.

In general, the lithologic logs created using data from the continuous sonic cores correlated well with previously prepared borehole logs. The vadose zone is dominated by silt and clay units to a depth of approximately 160 ft bgs. These low-permeability units are interbedded with higher-permeability sand units. Below 160 ft bgs, fine to coarse gravelly sand dominated to a depth of approximately 250 ft bgs. A lens of low permeability silt and clay was present between 250 and 300 ft bgs. Below 300 ft bgs, fine to coarse sand and gravel dominate to the total depth of the boreholes advanced during this investigation (approximately 515 ft bgs). These higher-permeability units are interbedded with lower-permeability units of silt and clay. These soil units are indicative of Ancestral Rio Grande deposits.

Soil samples were collected from drill cuttings and soil cores and then submitted to an analytical laboratory for TPH-GRO/DRO/MRO, VOCs, and EDB analysis. Field screening (heated headspace) was performed to guide collection of soil samples for laboratory analysis. The laboratory analytical data were used to assess the magnitude and location of contaminants in the subsurface. Evaluation of the data collected from TPH-GRO/DRO/MRO, VOCs, and EDB~~LNAPL~~ testing provided the following conclusions:

- The highest ~~C~~concentrations of BTEX (110 mg/kg, 3,100 mg/kg, 770 mg/kg, and 3,690 mg/kg, respectively), TPH (32,000 mg/kg), and EDB (2.1 mg/kg) ~~are elevated in the~~observed in the vadose zone were present in samples collected from KAFB-106V1 ~~and KAFB-106V2~~ (Figures 5-1~~3~~ through 5-3~~5~~, Table 5-1). Both borehole~~s~~ KAFB-106V1 and KAFB-106V2 are located within the source area and the observed concentrations are representative of the release location. The laboratory analytical data indicated petroleum hydrocarbon concentrations generally increased with depth in KAFB-106V1 and decreased with depth in KAFB-106V2 (see Figures 5-1 through 5-3 for depths of soil sample concentrations). However,~~These~~ concentrations ~~increased~~decreased significantly ~~with depth until a~~beneath the clay unit that was encountered at a depth of approximately 265 ft bgs (see soil boring logs in Appendix D and Figures 5-1 through

5-3 for depths of soil sample concentrations). ~~Below this clay unit, concentrations decrease significantly (Figures 5-3 through 5-5 and soil boring logs in Appendix XX).~~

- ~~Concentrations of TPH, BTEX, and EDB are below the laboratory reporting limit within the vadose zone in all other boreholes (Figures 5-3 through 5-5, Table 5-1).~~

- The highest concentrations in the saturated zone are in wells KAFB-106S9 and KAFB-106S1 (Figures 5-~~3~~1 through 5-~~5~~3, Table 5-1) located to the east of the source area (KAFB-106V1 and KAFB-106V2).

- Concentrations of BTEX, TPH, and EDB decrease significantly in wells located off-Base (KAFB-106S5 and KAFB-106S7). The highest concentrations in these wells are in soil samples collected at depths of 491 ft bgs (KAFB-106S5) and 495 ft bgs (KAFB-106S7).

Soil cores were also used to assess the location and percentage of saturation of LNAPL in the subsurface. Field screening for the presence of LNAPL was performed using UV light. Soil cores that indicated the presence of LNAPL were submitted for laboratory UV analysis to confirm or deny the presence of LNAPL. Soil cores that were confirmed to have LNAPL present were submitted for laboratory testing for saturation and mobility. The evaluation of the data collected from LNAPL testing provided the following conclusions:

- The LNAPL in the vadose zone core samples is immobile. This demonstrates that there is no drainage of LNAPL that could cause a continued LNAPL head in the source area that would be required to drive migration (ITRC, 2018).

The percentage of LNAPL saturation decreases away from the source area (KAFB-106V1 and KAFB-106V2). The highest LNAPL saturation from the vadose zone is in KAFB-106V1 at a depth of 122 ft bgs (Table 5-4). The highest LNAPL saturation in the saturated zone was observed in KAFB-106S9 at a depth of 484 ft bgs (Table 5-4). The lowest LNAPL saturations are in wells KAFB-106S5 and KAFB-106S7, which are located off-Base, farthest from the source area (Table 5-4). The LNAPL pore volume percentages and LNAPL total volume saturation percentages are presented in Figures 5-4 and 5-5, respectively. The following provides a summary of the findings.

UV fluorescence of core samples from KAFB-106S9 identified LNAPL in the saturated zone at a depth that coincides with the former lowest groundwater elevation from 2009 (approximately ~~500~~494 ft bgs). In addition, the highest PID concentrations collected from each of the borings advanced to the water table also generally correlate with this elevation.

- ~~The residual LNAPL (smear zone) in the vicinity of KAFB-106S9 is approximately 40 ft thick in the source area and thins to approximately 25 ft thick toward the south (KAFB-106S1) and less than 10 ft thick to the north (KAFB-106S5).~~

- A diffused and dispersed~~residual~~ LNAPL smear zone is present below the water table and downgradient from the source area extending northeast under USS Bullhead Memorial Park. Laboratory analysis demonstrates that the LNAPL in this zone is immobile.

- Diffused and dispersed~~Residual~~ LNAPL appears to coincide with the effective solubility of 1.43 mg/L benzene. Outside of this isocontour, dissolved-phase BTEX constituents are present.

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However, dissolved phase BTEX attenuates to below the project screening levels less than 500 ft from the diffused and dispersed~~residual~~ LNAPL (Figure 5-7~~97~~).

Soil samples were also collected for microbiological and mineralogic analyses to provide data to support the future evaluation of abiotic and microbiological remedial techniques in the Corrective Measures Evaluation. The evaluation of the data collected from these analyses provided the following conclusions:

- No microbial genes responsible for reductive dehalogenation were found in samples collected.
- No Dehalococcoides, the only bacteria known to be capable of complete reductive dehalogenation to ethane *including dehalogenation of EDB to ethane*, were found in any of the samples.

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- Microbial genes responsible for aerobic co-metabolism of chlorinated ethenes were present in most samples analyzed. These results indicate a low potential for anaerobic degradation of EDB, but moderate potential for aerobic degradation of BTEX.

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- The analytical laboratory indicated that an unidentified substance was present that appeared to inhibit the PCR. Based on this, it is not possible to determine whether these data are biased low due to an unknown compound present in the samples or if these organisms and functional genes are truly not widespread in significant numbers in the samples.
- Abiotic attenuation of EDB with respect to iron-bearing minerals is not anticipated to be significant~~.~~ because no pyrite or other iron sulfide minerals were present in the aquifer that can catalyze reductive dehalogenation of EDB. Magnetite was observed at 1.5-7 wt.% of soil samples by correlation of magnetic susceptibility. Magnetite can perform degradation of halogenated compounds; however, it reacts more slowly than pyrite. The rate of degradation for magnetite is approximately 20-40 times slower than ferrous sulfide~~ and has resulted in undetectable EDB attenuation~~. Some other iron-bearing silicate minerals may be able to catalyze abiotic EDB attenuation but these minerals could not be characterized in the samples by the methods used in this study.

The data indicates that the fuel migrated vertically through mostly permeable non-cohesive soil in the source zone by gravity drainage from the release point to the clay layer encountered around 260 to 270 feet bgs. Upon encountering the clay layer, the fuel saturated the soil above the clay, resulting in increased hydraulic head that eventually overcame the capillary pressure of pore water in the clay porosity. Once this pressure was overcome, LNAPL migrated into and through the clay layer (ITRC-3 2018) as evidenced in heated headspace readings from boring KAFB-106V1. Not only did the hydraulic head that built up drive the LNAPL into and through the clay, it spread LNAPL laterally on the clay layer as a saturated fluid. Laterally, LNAPL may have pooled with sufficient hydraulic head to penetrate the clay elsewhere.

Once the LNAPL entered the clay, structural changes to the clay facilitated greater permeability and ability to transmit the LNAPL through the clay to the underlying permeable soil. This mechanism is contrary to the concept that the clay formed an impermeable layer to the LNAPL. LNAPL migrated vertically through the clay, and laterally through the clay by capillarity. A physical absence of the clay layer to facilitate LNAPL migration past the clay layer is not required to explain the deeper migration of LNAPL to the water table.

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~~Moisture content data were collected to review the state of moisture in the vadose zone to assist with the Bioventing Pilot Study. Data collected from these analyses provided the following conclusions:~~

- ~~In general, soil moisture was less than 5% in vadose zone samples (Table 5-7).~~
- ~~There did not appear to be a significant difference in moisture contents in samples collected in the source area versus those collected off-Base (KAFB-106S5 and KAFB-106S7).~~

~~The lithologic data were combined with soil vapor data collected in Q2 2019 and LNAPL saturation data to create a subsurface lithologic model of the current state of the vadose and groundwater plumes. The model is useful to not only inform the current location of contaminants in the surface but also how they migrated historically through the subsurface. The model provided the following conclusions:~~

- ~~Subsurface stratigraphy (high permeability soils) was the dominant control for the downward migration of LNAPL resulting from loading caused by the historic release(s). The clays do not appear to have significantly affected lateral migration of the LNAPL. LNAPL migration was dominated primarily by gravity drainage rather than horizontal migration along low permeability (i.e., clay or silt) zones.~~
- ~~Vertical downward migration continues until the LNAPL intercepted the groundwater table at which point mobile LNAPL migrated northward in response to head resulting from loading when the release was occurring (Figure 5-10). Dissolved-phase EDB and benzene plumes developed and migrated according to the local historical groundwater gradient. As the groundwater decreased in elevation, transport would have followed the LNAPL gradient created by the continued drainage and favored the groundwater gradient.~~

The data collected during this coring investigation has provided detailed lithologic information in the source area. This information, when incorporated with existing data collected from other investigations from 1999 to present, will be presented in the RFI Phase II.

The monitor wells installed as part of this investigation will continue to be monitored quarterly and incorporated into the groundwater monitoring program.

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FIGURES

TABLES

APPENDICES

(Appendices Provided in Electronic Format via CD)

APPENDIX A

REGULATORY CORRESPONDENCE

APPENDIX B

DAILY QUALITY CONTROL REPORTS

APPENDIX C

CORE TEMPERATURE LOGS~~FIELD SCREENING LOGS (TEMPERATURE LOGS)~~

APPENDIX D

LITHOLOGIC LOGS AND WELL COMPLETION DIAGRAMS~~TECHNICAL MEMORANDUM FOR VADOSE ZONE CORE PHOTOGRAPHY LOGS (Provided Electronically via Compact Disc)~~

APPENDIX E

TECHNICAL MEMORANDUM FOR VADOSE ZONE CORE PHOTOGRAPHY LOGS
(Provided Electronically via Compact Disc)
~~SITE PHOTOGRAPHS~~

APPENDIX F

SITE PHOTOGRAPHS~~WASTE MANAGEMENT DOCUMENTATION~~

APPENDIX G
LABORATORY DATA PACKAGES – SOIL SAMPLES
~~APPENDIX F-1~~

~~NON-HAZARDOUS LIQUIDS INVESTIGATION-DERIVED WASTE PROFILING AND DISPOSAL DOCUMENTATION~~

APPENDIX ~~F-2~~G-1

TESTAMERICA, INC., ARVADA, COLORADO

~~HAZARDOUS WASTE INVESTIGATION-DERIVED WASTE PROFILING AND DISPOSAL DOCUMENTATION~~

APPENDIX G-2

PTS LABORATORIES, HOUSTON, TEXAS
~~F-3~~

~~SPECIAL WASTE SOLIDS INVESTIGATION-DERIVED WASTE PROFILING AND DISPOSAL DOCUMENTATION~~

APPENDIX G-3

MICROBIAL INSIGHTS, INC., KNOXVILLE, TENNESSEE
~~F-4~~

~~NON-HAZARDOUS SOLIDS INVESTIGATION-DERIVED WASTE PROFILING AND DISPOSAL DOCUMENTATION~~

APPENDIX G-4

DANIEL B. STEPHENS AND ASSOCIATES SOIL TESTING LABORATORY, ALBUQUERQUE, NEW MEXICO

~~LABORATORY DATA PACKAGES – SOIL SAMPLES~~

APPENDIX H~~G-1~~

DATA QUALITY EVALUATION REPORT, TEST AMERICA~~TESTAMERICA, INC., ARVADA, COLORADO~~

APPENDIX I~~G-2~~

COMPILED WELL COMPLETION REPORT~~PTS LABORATORIES, HOUSTON, TEXAS~~

APPENDIX J~~G-3~~

SEARCHABLE FLAT FILE OF VOCS, EDB, AND TPH ANALYTICAL ~~MICROBIAL INSIGHTS, INC., KNOXVILLE, TENNESSEE~~

APPENDIX K

WASTE MANAGEMENT DOCUMENTATION~~G-4~~

~~DANIEL B. STEPHENS AND ASSOCIATES SOIL TESTING LABORATORY, ALBUQUERQUE, NEW MEXICO~~

APPENDIX K-1~~H~~

NON-HAZARDOUS LIQUIDS INVESTIGATION-DERIVED WASTE PROFILING AND DISPOSAL DOCUMENTATION
~~DATA QUALITY EVALUATION REPORT, TESTAMERICA, INC~~.

APPENDIX K-2~~I~~

HAZARDOUS WASTE INVESTIGATION-DERIVED WASTE PROFILING AND DISPOSAL DOCUMENTATION ~~LITHOLOGIC LOGS AND WELL COMPLETION DIAGRAMS~~

APPENDIX K-3~~J~~

SPECIAL WASTE SOLIDS INVESTIGATION-DERIVED WASTE PROFILING AND DISPOSAL DOCUMENTATION
~~EARTH VOLUMETRIC SOFTWARE MODEL DATA~~

APPENDIX K-4

NON-HAZARDOUS SOLIDS INVESTIGATION-DERIVED WASTE PROFILING AND DISPOSAL DOCUMENTATION

Table A-1
Status of Work Plan Scopes of Work

Work Plan Section	Pertinent Scope of Work Description	Well Identification	Status of Scope of Work	Report Where Data was First Documented (Following Work Plan Approval)
3.1.1	Continuous Coring		Completed	Included in this Report
3.1.2	Soil Vapor Monitoring Point Installation in Boreholes KAFB-106V1 and KAFB-106V2	KAFB-106V1 and KAFB-106V2	Installed January 2019	Completion Report was Included in the First Quarter 2019 Groundwater Monitoring Report
3.1.3	Air-Lift Well Completion KAFB-106S1		Letter Requesting Deferral Submitted to NMED on 7/30/18	
3.1.4	Dual-Completion Vadose Zone/Groundwater Monitoring Wells	KAFB-106247	Installation completed 3/1/19	Well Completion Report was Included in the Second Quarter 2019 Groundwater Monitoring Report
		KAFB-106S1	Installation completed 2/18/19	Well Completion Report was Included in the Second Quarter 2019 Groundwater Monitoring Report
		KAFB-106S2	Installation completed 11/21/18	Well Completion Report was Included in the First Quarter 2019 Groundwater Monitoring Report
		KAFB-106S3	Installation completed 11/29/18	Well Completion Report was Included in the Second Quarter 2019 Groundwater Monitoring Report
		KAFB-106S4	Installation completed 11/16/18	Well Completion Report was Included in the First Quarter 2019 Groundwater Monitoring Report
		KAFB-106S5	Installation completed 11/15/18	Well Completion Report was Included in the First Quarter 2019 Groundwater Monitoring Report
		KAFB-106S7	Installation completed 2/4/19	Well Completion Report was Included in the Second Quarter 2019 Groundwater Monitoring Report
		KAFB-106S8	Installation completed 3/1/19	Well Completion Report was Included in the First Quarter 2019 Groundwater Monitoring Report
		KAFB-106S9	Installation completed 11/8/18	Well Completion Report was Included in the First Quarter 2019 Groundwater Monitoring Report
3.1.5	Vadose Zone Monitoring and Reporting		Initiated in the Second Quarter 2018	Reported Semiannually in the Second Quarter and Fourth Quarter Groundwater Monitoring Reports
3.1.6	Maintenance of the Soil Vapor Monitoring Well Network		Initiated in the Fourth Quarter 2019	Reported Semiannually in the Second Quarter and Fourth Quarter Groundwater Monitoring Reports
3.1.7	Water Supply Sampling and Reporting		Initiated in January 2018	Drinking water sampling results are reported in Monthly Technical Memorandums. Consent from the property owner was not given for the irrigation sample collection
3.2.13	Well Construction Diagrams	Appendix I of this Report		
3.2.14	Soil Sampling	See Tables 5-1 to 5-5 and 5-6 of this Report		

Table A-1
Status of Work Plan Scopes of Work

Work Plan Section	Pertinent Scope of Work Description	Well Identification	Status of Scope of Work	Report Where Data was First Documented (Following Work Plan Approval)
3.2.15	Well Development	KAFB-106247	Completed on 3/6/19	Well Completion Report was Included in the Second Quarter 2019 Groundwater Monitoring Report
		KAFB-106S1	Completed on 3/14/19	Well Completion Report was Included in the Second Quarter 2019 Groundwater Monitoring Report
		KAFB-106S2	Completed on 12/11/18	Well Completion Report was Included in the First Quarter 2019 Groundwater Monitoring Report
		KAFB-106S3	Completed on 12/3/18	Well Completion Report was Included in the Second Quarter 2019 Groundwater Monitoring Report
		KAFB-106S4	Completed on 10/10/18	Well Completion Report was Included in the First Quarter 2019 Groundwater Monitoring Report
		KAFB-106S5	Completed on 12/6/18	Well Completion Report was Included in the First Quarter 2019 Groundwater Monitoring Report
		KAFB-106S7	Completed on 3/7/19	Well Completion Report was Included in the Second Quarter 2019 Groundwater Monitoring Report
		KAFB-106S8	Completed on 3/5/19	Well Completion Report was Included in the First Quarter 2019 Groundwater Monitoring Report
		KAFB-106S9	Completed on 12/10/18	Well Completion Report was Included in the First Quarter 2019 Groundwater Monitoring Report
3.2.16	Groundwater Gauging and Sampling (First Sampled)	KAFB-106247	Completed 4/16/2019	Reported in the Second Quarter 2019 Groundwater Monitoring Report
		KAFB-106S1	Completed 4/16/2019	Reported in the Second Quarter 2019 Groundwater Monitoring Report
		KAFB-106S2	Completed 1/15/2019	Reported in the First Quarter 2019 Groundwater Monitoring Report
		KAFB-106S3	Completed 1/15/2019	Reported in the First Quarter 2019 Groundwater Monitoring Report
		KAFB-106S4	Completed 1/15/2019	Reported in the First Quarter 2019 Groundwater Monitoring Report
		KAFB-106S5	Completed 1/15/2019	Reported in the First Quarter 2019 Groundwater Monitoring Report
		KAFB-106S7	Completed 4/16/2019	Reported in the Second Quarter 2019 Groundwater Monitoring Report
		KAFB-106S8	Completed 4/16/2019	Reported in the Second Quarter 2019 Groundwater Monitoring Report
		KAFB-106S9	Completed 1/15/2019	Reported in the First Quarter 2019 Groundwater Monitoring Report

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Michelle Lujan Grisham
Governor

Howie C. Morales
Lt. Governor

James C. Kenney
Cabinet Secretary

Jennifer J. Pruett
Deputy Secretary

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

August 17, 2020

Colonel David S. Miller
Base Commander
377 ABW/CC
2000 Wyoming Blvd SE
Kirtland AFB, NM 87117

Lt. Colonel Wayne J. Acosta
Civil Engineer Office
377 Civil Engineering Division
2050 Wyoming Blvd SE, Suite 116
Kirtland AFB, NM 87117

RE: DISAPPROVAL
SOURCE ZONE CHARACTERIZATION REPORT FOR THE BULK FUELS FACILITY SOLID WASTE MANAGEMENT UNIT ST-106/SS-111
KIRTLAND AIR FORCE BASE, NEW MEXICO
EPA ID # NM9570024423
HWB-KAFB-19-012

Dear Colonel Miller and Lt. Colonel Acosta:

The New Mexico Environment Department (NMED) is in receipt of the U.S. Air Force (Permittee) Kirtland Air Force Base (Facility) *Source Zone Characterization Report for the Bulk Fuels Facility Solid Waste Management Unit ST-106/SS-111* (Report), dated October 2019. NMED has reviewed the Report and hereby issues this Disapproval.

Upon examination of the Report and associated documents, NMED discovered issues with data collection, data analyses, data quality, data presentation, and data interpretation. Therefore, NMED was unable to evaluate the validity of the conclusions presented by the Permittee in the Report. NMED's comments are attached. General topics and several examples of NMED's comments were discussed during a NMED/KAFB conference call on June 18, 2020.

The Permittee must submit a revised Report that corrects the deficiencies noted in this Disapproval. The revised Report must be accompanied by a response letter (also included as an appendix) that details where the comments were addressed and cross-references NMED' s numbered comments. The Permittee must submit a complete electronic redline-strikeout version of the revised Report that shows where all changes were made to the Report. In addition, all PDF versions of documents must be provided in a searchable format. The revised Report must be submitted no later than **December 31, 2020**.

If you have any questions regarding this letter, please contact me at (505) 476-6035.

Sincerely,

Kevin Pierard
Digitally signed by Kevin Pierard
Date: 2020.08.17 15:20:12 -06'00'

Kevin M. Pierard, Chief
Hazardous Waste Bureau

Attachment: NMED Comments

cc: D. Cobrain, NMED HWB
R. Murphy, NMED HWB
L. Andres, NMED HWB
B. Wear, NMED HWB
L. King, EPA Region 6 (6LCRRC)
S. Kottkamp, KAFB
K. Lynnes, KAFB

File: KAFB 2020 and Reading

Attachment 1

GENERAL COMMENTS

1. **Quality Control of document submittals.**

   NMED Comment: Quality control issues identified by NMED in documents previously submitted by the Permittee have also been identified in this Report. Examples include the lack of proper numbering of pages and tables, inconsistencies in the titles of related documents, and the lack of labeling of site features on figures. The Permittee must review its quality control procedures and address these issues to assist NMED in expediting document reviews and to assist the public in better understanding the documents that are submitted by the Permittee. This general topic and several examples of the following general comments were discussed during the NMED/KAFB conference call on June 18, 2020.

2. **Document titles and reporting for remaining scopes of work which were included in the Work Plan.**

   NMED Comment: Several scopes of work were included in the approved Work Plan but not all were addressed in this Report:

   a. The NMED approved June 2017 *Work Plan for Vadose Zone Coring, Vapor Monitoring, and Water Supply Sampling, Bulk Fuels Facility, Solid Waste Management Unit ST-106/SS-111* (Work Plan) provides:
      i. the technical approach for the continuous coring for subsurface sample collection, installation of soil vapor monitoring wells for future pilot testing at two of the coring locations, dual-completion of soil vapor/groundwater monitoring wells in eight of the coring locations;
      ii. soil vapor network monitoring and maintenance;
      iii. sampling of the newly installed groundwater monitoring wells and water supply wells; and
      iv. details for the air-lift enhanced bioremediation pilot test.

      The *Source Zone Characterization Report for the Bulk Fuels Facility Solid Waste Management Unit ST-106/SS-111*, dated October 2019, (Report) presents the results of item i and elements of items of ii and iii above: no information on item iv was provided. The Permittee is advised that, in order to avoid confusion, all future work plans must be written for one specific scope of work. No revision necessary.

   b. The title of the Report does not match the name of the relevant scope of work in the Work Plan. This letter pertains solely to the vadose zone coring and associated well installation activities as described in the Report. In order to maintain a clear administrative record, the names of all future documents and scopes of work must not change during the Resource Conservation and Recovery Act (RCRA) corrective action process (i.e., work plans through reports); however, the revised Report must retain its current title to avoid further confusion. No revision necessary. This issue was discussed during the NMED/KAFB conference call on June 18, 2020.

c. Future submittals that report on the activities performed under the Work Plan, must reference the Work Plan in the cover letter and executive summary of the document. Additionally, all future document titles and cover pages must include all major scope activities incorporated within that document, including those presented in appendices. No revision necessary. This issue was discussed during the NMED/KAFB conference call on June 18, 2020.

d. Report revision required. The workplan for the source zone characterization contained multiple scopes of work for various aspects of the study. The Report must clarify where the information regarding the other scopes of work presented in the Work Plan can be found (e.g., data associated with groundwater well gauging and sampling, drinking water and irrigation supply well sampling, and soil vapor monitoring data). The Work Plan discusses data collection for various scopes of work:

- **i.** Section 3.1.5, pages 3-6, 2nd paragraph of the Work Plan states: "Semiannual monitoring of the SVM network was approved...and will include sampling of the entire 284 SVMP network...".
- **ii.** Section 6.2 Project Data Types and Records, page 6-1, 1st paragraph, line 1 of the Work Plan states: "Field data will be collected.....in support of field activities associated with the BFF vadose zone treatability studies including coring, long term SVM, well drilling and installation, drinking water supply...[and]...irrigation well sampling."
- **iii.** Section 6.2.3 Chemical Analytical Data: page 6-2,1st paragraph, line 1 of the Work Plan states: "Chemical analytical data will include sample results from soil, soil vapor, and groundwater samples generated by the lab subcontractors."

The revised report must include a section describing the status of the remaining scopes of work included in the approved Work Plan. Include the date the work was performed and the specific document(s) where the information was reported.

3. Historic high and low water levels at the site

NMED Comment: Report revision required. The historic groundwater levels and present groundwater levels referenced by the Permittee in the Report are not consistently or clearly described in the text. For example:

a. The Work Plan states in Section 3.1.1, page 3-3, 1st paragraph, line 2: "The bottom of the designated coring interval extends approximately 10-20 feet (ft) below the lowest historic water level (2009) to ensure that the deepest vertical LNAPL migration is evaluated.

b. In the Report, Section 5.3, page 5-10, 3rd paragraph, 1st line states: "The highest LNAPL saturation percentage of the collected cores came from KAFB-106S9 at a depth of 484 feet below ground surface (ft bgs)). This is very close to the former lowest ground water elevation from 2009 (approximately 500 ft bgs)."

c. Section 7, page 7-2, 2nd paragraph, 3rd bullet, 2nd line: "...at a depth that coincides with the former lowest groundwater elevation from 2009 (approximately 500 ft bgs)."

d. The approved Work Plan states: "Coring intervals will begin at least ten (10) feet above the 1970s high water mark, which is equivalent to the 1960s high water mark."

Please revise the Report to provide a discussion of groundwater elevation changes over time at the site that includes the dates (month/year) of both the historical high and historical low water levels. Present the historic water levels in both depth below ground surface (ft bgs) and elevation relative to mean sea level (ft amsl) to the nearest 0.01 foot.

4. **Laboratory data, laboratory qualifiers, and data presentation**

NMED Comment: Report revision required. Quality Assurance (QA) and Quality Control (QC) of laboratory data:

a. The 2010 KAFB Hazardous Waste Facility Permit (Permit), Section 6.5.18, Laboratory Analyses Requirements for all Environmental Media, states "All analytical data (including non-detects, estimated values, and detects) shall be included in the electronic copy of the Investigation Report or other report in Microsoft™ Excel format with any qualifiers as attached from the analytical laboratory." The majority of the laboratory results for soil sampling at the facility presented in Table 5-1 were analyzed by Test America Laboratory. The associated laboratory reports are included as Appendix G-1, however, there are over 50 PDF laboratory reports, each consisting of 600 to 1,200+ individual pages. This format is inconsistent with the Permit requirements which makes it difficult to find specific data and information (e.g., a specific soil sample from a specific boring, at a specific depth, or specific data quality issues for samples associated with a particular laboratory report). The Permittee must revise the Report to provide a Microsoft™ Excel spreadsheet that includes the laboratory data in a searchable format.

This spreadsheet must include a specific field which indicates the laboratory report file name for each sample.

b. Permit, Section 6.5.18.2, Laboratory Deliverables, states "[l]aboratory analytical data packages shall be prepared in accordance with United States Environmental Protection Agency (EPA)-established Level III or IV analytical support protocols" and "[t]he Permittee shall present summary tables of these data and Level II QC results to the Department in reports or other documents...Raw analytical data, including calibration curves, instrument calibration data, data calculation work sheets, and other laboratory supporting data for samples from this project, shall be compiled and kept on file at the Facility for reference." The Permittee must revise Appendix G-1, Laboratory Data Packages- Soil Samples, Test America, Inc., to present Level II laboratory report data packages instead of Level IV laboratory report data packages.

c. The December 2017 *Quality Assurance Project Plan for Bulk Fuels Facility Vadose Zone Treatability Studies Solid Waste Management Unit St-106/Ss-111, Revision 1,* (QAPP) was included as an appendix to the Work Plan. Section 4.2 of the QAPP states that data will be validated and flagged with the following data qualifiers: J+, J-, U, UJ, and R. Laboratory case narratives outline numerous concerns resulting in a variety of laboratory data qualifiers which are not included on Table 5-1 or mentioned in text of the Report. For example, the case narrative for associated soil sample V-V2-131218-117 identified three laboratory qualifiers (i.e. J, D, and Q) for the ethylene dibromide (EDB) results for that sample, however, Table 5-1 of the Report shows only a J qualifier. In another example, the case narrative of the laboratory report for total petroleum hydrocarbon (TPH) gasoline range organics (GRO) results for P-V2-121218-080 and P-V2-121218-103 indicates that these samples have been reported with "Q" laboratory data qualifiers which indicate that "One or more quality control criteria failed", however, Table 5-1 of the Report shows only a J qualifier. Please revise the Report to include all laboratory-assigned data qualifiers, including dilution, with footnotes that adequately define the qualifier codes. Data qualifiers must be presented in Table 5-1, and elsewhere in the Report as appropriate.

d. Section 6.5.18.3.1 of the Permit, Laboratory Analyses Requirements for all Environmental Media, states that "[a] full review and discussion of QC data and all data qualifiers shall be submitted with Investigation Reports...". Section 4.2 of the QAPP, Analytical Data Verification and Validation, states "data review findings will be summarized and documented in task-specific data reports, completion reports or with each quarterly monitoring report." The Permittee must include a new section in the revised Report that discusses all data quality concerns and how these concerns may affect the data quality.

e. Table 5-1 indicates that several results are J-coded as a result of the laboratory having to dilute numerous samples prior to analysis due to high contaminant concentrations (e.g.: V-V2-131218-159). The Permittee is reminded that per 6.5.18 of the Permit "[t]he Department will not accept J-coded (estimated) results for samples requiring dilution prior to laboratory analysis." Please revise the Report to indicate that samples diluted prior to analysis will be not be used as decision level data but may be used qualitatively.

f. Laboratory reports indicate that some samples were analyzed outside of the holding time. As a result, the laboratory reports document data validation concerns for these samples. This important information is not included in the Report. The Permittee must revise Table 5-1 to note which samples exceeded holding times and include the applicable laboratory qualifiers on the revised table. Additionally, the Permittee must include an explanation of the issue causing the analysis outside of the holding time and the effect it may have on the data quality, an explanation of any steps taken to resolve the matter, and the results of those efforts in the revised Report. See Comment 4.c above regarding laboratory qualifiers.

g. Table 5-1 only presents analytical results under the column heading for the limit of detection (LOD). The LOD is the lowest analyte concentration at which an analyte can be detected, however, precision and accuracy are not achieved. The limit of quantitation (LOQ) is the lowest concentration at which an analyte can be reliably detected with precision and accuracy. Section 4.3.2, Project-Required Reporting Limits – Sensitivity, in the QAPP of the approved Work Plan indicates that LOQs will be calculated. Laboratory reports show that data is presented with the detection limit (DL), LOD, and LOQ for all analyses performed. Table 5-1 only includes LOD and is therefore not acceptable as presented for the purposes of data reporting. The Permittee must revise the Report to add columns to Table 5-1 to report the DL, LOD, and LOQ for each analysis presented.

SPECIFIC COMMENTS

5. Notice Page

Permittee Statement: "Physical and chemical characterization was performed on residual LNAPL samples."

NMED Comment: NMED Comment: Report revision required. The results of chemical characterization of residual LNAPL from samples collected in 2011 for the Phase I RCRA

Facility Investigation Report, Bulk Fuels Facility Release, Solid Waste Management Unit ST-106/SS-111 are presented in the Report rather than from samples collected as part of the field work implemented under the Work Plan. Please revise the statement for accuracy and revise Table 5-5 to include chemical characterization data performed on residual LNAPL samples collected as part of the field activities covered in this Report or provide an explanation in the revised Report justifying why these data were not collected. The purpose of collecting samples in 2018 was to allow for evaluation of the changing chemical composition of LNAPL in groundwater over time and to calculate new values for the effective solubility of benzene and EDB for estimating the current extent of LNAPL in groundwater. This is important information to obtain due to rising water levels.

6. **Executive Summary, page ES-1**

Permittee Statement: "The results of this investigation indicate that the presence of fuel has been significantly reduced in the vadose zone by remedial actions and natural processes."

NMED Comment: Report revision required. The Report does not include historical data from source area characterization to compare to the 2018 and 2019 soil, soil vapor, light non-aqueous phase liquid (LNAPL), and groundwater data presented in this Report that would support this statement. The Permittee must include the historical data and provide a discussion to support this statement or remove it from the narrative.

7. **Executive Summary, page ES-1**

Permittee Statement: "LNAPL saturation in vadose zone samples was highest in the source area and none of the samples were found to contain mobile LNAPL. This demonstrates that there is no drainage of LNAPL that could cause continued LNAPL head in the source area that would be required to drive migration."

NMED Comment: Report revision required. Analysis of multiple geophysical and lithologic logs at the site indicate it is likely that a discontinuous clay layer in the source area may have altered the pathway for the migration of fuels related contamination to groundwater. This potential migration pathway is likely to contain hydrocarbon saturated soils that, while not mobile under current conditions, would likely serve as a significant source of dissolved phase petroleum hydrocarbon contamination as groundwater levels continue to rise and come into contact with them. The lithologic cross sections and the discussion on the site hydrogeology presented in the Report do not address this issue. Revise the Report to address this possibility by identifying the top and bottom surfaces of both the upper and lower clay units beneath the site using cross sections and isopach maps.

8. **Section 2 Facility History and Project Background, page 2-1**

   NMED Comment: Report revision required. The Permittee must revise the Report to include a comprehensive general overview of the site history per reporting requirements outlined in Permit Section 6.2.4.3, Investigation Reports, item number 5, Background Information.

9. **Section 3 Scope of Activities, page 3-2**

   NMED Comment: Report revision required. Laboratory reports included in Appendix G-4 (DBSA Soil Testing Laboratory) include results for Fraction Organic Carbon (FOC). Revise the Report to add an additional bullet to the list on this page that states that FOC testing was conducted and provide the purpose of the tests. Include a table that summarizes the analytical results for FOC, as this is valuable information for use in valuating risk.

10. **Section 4.2.1 Groundwater Monitoring Wells, page 4-4**

    NMED Comment: Report revision required. The Permittee does not discuss well development, gauging, or sampling performed on new groundwater monitoring wells after well installation was complete. This information is essential for a comprehensive characterization of the source area. Revise the Report to include this information in accordance with Permit Sections 6.2.4.3 (Investigation Reports) and 6.5.17.10.8 (Well and Piezometer Completion Reports), see Comment 58, below.

11. **Section 5.1 Subsurface Lithology, page 5-1**

    Permittee Statement: "Soil descriptions from the lithologic logs created during coring activities were used to create detailed geologic models of the subsurface."

    NMED Comment: Report revision required. It appears that an incomplete data set was used to generate the model. Cross sections, fence diagrams, and models must be generated using lithologic, soil vapor, and water level data from all the available boreholes and monitoring locations. Failing to do so creates an incomplete picture of subsurface site conditions and may lead to erroneous conclusions regarding the nature and extent of contaminants. Please revise the figures to incorporate both the data collected during the vadose zone coring project and previously collected data.

12. **Section 5.1 Subsurface Lithology, page 5-1**

    Permittee Statements: "Data supplied to this module are based on Unified Soil Classification System (USCS) classifications logged during drilling that were simplified into nine categories reflecting observed grain-size distribution and inferred permeability."

    and

"The data used to construct the model are provided in Appendix J."

NMED Comment: Report revision required. The table provided in Appendix J, EVS Model Data does not appear to include most of the model inputs described in the Report. The column headers are not aligned with the data columns and the only units provided (feet and ppb) are both included in a single column. Revise the Report to define all of the parameters in the table and provide appropriate units for each column. NMED notes that Table 5-2, Soil Grain Size Distribution and Classification, contains only eight rather than nine grain-size distribution categories. Please resolve this discrepancy.

Additionally, please revise Appendix J to include the complete data set, data sources, and data quality assurance evaluation used to create the model presented in the Report. This information must include calibrated targets and estimated parameters, parameter distributions and sources of variability, and how each parameter is used in the model. Also include information on model boundary/source conditions, vadose zone and aquifer material properties, and contaminant transport properties. Identify all model assumptions and uncertainties and present the results of the uncertainty and sensitivity analyses in the revised report.

13. Section 5.1 Subsurface Lithology, page 5-1

Permittee Statement: "The subsurface in the area of the Source Zone Characterization project is shown on a west-to-east transect (A-A') and a north-to-south transect (B-B') (Figures 5-1 and 5-2)."

NMED Comments: Report revision required.

a. The Permittee must revise the Report to include a brief discussion of the regional geology and how it is expressed locally at the site.

b. Figures 5-1 and 5-2 contain errors. Please revise the report to correct the following errors:
  i. The X-axis on Figure 5-2 should read "1,474,500" rather than "1,475,500".
  ii. The inset aerial photograph in the Key incorrectly shows the scale of the axes as 2:1 while the scale of the photograph is shown as 1:1.

c. The Permittee must include copies of the field lithologic logs and well completion diagrams as an appendix to the Report.

14. Section 5.1.1 Field Screening, page 5-2

Permittee Statement: "The heated headspace values observed below the water table were indicative of the relative presence of hydrocarbons and were used to guide sample collection. In general, elevated heated headspace values (greater than 100 milligrams per kilogram) were observed predominately in the saturated zone (Table 4-1)."

NMED Comment: Report revision required. The Permittee's summary of heated headspace field screening lacks the necessary level of detail given its use in guiding sample collection for laboratory analyses. Please revise the discussion to provide a more complete summary of the heated headspace field screening results, including the increasing and decreasing trend in heated headspace readings followed by another increase at depth in heated headspace readings, which correspond to historical water levels at the Site. Additionally, PIDs typically give a response in units of parts per million by volume (ppmv). In heated headspace screening, the concentration in the headspace, measured in ppmv, does not equal the soil or water concentration, measured in mg/kg or mg/L. Correct the units in the revised report.

15. Section 5.2.1 Analytical Results for Organic Compounds, Vadose Zone, page 5-2:

Permittee Statement: "Concentrations of TPH, BTEX, and EDB are below the laboratory reporting limit in the vadose zone in all other boreholes (Figures 5-3 through 5-5, Table 5-1)."

NMED Comment: Report revision required. Soil coring was to be completed within set temperature parameters (≤ 20° Celsius) regardless of whether collection of a soil sample was planned for any given interval. On November 2, 2018 the Permittee requested via electronic mail a variance from meeting the temperature requirement for samples collected above 450 ft bgs for borings KAFB-106S2, KAFB-106S3, KAFB-106S6, KAFB-106S7, KAFB-106S8, and for samples above 400 ft bgs for boring KAFB-106S1. NMED approved the request on November 5, 2018 without comment. The Permittee's presentation of the analytical results for organic compounds in Section 5.2.1 fails to address their inability to meet the Work Plan requirement for completing sonic coring within set temperature parameters (≤ 20° Celsius). The Report must be revised to include a description of the process for measuring the core temperature and a discussion on the uncertainties associated with the temperature measurements. The Permittee must discuss the impact of elevated core temperatures on PID readings, sample integrity, and representativeness of the laboratory analytical results. The Permittee must include temperature data in appropriate tables. For example, Table 4-1 and Table 5-1 must have a column that displays the core temperature for each PID result or analytical sample. Lab analytical samples must be flagged for any sample that was collected above ≤ 20°Celsius. This issue was discussed during the NMED/KAFB conference call on June 18, 2020.

16. 5.2.1 Analytical Results for Organic Compounds, page 5-2

Permittee Statement: "For the purposes of this report, only results for the primary contaminants of concern BTEX, EDB, and TPH are discussed."

NMED Comment: Report revision required. Clarify why analyses for 61 other constituents is not discussed in the Report. Revise the Report to include a discussion of the other constituents listed in Table 5-1 and provide an explanation for excluding certain analytes.

17. 5.2.1 Vadose Zone Summary, page 5-2

Permittee Statement: "Concentrations of BTEX, TPH, and EDB were elevated in the samples collected from KAFB-106V1 and KAFB-106V2 (Figures 5-3 through 5-5, Table 5-1)."

NMED Comment: Report revision required. The Permittee's subsequent discussion addresses only KAFB-106V1. The Vadose Zone Summary must also include a discussion of organic compound trends in well KAFB-106V2. A discussion of the physical and interstitial properties of the stratigraphic intervals that control the migration and occurrence of the organic compounds in the vadose zone must be included in the revised report.

18. 5.2.1 Vadose Zone Summary, page 5-2

Permittee Statement: "The clay unit at these wells [KAFB-106V1 and KAFB-106V2] is very stiff to hard and contained up to 40 percent (%) silt."

NMED Comment: Report revision required. The source of the data for Permittee's statement must be included. The boring lithologic log for KAFB-106V1 indicates a maximum silt content of 10% in the clay layer. The boring lithologic log for KAFB-106V2 indicates a maximum silt content of 40% in the clay layer. Analytical data in Table 5-2 Soil Grain Size Distribution and Classification does not provide particle size distribution data for the clay layer at any of the boring locations. None of the analytical data presented in the Report includes measurements of sample stiffness or hardness. If the source of the data in the Permittee's statement is from the field borehole lithologic logs, the data must be reported in Section 5.1, Subsurface Lithology, rather than in Section 5.2, Laboratory Analytical Results. Please revise the Report for accuracy.

19. 5.2.1 Vadose Zone Summary, page 5-2

Permittee Statement: "Concentrations of BTEX, TPH, and EDB decrease significantly below the clay to the total depth of KAFB-106V1 at 285 ft bgs. Concentrations of TPH, BTEX, and EDB are below the laboratory reporting limit within the vadose zone in all other boreholes."

NMED Comment: Report revision required. The Permittee's statement is not supported by the data reported in Table 5.1. The table indicates elevated total petroleum hydrocarbons-diesel range organics (TPH DRO) and TPH GRO concentrations starting at a depth of 459' bgs in well KAFB-106S1. Concentrations for both analytes increase with depth to over 3000 milligram per kilogram (mg/kg) at a depth of 489' bgs. Depth to water (DTW) for KAFB-106S1 is recorded at 492' bgs in the boring log header and well construction diagram. Based on a DTW of 492' bgs, the elevated concentrations are within the vadose zone and both screened intervals of the well are above the water table.

NMED notes that the reported DTW at KAFB-106S1 is substantially greater than at any other ground water monitoring well. For instance, at nearby well KAFB-106S8, DTW is approximately 476' bgs. The anomalous DTW measurement at KAFB-106S1 must be corrected or explained. The Permittee must review the water level data and all related analytical data for all boreholes and revise the Report for accuracy.

20. 5.2.1 Saturated Zone Summary, page 5-3

Permittee Statement: "In wells located off-Base, toluene was the only constituent detected in KAFB-106S5 (farthest from source area) at concentrations of 0.00091 milligrams per kilogram (mg/kg) (417 ft bgs) and 0.00094 mg/kg (467 ft bgs)."

NMED Comment: Report revision required. The Permittee must identify the off-base wells. Additionally, Table 5-1 indicates that TPH DRO was detected at 5.6 mg/kg at a depth of 467 ft bgs at boring KAFB-106S5. Please revise the statement for accuracy.

21. 5.2.2 Light Non-Aqueous Phase Liquid Saturation, Mobility, and Effective Solubility, page 5-4

Permittee Statement: "The highest LNAPL saturation from the vadose zone sample was observed in KAFB-106V1 at a depth of 122 ft bgs...".

NMED Comment: Report revision required. No percentage is provided to compare with the ranges of LNAPL saturation results stated in the previous paragraphs. The Permittee must add the value for percent pore volume for KAFB-106V1 at 122 ft bgs to this sentence.

22. 5.2.2 Light Non-Aqueous Phase Liquid Saturation, Mobility, and Effective Solubility, page 5-4

Permittee Statement: "The percentage of LNAPL saturation decreases away from the source area (KAFB-106V1 and KAFB- 106V2). The highest LNAPL saturation in the saturated zone was found in KAFB-106S9 at a depth of 484 ft bgs (Table 5-4). The lowest LNAPL saturations KAFB-106S5 and KAFB-106S7, which are the farthest wells from the source area..."

NMED Comment: Report revision required. The Permittee must add the percentages of LNAPL saturation to this sentence for comparison purposes and reference the table that presents this information.

23. 5.2.2 Light Non-Aqueous Phase Liquid Saturation, Mobility, and Effective Solubility, page 5-4

Permittee Statement: "Soil grain distribution and classification was analyzed on 16 soil samples (six vadose zone and 10 saturated zone), along with 14 interstitial analyses of soil samples (six vadose zone and eight saturated zone)."

NMED Comment: Report revision required. NMED identified multiple problems with the data and discussion for Section 5.2.2 that make it difficult to evaluate the information presented by the Permittee. The tables and associated discussions must be revised for accuracy and the section rewritten. This issue was discussed during the NMED/KAFB conference call on June 18, 2020.

a. Table 5-3, Lithology and Interstitial Properties of Selected Core Samples, indicates that interstitial properties (total porosity, air filled porosity, pore fluid water saturation, and pore fluid LNAPL saturation) were determined for 16 rather than 14 samples. Resolve the discrepancy.

b. The sample depth column for Table 5-2 reports a depth range for some samples and a single depth for other samples. Explain the difference in the reported sampling intervals and explain how a representative particle size distribution for a 2-foot-long core sample was determined for samples where only a single depth is given. Explain why sample sizes listed in Table 5-4 range from 1/10 foot to 2 feet.

c. A description of the rationale for selecting discreet samples from core samples and at least two examples of the process must be provided in the discussion in Section 5.2.2. Compare the rationale for selecting a discreet sample from cores that fluoresced under ultraviolet (UV) light to cores that did not fluoresce.

d. Table 5-2 reports particle size distribution data and a corresponding United Soil Classification System (USCS) name. Sample GUV-S9-171018-473 is given a USCS classification of well graded sand. The particle size distribution data reports the sample as having 56.67 weight percent (wt.%) gravel 4.0 wt% coarse sand, 17.29 wt% medium sand, 18.97 wt% fine sand, and 3.07 wt% silt/clay. According to the USCS code the sample should be classified as a sandy gravel rather than a well graded sand. All such discrepancies in Tables 5-2 must be identified and corrected.

e. Issues were identified with the PTS Laboratories Physical Properties Data presented in Appendix G-2. For example, PTS File No: 48218 includes two samples, identified on some pages of the data sheets as GUV-S9-171018-473 and GUV-S9-181018-484 and on other pages as GUV-S9-171018-473 and GUV-S9-181018-474. Review the PTS lab data for accuracy. The Report must be revised to remove data, discussions, conclusions, and recommendations that are based on lab data that fails to meet data quality objectives.

f. NMED has identified discrepancies in the lithologic descriptions for samples reported in Tables 5-2, 5-3, and 5-4. For example, sample GUV-S5-231018-488 is described in Table 5-3 as a well graded sand with gravel while in Table 5-4 it is described as coarse sand. Aside from the descriptions being different, a well graded sand should contain a range of sand sizes rather than coarse sand only. All such discrepancies in Tables 5-2, 5-3, and 5-4 must be identified and the Report revised accordingly. The following are examples of some of the discrepancies identified:

  i. The PTS Laboratories sieve analysis results in Appendix G-2 report that sample GUV-S4-041118-486 is classified as a medium sand. Table 5-4 lists the soil type for the sample as fine sand. Resolve the discrepancy.

  ii. The PTS Laboratories sieve analysis results in Appendix G-2 report that sample GUV-S2-161118-489 is classified as fine sand. Table 5-4 lists the soil type for the sample as fine sand. Table 5-2 lists the sample as well graded gravel with sand. Resolve the discrepancy.

  iii. The PTS Laboratories sieve analysis results in Appendix G-2 report that sample GUV-S3-211118-494 is classified as gravel. Table 5-4 lists the soil type for the sample as gravel. Table 5-2 lists the sample as clay. Resolve the discrepancy.

  iv. The PTS Laboratories sieve analysis results in Appendix G-2 report that sample GUV-V1-161219-164 is 91 wt% fine sand. Table 5-2 lists the sample as clay. Resolve the discrepancy.

g. Appendix G-2 appears to contain duplicate Chain of Custody Record forms for individual samples. Remove the duplicate forms from Appendix G-2 or provide an explanation for retaining them.

h. Sample GUV-S7-220119-492 is attributed to coring location KAFB-106S7 in table 5-3, but it is attributed to coring location KAFB-105S7 in Table 5-4. Resolve the discrepancy.

i. The PTS Laboratories Chain of Custody Record for sample GUV-S5-231018-488 indicates that grain size distribution data was one of the analyses requested. Grain size distribution data for the sample is not presented in Table 5-2 of the Report and the footnotes for Table 5-3 indicate that the lithology description for the sample was obtained from logs. Explain why the log description was used rather than the laboratory analysis. Also, the PTS Laboratories data sheets for grain size distribution, interstitial properties, and fluid properties for the sample could not be located in Appendix G-2. All of the laboratory data for the sample must be provided in the revised Report or the sample must be excluded from the Report.

j. The Permittee states in Section 3 that the intensity of core sample response to UV light provided an approximation of the relative amount of LNAPL present in the soil and that this was used to select sample locations for further laboratory LNAPL analysis. The photo of core sample GUV-V2-131218 at a depth of 214-215 ft bgs appears to display the most intense response to UV light of any of the samples evaluated yet the Permittee did not select the sample for LNAPL analysis. Provide justification for not conducting LNAPL analysis on this sample.

24. 5.2.2 Light Non-Aqueous Phase Liquid Saturation, Mobility, and Effective Solubility, page 5-4

Permittee Statement: "For the purpose of assessing the location of LNAPL in the saturated zone, the more conservative effective solubility concentration of 1.43 milligrams per liter (mg/L) benzene is used as a line of evidence of potential LNAPL occurrence."

and

"Using the effective solubility concentration of 1.43 mg/L, the location of submerged LNAPL was approximated by locating this concentration isocontour on the benzene concentration map. Figure 5-7 shows the approximate location of LNAPL as superimposed on the [second quarter of 2019 sampling event] Q2 2019 benzene isocontour map (reference elevation interval 4857)."

NMED Comment: Report revision required. Figure 5-7, LNAPL-Filled Porosity from Continuous Coring, depicts the outline of the dissolved benzene plume where concentrations exceed the EPA maximum contaminant level (MCL) of 5 ug/L in groundwater rather than the contour for the effective solubility concentration of benzene 1.43 mg/L. Also depicted in the figure is an outline of the estimated extent of LNAPL/residual LNAPL in groundwater. The Permittee must clarify in the legend of Figure 5-7 if this contour is equivalent to the effective solubility of benzene (1.43 mg/L), if it is not, revise Figure 5-7 to show the isocontour for 1.43 mg/L benzene. Furthermore, it is not clear what data was used to create the LNAPL outline. The Permittee's statement refers to using the effective solubility concentration of 1.43 mg/L to construct the LNAPL isocontour however, the well identification numbers and analytical data used to construct the contour have not been provided. The Permittee must also revise the legend of Figure 5-7 to indicate the source of the data used to create the LNAPL isocontour and provide a table that identifies the wells, date of collection, and concentration data used to create the LNAPL isocontour.

25. 5.2.2 Light Non-Aqueous Phase Liquid Saturation, Mobility, and Effective Solubility, page 5-5 and 5-7

Permittee Statement: "Figure 5-7 indicates that the BTEX plume biodegrades within a relatively short distance (less than 500 ft) from the residual source and is fully attenuated before it reaches Ridgecrest Drive."

and

"Based on these data, it does not appear that biodegradation of EDB or BTEX can occur at significant rates at these sample locations [KAFB-106S7, KAFB-106S8, KAFB-106247]."

NMED Comment: Report revision required. The Permittee must revise the Report to include lines of evidence to demonstrate that biodegradation is the mechanism by which the BTEX plume is attenuated and resolve the discrepancy between the two conclusions presented in the statements above regarding biodegradation of the BTEX plume.

26. 5.2.2 Light Non-Aqueous Phase Liquid Saturation, Mobility, and Effective Solubility, page 5-4

Permittee Statement: "LNAPL samples collected from KAFB-106006 (alias KAFB-1066) and KAFB-106076 (alias KAFB-10676) in 2011 were used to calculate the effective solubility of BTEX in both samples (Kirtland AFB, 2018a). Solubility values from NMED guidance (NMED, 2019f) were used to calculate the molar fractions for each constituent. The effective solubility of BTEX (average of ortho-, meta-, and para-xylenes) in KAFB-106006 was calculated to be 6.44, 17.25, 1.03, and 1.37 milligrams per liter (mg/L), respectively. The effective solubility of BTEX in KAFB- 106076 was calculated to be 1.43, 6.89, 0.78, and 0.94 mg/L, respectively (Table 5-5)."

NMED Comment: Report revision required. This issue was discussed during the NMED/KAFB conference call on June 18, 2020.

a. The Permittee states that the solubility in water and effective solubility values for benzene are taken from the 2018 *Phase I RCRA Facility Investigation Report, Bulk Fuels Facility Release, Solid Waste Management Unit ST-106/SS-111* (2018 RFI), a document that has not been approved by NMED. The 2018 RFI, page 5-4, lines 24-27, reports the following values for benzene: solubility in water=1,780 mg/L; effective solubility= 1.494 mg/L at KAFB-106006; and effective solubility=6.408 mg/L at KAFB-106076. These values are different than what is presented in the discussion and in Table 5-5. Resolve the discrepancy.

b. NMED notes that the 2018 RFI, page 5-4, lines 28-31, states "It is important to note that additional LNAPL samples may yield additional effective solubilities for benzene that could be higher or lower than those yielded by the two collected LNAPL samples. The original composition of the LNAPL, and the degree of degradation, will both affect the mole fraction of benzene in each sample. These effective solubilities represent only one line of evidence indicating where residual LNAPL remains in the saturated zone." This statement identifies important uncertainties regarding the use of LNAPL samples from 2011 to calculate the effective solubility of benzene and, in turn, to estimate the current extent of LNAPL/residual LNAPL in water. The Permittee must revise the Report to identify the uncertainties associated with using LNAPL samples from 2011.

27. 5.2.2 Light Non-Aqueous Phase Liquid Saturation, Mobility, and Effective Solubility, page 5-5

Permittee Statement: "...exceeded the benzene standard of 5 µg/L ranging from 0.2 to 26,000 µg/L...Figure 5-6."

NMED Comment: Report revision required. The Permittee must add additional text to this section describing how many wells were sampled and where the wells with the highest concentrations are located.

28. Section 5.2.4 Microbial Analysis pages 5-7 and 5-8

Permittee Statement: "In general, concentrations of bacteria associated with potential EDB degradation in soil samples collected in 2018 were moderate... Concentrations of various well-studied reductase enzymes (including ethylene dichloride reductase) were not detected in any samples, and enzymes associated with aerobic cometabolic degradation of EDB during aerobic metabolism of BTEX (phenol hydroxylase and two toluene monooxygenases) were detected in significant numbers in five samples (collected from KAFB-106S1, KAFB-106S2, KAFB-106S3, KAFB-106S4, and KAFB-106S9)."

NMED Comment: Report revision required. Provide information or context on what constitutes "moderate" concentrations of bacteria or "significant number" of enzymes associated with aerobic cometabolic degradation of EDB during aerobic metabolism of BTEX. Revise the Report to include a table and discussions that provide a quantitative comparison of the data presented in the Report to an appropriate standard. Incorporate information on sample depth relative to the water table, lithology, and location relative to the submerged LNAPL plume.

29. Section 5.2.5 Moisture Content, page 5-8

Permittee Statement: "The results of the moisture analyses are shown in Tables 5-7 and 5-8 and in Appendix G-4."

a. **NMED Comment:** Report revision required. Table 5-7, Summary of Soil Analytical Moisture Content, lists the USCS lithology classification for each sample. It is unclear how the soil data in the USCS column corresponds to the data in the other columns. Revise the table to clearly attribute the appropriate soil type to each individual sample. The issues identified with the reporting of PTS Laboratories soil data in Tables 5-2, 5-3, and 5-4 also affects Table 5-7. Please revise all Tables containing USCS data to consistently report accurate USCS classifications for the samples.

b. **NMED Comment:** Report revision required. Table 5-7 reports percent moisture content and percent LNAPL for soil samples but provides no information as to what the percentage values refer to, such as percent pore volume or percent bulk volume. Revise Table 5-7 to indicate what the percentage values refer to.

30. Section 5.2.5 Moisture Content, page 5-8

Permittee Statement: "Moisture analyses were performed by American Society for Testing and Materials (ASTM) International D2216 (ASTM International, 2005) for geotechnical, TPH, EDB, and [volatile organic compounds] VOC analyses."

NMED Comment: Report revision required. ASTM International Test D2216 is a test for determination of the water (moisture) content by mass of soil, rock, and similar materials, not a test method used for geotechnical, TPH, EDB, and VOC analyses. Please revise the statement for accuracy.

31. Section 5.2.5 Moisture Content, page 5-8

Permittee Statement: "The moisture content ranged from 1.3 to 33.8 wt.% for the analyzed samples. The moisture content results and corresponding USCS classification for the samples are summarized in Table 5-7."

NMED Comment: Report revision required. Table 5-7 reports percent moisture content and percent LNAPL for soil samples but does not provide information as to what the percentage values refer to, such as percent pore volume or percent bulk volume. Please revise Table 5-7 accordingly.

32. 5.3 Light Non-Aqueous Phase Liquid and Fuel Hydrocarbon Spatial Distribution, page 5-9

Permittee Statement: "The vapor plume model was interpolated using a kriging method assuming a very low horizontal to vertical anisotropy (3 to 1). The very low anisotropy range (typical is 30 to 1) was selected because of the gravity dominated flow of the release. A lower value was not used because it resulted in isolated plumes with no constraint in between borehole locations, which is not considered reasonable."

NMED Comment: Report revision required. Model assumptions such horizontal to vertical anisotropy and gravity dominated flow must be based on empirical data acquired from the site. Please revise the Report to provide justification for the anisotropy ratio and for the modeling assumption that gravity dominated flow is consistent throughout the vadose zone. Discuss differences in anisotropy that may exist between the alluvial piedmont deposits and the Upper Santa Fe Group deposits.

33. 5.3 Light Non-Aqueous Phase Liquid and Fuel Hydrocarbon Spatial Distribution, page 5-9

Permittee Statement: "The vapor plume was then illustrated using an arbitrary iso-shell value of l00,000 micrograms per cubic meter. Model results are presented on Figures 5-8 through 5-14 and are discussed below."

NMED Comment: Report revision required. The term "iso-shell" must be defined. Based on the color bar representing BTEX concentrations in soil vapor and the depictions of the BTEX vapor plume in Figures 5-8 through 5-14, it appears that the Permittee used an "iso-shell" value of 10,000 micrograms per cubic meter rather than 100,000 micrograms per cubic meter as a cutoff value to define the boundary of the BTEX plume. Revise the figures and discussion to resolve the discrepancy.

34. 5.3 Light Non-Aqueous Phase Liquid and Fuel Hydrocarbon Spatial Distribution, page 5-9

Permittee Statement: "Subsurface geology (sands and gravels) was the dominant control for the downward migration of the release."

NMED Comment: Report revision required. The dominant control for the downward migration of the release was the continuous, extended release of fuel to the subsurface which provided the hydraulic head necessary to drive migration. The dominant control for the contaminant migration pathway was the subsurface geology. Please revise the statement for accuracy.

35. 5.3 Light Non-Aqueous Phase Liquid and Fuel Hydrocarbon Spatial Distribution, page 5-9

Permittee Statement: "The lack of significant soil vapor hydrocarbon results directly above these shallow clay units laterally from the source area suggests that LNAPL maintained a near vertical migration pathway through higher permeable areas around, as well as through the clays. This indicates that LNAPL migration was dominated by gravity drainage rather than horizontal migration along low permeability (i.e., clay or silt) zones."

a. **NMED Comment:** Report revision required. The Permittee makes a comparison of a physical process (gravity drainage) relative to horizontal migration. It is not clear how gravity drainage, migration direction, and permeability relate to one another in this example or why gravity drainage is considered the dominant factor for LNAPL migration. Revise the statement for clarity.

b. **NMED Comment:** Report revision required. In the discussion of downward migration of the contaminant plume the Permittee refers to shallow clay layers and deeper clay layers but provides no information on the different characteristics of the shallow versus deep clay layers to support the conclusions presented in the discussion. The Permittee must differentiate between the shallow and deeper clay layers by including in the discussion, at a minimum, information on the depositional environment, bed geometry and thickness, lateral continuity, and physical and interstitial properties.

36. 5.3 Light Non-Aqueous Phase Liquid and Fuel Hydrocarbon Spatial Distribution, page 5-10

Permittee Statement: "At that point, mobile LNAPL migrated northward on the groundwater in response to LNAPL head resulting from continued loading from the ongoing release (Figure 5-10)."

NMED Comment: Report revision required. Figure 5-10 does not clearly depict LNAPL. Revise Figure 5-10 to clearly depict LNAPL.

37. 5.3 Light Non-Aqueous Phase Liquid and Fuel Hydrocarbon Spatial Distribution, page 5-10

Permittee Statement: "Figure 5-11 shows the residual LNAPL (smear zone) to be approximately 40 ft thick in the source area (KAFB-106S9) and thins to approximately 25 ft thick toward the south (KAFB-106S1) and less than 10 ft thick to the north (KAFB-106S5)."

NMED Comment: Report revision required. Figure 5-11 must be modified to include a north arrow. Also, the figure depicts multiple isolated LNAPL bodies below the water table without explanation. Revise the Report to add a north arrow to all figures and include a discussion on the significance of the isolated LNAPL bodies depicted in Figure 5-11. Clarify whether all the LNAPL bodies are included in the estimation of the LNAPL smear zone thickness.

38. 5.3 Light Non-Aqueous Phase Liquid and Fuel Hydrocarbon Spatial Distribution, page 5-10

Permittee Statement: "Laboratory results during coring operations indicate elevated concentrations of adsorbed hydrocarbons at elevations that most likely relate to the local groundwater elevation steps."

NMED Comment: Report revision required. Provide lines of evidence to support the statement. Revise the discussion and provide a table that describes the number and depths of the elevation steps, the source of the data, the related laboratory results, and corresponding lithologies.

39. 5.3 Light Non-Aqueous Phase Liquid and Fuel Hydrocarbon Spatial Distribution, page 5-10

Permittee Statement: "Partitioning of benzene from residual LNAPL where the vadose zone source intersected the groundwater table serves as a continuing source of dissolved contamination."

NMED Comment: Report revision required. This statement must differentiate between past, current, and predicted vadose zone / groundwater table intersection. Please revise the statement for clarity and address submerged LNAPL in the discussion of continuing sources of dissolved contamination.

40. 5.3 Light Non-Aqueous Phase Liquid and Fuel Hydrocarbon Spatial Distribution, page 5-10

Permittee Statement: "The dissolved phase benzene plume is shown in map view on Figure 5-12."

NMED Comment: Report revision required. The referenced figure must include clear contaminant contour lines. Also, please clarify if this figure represents soil vapor or groundwater data. The Legend and Notes contradict each other. Revise figure 5-12 for clarity.

41. 5.3 Light Non-Aqueous Phase Liquid and Fuel Hydrocarbon Spatial Distribution, page 5-10

Permittee Statement: "The soil vapor plume in the vadose zone is shown on Figure 5-13."

NMED Comment: Report revision required. Figure 5-13 depicts a lone pocket of BTEX vapor to the west of KAFB-106S3 with no associated monitoring points to identify the source of these data. It is difficult to estimate the concentration of this pocket of BTEX soil vapor with the scale provided in the Legend of the figure. Discuss this anomaly, including its concentration and depth in the text of the revised Report.

42. 5.3 Light Non-Aqueous Phase Liquid and Fuel Hydrocarbon Spatial Distribution, page 5-10

Permittee Statement: "Figure 5-14 shows that the highest dissolved phase benzene concentrations are located where the soil vapor plume intersects the groundwater plume, demonstrating that the soil vapor and dissolved vapor data are in alignment."

NMED Comment: Report revision required. Figure 5-14 does not clearly illustrate this concept as data points appear to be omitted from the figure. Please revise the figure to clearly depict the relationship between the soil vapor plume and groundwater plume.

43. Section 6 Investigation Derived Waste, page 6-1

Permittee Statement: "Information regarding investigation-derived waste accumulation and storage, utilization of the Kirtland AFB groundwater treatment system, and other investigation-derived waste processes are described in more detail in the following reports generated for the BFF..."

NMED Comment: The Report contains no information on how the IDW was containerized, transported, characterized, stored, or disposed of. Appendices F-1 through F-4 contain tables but no descriptions of procedures. The Permittee may not refer to separate documents and must include all IDW information relevant to this scope of work as an appendix in the revised Report.

44. Section 7 Summary and Conclusions, page 7-1

Permittee Statement: "The source zone characterization included coring at 11 locations to assess the horizontal and vertical extent of LNAPL at the Site... the collection of over 3,600 linear ft of core, chemical analysis of 87 soil samples, UV fluorescence of 30 cores... Soil core samples were collected to obtain contaminant concentration and soil and LNAPL properties data."

NMED Comment: Report revision required. Please provide the results of these data on cross sections or fence diagrams so that a direct comparison can be made of the lithology and the locations of samples, LNAPL, and UV detections found through field screening and laboratory analyses.

45. Section 7 Summary and Conclusions, page 7-1

Permittee Statement: "Continuous cores were collected next to existing boreholes using sonic drilling to provide higher resolution lithologic data in the source area. The logs from the new cores were then compared to the logs from the existing boreholes."

NMED Comment: Report revision required. The cross sections in the Report do not reflect this higher resolution data and are presented in a different style than those presented in the Work Plan. Please revise the Report to present the data in a format that allows a comparison of the data from the new cores to the data from the pre-existing boreholes.

46. Section 7 Summary and Conclusions, page 7-1

Permittee Statement: "The SVM wells were installed as observation wells for the bioventing pilot study that initiated in 2018."

NMED Comment: Report revision required. Please cite and reference the specific documents in which the information related to the bioventing pilot study was submitted to NMED.

47. Section 7 Summary and Conclusions, page 7-1

Permittee Statement: "Soil samples were collected from drill cuttings and soil cores and then submitted to an analytical laboratory for TPH GRO/DRO/MRO, VOC, and EDB analysis."

NMED Comment: Report revision required. Please identify which soil samples were collected from drill cuttings and sent to analytical laboratories for analysis. Samples collected for investigation derived waste (IDW) analyses may be excluded.

48. Section 7 Summary and Conclusions, page 7-1

Permittee Statement: "Evaluation of the data collected from LNAPL testing provided the following conclusions:"

NMED Comment: Report revision required. This statement appears to be a typographical error. Concentrations of TPH, BTEX, and EDB rather than LNAPL are discussed in the bulleted paragraphs that follow. LNAPL is discussed in a separate section on page 7-2. Please revise the Report to correct the discrepancy.

49. Section 7 Summary and Conclusions, page 7-1

Permittee Statement: "These concentrations increased with depth until a clay unit that was encountered at a depth of approximately 265 ft bgs. Below this clay unit, concentrations decrease significantly (Figures 5-3 through 5-5)."

NMED Comment: Report revision required. Figures 5-3 through 5-5 do not depict lithology and the cross sections provided in Figures 5-1 and 5-2 are insufficient for correlating this information. Please revise the Report to provide adequate cross sections that depict the information presented in the discussion.

50. Section 7 Summary and Conclusions, page 7-2

Permittee statement: "The highest LNAPL saturation from the vadose zone is in KAFB-106V1 at a depth of 122 ft bgs (Table 5-4). The highest LNAPL saturation in the saturated zone was observed in KAFB-106S9 at a depth of 484 ft bgs (Table 5-4). The lowest LNAPL saturations are in wells KAFB-106S5 and KAFB-106S7, which are located off-Base, farthest from the source area (Table 5-4)."

NMED Comment: The revised report must include a figure and/or cross section that illustrates this statement. The figure must clearly depict lithology, LNAPL saturation, current and former groundwater levels, and clearly identify relevant boring locations. See Comment 14.

51. Section 7 Summary and Conclusions, page 7-2

Permittee Statement: "The LNAPL migrated as far north as Bullhead Park, and this was observed in the residual saturation data."

NMED Comment: Report revision required. Bullhead Park is not identified on any of the figures presented in the Report. Please revise the Report to ensure all geographical features and locations referenced in the text of the Report are identified on all relevant figures.

52. Section 7 Summary and Conclusions, page 7-2

Permittee Statement: "The highest LNAPL saturation from the vadose zone is in KAFB-106V1 at a depth of 122 ft bgs (Table 5-4). The highest LNAPL saturation in the saturated zone was observed in KAFB-106S9 at a depth of 484 ft bgs (Table 5-4). The lowest LNAPL saturations are in wells KAFB-106S5 and KAFB-106S7, which are located off-Base, farthest from the source area (Table 5-4)."

NMED Comment: Report revision required. Please revise the Report to add a figure that clearly depicts the spatial context of LNAPL saturation within the site and identify all relevant boring identification numbers, sample depths, groundwater depths at the times of investigation, and historical low and high groundwater depths.

53. Section 7 Summary and Conclusions, pages 7-2 and 7-3

Permittee Statements: "No microbial genes responsible for reductive dehalogenation were found in samples collected."

"No Dehalococcoides, the only bacteria known to be capable of complete reductive dehalogenation to ethane, were found in any of the samples."

and

"Abiotic attenuation of EDB with respect to iron-bearing minerals is not anticipated to be significant."

NMED Comment: Report revision required. Please revise the Report to discuss the presence or absence of bacteria and/or minerals that could have affected the degradation of site-specific contaminants of concern. This will serve to simplify Sections 5.2.3, Mineralogy and Magnetic Susceptibility and 5.2.4, Microbial Analysis, for the general public and stakeholders.

54. Section 7 Summary and Conclusions, page 7-3

Permittee Statement: "In general, soil moisture was less than 5% in vadose zone samples (Table 5-7)."

NMED Comment: Report revision required. According to Table 5-7, soil moisture in vadose zone samples were greater than 10% in many samples, and greater than 15% in approximately one dozen samples, while soil moisture was significantly lower, on average, in the saturated zone. The Permittee must revise the Report to correct this statement and explain why soil moisture levels are higher in the vadose zone relative to the saturated zone, particularly in the area where SVE systems have been operated (KAFB-106V1 and KAFB-106V2).

55. Section 7 Summary and Conclusions, page 7-3

Permittee Statement: "The clays do not appear to have significantly affected lateral migration of the LNAPL. LNAPL migration was primarily by gravity drainage rather than horizontal migration along low permeability (i.e., clay or silt) zones."

NMED Comment: Report revision required. The conclusion that clays do not appear to have significantly affected lateral migration of the LNAPL minimizes the importance of the impact of the clays at the site. The vapor and LNAPL plumes depicted in Figures 5-8 through 5-14 indicate that the clay layer identified at approximately 265 ft bgs caused lateral migration of the contaminant plume. The statement must be revised for clarity.

56. Section 7 Summary and Conclusions, page 7-3

Permittee Statement: "Average gravel LNAPL saturations were 2.57 and 0.9% relative to pore volume and total volume, respectively. For the medium sand samples from the saturated zone, LNAPL saturation ranged from 0.04 to 4.9% pore volume and from 0.02 to 2.0% total volume, respectively. The coarse sand sample from the saturated zone had a LNAPL saturation of 0.08% pore volume and 0.03% total volume. Average LNAPL saturation relative to pore volume and total volume for the three fine sand samples averaged 2.4 and 1.0%, respectively".

NMED Comment: Report revision required. The statement must be revised for accuracy once the issues identified by NMED related to the classification of soil types have been resolved.

57. Section 8 References, page 8-1

NMED Comment: Monitoring well completion reports are listed as individual references but were not submitted to NMED as individual documents. The reports were submitted as appendices in other documents and the title and cover pages of those documents did not identify the presence of the monitoring well completion reports. The Permittee must revise the Report to cite the document, section, and page numbers in which each of the monitoring well completion reports is presented. Additionally, the Permittee must revise the Report to include all of the well completion reports for the well installations associated with this scope of work as an appendix.

58. Section 8 References, page 8-1

NMED Comment: Report revision required. The document "NMED. 2019b. *Approval to Not Install KAFB-106S6 and Relocate KAFB-106247* by Mr. Dennis McQuillan, Chief Scientist. January 25." is not included in Appendix A, Regulatory Correspondence. Please revise the Report to include the reference in Appendix A.

59. Figures 5-1 Cross Section A-A' and 5-2, Cross Section B-B'

NMED Comment: Report revision required.

a. Figures 5-1 and 5-2 are not true cross sections or fence diagrams. They appear to be an interpolation of subsurface geology across the site. Some of the wells used to create the figures are offset too far from the transects to accurately depict subsurface geology. Please revise Figure 5-1 and 5-2 with more reasonable cross section lines. The Permittee must also depict the actual elevation/depth to water on the figure.

b. The cross-sections presented in Figures 5-1 and 5-2 are inadequate in depicting the subsurface conditions across the site, particularly in the source area, because they are inconsistent with much of the lithologic data previously obtained at the site. Revise the Report to include cross sections that appropriately incorporate existing lithologic and geophysical data from other nearby wells in the area and include depth to water and historic high and low water levels. The cross sections must also depict key stratigraphic surfaces such as the top of the ancestral Rio Grande sediments and the top and bottom of the fine grained, low permeability intervals that occur between 250-300 feet bgs. Multiple straight line transects must be presented rather than a single transect with multiple directional changes. The cross sections must be presented in a large enough format to allow the details to be discernable. This issue was discussed during the NMED/KAFB conference call on June 18, 2020.

60. Figures 5-3 BTEX Concentrations In Soil, 5-4, EDB Concentrations In Soil, and 5-5, TPH Concentrations In Soil

NMED Comment: Report revision required. Soil screening levels are not included on Figures 5-3, 5-4, and 5-5. Please revise these figures to include the soil screening levels used for each contaminant of concern and reference which screening levels were used (e.g., NMED, EPA, etc.) in the "Notes" section of the figures.

61. Figure 5-5 TPH Concentrations in Soil

NMED Comment: Report revision required. There is no unit of measurement for the TPH data in the figure. Please revise Figure 5-5 to indicate a unit of measurement for TPH concentration data.

62. Figure 5-6 Benzene Concentrations in Groundwater Reference Elevation Interval 4857, Q2 2019

NMED Comment: Report revision required. The "Notes" section of Figure 5-6 refers to two abbreviations, MVS and REI, that are not defined in the Report. Please revise the Report to define the abbreviations. Additionally, the title of the figure refers to Reference Elevation Interval 4857. This term is not defined in the Report. Revise the Report to provide an explanation of the term and the significance of the associated value. Add a figure similar to Figure 3-2, Reference Elevation Capture and Containment Intervals, of the Q2 2019 Quarterly Report to provide a point of reference for understanding the concept of reference elevations.

63. Figure 5-6 Benzene Concentrations in Groundwater Reference Elevation Interval 4857, Q2 2019

NMED Comment: Report revision required. A large portion of the figure depicts wells north of Ridgecrest Drive which were not sampled for benzene. Please provide an explanation in the relevant section of the revised Report as to why these wells were not sampled for benzene. In addition, provide the date when benzene was last detected north of Ridgecrest Drive, the wells in which it was last detected, and which wells currently provide evidence of lateral containment of the benzene plume. These wells must be easily identifiable in the revised Report.

64. Figure 5-7 LNAPL-Filled Porosity from Continuous Coring

NMED Comments: Report revision required. The legend indicates that the ≥5 µg/L isocontour for benzene is shown rather than the effective solubility concentration for benzene of 1.43 mg/L. The Permittee must depict the effective solubility concentration for benzene of 1.43 mg/L on Figure 5-7. Furthermore, the legend indicates that the green shaded area of the figure depicts the estimated extent of LNAPL/Residual LNAPL in groundwater while the title block of the figure indicates that the figure presents LNAPL filled porosity from continuous coring. Revise the Figure 5-7 to resolve the discrepancy. Finally, while Figure 5-7 shows wells that contain free phase LNAPL on groundwater, it is difficult to compare this with the submerged LNAPL in soil porosity that is also presented in the figure. Please revise Figure 5-7 to include contours for confirmed free phase LNAPL.

65. **Figure 5-8 EVS Model 3-Dimensional Views South to North and East to West**
Figure 5-9 EVS Model 3-Dimensionalview Showing Clays at 265 Feet Depth
Figure 5-10 EVS Model of Historical Groundwater Elevations Relative to the Vadose Zone Plume and the Dissolved Benzene Plume in Groundwater
Figure 5-11 3-Dimensional View Showing Estimated Location of LNAPL in the Saturated Zone

NMED Comment: Report revision required. NMED has identified the following issues with Figures 5-8 through 5-11:

a. Revise all figures to include a North arrow.

b. Revise the figures to include well identification numbers and pertinent site features (e.g.: source area, former loading racks, former and current above ground storage tanks, any visible KAFB boundaries, Ridgecrest Drive).

c. The plume depiction does not appear to match the data because there are several red and yellow soil vapor monitoring well (SVMW) points with elevated contaminant concentrations that are not incorporated into the plume. Explain this discrepancy and identify anomalous data on the figures in the revised Report.

d. Revise the Report to enable the reader to cross reference the lithologic data points for the intricate edges of the clay lenses with the other data presented in the report.

**66. Figure 5-8 EVS Model 3-Dimensional Views South to North and East to West
Figure 5-10 EVS Model of Historical Groundwater Elevations Relative to the Vadose Zone Plume and the Dissolved Benzene Plume in Groundwater**

NMED Comment: Report revision required. It is difficult to interpret what represents BTEX in soil vapor and what represents dissolved benzene in groundwater because the same color scale is used for both data sets. Please revise Figures 5-8 and 5-10 to utilize contrasting color scales for BTEX concentrations in soil vapor and dissolved benzene concentrations in groundwater.

67. Figure 5-10 EVS Model of Historical Groundwater Elevations Relative to the Vadose Zone Plume and the Dissolved Benzene Plume in Groundwater

NMED Comment: Report revision required. The figure is difficult to interpret because it is unclear if LNAPL thickness is represented and it is difficult to determine the compass orientation. Revise the figure to include well identification numbers and a north arrow for the purpose of orienting the features depicted in the figure. Also, the figure should be representative of the statements made in Section 5-3.

**68. Figure 5-9 EVS Model 3-Dimensionalview Showing Clays at 265 Feet Depth
Figure 5-10 EVS Model of Historical Groundwater Elevations Relative to the Vadose Zone Plume and the Dissolved Benzene Plume in Groundwater
Figure 5-11 3-Dimensional View Showing Estimated Location Of LNAPL in the Saturated Zone**

NMED Comment: Report revision required. The explanation of "Depth" in the legends is inaccurate. For example, on Figure 5-9, the legend states "(250) = Depth 100 feet below ground surface". Please revise the figures to accurately indicate depth.

**69. Figure 5-8 EVS Model 3-Dimensional Views South to North and East to West
Figure 5-11 3-Dimensional View Showing Estimated Location of LNAPL in the Saturated Zone**

NMED Comment: Report revision required. Both figures appear to be missing key soil vapor data from Q2 2019. For example, Q2 2019 soil vapor data from soil vapor monitoring point SVMW-09-266 shows a BTEX concentration of 3,398,000 parts per billion (ppb), which is not included in the figure. Please revise the figures to clearly depict all relevant Q2 2019 soil vapor data. Also, ensure that all monitoring points are labeled on all figures.

70. Figure 5-11 3-Dimensional View Showing Estimated Location of LNAPL in the Saturated Zone

NMED Comment: Report revision required. Figure 5-11 is very difficult to read and interpret. There is no information on the figure which allows the reader to place the information presented within a spatial context for the BFFS:

a. The figure depicts multiple isolated LNAPL bodies below the water table without explanation. Please revise the Report to include a discussion of the significance of the isolated LNAPL bodies depicted on Figure 5-11 and clarify whether all of the LNAPL bodies are included in the estimation of the LNAPL smear zone thickness.

b. It is difficult to correlate high levels of BTEX in soil vapor (<10,000 µg/m^3) in the representation of the subsurface of site. Add well identification numbers to the figure.

c. The legend indicates that "LNAPL in Groundwater" is depicted in the figure as a concentration ranging from 1,000 to 19,068 mg/kg. LNAPL is not usually presented as a concentration. Additionally, it is difficult to identify LNAPL in the figure. Please explain the presentation of LNAPL in units of mg/kg and revise Figure 5-11 so that LNAPL is readily identified.

d. Indicate which quarterly measurements (e.g., Q2 2019) were used to generate the depiction of LNAPL shown in the figure.

e. The area of interest on this figure is the submerged LNAPL in the saturated zone; however, the part of the figure in which the submerged LNAPL is illustrated is only a small portion of the total area available in the figure. Revise the Report to provide an additional figure focusing on the area of submerged LNAPL in the saturated zone which includes a way to identify the location beneath the BFFS site, appropriate scale indicators, and well identification numbers.

71. Figure 5-12 Dissolved Benzene in the Saturated Zone

NMED Comment: Report revision required. NMED has identified multiple issues with this figure:

a. It is difficult to interpret concentration data without clear contaminant contour lines. Please revise the figure to include contour lines.

b. It is unclear what data were used to create this plume image. If the data for all groundwater monitoring wells sampled during Q2 2019 were included, these wells must be identified in the figure. If not, the Permittee must justify that the limited data set is representative of the site conditions. The Permittee must clarify and provide an explanation in the appropriate section of the revised Report.

c. The legend shows a color scale for dissolved benzene in groundwater but the notes reference Q2 2019 soil vapor data. Please resolve the discrepancy.

72. Figure 5-13 Total BTEX in Soil Vapor in the Vadose Zone

NMED Comment: Report revision required. NMED has identified the following issues with the figure:

a. The area of interest is very small compared to size of the background aerial photograph, and therefore approximately 80% of figure is non-relevant imagery of the surrounding area. Please revise the figure scale to clearly depict area of interest.

b. It is unclear what data was used to create the figure. Revise the figure to identify the wells from which data was used to create the figure.

c. It is unclear what subsurface sampling elevations were used to create the depiction of the soil vapor plume. Revise the figure to indicate the subsurface elevations represented on the figure.

d. The color gradient scale in the legend is very subtle in its differentiation between values over several orders of magnitude; furthermore, the colors in the legend do not match the colors in the figure. Revise the figure using a more detailed color gradient that matches the colors used in the figure and add contaminant contour lines.

e. The figure depicts an isolated pocket of elevated BTEX vapor to the west of KAFB-106S3 with no associated soil vapor wells or data points in the vicinity to identify the source of the data used to create the figure. Also, it is difficult to estimate the concentration of this pocket of BTEX soil vapor using the scale provided in the legend of the figure. The Permittee must discuss this pocket of BTEX in the relevant portions of the Report and add associated data points to the revised Figure.

73. Figure 5-14 Total BTEX in Soil Vapor in the Vadose Zone, and Dissolved Benzene in the Saturated Zone

NMED Comment: Report revision required. NMED has identified multiple issues with the figure:

- **a.** It is not clear to which depth/elevations the depicted soil vapor data correspond. Please revise the figure to add depths/elevations.
- **b.** The figure portrays groundwater data and soil vapor data with the same color scheme making it difficult to precisely interpret the data presented on the figure. Revise the figure with different color schemes for each data set depicted on the figure.
- **c.** The color gradient panel for BTEX in soil vapor does not match the color presented on the figure. Revise the figure to use a color scale that matches both the key and the data.
- **d.** It is unclear which data were used to create Figure 5-14. Wells KAFB-106V1 and KAFB-106V2 are not included on Figure 5-14. Revise the figure notes to explain which data sets were used to create Figure 5-14 and include all data points in the revised figure.
- **e.** A large portion of Figure 5-14 depicts non-relevant surrounding satellite imagery. Revise the scale of the figure to provide greater detail for the area of interest.

74. Table 3-1 Coring Intervals and Soil Sample Locations

NMED Comment: Report revision required. Many different types of soil samples were collected for this field effort. Revise Table 3-1 to include any samples that may have been collected with drilling methods other than sonic (e.g., air rotary casing hammer). Additionally, please revise Table 3-1 to indicate which types of samples were collected at the depths presented on the revised table.

75. Table 4-1 Photoionization Detector Field Screening Data

NMED Comment: Report revision required. The depth for KAFB-106S8 is incorrectly expressed as a PID reading of 70.4 ppm rather than a depth of 450 ft bgs. Please revise the table to correct the error.

76. Table 4-1 Photoionization Detector Field Screening Data

NMED Comment: Report revision required. Table 3-3 of the Work Plan, along with Table 3-1 and Table 4-1 of the Report indicate that KAFB-106247, the 'background' boring, was only sampled at 5 of the 10 proposed sample intervals defined by the Work Plan. In Section 4.3 (Deviations from Work Plan) of the revised Report, please explain why laboratory samples for KAFB-106247 were not collected according to the approved Work Plan.

77. Table 5-1 Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

NMED Comment: Report revision required. All laboratory results are presented in Table 5-1 with the LOD only. Add a column to Table 5-1 to report the DL, LOD, and LOQ for each analysis presented. See General Comment 4.g.

78. Table 5-1 Analytical Results for Total Petroleum Hydrocarbons and Volatile Organic Compounds in Soil

NMED Comment: The table footnotes refer to "RSL = regional screening level". The regional screening levels (RSLs) are not included in Table 5-1. Revise Table 5-1 to include a column for the appropriate screening levels used for the Report and reference the screening levels correctly in the table footnotes (e.g., NMED, NMWQCC, EPA, etc).

79. Table 5-2, Soil Grain Size Distribution and Classification

NMED Comment: Report revision required. The USCS Classification appears to be based on the lithologic logs rather than the particle size distribution presented in the table. See Comment 25. The Permittee must also include a table which compares the lithologic log descriptions to the laboratory particle size distribution in the revised Report.

80. Table 5-3 Lithology and Interstitial Properties of Selected Core Samples

NMED Comment: Report revision required. Table 5-3 presents data quantifying porosity, permeability, and saturation of cores based on lithology and analyses of individual cores. In the relevant section of the Report, the Permittee must discuss fluid losses that may have occurred to cores during retrieval of the cores from boreholes during the drilling process and how this may affect sample integrity, data representativeness, and the representativeness of estimates of soil moisture in the vadose and saturated zones.

81. Table 5-4 Summary of LNAPL Saturation and Mobility for Select Core Samples

NMED Comment: Report revision required. Please revise the table to add a footnote explaining how LNAPL Saturation (%TV) was calculated for this table.

82. Table 5-7 Summary of Soil Analytical Moisture Content

NMED Comment: Report revision required. Table 5-7 contains inconsistencies, errors, and omissions. The Permittee must correct the following in the revised report:

a. Add a footnote to indicate what impact fluid loss, due to core retrieval and sample shipping and handling, may have had on soil moisture content in samples.

b. The manner in which the LNAPL data is presented is unclear. For example, the result of 7.2% LNAPL at 122 ft bgs could belong to either V1 or V2, or both, and the result of 2.1% LNAPL at 490 ft bgs could belong to either S5 or S9. Provide clarification on which borings and sample depths correspond to the percentages of LNAPL.

c. The manner in which the lithologic data is presented is misleading. It is not accurate to assume that lithologies remain consistent at any given depth across the area of investigation. Some cells in the "USCS" column of the table have more than one lithology listed, some are separated by dashes, slashes, and or/spaces and some are presented in different colored fonts. For example, at the depth of 360 ft bgs there are two readings for soil moisture (for S3 and S5), and the USCS is presented as "SW-SP/SM" on the left side of the cell and "SW" on the right side of the cell. It is unclear which lithology is associated with S3 and which is associated with S5. Furthermore, the color coding of the font to represent different laboratories that performed analyses does not always correlate with the order of presentation of the data at any given depth. Revise Table 5-7 to accurately present soil moisture data and lithology at the site.

d. The Permittee must add the DBS lab results for KAFB-106247 at 490 ft bgs.

e. The Permittee must add the PTS laboratory results for KAFB-106S5 at 488 ft bgs and KAFB-106S7 at 492 ft bgs.

f. The result for S9 at 342 ft bgs is presented as 14%, whereas the TA laboratory results present the value as 16.3%. Correct this discrepancy in the revised Report.

g. Adjust the font color for results for V1 at 158 ft bgs to blue to indicate that the analysis was performed by PTS laboratory.

h. Data in the Table is presented with inconsistent significant figures. The Permittee must use consistent significant figures in all data presented in the revised report.

83. Table 5-8, Table 5-8

NMED Comment: The results for percent moisture for five of the 22 samples presented do not match the results for percent moisture presented on Table 5-7. Please correct these discrepancies in the revised Report.

84. APPENDIX C - TEMPERATURE LOGS

NMED Comment: The Core Temperature Log indicates many instances where intervals of core were dropped from the core barrel into the borehole during the process of bringing the core to the surface. In some cases, the partial sections of disturbed core were retrieved by the driller. The driller also reports the addition of water to the borehole during drilling. The driller's comments must be addressed in Section 4.3, Deviations from Work Plan. The impact on sample integrity of dropped and/or lost core, and data representativeness must be addressed in the appropriate sections and tables of the Report. Revise the Report accordingly.

State of New Mexico
ENVIRONMENT DEPARTMENT

Office of the Secretary

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BUTCH TONGATE
Cabinet Secretary

J. C. BORREGO
Deputy Secretary

CERTIFIED MAIL – RETURN RECEIPT REQUESTED

November 16, 2017

Colonel Richard W. Gibbs
Base Commander
377 ABW/CC
2000 Wyoming Blvd SE
Kirtland AFB, NM 87117-5606

Chris Segura
Environmental Restoration
377 Civil Engineering Division
2050 Wyoming Blvd SE, Suite 116
Kirtland AFB, NM 87117-5270

RE: NOTICE OF DEFICIENCY
BULK FUELS FACILITY SPILL
SOLID WASTE MANAGEMENT UNIT ST-106/SS-111
KIRTLAND AIR FORCE BASE, NEW MEXICO
EPA ID# NM9570024423, HWB-KAFB-MISC

Dear Colonel Gibbs and Mr. Segura:

On August 3, 2017, the New Mexico Environment Department ("NMED") sent the U.S. Air Force ("Permittee") a letter containing three issues that were identified during NMED's preliminary review of the *Resource Conservation and Recovery Act Facility Investigation Report* ("RFI Report") dated January 20, 2017. The issues were raised ahead of formal completion of the NMED RFI Report review, as the issues are critical and required immediate attention from the Permittee. As part of the August 3, 2017 NMED letter, NMED required that the Permittee submit a work plan for NMED review and approval within 60 days of the conclusion of the technical working group meetings to address the issues outlined in the August 3, 2017 NMED letter. The technical working group meetings concluded on September 8, 2017, and therefore a work plan or a request for extension should have been submitted to NMED by November 8, 2017.

The accelerated rise in the water table that occurred in the first half of 2017 resulted in the rapid reduction to nine out of 62 groundwater monitoring wells screened at the water table and increased the urgency in enacting a plan for replacement of water table wells to maintain the sentinel well network and provide continued confidence in the delineation of the EDB plume at the water table. During the September 6-8, 2017 technical working group meetings, the locations of new water table groundwater monitoring wells were discussed and existing Pneulog and soil vapor monitoring wells were identified for incorporation into the groundwater monitoring program. The action items for the Permittee were to submit a work plan for the drilling and installation of the groundwater monitoring wells and to submit a modification to the Quality Assurance Project Plan ("QAPP") for groundwater monitoring to add the existing wells into the monitoring program. To date, the Permittee has neither submitted a work plan nor requested an extension, and is therefore deficient in meeting the requirements set forth in the NMED's August 3, 2017 letter.

The reduced resolution of monitoring data at the water table also impacts the Permittee's ability to complete a robust calculation of EDB plume mass and removal. Additional groundwater monitoring wells are required to adequately quantify the mass of EDB in groundwater and removed by the "pump and treat" interim measure. Additionally, both NMED and the Albuquerque Bernalillo County Water Utility Authority ("WUA") have expressed concerns with the Permittee's analysis of plume capture as presented in the Q2 2017 quarterly report. Specifically, the capture zone analysis appears to incompletely follow the U.S. Environmental Protection Agency ("EPA") guidance for plume capture analysis, focusing only on water levels for determining horizontal and vertical capture (Step 3) rather than following all six steps defined in the EPA guidance. The Permittee points to Step 5, *Evaluate concentration trends*, as the justification for skipping Steps 4 and 6, citing decreasing concentration trends as sufficient evidence of capture. In doing so, the Permittee fails to recognize that the observed concentration trends noted in the target capture zone could be attributed to the rising water table and loss of resolution of EDB concentration data across the thickness of the plume, and therefore is not a robust measure of plume capture effectiveness. Moreover, skipping Step 4 of the process results in an inadequate accounting of flow dynamics, drawdown, and uncertainty in hydraulic conductivity at the site. There is a wide range of measured hydraulic conductivity at the Kirtland Air Force Base ("KAFB") Bulk Fuels Facility ("BFF") leak site, ranging from 12 to 290 feet per day based on the constant rate pumping test completed at groundwater extraction well KAFB-106228. When Step 4 is executed, specifically the capture zone width calculation using the range of measured hydraulic conductivity, the current three extraction wells are not sufficiently capturing the EDB plume. For this level of uncertainty, the guidance states:

"*If hydrogeologic information such as hydraulic conductivity distribution and hydraulic gradient (magnitude and direction) are highly uncertain, then some of the techniques for evaluating capture may be subject to an unacceptable degree of uncertainty, and additional characterization may be appropriate*." (EPA, 2008; Section B, p. 5).

Both NMED and the Permittee agree that delineating the nature and extent of light non-aqueous phase liquid ("LNAPL") at the BFF leak site was an outstanding gap of data that needs to be addressed. The LNAPL data gap of extent and mass is critical data for informing the selection of remedies and for understanding potential impacts to groundwater concentrations at the BFF leak site as the water table continues to rise. Groundwater concentrations of benzene and EDB in the source area from Q2 2017 have increased in areas where LNAPL has historically been observed with concentrations greater than their respective site-specific effective solubility, indicating the presence of LNAPL at the water table. Through a series of technical working groups in 2015 and 2016, a work plan was scoped to fill the LNAPL data gap. On June 29, 2017, the Permittee submitted a *Work Plan for Vadose Zone Coring, Vapor Monitoring, and Water Supply Sampling*. On September 20, 2017, NMED and the Permittee met to discuss the June 2017 work plan and determined a path forward. As of the date of this letter, a draft revised work plan document was provided to NMED for concurrence. However, there remains outstanding concerns that the proposed coring intervals do not sufficiently address the LNAPL data gap.

NMED acknowledges receipt of an email from the Permittee dated November 14, 2017 that was sent to address the issues in this letter, in addition to concerns over the continued shutdown of groundwater extraction well KAFB-106233. The email indicates the willingness of the Permittee to work with NMED and technical working groups to make progress on plume capture, groundwater monitoring wells, and extraction well operation, but lacks any detail or dates on when deliverables will be submitted. The position of NMED is that all groundwater monitoring wells scoped to fill the data gap at the water table are priority and need to be installed as soon as possible. Additionally, the new water table groundwater monitoring wells were scoped with a reliance on the United States Geological Survey ("USGS") sentinel wells for continued confidence in the WUA water supply wells. The Permittee must either: A) Start reporting the results of the monitoring of the USGS sentinel wells in the quarterly reports; B) Integrate sampling and reporting of those wells into the BFF monitoring program; or C) Install sentinel wells that fill the need for the down-gradient water table and deep well screens. NMED acknowledges that the Permittee sent a second email dated November 15, 2017, again recognizing the need for the groundwater monitoring well work plan and the NMED's request for reporting USGS data.

As a point of clarification, plume capture and mass removal of EDB in the down-gradient plume are of utmost importance to NMED. The concern expressed to the Permittee regarding the continued shutdown of groundwater extraction well KAFB-106233 is that the well continues to be non-operational despite modeling and preliminary capture analysis showing that the well provides important mass removal and plume capture. NMED's position is that operational decisions should be data-driven and adhere to the primary goal of the interim measure – plume capture and mass removal.

As required by the August 3, 2017 letter, the Permittee shall submit a work plan for the installation of additional groundwater monitoring wells and a corrected, revised work plan for continuous coring by December 15, 2017, so that field work to address this critical data gap can begin as soon as possible. Additionally, the Permittee must submit a complete six-step capture zone analysis, including a numerical or analytical model, to NMED for review by December 31, 2017. Failure to submit these two documents by the deadlines of this letter could result in an issuance of a Notice of Violation.

If you have any questions regarding this letter, please contact Diane Agnew at (505) 222-9555.

Sincerely,

JCBr

Mr. Juan Carlos "J.C." Borrego
Acting Resource Protection Division Director
Deputy Secretary
Environment Department

cc: Col. M. Harner, KAFB
K. Lynnes, KAFB
B. Renaghan, AFCEC
S. Clark, KAFB-AFCEC
H. O'Grady, KAFB-AFCEC
T. Simpler, USACE

J. Kieling, NMED-HWB
D. Agnew, NMED-GWQB
S. Pullen, NMED-GWQB
M. Hunter, NMED-GWQB
D. McQuillan, NMED-OTS

File: KAFB 2017 Bulk Fuels Facility Spill

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Deputy Secretary

CERTIFIED MAIL – RETURN RECEIPT REQUESTED

February 23, 2018

Colonel Richard W. Gibbs
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Kirtland AFB, NM 87117-5606

Mr. Chris Segura
Chief, Installation Support Section
AFCEC/CZOW
2050 Wyoming Blvd SE, Suite 124
Kirtland AFB, NM 87117-5270

RE: WORK PLAN FOR VADOSE ZONE CORING, VAPOR MONITORING, AND WATER SUPPLY SAMPLING, REVISION 2
BULK FUELS FACILITY
SOLID WASTE MANAGEMENT UNIT ST-106/SS-111
KIRTLAND AIR FORCE BASE
EPA ID# NM9570024423, HWB-KAFB-13-MISC

Dear Colonel Gibbs and Mr. Segura:

The New Mexico Environment Department ("NMED") is in receipt of the Kirtland Air Force Base ("KAFB") ("Permittee") *Work Plan for Vadose Zone Coring, Vapor Monitoring, and Water Supply Sampling Revision 1* ("Work Plan"), dated December 15, 2017. The Work Plan addresses activities to be performed at the Bulk Fuels Facility ("BFF") site, including:

- Continuous coring and sample collection from up to twelve (12) boring locations;
- Installation of soil vapor monitoring ("SVM") points in three continuous coring locations;
- Installation of dual-completion soil vapor/groundwater monitoring wells in up to eight (8) boring locations;
- Vadose zone monitoring, maintenance, and reporting of existing SVM network; and
- Sampling and reporting for water supply wells.

The data collected under the Work Plan will provide critical data to address the existing data gap which is complicating efforts to define the nature and extent of light non-aqueous phase liquid ("LNAPL") at the Site along with allowing the Permittee to estimate the remaining mass of LNAPL. Further, as indicated in the Work Plan, the data will also be important for development of treatability studies at the BFF site in support of the Corrective Action process.

As stated in the Work Plan (Section 3.1.1), when the fuel leak began, the water table was likely higher than today. As the water table dropped over time due to increased demand and pumping of the aquifer, a "smear zone" was created. Therefore, the vertical extent of LNAPL is from a maximum elevation of the LNAPL layer above the highest historical water table elevation to the minimum elevation of LNAPL-water interface at the lowest water table elevation. The horizontal extent can be anticipated to be variable over time, with LNAPL migrating some distance over time, even as the water table dropped. An additional level of complexity is how the LNAPL thickness over time will be affected by the submergence of water table well screens, as the water table has rebounded since 2009. The coring locations, depths, and procedures provided in the Work Plan were scoped and designed over a series of technical working groups to most effectively and efficiently characterize the LNAPL remaining in the subsurface and understand any potential sources that remain.

An additional key component of the Work Plan is the installation of groundwater monitoring wells screened across the water table at the coring locations. With the rising water table, the majority of the water table groundwater monitoring well network has become submerged, resulting in a loss of data refinement at the water table for both dissolved-phase contaminants and measurable LNAPL thickness. A newly installed groundwater monitoring well, KAFB-106MW1, is monitored in support of the in-situ bioremediation pilot test and had measurable LNAPL in September and October 2017. This occurrence of LNAPL in a water table groundwater monitoring well, along with concentration data from 2017, indicates that LNAPL is present in sufficient quantities at the water table to enter a monitoring well in a measurable thickness.

The Work Plan is hereby approved, subject to the following conditions:

1. Photoionization detector ("PID") readings will be collected every twenty (20) feet from the ground surface to the top of the 1970 high water mark, at which point the frequency shall be increased to at least every ten (10) feet in order to capture zones of residual fuel contamination in the vadose zone.
2. Coring intervals will begin at least ten (10) feet above the 1970s high water mark, which is equivalent to the 1960s high water mark. Coring intervals may be changed based upon preceding coring and field data, and will be conveyed by the Permittee to NMED for approval prior to implementing changes in coring depths.
3. Figure 3-7 indicates that mineralogical and microbial data will only be collected from samples within the saturated and or smear zone. The Permittee shall propose, for NMED approval, unsaturated zone coring intervals for source area locations KAFB 106V1 and KARB-106V2 where these analyses also will be conducted.

4. Coring location KAFB-106S7 will remain as optional, pending the results obtained from coring locations KAFB-106S3 and KAFB-106S5.
5. Background coring ST-106 SBBG shall be the last drilling location. The Permittee and NMED shall meet to discuss observations and test results from other coring locations, and the Permittee shall propose to NMED for approval, coring intervals and analyses for ST-106 SBBG that will provide actual background data to use for screening data and informing decisions. The Permittee and NMED shall meet and agree on coring intervals and analyses for ST-106 SBBG, as expeditiously as possible, so as not to incur drilling down-time or a separate mobilization.
6. If the location of background well ST-106 SBBG becomes problematic due to its closeness to the airport runway, the Permittee shall propose, and obtain NMED approval for, a new location.
7. The Permittee shall core and install a groundwater monitoring well at location KAFB-106S5 first, so that information from this well can be used to monitor contamination conditions south of groundwater extraction well KAFB-106239.
8. During drilling, the Permittee shall provide a PDF copy of lithologic logs daily along with an update email documenting daily and planned activities. A well approval form with the proposed screen intervals for groundwater monitoring well completions must be submitted for NMED approval prior to the start of well construction. NMED understands the importance of no field delays and will return the approved well form within one working day of receipt.
9. This approval also applies to the drilling and construction of soil vapor monitoring and injection wells, injection points, and an air lift well that will be used in bioventing and air lift pilot tests. NMED is currently reviewing the full workplans for these pilot tests and will provide the Permittee with comments in the near future, but the Permittee is authorized to proceed with the drilling and construction of these wells and points.
10. Prior to drilling de-mobilization, and after the coring program has generated additional data, NMED and the Permittee shall meet to discuss feasibility of continuous coring and groundwater monitoring well installation at locations near KAFB-106MW1, where LNAPL was measured in September and October 2017, and KAFB-106018 where measurable LNAPL and high dissolved-phase hydrocarbons have been detected in the past.

If you have any questions regarding this letter, please contact NMED, Chief Scientist Dennis McQuillan at (505) 827-2140.

Sincerely,

JCB

Juan Carlos Borrego
Deputy Secretary
Environment Department

cc: Col. M. Harner, KAFB
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J. Kieling, NMED-HWB
B. Salem, NMED-HWB
S. Pullen, NMED-GWQB
M. Hunter, NMED-GWQB
D. McQuillan, NMED-OOTS

File: KAFB 2018 Bulk Fuels Facility Spill

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Hazardous Waste Bureau

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JENNIFER J. PRUETT
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CERTIFIED MAIL – RETURN RECEIPT REQUESTED

February 25, 2019

Colonel Richard W. Gibbs
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377 ABW/CC
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Mr. Chris Segura
Chief, Installation Support Section
AFCEC/CZOW
2050 Wyoming Blvd SE, Suite 124
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RE: BULK FUELS FACILITY SPILL;
SOLID WASTE MANAGEMENT UNIT ST-106/SS-111
KIRTLAND AIR FORCE BASE
HWB-KAFB-19-MISC

Dear Colonel Gibbs and Mr. Segura:

The New Mexico Environment Department (NMED) provides this letter to address several projects that Kirtland Air Force Base (Permittee) is undertaking as investigative or interim corrective measures related to the implementation of the Resource Conservation and Recovery Act (RCRA) *Hazardous Waste Treatment Facility Operating Permit EPA ID No.* NM9570024423 dated July 2010.

Item 1

NMED received the Permittee's *Work Plan for Vadose Zone Coring, Vapor Monitoring, and Water Supply Sampling Bulk Fuels Facility, Solid Waste Management Unit (SWMU) ST-106/SS-111, Kirtland Air Force Base, New Mexico, Revision R1* dated December 15, 2017. The Work Plan proposed additional vadose zone and groundwater investigation and monitoring, and was approved by NMED on February 23, 2018. Well drilling and vadose zone coring activities are ongoing since 2018 and expected to be complete within several weeks. The Permittee shall submit a report to NMED summarizing the LNAPL investigation findings by November 1, 2019.

Item 2

The Permittee's *Risk Assessment Report, Bulk Fuels Facility Spill; Solid Waste Management Unit ST-106/SS-111* (Report), dated July 15, 2017 was received by NMED on July 21, 2017. The Report concluded that contaminant exposure via vapor intrusion into indoor air in buildings located off-Base was an incomplete pathway. However, off-Base soil vapor data are limited to nested vapor probes, the shallowest of which are approximately 25 feet below ground surface, and none of which are located in the residential area north of Ridgecrest or amid buildings on the Veteran Affairs (VA) hospital campus. The Permittee must confirm this conclusion by collecting additional data to demonstrate that that there is no risk to off-site receptors located north of the Base. The Permittee shall send a work plan to NMED no later than May 30, 2019 that proposes to collect shallow soil vapor samples to evaluate for the presence of benzene, ethylene dibromide (EDB), and other volatile organic compounds (if present) in the residential area north of Ridgecrest, and on the campus of the VA Hospital.

The work plan shall select analytical methods for soil vapor analysis that comply with the requirements of Permit Section 6.5.18. (Laboratory Analyses Requirements for all Environmental Media). The work plan also shall include a schedule for at least two soil vapor sampling events, one in the summer and one in the winter, that shall be timed to verify that bioventing pilot testing is not causing an increase in shallow soil vapor contaminant levels in the residential and VA hospital areas.

Item 3

The Permittee has been conducting an EDB in-situ biodegradation pilot test in accordance with the work plan dated October 26, 2016, as most recently amended with NMED's August 7, 2018 approval letter. The Permittee shall submit a report summarizing the results of the in-situ biodegradation pilot test by May 1, 2019.

Item 4

The Permittee submitted a work plan for a bioventing pilot test that NMED approved by letter dated April 6, 2018. The Permittee submitted proposed bioventing respiration pilot testing procedures by letter dated September 7, 2018. The Permittee's proposed bioventing respiration pilot testing procedures are hereby approved subject to the following condition. Prior to the initiation of the dry and wet short-term pilot tests, the Permittee shall measure relative humidity (water activity) in the soil vapor probes that will be used for pilot testing in order to determine whether underlying groundwater caused relative humidity to increase following the 2015 shutdown of the soil vapor extraction system and subsequent biorespiration monitoring. Since the approved bioventing work plan involves delivering moisture to soil bacteria that were desiccated by 12 years of soil vapor extraction, the Permittee shall measure relative humidity prior to initiation of bioventing pilot tests. The Permittee shall submit the result the results of the bioventing pilot tests by January 31, 2020.

Pursuant to the RCRA corrective action permit, the Permittee shall submit to NMED by certified mail or hand delivery all reports, notifications, or other submittals. The Permittee shall submit two hard (paper) copies and one electronic copy of such reports to:

John Kieling, Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, New Mexico 87505-6303

The Permittee shall also submit one hard (paper) copy and one electronic copy of such reports to:

Jennifer J. Pruett, Deputy Secretary
New Mexico Environment Department
1190 St. Francis Drive, Room N-4050
Santa Fe, New Mexico 87505-6303

Pursuant to 40 C.F.R. § 270.11(d)(1), all corrective action documents, including those outlined in this letter, shall include a certification, signed by a responsible official, stating:

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

Failure to submit any of the work plans, schedules, reports, and other deliverable documents described in this letter may be deemed a violation of the permit and subject the Permittee to enforcement action under § 74-4-10 of the Hazardous Waste Act (HWA), or other applicable provisions of law, which may include fines, civil penalties, or suspension or revocation of the Permit.

Any noncompliance with approved plans and schedules shall be noncompliance with this Permit. The Department may grant extensions of written requests for due dates for submittals of reports and other deliverables, provided that the Permittee includes a written justification showing good cause and a proposed schedule for submittal.

If you have any questions regarding this letter, please contact me at 505-476-6035.

Sincerely,

John Kieling
Bureau Chief

JP:DM

cc:J. Kenney, NMED Cabinet Secretary
J. Pruett, NMED Deputy Secretary
Col. J. Alvarez, KAFB
K. Lynnes, KAFB
B. Renaghan, AFCEC
S. Clark, KAFB-AFCEC
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A. Romero, NMED-GWQB
M. Hunter, NMED-GWQB
D. McQuillan, NMED-OOTS

File: KAFB 2019 Bulk Fuels Facility Spill and Reading

NEW MEXICO
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CERTIFIED MAIL - RETURN RECEIPT REQUESTED

December 16, 2020

Colonel David S. Miller
Base Commander
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2000 Wyoming Blvd SE
Kirtland AFB, NM 87117

Lt. Colonel Wayne J. Acosta
Civil Engineer Office
377 Civil Engineering Division
2050 Wyoming Blvd SE, Suite 116
Kirtland AFB, NM 87117

RE: APPROVAL – REQUEST FOR EXTENSION TO SUBMIT THE
REVISED SOURCE ZONE CHARACTERIZATION REPORT FOR THE BULK FUELS FACILITY
SOLID WASTE MANAGEMENT UNIT ST-106/SS-111
KIRTLAND AIR FORCE BASE, NEW MEXICO
EPA ID # NM9570024423
HWB-KAFB-19-012

Dear Colonel Miller and Lt. Colonel Acosta:

The New Mexico Environment Department (NMED) has received the Kirtland Air Force Base (Permittee) request for an extension of time, dated December 4, 2020, to submit the revised Source Zone Characterization Report (revised Report). The current due date for the revised Report is December 31, 2020 as required by NMED's August 17, 2020 Disapproval Source Zone Characterization Report for the Bulk Fuels Facility Solid Waste Management Unit ST-106/SS-111 (NOD).

The request for an extension of time includes a request for a meeting with NMED to discuss comments associated with the NMED disapproval. As we are focused on moving this project forward expeditiously, please have your staff contact Lane Andress of my staff, at Lane.Andress@state.nm.us, to arrange this meeting as soon as possible. Any decisions or modifications made pursuant to this discussion will be documented in writing to assure that the administrative record is accurate and complete.

The Air Force's request for an extension of time to submit the revised report to NMED is hereby approved. The Permittee must submit the revised Report and response to comments no later than **April 30, 2021**, as requested.

If you have any questions regarding this letter, please contact me at (505) 476-6035.
Sincerely,

Kevin M. Pierard, Chief
Hazardous Waste Bureau

Attachment: NMED Comments

cc: D. Cobrain, NMED HWB
B. Wear, NMED HWB
R. Murphy, NMED HWB
L. Andress, NMED HWB
S. Kottkamp, KAFB
K. Lynnes, KAFB
C. Cash, KAFB
D. Agnew, ABCWUA
A. Tafoya, VA

File: KAFB 2020 and Reading

Bockisch, Bernard

From: Moayyad, Behnaum CIV USARMY CESPA (USA) <Behnaum.Moayyad@usace.army.mil>
Sent: Monday, January 28, 2019 7:07 PM
To: Jercinovic, Devon; Bockisch, Bernard
Subject: FW: Request for Background Core Sample Interval approval - SUSPENSE 25 JAN (UNCLASSIFIED)
Attachments: KirtlandSampleDistribution_Rev3.xlsx

Importance: Low

CLASSIFICATION: UNCLASSIFIED

Background boring depths approved. Yay!
We are good to go with the sampling table sent out last Wednesday (attached).

Ben Moayyad
USACE-Albuquerque
Mobile: (505) 639-3195

NOTICE: THE OFFICE IS UNDER CONSTRUCTION AND THE OFFICE PHONE LINE IS NOT AVAILABLE.

-----Original Message-----
From: Moayyad, Behnaum CIV USARMY CESPA (USA)
Sent: Monday, January 28, 2019 7:00 PM
To: 'McQuillan, Dennis, NMENV' <dennis.mcquillan@state.nm.us>
Cc: RENAGHAN, BRIAN J GS-13 USAF AFMC AFCEC/CZRX <brian.renaghan@us.af.mil>; Scott C. Clark (scott.clark@us.af.mil) <scott.clark@us.af.mil>; Kathryn D Lynnes (kathryn.lynnes@us.af.mil) <kathryn.lynnes@us.af.mil>; Phaneuf, Mark J CIV USARMY CESPA (USA) <Mark.J.Phaneuf@usace.army.mil>; Cordova, Amy Elizabeth CIV USARMY CESPA (USA) <Amy.E.Cordova@usace.army.mil>; Kunkel, Tara S CIV USARMY CESPA (USA) <Tara.S.Kunkel@usace.army.mil>; Dreeland, Linda E CIV USARMY CESPA (USA) <Linda.E.Dreeland@usace.army.mil>; Jercinovic, Devon <djercinovic@eaest.com>
Subject: RE: Request for Background Core Sample Interval approval - SUSPENSE 25 JAN (UNCLASSIFIED)
Importance: Low

CLASSIFICATION: UNCLASSIFIED

Thank you. We appreciate it.

Ben Moayyad
USACE-Albuquerque
Mobile: (505) 639-3195

NOTICE: THE OFFICE IS UNDER CONSTRUCTION AND THE OFFICE PHONE LINE IS NOT AVAILABLE.

-----Original Message-----
From: McQuillan, Dennis, NMENV [mailto:dennis.mcquillan@state.nm.us]
Sent: Monday, January 28, 2019 5:47 PM
To: Moayyad, Behnaum CIV USARMY CESPA (USA) <Behnaum.Moayyad@usace.army.mil>
Cc: RENAGHAN, BRIAN J GS-13 USAF AFMC AFCEC/CZRX <brian.renaghan@us.af.mil>; Scott C. Clark (scott.clark@us.af.mil) <scott.clark@us.af.mil>; Kathryn D Lynnes (kathryn.lynnes@us.af.mil) <kathryn.lynnes@us.af.mil>; Phaneuf, Mark J CIV USARMY CESPA (USA) <Mark.J.Phaneuf@usace.army.mil>; Cordova, Amy Elizabeth CIV USARMY CESPA (USA) <Amy.E.Cordova@usace.army.mil>; Kunkel, Tara S CIV USARMY CESPA (USA) <Tara.S.Kunkel@usace.army.mil>; Dreeland, Linda E CIV USARMY CESPA (USA) <Linda.E.Dreeland@usace.army.mil>; Jercinovic, Devon <djercinovic@eaest.com>
Subject: [Non-DoD Source] RE: Request for Background Core Sample Interval approval - SUSPENSE 25 JAN (UNCLASSIFIED)

Approved. I will email you a signed copy.

Dennis McQuillan
Chief Scientist
New Mexico Environment Department
1190 St. Francis Dr.
PO Box 5469
Santa Fe, NM 87502
505-827-2140 desk
505-660-1592 cell
dennis.mcquillan@state.nm.us

-----Original Message-----
From: Moayyad, Behnaum CIV USARMY CESPA (USA) <Behnaum.Moayyad@usace.army.mil>
Sent: Sunday, January 27, 2019 6:43 AM
To: McQuillan, Dennis, NMENV <dennis.mcquillan@state.nm.us>
Cc: RENAGHAN, BRIAN J GS-13 USAF AFMC AFCEC/CZRX <brian.renaghan@us.af.mil>; Scott C. Clark (scott.clark@us.af.mil) <scott.clark@us.af.mil>; Kathryn D Lynnes (kathryn.lynnes@us.af.mil) <kathryn.lynnes@us.af.mil>; Phaneuf, Mark J CIV USARMY CESPA (USA) <Mark.J.Phaneuf@usace.army.mil>; Cordova, Amy Elizabeth CIV USARMY CESPA (USA) <Amy.E.Cordova@usace.army.mil>; Kunkel, Tara S CIV USARMY CESPA (USA) <Tara.S.Kunkel@usace.army.mil>; Dreeland, Linda E CIV USARMY CESPA (USA) <Linda.E.Dreeland@usace.army.mil>; Jercinovic, Devon <djercinovic@eaest.com>

Subject: [EXT] RE: Request for Background Core Sample Interval approval - SUSPENSE 25 JAN (UNCLASSIFIED)

CLASSIFICATION: UNCLASSIFIED

Thank you Dennis.
Do you also approve of the proposed sample depth intervals, or are those under review?

Ben Moayyad
USACE-Albuquerque
Mobile: (505) 639-3195

NOTICE: THE OFFICE IS UNDER CONSTRUCTION AND THE OFFICE PHONE LINE IS NOT AVAILABLE.

-----Original Message-----
From: McQuillan, Dennis, NMENV [mailto:dennis.mcquillan@state.nm.us]
Sent: Friday, January 25, 2019 4:53 PM
To: Moayyad, Behnaum CIV USARMY CESPA (USA) <Behnaum.Moayyad@usace.army.mil>
Cc: RENAGHAN, BRIAN J GS-13 USAF AFMC AFCEC/CZRX <brian.renaghan@us.af.mil>; Scott C. Clark (scott.clark@us.af.mil) <scott.clark@us.af.mil>; Kathryn D Lynnes (kathryn.lynnes@us.af.mil) <kathryn.lynnes@us.af.mil>; Phaneuf, Mark J CIV USARMY CESPA (USA) <Mark.J.Phaneuf@usace.army.mil>; Cordova, Amy Elizabeth CIV USARMY CESPA (USA) <Amy.E.Cordova@usace.army.mil>; Kunkel, Tara S CIV USARMY CESPA (USA) <Tara.S.Kunkel@usace.army.mil>; Dreeland, Linda E CIV USARMY CESPA (USA) <Linda.E.Dreeland@usace.army.mil>; Jercinovic, Devon <djercinovic@eaest.com>
Subject: [Non-DoD Source] RE: Request for Background Core Sample Interval approval - SUSPENSE 25 JAN (UNCLASSIFIED)

Ben,

Approval for the background location is attached.

Thanks!

Dennis McQuillan
Chief Scientist
New Mexico Environment Department
1190 St. Francis Dr.
PO Box 5469
Santa Fe, NM 87502
505-827-2140 desk
505-660-1592 cell
dennis.mcquillan@state.nm.us

-----Original Message-----
From: Moayyad, Behnaum CIV USARMY CESPA (USA) <Behnaum.Moayyad@usace.army.mil>
Sent: Friday, January 25, 2019 12:21 PM
To: McQuillan, Dennis, NMENV <dennis.mcquillan@state.nm.us>
Cc: RENAGHAN, BRIAN J GS-13 USAF AFMC AFCEC/CZRX <brian.renaghan@us.af.mil>; Scott C. Clark (scott.clark@us.af.mil) <scott.clark@us.af.mil>; Kathryn D Lynnes (kathryn.lynnes@us.af.mil) <kathryn.lynnes@us.af.mil>; Phaneuf, Mark J CIV USARMY CESPA (USA) <Mark.J.Phaneuf@usace.army.mil>; Cordova, Amy Elizabeth CIV USARMY CESPA (USA) <Amy.E.Cordova@usace.army.mil>; Kunkel, Tara S CIV USARMY CESPA (USA) <Tara.S.Kunkel@usace.army.mil>; Dreeland, Linda E CIV USARMY CESPA (USA) <Linda.E.Dreeland@usace.army.mil>; Jercinovic, Devon <djercinovic@eaest.com>
Subject: [EXT] RE: Request for Background Core Sample Interval approval - SUSPENSE 25 JAN (UNCLASSIFIED)
Importance: High

CLASSIFICATION: UNCLASSIFIED

Good afternoon Dennis.
Please advise on if you will respond to the proposed background sampling intervals today.
If more time and discussion is requested please let us know if we can set up a meeting, or if we can add to the agenda for the regular Monday 11am meeting.

Thank you,
Ben Moayyad
USACE-Albuquerque
Mobile: (505) 639-3195

NOTICE: THE OFFICE IS UNDER CONSTRUCTION AND THE OFFICE PHONE LINE IS NOT AVAILABLE.

-----Original Message-----
From: Moayyad, Behnaum CIV USARMY CESPA (USA)
Sent: Wednesday, January 23, 2019 2:23 PM
To: Dennis McQuillan (dennis.mcquillan@state.nm.us) <dennis.mcquillan@state.nm.us>
Cc: 'RENAGHAN, BRIAN J GS-13 USAF AFMC AFCEC/CZRX' <brian.renaghan@us.af.mil>; Scott C. Clark (scott.clark@us.af.mil) <scott.clark@us.af.mil>; Kathryn D Lynnes (kathryn.lynnes@us.af.mil) <kathryn.lynnes@us.af.mil>; Phaneuf, Mark J CIV USARMY CESPA (USA) <Mark.J.Phaneuf@usace.army.mil>; Cordova, Amy Elizabeth CIV USARMY CESPA (USA) <Amy.E.Cordova@usace.army.mil>; Kunkel, Tara S CIV USARMY CESPA (USA) <Tara.S.Kunkel@usace.army.mil>; Dreeland, Linda E CIV USARMY CESPA (USA) <Linda.E.Dreeland@usace.army.mil>; Jercinovic, Devon <djercinovic@eaest.com>
Subject: RE: Request for Background Core Sample Interval approval - SUSPENSE 25 JAN (UNCLASSIFIED)
Importance: High

CLASSIFICATION: UNCLASSIFIED

Attached is the updated proposed coring table. There were a couple minor changes in one sample depth at 215 feet. Please replace the previous file (rev2).

Thank you,
Ben Moayyad
USACE-Albuquerque
Mobile: (505) 639-3195

NOTICE: THE OFFICE IS UNDER CONSTRUCTION AND THE OFFICE PHONE LINE IS NOT AVAILABLE.

-----Original Message-----
From: Moayyad, Behnaum CIV USARMY CESPA (USA)
Sent: Tuesday, January 22, 2019 8:29 PM
To: Dennis McQuillan (dennis.mcquillan@state.nm.us) <dennis.mcquillan@state.nm.us>
Cc: 'RENAGHAN, BRIAN J GS-13 USAF AFMC AFCEC/CZRX' <brian.renaghan@us.af.mil>; Scott C. Clark (scott.clark@us.af.mil) <scott.clark@us.af.mil>; Kathryn D Lynnes (kathryn.lynnes@us.af.mil) <kathryn.lynnes@us.af.mil>; Phaneuf, Mark J CIV USARMY CESPA (USA) <Mark.J.Phaneuf@usace.army.mil>; Cordova, Amy Elizabeth CIV USARMY CESPA (USA) <Amy.E.Cordova@usace.army.mil>; Kunkel, Tara S CIV USARMY CESPA (USA) <Tara.S.Kunkel@usace.army.mil>; Dreeland, Linda E CIV USARMY CESPA (USA) <Linda.E.Dreeland@usace.army.mil>; Jercinovic, Devon <djercinovic@eaest.com>
Subject: Request for Background Core Sample Interval approval - SUSPENSE 25 JAN (UNCLASSIFIED)

CLASSIFICATION: UNCLASSIFIED

Dennis,
On behalf of the Air Force, we are requesting review of the attached proposal for sampling intervals in the background coring location in advance of drilling (scheduled to begin 29 January).

In accordance with NMED Condition 5 in the 23 February 2018 letter approving the Coring Work Plan, coring at the background location is scheduled after completing coring at other locations and planned sample locations are being proposed to NMED for review prior to initiation of drilling. Summary information from the field screening data is also attached for your approval.

Please review and let us know if a call would be helpful to evaluate the optimal depths for background sampling.

Thank you,
Ben
Behnaum Moayyad, PG.
Project Manager
U.S. Army Corps of Engineers

4101 Jefferson Plaza NE
Albuquerque, NM 87109
Mobile: (505) 639-3195

XXXXXX Office: (505) 342-3104 XXXXXX
NOTICE: THE OFFICE IS UNDER CONSTRUCTION AND THE OFFICE PHONE LINE IS NOT ACCESSIBLE. CONSTRUCTION IS ANTICIPATED FOR 9 MONTHS. PLEASE USE THE MOBILE PHONE INSTEAD.

CLASSIFICATION: UNCLASSIFIED
CLASSIFICATION: UNCLASSIFIED
CLASSIFICATION: UNCLASSIFIED
CLASSIFICATION: UNCLASSIFIED
CLASSIFICATION: UNCLASSIFIED
CLASSIFICATION: UNCLASSIFIED

Bockisch, Bernard

From: Moayyad, Behnaum CIV USARMY CESPA (US) <Behnaum.Moayyad@usace.army.mil>
Sent: Tuesday, November 6, 2018 8:10 AM
To: Jercinovic, Devon; Bockisch, Bernard
Cc: Dreeland, Linda E CIV USARMY CESPA (US); Cordova, Amy Elizabeth CIV USARMY CESPA (USA); Phaneuf, Mark J CIV USARMY CESPA (US); Kunkel, Tara S CIV USARMY CESPA (US)
Subject: RE: Request for Variance from Coring Temperatures Threshold (UNCLASSIFIED)

CLASSIFICATION: UNCLASSIFIED

Devon and Bernie,
Please file this approval from Dennis for temperature issues above 450 ft bgs. Hope this help speed up your coring.
Still no word on approval letter conditions.

Ben Moayyad
USACE-Albuquerque
Mobile: (505) 639-3195

NOTICE: THE OFFICE IS UNDER CONSTRUCTION AND THE OFFICE PHONE LINE IS NOT AVAILABLE.

-----Original Message-----
From: McQuillan, Dennis, NMENV [mailto:dennis.mcquillan@state.nm.us]
Sent: Monday, November 5, 2018 5:11 PM
To: Kunkel, Tara S CIV USARMY CESPA (US) <Tara.S.Kunkel@usace.army.mil>
Cc: RENAGHAN, BRIAN J GS-13 USAF AFMC AFCEC/CZRX <brian.renaghan@us.af.mil>; Scott C. Clark (scott.clark@us.af.mil) <scott.clark@us.af.mil>; kathryn.lynnes@us.af.mil; Dreeland, Linda E CIV USARMY CESPA (US) <Linda.E.Dreeland@usace.army.mil>; Salazar, Carlos F CIV USARMY CESPA (US) <Carlos.F.Salazar@usace.army.mil>; Cordova, Amy Elizabeth CIV USARMY CESPA (USA) <Amy.E.Cordova@usace.army.mil>; Moayyad, Behnaum CIV USARMY CESPA (US) <Behnaum.Moayyad@usace.army.mil>; Phaneuf, Mark J CIV USARMY CESPA (US) <Mark.J.Phaneuf@usace.army.mil>; Jercinovic, Devon <djercinovic@eaest.com>; Bockisch, Bernard <bbockisch@eaest.com>
Subject: [Non-DoD Source] RE: Request for Variance from Coring Temperatures Threshold

Thanks Tara,

This request is approved.

Dennis McQuillan
Chief Scientist
New Mexico Environment Department
1190 St. Francis Dr.
PO Box 5469
Santa Fe, NM 87502
505-827-2140 desk
505-660-1592 cell
dennis.mcquillan@state.nm.us

-----Original Message-----
From: Kunkel, Tara S CIV USARMY CESPA (US) <Tara.S.Kunkel@usace.army.mil>
Sent: Friday, November 2, 2018 3:56 PM

To: McQuillan, Dennis, NMENV <dennis.mcquillan@state.nm.us>
Cc: RENAGHAN, BRIAN J GS-13 USAF AFMC AFCEC/CZRX <brian.renaghan@us.af.mil>; Scott C. Clark (scott.clark@us.af.mil) <scott.clark@us.af.mil>; kathryn.lynnes@us.af.mil; Dreeland, Linda E CIV USARMY CESPA (US) <Linda.E.Dreeland@usace.army.mil>; Salazar, Carlos F CIV USARMY CESPA (US) <Carlos.F.Salazar@usace.army.mil>; Cordova, Amy Elizabeth CIV USARMY CESPA (USA) <Amy.E.Cordova@usace.army.mil>; Moayyad, Behnaum CIV USARMY CESPA (US) <Behnaum.Moayyad@usace.army.mil>; Phaneuf, Mark J CIV USARMY CESPA (US) <Mark.J.Phaneuf@usace.army.mil>; Jercinovic, Devon <djercinovic@eaest.com>; Bockisch, Bernard <bbockisch@eaest.com>
Subject: [EXT] FW: Request for Variance from Coring Temperatures Threshold
Importance: High

Hi Dennis,

Please see below and attached with regard to the current temperature restrictions during sonic drilling and our request for an exception to this while drilling through the uncontaminated zones of upcoming boreholes. Please note that some of the temperatures have been recorded on the log in Fahrenheit, but in an effort to get this to you as quick as possible, we have provided the field logs as they are.

Please let us know if you need any additional information.

Thank you and have a good weekend!
Tara

Tara S. Kunkel
Project Manager
USACE-SPA
4101 Jefferson Plaza NE
Albuquerque, New Mexico 87109
Phone: (505) 319-2828
Email: Tara.S.Kunkel@usace.army.mil

-----Original Message-----
From: Bockisch, Bernard [mailto:bbockisch@eaest.com]
Sent: Friday, November 2, 2018 3:13 PM
To: Cordova, Amy Elizabeth CIV USARMY CESPA (USA) <Amy.E.Cordova@usace.army.mil>; Moayyad, Behnaum CIV USARMY CESPA (US) <Behnaum.Moayyad@usace.army.mil>; Dreeland, Linda E CIV USARMY CESPA (US) <Linda.E.Dreeland@usace.army.mil>; Phaneuf, Mark J CIV USARMY CESPA (US) <Mark.J.Phaneuf@usace.army.mil>; Salazar, Carlos F CIV USARMY CESPA (US) <Carlos.F.Salazar@usace.army.mil>; Kunkel, Tara S CIV USARMY CESPA (US) <Tara.S.Kunkel@usace.army.mil>
Cc: Jercinovic, Devon <djercinovic@eaest.com>
Subject: [Non-DoD Source] FW: Request for Variance from Coring Temperatures Threshold

USACE TEAM

As discussed during our meeting today (11/2), EA is requesting a variance from the Vadose Zone Workplan (dated December 2017) for meeting sonic core temperatures (20 degrees C) for soil samples collected above 450 feet (ft) below ground surface. This request is being made for borings KAFB 106S2, KAFB 106S3, optional wells KAFB 106S6, KAFB 106S7, KAFB 106S8, and 400 ft bgs for KAFB 106S1.

Field screening data collected from soil borings KAFB 106S9 (closest to the release area) and KAFB 106S5 did not indicate the presence of petroleum hydrocarbons above a depth of 460 ft bgs (see attached headspace versus depth tables). In order to maintain the required core temperatures, the drilling runs have been reduced to four to six feet-long. As the depth increases, these runs are taking up to two to three hours (including casing advancement and clean-out) with little to no benefit to sample integrity.

If the request is granted, EA will continue to monitor petroleum hydrocarbon concentrations in the upper 400 feet to 450 feet of soil column via field screening using the heated headspace method. In the event that petroleum hydrocarbon concentrations above 100 parts per million are observed, temperature control will be implemented immediately.

Bernard Bockisch, PMP

EA Engineering, Science, and Technology, Inc., PBC

Senior Project Manager

320 Gold Ave. SW, Suite 1300

Albuquerque, NM 87102

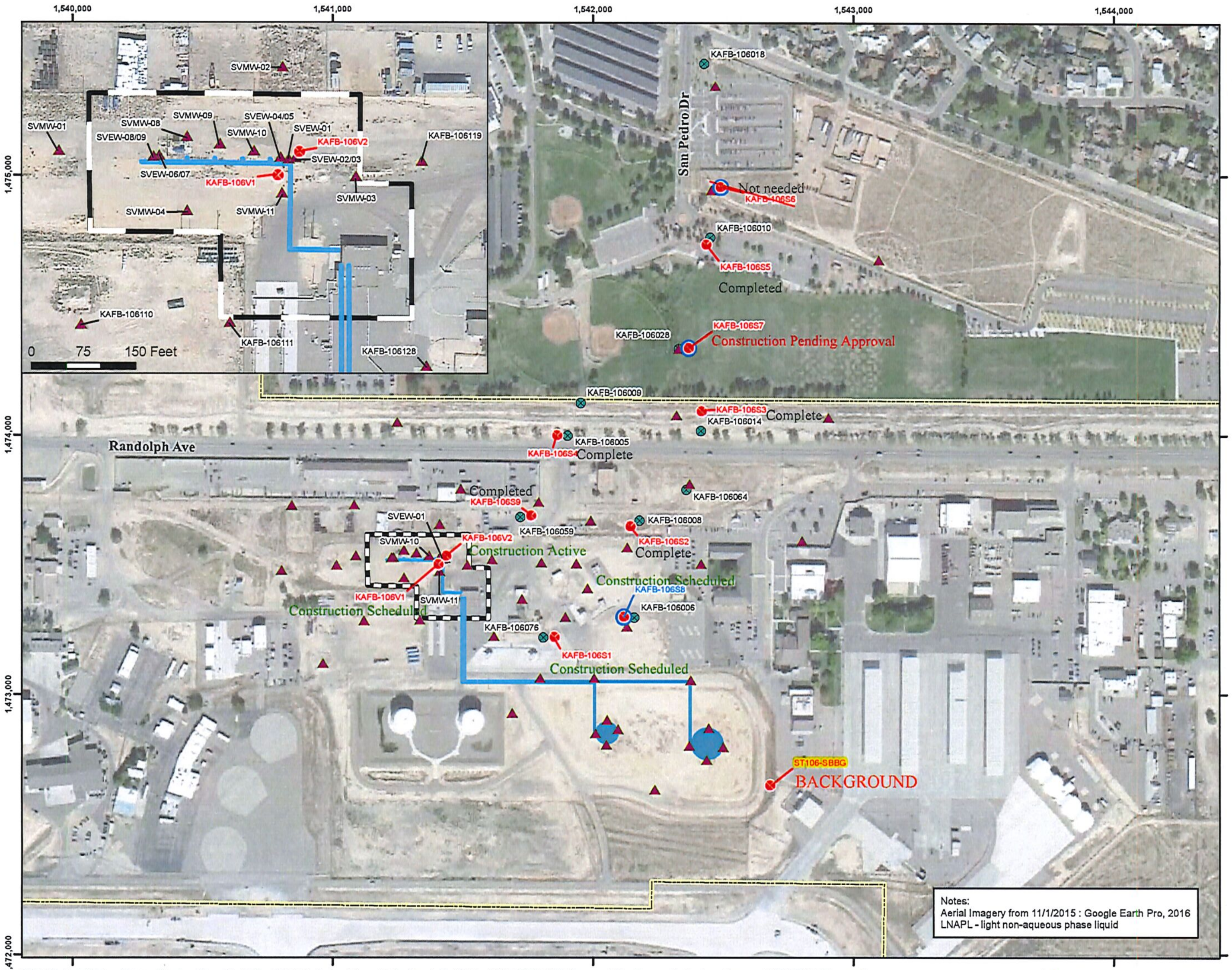
Cell: 505.280-0572

Office: 505.234-1105

Email: bbockisch@eaest.com <mailto:bbockisch@eaest.com>

BlockedBlockedwww.eaest.com <BlockedBlockedhttps://clicktime.symantec.com/a/1/sxDxt8bNyi214tKGSAclgOBOH_ZI5PVjeaMwdtOQzsg=?d=WMWYEdF5EJActf3q7pWL_R0g29S-1eevEFVUb34NtUN3LpFpVs5k5W7WB-URTaTk-MWnttD251T8_lqKbT59Go4PibWFjyyC9Cb5pOJineBa3XzjvGXNSe6uIs_A2hw2WPR3L6hBLt0ka0AY-y30TqMj_q2wo-9kcX5p9hfZAQHuJktOW4SKyyjUf6D9_KgEYnqLJQfFCcklfpEGmVmbUuYckRffYCN3qQK64vtm-AFkEEGbAHOxsrl_UqRnRF0FkfLLsyEclBvMgH_to2so9IQ93_45N3jLABbBynys_bZbLPjVwW-g9IWh9FFSSYMjmLaAt5I2Mu0phKcmm7bU677ZbpAXh9IuDuqpuM10M0e8VoFVYuQN8x3QHjOPtVdbHazgBM-PhQeSCNIQ9WCidHFUO10n1zDxUNvQMls9tYP8Jf61N_JdGmAE4-awTFG9basZ1oJsWw%3D%3D&u=http%3A%2F%2Fwww.eaest.com%2F>

CLASSIFICATION: UNCLASSIFIED

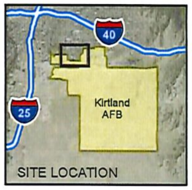


Notes:
Aerial Imagery from 11/1/2015 : Google Earth Pro, 2016
LNAPL - light non-aqueous phase liquid

P:\gis\Projects\Kirtland\Figures\Vadose Zone Work Plan\VZ_WP_Coring_Vapor_WaterSupply\3-1 KirtlandVZ_CVWS_WP_Proposed Continuous Coring Locations.mxd 5/8/2018 EA eomalia

Legend

▲	Existing Soil Vapor Well
⊗	Proposed Continuous Core Location
◎	Optional Continuous Core Location
⊗	Monitoring Well with Historical LNAPL Observation
●	Former Aboveground Storage Tank
—	Former Buried Fuel Transfer Line
—	Former Aboveground Fuel Transfer Line
---	Installation Boundary
▭	Source Area



N
0 200 400 800
Feet
1 inch = 400 feet

Projection: NAD83 State Plane New Mexico Central FIPS3002 Feet

WORK PLAN FOR VADOSE ZONE CORING,
VAPOR MONITORING, AND WATER SUPPLY SAMPLING
BULK FUELS FACILITY
SOLID WASTE MANAGEMENT UNIT ST-106/SS-111
KIRTLAND AIR FORCE BASE, NEW MEXICO

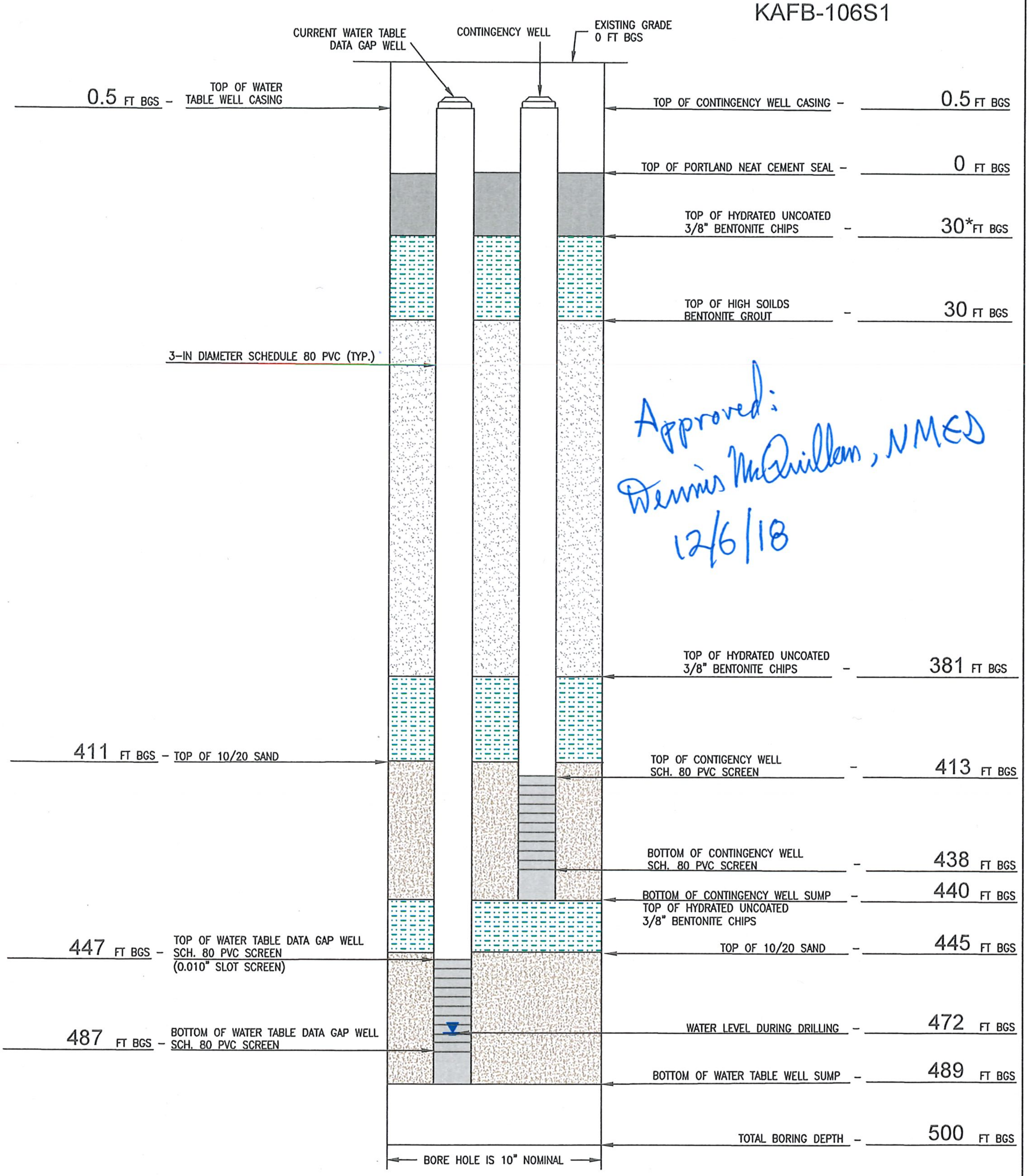
FIGURE 3-1

PROPOSED CONTINUOUS CORING LOCATIONS

Approved: Dennis McQuillan 1/25/19

NESTED MONITORING WELL CONSTRUCTION

KAFB-106S1



Approved:
Dennis McQuillan, NMED
12/6/18

*Additional bentonite chips may be added to account for bentonite grout settlement.

NOT TO SCALE
BGS=BELOW GROUND SURFACE
FT=FEET

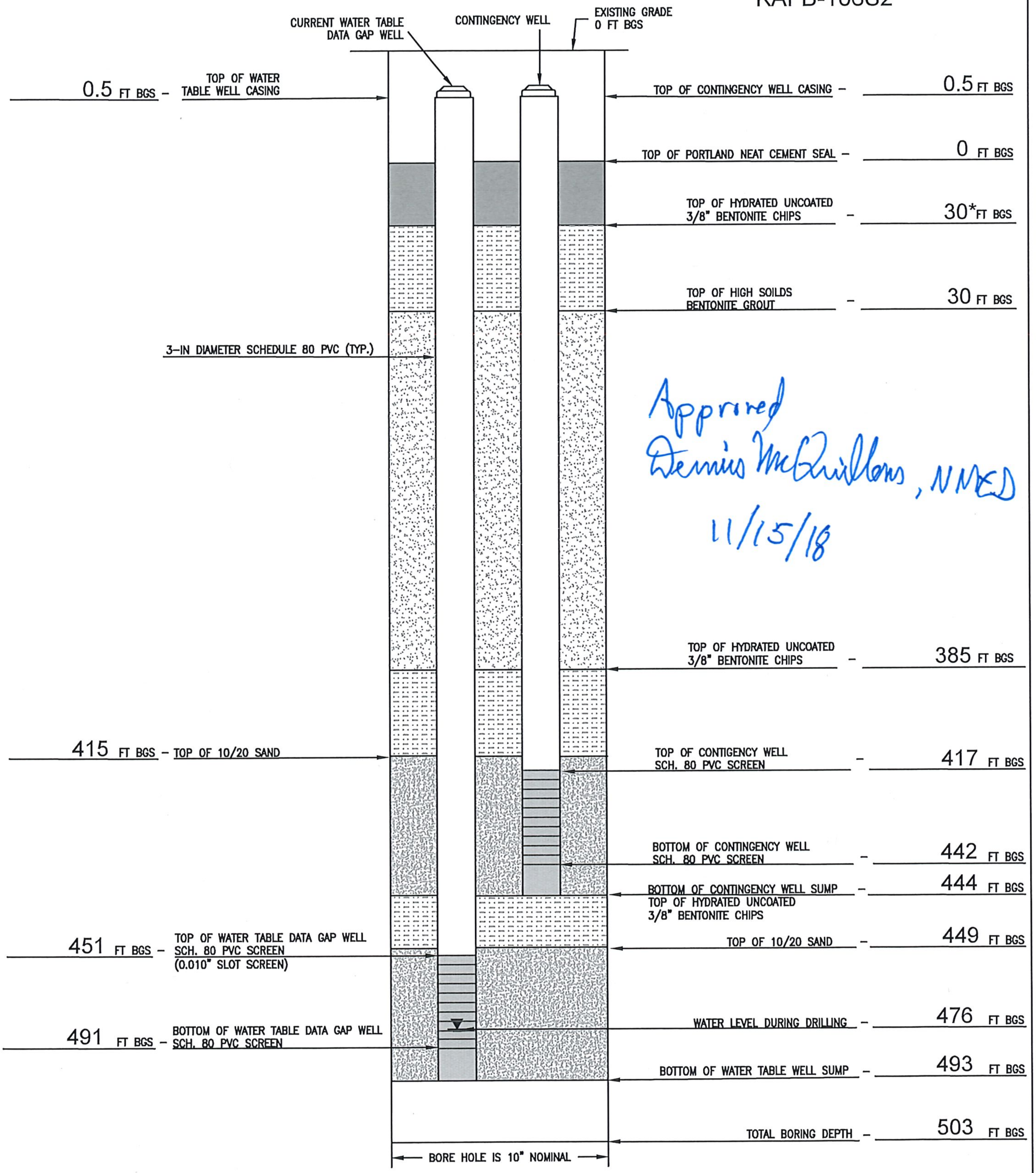
EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC., PBC
320 Gold Avenue, SW Suite 1300
Albuquerque, NM 87102
Phone: (505) 224-9013
Fax: (505) 224-9016

KIRTLAND AIR FORCE BASE		INSTALLATION START DATE/TIME: 01JAN19/0700	INSTALLATION END DATE/TIME: TBD
PROJECT NO.: 62735DM02	WELL ID: KAFB 106S1	GEOLOGIST: MESSENGER	DRILLER: CASCADE

CAD FILE: \\ABQ\Projects\Active Projects\62599DM01 Kirtland BFF_USACE\01_Work Plan\19.0 Data Gap Wells WP\Figures\Natives\Nested Monitoring well Field Form.dwg PLOT DATE/TIME: 8/8/2018 – 11:39am

NESTED MONITORING WELL CONSTRUCTION

KAFB-106S2



Approved
Dennis McQuillan, NMED
11/15/18

*Additional bentonite chips may be added to account for bentonite grout settlement.

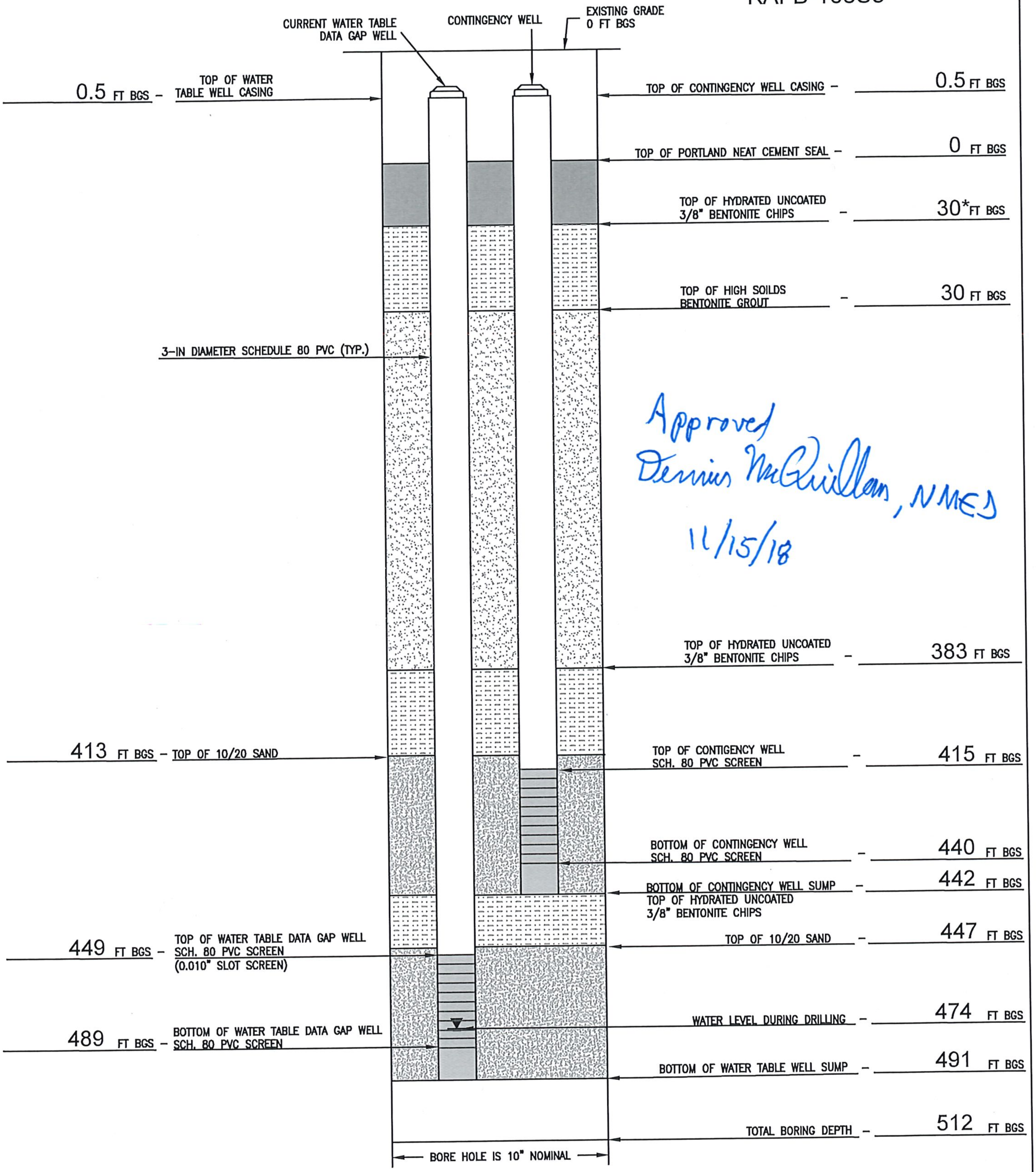
NOT TO SCALE
BGS=BELOW GROUND SURFACE
FT=FEET

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC., PBC 320 Gold Avenue, SW Suite 1300 Albuquerque, NM 87102 Phone: (505) 224-9013 Fax: (505) 224-9016	KIRTLAND AIR FORCE BASE		INSTALLATION START DATE/TIME: 19OCT18/0700	INSTALLATION END DATE/TIME: TBD
	PROJECT NO.: 62735DM02	WELL ID: KAFB 106S2	GEOLOGIST: ANDRESS	DRILLER: CASCADE

CAD FILE: \\ABQ\Projects\Active Projects\62599DM01 Kirtland BFF_USACE\01_Work Plan\19.0 Data Gap Wells WP\Figures\Natives\Nested Monitoring well Field Form.dwg PLOT DATE/TIME: 8/8/2018 – 11:39am

NESTED MONITORING WELL CONSTRUCTION

KAFB-106S3



Approved
Dennis McQuillan, NMED
11/15/18

*Additional bentonite chips may be added to account for bentonite grout settlement.

NOT TO SCALE
BGS=BELOW GROUND SURFACE
FT=FEET

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC., PBC

320 Gold Avenue, SW Suite 1300
Albuquerque, NM 87102
Phone: (505) 224-9013
Fax: (505) 224-9016

KIRTLAND AIR FORCE BASE		INSTALLATION START DATE/TIME: 27NOV18/0700	INSTALLATION END DATE/TIME: TBD
PROJECT NO.: 62735DM02	WELL ID: KAFB 106S3	GEOLOGIST: Messenger/Andress	DRILLER: CASCADE

CAD FILE: \\ABQ\Projects\Active Projects\62599DM01 Kirtland BFF_USACE\01_Work Plan\19.0 Data Gap Wells WP\Figures\Natives\Nested Monitoring well Field Form.dwg PLOT DATE/TIME: 8/8/2018 – 11:39am

Bockisch, Bernard

From:	McQuillan, Dennis, NMENV <dennis.mcquillan@state.nm.us>
Sent:	Tuesday, November 13, 2018 1:00 PM
To:	Moayyad, Behnaum CIV USARMY CESPA (US)
Cc:	Jercinovic, Devon; Bockisch, Bernard; Cordova, Amy Elizabeth CIV USARMY CESPA (USA); Dreeland, Linda E CIV USARMY CESPA (US); Kunkel, Tara S CIV USARMY CESPA (US); Phaneuf, Mark J CIV USARMY CESPA (US); RENAGHAN, BRIAN J GS-13 USAF AFMC AFCEC/CZRX; Scott C. Clark (scott.clark@us.af.mil); Kathryn D Lynnes (kathryn.lynnes@us.af.mil)
Subject:	RE: Kirtland BFF- Request for KAFB-106S4 Well Construction Approval - SUSPENSE 9 NOV COB (UNCLASSIFIED)

Ben,

Our printer has been down today. This well construction is approved and I will email you a signed copy when our printers return to service.

Dennis McQuillan
Chief Scientist
New Mexico Environment Department
1190 St. Francis Dr.
PO Box 5469
Santa Fe, NM 87502
505-827-2140 desk
505-660-1592 cell
dennis.mcquillan@state.nm.us

-----Original Message-----
From: Moayyad, Behnaum CIV USARMY CESPA (US) <Behnaum.Moayyad@usace.army.mil>
Sent: Sunday, November 11, 2018 6:42 PM
To: McQuillan, Dennis, NMENV <dennis.mcquillan@state.nm.us>
Cc: Jercinovic, Devon <djercinovic@eaest.com>; Bockisch, Bernard <bbockisch@eaest.com>; Cordova, Amy Elizabeth CIV USARMY CESPA (USA) <Amy.E.Cordova@usace.army.mil>; Dreeland, Linda E CIV USARMY CESPA (US) <Linda.E.Dreeland@usace.army.mil>; Kunkel, Tara S CIV USARMY CESPA (US) <Tara.S.Kunkel@usace.army.mil>; Phaneuf, Mark J CIV USARMY CESPA (US) <Mark.J.Phaneuf@usace.army.mil>; RENAGHAN, BRIAN J GS-13 USAF AFMC AFCEC/CZRX <brian.renaghan@us.af.mil>; Scott C. Clark (scott.clark@us.af.mil) <scott.clark@us.af.mil>; Kathryn D Lynnes (kathryn.lynnes@us.af.mil) <kathryn.lynnes@us.af.mil>
Subject: [EXT] RE: Kirtland BFF- Request for KAFB-106S4 Well Construction Approval - SUSPENSE 9 NOV COB (UNCLASSIFIED)

Importance: High

CLASSIFICATION: UNCLASSIFIED

Hi Dennis.
Well construction is scheduled to begin Monday 12 Nov. Please review well construction request at your earliest convenience.

Thank you,
Ben Moayyad
USACE-Albuquerque
Mobile: (505) 639-3195

NOTICE: THE OFFICE IS UNDER CONSTRUCTION AND THE OFFICE PHONE LINE IS NOT AVAILABLE.

-----Original Message-----
From: Moayyad, Behnaum CIV USARMY CESPA (US)
Sent: Wednesday, November 7, 2018 4:50 PM
To: Dennis McQuillan (dennis.mcquillan@state.nm.us) <dennis.mcquillan@state.nm.us>
Cc: Jercinovic, Devon <djercinovic@eaest.com>; 'Bockisch, Bernard' <bbockisch@eaest.com>; Cordova, Amy Elizabeth CIV USARMY CESPA (USA) <Amy.E.Cordova@usace.army.mil>; Dreeland, Linda E CIV USARMY CESPA (US) <Linda.E.Dreeland@usace.army.mil>; Kunkel, Tara S CIV USARMY CESPA (US) <Tara.S.Kunkel@usace.army.mil>; Phaneuf, Mark J CIV USARMY CESPA (US) <Mark.J.Phaneuf@usace.army.mil>; RENAGHAN, BRIAN J GS-13 USAF AFMC AFCEC/CZRX <brian.renaghan@us.af.mil>; Scott C. Clark (scott.clark@us.af.mil) <scott.clark@us.af.mil>; Kathryn D Lynnes (kathryn.lynnes@us.af.mil) <kathryn.lynnes@us.af.mil>
Subject: Kirtland BFF- Request for KAFB-106S4 Well Construction Approval - SUSPENSE 9 NOV COB (UNCLASSIFIED)

CLASSIFICATION: UNCLASSIFIED

Dennis,
On behalf of the Air Force, USACE is requesting approval for wells construction at the third core location KAFB-106S4 by the end of the work week (9 Nov COB). The proposed well design is attached (first attachment). Well construction is scheduled to begin at this location on Monday 12 Nov.

Well Screen Determination:
Information from the borehole and from nearby wells and boring was used to estimate the current water table depth at 471 ft bgs for the well screen design. Water levels were measured from nearby wells last month at depths between 470 and 472 feet bgs, with the closet well having a depth to water of 471 ft bgs (Excel second attachment). KAFB-106S4 was drilled to total depth yesterday. No representative static level was measured in the well casing. However, well core indicates saturated material somewhere below 469 feet bgs based on core moisture (third PDF attachment shows top of capillary fringe at 469). Nearby boring logs indicate similar geologic materials with good communication for hydrostatic conditions (last 3 attachments).

Coring Updates:
- KAFB-106S5 boring and well construction are complete
- KAFB-106S9 should grouted by end of shift tomorrow
- KAFB-106S2 coring has started from ground surface and will finish coring on next shift
- KAFB-106S3 drilled ARCH to target zone and will be cored to TD next (expedited this location to provide more information on optional locations)
- KAFB-106S4 cored to TD and ready to build On schedule to complete coring at S2 and S3 during next shift starting 12 NOV. Additional information to follow.

Please advise on your review of the proposed construction diagram and let us know if you have any questions or concerns. AFCEC has experienced some difficulties transmitting email with attachment recently. USACE is providing this information on their behalf.

Thank you for your time,
Ben Moayyad
USACE-Albuquerque
Mobile: (505) 639-3195

NOTICE: THE OFFICE IS UNDER CONSTRUCTION AND THE OFFICE PHONE LINE IS NOT AVAILABLE.

-----Original Message-----
From: Bockisch, Bernard [mailto:bbockisch@eaest.com]
Sent: Tuesday, November 6, 2018 4:19 PM
To: Cordova, Amy Elizabeth CIV USARMY CESPA (USA) <Amy.E.Cordova@usace.army.mil>; Moayyad, Behnaum CIV USARMY CESPA (US) <Behnaum.Moayyad@usace.army.mil>; Dreeland, Linda E CIV USARMY CESPA (US) <Linda.E.Dreeland@usace.army.mil>; Phaneuf, Mark J CIV USARMY CESPA (US) <Mark.J.Phaneuf@usace.army.mil>; Salazar, Carlos F CIV USARMY CESPA (US) <Carlos.F.Salazar@usace.army.mil>; Kunkel, Tara S CIV USARMY CESPA (US) <Tara.S.Kunkel@usace.army.mil>
Cc: Jercinovic, Devon <djercinovic@eaest.com>
Subject: [Non-DoD Source] Kirtland BFF- Request to NMED for KAFB-106S4 Well Construction Approval- Draft for USACE use

KAFB-106S4 is at total depth (504 ft bgs) and maybe reamed as early as Monday morning (12NOV18). We are requesting permission to construct the well per Condition 8 of the approval for the Work Plan for Vadose Zone Coring, Vapor Monitoring, and Water Supply Sampling, Revision 2 (approved by NMED on February 23, 2018).

An existing monitoring well (KAFB-106005) is located approximately 60 feet from our current drilling location at KAFB-106S4. EA collected a depth to water measurement on Wednesday (10OCT18) from KAFB-106005 (471.00 ft bgs).

We anticipate that the borehole will be ready for well construction by Monday (12NOV18). We will compare the boring log data we collect from KAFB 106S4 to KAFB 106005. If any significant lithologic conditions are observed in the borehole for KAFB 106S4 from the nearby existing well, we will communicate this change prior to well construction.

Please let us know if you have any questions.

Bernard Bockisch, PMP
EA Engineering, Science, and Technology, Inc., PBC Senior Project Manager
320 Gold Ave. SW, Suite 1300
Albuquerque, NM 87102
Cell: 505.280-0572
Office: 505.234-1105
Email: bbockisch@eaest.com <mailto:bbockisch@eaest.com> Blockedwww.eaest.com
<Blockedhttps://clicktime.symantec.com/a/1/dmYHw9VyknWlDGnU2aePr243WMQinwjiOsaWzhVE7O0=?d=nEVPqV-jmauTBWi-
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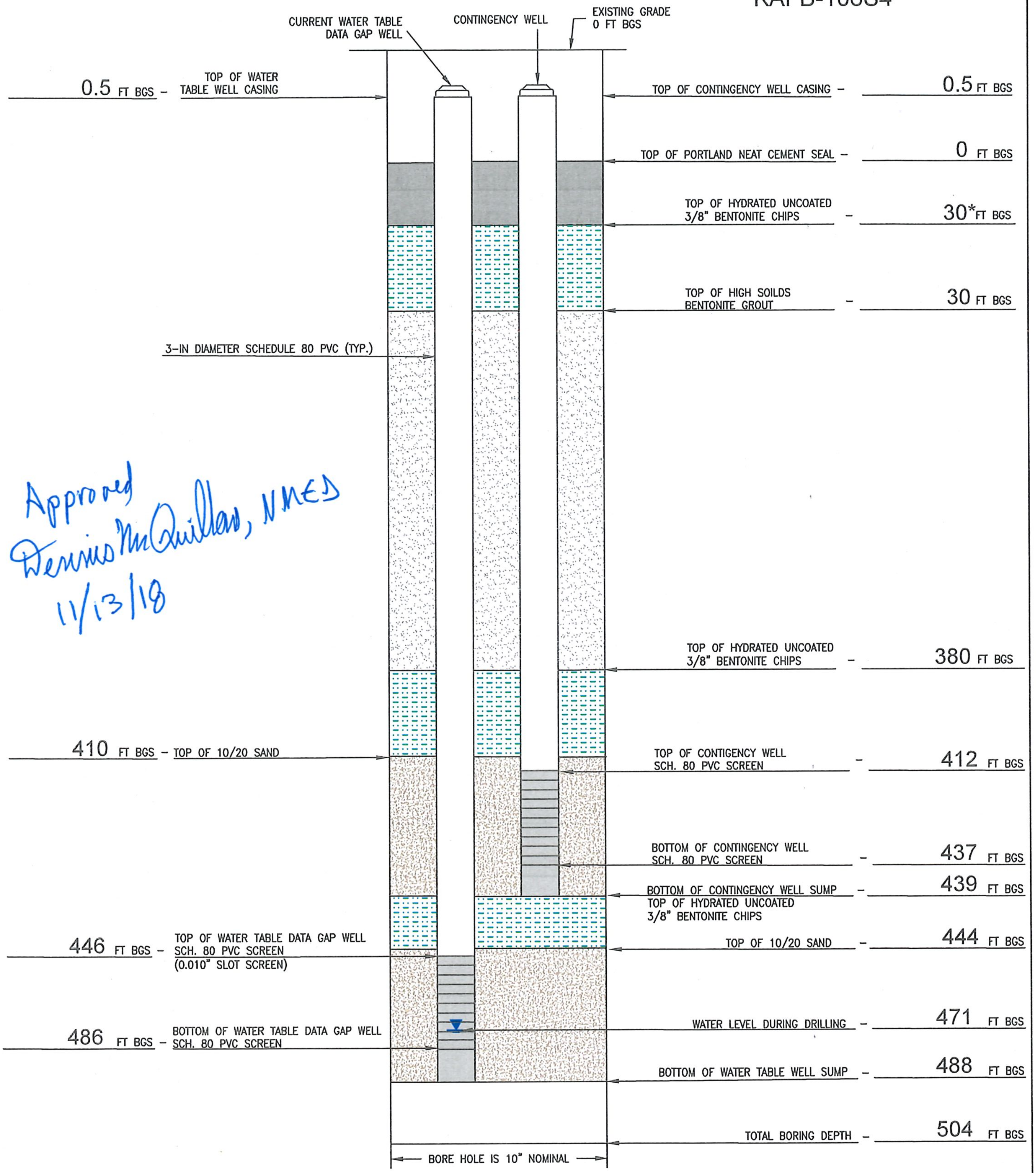
CLASSIFICATION: UNCLASSIFIED
CLASSIFICATION: UNCLASSIFIED

NESTED MONITORING WELL CONSTRUCTION

KAFB-106S4



Approved
Dennis McQuillan, NMED
11/13/18

*Additional bentonite chips may be added to account for bentonite grout settlement.

NOT TO SCALE
BGS=BELOW GROUND SURFACE
FT=FEET

CAD FILE: \\ABQ\Projects\Active Projects\62599DM01 Kirtland BFF_USACE\01_Work Plan\19.0 Data Gap Wells WP\Figures\Natives\Nested Monitoring well Field Form.dwg PLOT DATE/TIME: 8/8/2018 – 11:39am

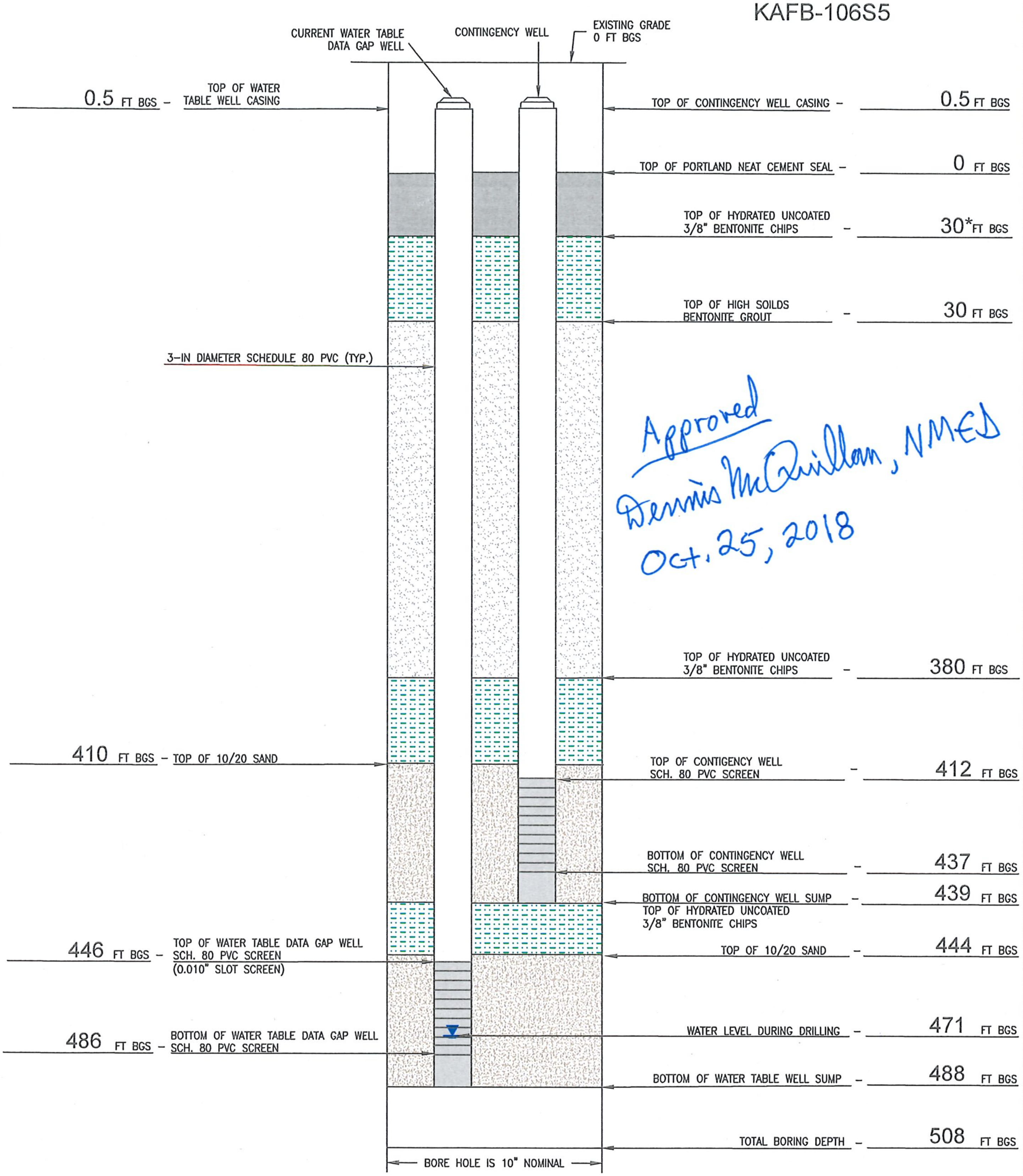
EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC., PBC

320 Gold Avenue, SW Suite 1300
Albuquerque, NM 87102
Phone: (505) 224-9013
Fax: (505) 224-9016

KIRTLAND AIR FORCE BASE		INSTALLATION START DATE/TIME: 12NOV18/0700	INSTALLATION END DATE/TIME: 16NOV18
PROJECT NO.: 62735DM02	WELL ID: KAFB 106S4	GEOLOGIST: Messenger/Montoya	DRILLER: CASCADE

NESTED MONITORING WELL CONSTRUCTION

KAFB-106S5



Approved
Dennis McQuillan, NMED
Oct. 25, 2018

*Additional bentonite chips may be added to account for bentonite grout settlement.

NOT TO SCALE
BGS=BELOW GROUND SURFACE
FT=FEET

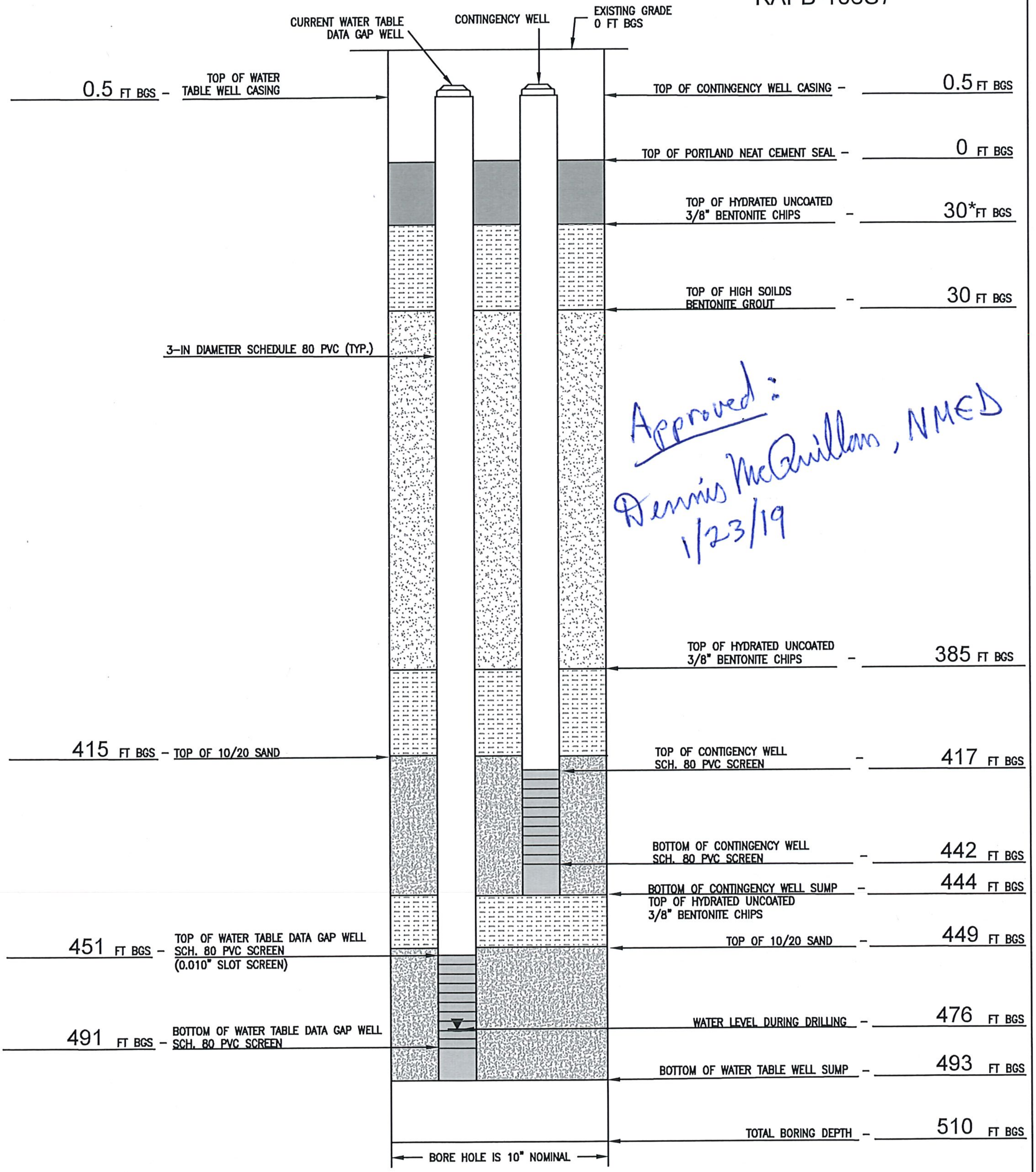
EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC., PBC
320 Gold Avenue, SW Suite 1300
Albuquerque, NM 87102
Phone: (505) 224-9013
Fax: (505) 224-9016

KIRTLAND AIR FORCE BASE		INSTALLATION START DATE/TIME: 06OCT18/0700	INSTALLATION END DATE/TIME: TBD
PROJECT NO.: 62735DM02	WELL ID: KAFB 106S5	GEOLOGIST: Messenger/Montoya	DRILLER: CASCADE

CAD FILE: \\ABQ\Projects\Active Projects\62599DM01 Kirtland BFF_USACE\01_Work Plan\19.0 Data Gap Wells WP\Figures\Natives\Nested Monitoring well Field Form.dwg PLOT DATE/TIME: 8/8/2018 – 11:39am

NESTED MONITORING WELL CONSTRUCTION

KAFB-106S7



Approved:
Dennis McQuillan, NMED
1/23/19

*Additional bentonite chips may be added to account for bentonite grout settlement.

NOT TO SCALE
BGS=BELOW GROUND SURFACE
FT=FEET

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC., PBC

320 Gold Avenue, SW Suite 1300
Albuquerque, NM 87102
Phone: (505) 224-9013
Fax: (505) 224-9016

KIRTLAND AIR FORCE BASE

INSTALLATION START DATE/TIME: 29JAN19/0700

INSTALLATION END DATE/TIME: TBD

PROJECT NO.: 62735DM02

WELL ID: KAFB 106S7

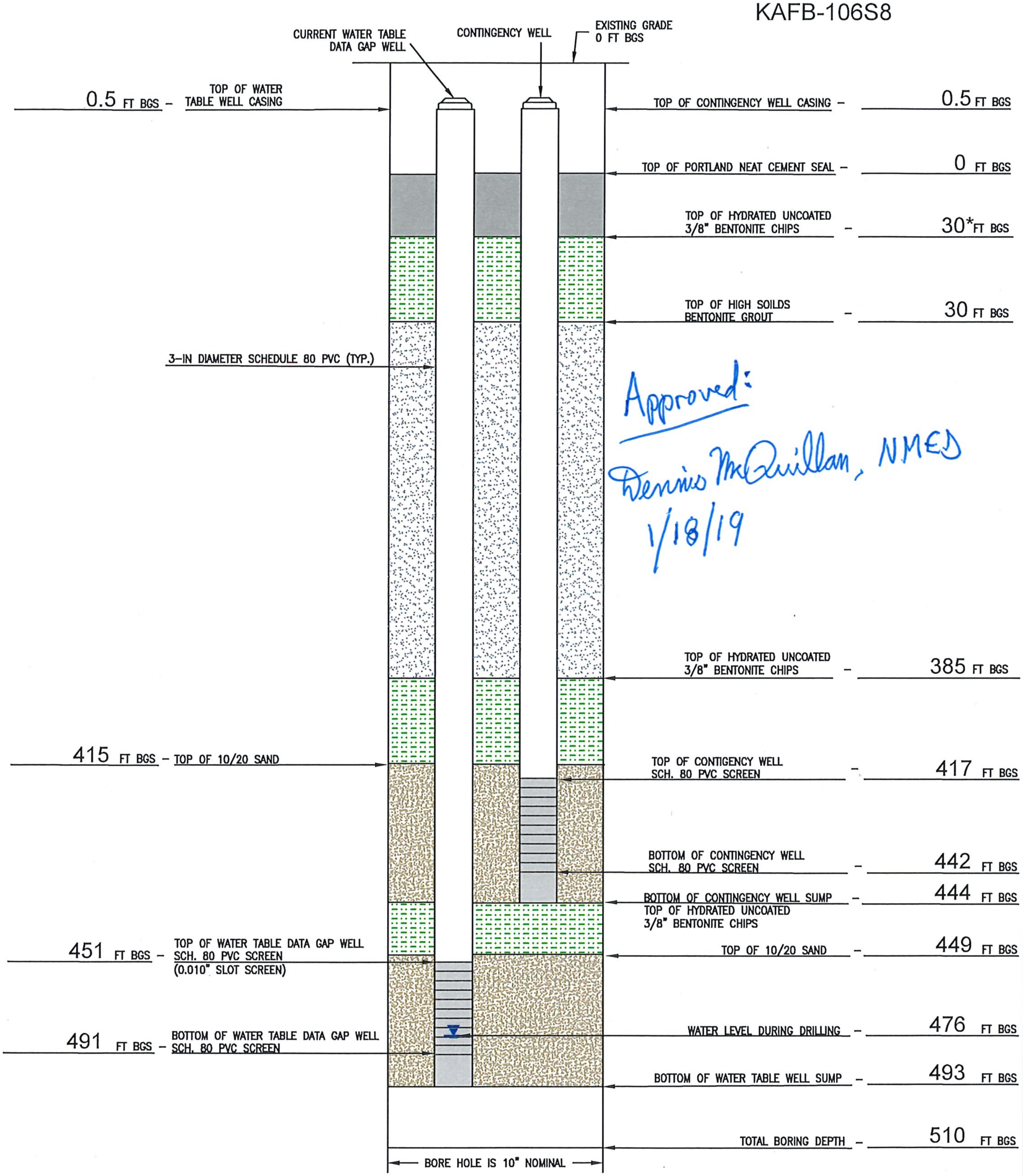
GEOLOGIST: MESSENGER

DRILLER: CASCADE

CAD FILE: \\ABQ\Projects\Active Projects\62599DM01 Kirtland BFF_USACE\01_Work Plan\19.0 Data Gap Wells WP\Figures\Natives\Nested Monitoring well Field Form.dwg PLOT DATE/TIME: 8/8/2018 – 11:39am

NESTED MONITORING WELL CONSTRUCTION

KAFB-106S8



Approved:
Dennis McQuillan, NMED
1/18/19

*Additional bentonite chips may be added to account for bentonite grout settlement.

NOT TO SCALE
BGS=BELOW GROUND SURFACE
FT=FEET

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC., PBC 320 Gold Avenue, SW Suite 1300 Albuquerque, NM 87102 Phone: (505) 224-9013 Fax: (505) 224-9016	KIRTLAND AIR FORCE BASE		INSTALLATION START DATE/TIME: 05FEB19/0700	INSTALLATION END DATE/TIME: TBD
	PROJECT NO.: 62735DM02	WELL ID: KAFB 106S8	GEOLOGIST: MESSENGER	DRILLER: CASCADE

CAD FILE: \ABQ\Projects\Active Projects\62599DM01 Kirtland BFF_USACE\01_Work Plan\19.0 Data Gap Wells WP\Figures\Natives\Nested Monitoring well Field Form.dwg PLOT DATE/TIME: 8/8/2018 – 11:39am

Bockisch, Bernard

From: Moayyad, Behnaum CIV USARMY CESPA (US) <Behnaum.Moayyad@usace.army.mil>
Sent: Friday, October 19, 2018 4:48 PM
To: Jercinovic, Devon; Bockisch, Bernard
Subject: FW: Request for KAFB-106S9 Well Construction Approval, SUSPENSE 20 OCT Saturday (UNCLASSIFIED)

CLASSIFICATION: UNCLASSIFIED

Good for construction at S9 this weekend.

Ben Moayyad
USACE-Albuquerque
Mobile: (505) 639-3195

NOTICE: BEGINNING 15 OCT 18 THE OFFICE WILL BE UNDER CONSTRUCTION AND THE OFFICE PHONE LINE WILL NOT BE ACCESSIBLE.

-----Original Message-----
From: McQuillan, Dennis, NMENV [mailto:dennis.mcquillan@state.nm.us]
Sent: Friday, October 19, 2018 3:37 PM
To: Moayyad, Behnaum CIV USARMY CESPA (US) <Behnaum.Moayyad@usace.army.mil>
Cc: Scott C. Clark (scott.clark@us.af.mil) <scott.clark@us.af.mil>; RENAGHAN, BRIAN J GS-13 USAF AFMC AFCEC/CZRX <brian.renaghan@us.af.mil>; SHEEN T CTR USAF AFSOC 27 SOCES/CEIER KOTTKAMP (sheen.kottkamp.1@us.af.mil) <sheen.kottkamp.1@us.af.mil>; SEGURA, CHRISTOPHER G GS-13 USAF AFCEC/CZO <christopher.segura.2@us.af.mil>; Phaneuf, Mark J CIV USARMY CESPA (US) <Mark.J.Phaneuf@usace.army.mil>; CORDOVA, AMY ELIZABETH CIV USARMY CESPA (US) <Amy.E.Cordova@usace.army.mil>; Dreeland, Linda E CIV USARMY CESPA (US) <Linda.E.Dreeland@usace.army.mil>; Kunkel, Tara S CIV USARMY CESPA (US) <Tara.S.Kunkel@usace.army.mil>
Subject: [Non-DoD Source] RE: Request for KAFB-106S9 Well Construction Approval, SUSPENSE 20 OCT Saturday (UNCLASSIFIED)

Approved

Dennis McQuillan
Chief Scientist
New Mexico Environment Department
1190 St. Francis Dr.
PO Box 5469
Santa Fe, NM 87502
505-827-2140 desk

505-660-1592 cell
dennis.mcquillan@state.nm.us

-----Original Message-----
From: Moayyad, Behnaum CIV USARMY CESPA (US) <Behnaum.Moayyad@usace.army.mil>
Sent: Friday, October 19, 2018 11:12 AM
To: McQuillan, Dennis, NMENV <dennis.mcquillan@state.nm.us>
Cc: Scott C. Clark (scott.clark@us.af.mil) <scott.clark@us.af.mil>; RENAGHAN, BRIAN J GS-13 USAF AFMC AFCEC/CZRX <brian.renaghan@us.af.mil>; SHEEN T CTR USAF AFSOC 27 SOCES/CEIER KOTTKAMP (sheen.kottkamp.1@us.af.mil) <sheen.kottkamp.1@us.af.mil>; SEGURA, CHRISTOPHER G GS-13 USAF AFCEC/CZO <christopher.segura.2@us.af.mil>; Phaneuf, Mark J CIV USARMY CESPA (US) <Mark.J.Phaneuf@usace.army.mil>; CORDOVA, AMY ELIZABETH CIV USARMY CESPA (US) <Amy.E.Cordova@usace.army.mil>; Dreeland, Linda E CIV USARMY CESPA (US) <Linda.E.Dreeland@usace.army.mil>; Kunkel, Tara S CIV USARMY CESPA (US) <Tara.S.Kunkel@usace.army.mil>
Subject: [EXT] Request for KAFB-106S9 Well Construction Approval, SUSPENSE 20 OCT Saturday (UNCLASSIFIED)
Importance: High

CLASSIFICATION: UNCLASSIFIED

Dennis,
Sorry for the Rush. Borehole stability at KAFB-106S9 is a concern and we would like to proceed with well construction tomorrow Saturday 20th. Boring 106S9 is located just north of the BFF, outside the fence (first figure).

On behalf of Kirtland, we request review and approval of the attached well construction specification (second attachment) for a monitoring well at borehole location KAFB-106S9. Coring will be completed today to total depth (third attachment). Water was identified in the boring at approximately 472 ft bgs. Construction is scheduled to begin Saturday, earlier than originally scheduled due to loose sands below the water table. Review and approval or comments is therefore requested by today if possible, or tomorrow if you are willing.

Backup information for screen selection:
EA performed water level measurements this month (fourth file attached) and identified 9 adjacent wells in the vicinity of KAFB-106S9 on flat ground. Based on gauging from these wells (locations on last attachments), static water is anticipated at depths between 471 and 474 feet bgs.

Information summarized by EA below. Please call for questions.

Thanks in advance for your time and prompt review,

Ben Moayyad

USACE-Albuquerque
Mobile: (505) 639-3195

NOTICE: BEGINNING 15 OCT 18 THE OFFICE WILL BE UNDER CONSTRUCTION AND THE OFFICE PHONE LINE WILL NOT BE ACCESSIBLE.

-----Original Message-----
From: Jercinovic, Devon [mailto:djercinovic@eaest.com]
Sent: Friday, October 19, 2018 8:56 AM
To: Moayyad, Behnaum CIV USARMY CESPA (US) <Behnaum.Moayyad@usace.army.mil>; Kunkel, Tara S CIV USARMY CESPA (US) <Tara.S.Kunkel@usace.army.mil>; CORDOVA, AMY ELIZABETH CIV USARMY CESPA (US) <Amy.E.Cordova@usace.army.mil>; Salazar, Carlos F CIV USARMY CESPA (US) <Carlos.F.Salazar@usace.army.mil>; Phaneuf, Mark J CIV USARMY CESPA (US) <Mark.J.Phaneuf@usace.army.mil>; Dreeland, Linda E CIV USARMY CESPA (US) <Linda.E.Dreeland@usace.army.mil>
Cc: Bockisch, Bernard <bbockisch@eaest.com>; Morse, Earl <emorse@eaest.com>; Andress, Lane <landress@eaest.com>; Bracht, Ginny <gbracht@eaest.com>
Subject: [Non-DoD Source] Kirtland BFF- Request to NMED for KAFB-106S9 Well Construction Approval- Draft for USACE use

USACE TEAM, Draft email for your use in requesting well construction approval for KAFB-106S9 from NMED

KAFB-106S9 drilling will be at total depth (508 ft bgs) today. We are requesting permission to construct the well per Condition 8 of the approval for the Work Plan for Vadose Zone Coring, Vapor Monitoring, and Water Supply Sampling, Revision 2 (approved by NMED on February 23, 2018).

An existing monitoring well (KAFB-106059) is located approximately 60 feet from our current drilling location at KAFB-106S9. EA collected a depth to water measurement on Wednesday (10OCT18) from KAFB-106059 (471.83 ft bgs). Based on this measurement, the depth to water at this location should be approximately 472 ft bgs. Saturated cores were also obtained at this depth (see attached lithologic log).

Attached:

- Proposed well construction with depth to water (472 feet bgs).
- Lithologic log for KAFB-106S9 to depth of 486 bgs (depth to date)
- Lithologic logs for KAFB-106059, KAFB-106060, KAFB-106061

* Q3/Q4 2018 well gauging measurements.

* Well Map (Figure 3-1)

We are requesting to immediately ream and start well construction on this borehole in advance of KAFB-106S5 to mitigate any well construction issues in the sands below the water table. We anticipate that the borehole will be ready for well construction by Saturday (20OCT18) afternoon. KAFB-106S5 will still be completed and sampled on schedule.

Please let us know if you have any questions.

Devon E. Jercinovic, PG, PMP

EA Engineering, Science, and Technology, Inc., PBC

Program Manager II

320 Gold Ave. SW, Suite 1300

Albuquerque, NM 87102

Cell: 505.401.1181

Office: 505.715.4248

Email: djercinovic@eaest.com <mailto:djercinovic@eaest.com>

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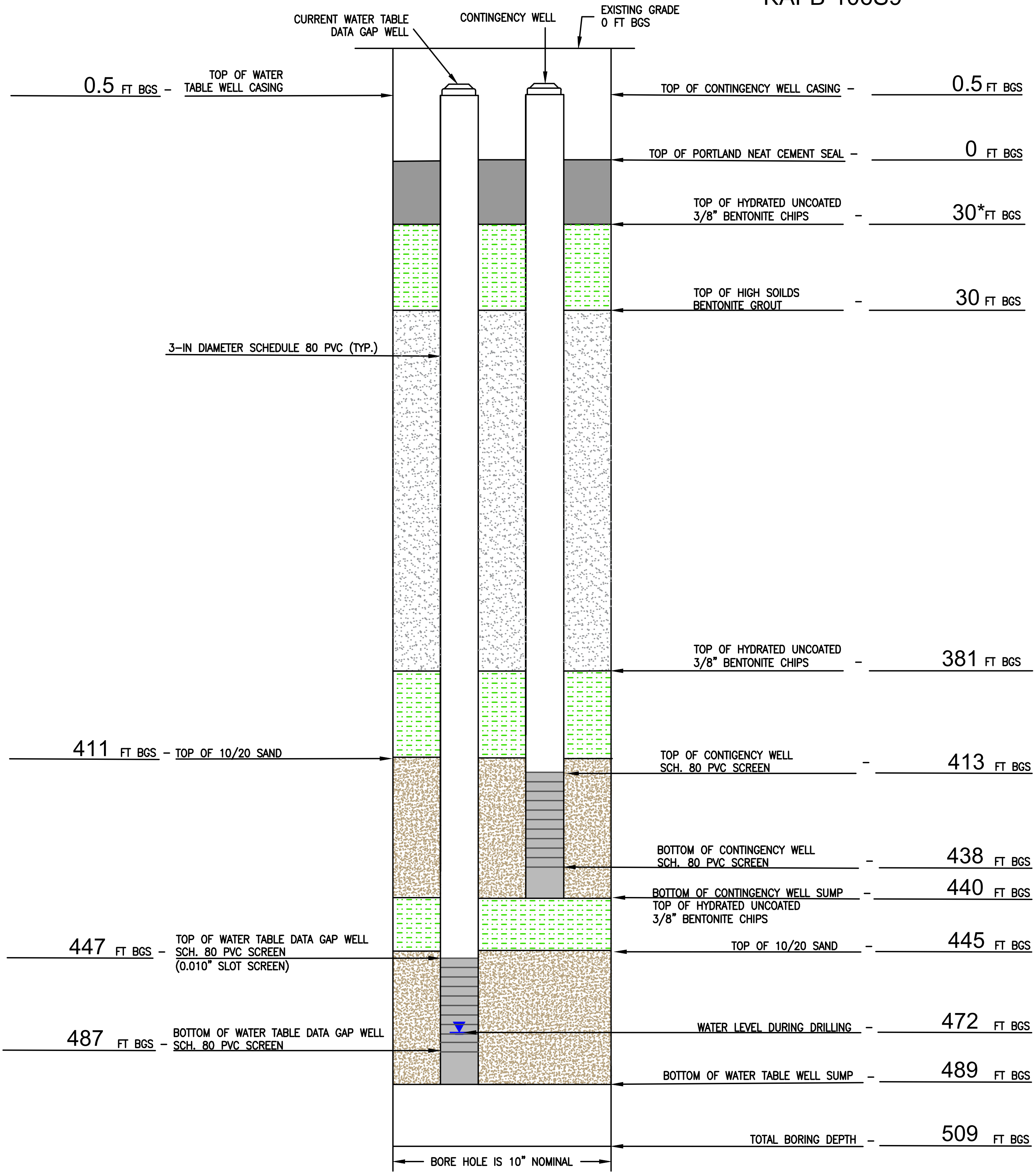
CLASSIFICATION: UNCLASSIFIED

CLASSIFICATION: UNCLASSIFIED

NESTED MONITORING WELL CONSTRUCTION

KAFB-106S9



*Additional bentonite chips may be added to account for bentonite grout settlement.

NOT TO SCALE
BGS=BELOW GROUND SURFACE
FT=FEET

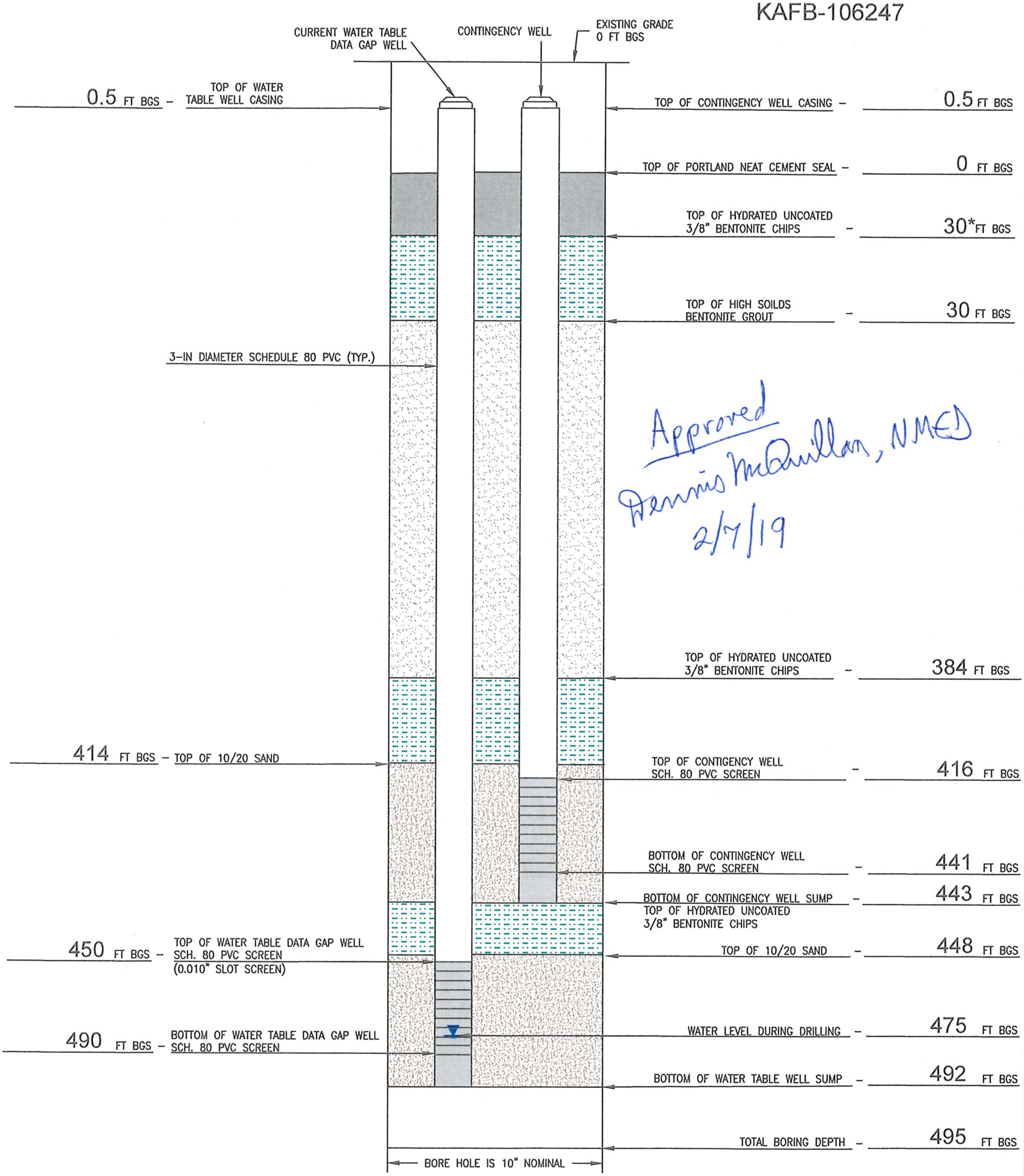
320 Gold Avenue, SW Suite 1300
Albuquerque, NM 87102
Phone: (505) 224-9013
Fax: (505) 224-9016
EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC., PBC

KIRTLAND AIR FORCE BASE		INSTALLATION START DATE/TIME: 06OCT18/0700	INSTALLATION END DATE/TIME: TBD
PROJECT NO.: 62735DM02	WELL ID: KAFB 106S9	GEOLOGIST: MONTOYA	DRILLER: CASCADE

CAD FILE: \\ABQ\Projects\Active Projects\62599DM01 Kirtland BFF_USACE\01_Work Plan\19.0 Data Gap Wells WP\Figures\Natives\Nested Monitoring well Field Form.dwg PLOT DATE/TIME: 8/8/2018 – 11:39am

NESTED MONITORING WELL CONSTRUCTION

KAFB-106247



Approved
Dennis McQuillan, NMED
2/7/19

*Additional bentonite chips may be added to account for bentonite grout settlement.

NOT TO SCALE
BGS=BELOW GROUND SURFACE
FT=FEET

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC., PBC 320 Gold Avenue, SW Suite 1300 Albuquerque, NM 87102 Phone: (505) 224-9013 Fax: (505) 224-9016	KIRTLAND AIR FORCE BASE	INSTALLATION START DATE/TIME: 17FEB19/0700	INSTALLATION END DATE/TIME: TBD
	PROJECT NO.: 62735DM02 WELL ID: KAFB 106247	GEOLOGIST: MESSENGER	DRILLER: CASCADE

CAD FILE: \ABQ\Projects\Active Projects\62599DM01 Kirtland BFF_USACE\01_Work Plan\19.0 Data Gap Wells WP\Figures\Natives\Nested Monitoring well Field Form.dwg PLOT DATE/TIME: 8/8/2018 – 11:39am

	NORTH										BFF AREA					SOUTH				
Top of Interval (Feet BGS)	**KAFB-106S5** TD=506 ft Cored:400-506 ft bgs	**KAFB-106S5 Lithology**	**KAFB-106S3 TD=512 ft Cored: 400-512 ft bgs**	**KAFB-106S3 Lithology**	**KAFB-106S4 TD=504 ft bgs Cored: 340-512 ft bgs**	**KAFB-106S4 Lithology**	**KAFB-106S9 TD=510 ft bgs Cored: 0 - 510 ft bgs**	**KAFB-106S9 Lithology**	**KAFB-106S2 TD=510 ft bgs Cored: 0-510 ft bgs**	**KAFB-106S2 Lithology**	**KAFB-106V2 TD=287 ft Cored: 0-287 ft bgs**	**KAFB-106V2 Lithology**	**KAFB-106V1 TD=285 Ft Cored: 0-285 ft bgs**	**KAFB-106V1 Lithology**	**KAFB-106S1** TD=510 Ft Cored: 0 - 510- ft bgs	**KAFB-106S1 Lithology**	**KAFB-106S8 TD=510 Ft (Planned) Cored: 0-510 ft bgs**	**KAFB-106S8 Lithology**	**KAFB-106247 (Background Well) TD=515 ft (Planned) Cored: 0 - 515 ft bgs**	**Background Sample Justification (Sample collection depths may vary based on site-specific field conditions)**
20		🟫	P	🟩		🟩		🟩		🟩		🟩		🟩	P	🟩		🟩		See below for background analytical suite provided in the workplan.
40		🟩		🟩	P	🟩		🟩		🟩		🟩		🟩		🟩		🟩		
50		🟩		🟫		🟫		🟩	P	🟩		🟩		🟩		🟩		🟩		
61		🟩		🟩		🟩		🟩		🟩		🟫	P,V	🟩		🟩		🟩		
80		🟩		🟫		🟩		🟩		🟩	P,V	🟩		🟩		🟩		🟩		
100 FEET																				
101		🟩		🟫		🟫		🟩		🟫		🟫	P,V	🟫		🟫		🟫		
102		🟩		🟫		🟫	V,P	🟩		🟫		🟫		🟫		🟫		🟫		
103		🟩		🟫		🟫		🟩		🟫	P,V	🟫		🟫		🟫		🟫		
105		🟩		🟫		🟫		🟩	P	🟫		🟫		🟫		🟫		🟫		
110		🟩		🟩	P	🟫		🟩		🟫		🟩		🟩		🟫		🟩		
115		🟩		🟩		🟩		🟩		🟩		🟩	P,V	🟩		🟩		🟩		
117		🟩		🟩		🟩		🟩		🟩	P,V	🟩		🟩		🟩		🟩		
120		🟩		🟩		🟩		🟩		🟩	UV	🟩	UV	🟩		🟩		🟩	**FOC** **P,V**	FOC being collected because of possible presence of LNAPL in V1 and V2. Hydrocarbons being analyzed for comparison to this zone.
122		🟩		🟩		🟩		🟩		🟩	UV	🟩	B,M P,V	🟩		🟩		🟩		
140		🟩		🟩		🟫		🟫		🟩		🟫		🟩	P,V	🟫		🟫		
144		🟩		🟩		🟩		🟫		🟩	B,M T	🟫		🟫		🟫		🟫	T B,M	T, B, M being collected to compare to sample collected at this depth in V2.
147		🟩		🟩		🟩		🟫		🟫		🟫	P,V	🟫		🟫		🟫		
158		🟫		🟩		🟫		🟫		🟫		🟫	UV	🟫		🟫		🟫		
159		🟫		🟩		🟫		🟫		🟫	P,V	🟫		🟫		🟫		🟫		
160		🟫	P	🟩		🟫		🟫		🟫		🟫		🟫		🟫		🟫		
161		🟫		🟫		🟫		🟫		🟫		🟫	B,M P,V	🟫		🟫		🟫		
162		🟫		🟫		🟫		🟫		🟫		🟫	UV	🟫		🟫		🟫		
164		🟫		🟫		🟫		🟫		🟫		🟫	UV	🟫		🟫		🟫	**FOC** **P,V**	
168		🟫		🟫		🟫		🟫		🟫	UV	🟫		🟫		🟫		🟫		FOC being collected because of possible presence of LNAPL in V1 and V2. Hydrocarbons being analyzed for comparison to this zone.
174		🟫		🟫		🟫	V,P	🟫		🟫		🟫		🟫		🟫		🟫		
194		🟫		🟫		🟫		🟫		🟫	UV	🟫		🟫		🟫		🟫		
200 FEET																				
202		🟫		🟫		🟫		🟫		🟫		🟫	UV	🟫		🟫		🟫		
210	P	🟫		🟫		🟫		🟫		🟫		🟫		🟫		🟫		🟫		
214		🟫		🟫		🟫		🟫		🟫	UV	🟫		🟫		🟫		🟫		
215		🟫		🟫		🟫		🟫		🟫	B,M P,V	🟫		🟫		🟫		🟫	B,M P,V	Analytes being collected to compare to similar analyses in KAFB-106V2 at this depth.
216		🟫		🟫		🟫		🟫		🟫		🟫	P,V	🟫		🟫		🟫		
240		🟫	P	🟫		🟩		🟫		🟫		🟫		🟫		🟫		🟫		
252		🟫		🟫		🟩	P,V	🟫		🟫		🟫		🟫		🟩		🟫		
254		🟫		🟫		🟩		🟫		🟩	P,V	🟫	P,V	🟫		🟩		🟩		
260		🟫		🟫		🟫		🟫		🟩		🟫		🟫	P,V	🟩		🟩		
270		🟫		🟫		🟫		🟫		🟫	P,V	🟩		🟩		🟫		🟩		
271		🟫		🟫		🟩		🟫		🟫		🟩	P,V	🟩		🟫		🟩		
278		🟫		🟩		🟩		🟫	P	🟫		🟩		🟩		🟩		🟫		
279		🟫		🟩		🟩		🟫		🟫		🟩		🟩	P,V	🟩		🟫		
285		🟫		🟩		🟫		🟫		🟫		🟫	P,V	🟫		🟩		🟫		
300 FEET																				
300		🟫		🟫	P	🟫		🟫		🟫		**TD=286'**		**TD=285'**		🟫		🟫		
338		🟫		🟫		🟫		🟫	P,V	🟫						🟫		🟫		
342		🟫		🟫		🟫	P,V	🟫		🟫						🟫		🟩		
360	P	🟫	P	🟫		🟫		🟫		🟫						🟫		🟫		
366		🟫		🟫	P	🟫		🟫		🟫						🟫		🟫		
400 FEET																				
400	P,V	🟫		🟫		🟫	P,V	🟫		🟫					P,V	🟫		🟫		
404	G,UV	🟩		🟫		🟫	T	🟫	P,V	🟫						🟫		🟫		
414		🟫		🟫		🟫		🟫		🟫					P,V	🟫		🟫		
416		🟫		🟫	P,V	🟫		🟫		🟫						🟫		🟫		
419		🟫		🟫		🟫		🟫	P,V	🟫						🟫	P,V	🟫		
424		🟫	P,V	🟫		🟫		🟫		🟫						🟫		🟫		
458		🟫		🟩		🟫	T	🟫		🟫						🟫		🟫		
459		🟫		🟫		🟫		🟩		🟫					P,V	🟫		🟫		
461		🟫		🟫		🟫		🟫		🟫					P,V	🟫		🟫		
463		🟫		🟫		🟫	T	🟫		🟫						🟫		🟫		
467		🟫		🟫	P,V	🟫		🟫		🟫						🟫		🟫		
470		🟫		🟫		🟫	P,V	🟫		🟫						🟫		🟫		
473		🟫		🟫		🟫	G,UV	🟫		🟫						🟫		🟫		
Approximate Water Table Depth																				
474		🟫		🟫		🟫		🟫	B,M P,V	🟫						🟫	P,V	🟫	FOC B,M	FOC, B, M being collected to compare to sample collected below, or near the water table.
475		🟫		🟫		🟫	B,M P,V	🟫		🟫					P,V	🟫		🟫		
476		🟫		🟫	UV	🟫		🟫		🟫					UV	🟫		🟫		
477		🟫	B,M P,V	🟫		🟫	B,M	🟫		🟫						🟫		🟫		
478		🟫		🟫		🟫		🟫		🟫					UV	🟫		🟫		
480		🟫		🟫	B,M	🟫		🟫		🟫					B,M P,V UV	🟫		🟫	FOC B,M P,V	Analytes being collected to compare to possible LNAPL and adsorbed phase observed in S1, S2, S3, S4, and S9.
482		🟫		🟫		🟫		🟫		🟫					UV	🟫		🟫		
483		🟫		🟫		🟫	M	🟫		🟫						🟫		🟫		
484		🟫		🟫		🟫	G,UV	🟫		🟫					UV	🟫		🟫		
486		🟫		🟫	UV	🟫		🟫		🟫					UV	🟫		🟫		
489		🟫	B,M P,V	🟫		🟫		🟫	UV	🟫					B,M P,V	🟫		🟫	B,M	Analytes being collected to compare to possible LNAPL and adsorbed phase observed in S1, S2, S3, S4, and S9.
490	T	🟫		🟩		🟫		🟫		🟫						🟩		🟫	FOC T P,V	
491	B,M P,V	🟫		🟩		🟫	UV	🟫	UV	🟫						🟩		🟫		
492		🟫	UV P,V	🟩	UV	🟫		🟫		🟫						🟩		🟫		
493		🟫		🟩		🟫	UV	🟫		🟫						🟩		🟫		
494		🟫	UV P,V	🟩	BM P,V	🟫		🟫		🟫						🟩		🟫		
496		🟫		🟫		🟫	B,M P,V	🟫		🟫						🟫		🟫		
499		🟫		🟫		🟫		🟫	B,M P,V	🟫						🟫	P,V	🟫	B,M P,V	B, M, P, V being collected to compare to concentrations observed in S2, S3, S4, and S9.
500 FEET																				
501		🟫		🟫		🟫	P,V	🟫		🟫						🟫		🟫		
506	B,M P,V	🟫		🟫		🟫		🟫		🟫						🟫		🟫		
510		**TD=506'**		🟫		🟫		🟫		🟫					P,V	🟫		🟫		
512			P,V	**TD=512'**		**TD=510'**		**TD=510'**		**TD=510'**						**TD=510'**		**TD=514'**		

Notes:

Top of Interval is the top of the depth at which a sample was collected.

P,V	TPH (P), Volatile organic compound (V) - Includes moisture content.
B,M	Biological (B) and mineralogical (M)
G,UV	LNAPL transmissivity (G), ultraviolet light analysis (UV)
T	Thermal conductivity (T)
FOC	Fraction organic carbon (FOC)

Generalized Lithology: Note, all lithologic units are not represented. See boring logs for a more accurate representation of lithology.

🟫	Sands - Includes well graded, poorly graded, silty, clayey sands and gravels
🟩	Silts/clays

Background analytical suite required in workplan:

TPH:	Five Samples
VOCs:	Five Samples
EDB:	Five Samples
Mineralogy:	Five Samples
Biological:	Five Samples
FOC:	Not required, however deemed necessary by EA.
T:	Not required, however deemed necessary by EA.