KIRTLAND AIR FORCE BASE
ALBUQUERQUE, NEW MEXICO

QUARTERLY REPORT – JANUARY-MARCH 2016
BULK FUELS FACILITY
SOLID WASTE MANAGEMENT UNIT ST-106/SS-111
KIRTLAND AIR FORCE BASE, NEW MEXICO

August 2016

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Bulk Fuels Facility
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Prepared for
U.S. Army Corps of Engineers
Albuquerque District
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NOTICE

This report was prepared for the U.S. Army Corps of Engineers by EA Engineering, Science, and Technology, Inc., PBC for the purpose of documenting the progress of an Interim Action being implemented by the U.S. Air Force Environmental Restoration Program (ERP) at Kirtland Air Force Base. As the report relates to actual or possible releases of potentially hazardous substances, its release prior to a final decision on remedial action may be in the public's interest. The limited objectives of this report and the ongoing nature of the ERP, along with the evolving knowledge of site conditions and chemical effects on the environment and health, must be considered when evaluating this report, since subsequent facts may become known that may make this report premature or inaccurate.

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14. ABSTRACT

This Quarterly Report summarizes the activities performed from January 1 through March 31, 2016 as part of the Resource Conservation and Recovery Act interim measures for soil and groundwater remediation at Solid Waste Management Unit ST-106/SS-111, the Bulk Fuels Facility (BFF) site, at Kirtland Air Force Base (AFB), New Mexico. Quarterly samples are collected and analyzed for soil vapor in the source area, groundwater, drinking water at proximal water supply wells, and samples from the Groundwater Treatment System (GWTS). The GWTS treated approximately 25 million gallons of extracted groundwater through a granular activated carbon filtration system and discharged the treated effluent to either the Kirtland AFB golf course main pond or to the regional aquifer via injection well KAFB-7. Concentrations in all treated effluent were non-detect and/or below regulatory standards before discharge.

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ERIC H. FROEHLICH, Colonel, U.S. Air Force
Commander, 377th Air Base Wing

This document has been approved for public release.

KIRTLAND AIR FORCE BASE
377th Air Base Wing Public Affairs

PREFACE

This Quarterly Report – January-March 2016 has been prepared by EA Engineering, Science, and Technology, Inc., PBC (EA) for the United States Army Corps of Engineers, under Contract Number W912DR-12-D-0006, Delivery Order DM01 and pertains to the Base Bulk Fuels Facility, Solid Waste Management Unit ST-106/SS 111, located in Albuquerque, New Mexico. This Report was prepared in accordance with applicable federal, state, and local laws and regulations, including the New Mexico Hazardous Waste Act, New Mexico Statutes Annotated 1978, New Mexico Hazardous Waste Management Regulations, Resource Conservation and Recovery Act, and regulatory correspondence between the New Mexico Environment Department Hazardous Waste Bureau and the United States Air Force, dated March 25, 2016 and May 20, 2016.

Quarterly monitoring of soil vapor, groundwater, and drinking water supply and operation of the groundwater treatment system were conducted from January through March 2016. Mr. Trent Simpler, PE, is the United States Army Corps of Engineers–Albuquerque District Project Manager. The Environmental Restoration Section Chief for this program is Mr. Ludie W. Bitner of Kirtland Air Force Base. Ms. Devon Jercinovic is the EA Project Manager.

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LIST OF ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
µg/L	microgram(s) per liter
$\mu g/m^3$	microgram(s) per cubic meter
µS/cm	microsiemen(s) per centimeter
AFB	Air Force Base
BFF	Bulk Fuels Facility
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
CFR	Code of Federal Regulations
CO_2	carbon dioxide
DO	dissolved oxygen
DoD	Department of Defense
EDB	ethylene dibromide or 1,2-dibromoethane
ELLE	Eurofins Lancaster Laboratories Environmental; LLC
EPA	United States Environmental Protection Agency
ERPIMS	Environmental Restoration Program Information Management System
ft	foot (feet)
g/mol	grams per mole
GAC	granular activated carbon
GWM	groundwater monitoring
GWTS	groundwater treatment system
HC	total hydrocarbon
Horiba	Horiba MEXA 584L auto emissions analyzer
HWB	Hazardous Waste Bureau
ID	identification
IDW	investigation-derived waste
K	Kelvin
LDC	Laboratory Data Consultants, Inc.
LNAPL	light non-aqueous phase liquid
LOQ	limit of quantitation
MCL	maximum contaminant level
mg/L	milligram(s) per liter
MW	molecular weight

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

NMED	New Mexico Environment Department
NMWQCC	New Mexico Water Quality Control Commission
O_2	oxygen
ORP	oxidation reduction potential
ppbv	parts per billion by volume
ppmv	parts per million by volume
PSL	project screening level
Q1	first quarter of the year, January 1 through March 31
Q2	second quarter of the year, April 1 through June 30
Q3	third quarter of the year, July 1 through August 31
Q4	fourth quarter of the year, September 1 through December 31
QAPjP	Quality Assurance Project Plan
QC	quality control
S.U.	standard unit
SVM	soil vapor monitoring
SVMP	soil vapor monitoring point
SWMU	Solid Waste Management Unit
TPH	total petroleum hydrocarbons
USACE	United States Army Corps of Engineers
USAF	United States Air Force
VA	United States Department of Veterans Affairs
VOC	volatile organic compound

EXECUTIVE SUMMARY

Kirtland Air Force Base (AFB) Bulk Fuels Facility (BFF) is Solid Waste Management Unit (SWMU) ST-106/SS-111 and became a cleanup site in November 1999 after fuel was observed day-lighting from the ground surface near the BFF fuel off-loading rack. Subsequent pressure testing identified three leaks from lines that transferred aircraft fuel from the fuel off-loading rack to the Pump House at the BFF. The leaking lines were immediately taken offline, and a temporary alternate off-loading rack was installed and used until construction of a new state-of-the-art BFF was online in April 2011. The ongoing investigation and cleanup activities of the BFF site began in 1999 by characterizing the extent of the contamination along with removing contaminated soil, vapors from the vadose zone, and contaminated groundwater. These cleanup efforts are ongoing.

This Executive Summary describes soil vapor monitoring (SVM), groundwater monitoring (GWM), and interim measure activities performed at the BFF between January 1 and March 31, 2016, which comprised the first quarter (Q1) of calendar year 2016 (herein referred to as Q1 2016). The activities included the following:

- Sampling the entire SVM network
- Sampling the subset GWM network
- Sampling the drinking water supply wells located in the vicinity of the dissolved benzene and ethylene dibromide (also known as 1,2-dibromoethane [EDB]) plumes
- Operation and maintenance of the EDB groundwater treatment system (GWTS).

ES-1 Vadose Zone Monitoring

Soil vapor samples were collected from 56 SVM locations (comprised of a total of 284 individual SVM points [SVMPs]) for field parameter measurements and laboratory analyses. Each SVM location is comprised of one to six SVMPs. These monitoring points are screened at discrete intervals ranging from 25 to 450 feet (ft) below ground surface (bgs). Each SVMP has a unique database identification (ID). Included in the database ID is the SVM location followed by a number identifying the approximate depth of the screened interval associated with an individual SVMP (example given, SVMW-04-250 is located at SVMW-04 and is screened at approximately 250 ft bgs).

SVM locations were separated into three areas of interest to evaluate soil vapor concentrations in Q1 2016. These areas include off-base SVM locations, on-base SVM locations outside of the source area, and on-base SVM locations inside of the source area. The source area is defined as a 100-ft buffer zone around the original jet fuel pipeline that was the source of the BFF releases. Within each area of interest, EDB, benzene, and total hydrocarbon (HC) concentrations were evaluated to determine areas of relative higher or lower contamination. Percent oxygen (O_2) at each SVMP was also evaluated.

The off-base SVM area of interest includes 28 SVMPs ranging in depth from approximately 25 to 450 ft bgs. All EDB, benzene, and HC concentrations in this area were below their threshold concentrations of 0.5, 1, and 1,000 parts per million by volume (ppmv), respectively. The highest concentrations of EDB and benzene in off-base wells were detected at KAFB-106142-450 (0.0016 ppmv and 0.0074 ppmv respectively). The highest HC concentration was 7 ppmv detected at KAFB-106028-450.

There are 224 SVMPs in the on-base area of interest outside of the source area. Seventy percent of the

SVMPs were non-detect for EDB in this area, 25 percent were non-detect for benzene, and 96 percent of HC concentrations were less than 1,000 ppmv. SVMPs with EDB greater than 0.5 ppmv, benzene greater than 1 ppmv, and HC greater than 1,000 ppmv were screened at depths ranging from approximately 100 to 450 ft bgs. The highest concentrations of EDB and HC were detected at KAFB-106128-450 (1.99 ppmv and 5,230 ppmv respectively). The maximum detected concentration of benzene in wells on-base outside the source area was 120 ppmv at SVMW-06-252.

There are 32 SVMPs inside the source area. The source area had the highest EDB, benzene, and HC concentrations when compared to the other areas of interest. All SVMPs with EDB greater than 0.5 ppmv, benzene greater than 1 ppmv, and HC greater than 1,000 ppmv were at depths ranging from approximately 50 to 450 ft bgs. The highest detection of EDB within the source area was 9.9 ppmv at SVMW-10-100. The highest concentrations of benzene and HC within the source area were detected at SVMW-11-100 (770 ppmv and 47,995 ppmv respectively).

At fuel release sites, microbial activity causes aerobic biodegradation of the fuel constituents, which consumes O_2 and produces carbon dioxide (CO_2). Field measured O_2 levels in SVMPs with HC concentrations greater than 1,000 ppmv ranged from 0.09 to 19.74 percent. The lowest O_2 level of 0.09 percent was measured in SVMW-11-250 and SVMW-03-050. Both SVMPs are located within the source area. Fifteen SVMPs within the source area had less than 5 percent O_2, which is considered anoxic conditions, and limits aerobic microbial activity.

ES-2 Groundwater Monitoring Network Gauging and Sampling

In previous quarters, 134 GWM wells were sampled, and a comprehensive laboratory and field analyses protocol was applied that covered a wide-range of contaminants and geochemical parameters, but that repeatedly produced non-detections for many parameters (United States Army Corps of Engineers [USACE], 2015d). Accordingly, the GWM program underwent optimization to remove the unnecessary analytical methods and reduce the frequency of GWM at wells showing stable or slowly changing trends (New Mexico Environment Department [NMED], 2016b). Starting in Q1 2016, groundwater and light non-aqueous phase liquid (LNAPL) measurements were performed at 49 GWM wells along with reduced field and laboratory analysis (Table 3-1). The following are the findings of the field sampling event:

- Twenty-seven sentinel wells (18 downgradient and 9 United States Department of Veterans Affairs [VA] proximal wells) were sampled in Q1 2016. EDB was detected in a field duplicate from only one downgradient proximal well, KAFB-106205, at an estimated 0.019 micrograms per liter (µg/L) concentration, below the 0.05 µg/L EDB maximum contaminant level (MCL). No VA proximal wells had any detections for benzene, toluene, ethylbenzene, and total xylenes (BTEX).

- Groundwater levels continued to rise in the GWM network; however, no additional screens became submerged since fourth quarter (Q4) 2015. Water levels rose between 0.93 and 4.59 ft, with the greatest increase observed in KAFB-106208 located in the northeastern extent of the network. The average water level rises were 1.98 ft in the shallow aquifer zone, 2.16 ft in the intermediate aquifer zone, and 2.15 ft in the deep aquifer zone.

- All 49 GWM wells were evaluated for floating fuel on the water table (i.e., LNAPL). Only KAFB-106005 had approximately 0.1 ft of measurable LNAPL; all other GWM wells had no measurable LNAPL.

- All 49 GWM wells were analyzed for EDB. Only three wells (KAFB-106005, KAFB-106225, and KAFB-106226) had detections over the 0.05 µg/L EDB MCL.

- Twelve (12) GWM wells were analyzed for BTEX. Two wells had detections above the 5 µg/L benzene MCL (KAFB-106005 and KAFB-106009). Toluene was detected above its 750 µg/L MCL in KAFB-106005. Ethylbenzene was detected in KAFB-106005, and xylenes were detected in KAFB-106005 and KAFB-106009. None of those detections exceeded the 700 µg/L ethylbenzene MCL or the 620 µg/L xylenes MCL.

- Twenty two (22) GWM wells were analyzed for metals, anions, and alkalinity. Dissolved manganese exceeded the 0.2 milligram per liter (mg/L) project screening level (PSL) in KAFB-106005 and KAFB-106009. Dissolved iron did not exceed its 1.0 mg/L PSL in any well. Chloride exceeded its 250 mg/L PSL in KAFB-106009. Sulfate exceeded its 250 mg/L PSL in KAFB-106009 and KAFB-106012R. Nitrate/nitrite nitrogen exceeded the 1.0 mg/L PSL for nitrite (10 mg/L for nitrate) in nine wells, including all three sampled source area wells and the six newly-installed shallow and intermediate zone wells. Alkalinity as calcium carbonate ranged from 93.3 to 300 mg/L.

- All 49 GWM wells were analyzed for field parameters. Groundwater temperature ranged from 17.8 to 19.0 degrees Celsius (°C), pH ranged from 6.76 to 7.90 standard units (S.U.), conductivity ranged from 181.2 to 1912 microsiemens per centimeter (µS/cm), dissolved oxygen (DO) ranged from 0.17 to 22.01 mg/L, oxidation reduction potential (ORP) ranged from -303.5 to 288.5 millivolts, and turbidity ranged from 0.05 to 5.69 nephelometric turbidity units. DO and ORP measurements indicated aerobic conditions in most wells, while shallow wells associated with the source area generally had lower DO and ORP.

ES-3 Drinking Water Supply Well Monitoring

Drinking water supply well samples were collected in February and March 2016. A total of four drinking water supply wells are in the vicinity of the benzene and EDB plumes and are sampled monthly; however, KAFB-015 and KAFB-016 have not been sampled due to ongoing repairs. KAFB-003 and ST106-VA-2 were sampled for BTEX and EDB because they are adjacent to the benzene and EDB plumes. Both drinking water wells were non-detect for all constituents from the February and March 2016 sampling events.

ES-4 Groundwater Treatment System Operation

The temporary GWTS operated intermittently during Q1 2016 to treat non-hazardous investigation-derived waste (IDW) water. The system ceased operation and was decommissioned on January 11, 2016. The volume of water treated at the temporary GWTS in Q1 2016 was 312,900 gallons, which brought the total volume treated to 17,501,100 gallons

The full-scale GWTS commissioned on December 16, 2015 and continued operation through Q1 2016. Monitoring was performed to ensure that the GWTS was effectively treating the EDB contaminated groundwater to achieve discharge permit requirements (NMED, 2016b, 2016a, and 2014). In Q1 2016, performance monitoring included weekly sampling in January 2016, and monthly sampling thereafter. Samples were collected from the influent, in between the two granular activated carbon vessels, and from the effluent. Water samples were analyzed for EDB, BTEX, dissolved iron, and dissolved manganese. Analytical results indicated that all treated water was below applicable United States Environmental

Protection Agency (EPA) MCLs (EPA, 2015a) and New Mexico Groundwater Protection Standards (20.6.2.3103 New Mexico Administrative Code, 2007).

The GWTS was 77 percent operational during Q1 2016 in conjunction with final commissioning activities. There were no unplanned shutdowns. The total volume of water treated at the GWTS in Q1 2016 was approximately 25 million gallons. Approximately 23.5 million gallons of treated water were discharged to the Kirtland AFB Tijeras Arroyo Golf Course Main Pond and 1.5 million gallons to pilot injection well KAFB-7 (NMED, 2016b, 2016a, and 2014).

ES-5 Projected Activities

Planned activities for Q2 2016 include the following:

- Perform vadose zone monitoring of the entire SVM network from April 18 through May 13, 2016.

- Perform GWM of the entire GWM network from April 1 through June 30, 2016.

- Initiate a passive-sampling demonstration deploying dual membrane samplers in a subset of GWM wells for data comparability with the current low-flow sampling method.

- Perform monthly drinking water supply well monitoring in April, May, and June 2016.

- Continue operating the GWTS and all three extraction wells KAFB-106228, KAFB-106233, and KAFB-106234.

1. INTRODUCTION

This Quarterly Report for Q1 2016 summarizes the activities performed from January 1 through March 31, 2016 as part of the interim measures for soil and groundwater remediation at SWMU ST-106/SS-111, the BFF site, at Kirtland AFB, New Mexico, in accordance with the Hazardous Waste Treatment Facility Operating Permit (Number NM9570024423).

The BFF site is located within the northwestern portion of Kirtland AFB on the southern end of the City of Albuquerque, as shown on site location map (Figure 1-1). Vadose zone and groundwater investigation and remediation activities are required to address the potential impact of fuels that were released from leaking pipelines at the Former Fuel Off-Loading Rack. As specified in the NMED–Hazardous Waste Bureau (HWB) letter to Kirtland AFB dated June 4, 2010 (NMED, 2010a) (Appendix A), quarterly reporting for both the vadose zone and groundwater impacted by dissolved fuel constituents is integrated for two reasons: (1) address the interrelation of the vadose zone and groundwater, and (2) avoid applying different data sets for characterization and remediation activities at the BFF site.

Groundwater monitoring, vadose zone investigation, and interim measures for SWMU ST-106/SS-111 were conducted concurrently in compliance with NMED technical directives for performing interim measures for the BFF site (SWMU ST-106/SS-111). Monitoring was performed in accordance with multiple Work Plans for soil vapor (NMED, 2015a; USACE, 2016b); groundwater (USACE, 2016a), and drinking water supply wells (USACE, 2016b). Groundwater Treatment System operations were performed in accordance with the Work Plan (USACE, 2016a), the temporary permission to discharge to KAFB-7 (NMED, 2016b), the monitoring and contingency plan (USACE, 2015b), and the Operations and Maintenance Plan (USACE, 2016d).

This Q1 2016 Report is prepared in accordance with NMED correspondence dated January 20, 2016 that approved the GWM Work Plan (USACE, 2016a). That correspondence stipulated that the quarterly reporting format include ".....the compilation of a robust annual report with the annual sampling event in Q4 and non-cumulative data reports for each of Q1, Second Quarter (Q2), and Third Quarter (Q3) sampling events." The revised Quarterly Report structure provides a streamlined, clear, and concise structure that focuses on the results of activities completed during the reporting period. This is the first Quarterly Report submitted under the new requirements.

2. VADOSE ZONE MONITORING

This section describes the field activities, analyses, and final results for the Q1 2016 monitoring of 56 SVM locations at Kirtland AFB (Figure 2-1). Quarterly soil vapor sampling is conducted to characterize and monitor contaminant concentrations in the vadose zone over time.

Each SVM location is comprised of one to six SVMPs, each screened at discrete intervals ranging from approximately 25 to 450 ft bgs. Each SVMP has a unique database ID; included in the database ID are the SVM location followed by a number identifying the approximate depth of the screened interval associated with an individual SVMP (example given, SVMW-04-250 is located at SVMW-04 and is at approximately 250 ft bgs). Table 2-1 lists each SVM location, its associated SVMPs, the screened intervals of each, and the pre-calculated purge volume.

Samples collected in Q1 2016 represent the vadose zone without the influence of induced air flow. All SVMPs are sealed to atmospheric air, which minimizes the exchange with the atmosphere during “inhalation” and “exhalation” cycles driven by barometric pressure fluctuations. In addition, there is no SVE system currently operational at SWMU ST-106/SS-111.

2.1 Field Vadose Zone Sampling Procedures and Analysis

Q1 2016 SVM and analyses were performed in accordance with Pilot Soil Vapor Extraction Shutdown Test Work Plan (USACE, 2015a), and Soil Vapor Monitoring and Drinking Water Monitoring Work Plan with the Quality Assurance Project Plan (QAPjP) attached as an Appendix (USACE, 2016b).

2.2 Vadose Zone Data Collection

Field parameters and soil vapor laboratory samples were collected from all SVMPs during Q1 2016. A well integrity checklist was completed by field personnel prior to sampling each well location. The purpose was to document the condition of the vault and the pneumatic quick connect fittings at each SVMP to ensure sample representativeness. After sampling SVEW-08-260, the well cap was found to be loose. The cap was replaced on March 30, 2016 by removing the existing well cap and installing a Fernco coupling to vacuum seal the pneumatic quick connect to the well casing. In addition, the pneumatic quick connect on SVMW-08-050 was found to no longer hold pressure. This pneumatic quick connect was replaced on March 11, 2016, prior to sampling the well. Well integrity checklists are included in Appendix C-1.

2.2.1 Field Soil Vapor Data

Field parameters including HC concentration (in ppmv), percent O_2, and percent CO_2 were measured and recorded at each SVMP using a Horiba MEXA 584L auto emissions analyzer (Horiba). Differential air pressure (inches of water column) readings were measured and recorded for pre-purging and post-purging conditions of each well using an electric manometer. SVMP data were recorded on purge logs, included in Appendix C-1. Horiba calibration and sample system leak tests were performed. Daily quality control (QC) reports are included in Appendix C-2. Soil vapor field data are listed in Table 2-2.

2.2.2 Laboratory Soil Vapor Analytical Data

Q1 2016 soil vapor samples were collected between February 22 and March 15, 2016. All 284 SVMP samples, plus 28 field duplicates, were collected using certified pre-evacuated Bottle-Vac^{TM} canisters fitted with a specialized female pneumatic connector that allowed only the vapor from the SVMP to enter the bottle. All samples were cataloged on sample collection logs included in Appendix C-1. Chain-of-custody forms are included in Appendix C-3. After collecting samples, each bottle was immediately placed into protective packaging, then shipped to ALS Environmental in Simi Valley, California, for analysis of the following soil vapor analytical suite:

- Volatile organic compounds (VOCs) by EPA Method TO-15
- Air-phase petroleum HCs by Method Massachusetts Department of Environmental Protection Air-Phase Petroleum Hydrocarbons 1.0
- Fixed gases (hydrogen, carbon monoxide, CO_2, nitrogen, methane, and O_2/argon by Method E3C)
- EDB by EPA Method California Air Resources Board 422.

Four trip blanks were analyzed for VOCs by EPA Method TO 15 to monitor and assess sample preservation, packing, shipping, and storage conditions. The Data Quality Summary Report is included in Appendix D-1. Analytical results are reported in the ALS Environmental report, included in Appendix D-2. Soil vapor analytical data were validated and given appropriate data qualifiers by Laboratory Data Consultants, Inc. (LDC). Data validation report data packets are included in Appendix D-2. Soil vapor analytical results are listed in Table 2-3.

2.3 Data Review and Usability

A third-party data-validation subcontractor, LDC of Carlsbad, California, performed 100 percent Level III data validation of Q1 2016 soil vapor analytical data. All data were validated usable. The technical data completeness was 100 percent. The data met data quality objectives and were appropriate for use in project decision-making. The results of the QC parameter and data quality indicator (precision, bias [accuracy], representativeness, comparability, completeness, and sensitivity) evaluation are provided in the data validation reports included in Appendix D-2 and data quality assessment report included in Appendix D-1. Final validated organic data are presented in Table 2-3.

2.4 Soil Vapor Data Evaluation

The Q1 2016 analytical results and field data from the 284 SVMPs were used to generate two-dimensional plan-view maps (Figures 2-2 through 2-8) that depict benzene, EDB, and HC concentrations at depths of approximately 25, 50, 100, 150, 250, 350, 450 ft bgs.

The SVM locations have been categorized into three areas of interest: off-base SVM locations, on-base SVM locations outside of the source area, and on-base SVM locations inside of the source area. Soil vapor analytical data are discussed in relation to each area. The source area (delineated by the black and white line on Figures 2-1 through 2-8), is defined as a 100-ft buffer zone around the original jet fuel pipeline that was the source of the BFF releases. That pipeline has since been removed.

EDB and benzene were evaluated based on the laboratory results; HC concentrations and percent O_2 concentrations were evaluated based on field measured data as discussed in Section 2.4.4.

Of the three areas of interest identified to evaluate soil vapor concentrations from Q1 2016, the off-base SVMPs had the highest percentage of non-detects for EDB and benzene (71 percent), and the lowest average detected EDB and benzene concentrations (0.0012 and 0.0018 ppmv, respectively). O_2 concentrations in these SVMPs were generally close to atmospheric levels (>15 percent) which suggests aerobic microbial activity is not limited and the native bacteria can degrade residual fuel constituents present. In the SVMPs located on-base but outside of the source area, EDB, benzene, and HC had average concentrations of 0.018, 1.6, and 143 ppmv, respectively. The areas with higher concentrations (EDB greater than 0.5 ppmv, benzene greater than 1 ppmv, and HC greater than 1,000 ppmv) were located at depths between approximately 150 and 450 ft bgs. The highest soil vapor EDB, benzene and HC concentrations for Q1 2016 were within the source area, with maximums of 9.9, 770, and 47,995 ppmv for EDB, benzene, and HC, respectively. This area of interest also had the highest percentage of detections for EDB and benzene (94 percent), and the highest average concentrations of EDB and benzene of 1.9 and 176 ppmv, respectively. The 15 SVMPs with O_2 concentrations less than 5 percent were located within this area of interest and suggests minimal aerobic microbial activity (i.e., native bacteria need more O_2 to degrade residual fuel constituents).

2.4.1 Off-Base Soil Vapor Monitoring Points

Figures 2-2 through 2-8 show the off-base SVMPs, which are all locations north of the Kirtland AFB installation boundary. There are five SVM locations off-base, with the furthest location approximately 1,200 ft north of Kirtland AFB. The off-base SVM locations consist of 28 SVMPs, which are screened at intervals from approximately 25 to 450 ft bgs.

Twenty of the 28 off-base SVMPs reported no EDB or benzene detection in Q1 2016. Of the eight remaining SVMPs, five had J flagged (estimated) detections. The three remaining SVMPs with detections were all screened between approximately 350 and 450 ft bgs. The highest EDB concentration was 0.0016 ppmv at KAFB-106142-450. The highest benzene concentration was 0.0074 ppmv at KAFB-106142-450.

HC concentrations the 28 off-base SVMPs ranged between 0 and 7 ppmv. O_2 levels were between 17.88 and 20.78 percent.

The monitoring of the off-base SVMPs demonstrated EDB concentrations below 0.0016 ppmv, benzene concentrations below 0.0074 ppmv, and HC concentrations below 10 ppmv in Q1 2016. Percent O_2 in the off-base SVMPs was close to atmospheric levels, which suggests aerobic microbial activity is not limited (i.e., native bacteria can degrade residual fuel constituents present).

2.4.2 On-Base Soil Vapor Monitoring Points Outside of Source Area

Figures 2-2 through 2-8 show the locations of the 224 SVMPs located on Kirtland AFB property, but outside of the source area boundary. Those SVMPs are screened at intervals from approximately 25 to 450 ft bgs. SVM location KAFB-106135 is the furthest away from the source area at approximately 1,400 ft to the northeast.

EDB was not detected in 70 percent of on-base outside of the source area SVMPs. EDB was J flagged (estimated detection) in 7 percent of SVMPs, and detected in 23 percent of SVMPs. One SVMP had an EDB concentration of greater than 0.5 ppmv. The highest detection was 1.99 ppmv at 106128-450, approximately 50 ft to the southeast of the source area.

Among the on-base outside the source area SVMPs, benzene was not detected in 25 percent, J flagged in 26 percent, and detected in 49 percent of SVMPs. Twenty-five SVMPs had benzene concentrations greater than 1 ppmv. The highest detection, 120 ppmv, was measured at SVMW-06-252 located approximately 175 ft due east of the source area.

Ninety-six percent of the on-base outside of the source area SVMPs had HC concentrations below 1,000 ppmv. The nine SVMPs with concentrations greater than 1,000 ppmv are screened from approximately 250 to 450 ft bgs. The highest concentration of HC for these SVMPs was 5,230 ppmv at 106128-450, which is approximately 50 ft to the southeast of the source area.

Percent O_2 in the on-base outside of the source area SVMPs ranged from 7.14 to 21.86 percent. O_2 levels greater than 15 percent were measured in 215 SVMPs. The lowest O_2 level was recorded at KAFB-106117-450, located approximately 100 ft away from the source area, which had an EDB concentration of 0.052 ppmv, a benzene concentration of 15 ppmv, and a HC concentration of 2960 ppmv.

The high-level EDB, benzene and HC concentrations (EDB greater than 1 ppmv, benzene greater than 10 ppmv, and HC greater than 1,000 ppmv) were measured at on-base outside of the source area SVMPs located within 900 ft of the source area toward the southeast and the northeast. SVMP screened intervals showing these concentrations ranged in depths between approximately 100 and 450 ft bgs. O_2 levels below 15 percent in nine SVMPs suggested that aerobic microbial activity is not limited and may be occurring.

2.4.3 Source Area Soil Vapor Monitoring Points

Figures 2-2 through 2-8 show the 32 source area SVMPs located within 100 ft of the original location of the underground jet fuel pipeline and screened from approximately 25 to 450 ft bgs.

EDB was non-detect in one of the source area SVMP, and there were no J flagged detections. The highest EDB concentration was 9.9 ppmv at SVMW-10-100. Benzene was not detected in one SVMP and there were no J flagged detection. The highest benzene concentration was 770 ppmv at SVMW-11-100. The higher concentrations (EDB greater than 0.5 ppmv and benzene greater than 1 ppmv) were all located at depths between approximately 50 and 450 ft bgs.

Eight of the source area SVMPs had HC concentrations less than 1,000 ppmv. The highest concertation was 47,995 ppmv (analytical value; Section 2.4.4) at SVMW-11-100. HC concentrations above 1,000 ppmv were all located from approximately 50 to 313 ft bgs. Twenty-six SVMPs had percent O_2 below 15 percent; of those, 15 were measured with a percent O_2 less than 5 percent. The SVMPs with O_2 below 15 percent ranged from depths of approximately 50 to 300 ft bgs.

The highest EDB, benzene, and HC concentrations (EDB greater than 0.5 ppmv, benzene greater than 1 ppmv, and HC greater than 1,000 ppmv) at source area SVMPs were measured at depths ranging from approximately 50 and 450 ft bgs. Generally, reduced O_2 concentrations corresponded with higher EDB, benzene, and HC concentrations (Table 2-2), suggesting that microbial degradation of fuel compounds may be taking place. Some SVMPs showed low percent O_2 corresponding with low EDB, benzene, and HC concentrations; however, the SVMP above or below those SVMPs at the same SVM location had higher VOC concentrations. Percent O_2 was less than 5 percent at 15 SVMPs ranging in depth from approximately 50 to 300 ft bgs. Aerobic microbial activity was most likely limited at these locations due to the anoxic conditions.

2.4.4 Comparison of Field Parameters with Laboratory Analytical

The field-measured percent O_2 (listed on Table 2-2) was compared with the fixed-gas laboratory analyses for percent O_2. The comparison showed that the laboratory results were on average 1.23 percent greater than the field-measured O_2. Laboratory percent O_2 was higher than atmospheric percent O_2 (21 percent) in 163 samples.

These factors suggest the field measured O_2 concentrations are a better representation of vadose zone conditions than laboratory analysis of percent O_2.

HC data were used to asses total VOCs in Q1 2016. An evaluation of HC concentrations in comparison to laboratory total petroleum hydrocarbon (TPH) concentrations was performed in the *Quarterly Pre-Remedy Monitoring and Site Investigation Report for October-December 2015 and Annual Report for 2015* (USACE, 2016c). That evaluation determined that HC data were biased higher in comparison to laboratory TPH data, and represented a more conservative estimate of total VOCs in soil vapor. A comparison of the Q1 2016 data supported this conclusion. As a result, HC measurements were used in this report to assess total VOC concentrations when laboratory TPH concentrations were lower than the Horiba's saturation limit of 32,760 ppmv. SVMW-11-100 and SVMW-10-100 were the only SVMPs where the laboratory TPH sum was used.

Laboratory TPH concentrations were calculated as follows. The aliphatic and aromatic carbon-range analytical results were converted from units of micrograms per cubic meter (µg/m^3) as reported by the analytical laboratory, to parts per billion by volume (ppbv) using the following equation:

$$CRppbv = CR\mu g/m^3 \cdot \frac{0.080205 \cdot T}{CRMW} \quad \text{Equation 1}$$

Where:

CRppbv	=	Carbon-range hydrocarbon concentration in ppbv of air
CRµg/m^3	=	Carbon-range hydrocarbon concentration in µg/m^{3}of air
0.080205	=	Universal Gas Constant in atm•liter (L)/mole• degrees Kelvin (°K)
T	=	Temperature in °K
CRMW	=	Average carbon-range molecular weight (MW) in grams per mole (g/mol)

Average MWs assigned to the carbon ranges were: 65.15 g/mol for C5-C8 aliphatic hydrocarbon compounds, 142.3 g/mol for C9-C12 aliphatic hydrocarbon compounds, and 120.2 g/mol for C9-C10 aromatic hydrocarbon compounds. An average temperature of 293.15 °K was used. The total VOC concentrations were calculated by totaling the TPH fractions (aliphatic and aromatic).

As a result of the conversion from µg/m^3 to ppbv using average MW, total VOC data by the laboratory method should be considered an estimated value representing the total volatile contaminant present in soil vapor. The average MWs assigned were representative weights for the three TPH fractions. The use of these weights allows all vapor data to be compared in units of ppbv or ppmv.

2.5 Time-Series Analysis of Soil Vapor Concentrations (Q4 Annual Report Only)

To be provided in the Q4 2016 Annual Report.

3. GROUNDWATER MONITORING NETWORK GAUGING AND SAMPLING

Quarterly GWM was conducted as part of the GWM program and for the GWTS interim measure implemented to assess system performance and determine contaminant plume changes over time. As of Q1 2016, the BFF GWM well network was comprised of the 134 GWM wells listed in Table 3-1; the well locations are shown on Figure 3-1. GWM includes measuring depths to groundwater and LNAPL thicknesses along with collection of groundwater samples for field measurements and laboratory analyses.

To characterize the distribution of the dissolved-phase contaminants in the shallow, intermediate, and deep groundwater zones, the BFF monitoring wells are classified into those three categories based on their screened intervals. No GWM wells are installed in the regional aquifer zone. The groundwater zones and well screen intervals for the entire GWM network, if applicable, are summarized below.

- ***Shallow Aquifer*** as defined in this report extends from the water table to 200 ft below the water table. Groundwater monitoring of this shallow aquifer is performed in the following monitoring well screened intervals:

  — ***Shallow Zone*** extends from the water table to 15 ft below the water table measured at the time of well installation. Sixty GWM wells are installed in this zone. These wells are designed as water table wells with screens that are partially submerged; however, only 16 shallow zone wells remain with partially submerged screens due to rising groundwater elevations.

  — ***Intermediate Zone*** is monitored by GWM wells with screens that extend from 15 to 30 ft below the water table measured at the time of well installation. Thirty-seven GWM wells are installed in this zone.

  — ***Deep Zone*** is monitored by GWM wells with screens that extended from 30 to 130 ft below the water table measured at the time of well installation. Thirty-seven GWM wells are installed in this zone. Deep zone GWM wells installed starting in the Q2 2011 were screened from 45 to 60 ft, from 85 to 100 ft, or from 115 to 130 ft below the water table measured at the time of well installation.

- ***Regional Aquifer*** contains most of the drinking water supply wells that are screened within this aquifer with screens 500 ft or more below the current water table. This zone does not contain any GWM wells.

3.1 New Groundwater Monitoring Activities

Q1 2016 GWM and analyses were performed in accordance with Expansion of the Dissolved-Phase Plume Groundwater Treatment System Design Work Plan with the QAPjP attached as an Appendix (USACE, 2016a) as follows. Additionally, the second GWM well optimization was implemented into this Work Plan (USACE, 2016a) and is described below (Section 3.2).

3.2 Groundwater Monitoring Optimization

The GWM was performed under the provisions of the optimized program that was proposed by the United States Air Force (USAF) under two requests.

1. May 12, 2015 (USAF, 2015a) and was approved with conditions by NMED on July 17, 2015 (NMED, 2015b).

2. December 9, 2015 (USAF, 2015b) and was approved with conditions by NMED on January 20, 2016 (NMED, 2016c).

The GWM program optimization established an updated monitoring frequency and analytical schedule on the 134 GWM network. Optimization was accomplished through examination of analytical data generated between 2011 and 2015. The data set was assessed to evaluate contaminant of concern concentration trends and to identify data redundancies. Each analyte was evaluated for its role in informing plume dynamics, defining risk, or aiding in future relevant site decisions. Results of the evaluation indicated that most wells showed either no trend or a decreasing concentration trend for individual analytes, presenting immediate opportunities to reduce analyses that were not informing risk or utilized for site decisions. As part of the optimization process, GWM wells were identified with different data objectives and sampling frequencies. Key sentinel wells are sampled quarterly to be protective of downgradient drinking water supply wells, while the rest of the GWM well are sampled semiannually. The 134 well GWM network classifications are summarized below (Figure 3-1).

- ***Sentinel Wells (Proximal and Signal Wells) (30 Wells)*** — To ensure protectiveness, a subset of wells within the GWM network are identified to serve as proximal wells (subdivided into VA and downgradient proximal wells), and signal wells to act as a decision trigger if constituents were detected at elevated concentrations at those locations. This category includes the following groups:

  — ***Downgradient Proximal Wells (18 Wells)*** — Wells located between the leading edge of the EDB plume and drinking water supply wells KAFB-003, Ridgecrest-5, and Burton-5.

  — ***VA Proximal Wells (9 Wells) —*** Wells located between the plume and the VA Medical Center drinking water supply well, and adjacent to the benzene plume footprint.

  — ***Signal Wells (3 Wells)*** — Wells located outside of the downgradient benzene plume boundary that would indicate migration of BTEX constituents, and prompt a re-evaluation of the BTEX or naphthalene sampling frequency.

- ***Source Area Wells (26 Wells)*** — GWM wells within the benzene plume footprint that are key to tracking and monitoring BTEX constituents. The majority of wells outside of this area in the more distal areas of the plume do not have benzene detections between 2011 and 2015.

- ***Newly-installed Monitoring Wells (19 Wells)*** — Monitoring wells recently installed for which four quarters of baseline data are required in order to determine their function within the network. If new wells are installed, they are added to this category. Conversely, wells are moved from this category after baseline data are collected and evaluated.

- ***GWM Network (59 Wells)*** — All other GWM wells installed at the BFF site to date that did not receive special classification into sentinel (i.e., proximal and signal), source area, and newly-installed wells listed above.

Table 3-1 lists the network GWM wells and their optimized sampling and analysis requirements. A condition of the NMED approval (NMED, 2016b) was the quarterly gauging and LNAPL measurement on all GWM network wells.

3.3 Q1 2016 Monitoring

During Q1 2016, GWM was performed according to the proposed optimized program; however due to timing of approval (NMED, 2016c) water elevation gauging and LNAPL thickness measurements were made in 49 of the 134 GWM wells scheduled for sampling. In the future, quarterly gauging and LNAPL measurements will be performed for the entire GWM network, as specified; activities performed are described on the Daily QC Reports for groundwater sampling (Appendix E-1).

Forty-nine GWM wells were sampled (Figure 3-2) and are comprised of the following well categories:

- Twenty-seven sentinel wells:
  - Eighteen downgradient proximal wells; six each installed in the shallow, intermediate, and deep zones
  - Nine VA proximal wells; three each installed in the shallow, intermediate, and deep zones
- Nineteen newly-installed wells; six installed in the shallow zone, seven in the intermediate zone, and six in the deep zone
- Three source area wells installed in the shallow zone.

The list of GWM wells sampled and their respective groundwater zones are provided in Table 3-3. The following sections describe Q1 2016 field GWM activities and present the analytical data for the samples collected.

3.4 Groundwater and Light Non-Aqueous Phase Liquid Level Monitoring

Depths to LNAPL and groundwater were measured in 18 shallow, 16 intermediate, and 15 deep zone wells between January 25 and February 15, 2016. The resulting measurements were used to calculate groundwater elevations and LNAPL thicknesses, with the groundwater elevation in the one gauged well that contained measurable LNAPL corrected to account for the presence of the LNAPL on the water surface in the well. The measurement dates, measured depths to LNAPL and groundwater, and the LNAPL thickness and water-level calculations performed using the field data are provided in Table 3-2. Depth-to-groundwater and LNAPL measurements are provided in Appendix E-2.

Solinst Model 122 oil-water interface probes were used to measure the depth to LNAPL and depth to groundwater at all locations. Prior to each use, the probes were checked for proper operation and cable integrity. Depth to LNAPL and groundwater measurements were recorded in the field on Groundwater Purge and Sampling Logs, which are provided in Appendix E-3. The probes were decontaminated between wells.

Well gauging was performed and to verify the accuracy of the measurements, four experienced staff went to each of seven GWM wells (KAFB-106002, KAFB-106003, KAFB-106004, KAFB-106011, KAFB-106012R, KAFB-106101, and KAFB-106102) to perform a three-way quality assurance check. Each of three staff were assigned one Solinst meter and required to independently gauge each well. The fourth person read each tape to eliminate any subjectivity in the reading when the measurements fell between gauge lines. Measurements collected from all three probes were consistently within ± 0.03 ft of each other and verified that all meters were properly calibrated and working properly.

GWM well gauging data are provided in Table 3-2. The water table in ten out of the 18 shallow wells gauged in Q1 2016 occurred within the screened interval (Tables 3-3); this had not changed since the Q4 2015 monitoring event. The other eight shallow GWM wells were gauged and their screens were submerged. The well screens became submerged due to continued rise of the water table as a result of ongoing water conservation practices in the Albuquerque area. As the water table is expected to continue to rise, it is anticipated that the screens of additional wells will become submerged.

Q1 2016 water levels were compared to Q4 2015 water levels (Table 3-4). Water level changes in the 49 GWM wells were evaluated by aquifer zone and it was noted that the levels increased in all wells gauged as summarized below.

- ***Shallow Zone*** — The water level increase ranged from 1.03 to 3.77 ft with an average increase of 1.98 ft.

- ***Intermediate Zone*** — The water level increase ranged from 1.00 to 4.59 ft with an average increase of 2.16 ft.

- ***Deep Zone*** — The water level increase ranged from 0.93 to 4.21 ft with an average increase of 2.15 ft.

As shown in Table 3-2, LNAPL was only detected in shallow source area GWM well KAFB-106005. The calculated LNAPL thickness was 0.1 ft. KAFB-106005 last had measurable LNAPL thickness in Q4 2013 and its screen became submerged in Q4 2015.

3.5 Quarterly Groundwater Sampling

Quarterly groundwater sampling was conducted at 49 GWM wells between January 25, 2016 and February 15, 2016 as presented in Table 3-3. The sampled well locations are shown on Figure 3-2. The groundwater samples were sent to the Eurofins Lancaster Laboratories Environmental (ELLE) LLC, Lancaster, Pennsylvania for analytical testing as listed in Table 3-3. The Groundwater Purge and Sampling Forms are provided in Appendix E-3 and the chain-of-custody forms are provided in Appendix E-4.

GWM well sampling was performed using either dedicated Bennett pumps or a portable Bennett pump system as indicated in Table 3-3. Portable Bennett sampling systems were decontaminated prior to deployment in each well. For portable Bennett pump sampling, new polyethylene tubing was purchased and measured for dedication to each well specific to the screen depth. Evaluation of tubing replacement is performed each quarter based on contaminant concentrations trends in the groundwater.

At least one well volume was purged from each well; the purge rate was approximately 1.2-4.8 liters per minute and the depth to water was monitored to ensure minimal drawdown. During purging, the following water-quality parameters were measured and recorded on the field forms (Appendix E-3): temperature, pH, DO, turbidity, ORP, conductivity, and specific conductivity. After reaching stabilization of the water-quality parameters and removal of at a minimum of one well volume, the purge rate was reduced to approximately 1.0 liter per minute to collect aliquots for the required analyses.

To minimize the potential for loss of EDB or BTEX during sample collection, the sampling method was slightly modified to fill the sample container more quickly, which minimized sample aliquot exposure to the atmosphere. The pump rate was increased for collection of the aliquots for analyses of volatile-type compounds (EDB and BTEX) so that the containers were filled during one pump discharge cycle and decrease loss of vapors. Sample aliquot collection for EDB and BTEX analysis was thus moved to the end of the sampling sequence. This modification improved data quality objectives for monitoring and will be identified as a standard procedure in Work Plan revision in accordance with standard practice (ASTM International, 2012).

Field parameters were measured for samples from all 49 GWM wells. Groundwater temperature ranged from 17.8 to 19.0 °C, pH ranged from 6.76 to 7.90 S.U., conductivity ranged from 181.2 to 1912 µS/cm, DO ranged from 0.17 to 22.01 mg/L, ORP ranged from -303.5 to 288.5 millivolts, and turbidity ranged from 0.05 to 5.69 nephelometric turbidity units. DO and ORP measurements indicated aerobic conditions in most wells except shallow wells associated with the source area (Figure 3-3), which generally had lower DO and negative ORPs. The field parameters measured prior to sample collection are summarized in Table 3-5.

Groundwater samples were analyzed by ELLE in Lancaster, Pennsylvania. ELLE maintains current Department of Defense (DoD) Environmental Laboratory Accreditation Program certification. Samples were analyzed in accordance with *DoD Quality Systems Manual Version 5.0* (DoD, 2013) as applicable and the specified analytical methodologies in the Work Plan (USACE, 2016a).

3.6 Data Review and Usability Results

The Q1 2016 analytical data were validated and reviewed for accuracy, precision, representativeness, comparability, completeness, and sensitivity, and all of the data met the project data quality objectives and were deemed usable for their intended purposes. No Q1 2016 data were R-qualified to signify the date were rejected or unusable. Validation qualifiers were uploaded to the EQuIS® project database and subsequently submitted to the Environmental Resources Program Information Management System (ERPIMS). The ERPIMS submittal insertion is scheduled for completion on May 27, 2016. The Data Quality Evaluation Report for groundwater samples collected is provided in Appendix F-1 and the final validation reports are included in Appendix F-2.

3.7 Project Screening Levels

The PSLs were selected to satisfy the requirements of the Kirtland AFB Hazardous Waste Treatment Facility Operating Permit Number NM9570024423 (NMED, 2010b) as the lowest of:

1. New Mexico Water Quality Control Commission (NMWQCC) standards per the New Mexico Administrative Code, Title 20.6.2.3101A, Standards for Ground Water of 10,000 mg/L Total Dissolved Solids Concentration or Less (New Mexico Administrative Code, 2004). For metals, the NMWQCC standard applies to dissolved metals and total mercury.

2. EPA National Primary Drinking Water Regulations, MCLs and Secondary MCLs, Title 40 Code of Federal Regulations (CFR) Part 141, 143 (EPA, 2015b).

If no MCL or NMWQCC standard existed for any analyte, the PSL was the EPA Tapwater Regional Screening Level (EPA, 2015b).

PSLs for groundwater samples are provided in all groundwater data tables included in this Report.

3.8 Groundwater Quality Data

All 49 GWM samples collected in Q1 2016 were analyzed for EDB and a subset of the samples was also analyzed for a larger suite of analytes. Contaminant concentrations were compared to the respective PSLs, and the results of this comparison are presented and discussed in the sections below. Of note, the analytical results for duplicate samples are presented in these tables but are used to perform data evaluation (Appendix F-1).

3.8.1 Sample Results for Sentinel Wells and Signal Wells

The purpose of sampling the 27 sentinel (nine VA and 18 downgradient proximal GWM) wells, and three signal GWM wells, is to ensure protectiveness of downgradient drinking water supply wells. Data from these wells serve to trigger actions in the event that constituents exceed pre-determined concentrations. As per the optimization sampling schedule, the signal wells were not required to be monitored during Q1 while the sentinel wells were sampled for EDB and BTEX. Analytical results for samples collected from the VA proximal wells are provided in Table 3-6 and from downgradient proximal wells in Table 3-7. The sampling results are discussed in the following sections.

3.8.1.1 Organic Compounds Analytical Results

Samples from the 27 sentinel GWM wells were analyzed for EDB (Figure 3-2) and nine samples from the VA proximal GWM wells were also analyzed for BTEX (Figure 3-4). EDB was the only organic compound detected in any of the 27 sentinel GWM wells. Shallow well KAFB-106205 had a concentration of 0.019J µg/L, equal to the limit of detection of 0.019 µg/L, which is below the PSL for EDB of 0.05 µg/L; additionally, a duplicate sample was collected from this well that had a non-detect concentration. The groundwater concentrations in samples collected from the sentinel wells that were either non-detect or below regulatory levels indicate protectiveness of drinking water supply wells in the vicinity of the dissolved-phase EDB and benzene plumes.

3.8.2 Sample Results for Newly-installed Wells

NMED requires four quarterly sampling events for newly-installed monitoring wells prior to implementing the approved optimization program at each well. Nineteen newly-installed wells are currently in this quarterly program. As shown on Table 3-8, 16 out of 19 newly-installed wells were sampled for four or five quarters as of Q1 2016. Table 3-9 provides groundwater analytical results from Q1 2016 for the newly-installed wells along with the grouping association of the wells and the zone where they are screened. Groundwater results for samples collected from these wells are summarized in Table 3-8 while concentrations of chloride, sulfate, and nitrate/nitrite nitrogen are presented on Figure 3-5 and concentrations of dissolved iron, manganese, bromide, and total alkalinity on Figure 3-6.

3.8.2.1 Organic Compounds Analytical Results

EDB was detected in samples from four of the newly-installed wells (KAFB-106220, KAFB-106225, KAFB-106226, and KAFB-106230). Concentrations exceeded the 0.05 µg/L PSL in samples from two wells, KAFB-106225 and KAFB-106226, at 0.40 and 0.47 µg/L, respectively. Moreover, EDB was estimated in the duplicate sample from KAFB-106220 at 0.013 µg/L and in the sample from KAFB-106230 at 0.020 µg/L. EDB was not detected in the samples collected from other wells. EDB concentrations are presented on Figure 3-2.

3.8.2.2 Inorganic Compounds Analytical Results

All samples collected from the newly-installed wells were analyzed for the following inorganic compounds: select total and dissolved metals, anions, and alkalinity (Table 3-9). These compounds were detected in all samples; however, only nitrate/nitrite nitrogen was detected at concentrations above the PSL (the MCL) for nitrite of 1.0 mg/L; of note, the PSL (MCL) for nitrate is 10 mg/L. These exceedances were recorded in samples collected from wells KAFB-106213, KAFB-106216, KAFB-106222. KAFB-106223, KAFB-106231, and KAFB-106232), with the highest nitrate/nitrite nitrogen concentration of 3.0 mg/L measured in the sample from KAFB-106222.

3.8.3 Sample Results for Source Area Wells

Three shallow zone GWM wells located in the source area on-base (KAFB-106005, KAFB-106009, and KAFB-106012R) (Figures 3-1 and 3-2) were sampled during Q1 2016 because historical data from these wells show increasing nitrate/nitrite nitrogen, chloride, and sulfate concentration trends. Samples from these wells were analyzed for a larger suite of analytes and the results are provided in Table 3-10. The data are summarized below, and a more in-depth analysis of the data will be included in the Q4 2016 Annual Report.

3.8.3.1 Organic Compounds Analytical Results

EDB was only detected in the sample collected from KAFB-106005 at a concentration of 0.69 µg/L, higher than the 0.05 µg/L PSL for this compound. Benzene, toluene, and xylenes were detected in samples from KAFB-106005 and KAFB-106009 (Figure 3-4). The highest concentrations were in the sample from KAFB-106005 at 2,000 µg/L for benzene, 860 µg/L for toluene, and 430 µg/L for xylenes. Benzene concentrations exceeded the PSL of 5.0 µg/L in both wells, and toluene exceeded the 750 µg/L PSL only in KAFB-106005. In addition, ethylbenzene was detected in the sample from KAFB-106005 at 150 µg/L, below the 700 µg/L PSL. The groundwater sample from KAFB-106012R still shows no impact by fuel constituents due to its location west and outside of the dissolved EDB and benzene plume footprints.

3.8.3.2 Inorganic Compounds Analytical Result

Inorganic compounds including metals, anions, and alkalinity were detected in all samples collected from source area GWM wells. PSL exceedances were noted as follows.

- Dissolved manganese in KAFB-106005 and KAFB-106009 exceeded the 0.2 mg/L PSL, with 1.73 mg/L the highest concentration measured in the sample from KAFB-106005 (Figure 3-6).

- Nitrate/nitrite nitrogen in all three wells (KAFB-106005, KAFB-106009, and KAFB-106012R) exceeded the 1.0 mg/L PSL established for nitrite (Figure 3-5). The highest nitrate/nitrite nitrogen concentration, 14.9 mg/L, was measured in the sample from KAFB-106009 (the MCL for nitrate is 10 mg/L).

- Sulfate in KAFB-106009 and KAFB-106012R exceeded the 250 mg/L PSL. The 372 mg/L concentration measured in the sample from KAFB-106009 represented the highest concentration.

- Chloride in KAFB-106009 was measured at 421 mg/L, which exceeded the 250 mg/L PSL.

3.8.4 Groundwater Trends for the Analyses Performed

Aerobic microorganisms require the presence of DO to effectively break down organic compounds found in the environment. Decreased DO and ORP can be indicators of microbial degradation in a subsurface environment as increased microbial activity can result in anaerobic conditions. These conditions are often associated with microbial growth and the subsequent degradation of organic compounds in an environment. Field measurements for DO and ORP (Figure 3-3) appeared to be higher in the distal plume area compared to the source area. This supports the hypothesis that microbial degradation is occurring in the vicinity of the source area.

Higher alkalinity and dissolved metals concentrations can often be associated with microbial activity as increased microbial activity can cause the dissolution of minerals. The dissolution of minerals is associated with excess respiration of CO_2 and subsequent drop in pH caused by high rates of microbial activity. The highest total alkalinity measured was detected in the source area at the KAFB-106005, and all other wells have approximately the same concentration of total alkalinity. The two dissolved manganese exceedances of PSL and the one detection (not exceedance) of dissolved iron occurred in samples collected from source area wells (Figure 3-6). The combination of elevated alkalinity and dissolved metals concentrations are likely associated with increased microbial degradation of organics in the source area.

Decreased concentrations of nitrate/nitrite nitrogen and sulfate are often associated with microbial activity. Nitrogen is incorporated into microbial biomass and sulfate can be used as an energy source by some microorganisms. The highest nitrate/nitrite nitrogen and only sulfate exceedances occurred in source area wells (Figure 3-5). These findings do not appear to be consistent with the other indicators of microbial activity in and around the three source area wells. There is a possibility that there may be an extraneous source of nitrate/nitrite nitrogen and sulfate as the chloride concentration in the sample from KAFB-106009 is the only exceedance of chloride PSL in the wells sampled.

Degradation of EDB can result in elevated concentrations of bromide in the subsurface as bromide ions can be liberated from EDB during decomposition. Bromide was detected in samples from all three source area wells and in two of the northernmost newly-installed wells (KAFB-106231 and KAFB-106232).

A trend of increasing ORP measurements and increasing anion and cations concentrations has been recorded in samples collected from three on-base source area wells screened in the shallow zone: KAFB-106005, KAFB-106009, and KAFB-106012R. The anions included chloride, sulfate, and nitrate/nitrite nitrogen and the cations included calcium and sodium. As a consequence, these source area wells were monitored during Q1 2016 and samples were analyzed for the following suites: BTEX, EDB, select metals, anions, and alkalinity. Water-quality parameters, which included ORP, were measured prior to sample collection.

Table 3-11 presents ORP, chloride, sulfate, nitrate/nitrite nitrogen, calcium, and sodium data for GWM wells for the following time periods: KAFB-106005 since Q2 2010, KAFB-106009 since Q2 2010, and KAFB-10612R since Q2 2014. The ORP level for KAFB-106009 was not recorded for Q4 2015 because, as per the Q4 2015 report (USAF, 2016), the high values reported rendered those data suspect.

Increasing and decreasing trends are identified as differences of greater than 10 percent between values reported in Q1 2016 and Q4 2015. Trends for the various analytes in each well shown on Table 3-11 are discussed below:

- KAFB-106005 — Chloride and sulfate concentrations decreased. Nitrate/nitrite nitrogen appeared to be stable. Calcium and sodium concentrations increased. ORP was the only major decrease observed between the two quarters, but data from before Q4 2015 indicated that the measurements from Q1 2016 were consistent with data recorded prior to Q4 2015.

- KAFB-106009 — Chloride and sulfate concentrations increased. Nitrate/nitrite nitrogen, calcium, and sodium concentrations appeared to be stable. ORP could not be compared to the previous quarter as the Q4 2015 measurement was not recorded. Comparison to the Q3 2015 ORP measurement indicated an increase in ORP.

- KAFB-106012R — Chloride and sulfate concentrations decreased. Nitrate/nitrite nitrogen, calcium, and sodium concentrations as well as ORP appeared to be stable.

3.9 Time-Series Analysis of Groundwater Elevations and Light Non-Aqueous Phase Liquid Thicknesses (Q4 Annual Report Only)

This section will be provided in the Q4 2016 Annual Report.

3.10 Time-Series Analysis of Concentrations in Groundwater (Q4 Annual Report Only)

This section will be provided in the Q4 2016 Annual Report.

4. DRINKING WATER SUPPLY WELL MONITORING

Monthly organic compound sampling, analyses, and reporting was performed during Q1 2016 at drinking water supply wells KAFB-003 and ST106-VA-2 as part of the monitoring associated with the BFF site. These wells are sampled monthly due to their proximity to the dissolved-phase EBD and benzene plumes. Inorganic compound sampling is performed semi-annually (Q2 and Q4 2016), and was not required in Q1 2016.

Four drinking water supply wells (KAFB-003, KAFB-015, KAFB-016 and ST106-VA-2) provide drinking water to Kirtland AFB employees and tenants, and VA Medical Center patients, employees, and visitors. In Q1 2016, Kirtland AFB wells KAFB-015 and KAFB-016 were not operational due to ongoing mechanical problems. As such, only wells ST106-VA-2 and KAFB-003 were sampled in February and March 2016. Results from those samples are summarized below.

4.1 Drinking Water Supply Well Sampling and Analysis Procedures

All field measurements, sample collection, packaging, shipping, and analyses were performed in accordance with the Soil Vapor Monitoring and Drinking Water Monitoring Work Plan with the QAPjP attached as an Appendix (USACE, 2016b). Field DO, pH, ORP, conductivity, and temperature measurements were made using a Yellow Springs Instrument 556 multi-probe system. Instrument calibration was performed daily to ensure accurate readings. The sample port at each drinking water wellhead was opened for 30 seconds prior to sampling to purge any entrained debris. Volatile organic analysis samples were collected first. Upon filling, the sample containers were immediately sealed, labelled and put into a cooler. Daily field activity logs and calibration logs are included in Appendix G-1. Completed sample collection logs and chain-of-custody forms are included in Appendix G-2.

Monthly water samples were collected for the following analyses:

- EDB using EPA Method 504.1
- BTEX using EPA Method 524.2.

Samples were submitted to ALS Environmental in Kelso, Washington, for analytical testing. Analytical results were validated by LDC of Carlsbad, California. The data quality assessment reports are included in Appendix H-1. ALS Environmental analytical reports for February and March 2016 are included in Appendix H-2.

4.2 Data Review and Usability

A third-party data-validation subcontractor, LDC of Carlsbad, California, performed a 100 percent Level III data validation for Q1 2016 organic compound analytical data. All data were validated and deemed usable. The technical data completeness was 100 percent. The data met data quality objectives and were appropriate for use in project decision-making. The QC parameter and data quality indicator (precision, bias [accuracy], representativeness, comparability, completeness, and sensitivity) evaluation results are provided in the organic compounds data validation and data quality assessment reports included in Appendix H-1. Final validated organic data are presented in Table 4-1.

4.3 Drinking Water Supply Well Water Quality

Analytical results for February and March 2016 are presented in Table 4-1 and Appendix H-2, and depicted in Figure 4-1. PSLs for drinking water supply wells were the lower of either the EPA or NMWQCC screening levels, as discussed in Section 3.6. There were no EDB and BTEX detections above the limit of detection in drinking water supply wells KAFB-003 and ST106 VA2 in either February or March 2016. This indicates that both wells have no detectable concentrations of EDB and BTEX in the drinking water that they supply to Kirtland AFB employees and tenants, and VA Medical Center patients, employees, and visitors.

5. GROUNDWATER TREATMENT SYSTEM OPERATION

5.1 New Groundwater Treatment System Activities

New activities at the GWTS included shake-down testing of the full-scale system (USACE, 2015c and USACE, 2015b) and testing injection well KAFB-7 under at temporary discharge permit (NMED, 2016a).

5.2 Temporary Groundwater Treatment System

The temporary GWTS continued operation through January 11, 2016 as described below.

5.2.1 Temporary Groundwater Treatment System Operation and Monitoring

When the full-scale GWTS was brought online on December 16, 2015, the temporary GWTS continued to treat IDW water through January 11, 2016, which included development and decontamination water from newly-installed extraction wells KAFB-106233 and KAFB-106234, and purge water generated during the Q4 groundwater sampling. After January 11, 2016, the system ceased operation and was decommissioned with all equipment demobilized by February 16, 2016.

The total volume of water treated at the temporary GWTS from January 1 through 11, 2016 was 312,900 gallons. The final routine monthly effluent sample was collected from the temporary GWTS on December 15, 2015. IDW water was held and sampled to confirm that contaminant of concern concentrations were below the regulatory limits for discharge prior to the release of the water to the Tijeras Arroyo Golf Course Main Pond. Monthly volumes of extracted groundwater treated during Q1 2016 are provided in Table 5-1.

5.3 Full-Scale Groundwater Treatment System

Commissioning of the well control house was completed on December 31, 2015. The GWTS treated groundwater from three extraction wells (KAFB-106228, KAFB-106233 and KAFB-106234) during Q1 2016.

5.3.1 Full-Scale Groundwater Treatment System Operation and Monitoring

The GWTS was operational for 77 percent of the time during Q1 2016 excluding planned shutdowns during non-work hours, system commissioning, and unplanned shutdowns that were caused by high water levels at the Tijeras Arroyo Golf Course Main Pond. System shutdown dates are provided in Table 5-2. The unplanned shutdowns were caused by alarms from the automated control system, which required a number of adjustments to its settings during commissioning and testing.

The GWTS operated during working hours and the commissioning process while the setup of the shutdown alarm and the leak detection systems were completed. During this time, manual observation was necessary to identify and react to any operational issues.

The total volume of extracted groundwater treated through March 31, 2016 at the full-scale GWTS was approximately 19 million gallons. Monthly volumes of groundwater pumped and treated during Q1 2016 are provided in Table 5-1.

5.3.1.1 Weekly and Monthly Compliance Sampling

Compliance samples were collected daily for the first 7 days of operation in December and were processed under a 24-hour laboratory analytical turnaround to ensure that treated water continued to meet the permit-discharge criteria (NMED, 2014). After the initial 7 days, samples were collected weekly beginning on January 7, 2016. Monthly sampling began on February 23, 2016 and will continue in Q2 2016. Weekly and monthly sample analytical results are provided in Table 5-3. Samples were collected from the influent, between the lead and lag GAC vessels, and the system effluent.

Analytical results for Q1 2016 full-scale GWTS samples are summarized below:

- Influent EDB concentrations ranged from 0.176 to 0.0756 µg/L, exceeding the 0.05 µg/L discharge limit. EDB was not detected above the 0.05 µg/L discharge limit in any system effluent samples from the lead granular activated carbon (GAC) vessel or in the treated-water storage tanks prior to discharge.

- Benzene was not detected above the 5 µg/L discharge limit in the influent or effluent water.

- Toluene was detected at 0.661 µg/L in one influent sample (GWTS-INF-0010); this concentration was below the 750 µg/L discharge limit.

- Total xylenes were not detected above the 620 µg/L discharge limit in any influent, lead GAC vessel effluent, or system effluent water samples.

- Dissolved manganese was detected at concentrations ranging from 0.00369J mg/L to 0.0256 mg/L in influent, lead GAC vessel effluent, and system effluent water samples during the weekly and monthly sampling events. All detected concentrations were below the 0.2 mg/L discharge limit.

- Dissolved iron was detected in one system effluent sample (GWTS-EFF-0009) at 0.0373J mg/L, which was below the 1 mg/L discharge limit.

All data for the full-scale GWTS were validated and deemed to be usable. The technical completeness was 100 percent. The GWTS data validation reports and data quality assessment reports are included in Appendix I-3.

5.3.1.2 Initial Groundwater Samples from Extraction Wells

Groundwater samples were collected on January 13, 2016 from extraction wells KAFB-106233 and KAFB-106234 following their completion. Samples were collected at the GWTS prior to treatment and prior to discharge to the golf course pond or KAFB-7 on January 21, 2016, which was when all three extraction wells began pumping to the GWTS. The samples were analyzed for EDB, BTEX, dissolved iron and manganese, total dissolved solids, and total suspended solids in accordance with the conditions listed in the Request for Temporary Permission to Discharge to KAFB-7 approval letter (NMED, 2016b). The initial analytical results of extraction wells are provided in Table 5-4 and are summarized below:

- EDB was estimated in the sample from KAFB-106234 at 0.112 µg/L, exceeding the 0.05 µg/L discharge limit. The EDB concentration did not exceed the discharge limit in the sample from KAFB-106233.

- Benzene was not detected above the 5 µg/L discharge limit in the samples from either extraction well.

- Toluene was measured at 1.17 and 0.278 µg/L in KAFB-106233 and KAFB-106234, respectively. Both concentrations were below the 750 µg/discharge limit.

- Total xylenes were detected at 1.54 and 0.921 µg/L in KAFB-106233 and KAFB-106234, respectively. Both concentrations were below the 620 µg/L discharge limit.

- Dissolved manganese was detected at concentrations of 0.0693 and 0.00823 mg/L in KAFB-106233 and KAFB-106234, respectively. Both detections were below the 0.2 mg/L discharge limit.

- Dissolved iron was not detected above the 1.0 mg/L discharge limit in either of the two extraction wells.

- Total suspended solids were not detected above the 10 mg/L LOQ in either of the two extraction wells.

- Total dissolved solids were detected at 195 and 360 mg/L in KAFB-106233 and KAFB-106234, respectively.

All initial extraction well data were validated and deemed to be usable. The technical completeness was 100 percent. The data validation reports and data quality assessment reports are included in Appendix I-3.

5.3.1.3 Effluent Compliance Samples for Discharge to KAFB-7

Between February 23 and March 22, 2016, nine samples were collected daily and three samples were collected weekly from the full-scale GWTS effluent prior to discharge to KAFB-7, in accordance with the conditions listed in the Request for Temporary Permission to Discharge to KAFB-7 approval letter (NMED, 2016b). The samples were analyzed for EDB, BTEX, and dissolved iron and manganese. Analytical results for daily and weekly effluent samples are provided in Table 5-5 and are summarized below:

- EDB was not detected above the 0.05 µg/L discharge limit in any effluent samples.

- Benzene was not detected above the 5 µg/L discharge limit in any effluent samples.

- Toluene was detected in 4 effluent samples at estimated concentrations ranging from 1.79 to 0.267 µg/L, but not in the corresponding trip blanks. All detections were below the 750 µg/L discharge limit.

- Total xylenes were not detected above the 620 µg/L discharge limit in any effluent samples.

- Dissolved manganese was not detected above the 0.2 mg/L discharge limit in any effluent samples

- Dissolved iron was not detected above the 1.0 mg/L discharge limit in any effluent samples.

It was determined that the toluene detections were not attributed to laboratory contamination, and the accompanying trip blanks were presumptively identified as having toluene present with estimated concentrations (Appendix I-2). Discussions with the field team indicated that the low toluene concentrations measured in the four effluent samples could be attributed to vapors released during painting activities inside the full-scale GWTS building where the sampling port was located; thus, the toluene results were estimated. This qualification did not impact data usability. Several corrective measures were implemented during sampling and as a result, no toluene was detected in subsequent GWTS effluent samples or associated trip blank samples collected for the remaining three weekly events in Q1 2016.

Having explained the source of the toluene in the four GWTS samples, all effluent data were validated and deemed usable. The technical completeness was 100 percent. The data validation reports and data quality assessment reports are included in Appendix I-3.

5.3.2 Groundwater Treatment System Operation and Maintenance

Flow meters were installed to continuously measure the volume of water treated through the full-scale GWTS. Meters were installed at the extraction wellheads, on the influent pump skid, and on the effluent pump skid after the GAC tanks. The volume of treated water discharged to the effluent pipeline was monitored on a monthly basis (NMED, 2014). The GWTS also electronically recorded daily flow rates and volume totals in the system controller.

During full-scale GWTS testing, an investigation of high pressure in the pipeline from extraction wells KAFB-106233 and KAFB-106234 found that gravel, sediment, and high density polyethylene debris were present in the pipeline causing clogging. The well control house was taken offline and the pipeline was cleaned out. Components of the two influent pipe stacks in the well control house were replaced in early January. The influent pipeline flow meters were also cleaned and retested after sediment and gravel were discovered in the flow meters.

A field calibration test was performed for all newly-installed and previously-installed flow meters on February 22, 2016. The field calibration check was performed by measuring the volume of water pumped into or from the influent tank during a 15-minute period, and comparing the flow rate derived from this test to the flow meter readout. Flow rates calculated during the field test were within 1 percent of the instantaneous flow meter readings.

6. INVESTIGATION-DERIVED WASTE

IDW is generated every quarter during operations at the BFF site and consists of liquid IDW, and solid IDW. Solid IDW can consist of waste from the installation of new wells, bag filters utilized at the GWTS, and/or construction activities that have taken place. During Q1 2016, liquid IDW was generated along with the GAC, which was returned to the vendor (Baker) for regeneration, and bag filters used at the temporary GWTS.

6.1 Liquid Investigation-Derived Waste

Liquid IDW generated during Q1 2016 consisted of purge water generated during GWM well sampling, and decontamination water generated from cleaning non-dedicated sampling equipment

The distinction between hazardous and non-hazardous well purge water was made prior to sampling the GWM network by considering historical data available for each GWM well, based on concentration of benzene exceeding the hazardous waste criterion of 500 µg/L for the previous four quarters. Decontamination water was considered non-hazardous due to the low potential of it carrying residual contamination from the well water; however, the decontamination water was characterized to ensure that it met treatment requirements for discharge to the GWTS

6.1.1 Non-Hazardous Water

The non-hazardous purge water was collected in 55-gallon plastic drums that were sealed with plastic covers with locking-ring steel collars. Water from individual wells was segregated into separate drums, which were labeled with vinyl Non-Hazardous Waste labels and transferred to the designated IDW storage yard located on Kirtland AFB.

A total of 107 drums containing 5,050 gallons of non-hazardous purge water was generated during Q1 2016. Table J-1-1 (Appendix J-1) provides well-specific purge water details. All non-hazardous purge water is being held until discharge into the GWTS can be scheduled, at which time it will be batched through the GWTS. A summary of all non-hazardous water management and disposal is provided in Table J-1-1.

6.1.2 Hazardous Water

Only one GWM well, KAFB-106005, had historically produced hazardous purge water containing benzene at concentrations above characteristic hazardous waste toxicity criteria (40 CFR Part 261.24) and was sampled in Q1 2016. Purging KAFB-106005 in Q1 2016 generated two drums (approximately 90 gallons) of hazardous (D018) purge water as summarized in Table J-2-1. The drums were properly labeled as hazardous waste (D018) and placed in the Kirtland AFB 90-day accumulation area pending offsite disposal.

6.2 Solid Investigation-Derived Waste

The temporary GWTS was decommissioned following shutdown and all equipment was demobilized by February 16, 2016. The piping, equipment and materials were returned to the vendor (Baker) including the GAC for regeneration. The bag filters were held until Kirtland AFB approved disposal as non-hazardous solid waste. The gravel pad that the system had been placed on was spread evenly around the site and graded per USACE and Kirtland AFB directions.

7. PROJECTED ACTIVITIES

Q2 2016 will comprise the period between April 1 and June 30, 2016. A corresponding Quarterly Report will be prepared that details the activities conducted during the quarter, presents the data obtained from all of the sampling, and provides a similar level of interpretation to this Report. Planned Q2 activities are summarized as follows.

Vadose Zone Monitoring

- Vadose zone monitoring will be performed between April 18 and May 13, 2016.

Groundwater Monitoring

- Groundwater monitoring will be performed between April 1 and May 25, 2016.
- A passive sampling demonstration will be initiated to validate the use of dual membrane samplers. The effort will entail analyses of samples collected using the passive sampler and the micro-purge methods. The resulting data will be compared to determine if dual membrane samplers are a viable alternative to the aging and inefficient dedicated pump sample collection infrastructure.

Drinking Water Supply Well Monitoring

- Drinking water supply well monitoring will continue on a monthly basis for organics and on a semi-annual basis for inorganics. Q2 2016 drinking water sampling for organic and inorganic compound analyses will be performed in April 2016. Samples collected in May and June of 2016 are scheduled for organic analyses only.

Groundwater Treatment System Operation

- GWTS operation will continue with expansion to include additional extractions wells scheduled to begin in late August 2016.

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FIGURES

TABLES

APPENDICES

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