

## EXECUTIVE SUMMARY

This report has been prepared in response to correspondence dated June 4, 2010, from the New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) (NMED, 2010a) to Kirtland Air Force Base (AFB) outlining the reporting, sampling, and analysis requirements related to the characterization and remediation of contaminated groundwater at Solid Waste Management Units ST-106 and SS-111, Bulk Fuels Facility (BFF) Spill, Kirtland AFB, New Mexico. Quarterly reporting incorporates information and data collected in support of ongoing remediation and site characterization activities related to the Stage 2 abatement action for the Former Fuel Offloading Rack (FFOR), designated as ST-106, and the phase-separated, hydrocarbon-impacted groundwater, designated as SS-111. As specified by the NMED-HWB, quarterly reporting for the ST-106 and SS-111 sites has been integrated due to the interrelated nature of the sites and the applicability of different data sets to characterization and remediation activities at the BFF Spill site.

Quarterly remediation and site investigation reporting presents field and analytical data and information associated with the operation, maintenance, and performance of the interim remedial measures soil-vapor extraction (SVE) and treatment systems; characterization and remediation activities associated with the groundwater, vadose zone, and FFOR investigations; and pre-remedy quarterly monitoring for groundwater and soil vapor at the BFF Spill site.

The major site characterization findings from the quarterly reports are cumulative and summarized as follows:

### ***Vadose Zone***

- Based on the three-dimensional (3D) distribution of vadose zone soil and vapor concentrations for wells installed and sampled to date, it appears that the majority of the vadose zone contaminant mass is located within 100 feet (ft) above the water table at depths of approximately 400 to 500 ft below ground surface (bgs).

- Based on the data collected to date and the soil concentration footprints at various depths, the soil concentrations indicate that the non-aqueous phase liquid (NAPL) migrated in a predominantly vertical direction along relatively narrow pathways until it reached the capillary fringe above the water table where it spread out in horizontal directions. The PneuLog<sup>®</sup> testing has further delineated these pathways.
- Soil concentrations define the soil residual NAPL saturations, which overall are less than 0.01 cubic centimeters (cm<sup>3</sup>)-NAPL/cm<sup>3</sup>-soil. This is a low value but is consistent with the medium- to coarse-grained nature of the sandy soil at the site.
- 3D volumetric analysis shows that the current extent of soil contamination, as defined by soil concentrations of total petroleum hydrocarbons (TPH) greater than 10 milligrams per kilogram (mg/kg), is approximately 29 million cubic yards with 12.4 million cubic yards (43%) at or below an elevation of 5,000 ft above mean sea level (approximately 350 ft bgs).
- Based on a screening process that accounts for frequency of detection, the following compounds are determined to be vapor constituents of concern (COCs): 1,2,4-trimethylbenzene (TMB); 1,3,5-TMB; 2-butanone; acetone; benzene; C5-C8 aliphatic hydrocarbons; C9-C10 aromatic hydrocarbons; C9-C12 aliphatic hydrocarbons; cyclohexane; ethylbenzene; heptane; isopropanol; m,p,o-xylenes; methylene chloride; n-hexane; propene; propylene; toluene; and total xylenes (in lieu of quantifying individual m,p,o-xylene isomers). Currently, there are no maximum contaminant level (MCL) standards for remediation of these vapor compounds. However, vapor will continue to be monitored to adequately characterize the vadose zone contaminant mass.
- Compared to the Fourth Quarter 2011 vapor plume maps, the First and Second Quarter 2012 total volatile organic compound (VOC) concentration footprints in the range of 100 to 1,000 parts per million by volume (ppmv) have expanded markedly. The 1,000- to 10,000-ppmv concentration range at the 4,900-ft elevation is somewhat smaller. The 1,000- to greater than 10,000-ppmv VOC concentration contours have not changed appreciably. Whether these changes are due to seasonal changes, the rising water table, or both is uncertain.
- The time-series analysis of the vapor concentration data since 2007 shows only marginal vapor concentration declines over time, even in the SVE wells. It is concluded that while substantial contaminant mass has been removed from the vadose zone (approximately 440,000 gallons of NAPL-equivalent mass vapor), the overall effect of the current SVE efforts is difficult to determine based on the vapor concentration data.
- During Second Quarter 2012, the SVE systems resumed operation. The SVE systems were moved to more optimum positions and monitored to ensure each system is functioning at its maximum capacity.
- The PneuLog<sup>®</sup> vadose zone testing generated distinctive permeability and vapor concentration profiles that will be used in the design of the overall vadose zone remediation system. In general, the permeability increases with depth, consistent with the lithologic data where the upper 250 ft of the vadose zone is composed of finer-grained material than that in the deeper intervals. In addition, two of the three PneuLog<sup>®</sup> tests (KAFB-106149 and KAFB-106150) show increasing vapor hydrocarbon concentrations with depth, consistent with the conceptual model described in Section 7 in terms of the declining water table creating a large NAPL “smear zone” extending from 250 ft bgs to the top of the current water table. The concentration profile for well KAFB-106148 shows higher concentrations in the upper 350 ft compared to the bottom 100 ft. This profile is consistent with the location of this well, which is closer to the initial FFOR release sites than the other two wells.

- The recently acquired PneuLog<sup>®</sup> data indicate that the water table was at approximately 350 ft when the NAPL releases started.
- Radius of influence (ROI) testing for SVE wells conducted in November and December 2011 shows that the ROI within the BFF is most likely between 220 and 300 horizontal ft using the current SVE system. A vertical ROI has not yet been determined.

### ***Groundwater and NAPL***

- Historical water level data for well KAFB-3 show that the groundwater table has declined approximately 140 ft since 1949 with the majority (approximately 100 ft) of this decline occurring since the mid-1970s.
- As the water table has declined as a result of regional groundwater extraction, the NAPL from the initial and subsequent releases has followed the falling water table downward. Over time, this has had the effect of creating a residual NAPL smear zone from nominal depths of 400 to 500 ft bgs.
- Based on an analysis of historical and current groundwater levels at the site, the water table has risen between approximately 4 and 6 ft since 2009. This can be attributed to the water conservation practices implemented by the City of Albuquerque and the San Juan-Chama Diversion Project completed in December 2008 to reduce groundwater withdrawals.
- These rising water levels have caused a number of wells to have screens that are now flooded with the top of the screen below the current water table. Second Quarter 2012 measurements show that groundwater elevations now exceed the top of the screens in nine shallow groundwater monitoring wells. Figure 5-2 and Table 5-7 illustrate the wells in which the screens are now below the water table, as the current April 2012 difference between the top of screen and water table. As of April 2012, nine Shallow Zone wells have flooded screens, seven wells have top of screen within 2 ft of the water table, and 33 wells have top of screens more than 2 ft above the water table.
- Rising groundwater levels continue to result in decreases in NAPL thickness and observations in monitoring wells. NAPL was detected in only one monitoring well (KAFB-106076) during this quarter. The majority of the NAPL mass observed in 2009, the year of lowest water levels, is now trapped below the water table.
- NAPL chemical analytical results show that the trapped NAPL will be an ongoing source of dissolved groundwater contamination indefinitely.
- Current groundwater flow directions are toward the KAFB-3 and Ridgecrest water supply wells with an average groundwater velocity of 95 ft/year (yr) and a range of 18 to greater than 300 ft/yr to the northeast at a direction of North 25° to 35° East.

- A number of hydraulic properties were measured at the site using field slug tests and laboratory tests. The results are incorporated into the following groundwater migration analysis:

Parameter	Units	Average Value <sup>a</sup>	Standard Deviation	Minimum Value <sup>b</sup>	Maximum Value <sup>b</sup>
Hydraulic conductivity (field tests)	ft/day	70	NM	40	129
Effective Porosity	Fraction	0.274	±0.049	0.22	0.32
Gradient	Fraction	0.001	±0.0006	0.0004	0.0016
Fraction Organic Carbon	mg/kg	230	±78	<100	380
Groundwater Velocity	ft/day	0.26	NM	0.05	0.94
Groundwater Velocity	ft/yr	95	NM	18	340
50-Year Downgradient Migration Distance	ft	4,750	NM	900	17,000

<sup>a</sup>Geometric mean used for hydraulic conductivity.

<sup>b</sup>Mean ±1 standard deviation used for minimum and maximum for gradient and porosity values. Minimum porosity value was used to calculate maximum velocity and maximum porosity was used to calculate minimum velocity.  
NM - not meaningful.

- Well KAFB-10612 could not be sampled due to pump failure and dropped tubing as discussed in Section 3.2.7. During the Third Quarter 2012 monitoring event, additional attempts will be made to retrieve this pump and tubing. If these are not successful, the well will be abandoned.
- In previous quarterly reports, a TPH-diesel range organics (DRO) plume map with a lower concentration of 150 micrograms per liter (µg/L) was generated. This was not done for this quarter because the analytical laboratory performed the TPH-diesel method detection limit study which resulted in a higher detection limit of 380 µg/L for samples from a number of wells. The laboratory regularly performs method detection limit studies in compliance with quality requirements. Therefore a standard dot map presentation was used for this compound.
- Groundwater analytical data for monitoring wells indicate that organic compounds are present in samples from 11 of the Intermediate and 3 of the Deep Zone wells. These wells are generally within the historic NAPL area; however, some wells are downgradient of the source area, including deep wells KAFB-106058 and KAFB-106057, located at the northeastern edge of the defined 1,2-dibromoethane (EDB) plume.
- Based on the analysis of the degradation indicator compounds and the spatial extent of the organic compounds, it appears that microbial degradation is limiting the extent of a majority of the organic compounds, including benzene; ethylbenzene; toluene; xylene; 1,2,4-TMB; and naphthalene. Additional evaluations are required to quantify the degradation rates and impact on future plume migration.
- EDB has migrated the full length of the monitoring network and was detected above the U.S. Environmental Protection Agency (EPA) MCL (0.05 µg/L) in samples from 30 of 51 Shallow Zone wells, 11 of 27 of Intermediate Zone wells, and 3 of 28 Deep Zone wells during the Second Quarter 2012 event. EDB is the only compound that was detected in the Shallow, Intermediate, and Deep Zones in samples from the farthest downgradient well clusters (GWM 10: KAFB-106055, KAFB-106057, and KAFB-106058; and GWM 3: KAFB-106035, KAFB-106036; KAFB-106037) for the last four quarters.

- The effect of microbial degradation on EDB migration rates and extent is more uncertain, and the current extent of EDB is a strong indication that any EDB degradation rates are quite slow. Additional compound-specific microbial and isotope data are required to determine whether microbial degradation is having any effect on EDB migration. Activities to acquire these additional data are planned for 2012.
- A Letter Addendum to the Groundwater Investigation Work Plan was submitted for NMED review and approval on June 13, 2012 (Appendix I-2) that requested approval of the installation of nine additional groundwater monitoring wells at three cluster locations, as directed in the letters from the NMED, dated April 13 and May 15, 2012 (Appendix I-4). The nine additional groundwater monitoring wells will address data gaps identified in the characterization of the dissolved-phase groundwater plume as part of the Resource Conservation Recovery Act Facility Investigation for groundwater.
- Based on a screening process that accounts for frequency of detection (5%) and comparison between maximum detected concentrations and NMED and EPA regulatory screening levels, the following analytes are determined to be groundwater COCs:
  - Shallow Zone: EDB; 1,2-dichloroethane; benzene; bis (2-ethylhexyl) phthalate; dibenzo(a,h)anthracene; ethylbenzene; iron; manganese; methylene chloride; naphthalene; nitrogen (nitrate as N); phenol; sulfate; tetrachloroethene; toluene; trichloroethene; and xylenes (total).
  - Intermediate Zone: EDB; benzene; ethylbenzene; iron; manganese; and naphthalene.
  - Deep Zone: EDB; bis (2-ethylhexyl) phthalate; and manganese.