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CERTIFIED MAIL – RETURN RECEIPT REQUESTED

January 19, 2018 DRAFT

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Mr. Chris Segura
Chief, Installation Support Section
AFCEC/ZCOW
2050 Wyoming Blvd SE, Suite 124
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RE: NOTICE OF DISAPPROVAL
RESOURCE CONSERVATION AND RECOVERY ACT INVESTIGATION REPORT
BULK FUELS FACILITY SPILL
SOLID WASTE MANAGEMENT UNIT ST-106/SS-111
KIRTLAND AIR FORCE BASE
EPA ID# NM9570024423, HWB-KAFB-MISC

Dear Colonel Gibbs and Mr. Segura:

The New Mexico Environment Department ("NMED") has received the U.S. Air Force's ("Permittee") *Resource Conservation and Recovery Act ("RCRA") Facility Investigation ("RFI") Report* ("RFI Report") dated January 20, 2017. This RFI Report summarizes the investigation of fuel releases at the Bulk Fuels Facility ("BFF") as well as a summary of interim measures performed between November 11, 1999 and December 31, 2015. The Report was submitted in accord with the Kirtland Air Force Base ("KAFB") Hazardous Waste Treatment Facility Operating Permit No. NM9570024423 ("Permit").

As stated in NMED's August 3, 2017 letter, there are three primary issues with the RFI Report as submitted on January 20, 2017:

1. Incomplete characterization of the dissolved-phase groundwater plume(s);

2. Technically incomplete and biased estimates of concentration trends and degradation rates; and
3. Incomplete delineation of the vertical and horizontal extent of light non-aqueous phase liquid ("LNAPL").

NMED issued a Notice of Deficiency ("NOD") on November 16, 2017 that included deadlines for the submittal of two work plans and a summary of plume capture analysis in order to make progress towards addressing the issues and concerns in the RFI Report. These work plans and summary were originally due to NMED by November 8, 2017 and the NOD set deadlines for December 15, 2017 for the work plans and December 31, 2017 for the plume capture analysis. As of the date of this letter, NMED has received a revised work plan for continuous coring in the vadose zone and groundwater to address the data gap to characterize LNAPL nature and extent, and a work plan for the installation of water table groundwater monitoring wells. The plume capture analysis summary will be submitted at a date to be set by NMED after the modelling working group meets on February 15, 2018.

NMED has completed a comprehensive review of the RFI Report and detailed comments are presented below. Due to the extensive outstanding data gaps in the characterization of dissolved-phase plumes and the LNAPL mass, the RFI Report is deemed incomplete and cannot be approved as submitted. The comments listed below must be corrected in either a revised RFI Report or in an addendum to the original RFI Report. NMED is open to meeting with the Permittee to discuss a path forward for resolution of comments on the RFI Report.

General Comments

1. The RFI report defines the acronym of fuel-related analytes ("FRAs") but also uses the terms "fuel-related constituents," "fuel-related contaminants," and "Site contaminants" without explaining whether these four terms are intended to be synonymous or if they have different meanings. The Permittee shall clarify and define each term so as to differentiate between their intended meanings or replace undefined terms with terms that have been clearly defined.
2. References and comparisons to NMED soil screening levels ("SSLs") in all parts of the RFI Report must be updated to include the SSLs published in March 2017. NMED understands and appreciates that the RFI Report makes references to the SSLs in publication at the time of specific soil investigations and removal actions. For the purpose of clarity and transparency, however, the Permittee shall include the date of NMED publication with all references to SSLs in the RFI Report.
3. The RFI Report discusses vapor testing in soil and on-base industrial buildings, including the issue of vapor intrusion into industrial buildings. The Permittee's discussion of the potential for groundwater contaminant diffusion and vapor transport, as it pertains to the potential for vapor intrusion both on-base and off-base, is piecemeal and does not compare off-base soil vapor and groundwater data with NMED risk-based screening levels. The Permittee shall provide a rigorous analysis of the potential for soil vapor contamination to migrate into homes and buildings located off-base and the findings integrated into the Conceptual Site Model presented in the RFI Report (Section 7).

4. Figure 6-35 clearly illustrates the change in hydraulic gradient and groundwater flow direction over time, transitioning from a strong gradient towards the northeast to a relatively flatter gradient in the area of the EDB plume. In particular, Q4 2015 water table levels in Figure 6-35 indicate a relatively flat gradient at the plume-scale with a component of groundwater flow towards the Veterans Administration ("VA") Hospital water supply well. These water table maps are generated using groundwater monitoring wells that are no longer screened at the water table and therefore there is uncertainty in both the extent and magnitude of contaminant concentrations at the water table. Due to the rising water table and submergence of groundwater monitoring well screens at the water table, there is no longer a functional sentinel well for the VA Hospital water supply well. The loss of the sentinel well and the lack of resolution of contaminant plume(s) at the water table gives NMED great concern about the potential westward migration of groundwater contaminants towards the VA Hospital well. The Permittee shall prioritize the installation of a water table groundwater monitoring well, as discussed in the September 6-8, 2017 technical working groups. Additionally, the Permittee shall provide a rigorous analysis of current hydraulic conditions across the plume to evaluate the potential westward migration of groundwater contaminants and implications for the VA Hospital well.
5. The Permittee inconsistently uses the term "bioslurping" throughout the report. Section ES-4.2 incorrectly describes the bioslurping systems employed at the site as having drop pipes that extended to the top of the water table. As explained in Section 5.4.2, however, the drop pipes installed in wells KAFB-1065, 1066 and 1068 extended to a depth just above the top of the LNAPL. The Permittee states in Section ES-3, Section ES-4.2, and elsewhere in the report that bioslurping volatilizes LNAPL from the water table but fails to indicate that bioslurping also directly removes LNAPL through its slurping function. The high vacuum recovered liquid and vapor-phase LNAPL, as well as soil vapor. Liquid LNAPL, however, was fully volatilized as it rose up the drop pipe, and no liquid LNAPL was recovered at the surface. The Permittee calls this design a "modified bioslurping" system and uses this term in several sections of the RFI to acknowledge this modification from conventional bioslurping designs. The Permittee shall define the term "modified bioslurping", use it consistently throughout the RFI, and shall edit the bioslurping description in Section ES-4.2 to be consistent with Section 5.4.2. Section 5.4.2 indicates that LNAPL entered the drop pipe but was then fully volatized as it rose up the drop pipe. This function should be mentioned in addition to bioslurping's LNAPL volatilization function and its soil gas removal/treatment function. The Permittee asserts that wells KAFB-106160 and 106161, which did not have drop pipes, but were subject to vacuum extraction designed to remove soil vapors from the vadose zone, also performed a bioslurping function by removing LNAPL utilizing vacuum extraction at and above the water table. While NMED agrees that LNAPL mass can be reduced by the operation of these soil vapor extraction ("SVE") wells, the wells do not perform a bioslurping function since a drop pipe is not used to slurp LNAPL that has collected inside the well. Both of these LNAPL removal activities are referred to in Figures ES-13 and 7-10 as "Bioslurping & SVE at and above the water table". This term should be used as the title of Section 5.4.2 and consistently throughout the RFI text in reference to the LNAPL removal efforts involving vacuum extraction in wells KAFB-1065, 1066, 1068, 106160

and 106161. The RFI contains multiple assertions that bioslurping resulted in an increase in observed LNAPL thickness in the bioslurping wells. While NMED does not dispute this possibility, all such assertions should consistently include the Permittee's statement that "water table fluctuations also influenced the occurrence of LNAPL in (groundwater monitoring "GWM") wells at the Site", and that "it is not possible to determine the exact amount of thickness increase caused by bioslurping".

6. In order to avoid any appearance of applying the outdated "pancake" model of the distribution of LNAPL in groundwater, the Permittee shall amend the RFI to clearly differentiate between LNAPL that is observed floating on the water surface inside monitoring wells, versus LNAPL that occurs in porous aquifer material co-existing with water at various percentages of saturation. When referring to LNAPL in porous aquifer media, the Permittee shall replace all references to LNAPL floating on the water table or on groundwater (including similar terms) with "LNAPL that has accumulated in the upper groundwater zone" or another such term that more accurately reflects the physical distribution of LNAPL. For example, in RFI Section 8.1, the Permittee shall amend the statement, "When LNAPL reached the water table it spread out and floated as an immiscible layer on the water table…" NMED suggests the following or similar language, "When LNAPL reached the water table it spread laterally in response to buoyancy forces, selectively displaced groundwater from the interior of the larger pores in the aquifer media, and began to dissolve into groundwater." The Permittee shall amend all relevant sections of the RFI to ensure that discussions of the distribution of LNAPL in groundwater are consistent with modern science and industry guidance documents such as those published by the American Petroleum Institute (API), and the Interstate Technology Regulatory Council (ITRC). Additionally, the Permittee shall thoroughly address the occurrence of residual LNAPL that does not accumulate in monitoring wells, but nonetheless provides a long-term source of dissolved groundwater contaminants. The Permittee's revised discussion of LNAPL shall explain the occurrence of benzene and other petroleum hydrocarbons in groundwater at concentrations exceeding effective solubility. The Permittee also shall include map(s) showing locations of all monitoring wells where benzene and/or other petroleum hydrocarbons have been detected at concentrations in excess of effective solubility, along with the footprint of historical LNAPL in groundwater, and present observations of LNAPL in monitoring wells.

EXECUTIVE SUMMARY

1. **Permittee's Statement, p. ES-3, 5th paragraph:** "Once leaked jet fuel enters the ground, it is called LNAPL. LNAPL includes liquid compounds that are not water, do not dissolve in water, and are less dense than water."

   NMED Comment: Aromatic compounds present in hydrocarbon fuels, including BTEX, and short-chain aliphatic compounds dissolve in groundwater and soil porewater at varying concentrations, which is controlled by their molecular weight, compound geometry, vapor pressure, and aqueous solubility. The Permittee shall amend this statement to acknowledge that many of the LNAPL compounds, over time, will dissolve into soil moisture and groundwater. Additionally, this statement should be revised to be inclusive of all three phases of LNAPL (e.g., soil gas, residual LNAPL, etc.).

2. **Permittee's Statement, p. ES-5, 2nd paragraph:** "The (Areas of Interest "AOIs") were assigned based on which Site media was being analyzed for fuel-related contamination: AOIs 1 through AOI 4 involve soil; AOIs 5 through AOI 7 involve soil vapor; and AOI 8 and AOI 9 involve groundwater."

   NMED Comment: NMED requests that the Permittee identify the AOIs where LNAPL was discovered, investigated, and removed.

3. **Permittee's Statement, p. ES-5, 4th paragraph:** "LNAPL interim measures included the use of a skimmer pump to skim LNAPL off the water table, and bioslurping to volatilize LNAPL from the water table."

   NMED Comment: See General Comment #5 above regarding bioslurping.

4. **Permittee's Statement, p. ES-5, 5th paragraph: "**Groundwater investigation activities included the installation and sampling of 134 groundwater monitoring (GWM) wells between 2000 and 2016."

   NMED Comment: The listing of a range of 2000 to 2016 implies that data from wells installed during the 2016 calendar year will be included in the RFI Report, which is not the case. NMED recommends revising the text to include dates (e.g., December 31, 2015) for clarity.

5. **Permittee's Statement, p. ES-5, 5th paragraph:** "Slug testing and aquifer testing was performed at GWM wells."

   NMED Comment: Slug testing is a form of aquifer testing. The term aquifer testing includes the performance of slug tests and pumping/recovery tests. The Permittee shall revise the text to clarify.

6. **Permittee's Statement, p. ES-9, 1st paragraph:** "The data show that biodegradation is occurring in [Area of Interest] AOIs 5 and 6 based on O_2 consumption rates and that some areas in AOI 5 are low in O_2. This suggests that aerobic biodegradation is rate-limited in these areas and optimal biodegradation is no longer occurring. Constant [soil vapor extraction] SVE operation from 2003 through Q2 2015 has limited the available moisture in the vadose zone which in turn limits biodegradation rates."

   NMED Comment: Suggest revising the cited text to clarify that optimal biodegradation is limited by both low oxygen and by low soil moisture.

7. **Permittee's Statement, p. ES-9, 4th paragraph:** "The SVE systems moved air through the subsurface, which feeds microbes that perform aerobic biodegradation of fuel constituents."

NMED Comment: Suggest revising the cited text to replace "feeds" with either "feeds and respirates" or "delivers hydrocarbons vapor and oxygen to…" in order to clarify the mechanisms of biodegradation affected by operation of SVE at the site.

8. **Permittee's Statement, p. ES-12, 2nd paragraph:** "Bioslurping systems are similar to SVE in that they create a vacuum and treat fuel-related contaminants from the subsurface, but bioslurping includes a drop pipe that is extended from the ground surface to the top of the water table."

   NMED Comment: See General Comment #5 above regarding the location of bioslurping drop pipes.

9. **NMED Comment, Section ES-4.3:** The Permittee shall revise the groundwater discussion to acknowledge that dissolved-phase contamination, exceeding standards, was discovered in 2001.

10. **Permittee's Statement, p. ES-12, 1st paragraph:** "Dissolved-phase fuel-related contamination has been delineated."

    NMED Comment: The Permittee's assertion that the dissolved-phase contamination has been delineated is no longer valid due to the continuing rising water table and the resulting submergence of groundwater monitoring well screens. The Permittee shall amend this statement to acknowledge the outstanding data gap at the water table and that NMED has required the Permittee to install additional water table groundwater monitoring wells.

11. **Permittee's Statement, p. ES-12, 2nd paragraph:** "Between Q4 2012 and Q4 2015, the average EDB concentration decreased from 9.6 µg/L to 1.1 µg/L. Average EDB concentrations and maximum EDB detections in both AOI 8 and 9 decreased. Although the interpreted length of the plume remained fairly constant throughout the four-year time period, as additional [groundwater monitoring] GWM wells were installed the interpreted width of the plume decreased from a maximum of 1,800 feet to 1,300 feet in the Shallow Zone (Figure ES-7). The average benzene concentration decreased between Q4 2012 and Q4 2015 from 580 µg/L to 175 µg/L. The maximum detected concentration also decreased from 13,000 µg/L to 8,940 µg/L. The length and width of the plume were stable to slightly decreasing, with the maximum length ranging from 3,000 to 2,800 feet in length, and the width ranging from a maximum of approximately 1,300 feet to a minimum of approximately 1,100 feet (Figure ES-8). The discussion that follows only addresses contaminant degradation."

    NMED Comment: The Permittee must revise this section to acknowledge that the observed decreasing trends in dissolved-phase concentrations and apparent plume stability could also result from the rising water table and migration of high contaminant concentrations to elevations above the screened intervals for the groundwater monitoring

wells. The following discussion must also be expanded to be inclusive of potential impacts of the rising water table on the contaminant trends.

12. **Permittee's Statement, p. ES-15, 1st paragraph:** "A statistical analysis was conducted using historical EDB and benzene data from Q1 2011 through Q4 2015 to determine concentration trends over time for these two constituents in each well. Results show that of the wells where a trend could be established, 60% showed a statistically significant decrease in EDB, and 47% showed a statistically significant decrease in benzene. All other FRAs in groundwater are found in AOI 8, within the footprint of the shallow benzene plume."

    NMED Comment: The Permittee shall revise this section to acknowledge that the observed decreasing concentration trends in dissolved-phase concentrations and plume stability may also be attributed to the rising water table and the migration of high contaminant concentrations to elevations above the top of groundwater monitoring well screens.

13. **NMED Comment, p. ES-15, 2nd paragraph:** NMED requests that the Permittee replace the term "alkalinity" throughout the document with "bicarbonate alkalinity" to be more precise. Additionally, the Permittee must revise the text to state that incomplete degradation of 1,2-dibromoethane is most likely occurring under sulfate-reducing conditions within the dissolved portion of the plume near the LNAPL source. Finally, the Permittee should add text discussing the occurrence of methanogenesis in groundwater in the source area.

14. **Permittee's Statement, p. ES-15, 3rd paragraph:** "Aerobic microbial respiration results in carbon dioxide (CO_2), which when released into groundwater dissolves carbonate minerals from the soil into the aquifer, which in turn increases groundwater alkalinity concentrations."

    NMED Comment: While dissolution of carbonate minerals may be contributing to increased groundwater alkalinity, it is much more likely that the predominant cause of increased groundwater alkalinity at this site is due to the transformation of CO_2 generated by hydrocarbon oxidation into bicarbonate/carbonate alkalinity. The Permittee shall therefore expand the discussion of groundwater alkalinity concentrations to be inclusive of all potential mechanisms occurring in the groundwater.

15. **Permittee's Statement, p. ES-15, 4th paragraph:** "In the downgradient aerobic portion of the plume, data indicate that abiotic degradation processes such as hydrolysis may be a significant favor in the degradation of EDB."

    NMED Comment: Hydrolysis of EDB is possible under aerobic conditions at KAFB, however, ethylene glycol, a degradation product, has not be measured in groundwater. Rate constants for EDB degradation through hydrolysis are much lower than reductive debromination of EDB under sulfate-reducing conditions. Most degradation of EDB is

occurring under sulfate-reducing conditions immediately downgradient from the LNAPL source release area. The RFI Report does not provide sufficient detail in analysis or discussion to support the Permittee's assertion of the significance of hydrolysis at the Site.

16. **Permittee's Statement, p. ES-15, 6th paragraph:** "As a result of technical discussions between [U.S. Army Corps of Engineers] USACE, Air Force Civil Engineer Center, and NMED in July 2014, it was determined that a groundwater extraction and treatment system interim measure would be installed to provide hydraulic control and collapse the EDB plume."

    NMED Comment: Both the Albuquerque Bernalillo County Water Utility Authority ("WUA") and the City of Albuquerque played an important role in the technical working group discussions and the decision to install a groundwater treatment interim measure. NMED requests that the Permittee revise the cited text to include both the WUA and the City of Albuquerque.

17. **NMED Comment, Section ES-5, Conceptual Site Model:** The fourth bullet of the Conceptual Site Model should be revised to include a sentence summarizing the biodegradation processes that have occurred naturally in the vadose zone.

18. **Permittee's Statement, p. ES-19, 6th bullet:** "The leaking LNAPL continued to migrate along this pathway to the water table, creating a layer of floating LNAPL that depressed the water table. It is estimated that LNAPL reached the water table sometime in the 1980s. Constituents of LNAPL at the LNAPL/groundwater interface dissolved into groundwater based on their solubility creating the groundwater contaminant plumes (Figure ES-12)."

    NMED Comment: See General Comment #6 above regarding the occurrence of LNAPL in groundwater.

19. **Permittee's Statement, p. ES-19, 6th bullet:** "Constituents of LNAPL at the LNAPL/groundwater interface dissolved into groundwater based on their solubility creating the groundwater contaminant plumes (Figure ES-12)."

    NMED Comment: The Permittee shall revise the cited text to clarify "dissolved-phase groundwater contaminant plumes."

20. **Permittee's Statement, p. ES-21, 1st bullet:** "The increased groundwater use by the growing Albuquerque population created not only a decline in water levels, but a cone of depression at drinking water supply wells such as Ridgecrest 3 and 5 to the northeast of the Site, causing groundwater to flow to the northeast. Groundwater flow was originally to the southwest, but reoriented 180 degrees to the northeast in the late 1970s due to Water Authority pumping regimes."

NMED Comment: Bullet text should be revised to clarify that the cone of depression was in the vicinity of the WUA Ridgecrest well field and was not limited to just Ridgecrest wells 3 and 5.

21. **Permittee's Statement, p. ES-21, 6th bullet:** "In 2009, the water table began to rise due to groundwater conservation efforts by the Water Authority and the citizens of Albuquerque."

    NMED Comment: The Permittee shall revise the bullet text to state that the rising water table is due to a combined effect of water conservation strategies undertaken by the WUA as well as the Drinking Water Project which uses surface water from the Rio Grande River as a source of drinking water, reducing the pumping of WUA water supply wells.

22. **Permittee's Statement, p. ES-21, 6th bullet:** "Rising water levels combined with active skimmer and bioslurping interim measures resulted in the reduction of free-phase LNAPL (Figure ES-13)."

    NMED Comment: This bullet, as written, overstates the effectiveness of LNAPL skimming at the Site. The LNAPL skimmer recovered only 280 gallons of LNAPL during its period of operation from Q4 2007 and Q3 2008; the skimmer was not active when the water table began to rise in 2009. Additionally, as the water table rose, the number of wells screened at the water table within the source area decreased and as of Q4 2015 there were no wells screened at the water table. The loss of water table groundwater monitoring wells is another, more likely explanation for the loss of measurable free-phase LNAPL. The Permittee shall revise the cited text to more accurately state contributing factors in the measured free-phase LNAPL at the Site.

23. **Permittee's Statement, p. ES-21, 9th bullet:** "Residual LNAPL in saturated pore spaces within the smear zone may still be a contributing source to the groundwater plume, however groundwater concentrations suggest this contribution is at equilibrium. Statistical analysis has shown that EDB concentrations have decreased in 59% of [groundwater monitoring] GWM wells, and benzene concentrations have decreased in 44% of GWM wells since 2011. In addition, both the dissolved-phase EDB and benzene plumes extent and footprint have remained stable between 2012 and 2015."

    NMED Comment: A statistical analysis is an insufficient and overly simplified approach to evaluate plume stability and to definitively eliminate LNAPL as an ongoing contributing source to the dissolved-phase groundwater plume. In fact, when the Q4 2015 concentrations of benzene and EDB are compared to their respective effective solubility limits, the groundwater concentration data appears to indicate the persistence of LNAPL source in the subsurface. For example, in Q4 2015, six Shallow Zone groundwater monitoring wells (KAFB-1065, -1068, -10610, -10614, -106059, and -106064) have benzene concentrations greater than the site-specific effective solubility of 1,424 µg/L; concentrations in these six wells range from 1,920 µg/L (KAFB-1065) to 8,940 µg/L

(KAFB-106059). Additionally, the statistical analysis does not address the rising water table and its impact to measured concentrations and the migration of high contaminant concentrations to elevations above the top of groundwater monitoring well screens. The Permittee must revise the text to be inclusive of all lines of evidence of residual LNAPL and plume stability, acknowledging the potential impact of the rising water table on the concentration trends observed.

24. **NMED Comment, Section ES-6, Remaining data gaps:** The Permittee shall add a bullet to state that additional information is required on locations of EDB partitioning out of the LNAPL and the rate(s) of partitioning under varying redox conditions. Additionally, a bullet is required to address the need for revising and updating the CISA that was conducted at the Site to obtain a more meaningful and robust analysis of residual and degraded fractions of EDB. The CSIA included in the RFI Report is not technically defensible due to coelution of benzene and other organic compounds with EDB, not using two-dimensional gas chromatography as the preferred analytical method, EDB concentrations at detection limits of analytical instruments, and lack of fresh LNAPL samples for carbon isotope analysis on EDB.

25. **Permittee's Statement, p. ES-24, 1st list item:** "Sufficient data were collected to characterize the nature and extent of fuel-related contamination at the Site with the exception of the data gaps listed below."

    NMED Comment: This statement is incorrect and overstates the conclusions that can be drawn from the data at the Site and is in conflict with the statement of "exception of data gaps listed below." The Permittee must revise this statement to more clearly state that data gaps remain in the characterization of nature and extent of fuel-related contamination at the Site.

26. **Permittee's Statement, p. ES-24, 2nd bullet: "**Groundwater: The dissolved-phase EDB plume boundary is not fully defined in the northwestern most area of the plume in AOI 9."

    NMED Comment: The Permittee must revise this statement to clearly state the existing data gap for the dissolved-phase plumes at the water table, including EDB and benzene, due to submergence of groundwater monitoring well screens with the rising water table. Additionally, the Permittee must also incorporate data from the two newest well nests, KAFB-106235 and KAFB-106236, and determine if a data gap remains at the northwestern edge of the dissolved-phase EDB plume.

27. **Permittee's Statement, p. ES-25, 2nd bullet,** "Groundwater: Install at least one additional GWM well cluster north and west of KAFB-10626 in order to fully delineate the dissolved-phase EDB plume in AOI 9 and provide an additional sentinel well in that area."

NMED Comment: A single GWM well cluster is not sufficient to address the dissolve-phase EDB plume data gap. The new groundwater monitoring wells scoped during the September 6-8, 2017 technical working group meetings, along with incorporation of existing monitoring well infrastructure, is the first phase of well installation and data collection to make progress towards addressing the data gap in the dissolve-phase plumes at the water table. The Permittee must revise this statement to include the additional wells that were scoped during the September 6-8, 2017 technical working groups as well as indicate the work plan to be submitted to complete well drilling, installation and sampling. Additionally, there is a reference to a "sentinel well" without defining the designation and purpose of a sentinel well. The Permittee must describe and consistently use the term sentinel well through the RFI Report, including the Executive Summary.

28. **Comments on Figures:**
    a. **Figure ES-1:** The timeline arrow for "Bioslurping/Skimmer Technology" runs from the beginning of 2008 thru the end of 2012. However, skimming was conducted from Q4 2007 thru Q3 2008 (Section 5.4.1), and bioslurping systems were operated from Q3 2008 thru Q3 2011 (Section 5.4.2). At a minimum, the timeline arrow for "Bioslurping/Skimmer Technology" should be amended to run from Q4 2007 thru Q3 2011. Additionally, RFI Report Section 5.1 suggests that wells KAFB-106160 and KAFB-106161 performed a bioslurping function even though they were not constructed with a small diameter drop pipe. The RFI Report suggests that these wells performed a bioslurping function from Q2 2012 thru Q2 2015. The Permittee must clarify both text and figure to be consistent with actual site bioslurping and skimmer technology operation. For example, based on RFI Report text, the "Bioslurping/Skimmer Technology" arrow in Figure ES-1 should be revised to extend from Q4 2007 thru Q2 2015.
    b. **Figure ES-9:** The Permittee must revise the figure to clarify if "nitrogen" is either nitrate as N, nitrate/nitrite as N, or total nitrogen.
    c. Figure ES-3: The Permittee must revise the figure to label AOI-9 on the map.
    d. **Figure ES-9:** The Permittee shall revise the figure to fix the typographical error and correct "Dissolve Magnesium" to "Dissolved Manganese."
    e. **Figure ES-13:** The Permittee shall revise the figure to identify which of the two wells attached to the internal combustion engine (ICE) Units are SVE wells or bioslurping wells. Specifically, the well on the left should be labelled as the SVE well and the well on the right should be labelled as the bioslurping well.

INTRODUCTION

29. **Permittee's Statement, p. 1-1, 1st paragraph:** "This Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Report was prepared by Kirtland Air Force Base (AFB) to document the investigations of the fuel release discovered on November 11, 1999. There are two Solid Waste Management Units (SMWUs) associated with the fuel release inside the Bulk Fuels Facility (BFF), designated as ST-106 and SS-111. The BFF was originally classified as SWMU ST-106; following the discovery of the light non-aqueous phase liquid (LNAPL) in groundwater in 2007, an additional designation of SWMU SS-111 was added."

NMED Comment: The Permittee must revise the cited text, along with all subsequent text, where appropriate, to acknowledge that dissolved-phase contamination, excess of standards, was initially discovered in 2001.

30. **NMED Comment, Figures:**
    a. **Figure 1-2, Generalized Site Conceptual Model:** The proximity of labeling for the "VA Complex" and the location of the extraction well symbol gives the impression that the VA Hospital water supply well extends down into the dissolved-phase plume and is therefore pumping contaminated groundwater. The Permittee should consider revising the graphic to make it clear that the well screened in the dissolved-phase plume is one of the pump and treat interim measure extraction wells and **not** the VA Hospital water supply well.
    b. **Figure 1-2, Generalized Site Conceptual Model:** The graphic shows a "sentinel vadose zone well" that is depicted as a shallow boring that does not extend to groundwater. NMED is unaware of this well designation or of what the design and purpose would be. The term "sentinel vadose zone well" has not previously been used on the project and implies the need for an early detection system for vapor migration. Additional discussions are required with NMED on this new well designation and the term must be defined in the RFI Report with a discussion of the well purpose.
    c. **Figure 1-2, Site Areas of Interest Map**: The various soil, soil vapor, and groundwater AOIs depicted in this map represent logical designations based on media and contaminant distribution. That said, the AOIs reply on detailed knowledge of the site and the fact that some AOIs cover groups of AOIs of different media can be confusing. Additionally, Soil AOI 1 appears to cover the same area as Soil Vapor AOI 5. In order to prevent possible confusion, the Permittee should consider revising the legend of Figure 1-2 to add prefixes to the AOIs to indicate the media addressed by the AOI. For example, the legend could be revised to list "Soil AOI 1," "Soil Vapor AOI 5," "Groundwater AOI 8," etc. NMED requests that the Permittee consider carrying this clarification through the RFI Report text for clarity of discussion.

SECTION 2.0, FACILITY HISTORY AND PROJECT BACKGROUND

31. **NMED Comment, p. 2-1, Bullets**: The list does not include the pump house at the BFF where overflows are known to occur, including a release in 2012. The Permittee must revise the text to include the pump house as it is a relevant and potential source.

SECTION 3.0, REGULATORY CONTEXT

32. **NMED Comment, p. 3-2, 2nd paragraph:** The Permittee may not split the Solid Waste Management Unit for application of screening levels. Moreover, Section 6.2.3 of the Permit requires that the site data be screened for the residential use scenario. The Permittee may also screen for the industrial and construction worker scenario but only in addition to residential. The Permittee shall revise the document accordingly.

33. **Permittee's Statement, p. 3-2, 3rd paragraph:** "Soil Vapor: The Permit does not specify screening criteria for soil vapor. The screening criteria for soil gas included in NMED, 2015a are based on sub-slab investigations and are not appropriate for evaluating nature and extent of soil vapor contamination throughout a 500-foot vadose zone. This Report evaluates reported soil vapor results to determine areas of relative high or low concentrations, but does not compare soil vapor data to screening criteria."

    NMED Comment: In March 2017, NMED revised the "*NMED Risk Assessment Guidance for Site Investigations and Remediation."* As part of this update to the NMED screening level guidance, Table A-3 has been added and lists vapor intrusion screening levels ("VISLs"). Additionally, the Permittee screens soil vapor concentrations in the Risk Assessment dated July 15, 2017 with the NMED VISLs in order to assess risk for the hypothetical future use scenario. The Permittee shall update the RFI Report to update screening levels and utilize the VISLs in the guidance document. Additionally, the Permittee must make the RFI Report and Risk Assessment consistent in application of NMED guidance and statement on risk.

34. **NMED Comment, Table 3-1:** The Permittee shall identify the following analytes as "Biodegradation indicator" in the Categorical Classification Column: Alkalinity, Bicarbonate Alkalinity, Bromide, Carbonate Alkalinity, Iron, Iron Dissolved, Manganese, Manganese Dissolved, Methane, Nitrogen Nitrate-Nitrite, Sulfate, Sulfide, and Total Nitrate/Nitrite.

    The Permittee shall identify Polycyclic Aromatic Hydrocarbons (PAH) as "Constituent of fuels" in the Categorical Classification column.

    Acetone has been detected in the source area groundwater at the Site and has been identified by the Permittee in quarterly reports as a hydrocarbon degradation byproduct. If the Permittee believes that the presence of acetone in groundwater at the Site is due to degradation, the Permittee shall add "Degradation Indicator" to the Categorical Classification column of the table.

SECTION 4.0, VADOSE ZONE INVESTIGATION METHODS AND RESULTS

35. **NMED Comment:** During an evaluation of soil vapor monitoring points ("SVMPs"), sampling processes, and development of the soil vapor rebound and biorespiration testing, the Permittee noted that many SVMPs did not have air tight seals. The Permittee must revise the RFI Report to include a discussion on the lack of SVMP seals and potential impacts on soil vapor concentration data as well as on estimates of soil vapor contaminant degradation.

36. **NMED Comment, Section 4.3:** The Permittee shall add a reference to the schematic of the pneulog system included in Appendix H.

37. **NMED Comment, Section 4.4.1:** The Permittee does not discuss soil vapor detections off-base and compare those detections to NMED VISLs, as outlined in the NMED

screening guidance published March 2017. The Permittee shall revise the RFI Report to incorporate NMED VISLs.

38. **Permittee's Statement, Section 4.5.1:** "All historical SVM results are included in Appendix G."

    NMED Comment: The 2005 temporary SVM results are not included in Appendix G. Additionally, the locations of and boring logs for SB-01 through SB-09 are not provided in the RFI Report. The Permittee must revise the RFI Report to include this missing data. If the data is not available to be included, the statement should be revised to clarify the data available and included in the report.

39. **NMED Comment, Section 4.5.5:** The Permittee shall add a discussion to explain why permeability testing was performed at only three of the nine Pneulog well locations.

40. **Permittee Statement, p. 4-24, 4th bullet:** "It is possible that EDB was degrading in the vadose zone under anaerobic conditions."

    NMED Comment: The second sentence of the cited bullet is incomplete and should be revised. The Permittee shall revise the cited bullet to add a discussion of the timing of EDB anaerobic degradation and the operation of SVE at the Site.

41. **Permittee's Statement, p. 4-27, 1st paragraph:** "… however, concentrations of BTEX constituents were all below the 2015 NMED industrial/construction worker SSLs."

    NMED Comment: The Permittee shall revise the RFI Report to update screening levels to those in 2017 March publication of NMED screening level guidance. Additionally, per Section 6.2.3 of the Permit, the residential scenario must be used for screening contaminants.

42. **Permittee's Statement, p. 4-27, 4th paragraph:** "NMED does not currently promulgate a SSL for [total petroleum hydrocarbon] TPH or 2-methylnapthalene…"

    NMED Comment: The March 2017 NMED "*Risk Assessment Guidance for Investigations and Remediation, Volume 1*" includes screening levels for both TPH and 2-methylnapthalene. The Permittee shall update the RFI Report to use the 2017 March screening levels.

43. **Permittee's Statement, p. 4-27, 5th paragraph:** "In 2014, based on exceedances of the 2012 NMED residential SSLs detected in samples from the former pipeline investigation, approximately 2,340 cy (3,648 tons) of soil was removed and transported off-Site for disposal at Valencia Regional Landfill in Los Lunas, NM…"

    NMED Comment: The Permittee shall update the text to include soil concentrations.

44. **Permittee's Statement, p. 4-28, 3rd paragraph:** "Minimal areas of remaining fuel-related contaminated soil exceeding 2012 NMED residential SSLs (to which analytical results were compared at the time of sampling) could not be excavated due to the proximity to operating underground infrastructure (i.e., SVMPs or underground electric utility lines) or the presence of existing high use roads associated with the delivery of fuel to the Site."

    NMED Comment: The Permittee shall update the cited text to include soil concentrations.

45. **NMED Comment, Section 4.6.2.5.1:** The equation for calculating the mass of hydrocarbon (HC) extracted is not dimensionally correct as provided. The Permittee shall revise the text and calculations to use the correct equation and show the units for the conversion factor of 24.055.

46. **Permittee's Statement, p. 4-35, 2nd paragraph:** "The mass of HCs extracted was calculated using daily flow rates, operating times, and Horiba readings taken at the CATOX SVE System, prior to the vapor stream entering the CATOX unit (pre-CATOX), from data collected at discrete sampling events."

    NMED Comment: The operating times are not provided in the RFI Report and the flowrate and hydrocarbon content are provided in a format that does not lend itself to being useful for checking the calculations. The Permittee must revise the RFI Report to include a summary table such as Table 3-5 in the April -July 2015 quarterly monitoring report. NMED is unable to verify the accuracy of the calculations in the report without the missing information.

47. **NMED Comment, p. 4-36, Equation for HC biodegraded:** The equation for calculating the mass of HC biodegraded is not dimensionally correct as provided. The Permittee must verify the equation being used and recomplete the calculations present. The Permittee must revise the text to define variable "D" and indicate the units. Additionally, the Permittee must include the value of $C_{V,bkgd}$ used in the calculation.

48. **NMED Comment, p. 4-36, 1st paragraph:** The Permittee points the reader to Appendix L for a summary of biodegradation calculations and the cover sheet for Appendix L-1 states that the calculations are provided. However, the appendix only contains the results and not the actual calculations. Consequently, NMED cannot verify the accuracy of the calculations. The Permittee must revise the RFI Report to include the calculations so that NMED can verify the results presented.

49. **NMED Comment, Figures:** Many of the figures in Section 4.0 rely on color to differentiate wells, borings, and sampling locations or data. Thus, these figures are essentially meaningless to the roughly 7 percent of the population who have color vision

deficiency. NMED requests that the Permittee revise the figures to be able to be interpreted by all readers, including those with color vision deficiency.

SECTION 5.0, LNAPL INVESTIGATION METHODS AND RESULTS

50. **NMED Comment:** See General Comment #5 above regarding bioslurping

51. **Permittee's Statement, p. 5-1, 2nd paragraph:** "LNAPL is composed of numerous hydrophobic liquid organic chemicals that are less dense than water (Tomlinson et.al., 2014). These characteristics make LNAPL immiscible with water, meaning water and LNAPL do not form a homogenous liquid when mixed. Instead, the density of LNAPL causes it to float on the surface of the water table."

    NMED Comment: The Permittee shall revise the cited text to acknowledge the potential for LNAPL constituents to both dissolve into groundwater and partition into soil vapor. Also see General Comment #6 above regarding the occurrence of LNAPL in groundwater.

52. **Permittee's Statement, p. 5-1, 3rd paragraph:** "The Site's LNAPL is comprised of jet fuel (AvGas, [jet propellant] JP-4, and JP-8) and jet fuel constituents from the BFF release."

    NMED Comment: Aviation gasoline ("AvGas") is used in piston-engine aircraft and is not classified as jet fuel; JP fuels are used in turbine-engine (jet) aircraft. The Permittee shall revise this sentence appropriately.

53. **Permittee's Statement, p. 5-2, 4th paragraph:** "Bioslurping employs vacuum removal systems, such as those discussed in Section 4; however, it differs from SVE in that a small diameter drop pipe is installed to just above the water table to volatilize LNAPL directly from the water table (KAFB, 2007b)."

    NMED Comment: See General Comment #5 above regarding bioslurping**.**

54. **Permittee's Statement, p. 5-2, 5th paragraph:** "These systems did not have a small diameter drop pipe but were still able to volatilize LNAPL off of the water table as these SVE locations are screened in both the saturated and unsaturated zone, thus performing a bioslurping function."

    NMED Comment: See General Comment #5 above regarding bioslurping

55. **NMED Comment, Section 5.2.2.3:** The Permittee must add a figure that shows the locations of the boring from which core samples were collected for geotechnical and LNAPL analyses.

56. **Permittee's Statement, p. 5-6, 1st paragraph:** "This indicates that the fluctuations of LNAPL thickness at the Site are not only due to groundwater elevation changes, but also to the operational LNAPL interim measures."

    NMED Comment: A single incident of decreased LNAPL thickness when the groundwater elevation decreased is not enough evidence to attribute this change to operational LNAPL interim measures.

57. **Permittee's Statement, p. 5-6, 2nd paragraph:** "The disappearance of measurable floating LNAPL prior to the submergence of the GWM well screens indicates that no substantial amount of floating LNAPL exists."

    NMED Comment: See General Comment #6 above regarding the occurrence of LNAPL in groundwater. The statement that there is "no substantial amount of floating LNAPL" in monitoring wells at the Site is misleading. All groundwater monitoring wells in the source area, except for the two monitoring well nests installed for the In-Situ Bioremediation Pilot Test, are submerged and no longer have well screens at the water table. The lack of measurable LNAPL in monitoring wells at the Site may be due to the submergence of monitoring well screens by the rising water table. Moreover, an evaluation of the site-specific effective solubility values for constituents such as benzene, relative to detected groundwater concentrations, indicate that LNAPL persists in the source area. The Permittee must revise the cited text and RFI Report to acknowledge the existing data gap for characterization of LNAPL floating inside monitoring wells at the site. The Permittee must include a thorough evaluation of groundwater concentrations and effective solubility as a line of evidence for the presence of LNAPL in the source area. The Permittee shall discuss the existence of residual LNAPL at the Site submerged by groundwater.

58. **Permittee's Statement, p. 5-6, 4th paragraph:** "Conceptually, when LNAPL initially reached the water table, being immiscible with water, the LNAPL remained as a separate phase liquid on the top of the water table."

    NMED Comment: See General Comment #6 above regarding the occurrence of LNAPL in groundwater.

59. **NMED Comment, Section 5.3.5, LNAPL Data Gaps:** The horizontal and vertical extent of LNAPL has not been adequately defined. The timing of the rising water table with the installation of groundwater monitoring wells at the water table resulted in a limited and too short period of monitoring to definitively determine extent of LNAPL at the Site. The Permittee leverages soil vapor data as the only other line of evidence for defining LNAPL but does not acknowledge the limitations of the soil vapor data set, including SVMP density on-base verses off-base and impact from poorly sealed SVMPs. Additionally, the discussion of LNAPL extent does not include an evaluation of effective

solubility and groundwater concentrations for constituents such as benzene, an important tool for evaluating the occurrence of LNAPL in the subsurface.

60. **Permittee's Statement, Section 5.4.2:** "The skimming operation at well KAFB-1065 was replaced in early August 2008 to implement a more efficient LNAPL recovery system. In August 2008, a bioslurping system was installed at KAFB-1065. Systems were installed at KAFB-1066 and KAFB-1068 in March 2009 (AFCEE, 2009b). The goals of the bioslurping units at KAFB-1065, KAFB-1066, and KAFB-1068 were to directly volatilize LNAPL on the water table and recover and destroy the vapors using the ICE vacuum systems. The ICE vacuum systems/CATOX SVE system at KAFB-106160 and KAFB-106161 from Q2 2012 through Q2 2015, were not bioslurping systems. These SVE systems preformed a bioslurping function because they still volatilized LNAPL on the water table due to the SVE locations being screened across the water table. In addition, the application of vacuum at these wells would induce flow of LNAPL towards the borehole, to increase capture and volatilization of LNAPL."

    NMED Comment: See General Comment #5 above regarding bioslurping

61. **Permittee's Statement, p. 5-11, 5th bullet:** "Bioslurping remediated LNAPL at the Site and removed approximately 225,000 equivalent gallons of LNAPL."

    NMED Comment: This statement incorrectly suggests that LNAPL at the site has been remediated. The Permittee shall amend this statement to read "Modified bioslurping and SVE at and above the water table at the Site removed approximately 225,000 equivalent gallons of LNAPL." Also see General Comment #5 above regarding bioslurping.

SECTION 6.0, GROUNDWATER INVESTIGATION METHODS AND RESULTS

62. **NMED Comment:** The RFI Report utilizes the term "sentinel well" but does not describe why some monitoring wells are designated as sentinel wells and does not summarize test results from sentinel wells. The Permittee shall add a section discussing the designation and purpose of sentinel wells, shall summarize results from sentinel wells, and discuss how the data is used to inform the Conceptual Site Model (CSM).

63. **Permittee's Statement, p. 6-8, 6th paragraph:** "The model results indicate that EDB plume capture will be most effective with 5 total extraction wells, the three existing plus two additional (USACE, 2016f)."

    NMED Comment: The RFI Report is not the appropriate step for evaluating and determining effectiveness of a remedy and optimization. The Permittee shall revise the text to clarify that the Corrective Measures Evaluation process is not being circumvented with a presumed remedy.

64. **Permittee's Statement, p. 6-26, 2nd paragraph:** "Aerobic microbial respiration results in the release of CO_2 into groundwater which dissolves carbonate minerals from the soil into the aquifer and increases groundwater alkalinity concentrations."

NMED Comment: While dissolution of carbonate minerals may be contributing to increased groundwater alkalinity, the predominant cause of increased groundwater alkalinity at this site is most likely the transformation of CO_2 generated by hydrocarbon oxidation into bicarbonate/carbonate alkalinity. The Permittee shall revise the discussion to incorporate all likely processes affecting groundwater alkalinity concentrations.

65. **Permittee's Statement, p. 6-29, Alkalinity:** "Alkalinity (as calcium carbonate) increases when there is an increased rate of mineral dissolution (USACE, 2016b). Microbial degradation of organic compounds causes an increase in CO_2 concentrations, which results in the lowering of the pH, which in turn, causes an increased rate of mineral dissolution."

    NMED Comment: While dissolution of carbonate minerals may be contributing to increased groundwater alkalinity, the predominant cause of increased groundwater alkalinity at this site is most likely the transformation of CO_2 generated by hydrocarbon oxidation into bicarbonate/carbonate alkalinity. The Permittee shall revise the discussion to incorporate all likely processes affecting groundwater alkalinity concentrations.

66. **Permittee's Statement, p. 6-29 & 6-30, Acetophenone and Methane:** "The Permittee discusses the detection of acetophenone and methane in groundwater as being byproducts of microbial degradation. The Permittee, however, does not discuss the origin of acetone in groundwater, although the Permittee has asserted in other documents submitted to NMED that acetone is a byproduct of microbial degradation of hydrocarbons."

    NMED Comment: Microbial degradation of fuel constituents in both the vadose zone and groundwater is an ongoing and significant process at the Site. It is therefore important that this section of the RFI Report discuss all constituents that may serve as indicators of microbial degradation. If the Permittee believes that the presence of acetone in groundwater at the site results from microbial degradation, the Permittee shall add a robust discussion of how acetone is generated from microbial degradation of hydrocarbons.

67. **NMED Comment, Section 6.3.2.7 Compound-Specific Isotope and Microbial Analysis Results:** The Permittee appears to be utilizing the data from the Q3 2013 compound-specific isotope analysis ("CSIA") that had significant concerns expressed by NMED and Dr. John Wilson regarding the test methods and data quality. The Q3 2013 is unusable and must be removed from the RFI Report, including tables and appendices.

68. **Permittee's Statement, p. 6-32, 2nd paragraph:** "In Q4 2015, the general horizontal groundwater gradient at the Site was approximately 5.4 × 10-4 foot/foot to the northeast (USACE, 2016b). Water levels in the Shallow Zone varied from a high of 4,866.6 feet above mean sea level (amsl) at KAFB-1065 to a low of 4,863.06 feet [above mean sea level] amsl at KAFB-106201 (a difference of 3.54 feet). Figure 6-35 shows the horizontal groundwater gradient at the Site in Q4 of the past four years, illustrating that the gradient

has flattened significantly in Q4 2015. As discussed below, this is due to reductions in pumping rates at Water Authority drinking water supply wells. Figures 6-36 and 6-37 illustrate reported water-level elevations over time along the axis of the plume."

NMED Comment: The RFI Report must be amended to include the most recent groundwater data, including the flattening of the groundwater gradient in the 2017 quarterly groundwater level data.

69. **Permittee's Statement, p. 6-32, 5th paragraph:** "The San Juan-Chama Diversion project, implemented in 2008 by the Water Authority, reduced groundwater withdrawals from the aquifer. As a result of these water conservation practices, water levels have risen in this area since 2009, with the most dramatic increases in the northern area of the plume."

    NMED Comment: The RFI Report must be revised to clarify that the rising water table is the result of increased water conservation practices by the WUA as well as the Drinking Water Project that utilizes surface water as a drinking water source.

70. **Permittee's Statement, p. 6-33, 1st full paragraph:** "These rising water levels caused tops of the screens in many GWM wells to become submerged (Table 6-11 and Figure 6-38; USACE, 2016b). As of October 2015, the screens of 45 Shallow Zone GWM wells were submerged and the top of the screens of 15 Shallow Zone GWM wells were above the water table. The Water Authority predicts that based on current and planned conservation practices water levels in Albuquerque's aquifer will continue to rise into the 2020s (See Section 7; Water Authority, 2016). The submersion of shallow GWM well screens may affect measurable analyte concentrations; however, GWM wells have multiple quarters of data prior to the submersion of their screens. As illustrated in Figure 6-15, decreasing trends in EDB concentrations were apparent prior to the submergence of GWM well screens. GWM wells shown in Figure 6-15 have between three and six years of data prior to the submergence of screens."

    NMED Comment: The Permittee must revise the RFI Report to acknowledge the impact of the rising water table on concentration trends. Additionally, the text must be revised to reflect that some, but not all, groundwater monitoring wells show decreasing trends prior to well screen submersion (Figure 6-15 and 6-16).

71. **NMED Comment, Section 6.3.4.3 Slug Testing Results:** The NMED communicated to the Permittee substantial concerns in the results of slug testing conducted at the Site. At a minimum, the Permittee must revise this section to include a thorough discussion of data quality and data usability and address the concerns raised by the NMED.

72. **NMED Comment, Section 6.4.1 EDB/BTEX Treatability Study:** The Permittee shall revise this section to include the ranges of initial concentrations of EDB in both the source area and side-gradient microcosms.

73. **Permittee's Statement, p. 6-37, 3rd paragraph:** "As a result of technical discussions between USACE, AFCEC, and NMED in July 2014, it was determined that a groundwater extraction and treatment system would be pilot tested to provide hydraulic control and collapse the EDB plume."

    NMED Comment: Both the WUA and City of Albuquerque participated in the July 2014 working group technical discussions that resulted in the selection of groundwater extraction as a groundwater interim measure for the BFF site. NMED requests that the Permittee revise the text to include the WUA and City of Albuquerque participating in these discussions and decisions.

74. **NMED Comment, Section 6.5 Groundwater Results and Interim Measures Summary:** On the whole, the RFI Report overly simplifies the processes occurring at the Site and omits important factors such as the rising water table and loss (submergence) of water table groundwater monitoring wells. A simple statistical analysis of concentration trends results in a failure to consider the multiple processes occurring in the groundwater that could influence EDB and BTEX concentrations. The Permittee must revise this section as well as all other relevant sections to address NMED comments on plume definition, cause(s) of observed decreasing contaminant concentration trends in groundwater, plume stability, and microbial degradation indicators.

SECTION 7.0, CONCEPTUAL SITE MODEL

75. **Permittee Statement, p. 7-5, 2nd paragraph:** "The braided-type nature of Ancestral Rio Grande deposits, combined with the structural dip of thin laterally discontinuous fine-grained zones within, has resulted in migration of the dissolved phase EDB plume parallel to general groundwater flow."

    NMED Comment: The migration of groundwater, and therefore of the EDB dissolved-phase plume, is primarily controlled by the direction of the hydraulic gradient towards the WUA Ridgecrest well field. Historic water level data for the Albuquerque Basin confirms that prior to the installation and operation of water supply wells, groundwater primarily flowed to the south and west towards the Rio Grande. As pumping demands on the Basin have increased over the decades, the hydraulic gradient has rotated by as much as 180 degrees to the current-day north-northeasterly flow. Since the timing of the leak is unknown, it is possible that EDB migrated initially in response to a hydraulic gradient that is different from the present gradient. The Permittee must update the discussion of the hydrologic conceptual site model to include the influence of hydraulic gradient and groundwater flow directions on the EDB plume.

76. **Permittee's Statement, p. 7-5, 4th paragraph:** "The sands of the Santa Fe Group in the Albuquerque Basin (Section 7.5.1) provide the majority of the groundwater resources for Albuquerque and Kirtland AFB."

    NMED Comment: The terms "sand" or "sands" are not used in the text of Section 7.5.1. NMED suggests that the term "sands" be replaced with the term "sand, gravel and sandy

gravel" as the Permittee has used this term in Section 7.5.2 to describe the coarse-grained Sierra Ladrones Axial Fluvial Member.

77. **NMED Comment, Section 7.9 Fate and Transport:** The Permittee's discussion of the potential for vapor transport in the subsurface as it pertains to the potential for vapor intrusion both on and off base is piecemeal, does not reference soil vapor data at the site, does not reference indoor vapor monitoring that has been conducted, and does not reference NMED or EPA risk-based guidelines for soil vapor and indoor air. The Permittee shall include a rigorous discussion of the potential for soil vapor to migrate to the surface and to intrude into buildings on and off base.

78. **Permittee's Statement, p. 7-10, 3rd paragraph:** "Once the capillary fringe is reached, the LNAPL may move laterally as a continuous, free-phase layer along the upper boundary of the water-saturated zone due to gravity and capillary forces. Although principal migration may be in the direction of the maximum decrease in water table elevation (hydraulic gradient), some migration may occur initially in other directions. A large continuous-phase LNAPL mass may hydrostatically depress the capillary fringe and water table."

    NMED Comment: The IRTC (May 2017) contends that the soil pores are never 100% saturated with LNAPL, but that LNAPL is mobile when its saturation percentage is greater than its residual saturation and when its relative permeability is greater than that of water. Mobile LNAPL may be found both above and below the water table. While a large mass of LNAPL may depress the apparent water table because of its greater saturation percentage, it is unlikely that such a large mass of LNAPL existed at this site to appreciably affect the water table. The Permittee shall revise the text to reflect the current, prevailing scientific theory on occurrence of LNAPL in capillary fringe.

79. **NMED Comment, Section 7.10, Conceptual Site Model:** The Conceptual Site Model as presented in the RFI Report is fundamentally flawed as it fails to acknowledge the persisting LNAPL source that exists in both the unsaturated and saturated zones. Soil vapor data, recent measurements of LNAPL in a groundwater monitoring wells, and effective solubility concentrations all indicate that LNAPL exists in the vadose zone and at the water table, providing a continuing source for both soil vapor and dissolved-phase contaminants. The Permittee must revise the text to be complete in its discussion of the occurrence of LNAPL and the potential source.

80. **Permittee's Statement, p. 7-20, 2nd bullet:** "Jet fuel was released from the underground pipelines in AOI 1. Although the exact time period of the release is unknown, it is estimated that leaks began no later than the mid-1970s, and continued through 1999. The timeline is constrained by the use of AvGas, which contained EDB (EDB was not a constituent of JP-4 or JP-8). Kirtland AFB transitioned from AvGas to JP-4 in 1975. Over time, AvGas, JP-4, and JP-8 have been released at the Site, hence the LNAPL is a mixture of all three of these fuels."

NMED Comment: AvGas is used in piston-engine aircraft and is not classified as jet fuel; JP fuels are used in turbine-engine (jet) aircraft. The Permittee shall revise the text accordingly.

81. **Permittee's Statement, p. 7-21, 2nd bullet:** "The leaking LNAPL continued to migrate along this pathway to the water table, creating a layer of floating LNAPL that depressed the water table."

    NMED Comment: See General Comment #6 above regarding the occurrence of LNAPL in groundwater.

82. **Permittee's Statement, p. 7-21, 8th bullet:** "In 2009, the water table began to rise due to groundwater conservation efforts by the Water Authority and the citizens of Albuquerque."

    NMED Comment: As stated in previous comments, the Permittee must revise the RFI Report to state that the rising water table is the result of both increased conservation practices by the WUA and implementation of the WUA Drinking Water Project that uses surface water as a drinking water source.

83. **Permittee's Statement, p. 7-21, 10th bullet:** "On-Base residual LNAPL in the source area from 20 feet bgs to the water table is an ongoing source of soil vapor contamination in the vadose zone. The residual LNAPL in AOI 5 has been removed to 20 feet by excavation, but is still present from 20 feet to approximately 300 feet bgs. Permeable sediments in the vadose zone provide a pathway for this relatively shallow contamination to migrate horizontally. However; the heterogeneous lithology and the active biodegradation ongoing in this area limit both horizontal and vertical migration of soil vapor. Additionally, the deep vadose zone to the ground surface along with limits of Henry's Constant and diffusion of fuel constituents prevents the migration to the surface (Figure 7-11)."

    NMED Comment: Figure 7-11 referenced in this text does not depict soil vapor at all and there is no information specific to Henry's Law Constant for the various fuel constituents or their potential to diffuse in and through the vadose zone. The Permittee must revise the RFI Report to include a robust and thorough analysis of the potential for soil vapor contamination to migrate to the surface and the resulting potential impacts to human health and the environment. Additionally, the 2014 soil removal actions were based on the NMED screening levels in publication at the time. The Permittee must revisit the concentrations of the soil left in place screened against the 2017 March NMED soil screening levels and include the results in this discussion.

84. **Permittee's Statement, p. 7-22, 1st bullet:** "Residual LNAPL in saturated pore spaces within the smear zone may still be a contributing source to the groundwater plume, however groundwater concentrations suggest this contribution is at equilibrium. Statistical analysis has shown that EDB concentrations have decreased in 59% of GWM

wells, and benzene concentrations have decreased in 44% of GWM wells since 2011. In addition, both the dissolved-phase EDB and benzene plumes extent and footprint have remained stable between 2012 and 2015."

NMED Comment: The Permittee must revise the text to include a discussion of the potential impacts of the rising water table and submergence of groundwater monitoring well screens on concentration trends in groundwater.

85. **NMED Comment, Figures:**
    a. **Figure 7-2:** The Permittee shall amend the legend to note that the regional geology and site transects are located on Figures 7-4 and 7-5, respectively.
    b. **Figures 7-4 and 7-5:** The Permittee shall amend the legends on Figures 7-4 and 7-5 to note that the transect locations are shown on Figure 7-2

SECTION 8.0, CONCLUSIONS

86. **Permittee's Statement, p. 8-1, 3rd paragraph:** "When LNAPL reached the water table it spread out and floated as an immiscible layer on the water table in AOI 8. As groundwater flowed around the edges of the LNAPL, the soluble constituents were dissolved into groundwater and moved downgradient through advection."

    NMED Comment: See General Comment #6 above regarding the occurrence of LNAPL in groundwater.

87. **Permittee Statement**, **p. 8-1, 3rd paragraph:** "Rising water levels combined with active interim measures such as bioventing reduced the LNAPL on the water table, and currently there is no observable floating LNAPL on the water table."

    NMED Comment: See General Comment #6 above regarding the occurrence of LNAPL in groundwater. This conclusion fails to acknowledge the lack of groundwater monitoring wells screened at the water table that could impact the ability for the Permittee to measure floating LNAPL inside monitoring wells at the Site. Additionally, it does not include lines of evidence such as effective solubility that indicate persistence of LNAPL at the site. Moreover, floating LNAPL has been detected in a water table groundwater monitoring well at the In-Situ Bioremediation Pilot Test, indicating that the Permittee's assertion of no floating LNAPL inside monitoring wells is incorrect. The Permittee must revise this conclusion.

88. **Permittee's Statement, p. 8-2, 2nd paragraph:** "As of Q4 2015, the nature and extent of groundwater contamination at the Site has been characterized with the exception of the northwestern most area of the dissolved-phase EDB plume, where concentrations at KAFB-10626 are below the MCL, but have been increasing."

    NMED Comment: This conclusion by the Permittee fails to acknowledge the loss of groundwater monitoring wells screened at the water table and the resulting critical data

gap of dissolved-phase constituent concentration data at the water table. The Permittee must revise this conclusion.

89. **Permittee's Statement, p. 8-2, 3rd paragraph:** "Water use in the Albuquerque Basin has had a significant effect on the nature and extent of contaminants in groundwater and will continue to influence contaminant transport at the Site into the future. The plume is oriented to the northeast due to the high pumping rates at Water Authority wells through 2009. As pumping rates decreased, the hydraulic gradient began to flatten through 2015, and water levels are projected to continue to rise over the next 50 years. Continued collaboration with the Water Authority will be essential during the CME phase to understand how current and projected use of Water Authority wells will affect groundwater conditions, and thus the implementation of any proposed remedy at the Site."

    NMED Comment: The Permittee must include the VA Hospital in stakeholder discussions and development of the CME as the VA Hospital supply well is the nearest in proximity to the dissolved-phase EDB and benzene plumes.

90. **Permittee's Statement, p. 8-3, 2nd bullet:** "Groundwater: Install at least one additional GWM well cluster north and west of KAFB-10626 in order to fully delineate the dissolved-phase EDB plume in AOI 9 and provide an additional sentinel well in that area."

    NMED Comment: The Permittee shall revise the RFI Report, including the recommendation cited, to be consistent with NMED requirements as set forth in the November 16, 2017 NOD letter. The Permittee must include a commitment to install water table groundwater monitoring wells, following a data-driven approach, to complete delineation of the dissolved-phase plumes at the water table. Additionally, the Permittee must replace sentinel wells to ensure maintenance of the Permittee's ability to have early-detection of plume migration to be protective of VA Hospital, WUA, and KAFB water supply wells.

APPENDICES

91. **NMED Comment, Appendix J:** Revise the time series graphs to indicate when the SVE catalytic oxidizer system (CATOX) system was shut down.
92. **NMED Comment, Appendix L-1:** The results are in units of volume (gallons) and not mass (pounds) as indicated by the sub-appendix title.
93. **NMED Comment, Appendix Q, Compound-Specific Isotope Analysis:** Please see Attachment A for NMED's technical memorandum on the errors, comments, and revisions required for Appendix Q.
94. **NMED Comment, Appendix R, Quant-Array™-Chlor and Reduced Gases (Hydrogen/Methane/Ethene/Ethane) Study:** Please see Attachment B for NMED's technical memorandum on the errors, comments, and revisions required for Appendix Q.
95. **NMED Comment, Appendix T, Trend Analysis of EDB and Benzene in Groundwater at Kirtland Air Force Base, Q4 2015:** Please see Attachment C for

NMED technical memorandum on errors, comments, and revisions required for Appendix T.

The EPA has also completed a review of the RFI Report and their comments are included as Attachment D to this letter. The Permittee must review, address, and make the necessary revisions in response to the EPA comments.

The Permittee must submit a revised RFI Report in addition to an RFI Addendum Report to address the deficiencies noted in this letter. NMED recognizes that the Permittee has submitted a work plan to collect data to address the existing data gaps in the characterization of LNAPL at the Site, and a work plan for the drilling and installation of water table groundwater monitoring wells. Any additional investigative work to address the data gaps in the RFI Report and noted in this letter will need to be done under a work plan that is submitted and approved by the NMED in accordance with the Permit. As part of the response to this letter, the Permittee must submit a timeline for deliverables to include submittal of a revised RFI Report and RFI Addendum Report.

If you have any questions regarding this letter, please contact Mr. John Kieling of the NMED's Hazardous Waste Bureau at (505) 476-6035.

Sincerely,

Juan Carlos Borrego
Deputy Secretary
Environment Department

Attachments:

A: NMED Comments on Appendix Q, Compound-Specific Isotope Analysis
B: NMED Comments on Appendix R, Quant-Array™-Chlor and Reduced Gases (Hydrogen/Methane/Ethene/Ethane) Study
C: NMED Comments on Appendix T, Trend Analysis of EDB and Benzene in Groundwater at Kirtland Air Force Base, Q4 2015
D: EPA Comments on RFI Report

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