Albuquerque Bernalillo County
Water Utility Authority

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Memo

To: Dennis McQuillan (NMED)

From: Diane Agnew (WUA)

CC: Katherine Yuhas (WUA), Rick Shean (WUA), Kate Mendoza (WUA), Bruce Yurdin (NMED), Michelle Hunter (NMED)

Date: 11/2/2018

Re: Kirtland Air Force Base Bulk Fuels Facility Numerical Flow Model

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The Albuquerque Bernalillo County Water Utility Authority (Water Authority) has reviewed the Appendix I-7, Numerical Flow Model Supporting Information, included with the *Quarterly Report – April-June 2018, Bulk Fuels Facility* (September 2018) (Report) submitted by Kirtland Air Force Base (KAFB) for the Bulk Fuels Facility (BFF) project site and prepared by their contractor, EA Engineering, Science and Technology, Inc. (EA). The Water Authority's review of the Report is ongoing but given the upcoming technical "deep dive" presentation of the model presented in Appendix I-7, the Water Authority is submitting comments on the appendix as a stand-alone memo. In order to review Appendix I-7, the Water Authority downloaded the FEFLOW Viewer software to look at the modeling files included with the Report, concurrent with review of the supporting documentation included in Appendix I-7. Below are Water Authority comments related to the numerical model submitted in the Report. Based on the Water Authority's review, we request that EA address the following comments to ensure confidence in their estimated capture zones for the interim measure extraction wells.

- The FEFLOW Viewer was challenging to download and is not well supported by MIKE Powered by DHI. We used a combination of the user manual, online help, and technical support line to complete the download and evaluate the files provided in Appendix I-7. The low level of technical support and information coupled with the difficulty loading and running the Viewer is concerning from the Water Authority's point-of-view as a public stakeholder reviewing the model. Due to the limitation of the Viewer, the Water Authority was unable to verify that the model results provided were generated by the input files.

- The eastern edge of the model domain is roughly 750 feet from KAFB 20, a water supply well for the base. Similarly, the "Government Well" is approximately 700 feet from the westernmost edge of the model domain. The model domain boundary conditions are defined as constant head and therefore serve as an infinite source or sink for water in the model. Pumping wells located close to a constant head boundary will preferentially pull water from the constant head boundary rather than pulling water across the model domain. The result could be that the effects of the water supply wells are not being properly simulated by the model. To minimize the influence of the constant head boundaries, the model domain should be extended out further away from the water supply wells.

- As stated in the *EPA Systematic Approach for Evaluating Capture Zones* guidance document, capture can be delineated by particle tracks which can then be used to delineate percentages of plume capture. The numerical model presented in Appendix I-7 of the Report uses backward extension particle tracking to define capture zones for the four interim measure extraction wells and three water supply wells ("government well," KAFB-3, and KAFB-20). These particle tracks are

seeded at the wells and are extended backwards in time to define the hydraulic containment of the wells. The particle tracks are being run through a model that is calibrated using a "best-fit" of simulated hydraulic head values verses hydraulic heads measured during a synoptic measuring event. Additionally, the calibrated model uses pumping rates that are defined as the operational rate for any wells operational for five or more days before the synoptic measuring event. This means that a given interim measure extraction well could be not be in operation for an entire quarter and then turned on five days before the measuring event and be included in the model as if it were in operation for the entire 90 days. In short, this gives a false representation of the modeled capture zone. The implication of this approach is that the pumping conditions occurring during the defined time period is an exaggerated representation of the extraction system's operation. Depending on well operation during a given quarter, this approach could easily overstate the hydraulic containment achieved by the system. The Water Authority would encourage EA to complete a sensitivity analysis for pumping rates to evaluate the variability in hydraulic containment for this approach, as stated in the ASTM standard for capture zone analyses (ASTM D5981-96). Additionally, Section 7 of Appendix I-7 needs to be revised to include the "snapshot in time" incorporation of interim remedy wells as a model limitation.

- One of the primary assumptions of EA's model approach is that there is a uniform gradient across the domain. This argument was tested, as outlined in Section 3.1, but seems to be nulled with the number of quarters eliminated from use due to a variety of reasons including: operation of nearby water supply well KAFB-3 and operation of the interim remedy extraction wells. The Water Authority agrees with the importance of using synoptic water levels for the gradient analysis but would argue that the fact that the uniform gradient does not hold for the scenario of operating a water supply well and the operation of the interim measure extraction wells indicates that there is not a uniform gradient across the model domain during pre-interim measure conditions nor during operation of the remedy. Therefore, it does not appear that applying a uniform gradient across the model domain to evaluate hydraulic containment is representative of site conditions. Additionally, selecting the well triplet that has the lowest root mean squared deviation (RMSD) could mean that the well triplet choice was biased to obtain desired results (an acceptable RMSD) instead of being representative of the gradient.

- EA is calibrating the model using a "best-fit" approach for a singular water level measurement event and will therefore need to be recalibrated for each evaluating period (2nd and 4th quarters of each year). The resulting hydraulic conductivity from the best-fit model calibration yielded a hydraulic conductivity value of 80 feet per day (ft/d). While this value yields a best-match to the observed water levels, it does not match the extensively available conductivity data for the aquifer. As stated in Section 5.1.1 of Appendix I-7, aquifer tests conducted in the aquifer where the contamination plume is located suggests that the horizontal hydraulic conductivity is on the order of 100 to 150 ft/d. The aquifer test completed by the Air Force's contract at the interim measure extraction well KAFB-106228 estimated a range of hydraulic conductivity from 50 to 310 ft/d. The existing calibrated model prepared by the Air Force's previous contractor in close consultation with the site stakeholders used a horizontal hydraulic conductivity value range of 120 to 155 ft/d within the model domain area. This information suggests that 80 ft/d is on the low end of possible hydraulic conductivities which may yield an overstatement of hydraulic containment for the system. Calibration of a model is not only performed to determine a greater degree of agreement with observations but is also done to understand the sensitivity of results to different input parameters and to evaluate the sensitivity of those results to spatial variability of uncertainty throughout the model domain. Given the known range of possible hydraulic conductivity and the importance of that parameter on capture zone dimensions the Water Authority urges EA to complete a sensitivity analysis for hydraulic conductivity as defined in ASTM D5981-96 to complete their calibration of their model

- Section 5.3 of Appendix I-7 notes that there are four locations where the simulated groundwater level is more than twice the acceptable error tolerance. It appears that not all of the wells illustrated on Figure 1-7-7 are shown on Figure I-7-6, Q4 2017 Numerical Model Calibration Results. Therefore, it is difficult to correlate the two graphics together and understand the complete distribution of wells

relative to the error tolerance set for the model. The Water Authority suggests that EA prepare a table that lists the wells used in the calibration with their corresponding observed/measured head value, simulated head value, and the calculated normalized root mean square deviation In addition, there are approximately 16 locations where wells have a residual above the error tolerance, 6 of which are wells that are not submerged and have screens across the water table. In fact, of the 12 wells that intersect the water table, 7 violate the error tolerance in the model calibration. These unsubmerged wells have high confidence measurements for both groundwater levels and groundwater concentrations. Given the error tolerance is exceeded for these wells, EA should have performed an additional evaluation of the underlying conceptual model. As EA's model is set up now, the error tolerances (in both magnitude and frequency of occurrence) could mean that the uniform hydraulic conductivity assigned to the model domain is not representative of the plume scale aquifer properties.

The Water Authority understands and agrees with the need for a simple modeling tool that can be easily revised and run to evaluate plume capture. However, this does not remove the need to ensure that the model is the best representation of the site for the purpose the model has been designed to evaluate. In the case of the EA's model, this tool is meant to define hydraulic containment every six months to inform system performance. To best meet that goal, addressing the proximity of the model domain boundaries and completion of the sensitivity analyses, as outlined above, are critical actions for this model.

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References:

ASTM Standard D5981-96, 1996 (2008), "Standard guide for calibrating a groundwater flow model application," ASTM International, West Conshohocken, PA, 2008, DOI: 10.1520/D5981-96R08, www.astm.org.

USACE. 2018. *Quarterly Report – April-March 2018, Bulk Fuels Facility, SWMU ST-106/SS-111.* Prepared by EA Engineering, Science, and Technology, Inc., Albuquerque.