



KAFB
Bulk Fuels Facility Spill
ST-106 and SS-111
Geophysical Data Comment
by NMED

August 7, 2013

NMED HWB staff has reviewed a draft letter from Col. Tom D. Miller, U.S. Air Force (Permittee) Kirtland Air Force Base (KAFB), to Mr. Tom Blaine, Director, Environmental Health Division, NMED. The draft letter was prepared in response to seven letters issued by the NMED that are related, at least in part, to geophysical logging conducted for the Bulk Fuels Facility Spill (BFFS) project; the seven letters referenced in the Permittee's draft letter date from August 6, 2010 to May 23, 2013. The Permittee argues that the well logs acquired for the BFFS project meet the objectives of the approved investigation work plans. The Permittee also states that it will not conduct geophysical logging of the PneuLog wells or repeat the logging for other wells until resolution and concurrence is reached on the calibration of Jet West logs. Additionally, unless resolution is reached, the Permittee warns it will be "exacerbating the issue".

The Permittee further "requires" that if NMED does not agree with their proposed approach for resolution, that the NMED produce examples of calibrated quantitative geophysical logs acquired at cased wells and used to calculate hydraulic properties at a site similar to KAFB. The Permittee also states that NMED "must also provide clearly stated directions and improvements such that the aforementioned work plans can be amended".

The draft letter is redundant with respect to many of the responses to NMED's letters, in part, because some of the NMED letters raise the same or similar issues repeatedly. In general, the issues raised by the NMED may be grouped into four main topics:

1. Calibration, and thus, accuracy of the induction and neutron logging
2. Completion and transmittal of geophysical logging
3. Errors in units of measurement found in reports
4. Use of the geophysical data to support the conceptual site model

NMED HWB will address each of these issues relative to the Permittee's assertions.

Comments on Calibration and Accuracy of Geophysical Logging

Just because ASTM standards and quality control (QC) procedures are mentioned in an approved set of work plans does not mean that these standards and procedures were faithfully or correctly followed, that operating errors did not occur, and that equipment malfunctions did not happen. Although the Permittee states that it talked to the subcontractor (Jet West) and reviewed the data, the Permittee did not say exactly how it determined that the Jet West logs are acceptable to be used for both qualitative and quantitative analysis based on their talk with contractor and review of the data other than stating that calibration procedures were attempted (for some unexplained reason, later in the draft letter the Permittee changes position and states that none of the geophysical logs can be used to calculate hydraulic properties via a quantitative basis). Oil

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companies use quantitative decisions frequently to make multi-million dollar decisions, justifying the use of obtaining calibrated logs.

Because the logs (particularly the induction logs) cannot be used adequately to refine the conceptual site model (particularly geology) or quantify porosity (the neutron logs), contrary to the Permittee's assertion, the "ultimate" goal of the geophysical borehole logging investigations has not been met.

Induction Logging

The goal of the induction logging is to provide continuous and objective coverage of lithologies encountered in a borehole. Typically, finer units, such as clays and silts, exhibit electrical resistivities lower than coarser units, such as sands and gravels. Differences of about an order of magnitude or so would not be uncommon. NMED finds that the Jet West induction logs are not calibrated for the following reasons.

- There should be an order of magnitude difference in the electrical resistivity between the finer upper Unit A and coarser deeper Unit B.
- Other boreholes in the area logged at other times by a variety of geophysical contractors exhibit the expected difference and clearly show the difference between Units A and B.
- The Jet West log for Borehole KAFB-10624 exhibited the expected difference in 2009, but not the log generated by the 2011 mobilization.
- The Jet West induction logs do not differentiate between Units A and B, nor do they differentiate between coarser units in Unit B.

The Permittee in this draft letter argues that calibrated induction logs are unnecessary because such logs cannot be used to quantitatively estimate hydraulic conductivity, and other geologic and hydraulic data are available from different sources of information. NMED HWB did not insist that induction logs be calibrated for the purpose of calculating hydraulic properties, although it is possible to assess qualitatively hydraulic conductivity. The goal of calibrated induction logs is to maximize their utility for correlating stratigraphy (mapping lithologic units) across the project area. The shape and the magnitude of the data plots shown on the logs matter when comparing the logs from one borehole to another in an effort to differentiate lithology and assess potential changes in lithologic facies. Samples of drill cuttings were collected and analyzed for grain size and hydraulic properties at only a few locations within each borehole and, thus, are inadequate by themselves to properly characterize the geology of the BFFS site. The geologic sample and the geophysical logs are the most important data sets to characterize the geology. From inspection of drill cutting samples, it is clear that some Shaw geologists did a good job logging boreholes and some did not. Geophysical logs are useful for scanning for and correcting errors and assessing subjective observations made by geologists. The geophysical logs also allow one to locate contacts between lithologic units more accurately, as the boreholes were not continuously cored.

The situation with the Jet West-generated induction logs is analogous to hiring two different contractors to measure the resistance of two different resistors that are suspected to differ by an order of magnitude, in the range of 10 ohms for one resistor and 100 ohms for the other. One contractor (analogous to Colog) shows up with a tool that he may or may not have calibrated and measures 9.9 and 100.2 ohms for the two resistors. The second contractor (analogous to Jet West) shows up with a different tool that he says is calibrated and measures 9.9 and 11.5 ohms. Although the second contractor says he calibrated his tool daily, and may be in good faith convinced that his calibration was done correctly, something is without doubt wrong (inaccurate) as the measurements did not produce the expected results. Any reasonable person would question the accuracy of such data.

Jet West calibrated their tool using only one calibration standard and a free air calibration, instead of using 2 calibration standards and a free air calibration check (as described in the ASTM standard). The Permittee in its letter admits that a nonstandard calibration procedure was also performed to shift the zero calibration point, and that shift may have been an overcorrection because it appears to have forced the resistivity logs to "...appear anomalously low for all lithologies at the BFF spill site." Jet West was also unable (over a vast area) to isolate the induction tool from nearby conductive sources. Clearly, based on this disclosure, the induction tool was not calibrated correctly and may have been malfunctioning leading to the inability to calibrate the induction tool correctly.

NMED HWB staff also note that the Permittee addresses slope deviations for gamma logs, but did not address slope deviations for induction logs that range at least as much as 28%. What constitutes an acceptable slope deviation for the calibration of induction tools?

The Permittee proposes to adjust the dual induction calibrations to values between 10 and 100 ohmmeters, with a goal of "emulating" one specific log that is known to be better in that it shows the expected order of magnitude range between fine and coarse grain units for both a Colog-generated log and an earlier Jet-West generated log. Essentially, the Permittee is proposing to apply a linear correction to Jet West logs that probably exhibit non-linear distortion. There is no scientific basis to force the resistivity values to fall within these arbitrarily chosen boundary conditions, for example, especially setting the highest value to be 100 ohmmeters when it is possible that it may be 150 ohmmeters in the next borehole. The bottom line is that bad data cannot be made into good, calibrated data using fudge factors.

NMED HWB staff finds the induction logs generated by Jet West have but one use only. Based on good, but imperfect, correlation with the geologic logs, it appears that where the deep and shallow induction data cross on a given induction log, the finest grain units (typically silty fine grain sand) in the sequence occur at these locations. However, it is not possible to reliably differentiate the coarser units making up the majority of the sequence. Therefore, much of each of the induction logs is essentially useless for characterizing geology.

NMED HWB staff do not concur that the induction logs are calibrated logs. The induction logs done by Jet West do not look similar to any other induction logs generated at the BFFS site or other nearby areas at KAFB or adjacent areas off the military base. The induction logging was simply not done with correctly calibrated equipment as clearly shown by the poor resolution of the data and the lack of conformity with logs done by other contractors or at other times. Because the induction logs generated by other contractors for the KAFB area are especially useful for mapping subsurface stratigraphy, the Permittee must obtain correctly calibrated induction logs for the BFFS project.

Gamma Logging

NMED noted a problem with one well where one gamma log for the well did not correlate with 3 other logs generated for the well. This suggests that one of the gamma tools used by Colog was not calibrated. Shaw claims that Colog reported the processed the data incorrectly, thus, it would appear that NMED was not provided correct logs to review.

NMED also noted a potential problem concerning calibration plots that seemed in some cases to exhibit appreciable variation. The Permittee makes a case that background gamma levels vary from area to area, which NMED HWB staff generally would agree. However, for the pre- and post-field calibration checks, one would expect background levels to remain constant. The draft letter also presents for the first time the Permittee's belief that a slope difference of 10% should be acceptable. The Permittee provided no reference supporting their claim as to why 10% should be acceptable.

The Permittee also states that there were 5 instances where the slope difference exceeded 10%. The Permittee did not indicate what was done to mitigate the problem, and did not provide any details on which borehole logs may be involved in these 5 instances (which could be more than 5 boreholes).

As an aside, NMED HWB staff notes that the draft letter states: "The "shop" background-count rates are typically higher than the field-calibration rates because Jet West has 12 nuclear sources in the shop, and even though these sources are shielded, they emit gamma rays above normal background levels." Hopefully, the radiation field in the shop is within safe levels, although adding more shielding would seem to be a good idea. Also, perhaps it would be better to calibrate gamma tools outside the shop or at areas further away from the sources where natural background levels are present. The Permittee did not explain in enough detail how the gamma calibration is performed and why background is changing between pre-and post-field checks which presumably are being measured at the same location.

Based on review of gamma logs prepared by several contractors for projects located on KAFB and the surrounding area, NMED HWB staff does not consider gamma logs to be as useful for mapping subsurface stratigraphy compared to induction logs.

Neutron Logging

NMED has noted that the two sets of neutron logs for well KAFB-10624, generated by Colog and Jet West, do not agree and contain results that differ by an order of magnitude. Thus one or both of the Colog/Jet West data sets are bad.

The sole hydraulic property to be quantitatively estimated from the geophysical logs is porosity. It was the Permittee that proposed estimating porosity using neutron logs (Interim Measures Work Plan).

The Permittee refused to collect soil samples for direct measurement of porosity as NMED instructed in its letter of February 21, 2011, which in part led to negotiations over the issue of obtaining site specific data for porosity. As one of the outcomes of these negotiations, the NMED agreed to allow porosity to be estimated from grain size distribution of disturbed soil samples (see NMED letter of June 1, 2011); in no small part NMED made this agreement due to the insistence from the Permittee that porosity data was best obtained from neutron logs. However, as part of this agreement, NMED did not relieve the Permittee of its responsibility to determine porosity using neutron logging as they had proposed in their Interim Measures Work Plan. It makes sense that good porosity data can only be acquired from calibrated neutron logs.

The Permittee has flip-flopped on its earlier position and now argues in the draft letter that porosity and other hydraulic properties cannot be quantitatively derived from the neutron logs.

The Permittee now argues that porosity data can be obtained from samples collected during drilling of the BFFS wells. Samples of drill cuttings were collected and analyzed for hydraulic properties at only a few locations within each borehole and, thus, cannot be used to characterize fully the hydraulic conditions in the vadose and saturated zones at the BFFS site.

Because the neutron logs are to be used to generate porosity data, which are critical data for modeling groundwater flow, the Permittee must either demonstrate rigorously that the existing Jet West and Colog neutron logs are correct, calibrated logs, or the Permittee should repeat the neutron logging to obtain properly calibrated data. The Permittee must also provide the analysis of the neutron logs, especially that involving the assessment of porosity.

Comments on Completion and Transmittal of Geophysical Logging

The NMED directed in its letters of August 17, 2011; February 1, 2013; March 6, 2013; and May 23, 2013; and email of December 20, 2012, that completed geophysical logs be submitted to the NMED in accordance with NMED's direction found in the letter issued on June 4, 2010. At this time, the Permittee has submitted copies of all logs, except those for the PneuLog wells, the deep wells in the newest three well clusters (106203, 106206, and 106209), 106043, and 106066, all which have not been generated as far as NMED HWB staff are aware. However, replacement

logs need to be submitted for most of the groundwater and soil-vapor monitoring wells where the induction logging, and maybe the neutron logging, was done incorrectly and needs to be repeated.

The Permittee states in the letter that data from certain relogged wells (8 total) can be found in the latest version of the quarterly report (for the first quarter 2013). NMED could not locate the data.

Comments on Errors in Units of Measurement Found in Reports

The Permittee admits that the units of measurement in question were reported incorrectly. The Permittee states that the units will be corrected in the Second Quarter 2013 report.

NMED HWB staff also note that in the draft letter, that in some cases, the Permittee is incorrectly mixing units between resistance/conductance with resistivity/conductivity.

Comments on Use of the Geophysical Data

The Permittee claims that the geophysical logs have been used to develop the conceptual site model for the BFFS site. Other than providing the geophysical logs, which has been problematic in itself (see above about NMED repeatedly asking for the logs), the Permittee's "use" of the logs has been limited to illustrating only the induction logs on geologic cross sections. NMED has not seen any detailed discussions or analysis of geophysical data in the quarterly reports which would support a claim that the logs have been put to good use. For example, there is no discussion of the results of each method individually (electric, gamma, neutron) or collectively. There is no discussion of more specific results such as the gamma highs detected at many locations at a depth of 250 ft, or any discussion of the widespread electric lows at 250 ft or other depths, or any discussion of the lateral continuity or lack thereof of subsurface units as may be demonstrated in the geophysical logs. Notably, there is also no presentation of porosity information obtained from the neutron logs, which is certainly a major deficiency because this is the sole purpose of the neutron logs.

Furthermore, the scale at which the induction logs are shown on the geologic cross-sections is so small that the logs are essentially useless for interpreting the geology of the BFFS project, even if NMED HWB staff had any confidence in the logs, which it does not (the scale problem in part is related to the resolution of the induction logs where fine grain units and coarse grain units are not readily differentiated). NMED HWB staff has also observed that on some geologic cross sections the induction logs were not properly scaled, suggesting little thought is given to correlating lithology using the logs.

NMED has also directed the Permittee to use geophysical logs (and geologic logs) that are available for production wells in the BFFS area, as they provide geologic information at deeper

depths than those obtained from the BFFS soil vapor and groundwater monitoring well networks. None of the quarterly reports has such information included.

Comments on Proposed Resolution of Disagreements

As mentioned previously, the Permittee “requires” that if NMED does not agree with their proposed approach for resolution, the NMED produce examples of calibrated quantitative geophysical logs acquired at cased wells and used to calculate hydraulic properties at a site similar to KAFB. The Permittee also states that NMED “must”, if the agency does not agree with their proposed approach for resolution, provide clearly stated directions and improvements such that the work plans can be amended.

Shaw (and thus, the Permittee?) proposes the following:

1. Repeat the logging of 8 wells identified by Shaw as being critical for understanding the geology and meeting the objectives of the RFI. The wells were selected because there is no nearby well with a log generated by Jet West.
2. Review Colog-generated logs and determine which are useable for qualitative analysis.

Wells completed for the BFFS project are spaced at large distances. All wells are critical for understanding the geology of the site, and all wells need to be properly logged to meet the objectives of the RFI Work Plans. The induction logs are the most critical for mapping subsurface stratigraphy and the neutron logs are important to estimate porosity.

Although NMED HWB possesses induction logs for cased wells located on and near KAFB, NMED HWB staff does not know whether the logs are calibrated. However, unlike those generated by Jet West, at least these other induction logs exhibit the expected order of magnitude range between fine grain and coarse grain units. Also unlike the Jet West logs, these other logs demark clearly the contact between the silty, fine-grain alluvial fan sediments that overlie ancestral Rio Grande deposits of medium to coarse sands and gravels. This contact, readily identified in drill cuttings, should have been easily seen in the Jet West induction logs, but it is not.

NMED HWB staff does not have any examples of calibrated logs used to estimate porosity. NMED favored direct measurement of porosity using soil samples.

The Permittee should consider using both Colog and Jet West (which have used different induction tools at the site) or different contractors to log the same hole(s) with the goal of showing that the induction tools are properly calibrated and can provide similar results with the expected range of measurements.

Finally, although the draft letter indicates that there are attachments, NMED HWB staff did not find any attachments.