**NMED Response to LNAPL Friction Point meeting with KAFB on 1/28/21**

The meeting was to discuss, as outlined in the agenda sent to NMED in December 2020:

- How do we achieve agreement on a CSM for how LNAPL migrated from the source area to the water table?
- Has the nature and extent of LNAPL been defined to the extent necessary to complete the investigation phase and move on to the CME?
- If not, where are any data gaps?

NMED response to these:

- How do we reach an agreement? KAFB must respond, in writing to NMED comments in disapprovals and modifications.
- Has the nature and extent of LNAPL been defined sufficiently to move to CME? Currently, no. NMED is awaiting written responses from KAFB, as stated above. With the information NMED currently has, the nature and extent and downward migration path of LNAPL has not been established.
- The largest data gap is defining the nature and extent and downward migration path of LNAPL. Additional borings may be needed to close this data gap and decide between the KAFB and NMED migration pathway theories.

The purpose of this meeting was for KAFB to present information which the AF believes confirms that the nature and extent of LNAPL had been defined to the extent necessary to complete the investigation phase at the BFF and move on to CME. Most of the data used in the presentation given by KAFB cannot be used for decision making purposes for the following reasons:

1. Documents and data that are not reviewed or approved by NMED cannot be used for decision making purposes. The following documents were not reviewed and approved by NMED:

    - AECOM, 2015. December 17, 2015. Correspondence from Mr. Tom Champion, AECOM, Mr. Colin Plank, AECOM, and Mr. Mike Schultz, AECOM to Mr. John Gillespie, AFCEC re: Regional Geology and Cross Sections.
    - AECOM, 2016. Plume and Water-Table Scale Cross Sections, Technical Memorandum. NMED has not formally reviewed this document.
    - An internal study in 2019/2020 by AFCEC/CZTE utilizing data from the two reports referenced above. NMED has not reviewed this document.
    - Quarterly Monitoring Report – April-June 2020. This report is still in review by NMED. Preliminary review of the soil vapor data revealed that approximately 30% of the soil vapor data is unusable because the detection limits exceeded screening levels (KAFB Permit Section 6.5.18). This was brought to the attention of KAFB in a meeting on the Shallow Soil Vapor Sampling Friction Point on January 6, 2021. Despite this input KAFB continued to use and rely upon this data in the LNAPL Friction Point meeting.

2. Documents reviewed by NMED for which disapprovals were issued and NMED is still waiting for a response to comments and revised report, and therefore, are not approved by NMED:

- Source Zone Characterization Report, October 2019. NMED issued a disapproval for the report on August 17, 2020. KAFB submitted a request for an extension of time, dated December 4, 2020 which included a request for a meeting with NMED to discuss comments associated with the NMED disapproval. This request was approved by NMED on December 16, 2020 with direction to contact NMED to arrange this meeting as soon as possible. To date, this meeting has not been requested. The current due date for the revised report is April 30, 2021. In addition, several of the comments in the disapproval relate directly to the data that was used in this LNAPL Friction Point presentation.

3. Documents that were approved with modifications, where specific data were excluded from use for decision making purposes:

- Phase I RCRA Facility Investigation Report, August 2018. Approved with Modification by NMED on September 25, 2020. The following data were not approved for decision making purposes in Comment 30.b:
    - "Geophysical Logs: A large portion of the geophysical logging conducted for the site is unreliable due to inaccurate calibration of the instrumentation resulting in inaccurate induction logs. These logs cannot be used to distinguish between coarser grained units, which are the predominant lithologies present throughout the site. However, the induction logs can be used qualitatively to identify clay layers and provide a means of correlating surfaces and some stratigraphic intervals across the site. The Permittee must ensure that instrumentation is properly calibrated when conducting future geophysical logging."

4. The presentation depicts information utilizing modeling software. NMED does not accept modeling for decision making purposes. Furthermore, the illustrations in the presentation were generated utilizing data that are excluded from use for decision making purposes as stated above in items 1, 2, and 3.

NMED is unable to use this presentation for decision making. In addition, data quality issues presented to KAFB through disapprovals of various documents remain unaddressed by KAFB. These data quality issues must be addressed through written responses to NMED comments. Until these issues are addressed, the extent and downward migration path of LNAPL cannot be considered adequately defined in context of selecting or defending a remedy.

The quantity of data collected to date at the site does not necessarily equate to data of sufficient quality needed to characterize the site.

5. NMED is not confident that the sub-regional, site-specific maps, and cross-sections accurately depict the site geology, some of the depictions are erroneous, and NMED has not formally reviewed them.

- In the interest of transparency and toward coming to a resolution on the site geology to develop a meaningful CSM, some of the problems with the sub-regional cross-sections have been included at the end of this response for KAFB to consider.

- In addition, while not included with the LNAPL Friction Point presentation, NMED has concerns with the site specific maps, cross sections, 'sequence stratigraphy' figures. For example, clays are connected that should not be connected, steel centralizers are mistaken for fine-grained zones, fine-grained zones are shown going through gamma lows, reliance on incorrectly calibrated geophysical logs for some stratigraphic units, erroneous clay thickness, etc.

  The combination of both of these figure sets, sub-regional, and site-specific cross-sections, along with the concerns NMED has highlighted, make the AF depiction of site geology unreliable, especially in the critical area of the downward migration path of the jet fuel from the FFOR to the water table.

**NMED response to individual slides in the presentation:**

Slide 3, bullet 3: Contamination descended to approximately 270 ft depth and then turned eastward.

Slide 3, bullet 4: There is no vertical offset in the clay layer, in the 250 – 300 foot depth range beneath the FFOR there is only one clay layer beneath the FFOR, the "lower clay".

Slide 3, bullet 6: KAFB-106S10 was intended to find the location where the "lower clay" does not exist, and may have allowed vertical migration of contamination to the water table. KAFB-106S10 determined that the "lower clay" is thinning in this location, and that a break in this clay may be in this area.

Slide 3, bullet 6: NMED did not perform "sequence stratigraphy".

Slide 4, bullet 3: Soil data shows no stair stepping, soil vapor shows vertical migration to 300 feet and then a shift.

Slide 4, bullet 5: NMED believes the "Geo feature" is a misinterpretation of the data, which erroneously connects two separate clay layers. KAFB-106S10 clearly showed two separate clay layers. However, NMED agrees that this "geo feature" may be near the location of the transition to the lower formation because it is near the edge of the "hole" in the "lower clay".

Slide 5: The scale of the figure is not appropriate for discussing the migration pattern in the vicinity of the source area to the water table and doesn't differentiate between the two theories. This slide utilized soil vapor data, where detection limits exceeded screening levels, inappropriately, which makes this slide inaccurate.

Slide 6: It is unclear what the contours represent. The scale of the figure is not appropriate for discussing the migration pattern in the vicinity of the source area to the water table and doesn't differentiate between the two theories.

Slide 7: Same as slide 5 and 6. The key says the yellow is 'clay bowl', it is unclear what this is representing.

Slide 8: Caution should be used when showing 3-dimensional data on a 2-dimensional figure. Much of the background geology is unreliable. The major clay shown is not continuous, this figure is connecting two unconnected clays. Many fine zones are not real (connecting steel centralizers), going through gamma lows, are not that horizontally continuous, etc. See NMED comments on AECOM cross sections

below. In addition, this slide utilized soil vapor data, where detection limits exceeded screening levels, inappropriately, which makes this slide inaccurate.

Slide 9: It is unclear how the figure matches the title “LNAPL Migration from the FFOR”. This figure does illustrate the two different theories of LNAPL migration.

Slide 10: This isopach map of the clay zones is incorrect. The lithologic and geophysical information showed that the lower clay in KAFB-106S10 is approximately 8 ft thick, significantly thinner than this map suggests. When this was mentioned during the meeting KAFB agreed and suggested there may be something wrong with the logging of this hole. This hole was cored using Sonic drilling where every inch of undisturbed core was brought to the surface to be observed. The majority of the lithologic logs that KAFB is relying on for the cross sections used in this presentation were drilled using air rotary casing hammer (ARCH) drilling, where cuttings are pulverized and blown up the borehole and then through a cyclone before being observed, it is difficult to accurately determine lithology and its depth of origin utilizing ARCH drilling. In addition, KAFB-106S10 and KABF-106V3 are the only boreholes at the site which have properly calibrated geophysical logs. There are many other concerns regarding this figure. For example, KAFB-106005 is shown with a clay thickness of 50.75 feet, which is not supported by the geologic or geophysical logs (It may well be two separate clay zones). Next to KAFB-106005 a borehole is shown with clay absent; how large is the clay absent zone? If such a zone is near the FFOR that could be critical to understanding the downward migration path.

Slide 11, Bullet 1: The clay at 250 (“upper clay)” does not extend beneath the FFOR. Little soil vapor was expected above 250 that far east of the FFOR. The clay beneath the FFOR is the one here at 270 (“lower clay”). There are elevated PID readings between the 2 clays in KAFB-106S10.

Slide 11, bullet 2: Vapor migration alone typically is horizontal and follows more porous and gravelly zones, this is not product migration. The product migrated 500 feet downward to the water table and seemed to have reached the water table somewhere less than 500 feet away from the FFOR. Vertical migration of the product was greater than horizontal migration of the product in the important region of the vadose zone between the FFOR and the water table. Soil vapor does extend horizontally, especially just above the water table, but that vapor is coming from the groundwater and not from the downward migration path.

Slide 11, bullet 4: Not finding the “hole” in the “lower clay” at KAFB-106S10 does not mean it doesn’t exist, it means it is likely to be in a different location and still needs to be located in order to optimize remedial activities. If the migration pathway is not outlined, whether NMEDs or KAFBs theory, remediation activities could easily be based on lower values of contamination in the vadose zone with no remediation occurring in the most productive area. Investigation activities must be complete and the nature and extent of contamination must be fully defined in order to properly evaluate corrective measures alternatives. Failure to fully define the nature and extent of contamination, including LNAPL, will necessarily result in a more conservative and robust requirement for corrective measures.

If the migration pathway is not investigated and directly addressed with remediation activities it will continue to be a source of contamination to the groundwater and a threat to the groundwater for the City of Albuquerque.

Slide 13: Several comments were made in the disapproval for the Source Zone Characterization Report regarding the residual LNAPL, which specifically relate to the data used in this figure. These comments must be addressed to determine the nature and extent of LNAPL to evaluate potential remedial options. In addition, LNAPL is submerged at the site and is not fully characterized at the site.

Slide 14: The sporadic appearance of LNAPL in wells toward the northern KAFB boundary in 2018 and 2019 indicates that LNAPL is potentially migrating on the water table. This does not demonstrate plume stability.

Slide 15, bullet 3: Lithology is not accurately depicted by KAFB.

Slide 15, bullets 5 and 6: It is unclear which four wells in Bullhead Park are monitored for LNAPL to verify the longevity of these wells.

Slide 16 bullet 1: The extent of soil vapor is not well defined, the term "sequence stratigraphy' is misused here, LNAPL is submerged and not fully characterized at the site, a highly refined CSM has not been produced for the site.

Slide 16, bullet 2: The extent of soil vapor is not well defined and soil vapor data does not illustrate the migration pathway, see comment for Slide 11 above.

Slide 16, bullet 3: Until the Air Force conducts appropriate shallow soil vapor sampling off-base to assess vapor intrusion risk off-base, the risk to off-base receptors remains unknown.

Slide 16, bullet 4: The investigation phase cannot be considered complete until NMED disapproval comments have been addressed.

Slide 16, bullet 5: NMED does not agree with the statement.

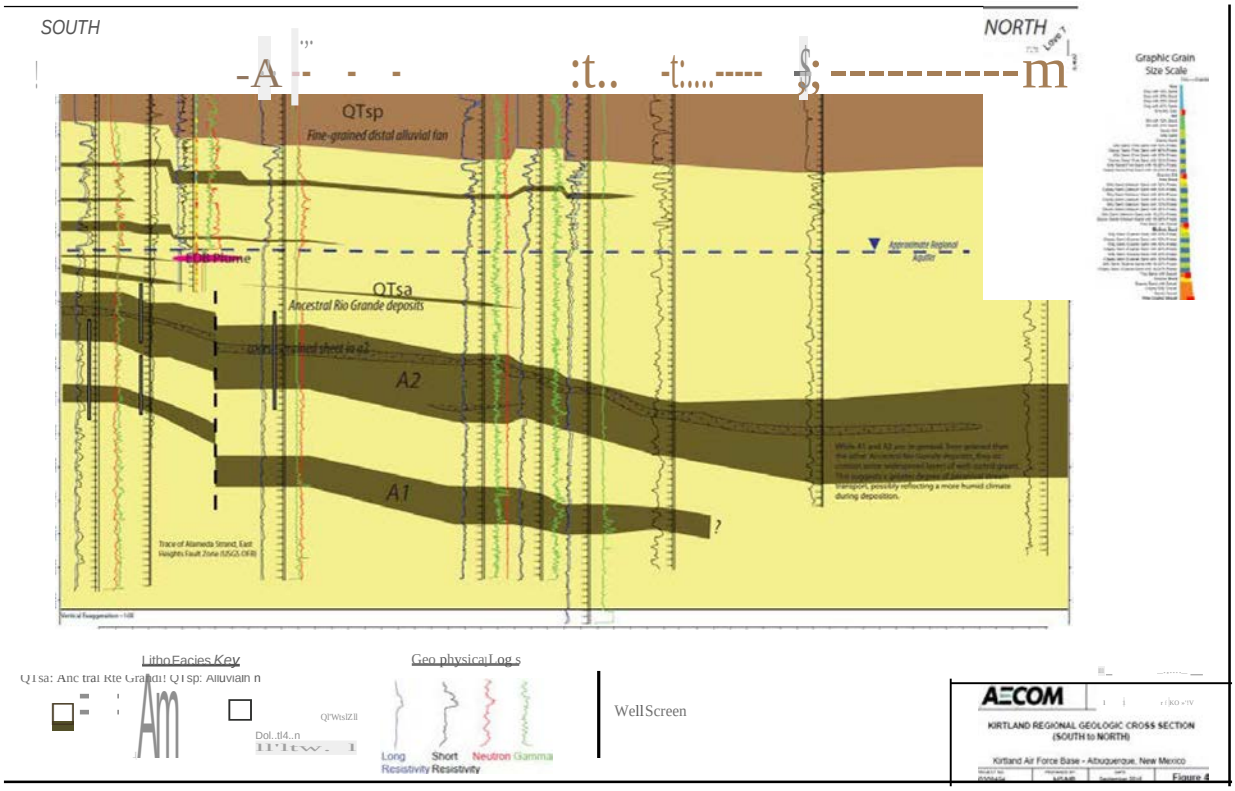
Slide 16, bullet 6: At this point NMED cannot agree with this

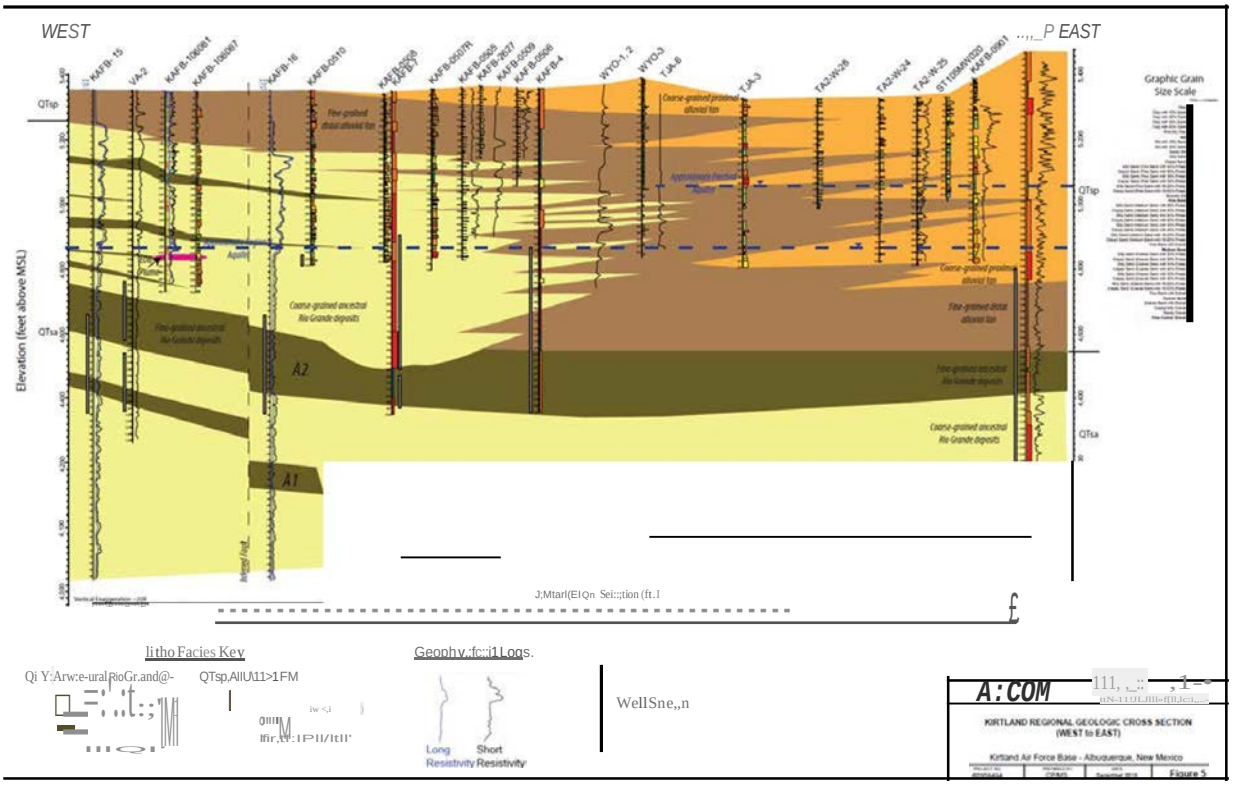
statement.

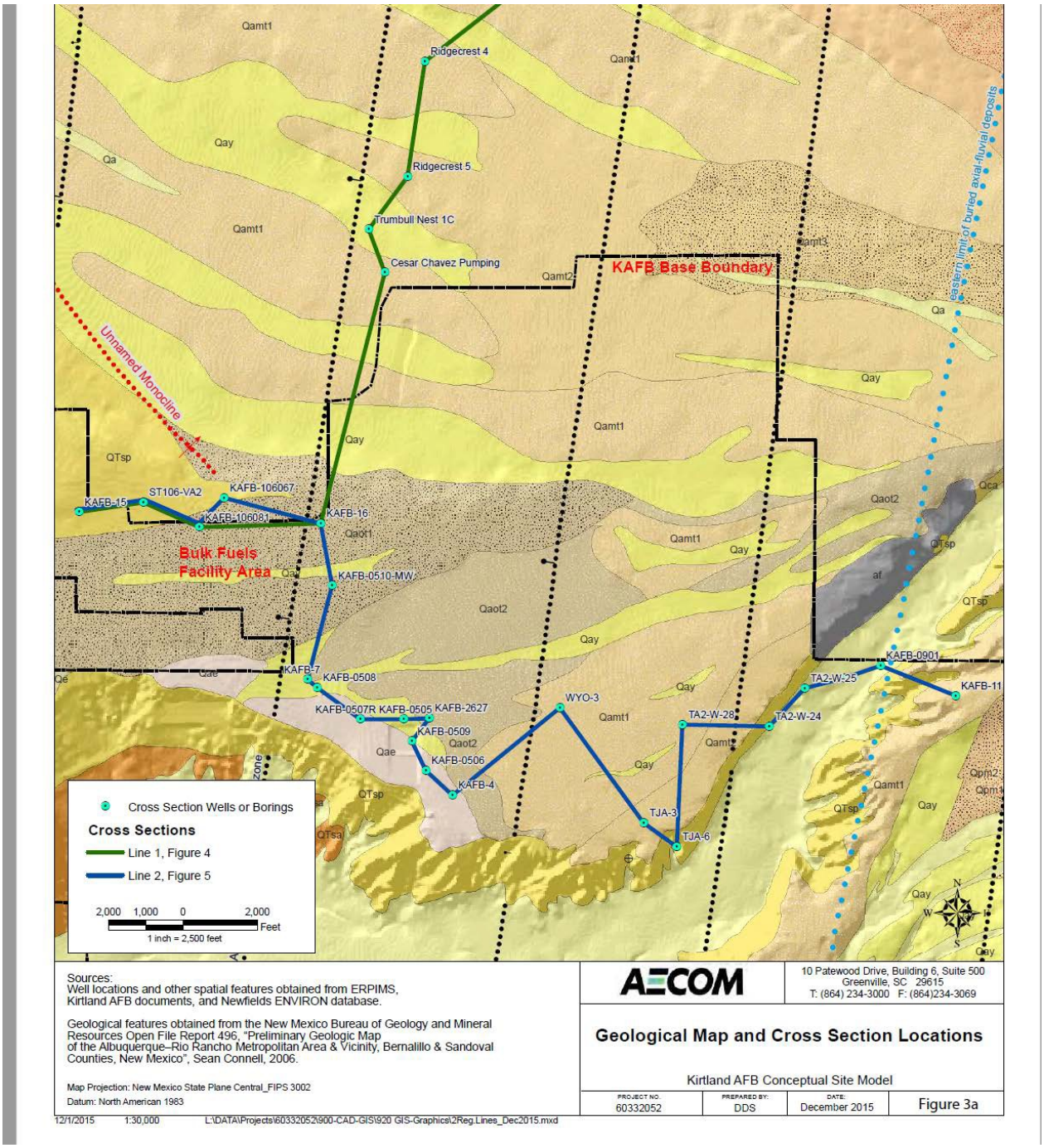
Slide 16, bullet 7: LNAPL is not the "remaining element", issues with the characterization of soil vapor remain. As groundwater continues to rise even more LNAPL will become submerged complicating effective remediation at the site.

**NMED issues with the way the site sub-regional geology is interpreted based on the AECOM cross sections of the site:**

Problems identified with the 2 cross sections and location map from the AECOM Technical Memorandum, dated Dec. 17, 2015:


SOUTH
NORTH
Graphic Grain Size Scale
QTsp
Fine-grained distal alluvial fan
QTsa
Ancestral Rio Grande deposits
A2
A1
Approximate Regional Aquifer
Trace of Alameda Strand, East Heights Fault Zone (USGS, OFR)
Litho Facies Key
Geo physical Log s
Long Resistivity
Short Resistivity
Neutron
Gamma
Well Screen
AECOM
KIRTLAND REGIONAL GEOLOGIC CROSS SECTION
(SOUTH to NORTH)
Kirtland Air Force Base - Albuquerque, New Mexico
Figure 4


WEST
EAST
Graphic Grain Size Scale
Elevation (feet above MSL)
QTsp
QTsa
A2
A1
Coarse-grained ancestral Rio Grande deposits
Fine-grained ancestral Rio Grande deposits
Coarse-grained proximal alluvial fan
Fine-grained distal alluvial fan
Approximate Regional Aquifer
Litho Facies Key
Geophysical Logs
Long Resistivity
Short Resistivity
Well Screen
A:COM
KIRTLAND REGIONAL GEOLOGIC CROSS SECTION
(WEST to EAST)
Kirtland Air Force Base - Albuquerque, New Mexico
Figure 5




Here are some of the problems:

- TJA-3 and TJA-6 are in different locations on the EW cross section and location map compared to each other and the inter-well distances don't match. Look at WYO-3, TJA-6 and TJA-3 on location map and on the east west cross section. On the location mapTJA-6 is East of TJA-3 and both are far from WYO-3. Look at the E-W cross section. TJA-6 is west of TJA-3 and close to WYO-3.

- KAFB-7 is west of KAFB-508 on the location map but east of KAFB-508 on the EW cross section.

- The dips of layers are not shown to change, even though the direction of the sections do change (since this is a fence diagram). For example, the 250' clay has the same dip on both sides of KAFB-16 on the EW section even though the direction of KAFB-10667 to KAFB-16 and the direction of KAFB-16 to KAFB-0510 is ~80 degrees apart.

- There are between-well distances that do not match on the cross section figures and location map. Also, both the EW and NS sections have an x-axis of about 28,500 feet yet the total measured distance of each line on the location map seems to differ by about 10%.

- KAFB-10681 has 2 different elogs below water table on the 2 sections.

- On a fence diagram breaks in section lines should be shown on the sections.

- While the interfingering between the fine-grained distal alluvial fan and coarse-grained ancestral Rio Grande deposits on the EW section by necessity is schematic, the dips shown are probably in the wrong direction. The dips in the alluvial fan area appear to be toward the east.

- Both water tables (regional and perched) are shown as flat. There is over 100 feet of relief in the regional water table (as can be seen in regional groundwater elevation maps in many Sandia National Laboratories Annual Environmental Restoration Reports) with bearing on the eastern extent of the ancestral Rio Grande deposits. Also, the relief on the perched water table has bearing on the dip of the beds in the area of the perched zone.

- The contaminant plume is shown below the water table instead of at the water table on both sections.

- The horizontal continuity of the clay at 250’ depth over 8000 feet and the vertical offsets of about 50 feet in the eastern and southern portions of both cross sections do not seem realistic based upon the other logs in the area not presented. (For instance, the VA EM log and nearby KAFB-106139 do not indicate an equivalent clay (the apparent resistivity values do not appear to be low enough for a clay)). To imply only one continuous clay in the area of the fuel plume does not accurately portray the geology in the area. In fact, it would have been appropriate to draw the cross sections through the FFOR and not to the north along Randolph Road. In the on-base area there are wells with none, one or two fine-grained layers in the 250–300 foot depth zone and the two zones coincide in some areas into one thicker zone.

- The depiction of a single thin continuous clay in the NS cross section in the 250-300 foot depth zone between KAFB-16 and Cesar Chavez SPW without any intervening data is not realistic, especially since a similar section through the axis of the plume to the west would not support that interpretation. In fact, the NS section would have served better if it was drawn through the

axis of the plume were there are a number of data points. For example, in that depth zone KAFB-106093 does not have a fine-grained layer, KAFB-106054 has a single fine-grained layer and KAFB-106058 has 2 fine-grained layers. This is typical of the on-base area around the FFOR.

- The depicted fine-grained deposits don't always agree with the graphic grain size scale on the right of the sections.

- There are wells on the cross sections that are not shown on location map, for example ST105MW020.

- Two wells have slightly different names on the location map and sections, for example, VA-2 or ST106-VA2 and KAFB-0510-MW or KAFB-0510.

- KAFB-16 does not show a coarse section in A2 in the EW section, while it does in the NS section.

- The tops and bottoms of A2 and A1 are shown differently between the EW and NS sections between KAFB-15 and VA2 even though the sections are in exactly the same place.

- The elevation scale on the EW section changes from 100 to 200 feet at the bottom of both eastern and western sides (probably a typo?).

- The fault to the west of KAFB-16 is shown at two different distances from KAFB-16 on the 2 cross sections, even though it should be very close to the same distance.

- On the EW section the fault is shown as extending from the surface downward and is called "inferred fault". On the NS section it is shown as not reaching the surface and is given a USGS OFR reference (trace of Alameda strand). There is no such reference in the list of references in the text accompanying the figures, but the reference should be the NMBG&MR map used as the base for the location map. The question of how high in the section the fault goes also has bearings on A2 and the sense of throw (see first item in "Disagreements" below).

- Disagreements with other maps/literature: It is not necessarily incorrect to disagree with existing maps/literature as long as there is a valid reason. Here are a few instances where such reasons would be necessary:

    - The fault near KAFB-16 is shown on the cross sections with the opposite throw as on the location map (based on NMBG&MR). The NMBG&MR down to the west movement is based on deeper stratigraphic and structural considerations. It doesn't seem probable that this is both a typical down to the west fault and an antithetic fault.
      It would be difficult to show down to the east movement. It is not clear that the down to the east offsets in A1 and A2 shown on the 2 sections are necessary (other interpretations based on the elogs are also possible.)

- The location map (based on NMBG&MR) shows more faults than are shown on the cross sections.
- The eastward extent of the ancestral Rio Grande deposits is shown on the sections as extending further east than shown on the location map (NMBG&MR) and in Sandia National Laboratories (SNL) reports (for example, Van Hart, 2003).
- Connell et al. 1998 (discussed in the accompanying text to the figures but is not in the list of reference) implies there may not be an A2 layer in Love7.
- Cross section C-C' in the NMBG&MR OFR that the base map is taken from shows Love 7 bottoming in a different geologic unit than shown on the NS section.
- The stratigraphic interpretation of the area around WYO-1, WYO-2 and TJA-6 differs from SNL's interpretation (for example Van Hart, 2003).

An aside question – Is the shown A1 and A2 interpretations here the same as used in the groundwater models? If A1 has a gap at the fault as shown how does that affect confined conditions and the groundwater model?

References for the sub-regional cross-section comments:

Dirk Van Hart, 2003, Geologic Investigation: An Update of Subsurface Geology on Kirtland Air Force Base, New Mexico, SAND2003-1869, Sandia National Laboratories.

Sean D. Connell et al., 1998, Subsurface stratigraphy of the Santa Fe Group
from borehole geophysical logs, Albuquerque area, New Mexico, New Mexico Geology Volume 20, Number 1, February 1998, New Mexico Bureau of Mines and Mineral Resources.