



# Kirtland Air Force Base Fuel Spill RCRA Facility Investigation Reports

RFI Review Comments

**New Mexico Environment Department**

August 14, 2014



# RCRA Corrective Action Process

## Corrective Action Process

### Regulatory Agency

RCRA Regulatory Oversight (Permit)

- Review Interim Measures
  - Expand SVE System (partial approval 3/4/14)
  - LNAPL/EDB Treatment

- Review RFI Reports RFI Report Submittals
  - Vadose Zone RFI
  - GW RFI

- RFI Reports Approval

- Class 3 Permit Modification
- Statement of Basis
  - Public Participation
  - Public Hearing
  - Remedy(ies) Selected

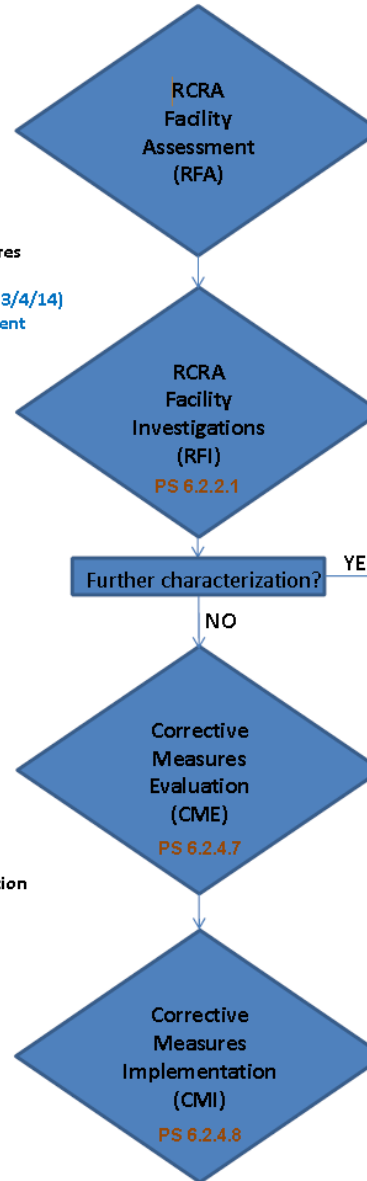
### Facility

- Interim Measure(s) PS 6.2.2.2.12
  - Tasks/Goals:
    - 1) Expand SVE System (3/31/14)
    - 2) LNAPL/EDB Treatment (6/30/14)
    - 3) EDB Treatment (12/31/14)

- RFI Work Plans
- Facility Investigations
- RFI Reports
- Interim Measures

- Identify and evaluate alternatives
- Recommend corrective measures
- CME Report
- Interim Measures

- CMI Plan
- Design & Construction
- CMI Report
- Operations/Maintenance
- Monitoring



Notes:  
 black type = corrective action process  
 blue type = KAFB submittals/status  
 brown type = KAFB permit section cite



# *RFI Reviewers*

---

- New Mexico Environment Department
  - Hazardous Waste Bureau
  - Petroleum Storage Tank Bureau
  - DOE Oversight Bureau
  - Ground Water Quality Bureau
  - Environmental Health Division
- Albuquerque Bernalillo County Water Utility Authority
- U.S. EPA



# *RFI Content*

---

- Background / History
- Data
- Interpretation
- Recommendations
- Justifications



# *RFI Discussion*

---

- NMED specifically met with KAFB and CB&I to discuss RFI content on February 13, 2014
- NMED sent a compilation of Quarterly Report comments for consideration in the RFI preparation on February 2014
- Discussed requirements and content of RFI
- Provided requirements in permit
- Provided examples of RFI at other facilities where CB&I is a contractor
- NMED offered to meet and further discuss RFI requirements and content
- KAFB and CB&I did not request additional meetings
- RFIs were submitted on March 31, 2014
- A portion of the RFI was resubmitted informally to technical (DOE OB) staff. This is inappropriate and a violation of the permit requirements for submission of documents to NMED



# *RFI Deficiencies*

---

- Numerous errors and omissions:
  - Incorrect/incomplete site history
  - Inaccurate and invalid data
  - Some data not discussed or interpreted
  - Anomalous data ignored
  - Incorrect calculations
  - No mass balance
  - Conflicting data presented and interpretations
  - Invalid conclusions
- RFI is overly simplistic and incomplete:
  - Many basic analyses of contouring data, graphing concentrations over time, and comparing relations between parameters are missing.
  - Consequently, the RFI has failed to make some important observations with existing data.



# *RFI Deficiencies*

---

- Errors made in previous documents (e.g. Quarterly Reports) were repeated in the RFIs
- Permittee committed to make corrections to the RFIs in previous responses rather than correct the subject documents
- Administrative record is inaccurate because previous submittals have not been addressed to correct the problems
- Comments made since 2011 were not addressed in the RFIs
  - Comments made on Quarterly Reports, In-well Treatment, Interim Measures Work Plans



---

Conclusions made by  
Kirtland Air Force Base Fuel Spill  
RCRA Facility Investigation Report for  
**GROUNDWATER ZONE**



# *CB&I #1. Nature and extent of contamination and aquifer characteristics have been defined.*

---

- How deep is EDB and benzene contamination?
  - Don't know.
- What are lateral extents of shallow, intermediate, and deep EDB and benzene plumes?
  - Don't know.
- Aquifer Characteristics –
  - no representative data
- Geologic controls on extent ignored
- Effective corrective measures depend on an adequate definition of the GW plumes and understanding of aquifer characteristics.



## *CB&I #3. CSIA data indicate anaerobic degradation of benzene and EDB and an unquantified amount of aerobic degradation of EDB also occurs*

---

- Conclusion neither correct nor justified by RFI data and analyses
- Multiple lines of evidence either invalid or misrepresented
  - CSIA did not follow SOPs
    - Results cannot support anaerobic degradation for EDB
  - Misrepresented concentration changes over time – ignored mass removed by remediation and decreases caused by submerged screens
  - Distance vs. concentration analysis inconclusive
- Is anaerobic degradation occurring?
  - Probably
- Is anaerobic degradation occurring at rate faster than rate of EDB GW migration?
  - EDB plume data say “No”



*CB&I #4. Groundwater flow and transport modeling results indicates fuel contamination reached groundwater in 1980 and created a residual LNAPL smear zone from 400 to 500-feet .*

---

- GW flow model based on incorrect conceptual model
  - Heads are much higher in deeper confined aquifers
  - Unknown pumping stresses on BFF unconfined aquifer
- Historical calibration biased to deep confined aquifers
  - Only tens of feet of drawdown in unconfined aquifer
- Cannot recreate time history of head change in unconfined aquifer
- Model is very poorly constrained for BFF unconfined aquifer
  - Does not represent hydraulics of BFF unconfined system



*CB&I #5. Groundwater levels have risen since 2009.  
The source of dissolved contamination is the  
submerged LNAPL*

---

- Ignores source added monthly by rising water table
  - No data on LNAPL mass in bottommost 50 feet of vadose zone
- Provides no data on extent, saturation, or mass of LNAPL in bottommost vadose zone or below water table
  - No data about EDB fraction in these LNAPL sources



## *CB&I #6. RFI data collected are sufficient for determining future actions at SS-111.*

---

- RFI documents cannot be used to develop successful corrective measures because
  - Inadequately define the nature and extent of vadose zone and groundwater contamination
  - Misrepresent other known processes as degradation
    - This skews the selection process for corrective measures
  - Anaerobic degradation may occur, but are the rates significant for controlling groundwater EDB migration?
    - RFI evidence supports a negative answer
  - GW flow model is flawed and too poorly constrained to simulate flow and transport in BFF unconfined aquifer
  - Do not determine LNAPL sources and EDB fraction



---

Conclusions made by  
Kirtland Air Force Base Fuel Spill  
RCRA Facility Investigation Report for  
**VADOSE ZONE**

## *CB&I #4. Ten contaminants of concern (COCs) have been identified in the vadose zone soil.*

---

- **Did not include EDB**

- EDB trapped in residual LNAPL in the vadose zone may be remobilized by migrating JP-4 or JP-8 and/or submerged if water levels continue to rise and could pose a potential threat to the regional aquifer.



*CB&I #5. The areas encompassing soil vapors of volatile organic compounds (VOCs) and benzene have been decreasing since the second quarter of 2011.*

---

- Do not discuss the mechanisms causing these decreases.
- Decrease at the deepest interval most likely caused by the drowning of the LNAPL.
- Soil vapor network is limited to “standard depths”. No information provided between these depths.





*CB&I# 7. The RFI data collected meet the Quality Assurance Project Plan requirements and are sufficient for “informing” future actions at SS-106.*

---

- RFI documents cannot be used to develop successful corrective measures because
  - Inadequately define the vertical and lateral distribution of LNAPL saturation in the vadose zone
  - No data on location and mass of EDB contained in vadose zone LNAPL



# Summary of RFI Conclusions

---

- 11 of 14 RFI conclusions are invalid because:
  - Inadequately define the extent of vadose zone and groundwater contamination
  - Misrepresent other known processes as degradation
    - This skews the selection process for corrective measures
  - Anaerobic degradation may occur, but are the rates significant for controlling groundwater EDB migration?
    - RFI evidence supports a negative answer
  - GW flow model is flawed and too poorly constrained to simulate flow and transport in BFF unconfined aquifer
  - Do not determine LNAPL sources and EDB fraction
- RFI documents cannot be used to develop successful corrective measures



---

# Critical Deficiency Examples

# Site History Error: 2001 Groundwater Detections

“The first detection of 1,2-dibromoethane (EDB) in groundwater was in March 2001 at KAFB-106-1 at a concentration of 0.21 microgram per liter ( $\mu\text{g/L}$ ).

“There were no additional detections of EDB in this well from March 2001 until January 2004 when EDB was detected in the same well at a concentration of 0.049  $\mu\text{g/L}$ .” (RFI, page 2-4)

**Table 2-4. Summary of Reportable Groundwater Sampling Results at Bulk Fuels Facility (ST-106)**

Compound Class	Analyte	EPA MCL ( $\mu\text{g/L}$ )	NMED Groundwater Standard ( $\mu\text{g/L}$ )	Detected Concentration ( $\mu\text{g/L}$ )				
				KAFB-106-1			KAFB-341-1	
				March 2001	June 2001	Sept 2001	March 2001	Sept 2001
VOCs	Benzene	5	10	4.7	0.5	1.2	ND	ND
	Toluene	1,000	750	8.6	1.8	2.4	ND	ND
	Ethylene dibromide	0.05	0.1	0.21	0.11	0.047	ND	ND

Note:  $\mu\text{g/L}$  = microgram per liter.  
 ND = not detected above the method detection limit.

KAFB Stage 2 Abatement Plan, February 14, 2002.



**There were in fact three detections of EDB in KAFB-1061 in 2001.**



# Site History Omission: 2007 LNAPL\* Recovery

## 3.3.2 PSH Recovery Activities

Ongoing operation of the installed PSH skimmer pump will continue as part of the FY07 abatement activities. As discussed in Section 2.3 the skimmer pump assembly has been operating at well KAFB-1065 since March 2007. Operation and monitoring of the system will continue and the following tasks will be performed:

- The PSH skimmer system will operate in an automatic mode with an anticipated five minute pumping cycle operating at a frequency of three times a day. Routine site visits will be conducted twice weekly to monitor PSH recovery and nitrogen use.
- The volume of PSH recovery will be monitored over time to assess whether operational changes in the pumping cycle time or frequency should be made to optimize PSH recovery.
- As recovered PSH is accumulated in the onsite storage vessels it will be periodically disposed of offsite through an appropriate petroleum product recycling facility.

The proposed continuation of the PSH recovery using the skimmer pump system partially addresses the NMED's specific requirement in the March 9, 2007 letter that Kirtland AFB provide "A plan to recover LNAPL".

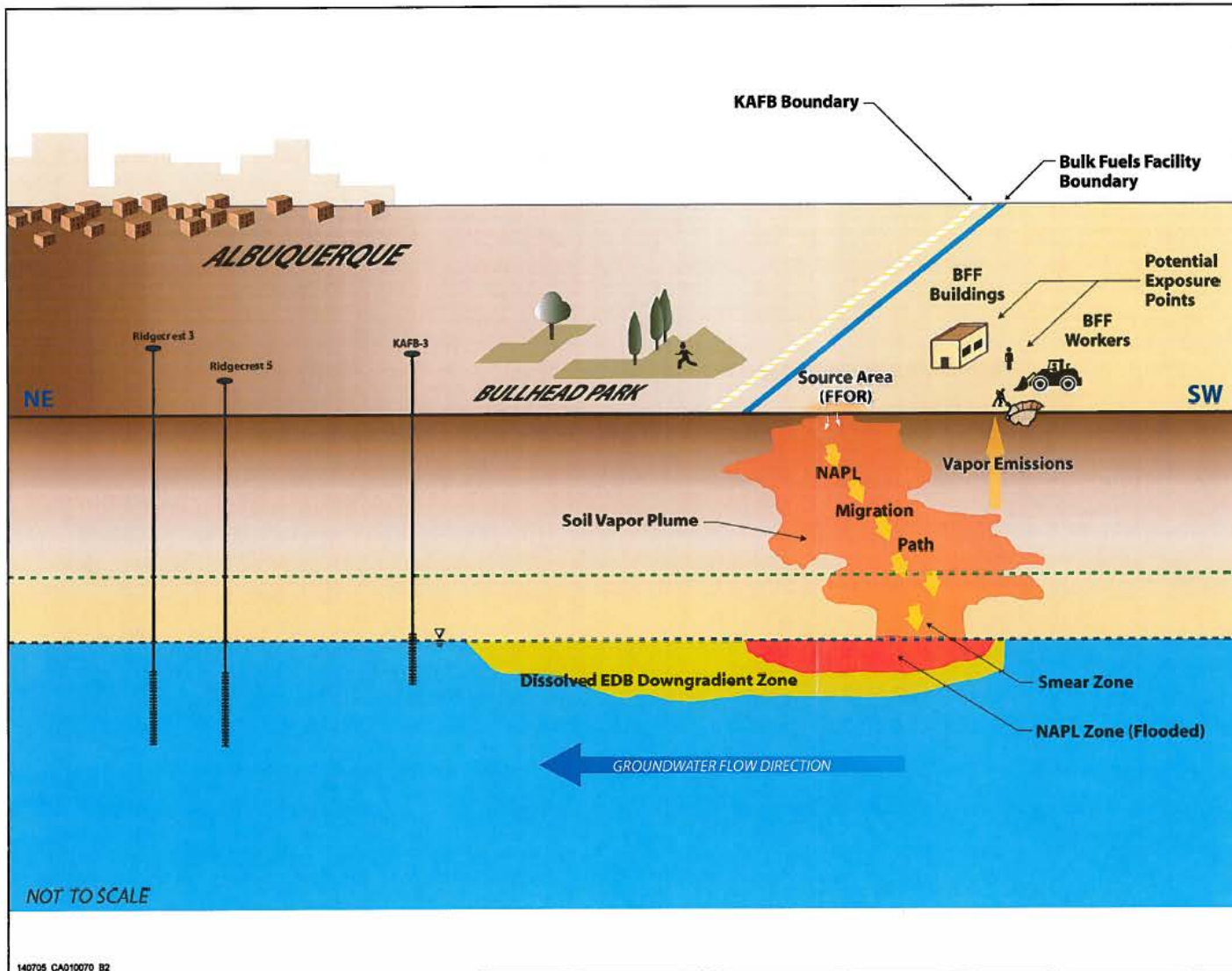
(KAFB Stage 2 Abatement Plan Modification, August 1, 2007, p. 3-9)

**\*LNAPL and PSH (phase-separated hydrocarbons) are synonymous.**

**➔ The RFI does not discuss this previous corrective action, and its outcome, in Section 2, Background Information. This historical action may become important if significant floating LNAPL occurs at the site again.**



# Conceptual Site Model Deficiencies



## Legend

- - - - - Water Table
- - - - - Historical Water Table Circa 1975
- BFF = Bulk Fuels Facility
- EDB = 1,2, dibromethane
- FFOR = Former Fuel Rack
- KAFB = Kirtland Air Force Base
- NAPL = Non-Aqueous Phase Liquid



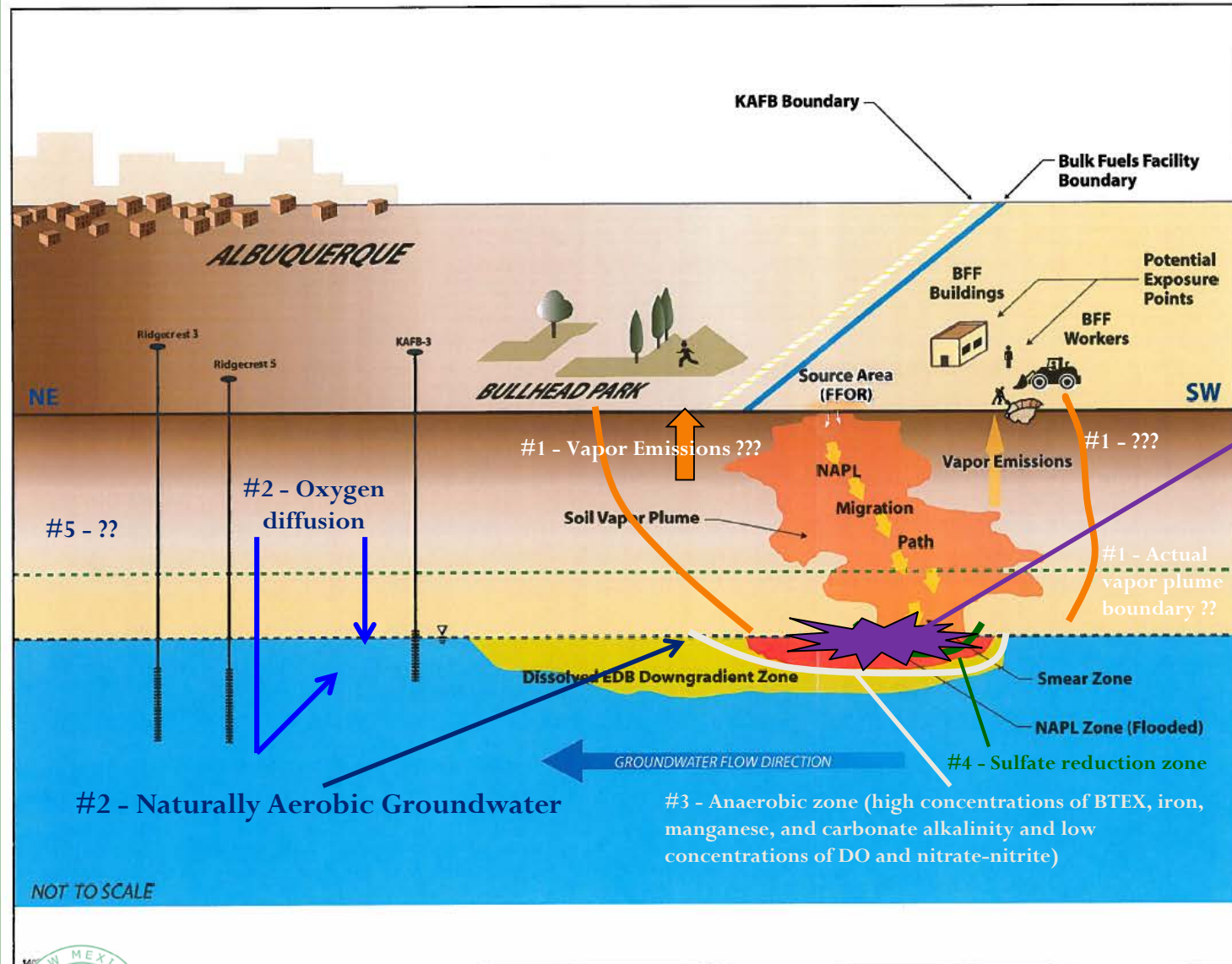
SITE LOCATION AND GROUNDWATER PLUME

GROUNDWATER ZONE RFI REPORT  
BULK FUELS FACILITY  
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 7-1

CONCEPTUAL SITE MODEL

# Conceptual Site Model Deficiencies



**SITE LOCATION AND GROUNDWATER PLUME**

GROUNDWATER ZONE RFI REPORT  
BULK FUELS FACILITY  
KIRTLAND AIR FORCE BASE, NEW MEXICO

**FIGURE 7-1**

**CONCEPTUAL SITE MODEL**



# Conceptual Site Model Deficiencies

---

- #1 - CSM suggests a vapor exposure pathway to KAFB workers
  - Vapor exposure is not discussed in the RFI
  - What is the basis exposure pathway?
  - What concentrations might workers be exposed to?
  - What precludes vapor exposure pathways in other directions and off the base?
- #2 - Analysis of groundwater background quality, critically important with regard to hydrocarbon biodegradation and other impacts to the aquifer
  - Incomplete in the RFI report.
- #3 - The anaerobic plume core and other redox zones are not illustrated and discussed relative to each other and to dissolved contaminant phases.





# Conceptual Site Model Deficiencies

---

- #4 - The sulfate reduction and methanogenesis redox zones were not identified either in the RFI or in the conceptual model.
- #5 - The CSM does not contain readily available geologic information that has been discussed at length in previous meetings
- Model fails to provide a comprehensive understanding of the physical, chemical, and biological processes that influence contaminant fate and transport. Understanding all processes that occur at the site is critical for corrective measure evaluation and selection.



# Plume Definition

---

The following activities were completed:

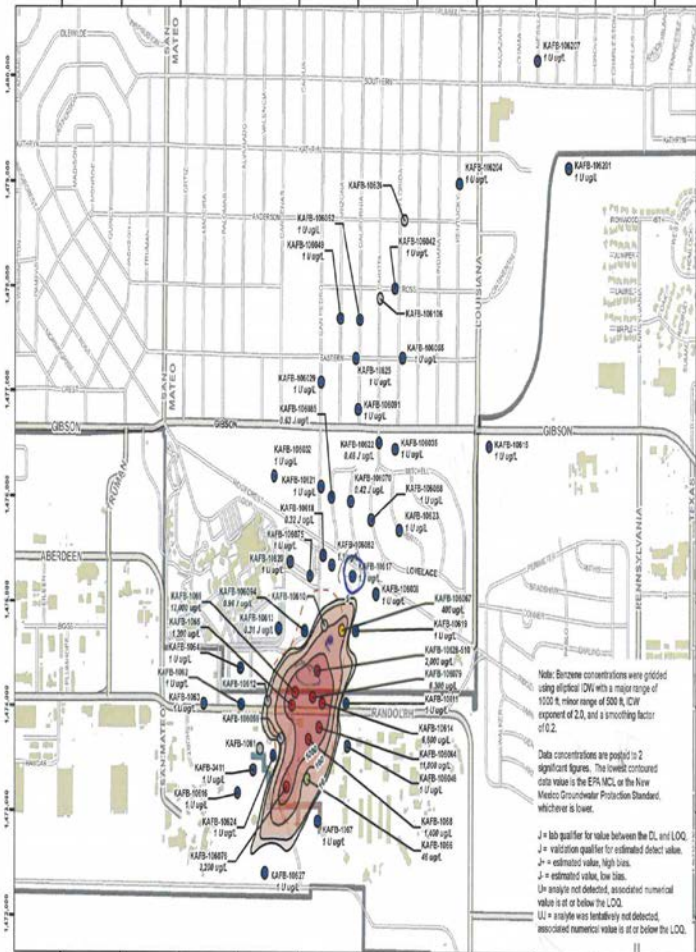
- Characterization of the vertical extent of the dissolved-phase contamination in the groundwater and the effect of vertical gradients.
- Characterization of the leading edge (northern) and eastern and western margins of the NAPL, benzene, and EDB plumes” (RFI, page 2-7)



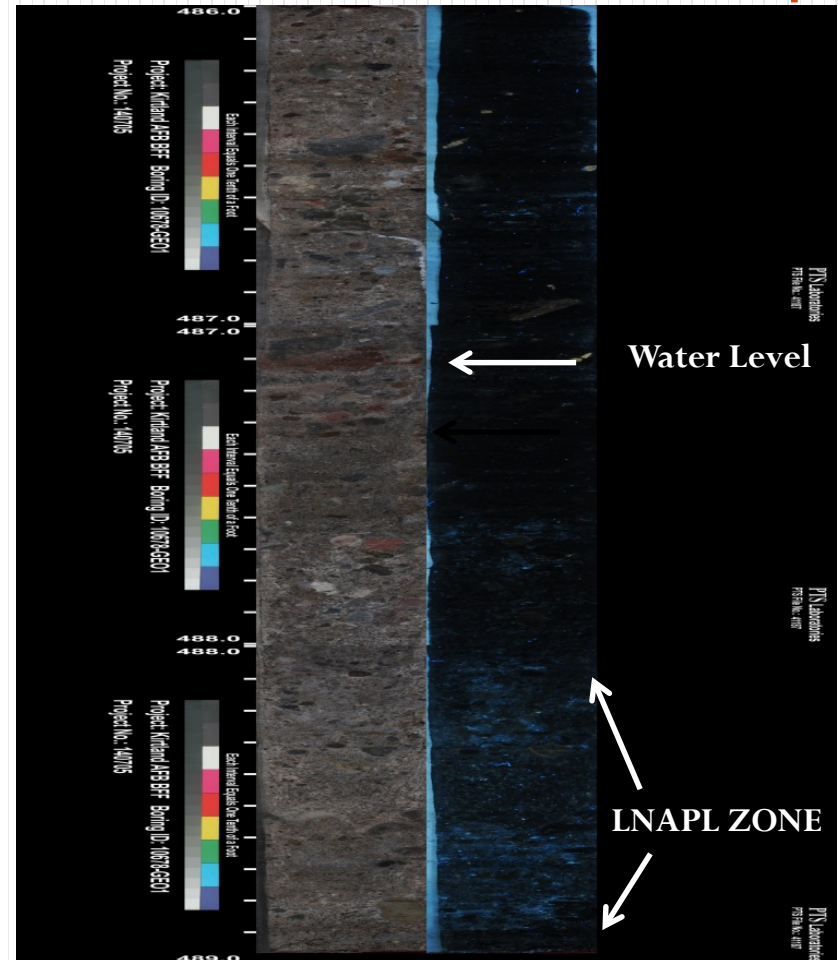


# Vertical Extent of LNAPL Not Defined

## Horizontal Extent



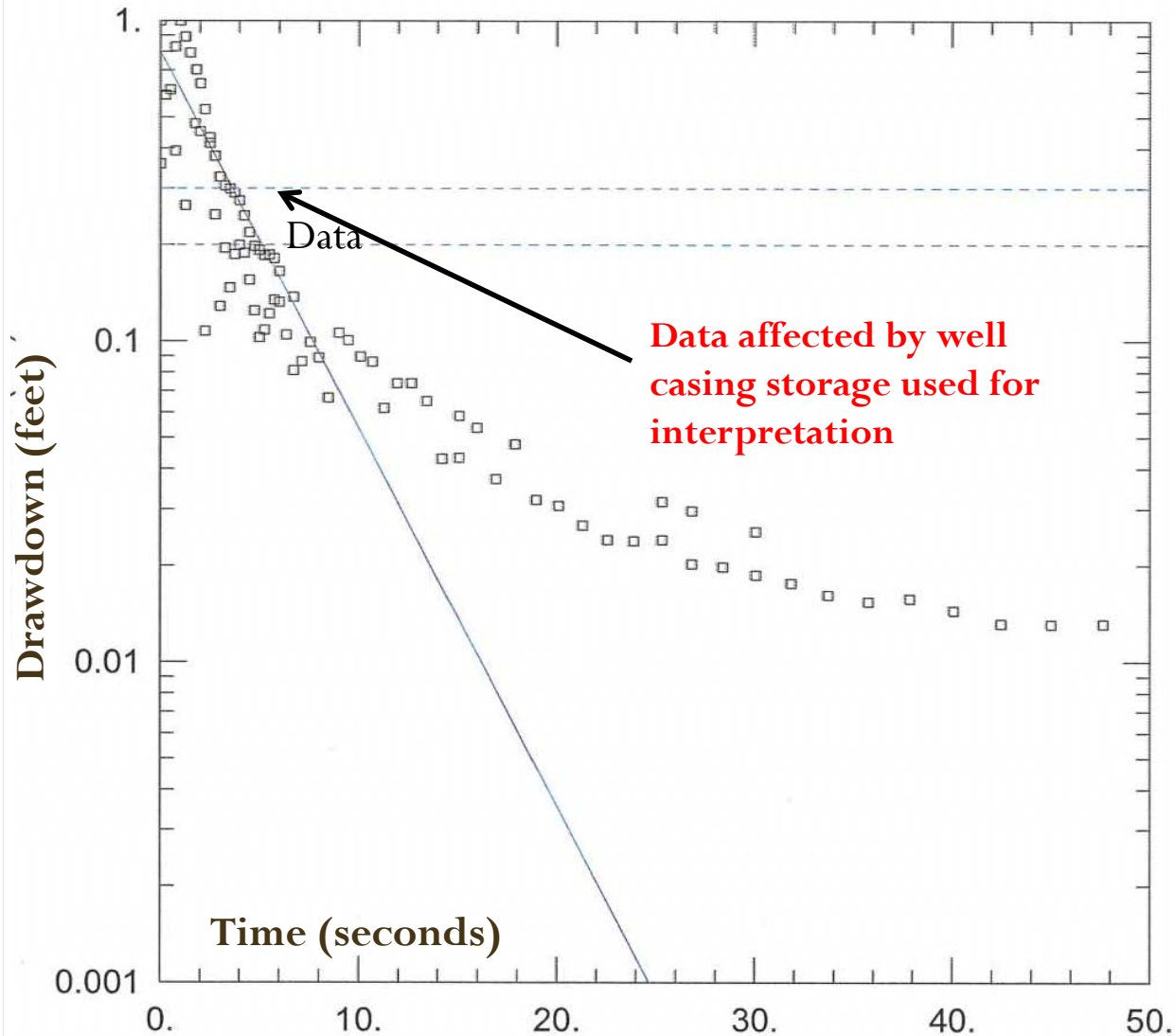
## Drowned LNAPL in core sample



Normal light ↑      ↑ UV light



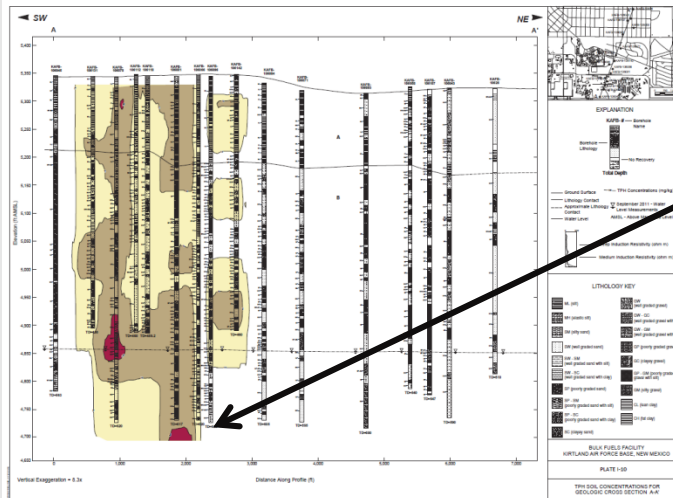
# Inappropriate Use of Slug Test Data



# Erroneous/Misleading Graphics

Graphics indicate sediment contamination 150 feet deep in the aquifer.

*This is deeper than any boring/monitoring well at the site and is not discussed in the text. Graphics are misleading and most likely wrong.*



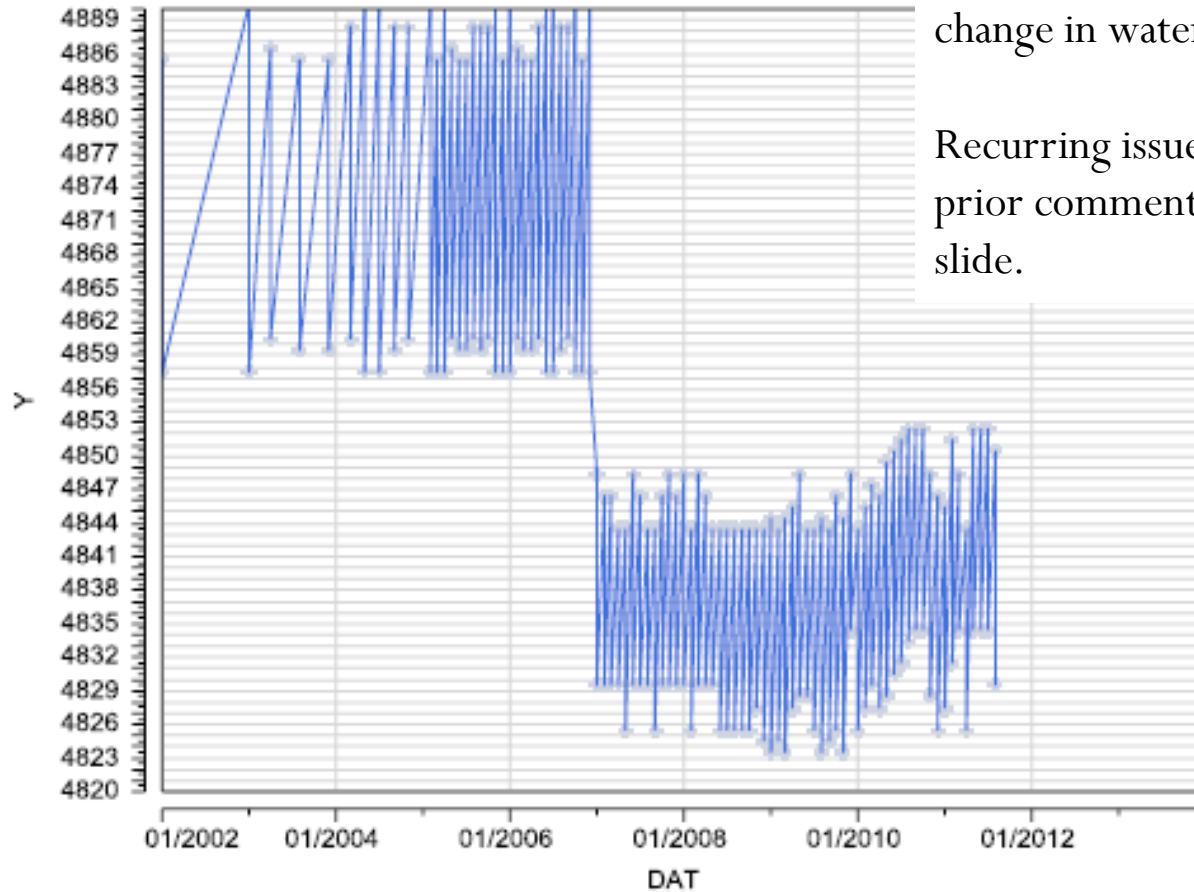
TPH in soil 150' below water table



# Strange Hydrographs

Well ID KAFB-016

Hydrograph



No description or correction of major change in water level.

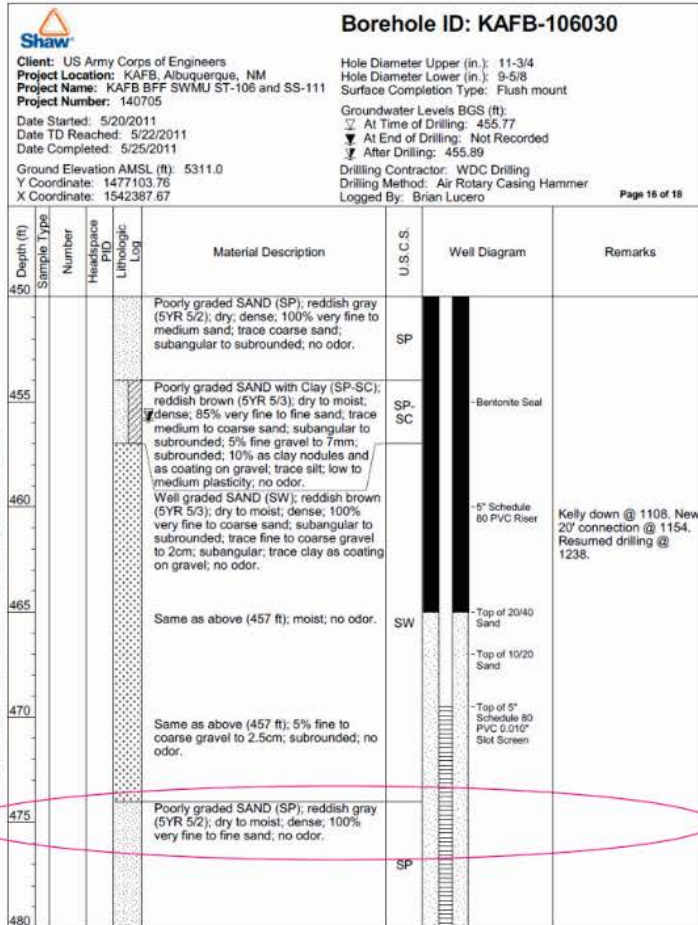
Recurring issue - NMED has made prior comment on this and previous slide.

Y ○ — NAPL Elev. (ft) + — Groundwater Elev. (ft)



# Conflicting Lithology Interpretation

**KAFB 106-030 at 475 feet: Borehole log describes it as 100% very fine to fine sand; Particle size analysis describes it as gravel.**



PTS Laboratories, Inc.

Shaw E & I  
 PTS File No: 41516

**PARTICLE SIZE SUMMARY**  
 (METHODOLOGY: ASTM D422)

PROJECT NAME: KAFBBFF  
 PROJECT NO: 667917

Sample ID	Depth, ft.	Description USCS/ASTM (1)	Median Grain Size, mm	Particle Size Distribution, wt. percent				
				Gravel	Sand Size			Silt/Clay
					Coarse	Medium	Fine	
106042-485	N/A	Medium sand	0.604	7.53	10.10	57.03	25.01	0.32
106091-465	N/A	Coarse sand	0.820	30.81	7.99	47.25	13.37	0.58
106041-460	N/A	Medium sand	1.702	11.39	32.40	38.81	16.59	0.82
106095-510	N/A	Gravel	1.458	37.97	7.63	45.22	8.40	0.78
106070-460	N/A	Medium sand	0.540	0.00	2.24	58.62	34.82	4.32
106034-505	N/A	Medium sand	0.701	9.14	13.16	55.07	20.60	2.03
106030-475	N/A	Gravel	0.713	27.38	2.88	48.49	20.92	0.34
106029-460	N/A	Gravel	1.363	42.69	3.17	46.14	7.79	0.20
106088-475	N/A	Medium sand	0.943	4.14	24.14	58.04	13.08	0.59
106058-515	N/A	Medium sand	0.626	17.07	8.52	46.66	25.42	2.33
106104-515	N/A	Medium sand	0.514	7.04	5.28	51.50	33.38	2.80
106087-545	N/A	Gravel	0.733	31.49	5.68	30.45	30.69	1.70
106033-480	N/A	Medium sand	0.427	0.00	0.27	51.05	48.20	0.48
106103-490	N/A	Coarse sand	1.292	26.42	17.94	29.85	25.30	0.49





# Lack of Analysis and Conclusions - Geophysical Borehole Logging

---

- No discussion of the findings of the geophysical logging
- Gamma, neutron, and induction logging was conducted:
  - When appropriately interpreted provides information on lithology, stratigraphy, water content, and other important subsurface information
- Useful for site specific hydrologic characterization and contaminant migration pathway analysis.



# Invalid Data Collection Geophysical Borehole Logging

---

Many induction geophysical logs were not calibrated properly. The work plan called for calibrated logs.

The EPA review of geophysical logs stated:

*“a calibration issue was noted in the induction data...” and “the induction probe used by Jet West may be faulty due to the unrealistic readings in the casing and underwater.”*



# SVE Radius of Influence

---

The VZ RFI states:

*“[t]o determine the ROI [radius of influence] of the CATOX SVE system, the corrected observed vacuum pressures for each well depth and type were plotted against radial distance from the nearest extraction well, and a best-fit line was fit to the data... The distance at which the best-fit line crosses the corrected observed vacuum pressure of 0.2 inWC is the ROI observed in that well depth and type.”*

However, ...



# SVE Radius of Influence

---

EPA's 1998 Innovative Site Remediation Technology, Volume 7: Vacuum Extraction and Air Sparging states:

*“[h]istorically, radius of influence has been determined by plotting the log of subsurface pressure with distance from the extraction well, regression, and interpolating the regression line to an arbitrary pressure value, typically ranging from 0.01 to 1 inch water column... The radius of influence evaluated in this way is arbitrary, because the vacuum cutoff level is arbitrary.... Many alternative approaches have been developed that focus on air flow.”*

In addition, ...



# SVE Radius of Influence

---

The 2002 US Army Corps of Engineers' Engineering and Design Soil Vapor Extraction and Bioventing Engineer Manual specifically states:

*“[t]he radius of vacuum/pressure influence does not provide, in most cases, an estimate of the zone of effective air exchange of the vent..., which is often much smaller than the radius of pressure influence.”*

and

*“[p]ractitioners who use ROI testing to design soil venting systems assume that observation of subsurface vacuum ensures sufficient airflow in contaminated soils for timely remediation via organic compound volatilization and/or biodegradation. As Johnson and Ettinger point out, however, measurement of vacuum says very little about pore-gas velocities that prevail within the subsurface.”*



# Errors and Omissions

---

## Examples



# Groundwater Chemistry Time Trends Not Analyzed

---

For Example:

- DO data for the shallow groundwater zone suggest that the anaerobic zone has generally decreased in area from 2011 to 2014. This provides evidence for a larger anaerobic plume zone in past.
- DO, nitrate, manganese, iron...



# Significance of Anaerobic (Low Dissolved Oxygen) Zone Footprint

---

- DO is an important parameter and was not presented in the RFI
- Anaerobic conditions with high concentrations of electron donors (BTEX) are most favorable for EDB biodegradation.
- If the anaerobic zone has, in fact, been shrinking, this has profound implications for corrective measure evaluation and selection.





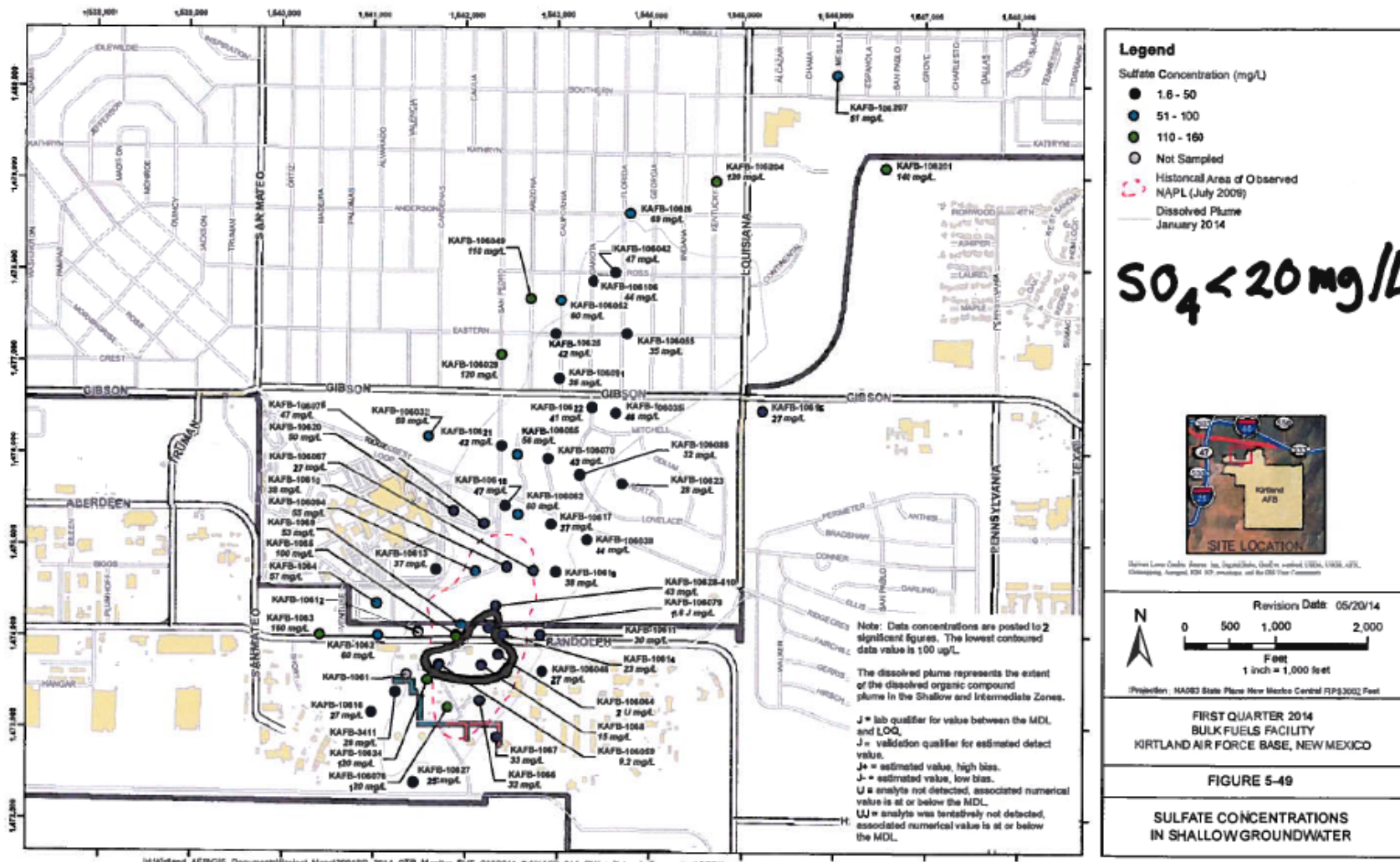
# Sulfate Data Misinterpreted

---

- The RFI (p. 6-10) states:  
*“No obvious pattern is apparent in the Shallow, Intermediate, and Deep Zone sulfate results, and none has been observed since monitoring began in First Quarter CY 2011.”*
- **However:** RFI Figure 6-19 clearly shows very low sulfate concentrations (ie. sulfate reducing conditions) in the LNAPL area.



# Sulfate Concentrations in Shallow Groundwater



# Compound Specific Isotope Analysis (CSIA) for EDB is Unreliable

---

- CSIA used as the sole quantitative tool to demonstrate biodegradation
- The CSIA is a key element in the RFI to support the conclusion of biodegrading EDB
- EPA, however, has identified serious problems with the CSIA study (insufficient concentrations of EDB in many CSIA samples and co-elution of hydrocarbons with EDB in samples submitted for CSIA)
- The study must be redone



# Conclusions

---

- The RFIs contain numerous errors, omissions, and invalid conclusions, and is significantly incomplete.
- Many of these deficiencies have been carried over from the quarterly reports, and have previously been brought to the attention of KAFB and CB&I.
- The RFI fails to provide the comprehensive technical analyses needed for remedy evaluation and selection.
- The RFI cannot be approved with these deficiencies.

