Sand and gravel deposited by the ancestral Rio Grande is the host material for a major aquifer in the Albuquerque area.
Goal: Protect Albuquerque’s aquifer and drinking water supply wells in the area of the fuel leak

Strategies to Achieve the Goal

In 2018, NMED and the Air Force will continue to:

1. Implement a robust site monitoring and wellhead protection program
2. Update the Conceptual Site Model, as necessary, to describe physical, chemical and biological processes that affect the migration and fate of fuel contamination in soil, soil vapor and groundwater
3. Using information gained in Strategies 1 and 2, deploy multiple engineered technologies, both simultaneously and sequentially as interim corrective measures, to mitigate soil, soil vapor and groundwater contamination
4. Meet or exceed all requirements for providing public information and involvement
Strategy 1 – Implement Robust Site Monitoring and Wellhead Protection

• No detections of EDB in drinking water wells or sentinel wells
• Cone of depression persists in groundwater extraction area
• Rigorous EDB plume capture analysis/modelling is underway by both Air Force and NMED
• Soil coring will fill data gaps on residual LNAPL
• Evaluate changes to groundwater flow direction and contaminant migration
• Data gaps caused by water level rise are being filled by:
  – Drilling new monitoring wells
  – Monitoring previously dry soil-vapor wells that now contain groundwater

KAFB fuel contaminants will not be allowed to adversely impact any community drinking water wells
1 – Drilling is Underway to Fill Groundwater and LNAPL Data Gaps
Strategy 2 – Update Conceptual Site Model

- Define effect of water table fluctuations on locations and amounts of residual LNAPL
- Identify natural degradation processes and potential opportunities for enhancement through engineered cleanup technologies

Contaminant partitioning between LNAPL, water, soil gas and soil (adsorbed) phases

Hydrocarbon oxidation in soil and groundwater

Residual LNAPL

EDB hydrolysis

Reductive debromination of EDB comingled with hydrocarbons
2. It is safe to drink city water, grow gardens and fruit trees, and enjoy back yards and parks.
Soil and groundwater bacteria can oxidize petroleum hydrocarbons, such as benzene, into carbon dioxide and water. Naturally occurring biodegradation process can sometimes be enhanced, for example, by delivering additional oxygen to soil bacteria during bioventing.

$$C_6H_6 + 7.5O_2 \rightarrow 6CO_2 + 3H_2O$$

Aerobic Benzene Biodegradation
Strategy 3 – Deploy Multiple Engineered Cleanup Technologies, Simultaneously and Sequentially, as Interim Corrective Measures

During 2018:
• Efforts to collapse the EDB groundwater plume with pump-and-treat technology will continue; and
• Pilot tests for enhanced in-situ anaerobic groundwater biodegradation, and soil bioventing will be conducted.

4,822 tons of soil excavated
12 Years of soil vapor extraction
Bioventing pilot test; planned
Groundwater pump-and-treat to collapse EDB plume; 3 years and ongoing
Enhanced in-situ anaerobic groundwater biodegradation pilot test; underway
4 Years of bioslurping groundwater LNAPL
3. Soil Vapor Extraction (SVE) and Biospurring

- 12 years of SVE vacuumed and biodegraded fuel out of spaces between soil particles in the source area
- 3 years of bioslurping removed and biodegraded fuel from the water table zone in the source area
- The combined removal and biodegradation of approximately 750,000 gallons of fuel has significantly decreased soil vapor contaminant concentrations in the source area
- Based on this success, the SVE was shut down in 2015 to perform rebound and bio-respiration testing which confirmed that soil bacteria continue to biodegrade fuel contaminants
- A bioventing pilot test (interim measure) is a logical next step
3. Total VOC Soil Vapor, June 2011

The aerial zone VOC plume was gridded in three dimensions using inverse distance weighting in RockWorks and then concentration plan-view maps were "cut" at respective elevations. On-ground elevations range from 5314 to 5394 ft above mean sea level across the GT-100/G-111 investigation area.
3. Total VOC Soil Vapor, Sept. 2014
Bioventing is a logical follow up to SVE and bioslurping. Air will be blown into the soil to deliver oxygen and moisture to naturally occurring bacteria and enhance their ability to biodegrade petroleum hydrocarbons.
3. Collapse the EDB Plume

Groundwater Extraction and Treatment System:

- Pump contaminated groundwater from extraction wells, treat water to remove contaminants, use treated water for KAFB golf course irrigation and aquifer recharge
- Four extraction wells have been installed to date
- Analyze plume capture, optimize system operation, add extraction wells if necessary
- Monitor for evidence of decreasing contaminant levels and plume collapse
The EDB footprint in the groundwater extraction area has varied, but is presently the smallest it has been since extraction began in 2015. The most likely explanation for this is that the extraction system is beginning to collapse the plume.
3. Anaerobic Biodegradation Pilot Test

Tara Kunkel
APTIM Geologist and Project Manager
EDB In Situ Biodegradation Pilot Test

- Multi-part, data driven pilot test
- Phase 1 – Baseline definition, tracer, test circulation, passive monitoring (completed Dec 2017)
- Phase 2 – Bio-Stimulation by adding nutrients and lactate (completed July 2018)
- Phase 3 – Based on Phase 2 success, additional Bio-Stimulation. (scheduled for summer 2018). Bio-Augmentation on hold.
- Phase 4 – Additional passive monitoring
EDB In Situ Biodegradation Pilot Test

- Began Phase 1 in October 2017 - GW extracted and injected for 30 days with tracers to evaluate transport times and distribution throughout the pilot test area
- Completed passive part of Phase 1 from Nov – Dec 2017
- Phase 1 showed effective distribution of tracers at the site and provided opportunity to evaluate EDB concentrations and native bacteria already present
- Began Phase 2 in Dec 2017 - GW extracted and injected for ~30 days with addition of treatment amendments and tracer
- Completed passive monitoring part of Phase 2 from Feb – July 2018
EDB In Situ Biodegradation Pilot Test

- Phase 1: Tracer Recirculation
- Non pumping passive phase
- Phase 2: Biostimulation Recirculation
- Non pumping passive phase

Time:
- 9/2/17
- 10/22/17
- 12/11/17
- 1/30/18
- 3/21/18
- 5/10/18

EDB (µg/L):
- 106054
- 106EX1
- 106EX2
- 106IN1
- 106MW1-S
- 106MW2-S
- EPA MCL
Phase 2 results:

- Effective distribution of tracers and amendments
- Decreasing concentrations of EDB at the shallow monitoring wells, injection well, and 1 extraction well
- Native dehalogenating bacteria present in high counts at all wells in the pilot test area
- Other VOC constituents remain at higher and steady concentrations, indicating little dilution
EDB In Situ Biodegradation Pilot Test

- Will begin Phase 3 in July 2018 – Phase 3 will now be additional Biostimulation based on results of Phase 2
- Phase 3 will include extraction/injection of GW for ~30 days with addition of treatment amendments to stimulate biodegradation of additional EDB at the pilot test site
- Phase 3 will also be followed by a period of passive monitoring for evaluation of effectiveness
The Air Force and NMED are conducting public outreach and involvement activities related to investigation and cleanup of the KAFB aviation fuel contamination in accordance with the public notice and community relations requirements of the WQCC and RCRA Permits.


<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
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<tbody>
<tr>
<td>March 21, 2018</td>
<td>ABCWUA Governing Board Meeting, project update</td>
</tr>
<tr>
<td>March 22, 2018</td>
<td>Regular Public Meeting with Technical Poster Session</td>
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<tr>
<td>March 24, 2018</td>
<td>Groundwater Treatment System Open House</td>
</tr>
<tr>
<td>July 12, 2018</td>
<td>Regular Public Meeting with Technical Poster Session</td>
</tr>
<tr>
<td>July 31, 2018</td>
<td>Draft NMED Public Involvement Plan to be issued for public comment</td>
</tr>
<tr>
<td>October 12, 2018</td>
<td>ABCWUA Water Protection Advisory Board</td>
</tr>
<tr>
<td>October 17, 2018</td>
<td>63rd Annual New Mexico Water Conference</td>
</tr>
<tr>
<td>November 15, 2018</td>
<td>Regular Public Meeting with Technical Poster Session</td>
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</tbody>
</table>

NMED and the U.S. Air Force welcome invitations from neighborhood associations, civic organizations, environmental groups, and local government agencies.
NMED will engage middle school, high school and college students with the project by:

1. Making presentations to schools and colleges;

2. Encouraging and assisting students with the creation of original papers, slide presentations, physical models, digital animations, poetry, and musical compositions based on protecting the environment;

3. Providing opportunities for students to present their original work at public meetings.

Outreach will include all students who are interested in environmental protection.
4. Public Involvement Plan (PIP)

- NMED will develop a Public Involvement Plan (PIP) to ensure that public participation opportunities related to NMED activities and proceedings on the KAFB fuel cleanup project are in accordance with Title VI of the Civil Rights Act of 1964, 42 U.S.C. §§ 2000d to 2000d-7, and the EPA regulations at 40 C.F.R. Parts 5 and 7.

- NMED plans to issue a draft PIP by July 31, 2018 for a 30 day public comment period.
Site Activity Timeline

1999 - 2020

- Phase I and Phase II RCRA Facility Investigation
- Corrective Measures Evaluation
- Soil Investigation
- Installation of Groundwater Monitoring Wells
- Groundwater Monitoring
- Installation of SVE/SVM/PneuLog Locations
- Soil Vapor Monitoring
- LNAPL Thickness Monitoring
- LNAPL Chemical Characterization
- Slug Test of Groundwater Monitoring Wells
- Aquifer Test of KAFB-106228

INTERIM CLEANUP MEASURES

- Excavation of Contaminated Soil - Three Excavations
- Operation of SVE Systems
- Groundwater Treatment System Operation
- Vadose Zone: Bioventing Pilot Test
- Groundwater: EDB In-Situ Biodegradation Pilot Test
- AS/SVE Pilot Study
- EDB/BTEX Treatability Study
- Bioslurping/Skimmer Technology
2018 to 2020 Activities

2018
• In-situ bioremediation pilot test is underway
• Drilling to fill groundwater and LNAPL data gaps is underway
• Public Involvement Plan will be published for public comment, then finalized with edits/additions based on public input
• Risk Assessment will be finalized
• Phase 1 RFI report will be submitted
• Bioventing pilot test will be commenced
• Plume capture analyses will be performed by USAF and NMED

2019
• Site investigations and pilot tests will be completed
• Phase 2 RFI report will be submitted

2020
• Corrective Measures Evaluation will begin
About NMED’s Strategic Plan

- NMED’s annual Strategic Plans are not regulatory documents, but serve to communicate goals and strategies with the public.

- NMED’s Strategic Plans summarize the detailed, and often highly-technical, regulatory permits, workplans, engineering specifications, schedules, and approval letters that can be accessed from the NMED Hazardous Waste Bureau website: [https://www.env.nm.gov/hazardous-waste/kafb/#KAFBBulkFuelsFacSpill](https://www.env.nm.gov/hazardous-waste/kafb/#KAFBBulkFuelsFacSpill).


- Kirtland Air Force Base jet fuel remediation website: [https://www.kirtlandjetfuelremediation.com/](https://www.kirtlandjetfuelremediation.com/)

- Drinking Water Watch contains information and drinking water test results for public water systems in New Mexico, including Albuquerque Bernalillo County Water Utility Authority, Kirtland Air Force Base, and Veterans Administration Hospital: [https://dww.water.net.env.nm.gov/NMDWW/](https://dww.water.net.env.nm.gov/NMDWW/)

- NMED does not discriminate on the basis of race, color, national origin, disability, age or sex in the administration of its programs or activities.