New Mexico Environment Department

2015 Strategic Plan

Kirtland Air Force Base Fuel Spill

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Written comments due to NMED by close of business, January 30, 2015.

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Albuquerque-Bernalillo County Water Utility Authority,

City of Albuquerque, Environmental Health Department

U.S. Air Force, Kirtland Air Force Base

U.S. Air Force Civil Engineering Center

U.S. Environmental Protection Agency

A Message from NMED Cabinet Secretary Ryan Flynn:

Cleaning up the Kirtland Air Force Base fuel spill is one of the highest priorities of the New Mexico Environment Department (NMED) and I am certain we will be able to prevent the spill from threatening the health and safety of Albuquerque's citizens. As Cabinet Secretary, I have committed to working with the City of Albuquerque and the Albuquerque-Bernalillo County Water Utility Authority to ensure Albuquerque's drinking water supply is not endangered by the fuel spill. Designing and implementing a successful cleanup is an ongoing process and this 2015 Strategic Plan is an important part of that process.

Over the past year, NMED has worked closely with the Air Force, the Albuquerque-Bernalillo County Water Utility Authority, the City of Albuquerque and the U.S. Environmental Protection Agency to design effective measures for cleaning up the fuel spill based on sound science and engineering . We developed productive working groups with top technical experts from our project partner organizations and other entities and are beginning to see meaningful progress. Although I will not be satisfied until we have successfully cleaned up the entire spill, I am very pleased with the progress we are making and feel confident that we are on the right path.

In 2014, NMED and the technical working groups made progress to identify and fill data gaps, and increase the robustness of interim corrective measures. I am pleased to report the following progress that was accomplished in 2014:

- The soil vapor extraction system, which has already removed more than 500,000 gallons of fuel from the subsurface, was upgraded.
- An air sparging pilot test well was drilled and put into operation.
- A work plan to drill an additional 16 monitoring wells to fill data gaps in the horizontal and vertical plume definition was approved, and drilling commenced in early December.
- A work plan to drill the first groundwater extraction well and treatment system, which will begin to collapse the dissolved phase contamination plume and pull it away from the City of Albuquerque's water supply wells, was recently approved.
- An e-mail Listserv to keep the public better informed of site developments and opportunities for involvement was created.
- Quarterly public meetings were modified to include poster sessions that allow members of the public to speak directly with NMED and Air Force technical experts.
- A geological field trip was held to discuss the hydrogeology and geochemistry of the site with members of the public.

The measures outlined above are expected to remove significant amounts of contamination and may be incorporated in a larger-scale final remedy. The following pages describe remediation activities we expect the Air Force to complete in 2015. These include:

- Installing 16 new monitoring wells.

- Making up to 4 extraction wells operational. The extracted groundwater will be treated to drinking water standards and re-injected back into the aquifer or used for irrigation.
- The existing soil vapor extraction system will be expanded to increase the hydrocarbon removal capacity from 90 pounds per hour to 1,500 pounds per hour.
- Laboratory and field tests of various technologies that might be used to clean up the light non -aqueous phase liquid (LNAPL) fuel will continue and, in some cases be scaled up.

We hope that many of you will continue to participate in the quarterly public meetings and periodic field trips to stay informed of site developments and to make sure your voice is heard as we continue to make progress on this important project.

Sincerely,

Ryan Flynn

Ryan Flynn

NMED Cabinet Secretary

Commonly used acronyms and abbreviations:

AFCEC	Air Force Civil Engineering Center
EDB	Ethylene dibromide
EPA	U.S. Environmental Protection Agency
KAFB	Kirtland Air Force Base
LNAPL	Light Non-Aqueous Phase Liquid (in this case, aviation gasoline & jet fuel)
MCL	Maximum Contaminant Level
NMED	New Mexico Environment Department
RCRA	Resource Conservation and Recovery Act (federal)
SDWA	Safe Drinking Water Act (federal)
SVE	Soil Vapor Extraction

Leakage of aviation gasoline and jet fuel from the Kirtland Air Force Base (KAFB) bulk fuel facility migrated through ~500 feet of vadose-zone sediment, and into the underlying aquifer.

The fuel has partitioned into four phases in the soil and groundwater:

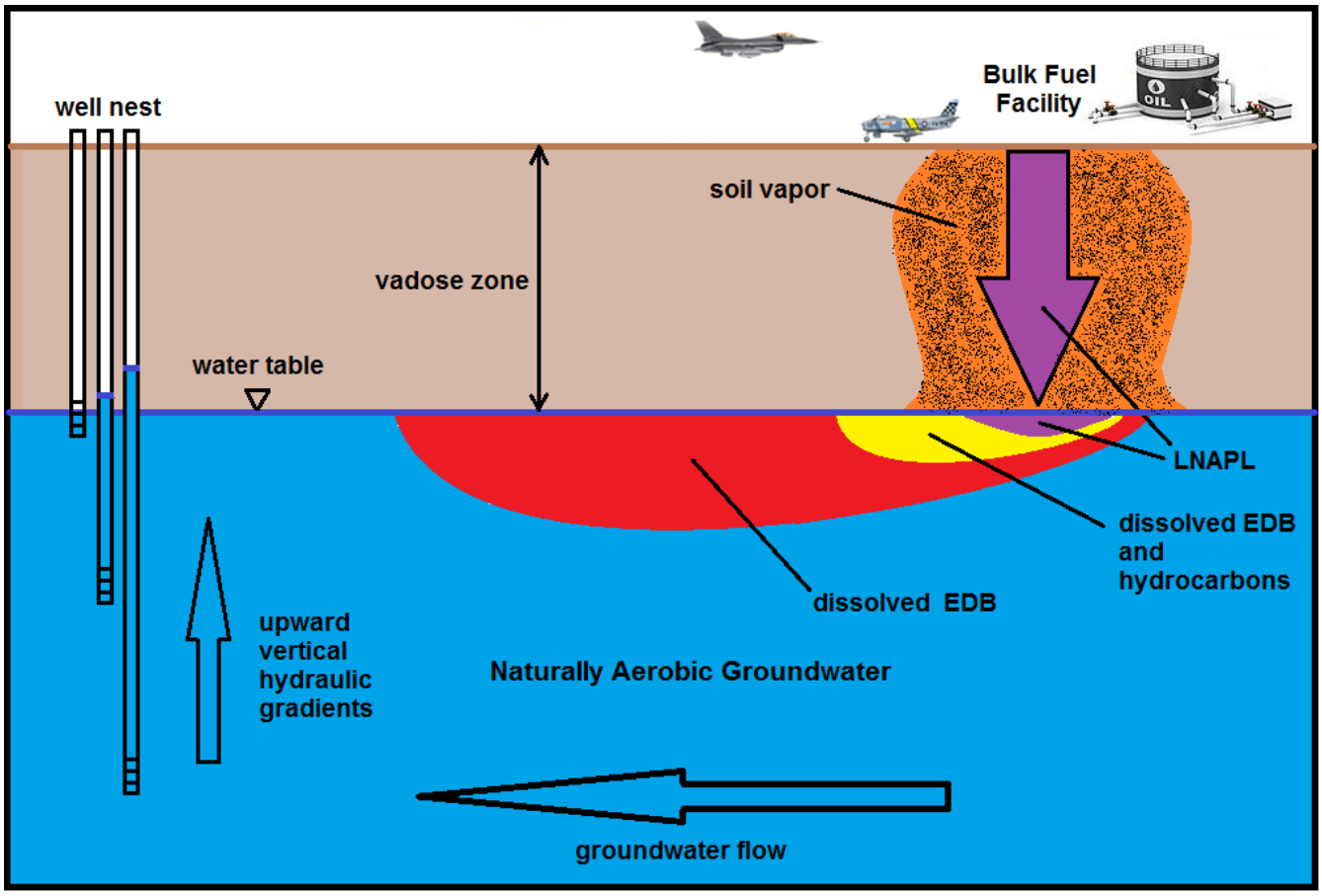
- Light non-aqueous phase liquid (LNAPL, liquid fuel);
- Soil vapor;
- Adsorbed contaminants (attached to soil particles and aquifer matrix);
- Dissolved contaminants (fuel constituents dissolved in groundwater).

LNAPL initially floating on top of the aquifer has become submerged in groundwater by a rising water table.

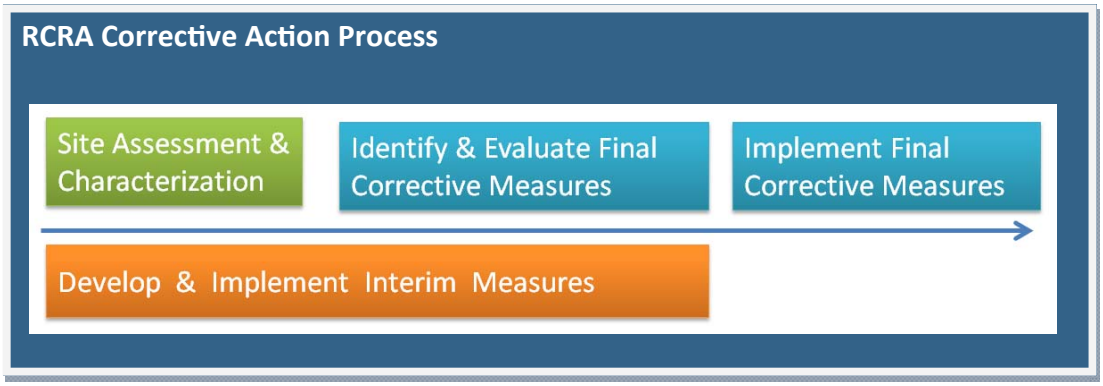
Dissolved ethylene dibromide (EDB, an additive of aviation gasoline) has migrated in groundwater about 6,000 feet away from the source area, but has not contaminated any water supply well.

References for additional technical information are attached in Appendix A.

Schematic Diagram of the KAFB Fuel Spill



New Mexico has primacy granted by the U.S. Environmental Protection Agency (EPA) to administer the federal Resource Conservation and Recovery Act (RCRA) hazardous waste program. The New Mexico Environment Department (NMED) implements the program. Kirtland Air Force Base (KAFB) must comply with their RCRA Hazardous Waste Permit, including the Corrective Action Process.



Some interim measures have been put into place and additional measures are scheduled. Site assessment and characterization activities are ongoing and, upon completion, RCRA Facilities Investigation (RFI) reports will be submitted to NMED. The RFI reports, after approval by NMED, will be used to support the Corrective Measures Evaluation. Teams of multi-disciplinary technical experts (Appendix B) have been created to provide the following support for the corrective action process:

- Identify, and make recommendations to fill data gaps;
- Identify and resolve data quality issues;
- Define and evaluate the physical, chemical, and biological processes that affect the migration and fate of fuel constituents in the vadose zone and groundwater;
- Establish mass balance equations to calculate the amounts of fuel recovered by engineered cleanup actions, destroyed by biodegradation, and remaining in the aquifer and vadose zone.
- Develop a conceptual site model;
- Develop recommendations for cleanup technologies and strategies.

CRITICAL GOALS

1. Protect drinking water wells - do not allow fuel constituents to migrate into any drinking water well at detectable concentrations.
2. Collapse the dissolved-phase EDB plume and pull it back towards the boundary of KAFB, away from the seven supply wells in the area;
3. Remediate fuel (LNAPL) floating on top and submerged in groundwater;
4. Vacuum fuel vapor from the soil to prevent it from migrating into and contaminating groundwater;
5. Maintain a high level of project transparency that exceeds statutory RCRA requirements for public information and involvement.

Each of these goals require a different strategy and course of action which are outlined in the following pages.

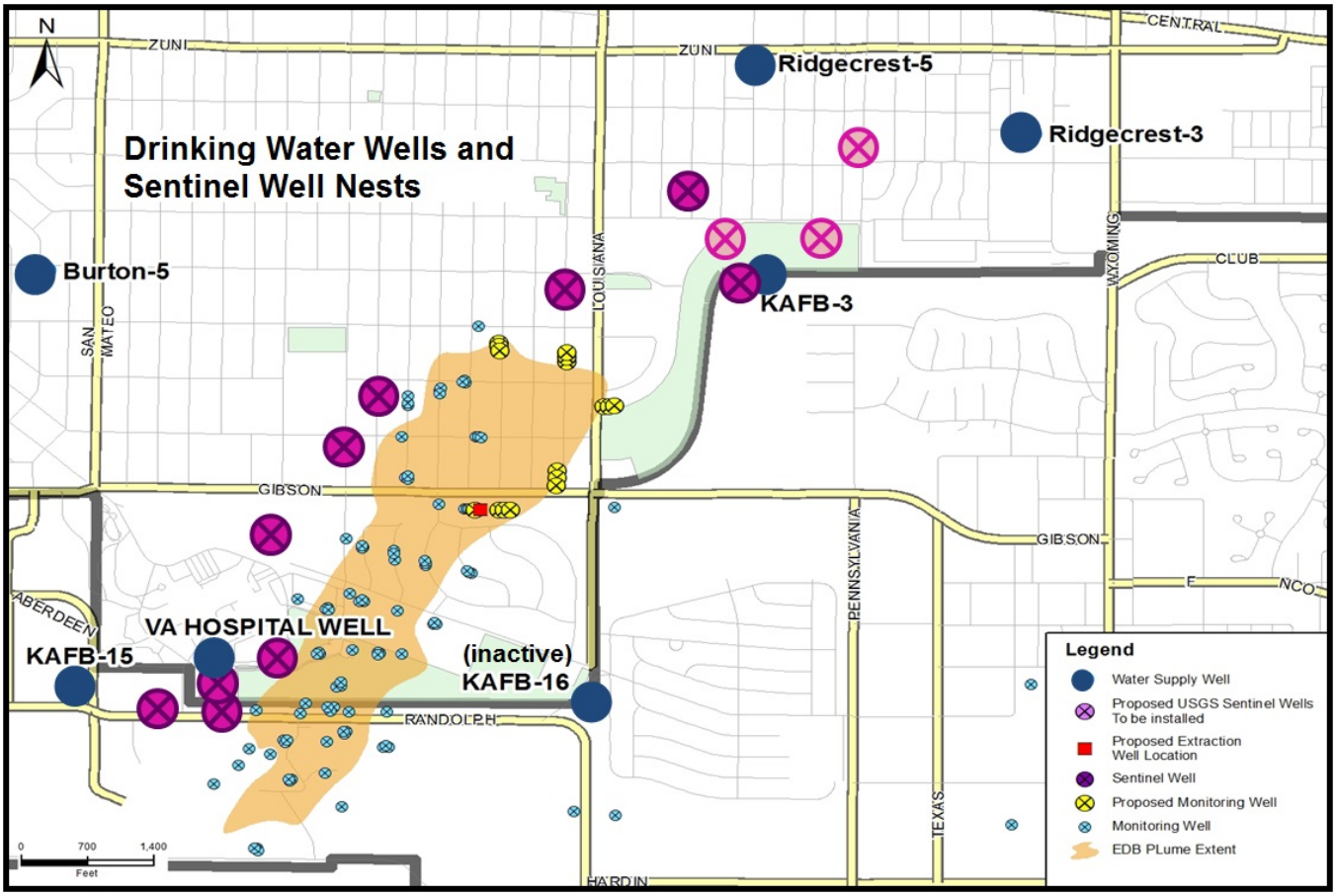
GOAL 1

Protect Drinking water wells - do not allow fuel constituents to migrate into any drinking water well at detectable concentrations.

Strategy

As fuel plume cleanup proceeds, the following plan is being implemented to protect drinking water wells:

- Test for fuel contaminants at drinking water wellheads monthly. (current requirements are for testing every 3 years).
- Drill nests of sentinel wells (minimum of 3 wells per nest) located between the fuel plume and drinking water supply wells.
- Test sentinel wells quarterly to provide early detection of any contaminant migration towards the drinking water wells.
- Establish geochemical indicator parameters and action levels for sentinel wells, attainment of which would trigger a review of current hydrogeological conditions, increased monitoring, or intervention.



Drinking Water Standards

NMED has primacy granted by the U.S. EPA to administer the federal Safe Drinking Water Act (SDWA) program. One of NMED's SWDA responsibilities is to require that public water systems supply drinking water to consumers that complies with the EPA Primary (human health based) Maximum Contaminant Levels (MCLs).

Constituent	Primary MCL* (µg/L)
Ethylene dibromide (EDB)	0.05
Ethylene dichloride (EDC)	5
Benzene	5
Toluene	1,000
Ethylbenzene	700
Xylenes (total)	10,000

*EPA Maximum Contaminant Levels (MCLs) adopted by NM as part of our primacy.
(http://water.epa.gov/drink/contaminants/)

To date, fuel constituents have never been detected in any of the public water supply wells.

The goal of this strategic plan is to collapse the contamination plume and pull it back towards the boundary of KAFB before it ever reaches a drinking water well.

GOAL 2

Collapse the dissolved-phase EDB plume and pull it back towards the boundary of KAFB, away from the seven drinking water wells in the area.

Strategy

Develop a robust monitoring and pump and treat system. NMED will oversee the following actions to be performed by the Air Force and their contractors:

Phase 1 (Interim measures)

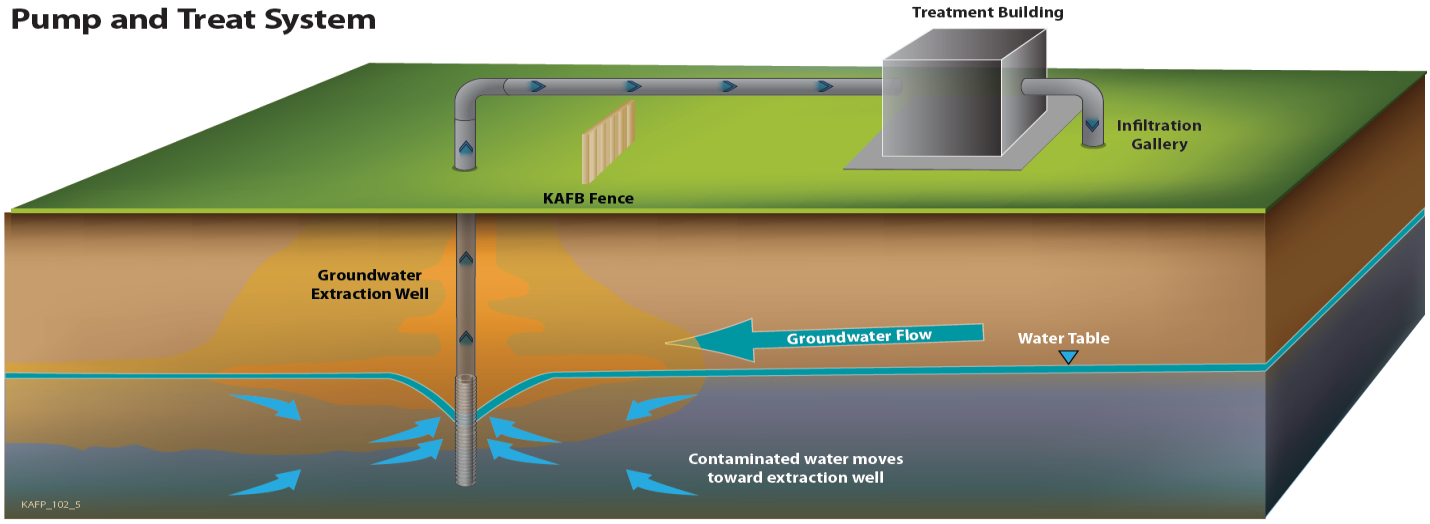
- Define the horizontal and vertical extent of EDB contamination in groundwater by the drilling of at least 16 additional monitoring wells.
- Install a pilot extraction well at the KAFB-106035 well nest location.
- Construct a pipeline to convey water from the KAFB-106035 well nest location.
- Construct a granular activated carbon filtration system to treat the approximately 100 gallons per minute of extracted water to at least the EPA drinking water MCL of 0.05 µg/L.
- Construct an infiltration gallery, permitted by the NMED Groundwater Bureau, to disperse the treated water into the subsurface and allow it to recharge groundwater.
- Explore other options for the beneficial use of treated water such as landscape irrigation and dust control.

Phase 2 (Interim measures)

- Use hydrogeological data and numerical modeling simulations, as appropriate, to locate and design up to 7 additional extraction wells located throughout the dissolved-phase EDB plume.
- Drill up to 7 additional extraction wells.
- Upgrade conveyance, treatment and infiltration systems, as necessary, to accommodate up to approximately 600-800 gallons per minute of extracted water.

Phase 3 (Final measures)

- In accordance with the requirements of the federal Resource Recovery and Conservation Act, evaluate, select and implement a final corrective measure for dissolved-phase EDB.
- Implement long-term operation, maintenance and optimization of pump-and-treat system to collapse plume and pull it back towards the boundary of KAFB.


Pump and Treat System
Treatment Building
Infiltration Gallery
KAFB Fence
Groundwater Extraction Well
Groundwater Flow
Water Table
Contaminated water moves toward extraction well
KAFP_102_5

GOAL 3

Remediate the fuel (LNAPL) floating on top and submerged in the groundwater (above and below the aquifer water table). **LNAPL = light non-aqueous phase liquid*

Strategy

Pilot Tests

NMED will oversee evaluations performed by the Air Force and their contractors to explore the feasibility and effectiveness of the following remediation technologies:

- Air sparging (blowing air into the groundwater to strip out contaminants, followed by vacuuming the stripped contaminants from soil);
- Steam sparging (blowing steam into the groundwater to strip out contaminants, followed by vacuuming the stripped contaminants from soil);
- Surfactant flushing (injection of surfactant into the LNAPL zone to mobilize the LNAPL to facilitate fuel recovery);
- Bio-stimulation (introducing amendments to stimulate native aquifer bacteria into doing a better job of biodegrading contaminants);
- Bio-augmentation (introducing specialized bacteria into the aquifer to biodegrade the contaminants even faster).

Scaled-up laboratory and field pilot tests will be conducted for critical evaluation of remediation technologies that are deemed to be potentially feasible. Numerical modeling simulations will be performed, as needed, to assist with the evaluation of these technologies.

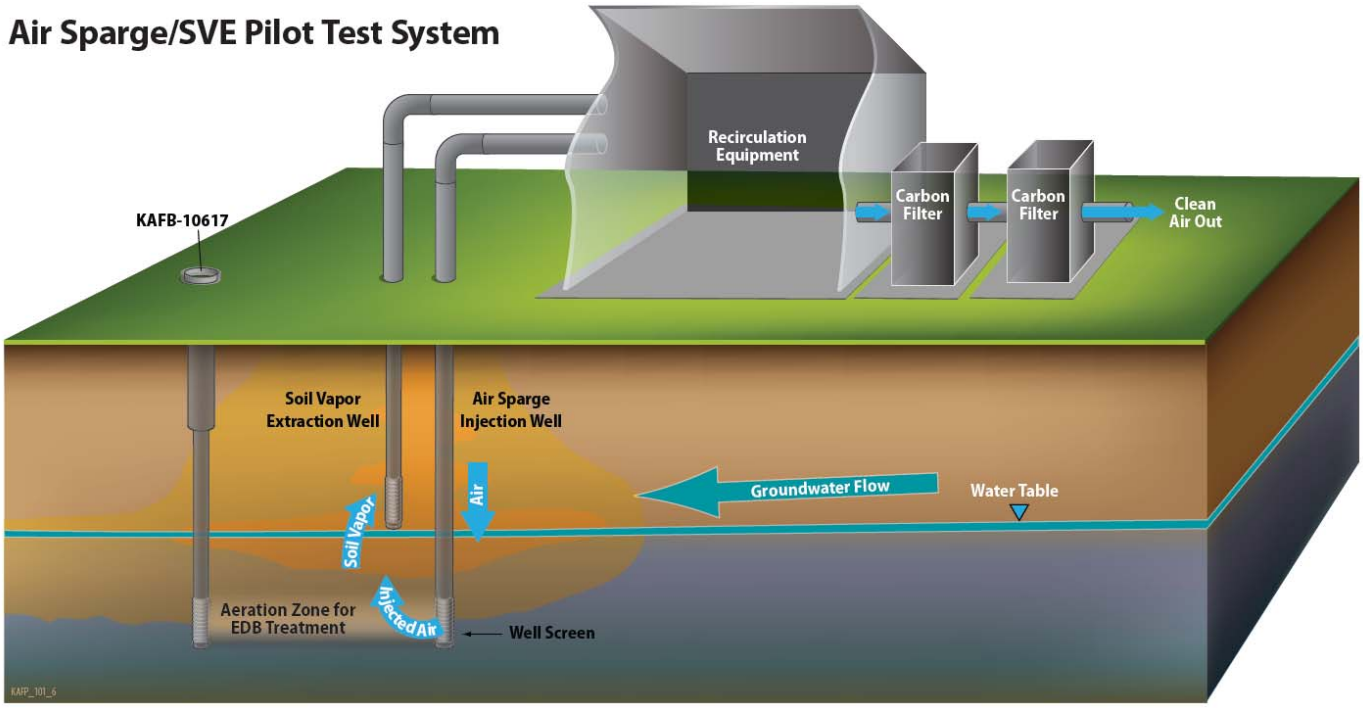
LNAPL Measurement Techniques

Evaluations and tests of non-invasive methods of detecting and measuring submerged LNAPL will be conducted in parallel with the remediation pilot tests. Techniques to be considered include, but are not necessarily limited to:

- Borehole geophysics;
- Contaminant concentration gradients;
- Environmental Tracers.

Final Corrective Measure Evaluation, Selection, and Implementation

- In accordance with the requirements of the federal Resource Recovery and Conservation Act, evaluate, select and implement a final corrective measure for LNAPL remediation. This may include a combination of different treatments.
- Establish LNAPL metrics to determine when LNAPL remediation is complete.
- Operation, maintenance, and optimization of the remediation system until LNAPL metrics approved by NMED are met.


Air Sparge/SVE Pilot Test System
Recirculation Equipment
Carbon Filter
Carbon Filter
Clean Air Out
KAFB-10617
Soil Vapor Extraction Well
Air Sparge Injection Well
Air
Soil Vapor
Groundwater Flow
Water Table
Aeration Zone for EDB Treatment
Injected Air
Well Screen

GOAL 4

Vacuum fuel vapor from the soil to prevent it from migrating into and contaminating groundwater.

Strategy

Interim Measures

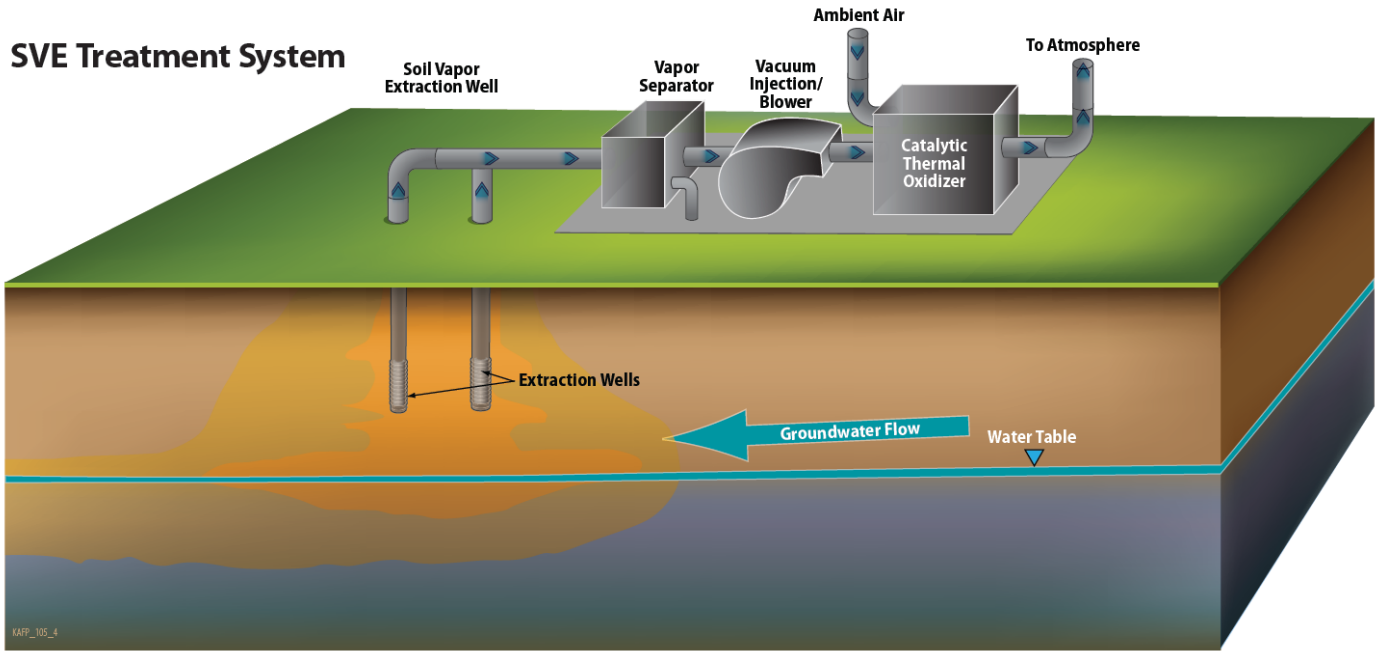
Soil vapor extraction (SVE) has been operating since 2003 and has removed more than 500,000 gallons of fuel from the vadose zone.

NMED will oversee the following additional actions by the Air Force to increase the robustness of SVE:

- Shut down SVE for an appropriate period of time to observe rebound of contaminant levels.
- Conduct *in-situ* microbiological respiration tests during the SVE shutdown period.
- Drill additional SVE wells into suspected LNAPL and hotspot areas.
- Terminate the current air quality permit, and apply to the Albuquerque Environmental Health Department (AEHD) for a new permit for pilot testing of the new SVE wells.
- Install temporary internal combustion engine (ICE) treatment systems, in accordance with the new permit, for pilot testing of new SVE wells.
- Conduct pilot testing using both the current catalytic oxidation (CATOX) and ICE treatment systems.
- After pilot testing, dismantle the CATOX system use ICE treatment to vacuum hotspots.
- After completion of all pilot testing and hot spot treatment, remove the ICE systems.
- Evaluate the potential benefits of a bioventing pilot test. If justified, conduct a bioventing test after all pilot testing and hotspot treatment are complete.
- Design a new robust SVE system, capable of treating up to 1,500 pounds per hour of hydrocarbons extracted in soil vapor; apply for an AEHD air permit for the system.
- Construct the new robust SVE system, operate, maintain and optimize as necessary in accordance with the permit.
- Treat soil vapor extracted from the LNAPL air-sparging pilot test as treatment capacity allows.

Final Corrective Measure Evaluation, Selection and Implementation

- In accordance with the requirements of the federal Resource Recovery and Conservation Act, evaluate, select, and implement a final corrective measure for the vadose zone.
- Establish soil vapor cleanup concentrations that will not be capable of contaminating groundwater.
- Operation, maintenance, and optimization of the SVE system until soil vapor cleanup concentrations approved by NMED are met.


SVE Treatment System
Soil Vapor Extraction Well
Vapor Separator
Vacuum Injection/ Blower
Ambient Air
To Atmosphere
Catalytic Thermal Oxidizer
Extraction Wells
Groundwater Flow
Water Table
KAFP_105_4

GOAL 5

Maintain a high level of project transparency that exceeds statutory RCRA requirements for public information and involvement.

Strategy

- Maintain a KAFB fuel spill cleanup website on the NMED server to make correspondence and technical information readily available to the public. Documents to be posted include, but will not necessarily be limited to, proposed and final work plans, quarterly reports, technical working group meeting minutes, RFI reports, and NMED approval letters.
- Maintain a KAFB fuel spill cleanup Listserv to send out periodic messages informing the public of important news and opportunities for involvement.
- Participate in quarterly public meetings hosted by the Air Force, to include poster sessions and presentations.
- Make presentations, as requested, to neighborhood associations, city and county governmental agencies, legislative committees, and to other organizations interested in the KAFB fuel cleanup.
- Host occasional field trips, in coordination with other stakeholders, to inform the public about site geology, hydrology, geochemistry, and cleanup actions.
- Explore public interest in participating in working groups to address various components of site investigation and cleanup. Host working group sessions, in coordination with other stakeholders, if public interest exists.
- Conduct a robust public outreach and involvement program for evaluation and selection of final corrective measures in compliance with statutory RCRA requirements.
- Update this Strategic Plan on an annual basis.

KAFB Fuel Spill Updates on NMED homepage

Also see: Kirtland Air Force Base Bulk Fuels Facility - Jet Fuel Plume Remediation Web Page at….

http://www.nmenv.state.nm.us/NMED/Issues/KirtlandFuelPlume/index.html

References for Additional Technical Information

Groundwater Extraction Pilot and Additional Characterization

KAFB workplan, August 1, 2014
http://www.nmenv.state.nm.us/NMED/Issues/KAFB_docs/KAFB_EDB%20IM%20Work%20Plan_2014Aug1_Rev1+figures+letter.pdf

NMED approval letter, August 20, 2014
http://www.nmenv.state.nm.us/NMED/Issues/KAFB_docs/NMED%20Approval%20Letter%208-20-14%20Signed.pdf

Quarterly Monitoring and Site Investigation Reports (full text, figures and tables)
http://www.kirtlandjetfuelremediation.com/projdocs/projdocs_ov.htm

- 2014, April-June
- 2014, January-March
- 2013, October-December
- 2013, July-September
- 2013, April-June

Public Meeting Presentations and Field Trip Handouts
http://www.nmenv.state.nm.us/NMED/Issues/KirtlandFuelPlume/PublicOutreach.html

Historical Reports and Correspondence (dating back to 1999)

- NMED http://www.nmenv.state.nm.us/HWB/kafbperm.htm#KAFBBulkFuelsFacSpill
- KAFB http://www.kirtlandjetfuelremediation.com/

KAFB Technical Working Group Mission Statements

Multidisciplinary working groups have been established to provide detailed review and analysis of highly technical issues pertaining to the investigation and cleanup of the Kirtland Air Force Base fuel spill. The groups consist of staff scientists and engineers from the New Mexico Environment Department, Kirtland Air Force Base, the Air Force Civil Engineering Center, Air Force consultant CB&I, the Albuquerque Bernalillo County Water Utility Authority (ABCWUA), ABCWUA consultant INTERA, the City of Albuquerque Environmental Health Department, and U.S. Environmental Protection Agency (EPA). Each working group shall prepare minutes documenting the attendance, discussion, and homework assignments from each meeting, and the minutes shall be posted on the NMED web site.

Hydrogeology Working Group

The hydrogeology working group will review published maps and reports, lithologic logs, well records, core samples, drill cuttings, airborne, surface and borehole geophysical data, water level data and other information. The hydrogeology group will use this information to define stratigraphy, structural features, and aquifer hydraulics in the vicinity of the fuel contamination. The hydrogeology group also will define background aquifer geochemistry, but will not address geochemical alterations caused by fuel contamination as that subject will be addressed by the biogeochemistry/LNAPL working group.

The hydrogeology group will have the following specific responsibilities:

1. Assembly or, if necessary, preparation of maps, cross sections, fence diagrams, graphs, Stiff diagrams, trilinear plots, time trends, interpretations and other material as appropriate to document site hydrogeologic conditions.
2. Provide detailed stratigraphic and other geotechnical information to the SVE, biogeochemistry/LNAPL and modeling work groups for their consideration and use in their areas of responsibility.
3. Field oversight of drilling operations, including review and approval of lithologic logs and proposed well completions.
4. Oversee borehole geophysical logging; analysis of logging data.
5. Oversee the design, implementation and interpretation of aquifer performance testing.
6. Develop a conceptual site model in coordination with other technical work groups.
7. Identify and resolve field and laboratory QA/QC issues.
8. Review water-level and water-quality monitoring data from the hydrodynamic dissolved-phase EDB extraction system.
9. Coordinate with ABCWUA, KAFB and NMVAHCS on protection of public drinking water wells.
10. Define background conditions for dissolved oxygen, nitrate, alkalinity, bromide and other parameters of concern.
11. Develop indicator parameter concentrations for sentinel wells that, if observed, would trigger additional review, increased monitoring, or intervention.
12. Plan and host occasional geological field trips for the general public, in coordination with other working groups.

Biogeochemistry/LNAPL Working Group

The biogeochemistry/LNAPL working group will investigate and define the physical, microbial, geochemical, and hydrogeological processes that control the fate and transport of dissolved, non-aqueous liquid, gaseous and adsorbed phase contaminants, and evaluate potential remediation options. Dissolved phase contaminants of concern include 1,2-dibromoethane (ethylene dibromide, EDB), benzene, toluene, ethylbenzene, and xylene isomers (BTEX), polynuclear aromatic and aliphatic hydrocarbons, and 1,2-dichloroethane. Parameters of interest regarding natural and engineered degradation processes include dissolved oxygen, ORP, nitrate, manganese, iron, sulfate, methane, carbon dioxide, alkalinity, bromide, chloride, and stable isotopes of various elements.

The biogeochemistry/LNAPL group will have the following specific responsibilities:

1. Characterize the physical and chemical properties of light non-aqueous phase liquids (LNAPLs) that are submerged within or floating atop groundwater.
2. Identify specific chemical and biological mechanisms that have transformed or degraded contaminants, along with reaction rates and byproducts.
3. Make recommendations for additional sampling and analysis as needed.
4. Use stoichiometric equations to calculate the amounts of contaminants that have been transformed or degraded in the vadose zone and in groundwater.
5. Maintain a running quantification of the amount of EDB that has been removed by the pump-and-treat system.
6. Evaluate potential remediation options for additional removal or destruction of fuel contaminants. Such options may include, but may not necessarily be limited to, pump and treat, air or steam sparging, soil vapor extraction, biostimuation, bioaugmentation, bioventing, surfactant flooding, and monitored natural attenuation.
7. Make recommendations for scaled up laboratory and field-scale pilot tests of potentially viable remediation technologies.

Soil Vapor Extraction Working Group

The soil vapor extraction (SVE) working group will review lithologic data, soil vapor concentrations, and performance data from historical and ongoing SVE operations to make recommendations on increasing the robustness of SVE activities.

The SVE group will have the following specific responsibilities:

1. Identify soil vapor hotspots needing additional treatment.
2. Recommend locations and completion specifications for additional extraction wells.
3. Oversee pilot testing, shutdown/rebound periods, and the ongoing performance of SVE activities.
4. In coordination with the biogeochemistry/LNAPL group, maintain a running quantification of the amounts of hydrocarbons that have been removed by SVE and by biodegradation in the vadose zone.

Modeling Working Group

The modeling working group will design, run and calibrate numerical simulations of contaminant transport and fate.

The modeling group will be responsible for the following types of simulations:

1. EDB transport times to drinking water wells in the area under various scenarios.
2. Hydrodynamic capture zones for various configurations of extraction wells for pump-and-treat remediation.

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