



Environmental Restoration Overview

Mission:

Identify, characterize, and remediate sites where hazardous and/or radioactive materials may have been released to the environment.

Regulation:

- Activities regulated by New Mexico Environment Department (NMED):
 - 2004 Sandia National Laboratories (SNL) Compliance Order on Consent for corrective action under authority of Hazardous Waste Bureau.
 - 2017 Discharge Permit for Technical Area-V Groundwater Area of Concern (AOC) under authority of Ground Water Quality Bureau.

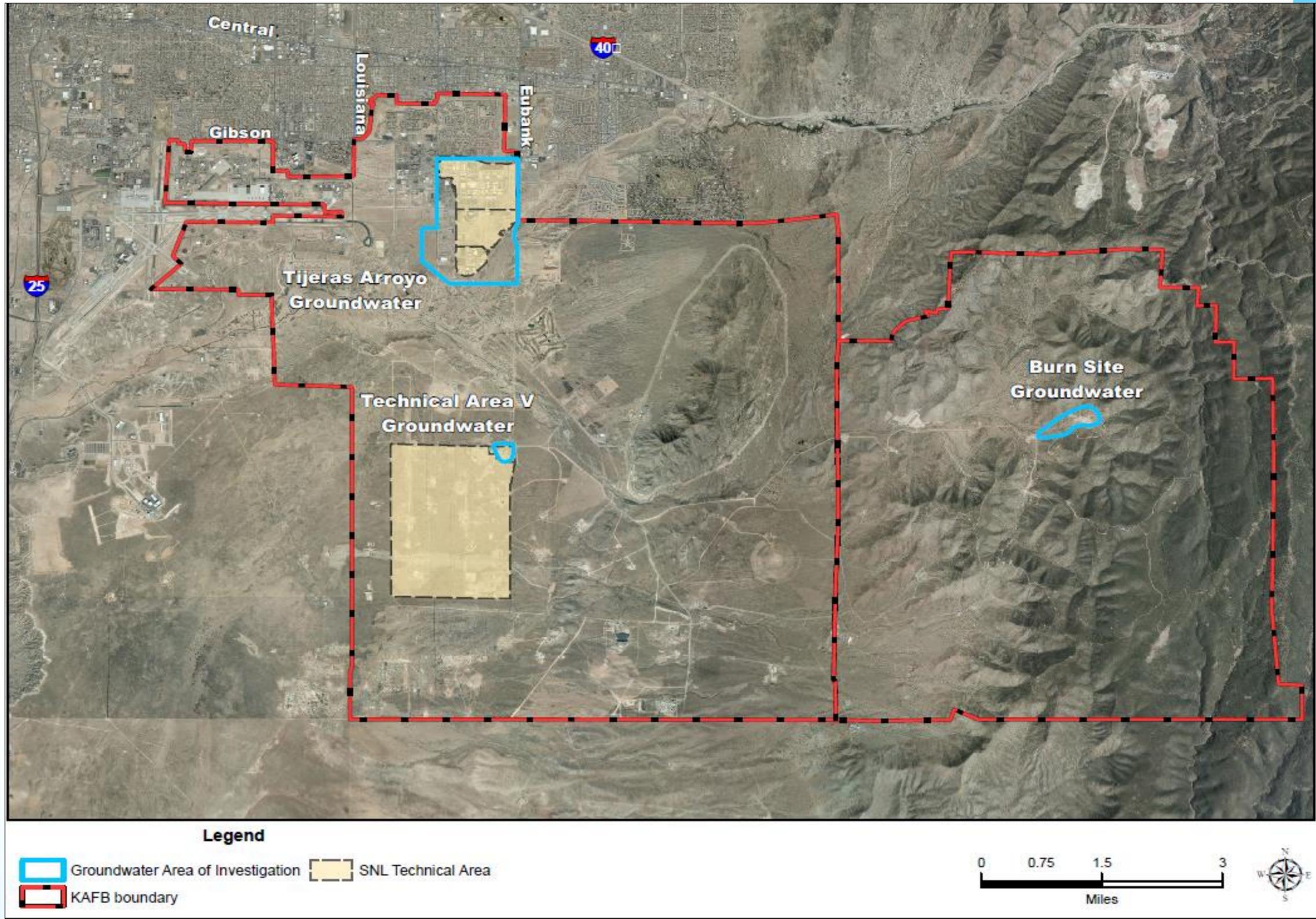
Current Activities:

- Burn Site Groundwater Investigation AOC:
 - Installing four additional groundwater monitoring wells to characterize nitrate in the groundwater.
- Technical Area-V Groundwater Investigation AOC:
 - Conducting treatability study for using in-situ bio-remediation to treat nitrate and trichloroethene in groundwater.
- Tijeras Arroyo Groundwater Investigation AOC:
 - Proposed corrective measures to the NMED for remediation of nitrate contamination in the perched groundwater system.

What are the health risks of contaminated groundwater at SNL?

- There is no known harm to human health because:
 - No one is drinking contaminated groundwater.
 - There are no drinking water wells in or near the contaminated groundwater.
 - Boundaries of groundwater contamination are defined.
 - On-going monitoring of contaminated groundwater continues.
- Drinking water standards serve as groundwater cleanup goals for human health and environmental protection.





Map of Kirtland Air Force Base showing location of 3 Sandia National Laboratories Groundwater Areas of Concern

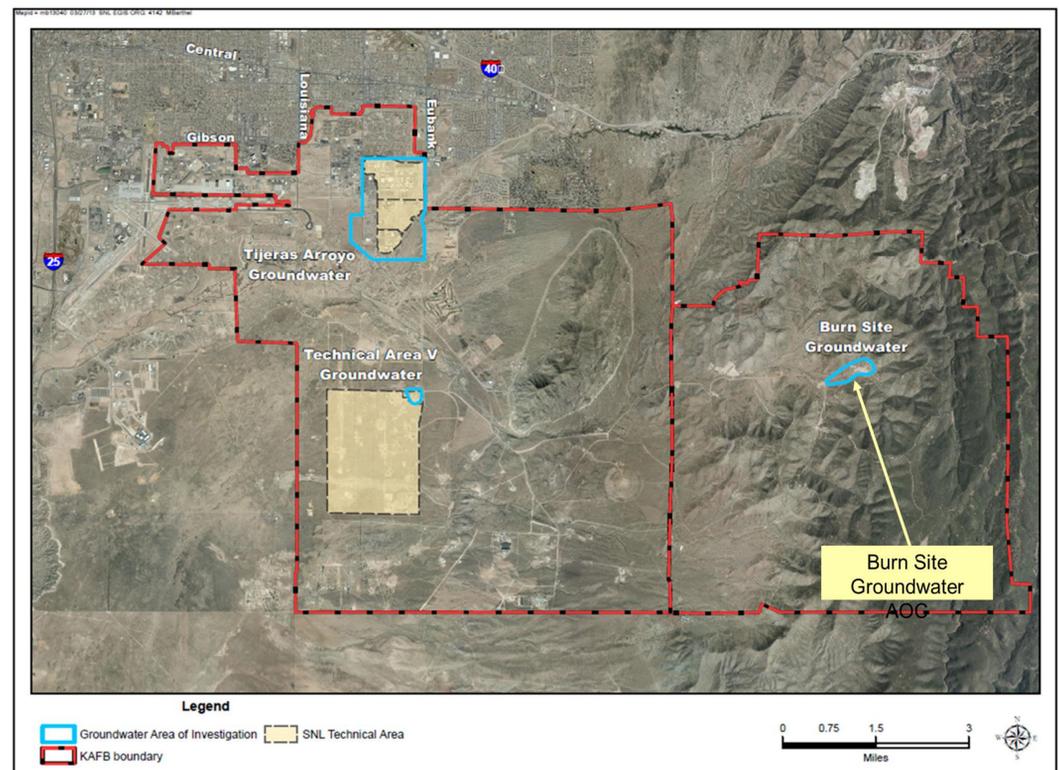
For more detail, see *Calendar Year 2018 Annual Groundwater Report, June 2019* available at: https://www.sandia.gov/news/publications/environmental_reports/index.html



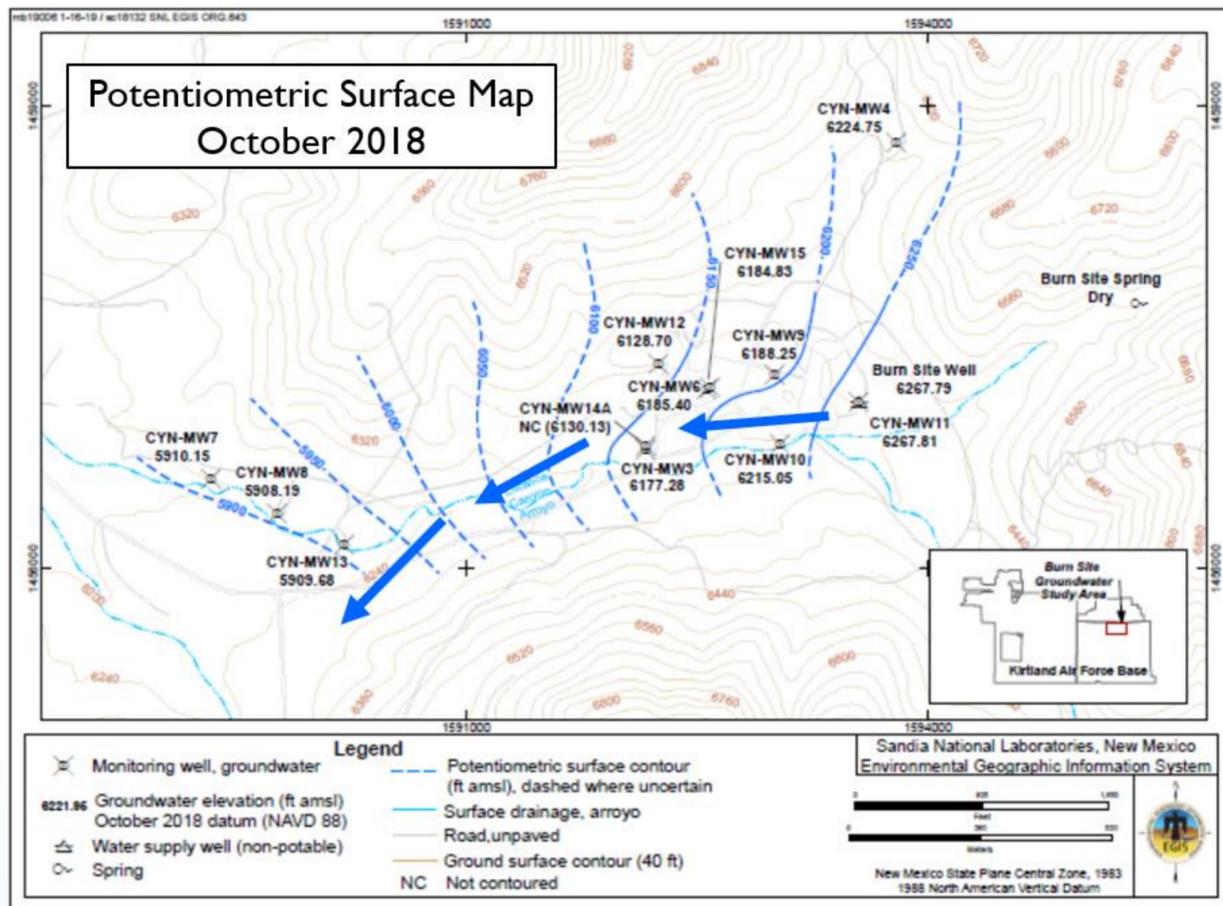
Burn Site Groundwater Investigation

Site Description

- The Burn Site Groundwater Investigation Area of Concern is located in a remote area in the Manzanita Mountains.
- Lurance Canyon is a west-flowing drainage deeply incised into Paleozoic and Precambrian rocks in moderately- to heavily-wooded pinon-juniper forest.
- SNL activities at the Burn Site began in 1967; early site test activities included explosives testing, current use is fire-survivability studies (i.e., burn testing).



- Corrective action is required only for groundwater at the Burn Site.
- Groundwater occurs in Precambrian fractured bedrock that is recharged by infiltration of precipitation; flow is controlled by changes in rock type and faults/fractures.



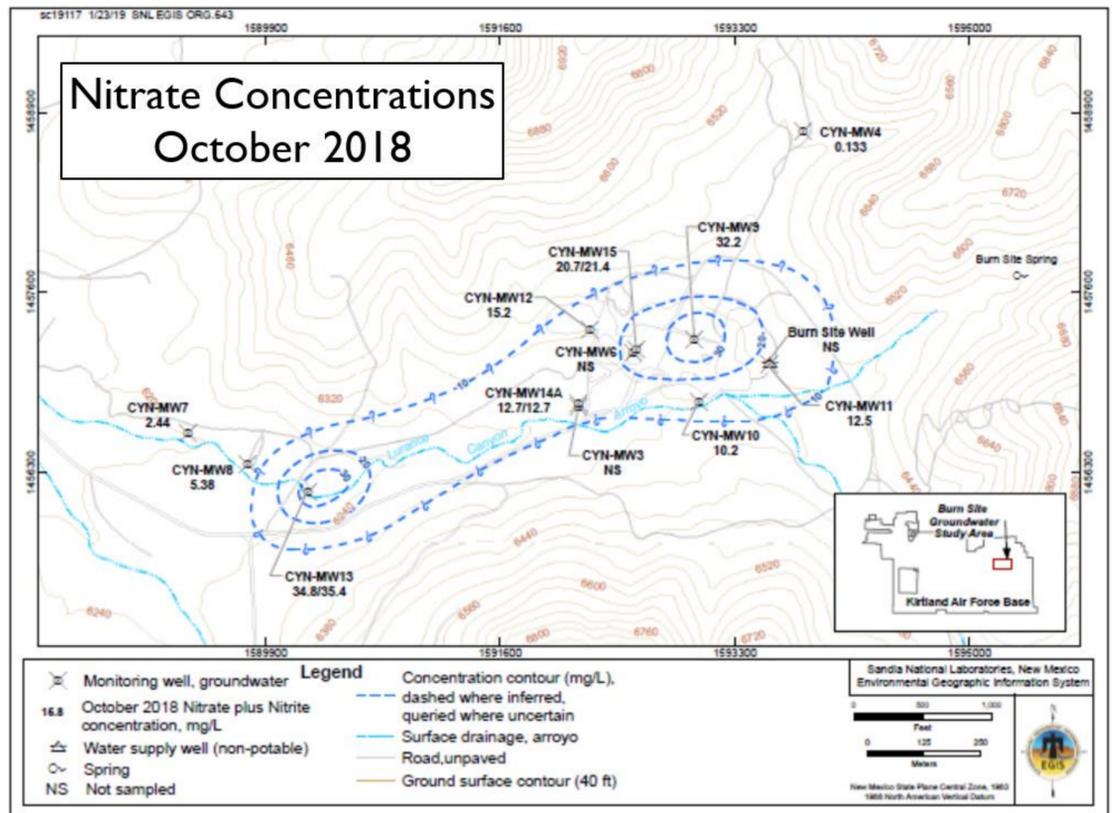
- Groundwater monitoring began 1996.
- Depth to groundwater ranges from 107 to 328 feet below ground surface and groundwater flows to the west.
- The monitoring network consists of 12 monitoring wells, soon to be 16 wells.



Burn Site Groundwater Investigation

- The constituent of concern is nitrate, which has been detected in 7 of the 10 wells that are sampled.
- Groundwater is contaminated with nitrate at concentrations above the maximum contaminant level (MCL); the plume is 79 acres.

Constituent of Concern	Maximum Concentration in 2018	MCL
Nitrate	35.4 milligrams per liter (well CYN-MW13)	10.0 milligrams per liter

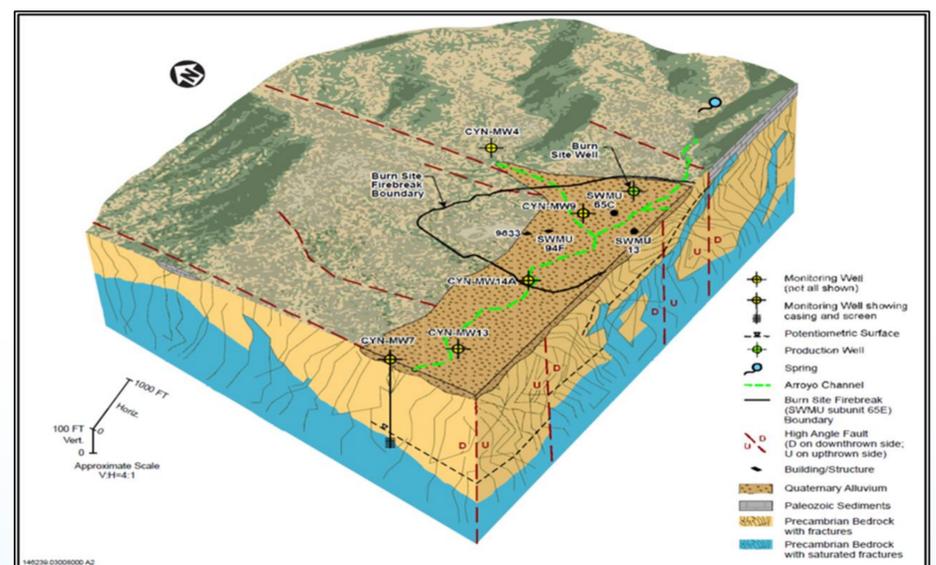


- Groundwater in this area is not used for any purpose; no one is drinking contaminated groundwater. The nearest downgradient drinking-water supply well (KAFB-4) is 8.4 miles to the west.
- Nitrate is derived from both man-made and natural sources, and may include ammonium nitrate slurry, wastewater discharges, and degradation of explosive compounds.

Current Status and Recent Activities

- Completing characterization of the nature and extent of nitrate contamination before resuming the corrective action process and proposing alternatives for a remedy.
- Performed quarterly water level measurements and semiannual groundwater sampling that was presented in the *Annual Groundwater Monitoring Report* submitted to the New Mexico Environment Department (NMED) in June 2019 (approved by NMED in September 2019).
- Recommendations for future characterization were submitted to the NMED in June 2018; and NMED responded in June 2018 requesting four wells.
- Submitted a Monitoring Well Installation Work Plan to NMED in January 2019. Approved by NMED in February 2019. Four wells are currently being installed.

Conceptual Site Model for the BSG Vicinity





Technical Area-V Groundwater Investigation

Site Description

Where

- Technical Area-V Groundwater Area of Concern covers 35 acres of industrial land in the central portion of Kirtland Air Force Base.

What Happened

- Sandia National Laboratories activities at Technical Area-V (operating research reactors) began in 1961.

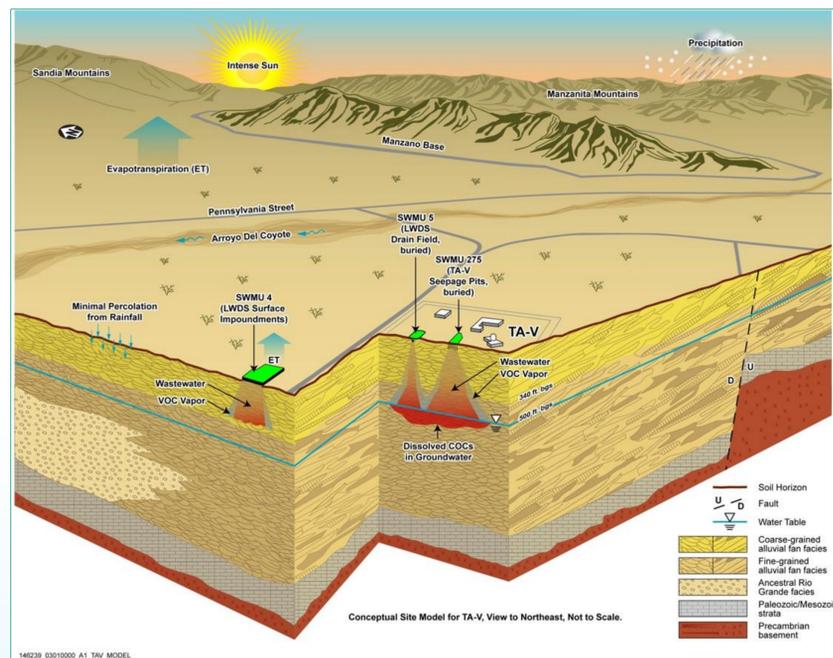
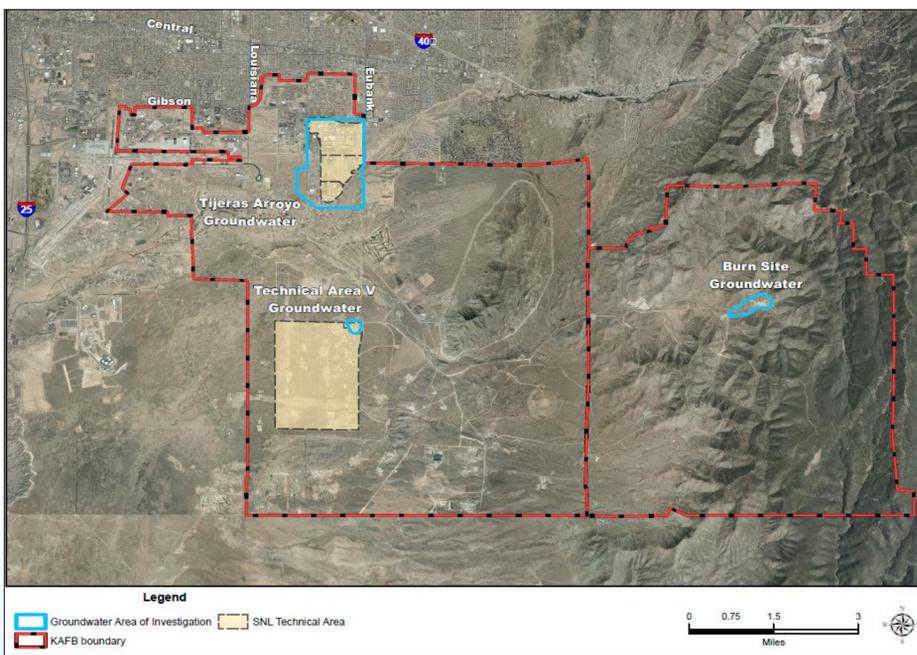
Environmental Impact

- Groundwater is contaminated with nitrate and trichloroethene at concentrations above the maximum contaminant levels; the drinking water standards established by the Environmental Protection Agency.
 - The nitrate contaminant plume is 1.4 acres.
 - The trichloroethene contaminant plume is 13 acres.
 - The two contaminant plumes are not moving.

Constituent of Concern	Maximum Concentration in 2018	Maximum Contaminant Level
Nitrate	12.9 milligrams per liter (well LWDS-MWI)	10 milligrams per liter
Trichloroethene	17.7 micrograms per liter (well LWDS-MWI)	5 micrograms per liter

Technical Area V Groundwater

- Groundwater occurs approximately 500 feet below ground surface.
- Groundwater monitoring began in 1993. Current network has 18 wells.
- Groundwater in this area is not used for any purpose. The nearest downgradient drinking-water supply well is 2.7 miles to the north.



Conceptual Site Model for Contaminant Releases to TA-V Groundwater



Technical Area-V Groundwater Investigation

Treatability Study of In-Situ Bioremediation

Objective

- The objective is to evaluate bioremediation as a potential remedy for Corrective Measures Evaluation.

What is In-Situ Bioremediation?

- “In-situ” means treating the contamination in-place (in the aquifer sediments).
- “Bioremediation” uses biological processes (bacteria) to remediate the groundwater by degrading the nitrate and trichloroethene to levels below drinking water standards.

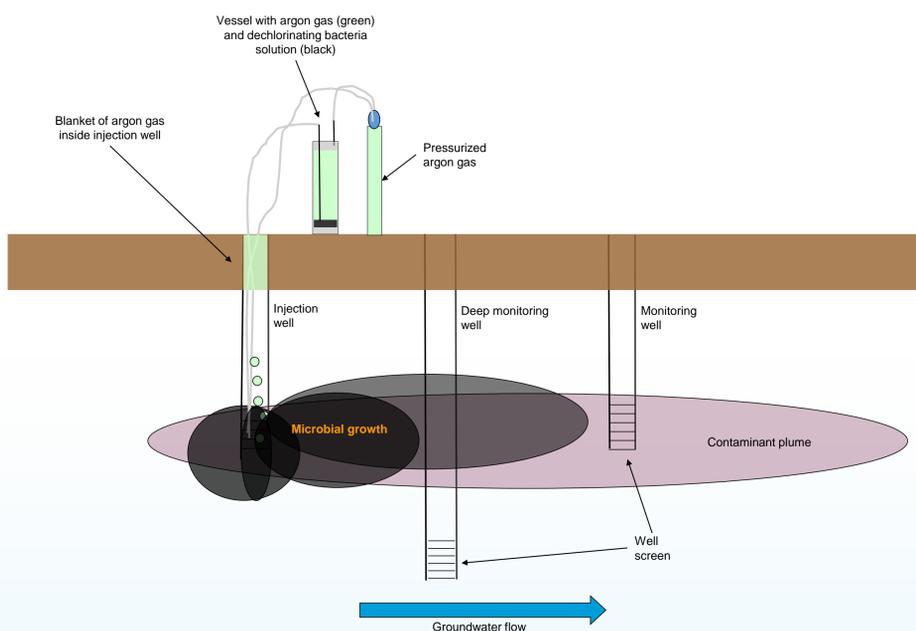
Scope of the Treatability Study

- The treatability study plan is to deliver bioremediation solution using one injection well first and possibly up to three injection wells.

State Regulators

- The New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) is the regulator for the investigation.
- Sandia has obtained the Discharge Permit DP-1845 from the New Mexico Environment Department Ground Water Quality Bureau (GWQB) to inject bioremediation solution.

Implementation of In-Situ Bioremediation



- Groundwater at TA-V is aerobic and biodegradation is not naturally occurring.
- Bioremediation solution provides nutrients and pH buffer for biodegrading nitrate and trichloroethene.
- “It’s all about delivery” – how big an area can be treated by the bioremediation solution?



Technical Area-V Groundwater Investigation

Treatability Study at Injection Well TAV-INJ1

Duration

- The injection period was from November 2018 through April 2019.

Volume

- The total volume of bioremediation solution injected was approximately 531,000 gallons mixed with 123 liters of trichloroethene-degrading bacteria.

Evaluating Performance of Bioremediation

- Groundwater at wells TAV-INJ1 and TAV-MW6 will be monitored for two years to track in-situ bioremediation.

Evaluating Impact on Surrounding Groundwater

- One deep well and eight surrounding wells will be monitored for two years to determine potential impact on groundwater quality caused by the injections.

Current Status

- Groundwater at well TAV-INJ1 has been maintaining optimal conditions for biodegradation.
- The inert tracer (bromide) injected with the treatment solution has reached well TAV-MW6.
- Dissolved oxygen levels have decreased in the groundwater at well TAV-MW6.
- No change in groundwater quality has been observed in the deep monitoring well and the surrounding wells.
- Progress on the treatability study is provided to the NMED HWB and GWQB through quarterly reporting.





Tijeras Arroyo Groundwater Investigation

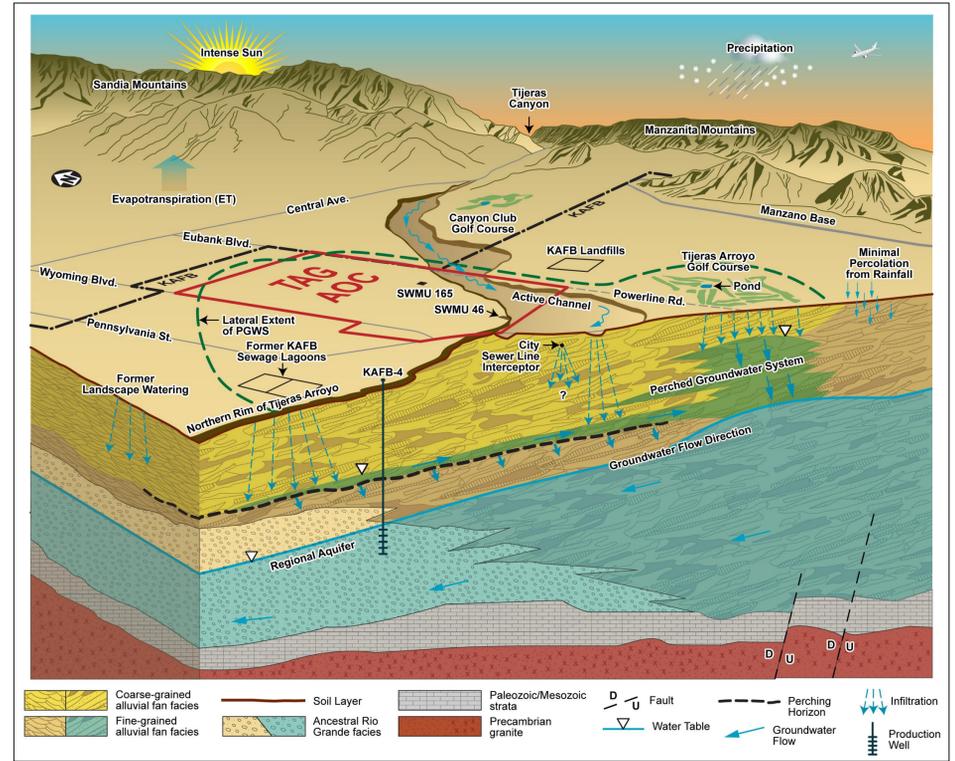
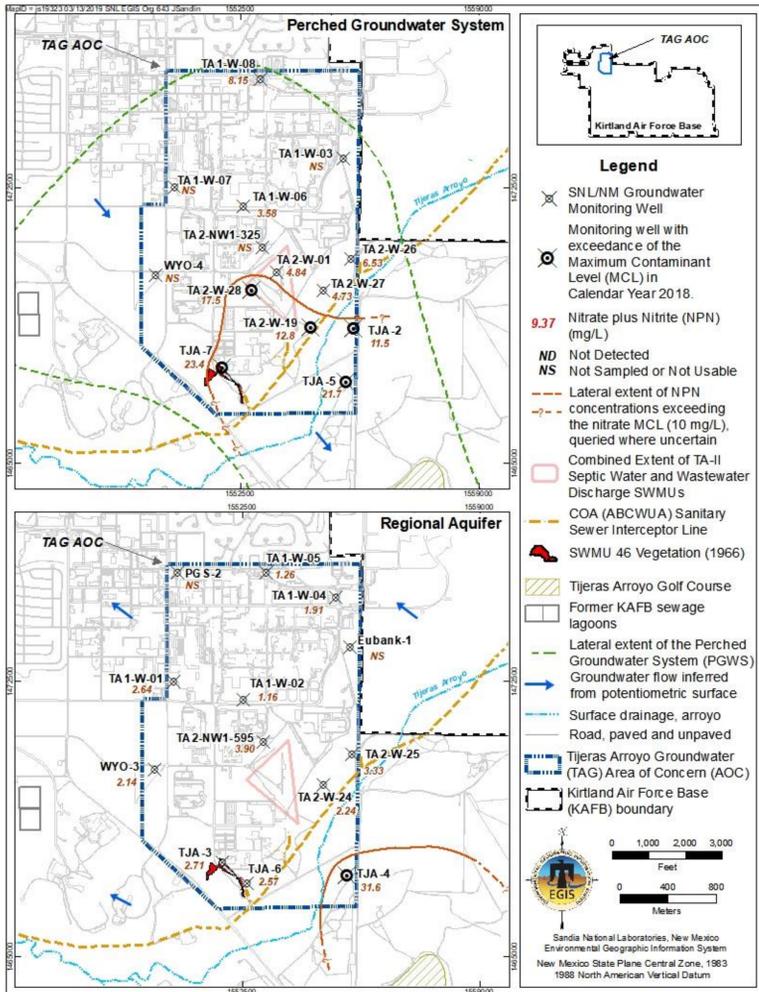
Site Description

- The Tijeras Arroyo Groundwater (TAG) Investigation Area of Concern (AOC) covers 1.82 square miles (1,165 acres) within the northern part of Kirtland Air Force Base (KAFB), and extends across Sandia National Laboratories (SNL) Technical Areas I, II, and IV.
- SNL activities at TAG began in 1948 and primarily involve weapons development and energy research.
- Corrective action is required only for the groundwater in the TAG AOC.
- Two water-bearing units, the Perched Groundwater System (PGWS) and the Regional Aquifer, are present in the alluvial fan sediments under the TAG AOC.
 - The PGWS water table occurs at a depth of approximately 330 feet below the ground surface at TA-II. The PGWS was created by manmade activities, including recharge from a sewage system, landscape watering, and wastewater outfalls. These activities have been eliminated and the PGWS is naturally dewatering (drying up) at approximately 0.5 feet per year. A thin layer of 7 to 20 feet of saturation remains in the central TAG AOC.
 - Thickness of the saturated layer is consistently decreasing; water mostly percolates downward.
 - The Regional Aquifer occurs at a depth of 520 feet below the ground surface; it is vertically separated from the PGWS by a Perching Horizon and about 200 feet of unsaturated strata.
- Groundwater in the PGWS flows southeast at approximately 24 feet per year on average, and merges with the Regional Aquifer along Powerline Road on KAFB. Groundwater in the Regional Aquifer flows west and northwest at approximately 55 feet per year.
- Groundwater monitoring began in 1992.
 - The U.S. Department of Energy (DOE) and its prime contractor for SNL have installed 31 monitoring wells in the TAG AOC.
 - KAFB and the City of Albuquerque have installed 70 monitoring wells in the surrounding area.
 - Monitoring wells screened in the PGWS yield small volumes of water (typically one to two gallons per minute).
- Groundwater in the PGWS is contaminated with nitrate at concentrations slightly above the maximum contaminant level (MCL); the plume in the southeast corner of the TAG AOC is approximately 280 acres and does not pose a threat to drinking water in the Regional Aquifer. No other chemicals exceed the MCL.

Constituent of Concern	Maximum Concentration in Perched Groundwater System, 2018	Maximum Concentration in Regional Aquifer, 2018	MCL
Nitrate	23.4 milligrams per liter (well TJA-7)	3.90 milligrams per liter (well TA2-NW1-595) 31.6 milligrams per liter (well TJA-4, merging zone)	10 milligrams per liter
Trichloroethene	4.62 micrograms per liter (well TJA-2)	0.910J micrograms per liter (well TJA-3)	5 micrograms per liter

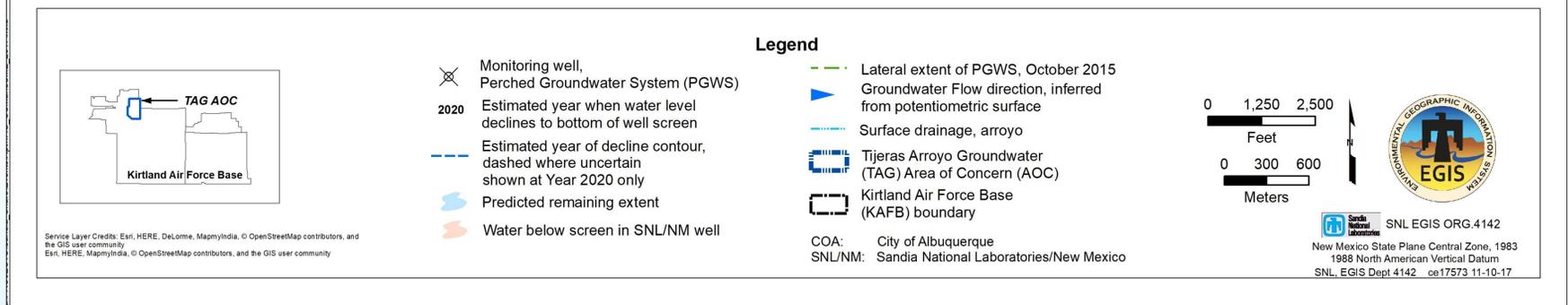
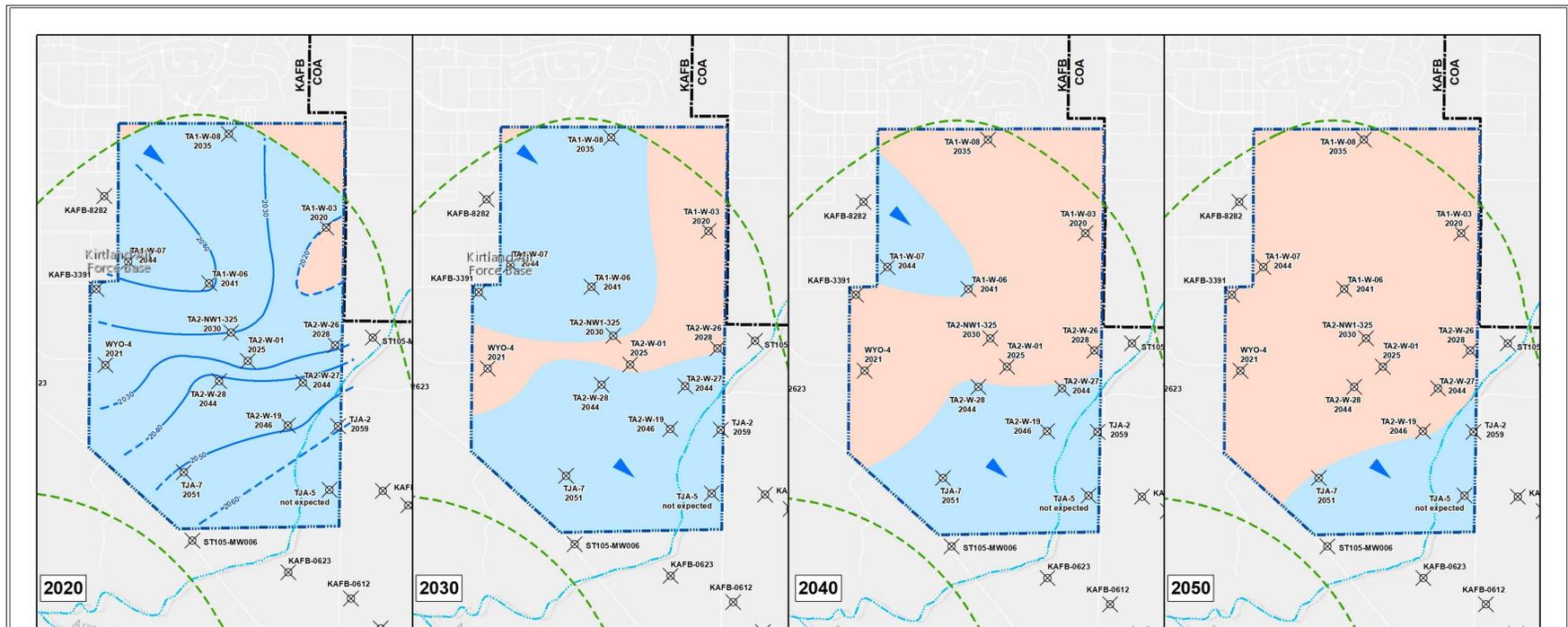


Tijeras Arroyo Groundwater Investigation



Conceptual Site Model for the TAG Vicinity

Maximum 2018 Nitrate Concentrations in the Perched Groundwater System and the Regional Aquifer



Predicted Declining Water Levels in the Perched Groundwater System from 2020 - 2050



Tijeras Arroyo Groundwater Investigation

Site Description (continued)

- Perched groundwater is not used for any purpose at SNL; no one is drinking contaminated groundwater. Perched groundwater flows to the southeast.
- Depending on location, PGWS monitoring wells will go dry in 5 to 44 years, except in the extreme southeast corner of the AOC.
- SNL operations have not contaminated the Regional Aquifer.
- The nearest drinking-water production well in the Regional Aquifer is KAFB-20, which is located approximately 1 mile to the west of the elevated nitrate concentrations that are in the PGWS. The nearest Albuquerque Bernalillo County Water Utility Authority well is Ridgecrest I which is located approximately 2 miles to the north of the elevated nitrate concentrations that are in the PGWS.
- Nitrate is typically derived from both man-made and natural sources, and may include septic leach fields, wastewater discharges, fertilizers, and degradation of minerals in soil.

Current Status and Recent Activities

- Results from ongoing water-level measurements and groundwater sampling will be presented in the next *Annual Groundwater Monitoring Report* that will be submitted to the New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) in June 2020.
- The *TAG Current Conceptual Model and Corrective Measures Evaluation (CCM/CME) Report* was submitted to the NMED HWB in December 2016.
- Based on a May 2017 NMED HWB letter requesting more information for the proposed remedial alternatives, a *Revised TAG CCM/CME Report* was submitted to the NMED HWB in February 2018.
- Three remedial alternatives were proposed in the revised CCM/CME report:
 - Monitored natural attenuation using the existing well network.
 - In-situ bioremediation requiring installation of numerous wells.
 - Groundwater extraction and treatment requiring installation of numerous wells.
- All three remedial alternatives require the semiannual sampling of both water-bearing units.
- NMED HWB is anticipated to select a remedial alternative in late 2019.