



Department of Energy/National Nuclear Security Administration and Sandia National Laboratories

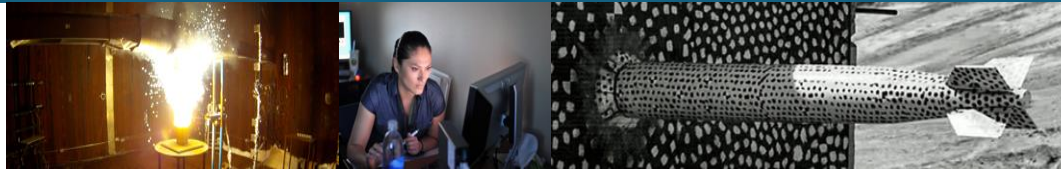
- Semiannual public meeting
 - Virtual session held in response to New Mexico Executive and Public Health Orders
- Environmental restoration activities at Sandia National Laboratories
- Stormwater monitoring and pollution control activities at Sandia National Laboratories
- Information resources for environmental restoration activities at Sandia National Laboratories
 - New Mexico Environment Department Hazardous Waste Bureau
<https://www.env.nm.gov/hazardous-waste/sandia-national-laboratories/>
 - Sandia National Laboratories
<https://www.sandia.gov/about/environment/index.html>
https://www.sandia.gov/about/environment/environmental_management_system/index.html
- Questions? Send email to envinfo@sandia.gov

Environmental Restoration Activities at Sandia National Laboratories



- Mission: identify, characterize, and remediate sites where hazardous materials may have been released to the environment.
- Current activities: investigations at three areas of concern (AOCs)
 - Burn Site Groundwater Investigation AOC
 - Tijeras Arroyo Groundwater Investigation AOC
 - Technical Area V Groundwater Investigation AOC
- Activities are regulated by the New Mexico Environment Department
 - 2004 Compliance Order on Consent under the Hazardous Waste Bureau
 - 2017 Discharge Permit for Technical Area V Groundwater Investigation AOC under the Ground Water Quality Bureau
- Drinking water standards serve as groundwater cleanup goals for human health and environmental protection
 - No drinking water production wells are located in or near the contaminated groundwater
 - Boundaries of contaminated groundwater at each area are defined
 - No one is drinking contaminated groundwater

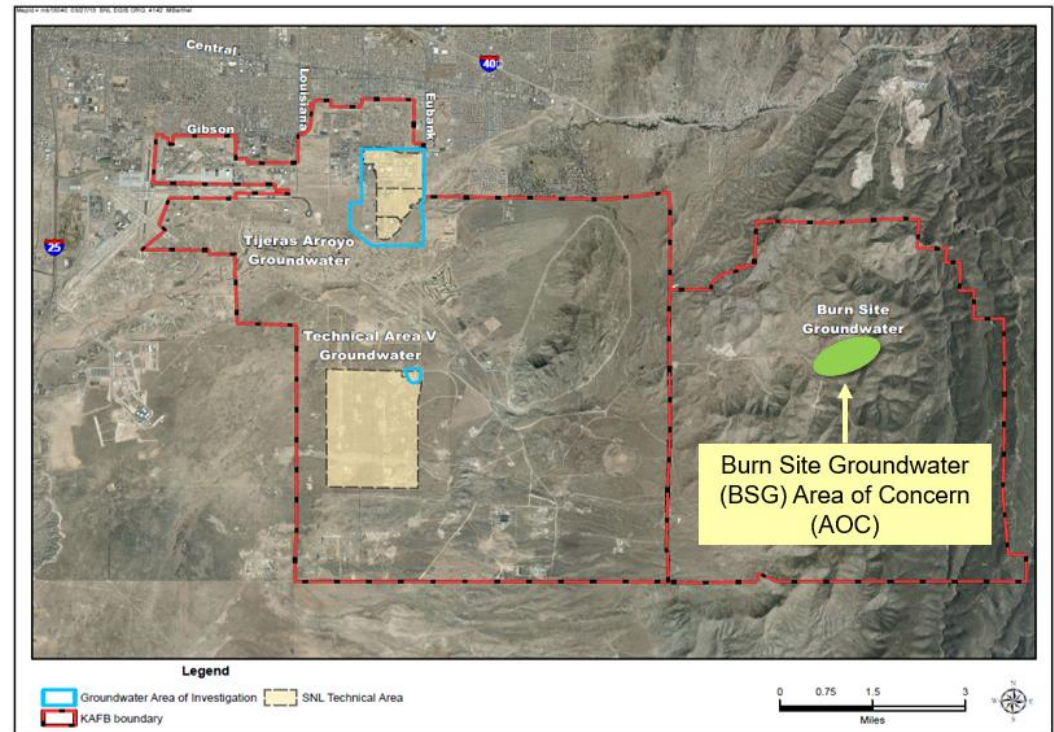
Burn Site Groundwater (BSG) Investigation



*Michael Skelly
Environmental Restoration Operations*



- The BSG Area of Concern is located in Lurance Canyon.
- It is in a remote area of the Manzanita Mountains.
- Lurance Canyon is a west-flowing drainage deeply incised into Paleozoic and Precambrian bedrock in moderately- to heavily-wooded pinon-juniper forest.



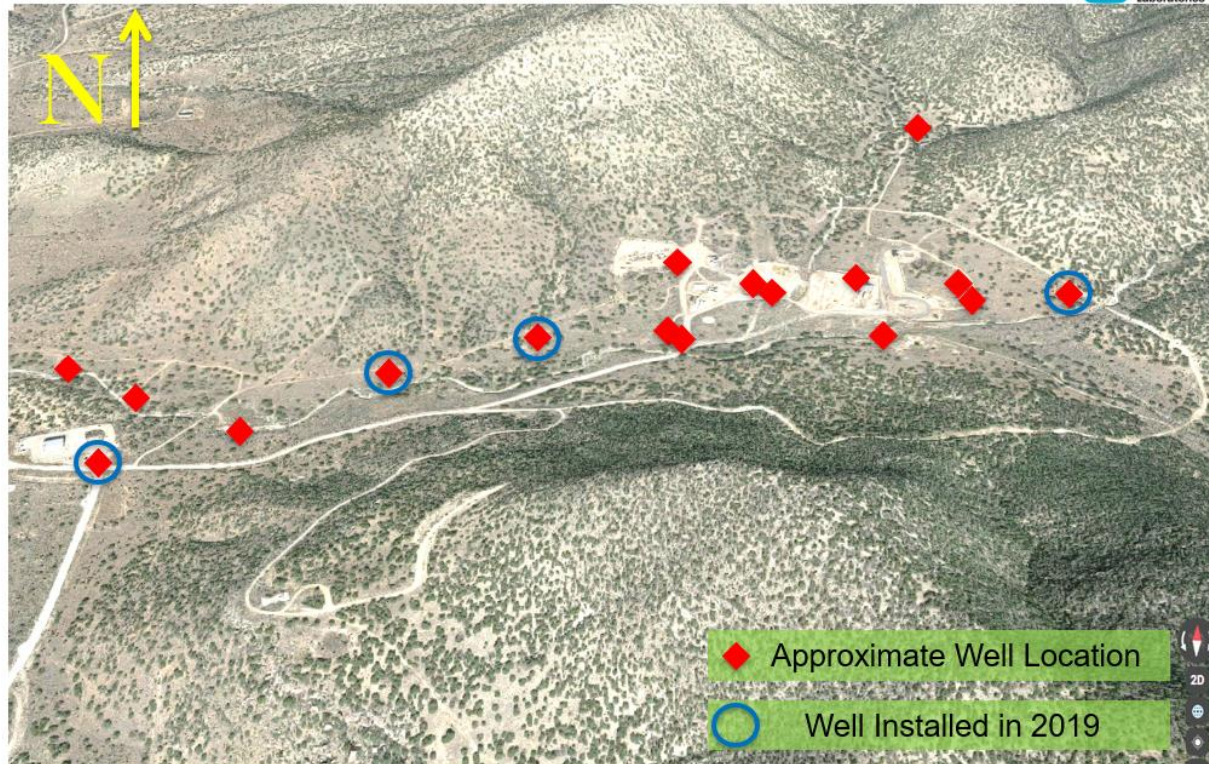
- SNL activities at the Burn Site testing area began in 1967; early site test activities included explosives testing, current use is fire-survivability studies (i.e., burn testing).
- Corrective action is required only for the groundwater in the BSG AOC.
- Groundwater occurs in fractured Precambrian bedrock that is recharged by infiltration of precipitation; flow is controlled by changes in rock type and faults/fractures.

BSG Groundwater Monitoring

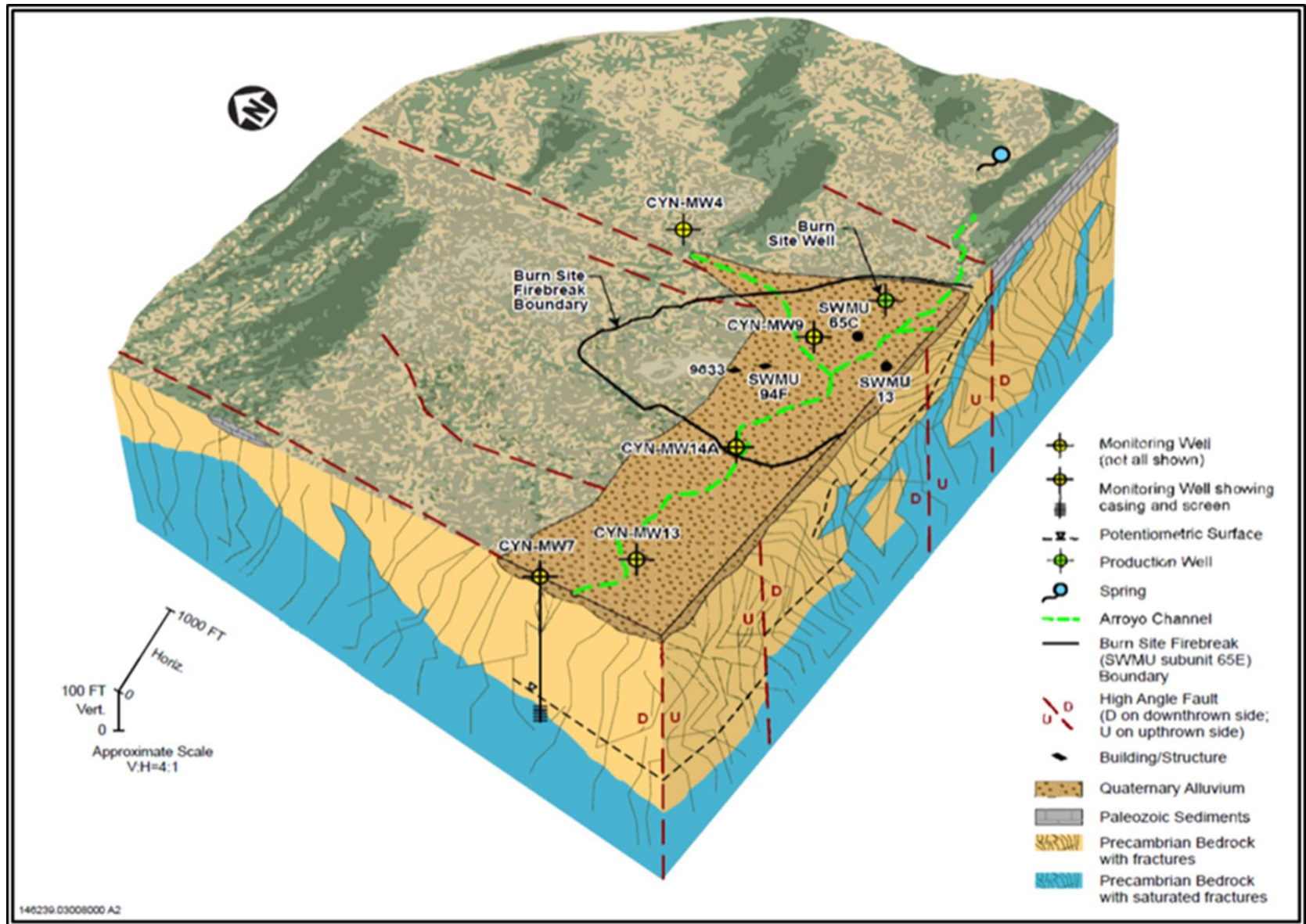


- Groundwater monitoring began in 1996.
- Depth to groundwater ranges from 45 to 360 feet below ground surface and groundwater flows to the west.
- The monitoring network consists of 16 monitoring wells and an inactive production well, with 4 newest wells installed in October/November 2019.

Oblique Aerial View of the BSG AOC; View is toward the North



Conceptual Site Model for the BSG AOC

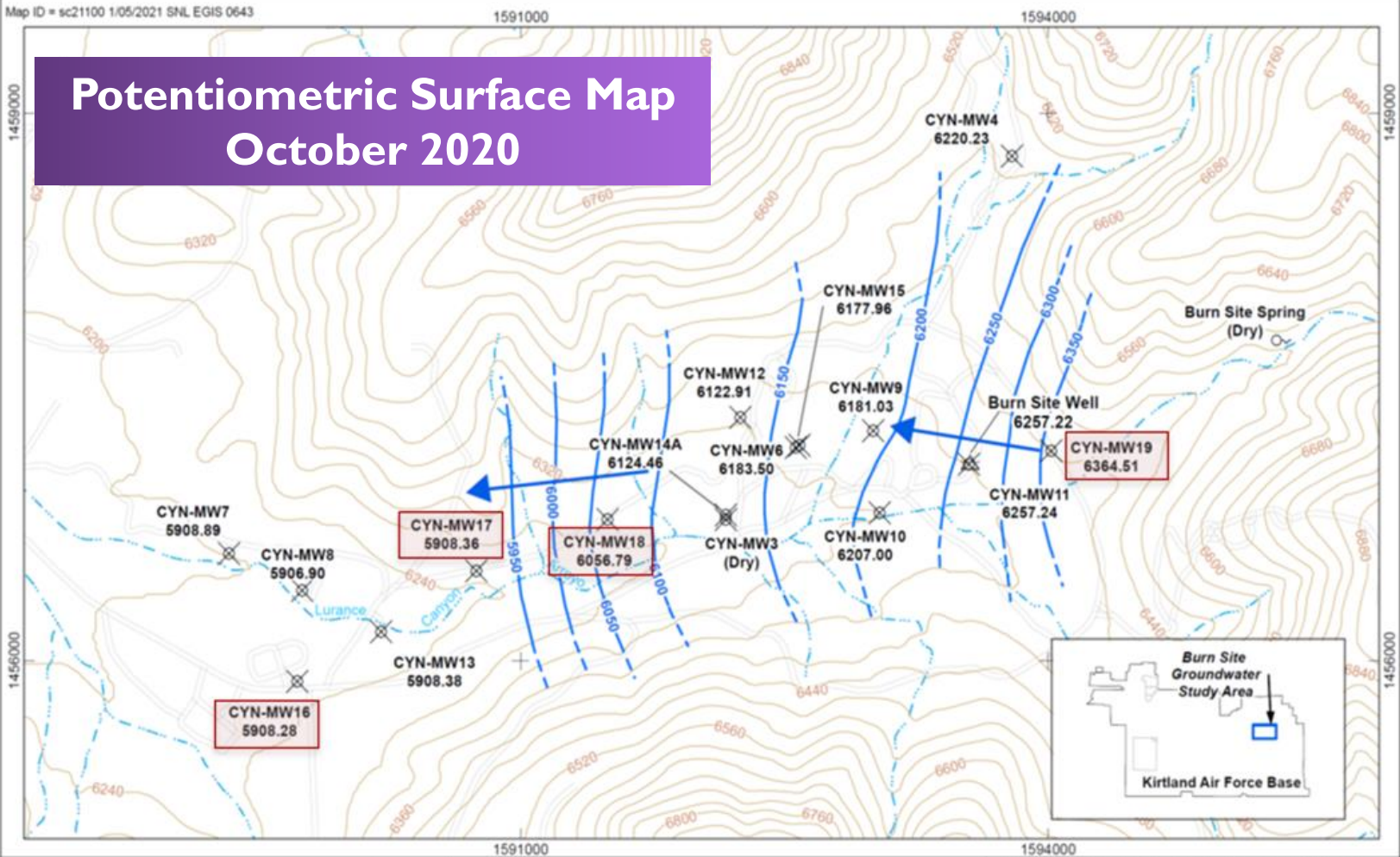


BSG Groundwater Monitoring



- Groundwater is contaminated with nitrate at concentrations above the maximum contaminant level (MCL).
- Nitrate has been detected above the MCL in about half of the wells.
- The combined plumes are approximately 41 acres.
- Groundwater in the 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 typically derived from both man-made and natural sources, and may include ammonium nitrate slurry, wastewater discharges, and degradation of explosive compounds.
- No other chemicals exceed the MCL.

Constituent of Concern	Maximum Concentration in 2020	MCL
Nitrate	49.6 milligrams per liter (well CYN-MW9; April)	10.0 milligrams per liter



Legend

- Monitoring well, groundwater
- Potentiometric surface contour (ft amsl), dashed where uncertain
- Surface drainage, arroyo
- Road, unpaved
- Ground surface contour (40 ft)
- Inferred direction of groundwater flow

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

0 1,000 2,000
Feet

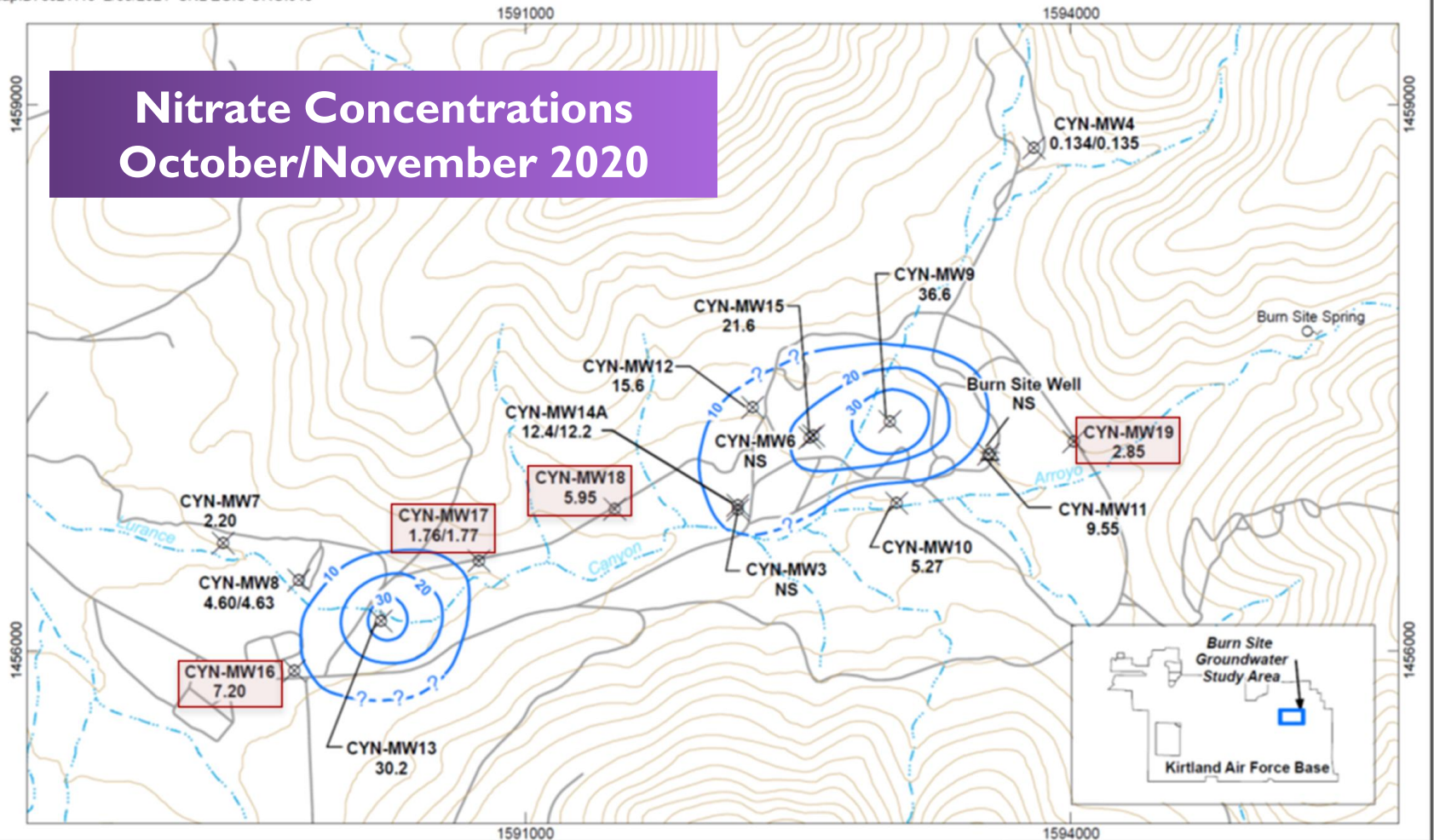
0 250 500
Meters

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum



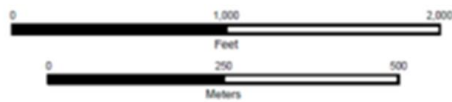
MapID: sc21110 2/05/2021 SNL EGIS ORG.643

Nitrate Concentrations October/November 2020



- | | |
|--|--|
| <ul style="list-style-type: none"> ⊗ Monitoring well, groundwater 15.8 October/November 2020 Nitrate plus Nitrite concentration, mg/L △ Water supply well (non-potable) ○ Spring NS Not sampled | <p>Legend</p> <ul style="list-style-type: none"> --- Concentration contour (mg/L), dashed where inferred, queried where uncertain --- Surface drainage, arroyo — Road, unpaved — Ground surface contour (40 ft) |
|--|--|

Sandia National Laboratories, New Mexico
Environmental Geographic Information System



New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum





- Recently completed characterization of the extent of nitrate contamination, will now resume the corrective action process and propose 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 2021 (approved by NMED in August 2021).
- Eight quarters of groundwater sampling and analysis completed for the four newest wells in July 2021.
- Preparing a revised Current Conceptual Model and Corrective Measures Evaluation Report with a planned delivery date to NMED of January 2023.



Sandia National Laboratories

Tijeras Arroyo Groundwater (TAG) Investigation



*John R. Copland
TAG Task Leader
Environmental Restoration Operations*



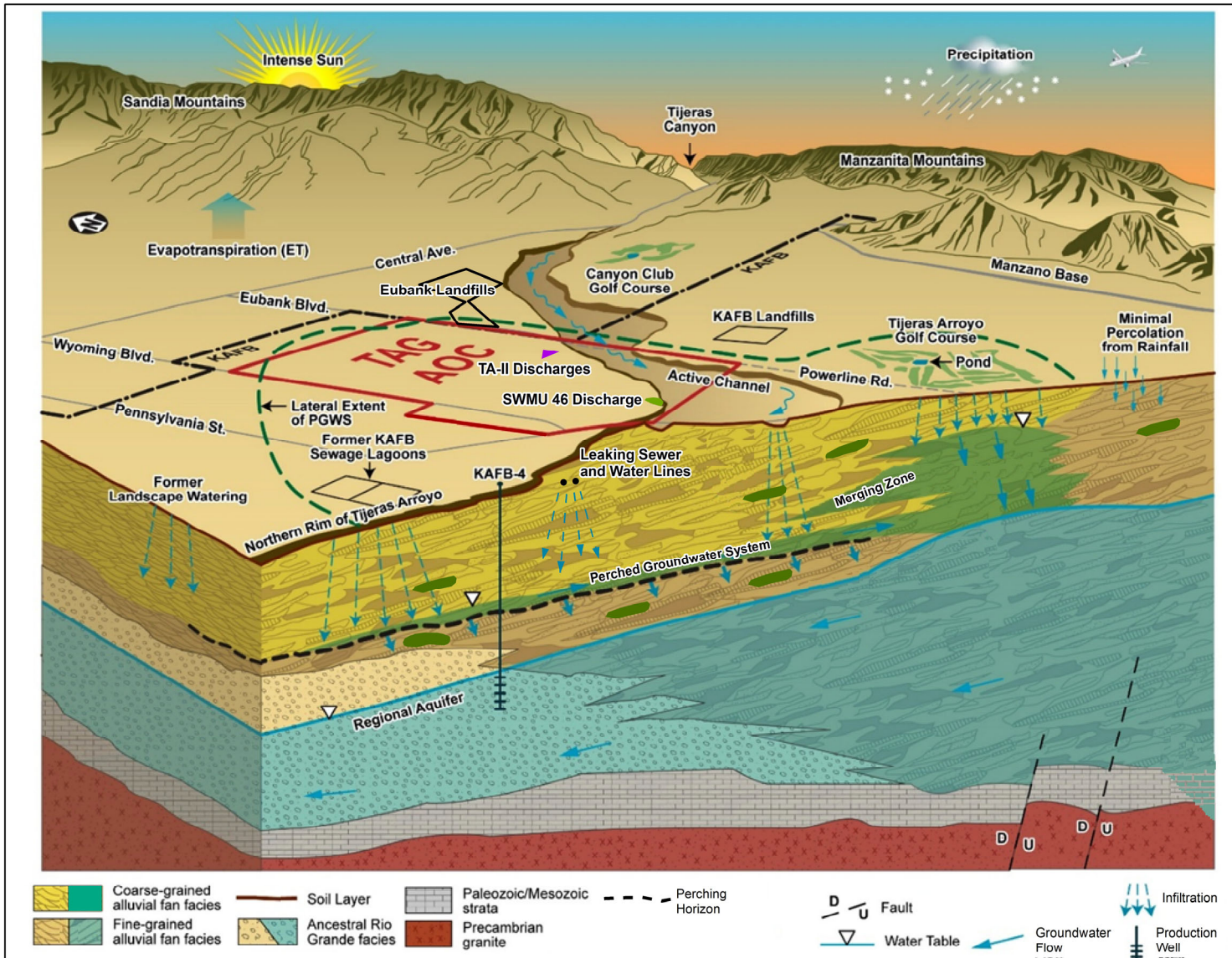
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SAND2021-12608 O

TAG Site Description



- The Tijeras Arroyo Groundwater (TAG) Investigation Area of Concern (AOC) covers approximately 1.82 square miles in the north-central portion of Kirtland Air Force Base (KAFB) and is located just south of the Wyoming and Eubank gates. SNL Technical Areas I, II, and IV are located in the TAG AOC.
- All 47 of SNL's surface-soil Solid Waste Management Units in the TAG AOC are approved for Corrective Action Complete status.
- Two water-bearing units, the Perched Groundwater System (PGWS) and the Regional Aquifer, are present in fluvial and alluvial-fan sediments that consist mostly of sands and gravels. Beneath much of the TAG AOC, a 160- to 250-foot thick layer of unsaturated sediments are sandwiched between the Perching Horizon and the Regional Aquifer. A Merging Zone between the PGWS and the Regional Aquifer is located near the southeast corner of the TAG AOC.
- Two SNL sites (SWMU 46 discharge and the TA-II discharges) are where significant volumes of wastewater and septic water were disposed of prior to 1992. SWMU 46 discharged 1,300 million gallons from 1948-1974. TA-II sites discharged 100 million gallons from 1948-1992.
- Elevated nitrate concentrations in the PGWS were proposed for Monitored Natural Attenuation in the *Revised TAG Current Conceptual Model (CCM) and Corrective Measures Evaluation (CME) Report* that was submitted to the New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) in February 2018.

Conceptual Site Model for the TAG Vicinity



TAG Groundwater Monitoring

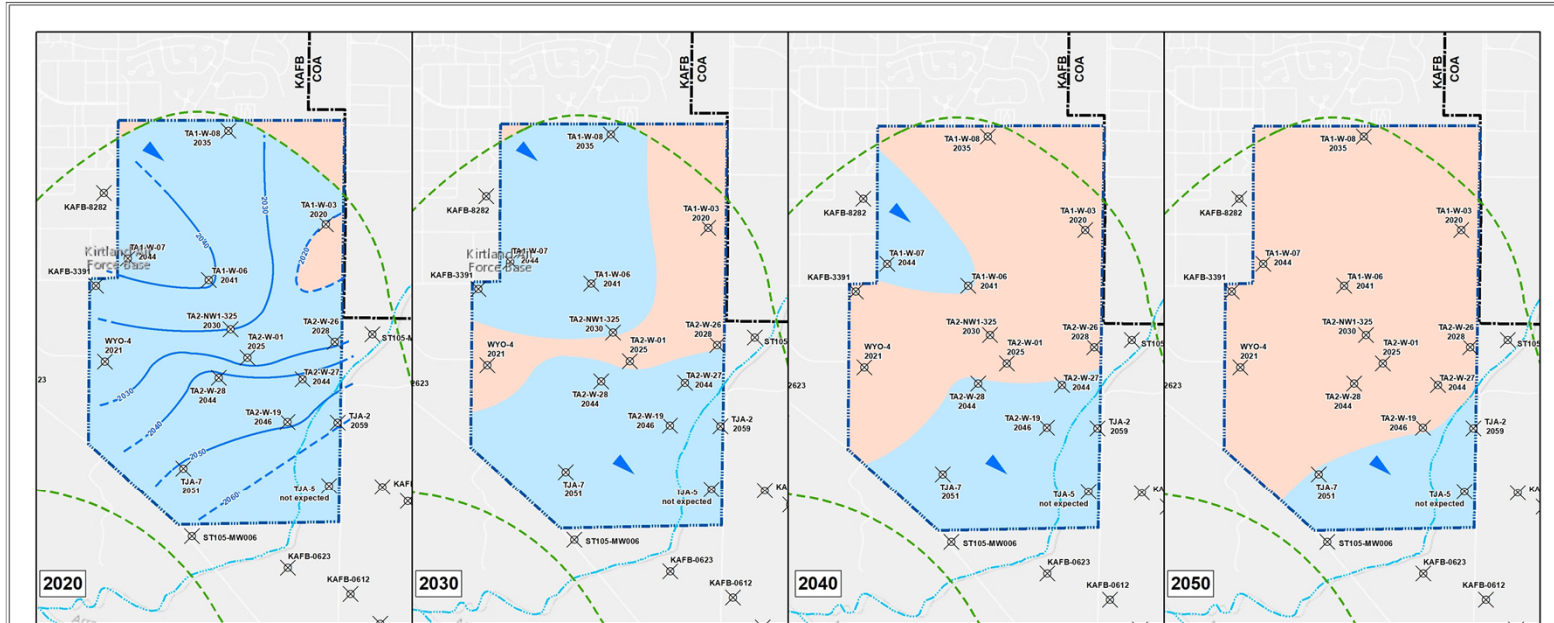


- Groundwater monitoring began in 1992.
 - The U.S. Department of Energy (DOE) and its prime contractor for SNL have installed 31 monitoring wells in the TAG AOC.
 - KAFB has 84, and the City of Albuquerque has 4, active monitoring wells in the surrounding area. Cooperation and data sharing enhances our understanding of the hydrogeologic setting.
 - 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 inside the southeast corner of the TAG AOC is approximately 280 acres.
 - Nitrate is typically derived from both man-made and natural sources, and may include septic leach fields, wastewater discharges, fertilizers, decomposition of organic matter, and the degradation of minerals in soil.
 - Depending on stratigraphic variations, PGWS monitoring wells will go dry in 5 to 44 years, except in the extreme southeast corner of the AOC.
 - Water from the PGWS is not used for any purpose at SNL; no one is drinking contaminated groundwater.



Expected progression of dewatering of the PGWS in 10 year intervals.

Year 2020 is at the left side. Hydrograph estimates were used for forecasting the 2030, 2040, and 2050 panels. The tan areas show where monitoring wells are projected to no longer produce enough groundwater for sampling in those years.



Predicted lateral extent of the Perched Groundwater System (Years 2020-2050) when water level is estimated to decline to bottom of well screen.

Service Layer Credits: Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community
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Legend

- Monitoring well, Perched Groundwater System (PGWS)
- Estimated year when water level declines to bottom of well screen
- Estimated year of decline contour, dashed where uncertain shown at Year 2020 only
- Predicted remaining extent
- Water below screen in SNL/NM well
- Lateral extent of PGWS, October 2015
- Groundwater Flow direction, inferred from potentiometric surface
- Surface drainage, arroyo
- Tijeras Arroyo Groundwater (TAG) Area of Concern (AOC)
- Kirtland Air Force Base (KAFB) boundary

0 1,250 2,500
Feet

0 300 600
Meters

SNL EGIS ORG.4142
New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum
SNL_EGIS Dept 4142 ce17573 11-10-17



6 TAG Groundwater Monitoring Results

- Elevated nitrate concentrations in the PGWS do not pose a threat to drinking water in the Regional Aquifer. Sandia operations have not contaminated the Regional Aquifer. Computer modeling and ongoing groundwater sampling continue to demonstrate that the Regional Aquifer will not be impacted.
- 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 in the PGWS.
- The nearest Albuquerque Bernalillo County Water Utility Authority well is Regional Aquifer well Ridgecrest 1, which is located approximately 2 miles to the north of the elevated nitrate concentrations in the PGWS.
- Two constituents of concern, nitrate and trichloroethene (TCE), were identified by NMED in the 2004 Consent Order. Results for the 2020 sampling are shown below.

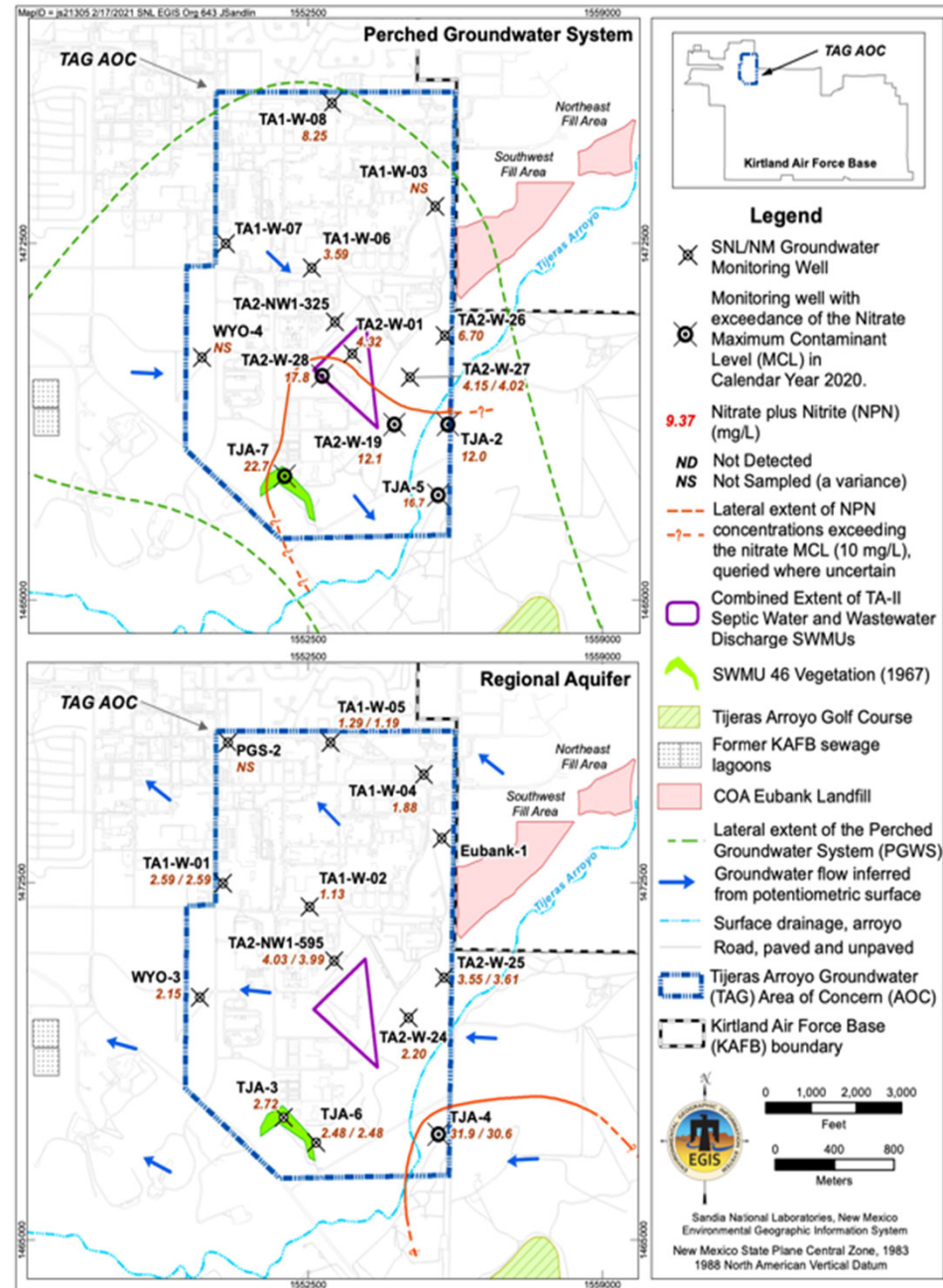
Constituent of Concern	Maximum Concentration in Perched Groundwater System, 2020	Maximum Concentration in Merging Zone, 2020	Maximum Concentration in Regional Aquifer, 2020	MCL
Nitrate	22.7 mg/L at well TJA-7	31.9 mg/L at well TJA-4	4.03 at well TA2-NW1-595	10 milligrams per liter (mg/L)
Trichloroethene	15.7 ug/L at well TA2-W-26	ND (<0.300) ug/L at well TJA-4	0.380] ug/L at well TJA-3	5 micrograms per liter (ug/L)

Nitrate Results

Nitrate release sites and the 2020 maximum nitrate concentrations for the PGWS are shown in the upper panel. The lower panel shows nitrate results for the Regional Aquifer.

For the PGWS, the red line shows that nitrate exceeds the MCL at five monitoring wells inside the southeast corner of the TAG AOC.

For the Regional Aquifer, one monitoring well in the far southeast corner of the TAG AOC exceeded the nitrate MCL. However, the groundwater sampled at Merging Zone well TJA-4 is likely from an upgradient source such as the golf course or has natural origins.



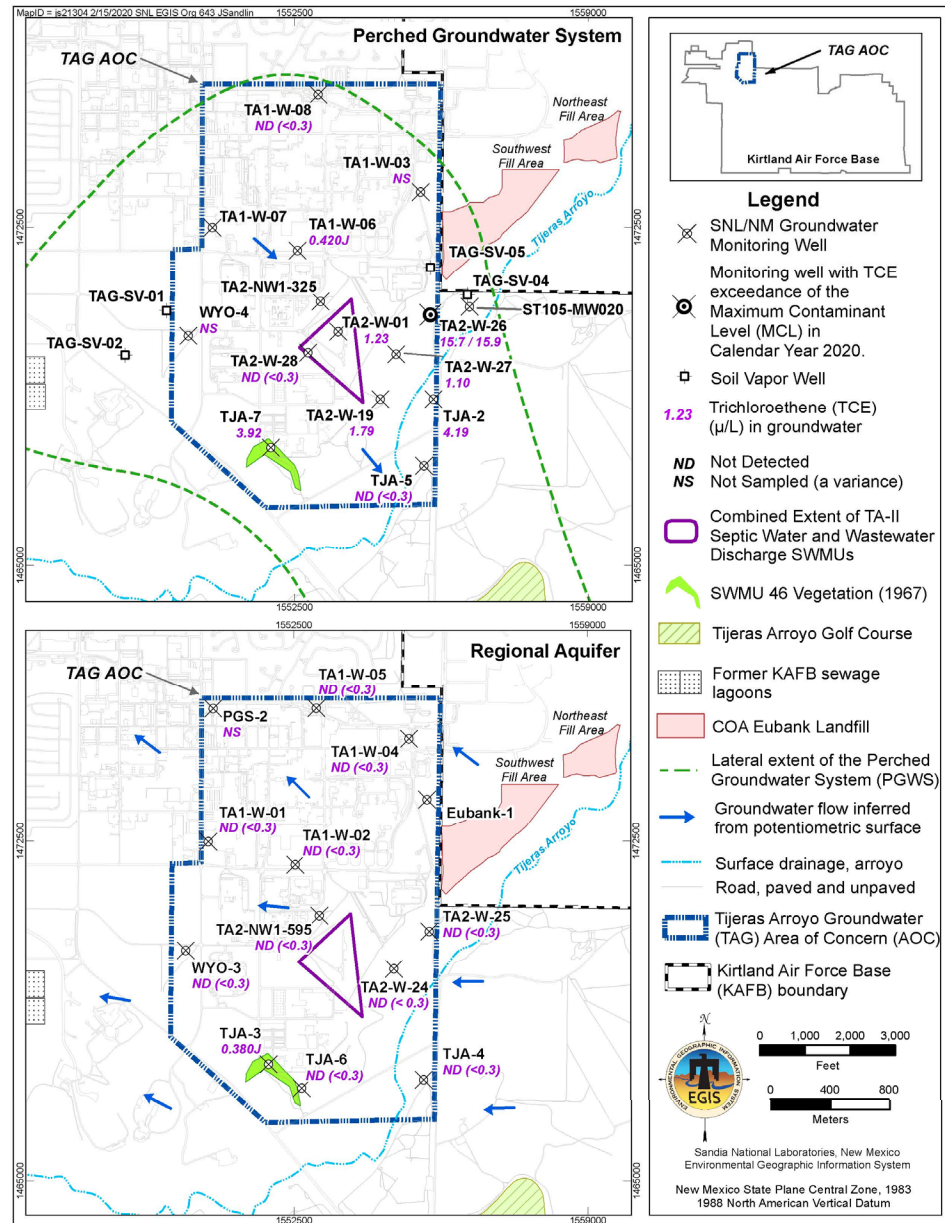
TCE Results

In September 2020, TCE exceeded the MCL in the PGWS for first time in 17 years.

SNL proactively implemented a strategy consisting of (1) installing a BaroBall at well TA2-W-26 in December 2020, (2) sampling two inactive soil-vapor wells TAG-SV-04 & TAG-SV-05 in May 2021, and (3) coordinating with a KAFB contractor to collect a split sample at well ST105-MW020 in September 2021.

In the April 2021 meeting, NMED HWB verbally endorsed the SNL strategy.

Recent TA2-W-26 results for TCE:
 June 2020 TCE at 3.68 ug/L.
 September 2020 TCE at 11.6 ug/L.
 December 2020 TCE at 15.7 ug/L with a duplicate at 15.9 ug/L.
 March 2021 TCE at 3.81 ug/L with a duplicate at 13.8 ug/L.
 June 2021 TCE at 1.38 J ug/L with a duplicate at 15.9 ug/L.

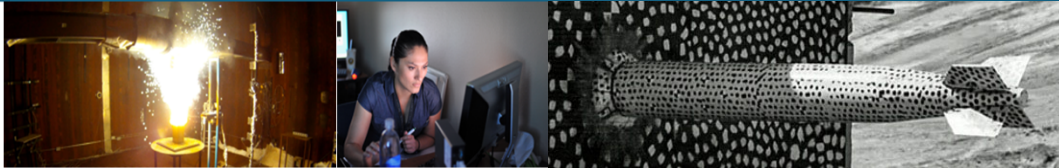


TAG Current Status and Recent Activities



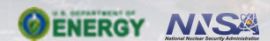
- The *Revised TAG CCM and CME Report* was submitted to the NMED HWB in February 2018.
- Three remedial alternatives were proposed in the report:
 1. Monitored natural attenuation (MNA) using the existing well network. This involves sampling of 16 wells. The estimated total cost is \$7.8 M over a period of 41 years.
 2. Groundwater Extraction and Treatment would also require the installation of 73 extraction wells and 25 performance-monitoring wells. The estimated total cost is \$61.5 M over a period of 27 years.
 3. In-situ Bioremediation would also require the installation of 575 injection wells and 25 performance-monitoring wells. The estimated total cost is \$173.3 M over 27 years.
- Each remedial alternative requires the semiannual sampling of the PGWS and annual sampling of the Regional Aquifer.
- The United States Geological Survey has independently conducted groundwater sampling and analysis using innovative parameters for the TAG vicinity. Elevated nitrate concentrations above the MCL are likely attributable to the leaching of natural nitrate from sediments.
- In April and May 2021, meetings were held with personnel from SNL, DOE SFO, and NMED HWB to discuss the *Revised TAG CCM/CME Report*. No shortcomings were identified. NMED HWB is anticipated to select the MNA alternative in 2021.

Technical Area-V Groundwater Investigation



Jun Li
Environmental Restoration Operations
Sandia National Laboratories

October 2021

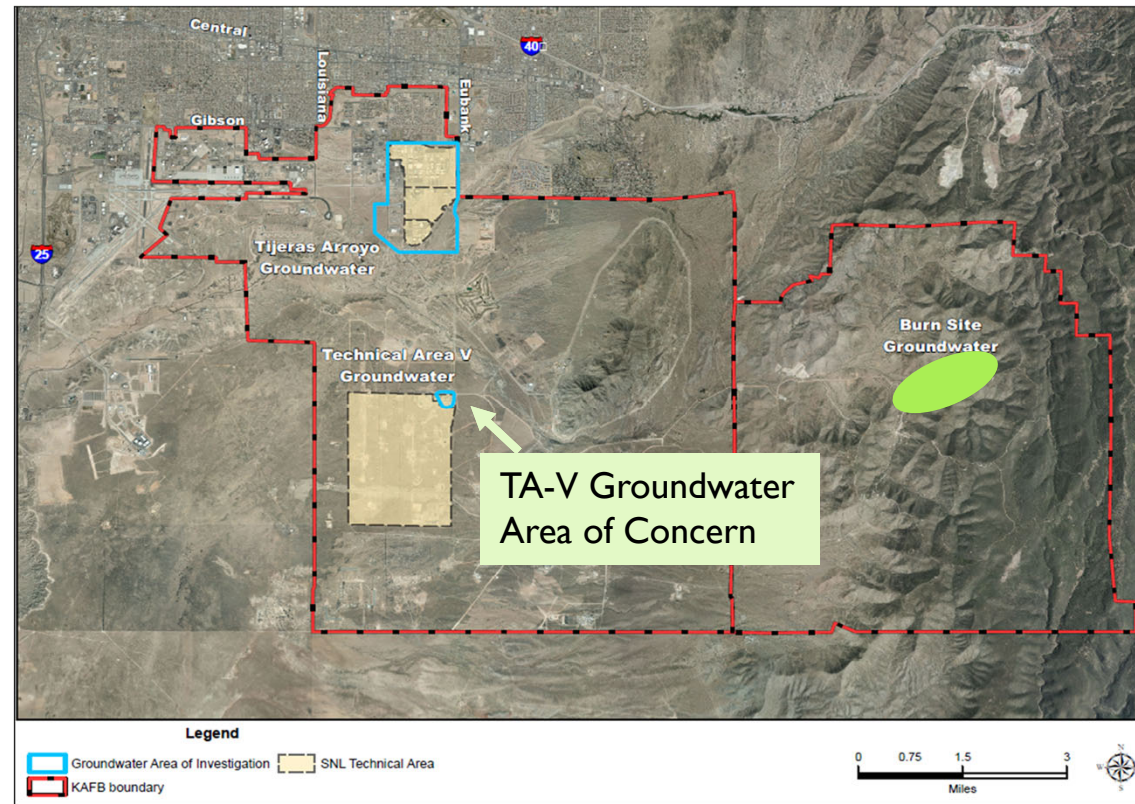


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TA-V Groundwater AOC Site Description

- The groundwater at Technical Area-V (TA-V) at Sandia National Laboratories (SNL) is designated an Area of Concern (AOC) in the 2004 Compliance Order on Consent.
- New Mexico Environment Department (NMED) is the regulatory agency for enforcing the requirements of the Compliance Order on Consent.

TA-V is an industrial area in the west-central portion on Kirtland Air Force Base (KAFB). The area of TA-V is approximately 35 acres.



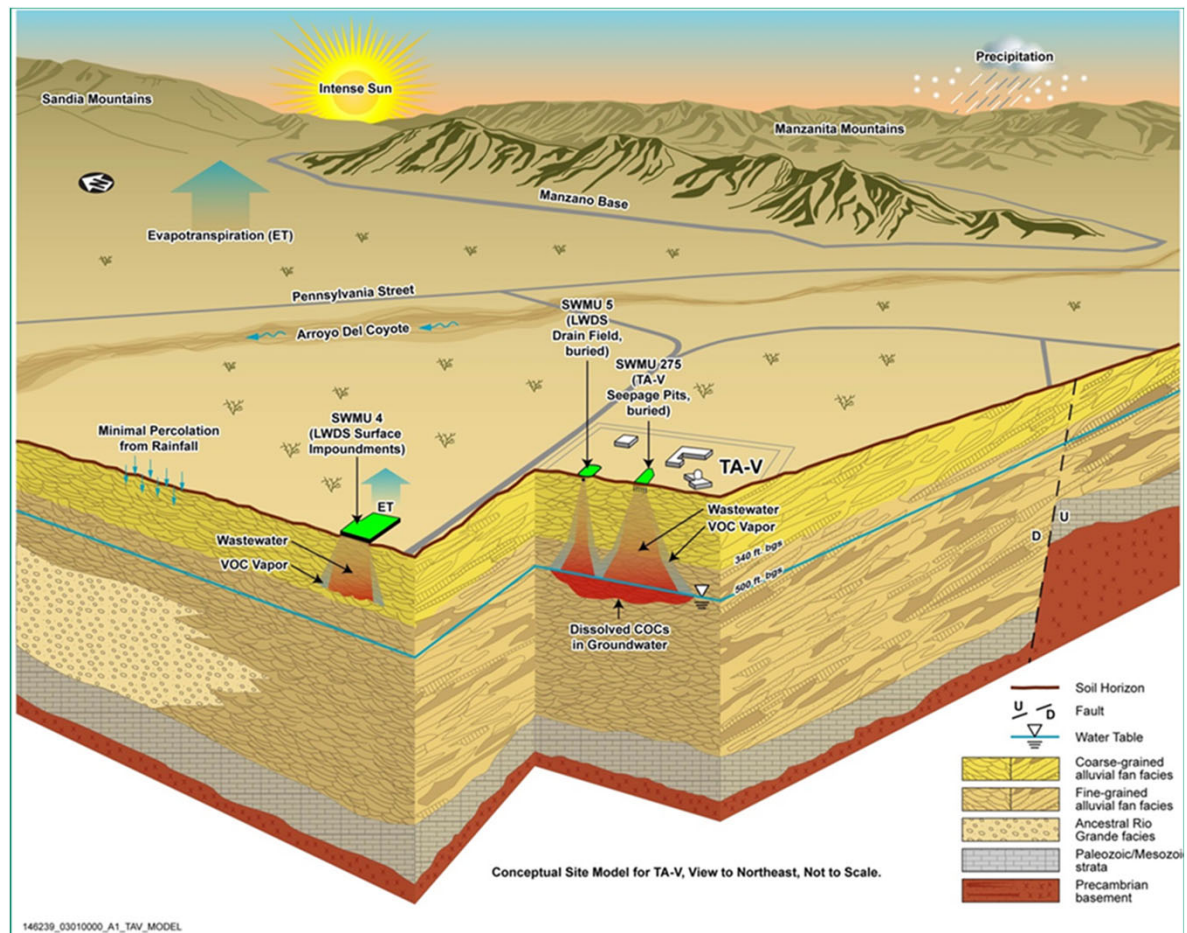


TA-V Groundwater AOC Site Description

- SNL activities at TA-V began in 1961 and involve operating research reactors.
- All the surface and shallow subsurface contamination has been addressed and corrective action is complete. Now corrective action is required only for the groundwater at TA-V.

Groundwater at TA-V occurs in the Regional Aquifer that resides in fine-grained, clay-rich, alluvial fan sediments. The water table is approximately 500 – 520 feet below the ground surface at TA-V.

The picture shows the Conceptual Site Model of Groundwater Contamination Process at TA-V.

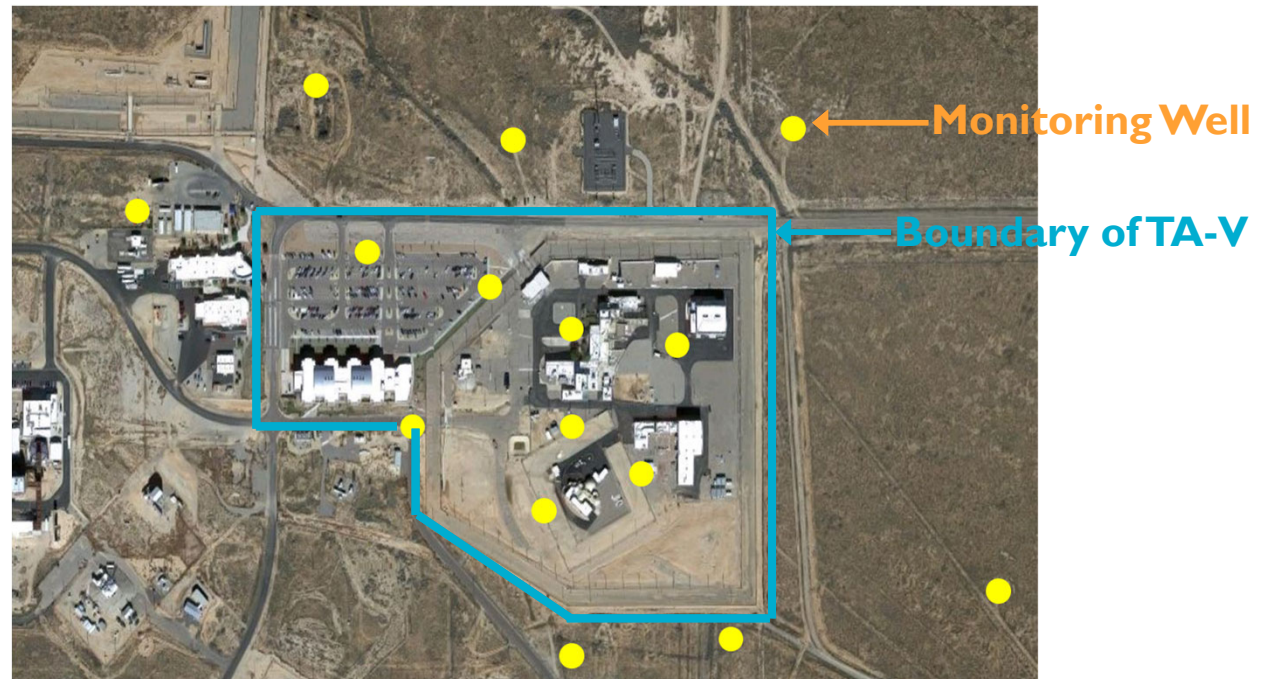


TA-V Groundwater Monitoring

- Groundwater monitoring began in 1992.
- Current monitoring network consists of 18 wells.
- Groundwater is contaminated with nitrate and trichloroethene at concentrations above the U.S. Environmental Protection Agency maximum contaminant levels (MCLs) for drinking water.
- No other constituents in TA-V groundwater exceed the MCLs.

Groundwater in this area is not used for any purpose.

Nearest downgradient drinking-water supply well (KAFB-4) is 2.7 miles to the north.

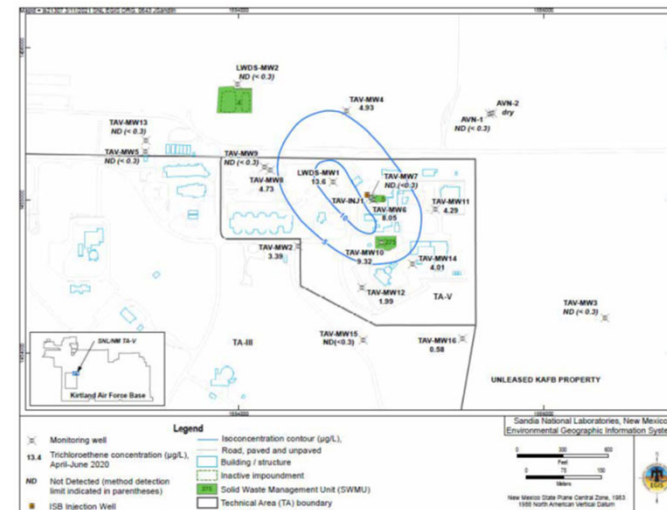
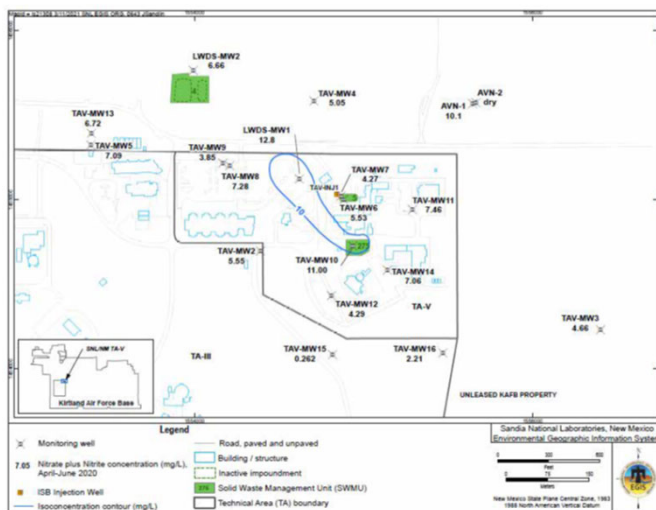




TA-V Groundwater Monitoring

- Nitrate plume covers approximately 1.4 acres.
- Trichloroethene (TCE) plume covers approximately 13 acres.
- Both plumes are stable. Neither plume is moving away from TA-V.
- The plumes are not adversely impacting human health and the environment.

Constituent of Concern	Maximum Concentration in 2020	MCL
Nitrate	14.6 milligrams per liter (well LWDS-MW1)	10 milligrams per liter
Trichloroethene	14.8 micrograms per liter (well LWDS-MW1)	5 micrograms per liter



Source: 2020 Annual Groundwater Monitoring Report; Nitrate Plume (left) and TCE Plume (right), April – June 2020

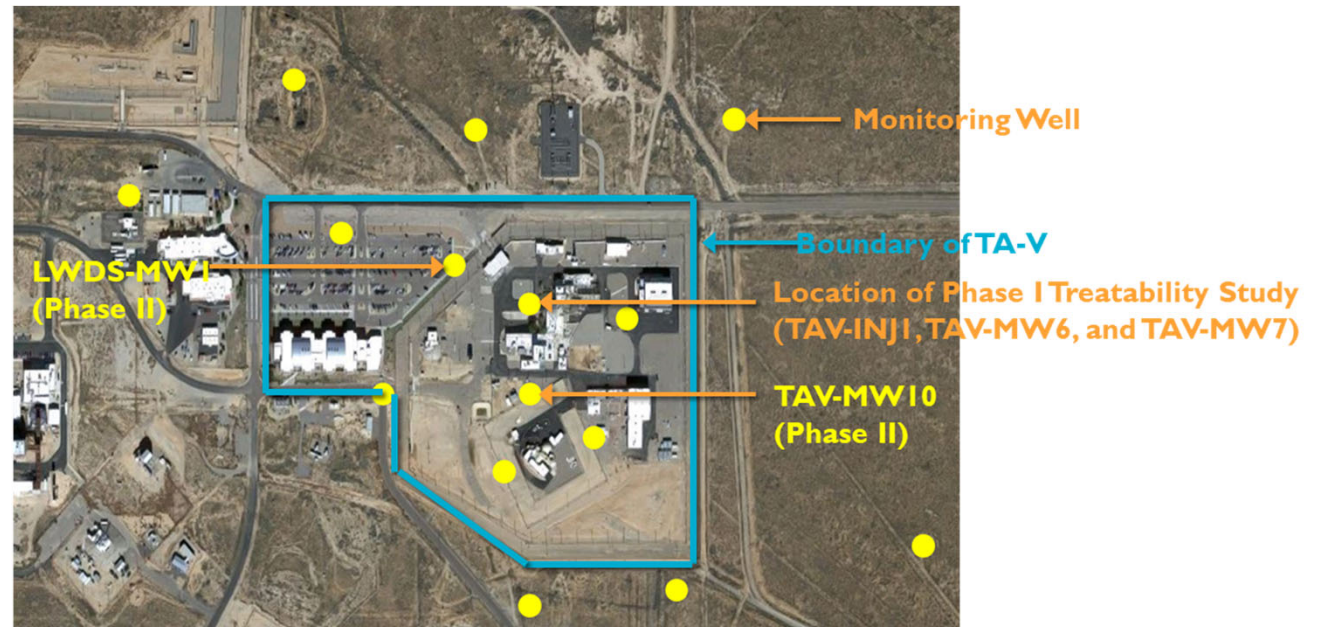
Treatability Study of In-Situ Bioremediation at TA-V

- The plan of the treatability study is to deliver bioremediation treatment solution using an injection well.
- The objective is to evaluate the effectiveness of in-situ bioremediation as a corrective measure to treat the contamination at the TA-V Groundwater AOC.

The Treatability Study of ISB includes two phases:

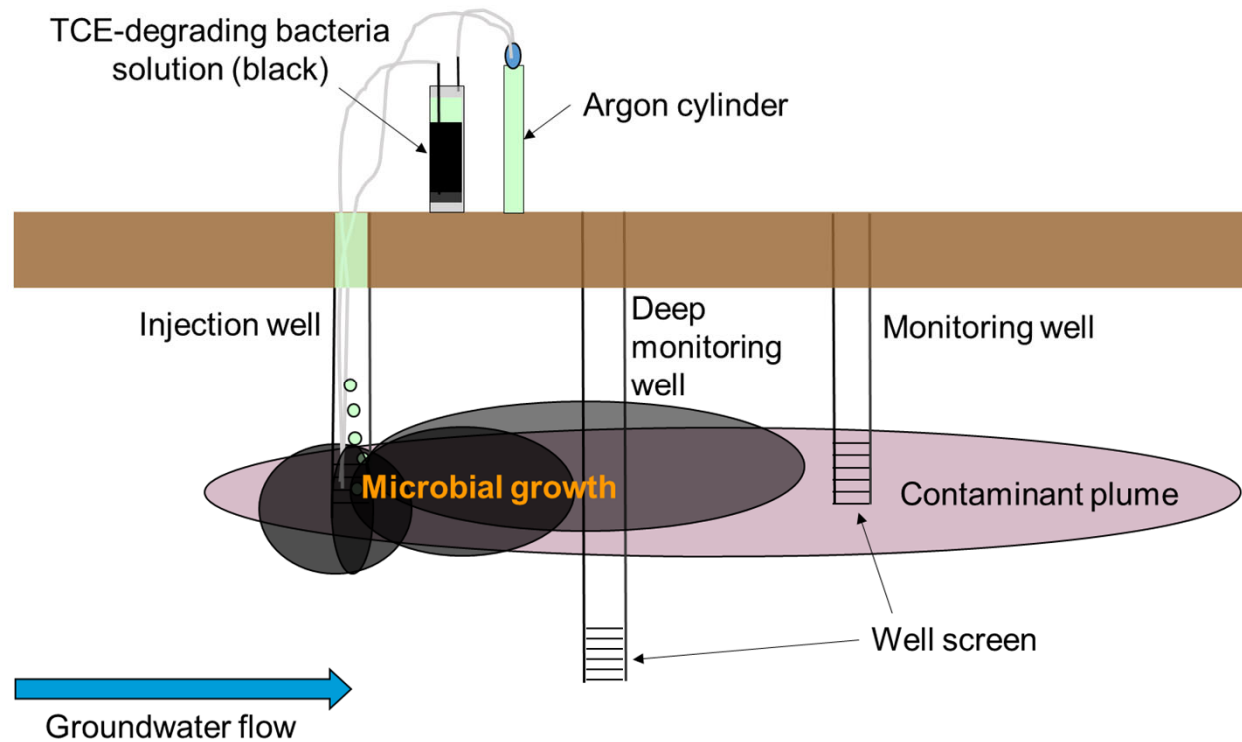
Phase I includes installation of one injection well (TAV-INJ1), followed by a Pilot Test and a Full-Scale Test at the Phase I treatment zone.

Phase II could include installation of two additional injection wells, followed by Full-Scale Tests at the Phase II treatment zones, contingent on the results of Phase I Full-Scale Test.



Treatability Study of In-Situ Bioremediation at TA-V

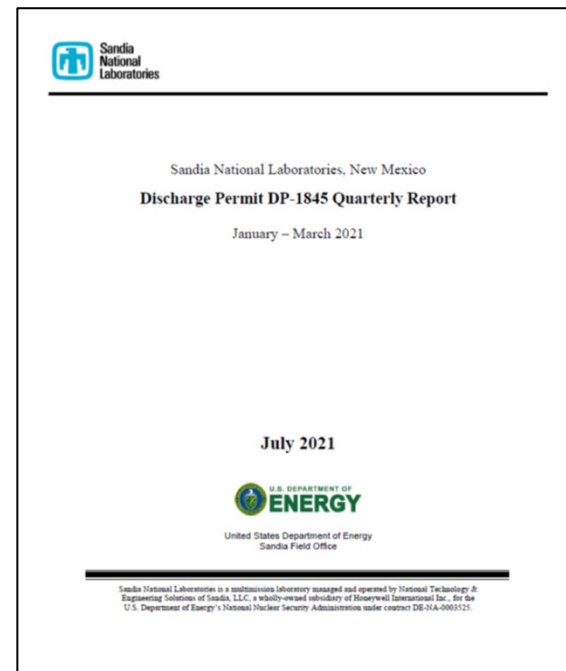
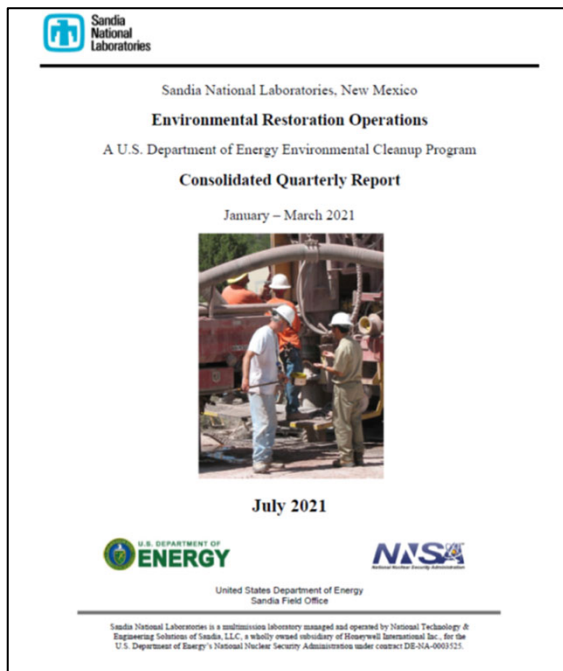
- Groundwater at TA-V is aerobic, and biodegradation is not naturally occurring.
- Bioremediation solution provides the nutrients and pH buffer for the injected bacteria to biodegrade nitrate and trichloroethene.
- How large an area can be treated by the bioremediation treatment solution injected?





Treatability Study of In-Situ Bioremediation at TA-V

- The NMED Hazardous Waste Bureau (HWB) is the regulator for the investigation.
- The NMED Ground Water Quality Bureau (GWQB) issued Discharge Permit-1845 that allows SNL to discharge bioremediation solution to groundwater using injection well.
- Progress on the treatability study is provided to the NMED HWB and GWQB through quarterly reporting.





Phase I Treatability Study at Injection Well TAV-INJ1



- Phase I Pilot Test started in November 2017 and completed in June 2018.
- Injected approximately 531,000 gallons of bioremediation solution and 123 liters of trichloroethene-degrading bacteria from November 2018 to April 2019 for the Phase I Full-Scale Test.
- Injections were followed by two-years of groundwater monitoring.
 - Injection well TAV-INJ1 and monitoring well TAV-MW6 were monitored for the performance of in-situ bioremediation.
 - One deep well and eight surrounding wells were monitored to determine potential impact on groundwater quality caused by the bioremediation solution injected.
- After completion of two years performance monitoring, Phase I Treatability Study concluded in May 2021.

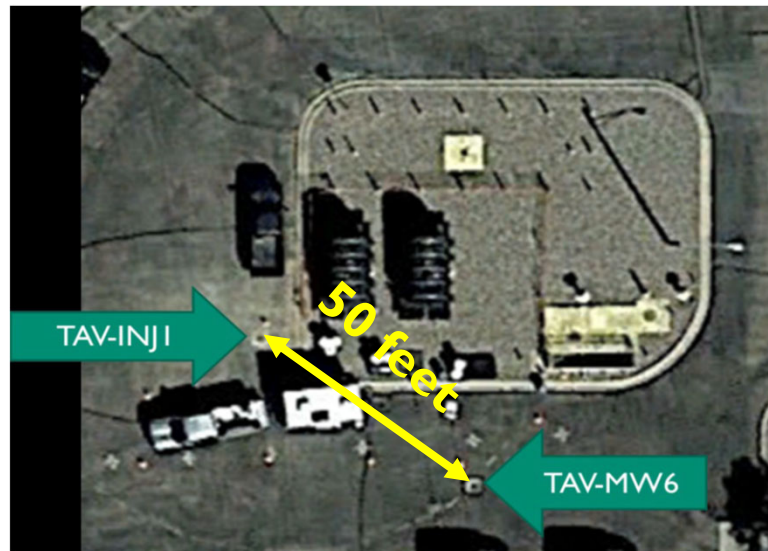




Findings of Phase I Treatability Study at Injection Well TAV-INJ1

- Groundwater at injection well TAV-INJ1 has been maintaining optimal conditions for biodegradation.
- Nitrate and TCE were mostly not detected during the two-year monitoring. No concentration rebound has been observed.
- The inert tracer (bromide) injected with the bioremediation solution reached monitoring well TAV-MW6
- Bromide concentration subsequently decreased to baseline.
- Dissolved oxygen level has decreased in the groundwater at well TAV-MW6; however, anaerobic condition is not established.
- No change in groundwater quality has been observed at the deep monitoring well and the eight surrounding wells.

Phase I Full-Scale Test results show limited success of ISB: Discharges affected a small, localized area near the injection well.



Findings of Phase I Treatability Study at Injection Well TAV-INJI

- In-Situ Bioremediation does not prove to be a viable technology to treat the groundwater contamination at the TA-V Groundwater AOC.
 - Delivery of bioremediation solution was limited by low hydraulic conductivities of the aquifer at TA-V.
 - Infrastructure at TA-V (buildings and utilities) limits installation of multiple injection wells impeding the success of the in-situ bioremediation technology at this site.
- NMED HWB has indicated that Phase II Treatability Study is not warranted.
- Data obtained during the Phase I Treatability Study will provide input to recommending a final remedy for corrective action in the Corrective Measures Evaluation process of the TA-V Groundwater AOC.



Path Forward as of October 2021

- Preparing termination request of DP-1845 to NMED GWQB.
- Preparing Phase I Treatability Study Report to NMED HWB.
- Will recommend to the NMED HWB proceeding with the Corrective Measures Evaluation (CME) process of the TA-V Groundwater AOC.

The CME Process of SNL's TA-V Groundwater AOC:

