



Sandia National Laboratories

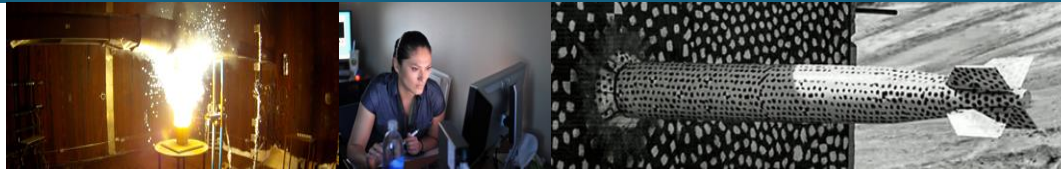
- Semi-annual public meeting
- Environmental activities at Sandia National Laboratories
- Information resources for environmental restoration activities at Sandia National Laboratories
 - New Mexico Environment Department Hazardous Waste Bureau
<https://www.env.nm.gov/hazardous-waste/sandia-national-laboratories/>
 - 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
 - Discharge Permit 1845 for Technical Area-V Groundwater Investigation AOC was issued by the Ground Water Quality Bureau in 2017 and terminated in 2022.
- Drinking water standards serve as groundwater cleanup goals for human health and environmental protection
 - No drinking water wells are located in or near the contaminated groundwater
 - Boundaries of contaminated groundwater at each area are defined
 - No one is drinking contaminated groundwater

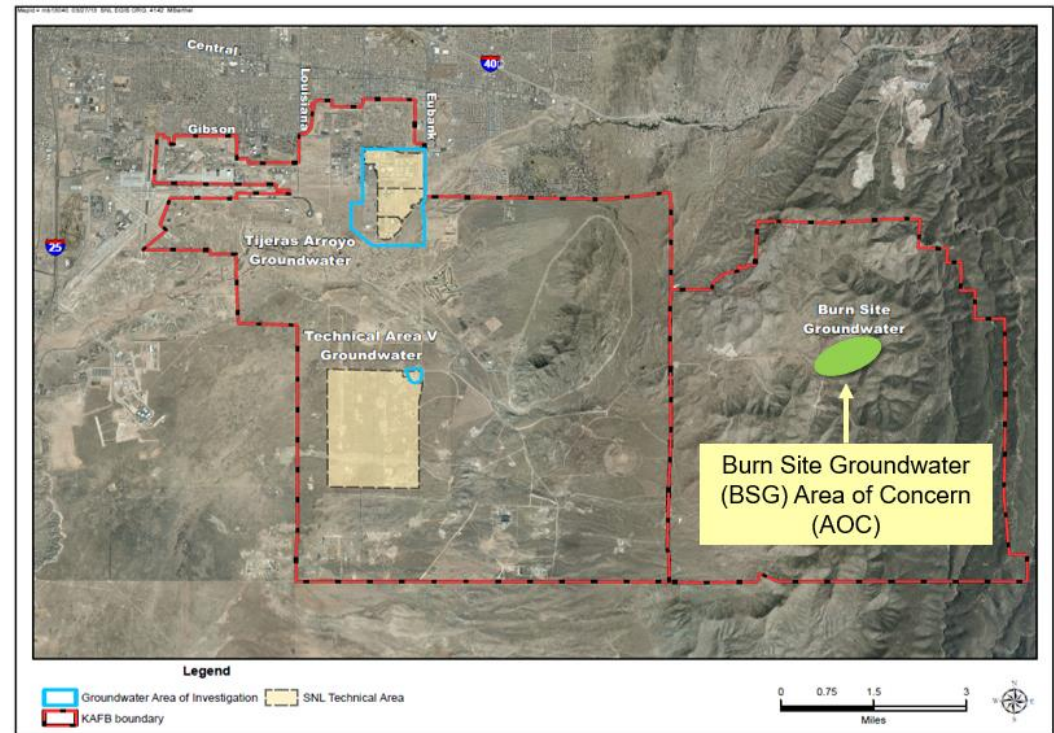
Burn Site Groundwater (BSG) Investigation



*Michael Skelly
Environmental Restoration Operations*



- The BSG Area of Concern (AOC) 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.



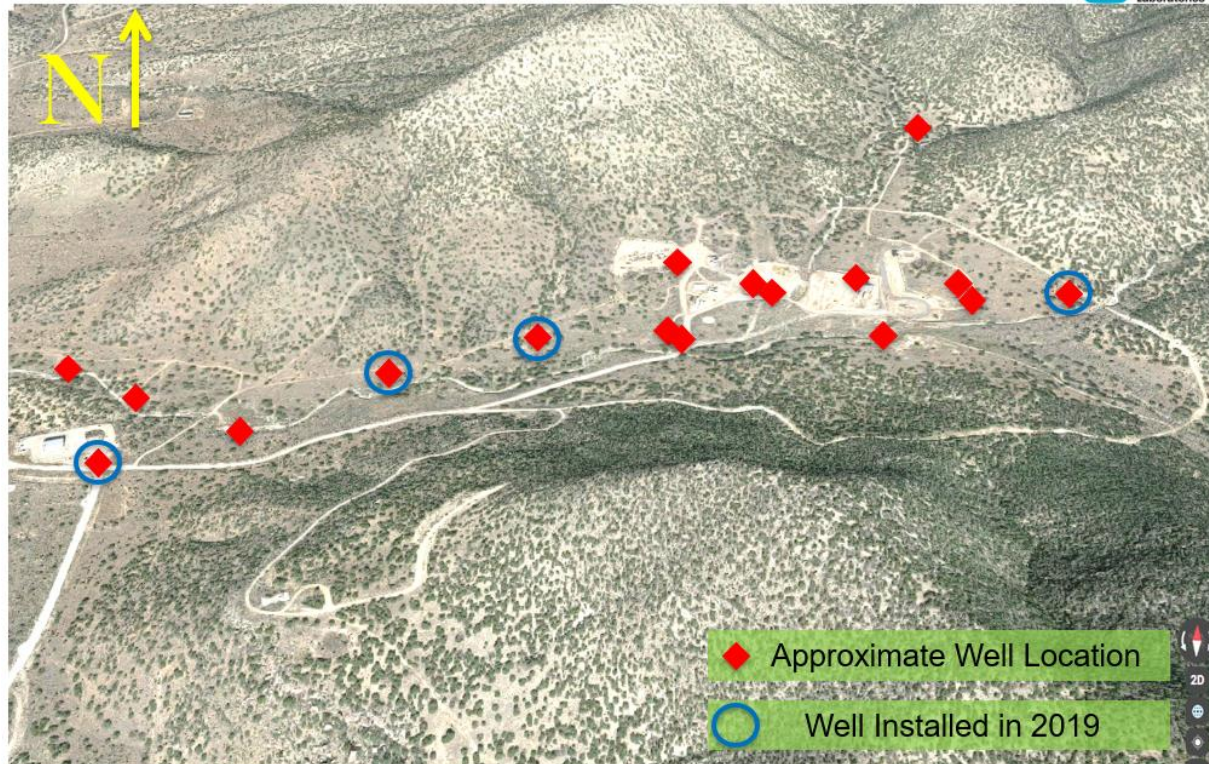
- Groundwater occurs in fractured Precambrian bedrock that is recharged by infiltration of precipitation; flow is controlled by changes in rock type and faults/fractures.
- SNL activities at the Burn Site testing area began in 1967; early site test activities included explosives testing, current use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

BSG Groundwater Monitoring

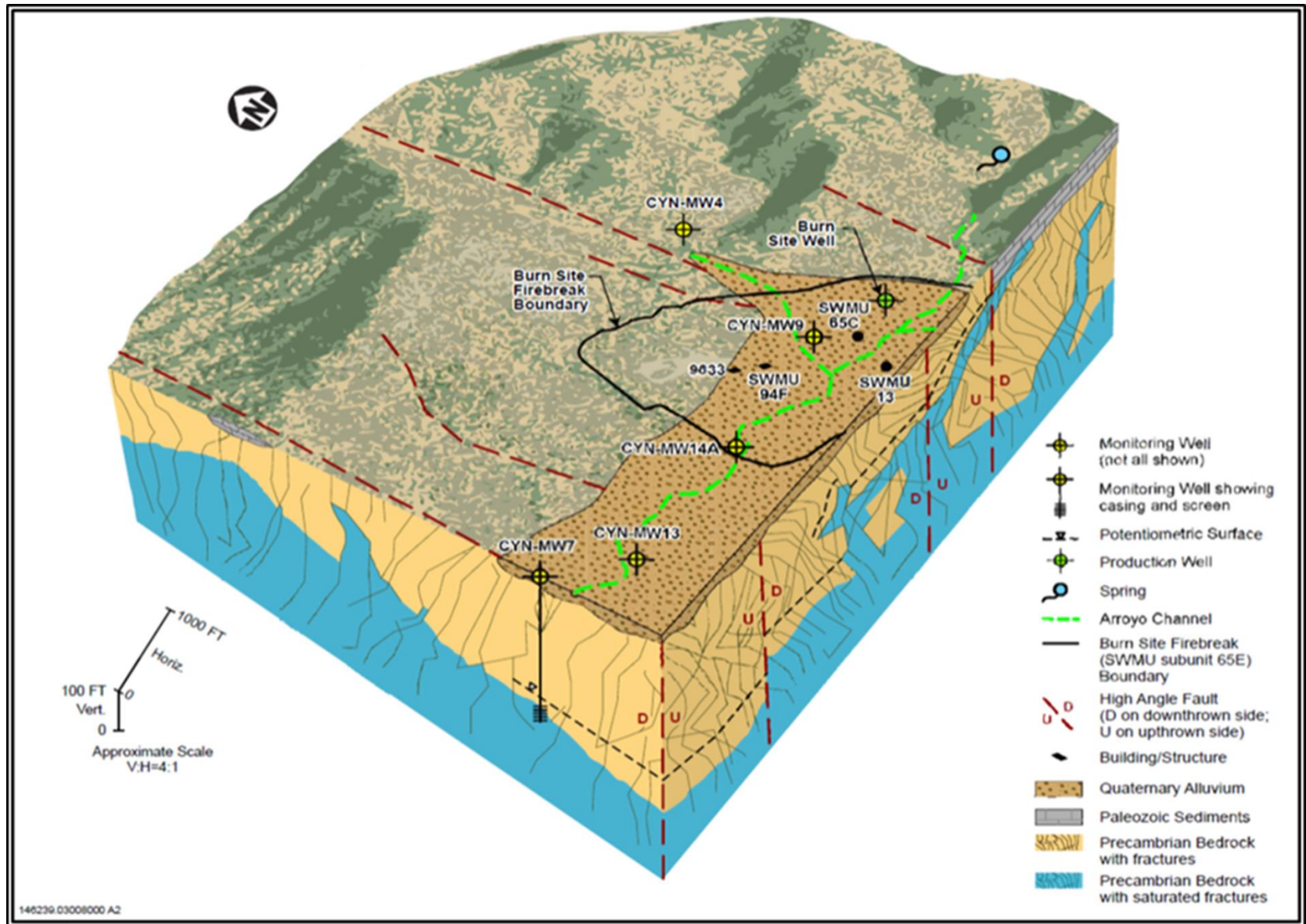


- Groundwater monitoring began in 1996.
- Depth to groundwater ranges from 45 to 360 feet below ground surface and groundwater flows to the west.
- The monitoring network consists of 16 monitoring wells and an inactive production well, with 4 newest wells installed in October/November 2019.

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



Conceptual Site Model for the BSG AOC

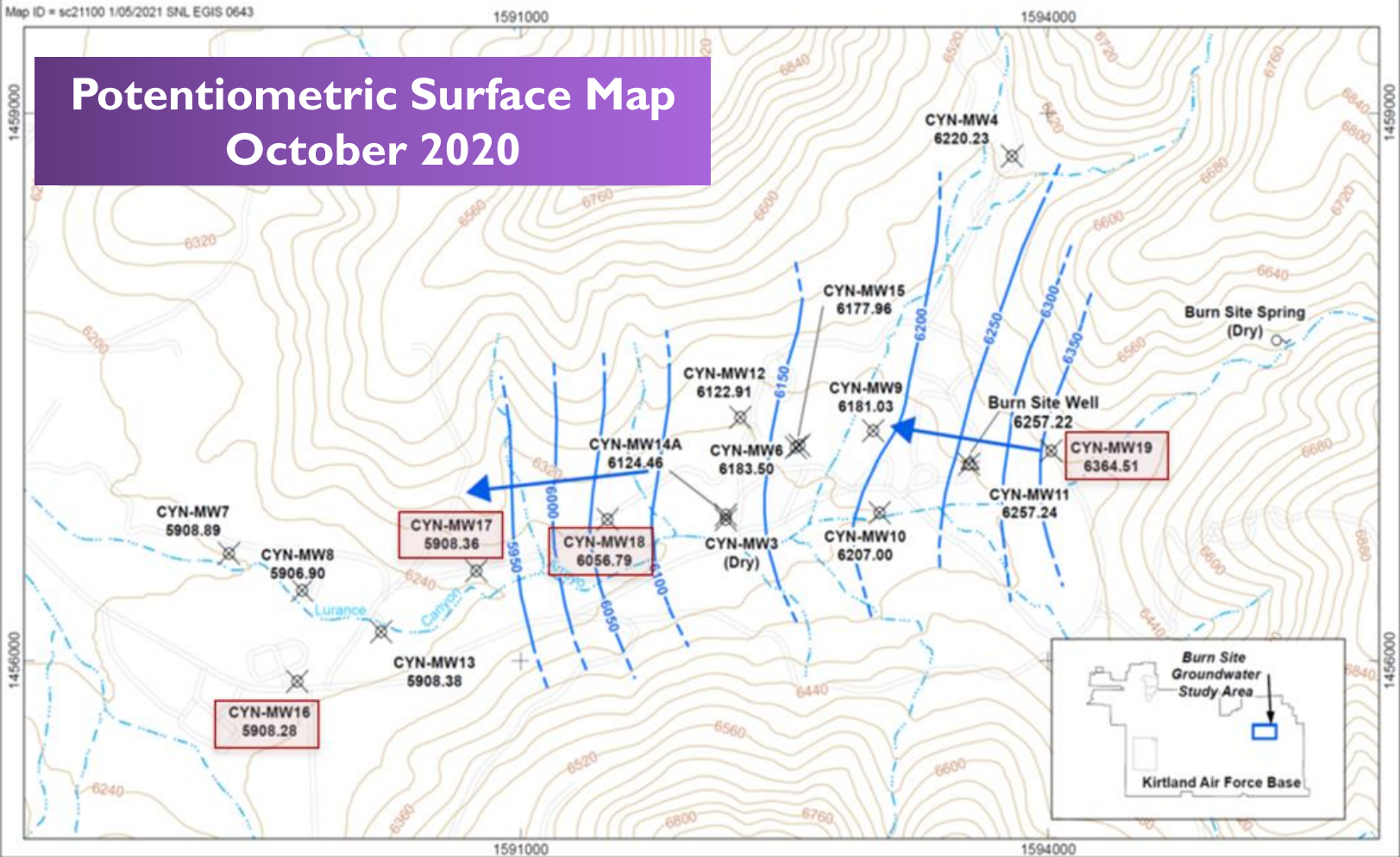


BSG Groundwater Monitoring



- 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
- Groundwater elevation (ft amsl) October 2020, datum (NAVD 88)
- Water supply well (non-potable)
- Spring
- 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

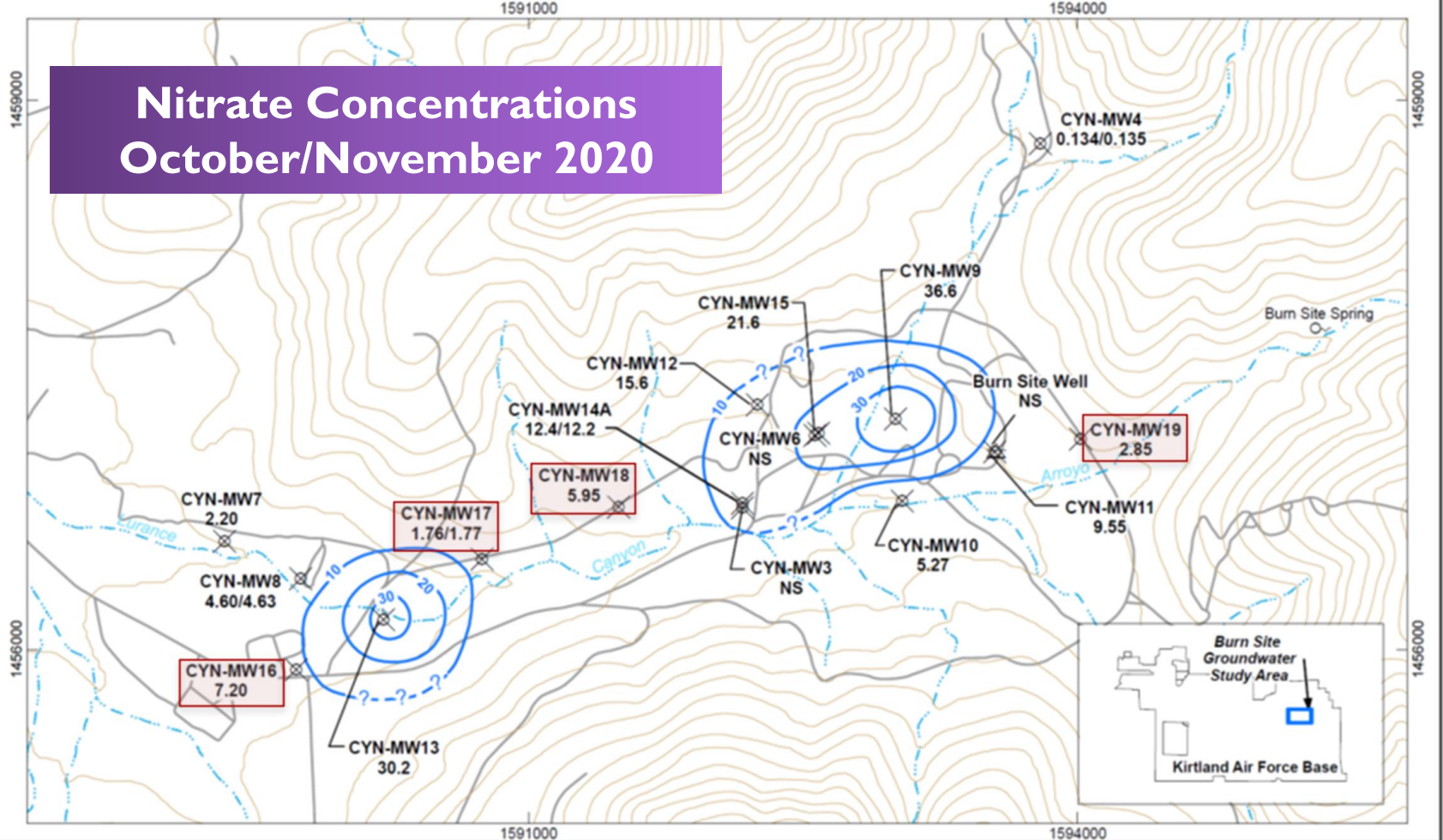
Scale: 0 to 2,000 Feet / 0 to 500 Meters

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



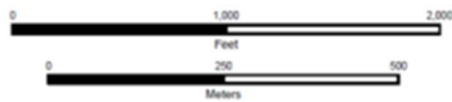
MapID: sc21110 2/05/2021 SNL EGIS ORG.643

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) |
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Sandia National Laboratories, New Mexico
Environmental Geographic Information System



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



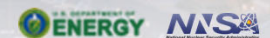


- Recently completed characterization of the extent of nitrate contamination, will now resume the corrective action process and propose alternatives for a remedy.
- Performed quarterly water level measurements and semiannual groundwater sampling that was presented in the *Annual Groundwater Monitoring 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.

Tijeras Arroyo Groundwater (TAG) Investigation – Public Meeting 28 April 2022



John R. Copland
TAG Task Leader
Environmental Restoration Operations



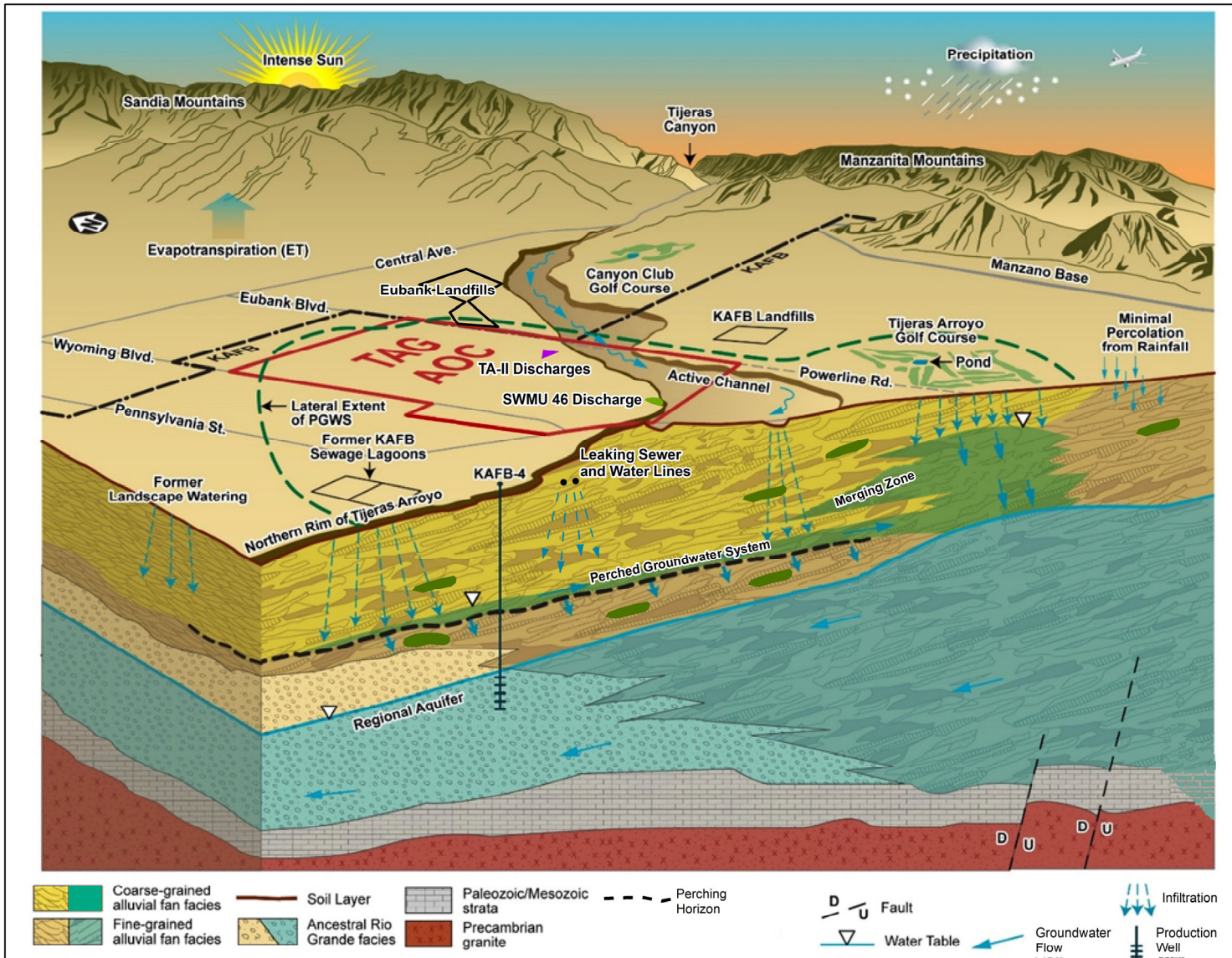
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TAG Site Description



- The Tijeras Arroyo Groundwater (TAG) Investigation Area of Concern (AOC) covers approximately 1.8 square miles in the north-central portion of Kirtland Air Force Base (KAFB) and is located just south of the Wyoming and Eubank gates. Technical Areas I, II, and IV are located in the TAG AOC at SNL.
- All 47 of SNL's surface 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. The depth to water for the PGWS is approximately 300 feet. 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 localized Merging Zone between the PGWS and the Regional Aquifer is located near the southeast corner of the TAG AOC.
- 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.
- Two SNL sites (SWMU 46 and TA-II) are where significant volumes of wastewater and septic water were disposed of prior to 1992. SWMU 46 discharged an estimated 1,300 million gallons of water from 1948-1974. TA-II sites discharged an estimated 100 million gallons of water from 1948-1992. The discharged waters contained low concentrations of nitrate and trichloroethene (TCE).

Conceptual Site Model for the TAG Vicinity



TAG Groundwater Monitoring



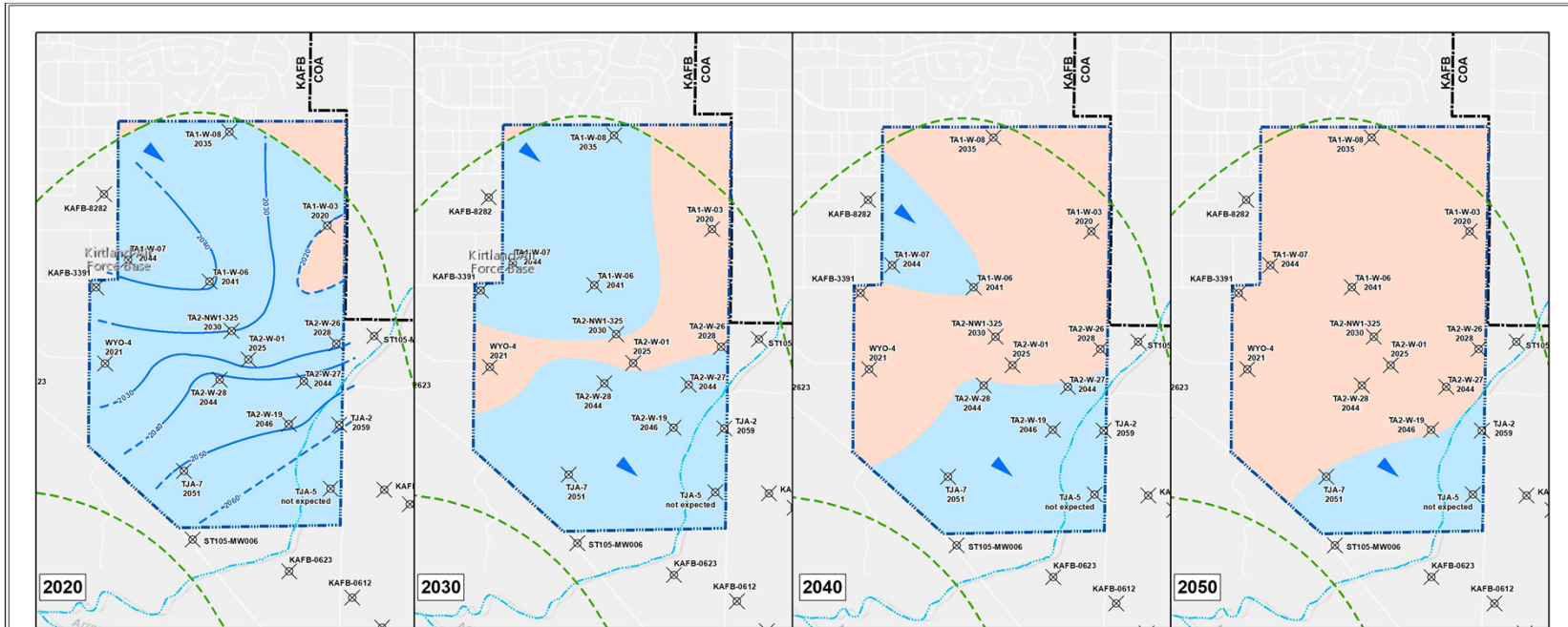
- Groundwater monitoring began at the TAG AOC in 1992.
- 31 groundwater and 14 soil-vapor monitoring wells have been installed.
- SNL personnel currently sample 21 groundwater monitoring wells for volatile organic compounds (VOCs), metals, nitrate, and radionuclides. The wells are sampled on a quarterly, semiannual, or annual basis.
- Active groundwater monitoring wells in the surrounding area include 84 KAFB wells and 4 City of Albuquerque wells. Cooperation and data sharing enhances our understanding on the hydrogeologic setting.
- Monitoring wells screened in the PGWS yield small volumes of water, typically one to two gallons per minute.
- Water from the PGWS is not used for any purpose at SNL. Nearby production wells operated by KAFB, the Veterans Affairs, and the Albuquerque Bernalillo County Water Utility Authority (ABCWUA) are not screened in the PGWS. Their production wells are screened in the Regional Aquifer.
- Over much of the TAG AOC, monitoring wells in the PGWS are predicted to go dry by 2059 because man-made sources of recharge such as the KAFB sewage lagoons and SNL wastewater outfalls have been eliminated. Landscape watering has also been reduced.

Nitrate in Groundwater



- Nitrate can be produced by both man-made and natural sources. Prior to 1992, the man-made sources at SNL/NM were septic leach fields and wastewater outfalls. The SNL discharges were discontinued in 1992. Other possible sources in the vicinity of the TAG AOC include fertilizer usage, decomposition of organic matter, and the degradation of minerals in soil and sediments.
- In addition to groundwater sampling conducted by SNL, KAFB, and City personnel, the United States Geological Survey (USGS) has also independently collected groundwater samples for the purpose of evaluating the occurrence of nitrate in soil, sediments, and groundwater. The USGS study evaluated isotopic, geochemical, and pharmaceutical data.
- The USGS study concluded that previously unrecognized natural occurring accumulations of nitrate in sediments beneath the shifting Tijeras Arroyo channel can be flushed downward and are likely responsible for the elevated nitrate concentrations in groundwater.

6 Predicted Dewatering of the PGWS



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

Monitoring well, Perched Groundwater System (PGWS)
 2020 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

Legend
 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

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

COA: City of Albuquerque
 SNL/NM: Sandia National Laboratories/New Mexico

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

7 TAG Groundwater Monitoring Results



- Elevated nitrate concentrations in the PGWS do not pose a threat to drinking water in the Regional Aquifer. SNL 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 is KAFB-20, which is located approximately 1 mile to the west of the elevated nitrate concentrations in the PGWS.
- The nearest ABCWUA drinking-water production well is 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 TCE, were identified by NMED in the 2004 *Compliance Order on Consent* because the two compounds exceeded their drinking water standards (maximum contaminant levels [MCLs]). Results for the 2020 groundwater sampling are shown below.

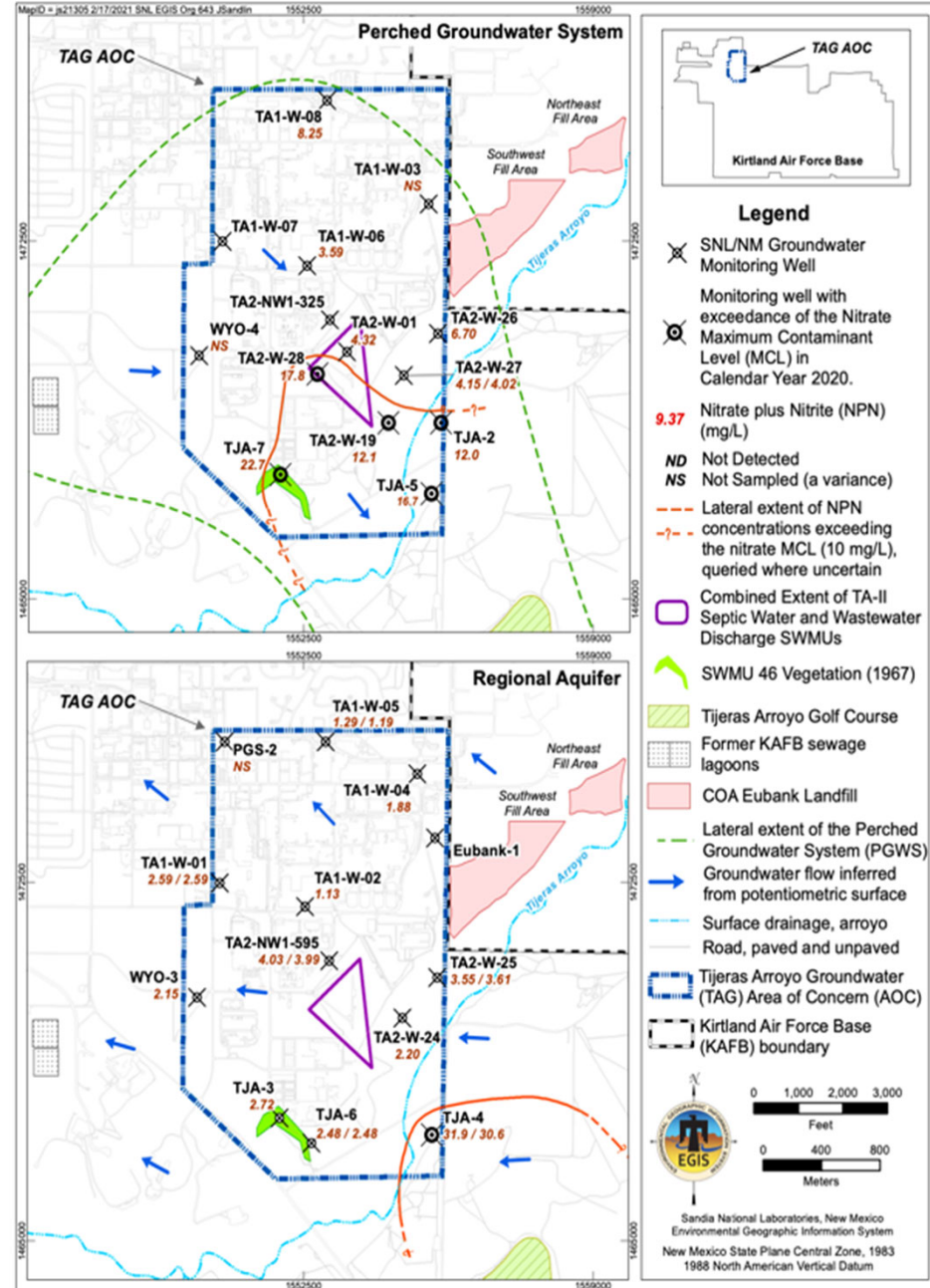
Constituent of Concern	Maximum Concentration in Perched Groundwater System, 2020	Maximum Concentration in Merging Zone, 2020	Maximum Concentration in Regional Aquifer, 2020	MCL
Nitrate	22.7 mg/L at well TJA-7	31.9 mg/L at well TJA-4	4.03 at well TA2-NW1-595	10 milligrams per liter (mg/L)
Trichloroethene	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 wells are shown in the upper panel. The lower panel shows results for the Regional Aquifer.

For the PGWS, the red line shows that nitrate exceeds the MCL at five monitoring wells in 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 and/or has natural origins.



TCE Results

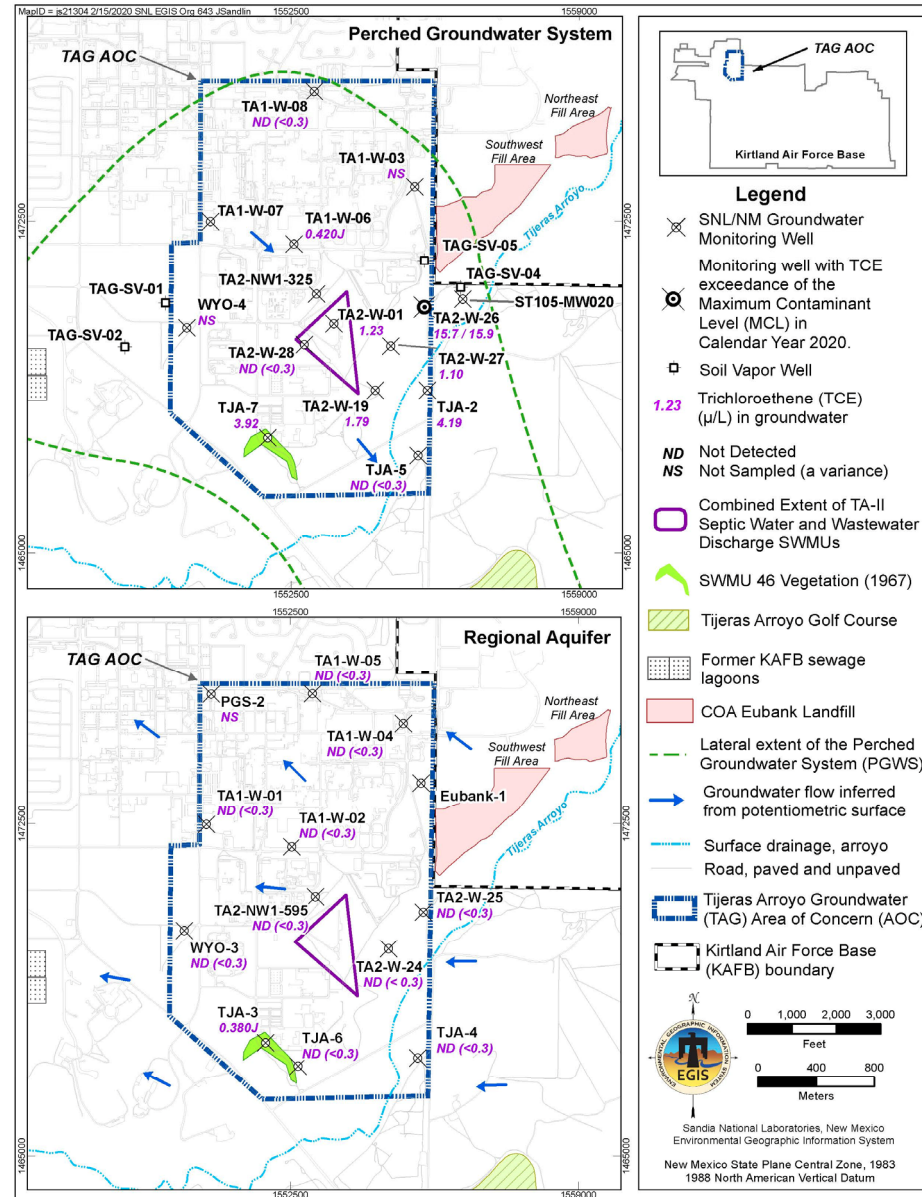
In September 2020, TCE exceeded the MCL for first time in 17 years. The exceedance occurred at one PGWS well, TA2-W-26.

SNL personnel 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) collecting more quality control groundwater samples than NMED HWB requires.

In an October 2021 meeting, NMED HWB verbally endorsed the sampling strategy and stated that recent VOC exceedances are not expected to negatively impact the corrective measures process.

Recent TA2-W-26 groundwater results indicate that TCE now averages approximately 15 ug/L, which exceeds the MCL of 5 ug/L. PCE averages approximately 8 ug/L, which exceeds the MCL of 5 ug/L.

The May 2021 samples from the two soil-vapor wells contained low VOC concentrations that were consistent with previous results.

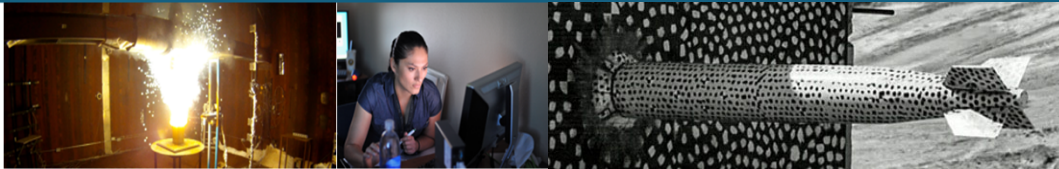


TAG Current Status and Recent Activities



- The NMED HWB has determined that corrective action is required for the elevated nitrate concentrations in the PGWS.
- 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.
- April, May, and October 2021 meetings with personnel from SNL, DOE/NNSA, and NMED HWB were held to discuss the *Revised TAG CCM/CME Report*. No short comings were identified.
- NMED HWB is anticipated to select the MNA remedial alternative in 2022. After that, there will be an opportunity for public input at various stages of the CME process.

Technical Area-V Groundwater Investigation



Jun Li
Environmental Restoration Operations
Sandia National Laboratories, New Mexico

April 2022

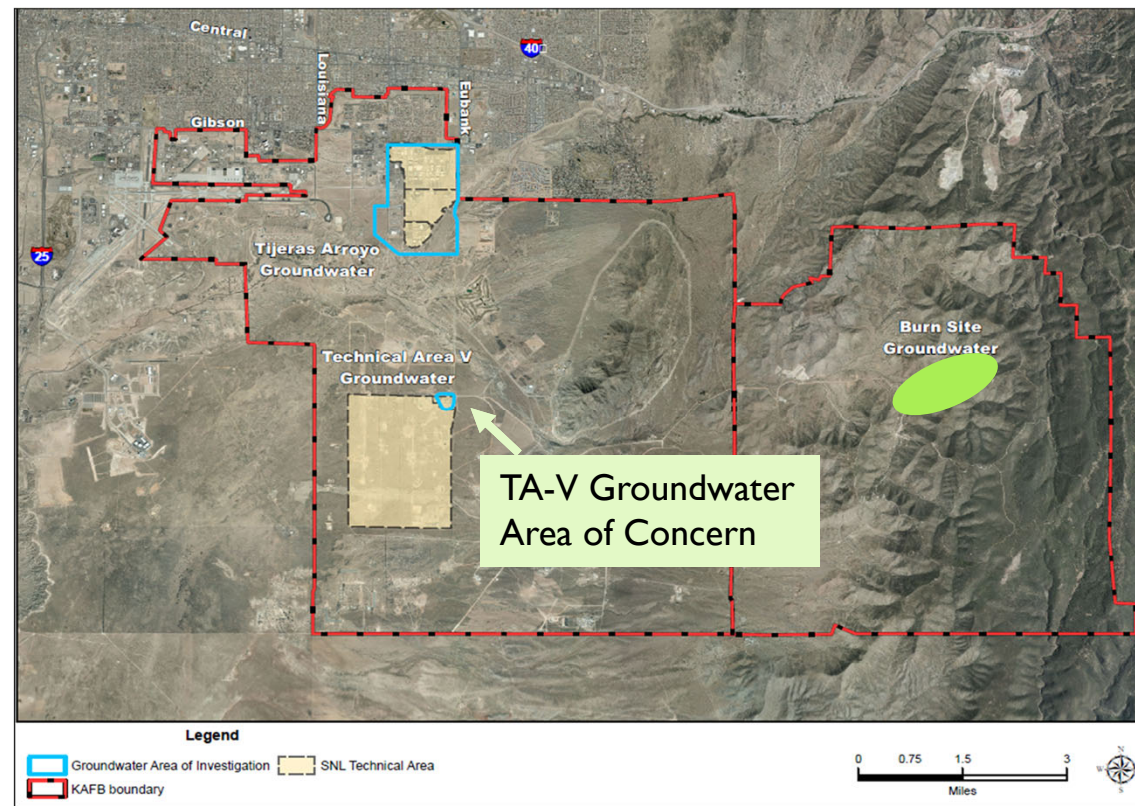


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TA-V Groundwater AOC Site Description (I)

- The groundwater at Technical Area-V (TA-V) at Sandia National Laboratories, New Mexico (SNL/NM) is designated an Area of Concern (AOC) in the 2004 Compliance Order on Consent.
- New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) 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.



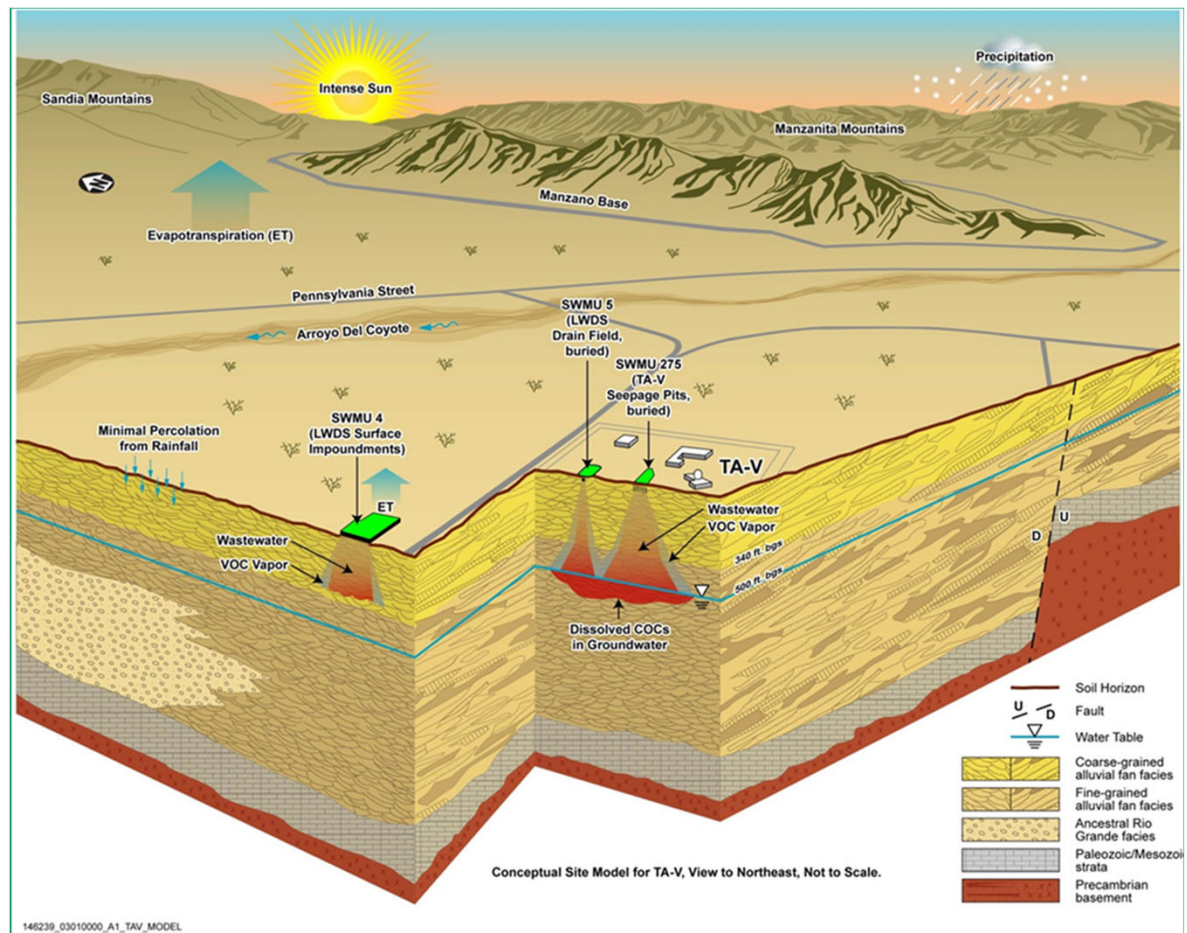


TA-V Groundwater AOC Site Description (2)

- 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.

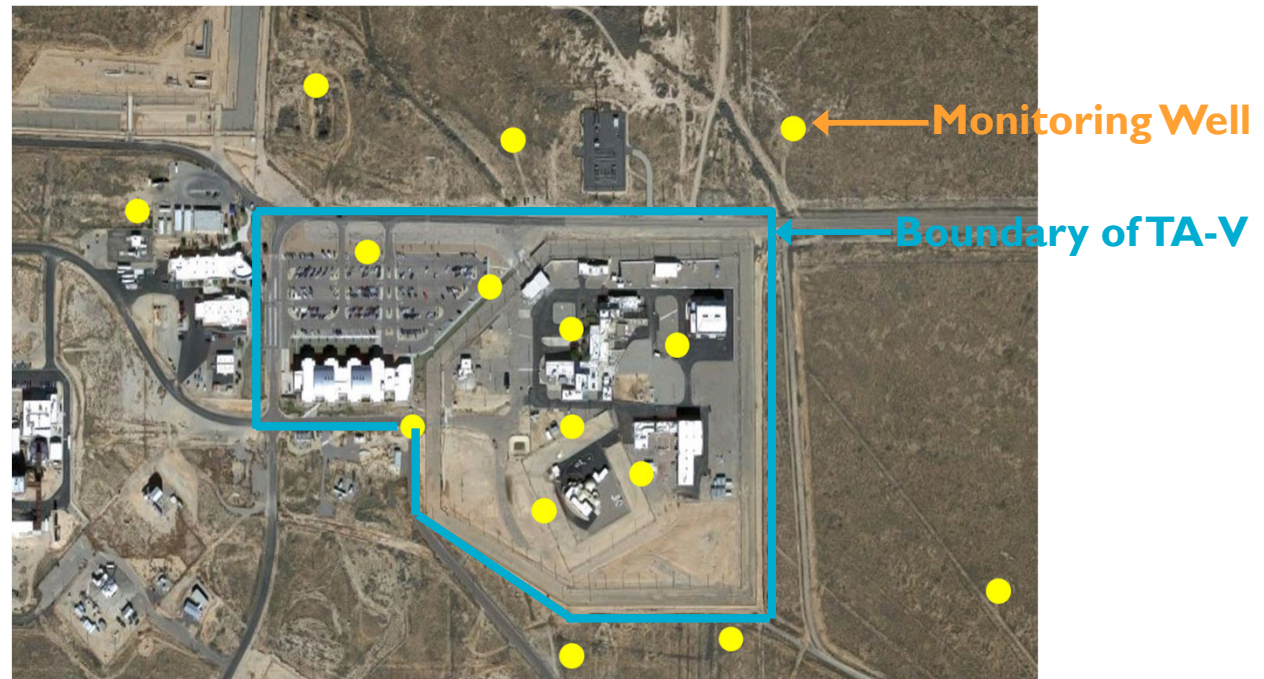


TA-V Groundwater Monitoring (I)

- Groundwater monitoring began in 1992.
- Current monitoring network consists of 18 wells.
- Groundwater is contaminated with nitrate and trichloroethene (TCE) 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 beneficial purpose.

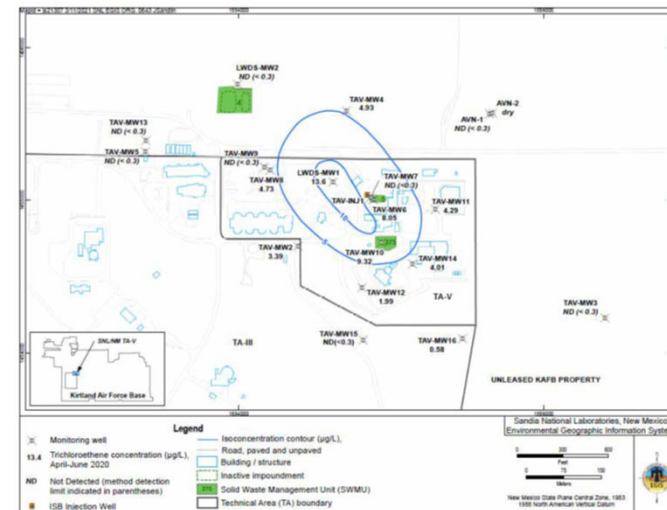
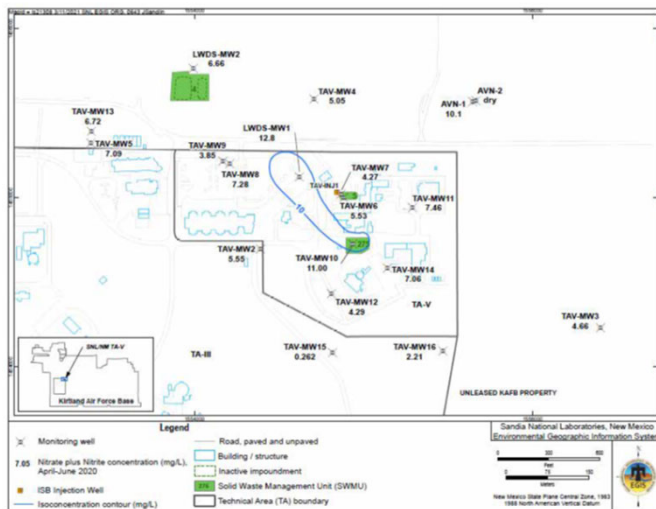
Nearest downgradient drinking-water supply well (KAFB-4) is 2.7 miles to the north.



TA-V Groundwater Monitoring (2)

- Nitrate plume covers approximately 1.4 acres.
- Trichloroethene 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

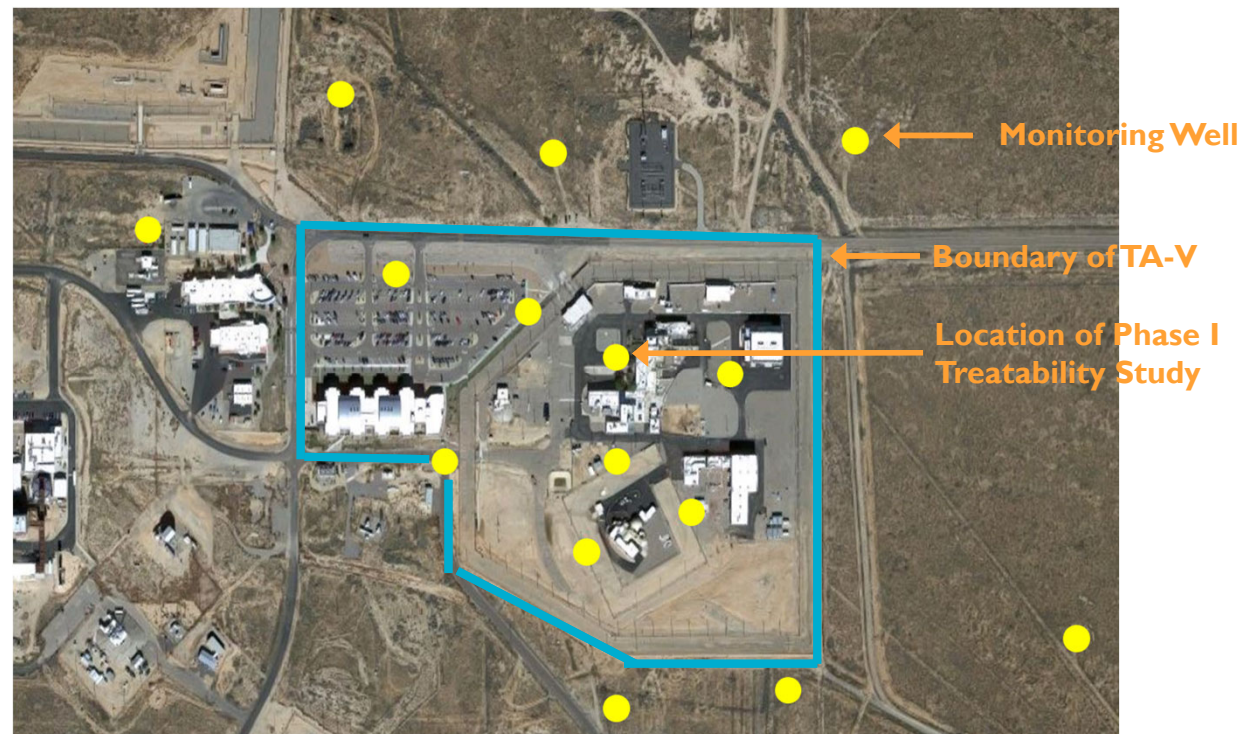


Source: 2020 Annual Groundwater Monitoring Report; Nitrate Plume (left) and TCE Plume (right), April – June 2020

Treatability Study of In-Situ Bioremediation at TA-V

- Groundwater at TA-V is aerobic, and biodegradation is not naturally occurring.
- The plan of the treatability study was to deliver bioremediation solution using an injection well.
- The objective was to evaluate the effectiveness of in-situ bioremediation (ISB) as a corrective measure for the TA-V Groundwater AOC.
- The original plan of the Treatability Study involved two Phases.

Phase I of the ISB Treatability Study included installation of an injection well (**TAV-INJ1**), and a Pilot Test and a Full-Scale Test at the Phase I treatment zone where monitoring wells **TAV-MW6** and **TAV-MW7** are located.

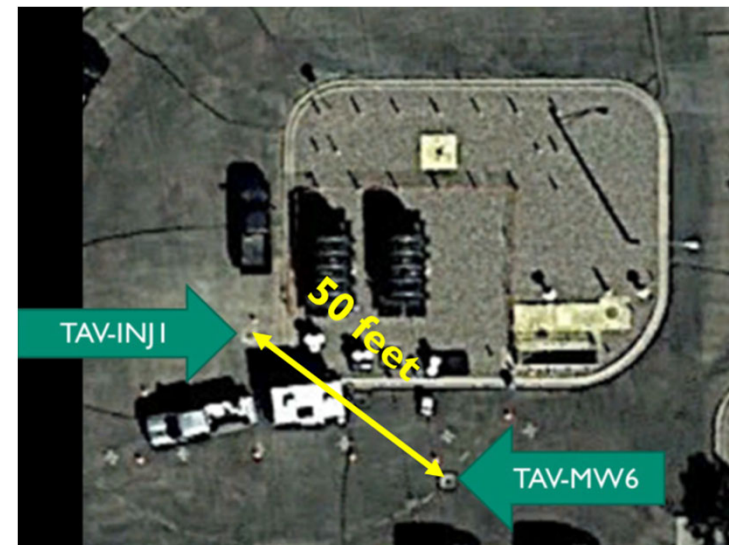




Phase I Treatability Study



- **Phase I Pilot Test** started in November 2017 and concluded in June 2018.
- **Phase I Full-Scale Test** started in November 2018 and concluded in May 2021.
 - Phase I Full-Scale injections of bioremediation solution with TCE-degrading bacteria were conducted from November 2018 to April 2019.
 - Injections were followed by two-years of groundwater monitoring from May 2019 to May 2021:
 - Injection well **TAV-INJ1** and monitoring well **TAV-MW6** were monitored for the performance of ISB.
 - One deep well (**TAV-MW7**) in the Phase I treatment zone and eight surrounding wells were monitored to determine potential impact on groundwater quality caused by the bioremediation solution injected.





Findings of Phase I Treatability Study

- Groundwater at injection well TAV-INJ1 maintained optimal conditions for biodegradation.
- Anaerobic condition was not established at well TAV-MW6.
- No change in groundwater quality was observed in the deep monitoring well (TAV-MW7) inside the Phase I treatment zone and in the eight surrounding wells.
- These data indicated that ISB was not effective in the Phase I treatment zone.
 - Delivery of bioremediation solution was limited by low hydraulic conductivities of the regional aquifer at TA-V.
 - Infrastructure at TA-V (buildings and utilities) limited installation of multiple injection wells, impeding the success of ISB technology at this site.
 - TCE concentrations were too low to sustain the growth of TCE-degrading bacteria that were injected with the bioremediation solution.

Conclusions of Phase I Treatability Study

- Phase II Treatability Study of ISB is not warranted
- ISB does not prove to be a viable technology to treat the groundwater contamination at the TA-V Groundwater AOC.

Treatability
Study
Concluded at
TA-V

- The Discharge Permit (DP)-1845 was terminated by the NMED Ground Water Quality Bureau in February 2022.
- Phase I Treatability Study Report was submitted to the NMED HWB in April 2022.
- As DP-1845 terminated, NMED HWB agreed to re-designate injection well TAV-INJ1 as the 19th groundwater monitoring well of the TA-V monitoring network.





Path Forward for TA-V Groundwater AOC

- Continuing quarterly monitoring of the Phase I ISB treatment zone (wells TAV-INJ1 and TAV-MW6) for one year from July 2021 to June 2022.
- Preparing to start on updating the 2005 Corrective Measures Evaluation (CME) Report. Data obtained from the Phase I Treatability Study will provide input to recommending a final remedy for corrective action at the TA-V groundwater AOC.

TA-V Groundwater AOC is in the CME process and on its way to site closure:

