FACT SHEET/STATEMENT OF BASIS

Remedy Selection
For the
Burn Site Groundwater Area of Concern

Sandia National Laboratories
New Mexico

RCRA Permit No. NM5890110518

February 15, 2024

FACT SHEET/STATEMENT OF BASIS
Proposed Corrective Action Remedy for the Burn Site Groundwater Area of Concern Sandia National Laboratories New Mexico EPA ID No. NM5890110518

INTRODUCTION

The New Mexico Environment Department (Department/NMED) proposes to select a remedy for corrective action for the Burn Site Groundwater (BSG) Area of Concern (AOC) at Sandia National Laboratories (SNL). The United States Department of Energy/National Nuclear Security Administration (DOE/NNSA) and National Technology and Engineering Solutions of Sandia, LLC (NTESS) conducted a Corrective Measures Evaluation (CME) to evaluate different alternatives for remediation of the BSG AOC and submitted a CME Report to NMED on January 30, 2023 (SNL 2023). NMED is proposing this action under the New Mexico Hazardous Waste Act, NMSA 1978 §§ 74-4-1 to 74-4-17, and under the terms of the Compliance Order on Consent (Consent Order), dated April 29, 2004, executed by NMED and by the DOE and Sandia Corporation. The BSG AOC has been under investigation since the 1990s. Based on the information collected, NMED intends, pending public input, to select a remedy for the BSG AOC.

A. FACILITY DESCRIPTION

SNL is located within the boundaries of Kirtland Air Force Base (KAFB) adjacent and southeast of Albuquerque in Bernalillo County, New Mexico. KAFB covers 52,223 acres on a high arid mesa approximately 5 miles east of the Rio Grande. SNL occupies 2,829 acres of land owned by the DOE and an additional 14,920 acres of land provided through land-use permits with KAFB, the U.S. Forest Service (USFS), the State of New Mexico, and the Isleta Pueblo Indian Reservation. Sandia Corporation, a former subsidiary of American Telephone and Telegraph (AT&T) Corporation, operated the properties for the DOE from the time of its opening in 1945 until September 1993, when Martin Marietta Corporation (now Lockheed Martin) took over operations from AT&T. The management and operating name changed on May 1, 2017, from Sandia Corporation to National Technology and Engineering Solutions of Sandia, LLC (NTESS). NTESS is owned by Honeywell International. The Facility is owned by the DOE and jointly operated by the DOE and NTESS.

SNL is engaged in research and development of conventional and nuclear weapons, alternative energy sources and a wide variety of national security-related research and development. SNL consists of five technical areas (TAs) and several test areas. The primary mission of SNL is to provide engineering and testing support for nuclear weapons components and related systems. During the late 1940s, the final assembly of weapons was conducted at SNL. Since 1949, SNL has been dedicated to research, development, and testing. SNL currently employs approximately 9,300 people. Because of its testing and research activities, SNL generates hazardous,

radioactive, mixed (wastes containing both hazardous and radioactive components), and solid wastes. From 1945 to 1988 most of these wastes were disposed of at SNL at numerous locations which have been classified by NMED as Solid Waste Management Units (SWMUs). The SWMUs include unpermitted landfills, septic system drain-fields and seepage pits, outfalls, waste piles, test areas, and surface discharge sites. Past waste management activities at SNL have caused the release of hazardous, mixed, and radioactive contaminants into the environment.

SNL is located at 1515 Eubank SE, Albuquerque, New Mexico, 87123. The National Nuclear Security Administration (NNSA)/DOE Site Field Office is located at KAFB East of Pennsylvania & H Street, Albuquerque, NM 87116. The Permittee's primary contact for this action is Mr. Daryl Hauck, DOE/NNSA/SFO, PO Box 5400, MS-0184, Albuquerque, NM 87185.

B. STATUTORY AND REGULATORY FRAMEWORK

The Statement of Basis is a decision document that discusses the proposed remedy selection and the key information supporting the proposed selection, primarily contained in the Current Conceptual Model/Corrective Measures Evaluation (CCM/CME) Report and other reports that the Respondents have submitted to NMED. In accordance with regulatory guidance (USEPA 1991) and the Consent Order (Section VII.C.5), the purpose of the Statement of Basis is to:

- Describe the remedies that were considered;
- Identify the remedies that are proposed;
- Explain the rationale for selecting the proposed remedies;
- Solicit public review and comment on the proposed remedies; and
- Provide information on how the public can be involved in the remedy selection process.

In 1976, Congress passed, and the President signed, the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. §§ 6901 to 6992k, as an amendment to the Solid Waste Disposal Act of 1965. RCRA provides for the "cradle to grave" regulation of hazardous wastes and requires the Environmental Protection Agency (EPA) to develop regulations governing the generation, transportation, treatment, storage, and disposal of hazardous wastes, including corrective action for releases into the environment of hazardous wastes or hazardous waste constituents.

On November 19, 1980, the first RCRA regulations became effective, and it became unlawful to treat, store, or dispose of hazardous waste without having, or having applied for, a permit. For existing treatment, storage, or disposal facilities, the requirement to submit an application is satisfied by submitting the "Part A" portion of the application; the "Part B" portion was allowed to be submitted at a later time. The content and function of these permit parts are explained in 40 Code of Federal Regulations (CFR) § 270.10.

EPA authorized the State of New Mexico, through the Environment Department, to implement and enforce its own hazardous waste management program, including corrective action requirements, in lieu of the federal program, under the New Mexico Hazardous Waste Act (HWA), New Mexico Statutes Annotated (NMSA) 1978, §§ 74-4-1 through 74-4-14. The HWA authorizes the New Mexico Environmental Improvement Board (EIB) to adopt hazardous waste

management regulations for the management of hazardous waste. Pursuant to this authority, the EIB has adopted the Hazardous Waste Management Regulations (HWMR), which govern the generation, transportation, treatment, storage, and disposal of hazardous waste, including permit requirements for facilities that treat, store, or dispose of hazardous waste, and including corrective action for releases of hazardous waste or hazardous waste constituents into the environment. These regulations incorporate by reference pertinent provisions of the RCRA Title 40 Code of Federal Regulations (CFR) – 40 CFR Parts 260 through 270, 273, and 280 – and are codified in the HWMR, 20.4.1 New Mexico Administrative Code (NMAC).

The HWA and HWMR require each person owning or operating an existing facility or planning to construct a new facility for the treatment, storage, or disposal of hazardous waste to have an HWA permit (see 42 U.S.C. 6925 and 20.4.1.900 NMAC incorporating 40 CFR § 270.1)). The HWA and HWMR also require corrective action for all releases of hazardous waste or hazardous constituents, regardless of when waste was placed in such a unit, from any SWMU at a permitted facility, or a facility seeking a permit (NMSA 1978, § 74-4-4.2(B); 20.4.1.500 NMAC, incorporating 40 CFR § 264.101(a)). Corrective action is also required for releases of contaminants beyond the facility boundary (20.4.1.500 NMAC, incorporating 40 CFR § 264.101(c)).

On January 26, 1983, RCRA subjected "units" managing and disposing of hazardous waste to the closure and post-closure standards of 40 CFR Part 264, Subpart G and Part 265, Subpart G and required a post-closure care permit in some circumstances.

On January 25, 1985, the Environment Department received from EPA authorization to implement its hazardous waste program under the HWA. 50 Fed. Reg. 1515 (Jan. 11, 1985). Subsequent program revisions were approved effective on April 10, 1990, July 25, 1990, December 4, 1992, August 23, 1994, December 21, 1994, July 10, 1995, January 2, 1996, March 10, 1997, July 13, 1998, October 9, 2001, and October 16, 2007.

On July 25, 1990, the Environment Department received from EPA authorization that clarified its authority to regulate the hazardous component of mixed waste. 55 Fed. Reg. 28397 (July 11, 1990). Mixed waste is waste that contains both hazardous waste under RCRA and source material, special nuclear material, or byproduct material under the Atomic Energy Act of 1954. Due to its hazardous component, mixed waste is regulated under RCRA.

On January 2, 1996, the State received from EPA authorization to implement the corrective action program under the HWA. See 60 Fed. Reg. 53708 (Oct. 17. 1995); 61 Fed. Reg. 2450 (Jan. 26, 1996).

On August 6, 1992, NMED issued a Hazardous Waste Facility Permit (Permit) to DOE and SNL (Respondents) to operate treatment and storage facilities at SNL. NMED renewed the Permit on January 27, 2015 (NMED, 2015).

The corrective action requirements in the 1992 permit were vague and largely ineffective. Consequently, on September 3, 2002, NMED issued a draft Order requiring investigation and

cleanup of environmental contamination at SNL. DOE and its contractor challenged the Order in state and federal court, and the parties entered into lengthy settlement negotiations. On April 29, 2004, the parties executed the Consent Order, which requires DOE and its contractor to conduct comprehensive investigation and cleanup of environmental contamination at SNL (NMED 2004). Therefore, corrective action at SNL is addressed primarily under the Consent Order, rather than the Permit.

Section IV.C of the Consent Order required the Respondents to conduct a thorough investigation of soil, sediment, groundwater, and surface water contamination at the BSG AOC. Section VII.C of the Consent Order required the Respondents to conduct a CME for the BSG AOC to evaluate a range of potential remedial alternatives and to recommend a preferred remedy. The Respondents were required to submit a CME Report to NMED (NMED 2004).

After review of the CME Report, NMED selects a remedy and provides for public comment as discussed in the Statement of Basis below. The public may also request a public hearing concerning the selected remedy. NMED will select the final remedy that will be protective of human health and the environment and attain the appropriate cleanup goals. All applicable closure and post-closure requirements in 40 CFR § 264.110(c), incorporated by 20.4.1.500 NMAC, must also be satisfied by the selected remedy. The alternative requirements for groundwater monitoring, as described in 40 CFR § 264.90(f), incorporated by 20.4.1.500 NMAC, also apply to the remedy for the BSG AOC. Section VII.D of the Consent Order requires that the Respondents implement the selected remedy.

Section VII.C.3.a of the Consent Order states, "[t]he Respondents shall evaluate each of the remedy alternatives for the following threshold criteria. To be selected, the remedy alternative must:

1. Be protective of human health and the environment.
2. Attain media cleanup standards.
3. Control the source or sources of releases so as to reduce or eliminate, to the extent practicable, further releases of contaminants that may pose a threat to human health and the environment; and
4. Comply with applicable standards for management of wastes." (NMED 2004).

Section VII.C.3.b of the Consent Order outlines the evaluation criteria for each potential remedy under consideration. These five criteria include:

1. Long-term reliability and effectiveness,
2. Reduction of toxicity, mobility, or volume,
3. Short-term effectiveness,
4. Implementability, and
5. Cost (NMED 2004).

Pursuant to Section VII.D.2 of the Consent Order, after the selection of the remedy, the Respondents shall submit a Corrective Measures Implementation (CMI) Plan for NMED approval that must meet the general requirements for closure of the BSG AOC. The CMI Plan must include the specific design of the selected remedy including construction specifications, operation and maintenance plans, performance monitoring for the selected remedy, and an implementation schedule.

Following completion of corrective measures, the Respondents are required to submit a CMI Report to NMED in accordance with Section VII.D.5.a of the Consent Order. Following NMED approval of the CMI Report, the Respondents must submit a request for a Class 3 modification to the Permit to add the BSG AOC to Table K-3 (Corrective Action Complete With Controls) or Table K-4 (Corrective Action Complete Without Controls) (NMED 2004).

C. PUBLIC PARTICIPATION

The Administrative Record for this proposed remedy selection consists of this Fact Sheet/ Statement of Basis (FS/SOB), a Public Notice, the April 29, 2004 Compliance Order on Consent (Consent Order), the Current Conceptual Model and Corrective Measures Evaluation (CCM/CME) Report, and associated investigation reports, monitoring reports, work plans, correspondence, and other referenced supporting documents. The Administrative Record may be reviewed, with prior appointment, at the following location during the public comment period:

NMED - Hazardous Waste Bureau
2905 Rodeo Park Drive East, Building 1
Santa Fe, New Mexico 87505-6313
Phone: (505) 476-6000
Monday – Friday: 8:00 a.m. to 5:00 p.m.
Contact: Naomi Gonzalez

The Administrative Record Index, Public Notice, FS/SOB, CCM/CME Report and Consent Order are also available on the NMED website at https://www.env.nm.gov/hazardous-waste/sandia-national-laboratories/#SNLBSG. To obtain a copy of the Administrative Record or a portion thereof, please contact Ms. Naomi Gonzalez at (505) 476-6000, or at the address given above. NMED will provide copies, or portions thereof, of the Administrative Record at a cost to the requestor.

NMED issued this public notice on **February 15, 2024,** to announce the beginning of a 60-day comment period that will end at **5:00 p.m. MST, April 15, 2024**. Any person who wishes to comment on this action or request a public hearing should submit written or electronic mail (email) comments with the commenter's name and address to the address below. Only comments received **on or before 5:00 p.m. MST, April 15, 2024,** will be considered.

Neelam Dhawan, Acting Program Manager
NMED - Hazardous Waste Bureau
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6313

Or via e-mail: neelam.dhawan@env.nm.gov
Ref: SNL BSG Remedy Selection.

Written comments must be based on reasonably available information and include, to the extent practicable, all referenced factual materials. Documents in the administrative record need not be re-submitted if expressly referenced by the commenter. Requests for a public hearing shall provide: (1) a clear and concise factual statement of the nature and scope of the interest of the person requesting the hearing; (2) the name and address of all persons whom the requestor represents; (3) a statement of any objections to this action, including specific references to any conditions being addressed; and (4) a statement of the issues that the commenter proposes to raise for consideration at the hearing. Written comments and requests for a Public Hearing must be filed with Ms. Neelam Dhawan **on or before 5:00 p.m. MDT, April 15, 2024.** NMED will provide a minimum thirty (30) day notice of a public hearing, if scheduled.

D. NEXT STEPS

NMED must ensure that the selected remedies are consistent with the Hazardous Waste Act (HWA), the Hazardous Waste Management Regulations (HWMR), and the Consent Order. All written comments submitted on this matter will become part of the administrative record. NMED will consider all written comments in formulating a final decision, and it may select a different remedy based on public comments. NMED will respond in writing to all written public comments received during the public comment period. This response will specify which provisions, if any, have been changed in the final decision and the reasons for the changes; and briefly describe and respond to all public comments raised during the public comment period. All persons presenting written comments or who requested notification in writing will be notified of the decision by mail. These responses will also be posted on the NMED website.

After consideration of all the written public comments received, NMED will select the appropriate remedy for the site based on information in the administrative record. In all cases, the Respondents will be provided by certified mail a written notice in accordance with the Consent Order. NMED will make the notice available to the public.

Arrangements for Persons with Disabilities
Any person with a disability requiring assistance or auxiliary aid to participate in this process should contact Kate Cardenas no less than ten days prior to the end of the public comment period at the following address: New Mexico Environment Department, P.O. Box 5469, 1190 St. Francis Drive, Santa Fe, New Mexico, 87502-6110, (505) 469-0732. TDD or TDY users please access Ms. Cardenas's number via the New Mexico Relay Network at 1 (800) 659-8331.

Non-Discrimination Statement
NMED does not discriminate on the basis of race, color, national origin, disability, age, or sex in the administration of its programs or activities, as required by applicable laws and regulations. NMED is responsible for coordination of compliance efforts and receipt of inquiries concerning non-discrimination requirements implemented by 40 CFR Part 7, including Title VI of the Civil Rights Act of 1964, as amended; Section 504 of the Rehabilitation Act of 1973; the Age

Discrimination Act of 1975, Title IX of the Education Amendments of 1972, and Section 13 of the Federal Water Pollution Control Act Amendments of 1972. If you have any questions about this notice or any of NMED's non-discrimination programs, policies or procedures, you may contact:

Kate Cardenas, Non-Discrimination Coordinator
New Mexico Environment Department
1190 St. Francis Dr., Suite N4050
P.O. Box 5469
Santa Fe, NM 87502
(505) 469-0732
nd.coordinator@env.nm.gov

If you believe that you have been discriminated against with respect to an NMED program or activity, you may contact the Non-Discrimination Coordinator identified above or visit our website at https://www.env.nm.gov/non-employee-discrimination-complaint-page/ to learn how and where to file a complaint of discrimination.

E. BURN SITE GROUNDWATER (BSG) AREA OF CONCERN (AOC)

E.1 BACKGROUND AND HISTORY OF THE BSG AOC

E.1.1 Location/Unit Description

The Burn Site Groundwater (BSG) Area of Concern (AOC) is in the eastern portion of KAFB, in Lurance Canyon, one of three canyons that are located on the eastern edge of the Coyote Canyon Test Area within the Manzanita Mountains. Two other canyons, Madera Canyon and Sol se Mete Canyon, intersect Lurance Canyon to the west of the BSG AOC. These three canyons are the headwaters of Arroyo del Coyote, which is a tributary to Tijeras Arroyo. The BSG AOC is located just east of the margin of the Albuquerque Basin, and the terrain is characterized by large topographic relief, locally exceeding 500 feet (ft). Lurance Canyon, deeply incised into Paleozoic and Precambrian rocks, provides local westward drainage of ephemeral surface water flows to Arroyo del Coyote. Testing activities at the Lurance Canyon Burn Testing Facility, near the center of the BSG AOC, began in 1967.

Groundwater issues at the BSG AOC are primarily associated with two SWMUs. The Lurance Canyon Burn Site Testing Facility (SWMU 94) and the nearby/overlapping Lurance Canyon Explosive Test Site (SWMU 65) have been used since 1967. Most of the operational activities involved testing the fire survivability of transportation containers, weapon components, simulated weapons, and satellite components. Historical operations included open detonation of high explosive (HE) compounds and ammonium-nitrate slurry along with the open burning of HE compounds, liquid propellants, and solid propellants. Most HE testing activities occurred between 1967 and 1975 and were completely phased out by the 1980s.

Burn testing began in the early 1970s and has continued to the present. Early burn testing was conducted in unlined pits excavated in native soil and alluvium. By 1975, portable steel burn pans were used for open burning, mostly using jet propellant, fuel grade 4 (JP-4). Several engineered structures, such as the Light Air-transport Accident Resistant Container (LAARC) Unit, were used at the facility. The structures mostly used JP-4 and occasionally used diesel fuel and gasoline to create the high temperatures associated with transportation accidents. In the mid-1990s, jet propellant, fuel grade 8 (JP-8) replaced JP-4 as the petroleum fuel used for burn tests. Most test structures have been dismantled. The Smoke Emissions Reduction Facility (SMERF) and the Large Open Burn Pool are the only remaining test structures. Portable burn pans up to 25 ft in diameter are still occasionally used.

The BSG AOC has a footprint substantially bigger than both the Lurance Canyon Burn Site Testing Facility and the footprint of the Burn Site SWMUs. The location of the BSG AOC area and surrounding groundwater monitoring wells are depicted in Figures E.1 and E.2.

E.1.2 Geologic and Hydrologic Framework

Groundwater in the Manzanita Mountains predominantly occurs in fractured Precambrian metamorphic rocks (metavolcanics, quartzite, schists, phyllites, and granitic gneiss) as depicted in Figure E.3. Some fractures in shallow bedrock are filled with chemical precipitates such as calcium carbonate, which effectively reduces permeability and may create a semiconfined unit above open fractures in bedrock. The BSG AOC is bisected by a north-south trending system of faults, consisting locally of several high-angle normal faults that are typically downthrown to the east. Faults (where exposed) are characterized by zones of crushing and brecciation. Groundwater in these rocks moves primarily as flow through fractures. The permeability of these fractured rocks characteristically is low and well yields are small. Based upon drilling activities, the depth to the uppermost water-bearing fracture zones has varied from approximately 124 to 379 feet below ground surface (bgs) across the monitoring well network. Initial water levels above the screened intervals have varied from approximately 5 to 153 feet due to semiconfined or confined conditions. As a standard practice, each monitoring well is screened across an individual fracture zone, which is interpreted to be at most a few feet thick for the BSG AOC. The depth to water in the well casings across the monitoring well network varies from approximately 108 to 326 feet bgs.

E.1.3 Previous Investigations at BSG AOC

Groundwater samples collected during 1996 from the Burn Site Well (a non-potable production well used for fire suppression; Figure E.2) contained elevated concentrations of nitrate with a maximum of 27 milligrams per liter (mg/L) detected in August 1996. Since the initial discovery of nitrate at the BSG AOC, numerous characterization activities have been conducted. The results of these characterization activities were summarized in the *Current Conceptual Model of Groundwater Flow and Contaminant Transport at Sandia National Laboratories/New Mexico Burn Site* (SNL/NM, 2004a) and subsequent update (SNL/NM, 2008a).

Site-specific environmental investigations have been conducted at the SWMUs within the BSG AOC since the late 1990s. These investigations included a review of background information/process knowledge, and as necessary, the implementation of characterization and remedial activities including soil sampling, and the excavation of contaminated soil and debris. No Further Action (NFA) proposals summarized findings for each SWMU. To facilitate the timely regulatory review of the NFA proposals, the groundwater issues associated with the BSG AOC were decoupled from the individual SWMUs. By April 2005, the NMED had approved Corrective Action Complete (CAC) Without Controls status for each of the 21 SWMUs.

In 1997, the NMED Hazardous Waste Bureau (HWB), DOE, and SNL/NM personnel agreed to investigate the source of the nitrate contamination. Later in 1997, monitoring wells CYN-MW1D and CYN-MW2S were installed downgradient of the Burn Site Well (Figure E.2). Samples from monitoring well CYN-MW1D contained nitrate concentrations exceeding the EPA MCL. Two more monitoring wells, CYN-MW3 and CYN-MW4, were installed in 1999 to further characterize the study area.

In response to the Consent Order, the BSG AOC CME Work Plan was submitted to the NMED in June 2004 (SNL/NM, 2004b). The Work Plan was not approved and based on requirements stipulated by the NMED (NMED, February 2005), the BSG Interim Measures Work Plan (IMWP) was submitted (SNL/NM, May 2005) on May 30, 2005. As detailed in the IMWP, three monitoring wells (CYN-MW6, CYN-MW7, and CYN-MW8) were installed between December 2005 and January 2006. Quarterly sampling for eight quarters began for these three monitoring wells in March 2006 and was completed in December 2007. Samples from the two monitoring wells (CYN-MW7 and CYN-MW8) located downgradient of CYN-MW1D were analyzed for nitrate and other analytes. Groundwater samples from monitoring well CYN-MW6 (adjacent to SWMU 94F (LAARC Discharge Pit)) were analyzed for nitrate, total petroleum hydrocarbons (TPH) as gasoline range organics (GRO) and diesel range organics (DRO), and other parameters.

DOE/NNSA and SNL/NM personnel were required to further characterize the nature and extent of the perchlorate contamination at the BSG AOC (NMED, 2009). The BSG Characterization Work Plan (SNL/NM, 2009) was submitted and then conditionally approved by the NMED (NMED, 2010). In July 2010, the requirements of the BSG Characterization Work Plan were implemented and four groundwater monitoring wells (CYN-MW9, CYN-MW10, CYN-MW11, and CYN-MW12) were installed to determine the extent of groundwater contamination. These four monitoring wells were sampled for the first time in September 2010.

In February 2012, a work plan was submitted by DOE/NNSA and SNL/NM personnel to decommission three obsolete groundwater monitoring wells (12AUP01, CYN-MW1D, and CYNMW2S); and install a replacement groundwater monitoring well, CYN-MW13 (SNL/NM, 2012). Monitoring wells 12AUP01 and CYN-MW2S were screened at the contact of unconsolidated coarse sand and gravel (alluvium) and the underlying bedrock. Although alluvium at this contact was dry during drilling, these wells were installed in anticipation of recharge occurring after rainfall events. However, these wells were consistently dry. Monitoring well CYNMW1D was constructed with a nonstandard completion (low carbon steel screen and riser pipe), had very turbid water, and exhibited variable nitrate concentrations. A video log showed that monitoring well CYN-MW1D was heavily corroded. In April 2012, the NMED approved the work plan (NMED, 2012); the three monitoring wells (12AUP01, CYN-MW1D, and CYN-MW2S) were decommissioned in November 2012, and replacement monitoring well CYN-MW13 was installed in December 2012 near monitoring well CYN-MW1D.

In September 2013, a work plan for the installation of two groundwater monitoring wells was submitted (SNL/NM, 2013), and in June 2014 the work plan was approved by the NMED (NMED, 2014). The work plan discussed the need for installing two replacement monitoring wells (CYN-MW14 and CYN-MW15) because of declining groundwater levels. Monitoring well CYN-MW14 was planned to replace CYN-MW3, whereas monitoring well CYNMW15 was planned to replace CYN-MW6. In December 2014, monitoring wells CYN-MW14A (note the ‘A’ suffix) and CYN-MW15 were installed (SNL/NM, 2015). The installation of a direct replacement for monitoring well CYN-MW3 was not possible because the shallow water bearing fracture zone was not encountered. A deeper-than-planned well, CYN-MW14A, was installed near CYN-MW3. The

replacement monitoring well, CYN-MW15, was installed as planned (at a similar to slightly deeper water-bearing fracture depth) near well CYN-MW6.

In October 2013, DOE Office of Environmental Management submitted the BSG AOC Internal Remedy Review memorandum to the DOE/NNSA Sandia Field Office (DOE, 2013). This memorandum stated that more characterization activities should be conducted at the BSG AOC before a CME could be prepared. The Internal Remedy Review recommended a weight of evidence approach to determine the source(s) of nitrate contamination.

In January 2019, a work plan for the installation of up to eight groundwater monitoring wells was submitted (SNL/NM, 2019), and in February 2019 the work plan was approved by the NMED (NMED, 2019). Based on NMED requirements (NMED, 2018), the work plan discussed the need for installing four monitoring wells (CYN-MW16, CYN-MW17, CYN-MW18, and CYN-MW19) to help define the extent of nitrate concentrations in groundwater and refine the potentiometric surface. Specifically, these monitoring wells were required to define the upgradient and downgradient extent of the elevated nitrate plus nitrite (NPN) concentrations and provide information on the 2,000-ft data gap between existing monitoring wells CYN-MW14A and CYNMW13.

Groundwater monitoring wells CYN-MW16, CYN-MW17, CYN-MW18, and CYN-MW19 were installed in 2019. The potential installation of up to four additional monitoring wells (SNL/NM, 2019) was evaluated after the July 2021 sampling event when eight quarters of water level and validated analytical sample data were available. DOE/NNSA and SNL/NM personnel postulated that the existing monitoring well network was sufficient to characterize the extent of nitrate contamination (DOE, 2021) and the NMED agreed that the four additional monitoring wells were not required at this time (NMED, 2021). The groundwater elevation potentiometric contours were updated and are depicted in Figure E.4.

E.2 BSG AOC CORRECTIVE MEASURES EVALUATION SUMMARY

The Respondents evaluated several corrective measure alternatives for the BSG AOC. The following remedial technologies were initially considered to address elevated nitrate at the BSG AOC in the first CME Work Plan (SNL/NM, 2004b) and the second CME Work Plan (SNL/NM, 2008b):

- Groundwater monitoring,
- In situ bioremediation,
- Monitored Natural Attenuation (MNA),
- Monolithic confinement,
- Permeable reactive barriers,
- Phytoremediation, and
- Groundwater extraction, treatment, and reinjection.

The initial screening of technologies performed in the two CME Work Plans removed Monolithic confinement, Permeable reactive barriers, and Phytoremediation from consideration. These three technologies were screened out because: (1) construction of deep mechanical structures in well-indurated metamorphic lithologies would be technically difficult, and/or (2) they are only applicable to relatively shallow groundwater conditions.

The remedial technologies that were retained in the CME Work Plans technology screening were:

- Groundwater monitoring (long-term monitoring),
- MNA,
- Groundwater extraction, treatment, and reinjection, and
- In situ bioremediation.

The second CME Work Plan (SNL/NM, 2008b) was approved by the NMED HWB in August 2011 (NMED, 2011). Since then, a significant amount of information has been gathered at the BSG AOC. Several additional monitoring wells have been installed resulting in a more refined understanding of the concentrations and extent of nitrate and improving the current conceptual model (CCM). Also, a 24-hour pump test showed extensive compartmentalization of the fractured bedrock aquifer system (SNL/NM, 2017). Hydraulic conductivities are low at the BSG AOC where the two nitrate plumes are estimated to have a combined area of 41 acres. The recent treatability study conducted at the Technical Area V (TA-V) AOC evaluated the practicality of using in-situ bioremediation to reduce nitrate concentrations where nitrate exceeded the EPA MCL in a 1.4-acre plume. Due to low hydraulic conductivities, the TA-V pilot test was not successful because the radius of influence surrounding the injection well was negligible (SNL/NM, 2022a). Using in-situ bioremediation at the BSG AOC is considered unrealistic due to low hydraulic conductivities and is not carried forward as a viable technology.

Three remedial alternatives for nitrate in groundwater at the BSG AOC were identified during a May 2021 virtual meeting held by technical staff members from SNL/NM, DOE/NNSA, and the NMED HWB:

1. Long-Term Monitoring,
2. MNA, and
3. Groundwater extraction, treatment, and reinjection.

E.2.1 Corrective Measures Alternatives Evaluated by SNL for BSG AOC

Alternative 1: Long-Term Monitoring

Long-term monitoring consists of the continued evaluation of the concentrations and extent of nitrate throughout the duration of the remedy. Natural processes, that may include sorption, dispersion, dilution, evaporation, and chemical reactions, will decrease the concentration of the contaminants in soil and groundwater.

The Respondents propose to monitor the concentrations and extent of nitrate and prevent exposure throughout the duration of the remedy until remedial objectives are met. This technology requires no removal, treatment, or storage of groundwater other than the minor volumes of purge water generated during monitoring well sampling.

Implementation

The Respondents propose to measure water levels quarterly at 17 monitoring wells and sample 14 wells annually for nitrate in the BSG AOC during remedy implementation. Figure E.5 depicts the monitoring well network for the BSG AOC during remedy implementation for Alternative 1. The Respondents propose to analyze additional analytes required for the disposal of purge water and equipment decontamination water to the sanitary sewer system. The additional analytes would also function for surveillance monitoring purposes of the fractured bedrock aquifer system and would ensure that no new releases are overlooked.

Remedy Performance Monitoring, Maintenance, and Closure

The Respondents propose to redevelop and repair groundwater monitoring wells as needed. The need for replacing a monitoring well where the water level has dropped below the bottom of the screen would be determined on a case-by-case basis, depending on the progress of the remedy, and would also take into account the local nitrate concentrations and the need for water level data. The Respondents propose to submit Well Installation Work Plans to the NMED HWB within one year of a well having a water level becoming unsuitable for sampling purposes. Work Plans would be used for obtaining NMED HWB approval of proposed field tasks.

The Respondents propose to prepare Performance Monitoring Reports (identified in the Consent Order as "Progress Reports") every five years. The reports would summarize the monitoring results for the five-year period and would identify any required modifications or optimization measures for the remedy. A review of land use controls would also be incorporated into this process.

The Respondents propose to keep the public informed of the progress of the remedy by: (1) semiannual public meetings, (2) discussions in the annual groundwater monitoring reports (AGMRs), (3) Five-year Performance Monitoring Reports, and (4) postings on internet websites (i.e., www.sandia.gov/about/environment/, https://digitalrepository.unm.edu/snl/, and https://www.env.nm.gov/hazardous-waste/sandia-national-laboratories/).

After this alternative is complete and verified, the 14 monitoring wells would be plugged and abandoned. The Respondents propose to retain the three most downgradient monitoring wells (CYN-MW7, CYN-MW8, and CYNMW16) as sentry wells and transfer them to the SNL/NM Long-Term Stewardship program.

Land Use Controls

The Respondents propose to use land use controls to mitigate potential exposure to contaminated groundwater. The Respondents state that most of these controls are already in place and include maintaining existing SNL/NM site access controls. The Respondents propose to

review land use controls annually and modify if necessary. The Corrective Measures Implementation Plan would include a Land Use Controls Implementation Plan that would be amended if site conditions change (SNL 2023).

Timeframe

The estimated timeframe to achieve remedial objectives for Alternative 1 is 38 years. This includes one year to prepare plans, 30 years of remedial sampling and water-level measurements, two years of post-remediation verification sampling and water-level measurements, and five years of final reporting efforts and plugging and abandonment (P&A) of monitoring wells (SNL 2023).

Cost

The estimated total Present Value cost of the Long-Term Monitoring Alternative (in 2022 dollars) is $10,977,650.

Alternative 2: Monitored Natural Attenuation

Monitored natural attenuation relies on natural processes to decrease concentrations of contaminants in soil and groundwater. These processes may include denitrification (microbial destruction), advection, sorption, dispersion, dilution, and certain chemical reactions. The Respondents propose to monitor the concentrations and extent of contaminants throughout the duration of the remedy until remedial objectives are met. This technology requires no removal, treatment, or storage of groundwater other than the minor volumes of purge water generated during monitoring well sampling (SNL 2023).

Implementation

The Respondents propose to measure water levels quarterly at 17 monitoring wells and sample eight monitoring wells annually for nitrate, and biennially (every two years) for the denitrification suite (isotopes, dissolved gases, and total dissolved carbon) in the BSG AOC during remedy implementation. These eight monitoring wells are the wells that have had historical detections of NPN above the EPA MCL. The Respondents propose to analyze additional analytes required for the disposal of purge water and equipment decontamination water to the sanitary sewer system which would also function for surveillance monitoring purposes. Evaluation of the additional analytes would ensure that no new releases are overlooked. Figure E.6 depicts the monitoring well network for the BSG AOC during remedy implementation.

Remedy Performance Monitoring, Maintenance, and Closure

The Respondents propose to redevelop and repair groundwater monitoring wells as needed. The need for replacing a monitoring well where the water level has dropped below the bottom of the screen would be determined on a case-by-case basis, depending on the progress of the remedy, and would consider the local nitrate concentrations and the need for water level data. The Respondents propose to submit Well Installation Work Plans to the NMED HWB within one year of a well having a water level becoming unsuitable for sampling purposes. Work Plans would be used for obtaining NMED HWB approval of proposed field tasks.

The Respondents propose to prepare Performance Monitoring Reports (identified in the Consent Order as "Progress Reports") every five years. The reports would summarize the monitoring results for the five-year period and would identify any required modifications or optimization measures for the remedy. A review of land use controls would also be incorporated into this process.

The Respondents propose to keep the public informed of the progress of the remedy by: (1) semiannual public meetings, (2) discussions in the AGMRs, (3) Five-year Performance Monitoring Reports, and (4) postings on internet websites (i.e., www.sandia.gov/about/environment/, https://digitalrepository.unm.edu/snl/, and https://www.env.nm.gov/hazardous-waste/sandia-national-laboratories/).

After this alternative is complete and verified, 14 monitoring wells would be plugged and abandoned. The Respondents propose to retain three downgradient monitoring wells (CYN-MW7, CYN-MW8, and CYN-MW16) as sentry wells and transfer them to the SNL/NM Long-Term Stewardship program.

Land Use Controls

The Respondents propose to use land use controls to mitigate potential exposure to contaminated groundwater. The Respondents state that most of these controls are already in place and include maintaining existing SNL/NM site access controls. The Respondents propose to review Land use controls annually and modify if necessary. The Corrective Measures Implementation Plan would include a Land Use Controls Implementation Plan that would be amended if site conditions change.

Timeframe

The estimated total timeframe for Alternative 2 is 38 years. This includes one year to prepare plans, 30 years of remedial sampling and water-level measurements, two years of post-remediation verification sampling and water-level measurements, and five years of final reporting efforts and P&A of monitoring wells.

Cost

The estimated total Present Value cost of the MNA Alternative (in 2022 dollars) is $7,683,612.

Alternative 3: Groundwater Extraction, Treatment, and Reinjection

The objective of Alternative 3 is to remediate all BSG AOC groundwater with a nitrate concentration exceeding the EPA MCL. The remedial system would consist of extraction wells to remove contaminated groundwater for ex-situ treatment and subsequent reinjection of the treated water into upgradient wells. Under Alternative 3, the Respondents propose to install groundwater extraction wells, nitrate treatment systems consisting of sorption onto ion-exchange resin, treated-water reinjection wells, hydraulic communication test wells, and constructing infrastructure (piping and electrical networks). The Respondents propose to install separate systems in the eastern and western nitrate plumes to create two groundwater recirculation cells.

Implementation

The Respondent proposes to install twelve groundwater extraction wells to capture all groundwater in the two nitrate plumes in the BSG AOC with a nitrate concentration exceeding the EPA MCL. Six extraction wells would be located downgradient of each nitrate plume. The Respondent also proposes to install twelve reinjection wells for treated groundwater. Six reinjection wells would be located upgradient of each nitrate plume. This would create two recirculation cells within the fractured bedrock aquifer system to flush nitrate from the groundwater. The wells would be completed to approximately 250 ft bgs and intercept productive fractures in the fractured bedrock aquifer system. The Respondent proposes to install four hydraulic communication test wells (two wells for each nitrate plume) prior to full remedy implementation; hydraulic communication evaluations are utilized to support the optimal locations of the extraction and reinjection wells that would be completed.

The Respondent proposes to convey groundwater from the extraction wells to two treatment facilities (one for each nitrate plume) via a network of buried double-contained piping (approximately 0.6 miles in total length). The extracted water would be treated with a strong base anion ion-exchange resin to reduce nitrate concentrations to below the 10 mg/L EPA MCL. The total length of the two treated water conveyances to the reinjection wells would be approximately 0.5 miles. Spent ion-exchange resin would be regenerated offsite.

Figure E.7 depicts the conceptual design for the BSG AOC. The figure depicts the modeled flow paths within the two groundwater recirculation cells.

The Respondent simulated groundwater travel times and flow paths for this alternative using the numerical models MODFLOW and MODPATH, with Groundwater Vistas pre-/post-processing (Environmental Simulations, Inc., 2022):

- The model domain included the entire BSG AOC and was comprised of approximately 20,000 finite difference cells.
- The model was calibrated to October 2021 groundwater elevations using constant-head boundary conditions under steady-state conditions.
- Hydraulic conductivity values obtained from slug and hydraulic tests were interpolated across the model domain using a kriging algorithm. Porosity was assigned a value of 0.015.
- Groundwater flow paths and velocities were predicted by inserting virtual particles into the reinjection wells and conducting MODPATH simulations.
- Individual extraction well yields were estimated to vary between 1 to 1.25 gpm but are dependent on lateral variability in hydraulic conductivity and saturated thickness.
- The total extraction rate is estimated to be approximately 7.5 gpm for each of the eastern and western recirculation cells (15 gpm total).
- For the eastern nitrate plume, the modeled time for one particle of water (one pore volume) to travel between the reinjection and extraction wells was 2,450 days

(approximately 6.7 years). For the western nitrate plume, the predicted time was 600 days (approximately 1.6 years).

- Based upon the standard industry practice of using three pore volumes to flush contaminants such as nitrate that do not sorb to the rock matrix, the eastern nitrate plume would require approximately 20 years of active extraction and reinjection. For the western nitrate plume, approximately 5 years would be required.
- The extracted groundwater volumes for the eastern and western nitrate plumes are estimated to be 98,550,000 and 19,710,000 gallons, respectively. The total estimated volume is 118,260,000 gallons.

Water levels would be measured quarterly at 17 monitoring wells in the BSG AOC during remedy implementation. The number of monitoring wells to be measured is consistent with the current AGMR monitoring protocol (SNL/NM, 2022b). The Respondents propose to sample eight monitoring wells annually for nitrate. These eight wells are the wells that have had historical detections of NPN above the EPA MCL. In addition, the Respondents propose to collect groundwater samples quarterly from the 12 extraction wells. The Respondents propose to analyze additional analytes required for the disposal of purge water and equipment decontamination water to the sanitary sewer system would also function for surveillance monitoring purposes. Evaluation of the additional analytes would ensure that no new releases are overlooked.

Remedy Performance Monitoring, Maintenance, and Closure

The Respondents propose to redevelop and repair groundwater monitoring wells as needed. The need for replacing a monitoring well where the water level has dropped below the bottom of the screen would be determined on a case-by-case basis, depending on the progress of the remedy, and would also take into account the local nitrate concentrations and the need for water level data. The Respondents propose to submit Well Installation Work Plans to the NMED HWB within one year of a well having a water level becoming unsuitable for sampling purposes. Work Plans would be used for obtaining NMED HWB approval of proposed field tasks.

Sampling of monitoring wells within the two remediation areas and all extraction wells for nitrate as NPN would initially be quarterly and transitioned to semiannual sampling after two years. Electronic logging of water levels would be implemented in selected monitoring and extraction wells. The groundwater treatment systems would be sampled at required points of treatment (influent and effluent) prior to discharge in compliance with the discharge permit. For costing purposes, it is assumed that groundwater samples would be collected monthly at these points during system operation and analyzed for NPN. Purge water samples would also be analyzed for VOCs, metals, radionuclides, alkalinity, anions, and petroleum hydrocarbons.

Quarterly post-remediation verification monitoring would be performed for two years after the cleanup standard is reached to detect any rebound (increase) of nitrate concentrations in groundwater.

For waste management purposes, groundwater from each monitoring well would be sampled annually for constituents required under the sanitary sewer discharge permit that is currently used for purge water and equipment decontamination water disposal.

The Respondents propose to prepare Performance Monitoring Reports (identified in the Consent Order as "Progress Reports") every five years. The reports would summarize the monitoring results for the five-year period and would identify any required modifications or optimization measures for the remedy. A review of land use controls would also be incorporated into this process.

The Respondents propose to keep the public informed of the progress of the remedy by: (1) semiannual public meetings, (2) discussions in the annual groundwater monitoring reports (AGMRs), (3) Five-year Performance Monitoring Reports, and (4) postings on internet websites (i.e., www.sandia.gov/about/environment/, https://digitalrepository.unm.edu/snl/, and https://www.env.nm.gov/hazardous-waste/sandia-national-laboratories/).

After this alternative is complete and verified, 14 monitoring wells would be plugged and abandoned. The Respondents propose to retain the three most downgradient monitoring wells (CYN-MW7, CYN-MW8, and CYNMW16) as sentry wells and transfer them to the SNL/NM Long-Term Stewardship program.

Land Use Controls

The Respondents propose to use land use controls to mitigate potential exposure to contaminated groundwater. The Respondents state that most of these controls are already in place and include maintaining existing SNL/NM site access controls. The Respondents propose to review land use controls annually and modify if necessary. The Corrective Measures Implementation Plan would include a Land Use Controls Implementation Plan that would be amended if site conditions change.

Timeframe

The estimated total timeframe for Alternative 3 is 31 years. This includes four years to design the remedy, prepare plans, obtain permits, install hydraulic communication test, extraction, and reinjection wells, and construct the pipelines and treatment facilities, 20 years of active groundwater extraction, treatment, and reinjection, including remedial sampling and water-level measurements, two years of post-remediation verification sampling and water-level measurements, and five years of final reporting efforts, P&A of all but three wells, and removal of infrastructure.

Cost

The estimated total Present Value cost of the Groundwater Extraction, Treatment, and Reinjection Alternative (in 2022 dollars) is $26,793,676.

E.2.2 Corrective Measures Recommended by Respondents for BSG AOC

The Respondents recommended Alternative 1: Long-Term Monitoring for the BSG AOC. The Respondents assert that this alternative meets the threshold criteria and is readily implementable.

The Respondents assert that nitrate concentrations in groundwater are low at this site (slightly exceeding the EPA MCL), are inaccessible to onsite receptors, and do not pose a potentially unacceptable risk to offsite receptors. The nitrate plumes at the BSG AOC are located in a remote eastern part of KAFB. Nitrate concentrations in groundwater are slightly decreasing to slightly increasing. Alternative 1 includes development of a Contingency Plan that would provide mechanisms for changing the remedial approach if the remedy does not proceed as anticipated.

The Respondents assert that there is no current or anticipated use of groundwater near the BSG AOC. The nearest receptor is production well KAFB-4, which is approximately 9 miles from the BSG AOC. Thus, there is no foreseeable risk to human health or threat to beneficial use of groundwater. The two stable nitrate plumes are in a remote part of KAFB where public access is restricted. Groundwater in the fractured bedrock aquifer system is relatively deep. The depth to saturated bedrock fractures with NPN concentrations exceeding the EPA MCL ranges from approximately 180 to 380 ft bgs. There is no potential for direct human contact or exposure to groundwater contaminants near the BSG AOC.

The Respondents assert that there are no remaining active sources of contaminant release at the BSG AOC. Explosive testing and wastewater discharges associated with ammonium nitrate slurry have not been conducted at the BSG AOC since 1975. The relative stable or slightly decreasing or increasing concentrations of nitrate in groundwater for the last 20 years indicates that no significant amounts of residual nitrate remaining in the alluvium or shallow bedrock would result in future impacts to groundwater at higher concentrations than are now present.

The Respondents assert that attenuation is projected to occur within a reasonable timeframe The Respondents assert that land use controls can be controlled, maintained, or implemented. DOE/NNSA and SNL/NM personnel are expected to retain stewardship of the site for the foreseeable future. If land use changes at the BSG AOC, or transfer of the property from DOE/NNSA and SNL/NM personnel control were to occur in the future, the remedy would be reevaluated to ensure the protectiveness of the remedy. Existing or readily implementable land use controls would prevent any exposure to contaminants. These controls would include site access controls and production well drilling restrictions.

The Respondents assert that the remedy is readily implementable. The monitoring well network is already in place. The remedy would have few detrimental impacts on ongoing programmatic operations in the area. The remedy minimizes safety risks to field personnel otherwise present during drilling, construction, and operation of more active measures.

The Respondents assert that construction of the Groundwater Extraction, Treatment, and Reinjection remedy would be difficult to implement at the BSG AOC, which is an active testing facility. Demonstrating an MNA remedy to be effective might be difficult. Groundwater analyses indicate that denitrification might not be occurring.

The Respondents assert that Long-Term Monitoring Alternative would include groundwater monitoring until remedial objectives are achieved. A Contingency Plan would include measures to be implemented if the remedy does not proceed as anticipated.

E.2.3 Corrective Measures Criteria Evaluation by NMED for BSG AOC

Alternative 1 – Long Term Monitoring

1. *Long-Term Reliability and Effectiveness*
   Alternative 1 would be fairly reliable and effective over the long-term as the contamination in the aquifer may degrade due to dispersion and dilution over time. Monitoring would continue until after the nitrate plume no longer exists. Therefore, Alternative 1 rates moderately for this criterion.

2. *Reduction of Toxicity, Mobility, or Volume*
   Alternative 1 would reduce the volume of nitrate due to dispersion and dilution over time. There is no risk to human health or the environment, even if no degradation occurred. No hazardous byproducts would be produced during the remedy implementation. Therefore, Alternative 1 rates moderately for this criterion.

3. *Short-Term Effectiveness*
   Alternative 1 would require many years' time to complete, however, there would be no short-term risks from construction or transportation of contaminants. Therefore, Alternative 1 rates moderately low for this criterion.

4. *Implementability*
   Alternative 1 rates very high for this criterion because no additional infrastructure is required and land use controls are already in place.

5. *Cost*
   Alternative 1 would cost $10,977,650 in 2022 dollars. Therefore, Alternative 1 rates high for this criterion.

Alternative 2 – Monitored Natural Attenuation

1. *Long-Term Reliability and Effectiveness*
   Alternative 2 would be fairly reliable and effective over the long-term as the contamination in the aquifer may degrade due to dispersion and dilution over time.

Monitoring would continue until after the nitrate plume no longer exists. Therefore, Alternative 2 rates moderately for this criterion.

2. *Reduction of Toxicity, Mobility, or Volume*
   Alternative 2 would reduce the volume of nitrate due to dispersion and dilution over time. There is no risk to human health or the environment, even if no degradation occurred. No hazardous byproducts would be produced during the remedy implementation. Therefore, Alternative 2 rates moderately for this criterion.

3. *Short-Term Effectiveness*
   Alternative 2 would require many years' time to complete, however, there would be no short-term risks from construction or transportation of contaminants. Therefore, Alternative 2 rates moderately low for this criterion.

4. *Implementability*
   Alternative 2 rates very high for this criterion because no additional infrastructure is required, and land use controls are already in place.

5. *Cost*
   Alternative 2 would cost $7,683,612 in 2022 dollars. Therefore, Alternative 2 rates very high for this criterion.

Alternative 3 – Groundwater Extraction, Treatment, and Reinjection

1. *Long-Term Reliability and Effectiveness*
   Alternative 3 would be fairly reliable and effective over the long-term as contaminated water would be removed from the aquifer and treated. Monitoring would continue until the nitrate plume no longer exists. Therefore, Alternative 3 rates high for this criterion.

2. *Reduction of Toxicity, Mobility, or Volume*
   Alternative 3 would provide a reduction in toxicity, mobility, or volume because nitrate would be removed from the aquifer and treated and, therefore, rates high for this criterion.

3. *Short-Term Effectiveness*
   Alternative 3 would require approximately 31 years' time to implement. Short-term risks include increased greenhouse gas emissions, higher emissions from vehicles, highest electrical usage due to the operation of extraction pumps, higher injury risk and the highest accident risk due to the transportation of ion-exchange resin to a regeneration facility. Therefore, Alternative 3 rates moderately low for this criterion due to the relatively long timeframe required and increased short-term risk.

4. *Implementability*
   Alternative 3 rates very low due for this criterion due to the high amount of infrastructure required, including twelve extraction wells, pipelines, transfer tanks, treatment facilities, and twelve reinjection wells. Additionally, because of the complex geology of the area with fracture flow, it is unclear whether all extraction wells and injection wells would work successfully.

5. *Cost*
   Alternative 3 would cost $26,793,676 in 2022 dollars. Therefore, Alternative 3 rates very low for this criterion.

E.2.4 Corrective Measures Selected by NMED for BSG AOC

NMED believes that Alternative 1 – Long Term Monitoring is the corrective measure for BSG AOC that would best meet the evaluation criteria of the Consent Order, would be protective of public health and the environment, and would attain cleanup standards because of natural dispersion and dilution of nitrate contamination. The following is a summary of the rationale for this proposed remedy selection.

Alternative 1, Long-Term Monitoring, is rated low for short-term effectiveness, but it rates moderately for long-term reliability and effectiveness and reduction of toxicity, mobility, or volume, and rates highest on implementability and cost.

Alternative 2, Monitored Natural Attenuation, is rated low for short-term effectiveness, but it rates moderately for long-term reliability and effectiveness and reduction of toxicity, mobility, or volume, and rates highest on implementability and cost.

Alternative 3, Groundwater Extraction, Treatment, and Reinjection rates the highest for both long-term reliability and effectiveness and reduction of toxicity, mobility, or volume; it also rates the lowest for short-term effectiveness, implementability, and cost.

NMED did not select Alternative 3 because the implementation of this alternative is very costly and complex and increases risk to workers and the community with little decrease in completion time (31 vs. 38 years). The implementability of this alternative is not fully confirmed; the location of some of the injection wells would likely need to be modified due to complex geology and fracture flow, in addition to geographic/topologic access constraints for well installation. The need to modify the locations of multiple injection wells due to these constraints will further increase the amount of time for completion. The difference in the estimated timeframes for remedy completion is not sufficient to justify the selection of an active remedy, given the technological challenges of implementing the remedy.

NMED did not select Alternative 2 because in general, NMED does not prefer no action with monitoring when groundwater contamination plumes exist. While the cost is greater, Alternative 1, Long-Term Monitoring is a more appropriate choice because the greater number of wells

sampled will provide a more comprehensive picture of the contaminant plume changes over time. As part of Alternative 1, all wells at the BSG AOC must be sampled once every five years in order to get a fuller picture of the plume changes over time. Additionally, sampling for other emerging constituents of concern such as PFAS is required.

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FIGURES

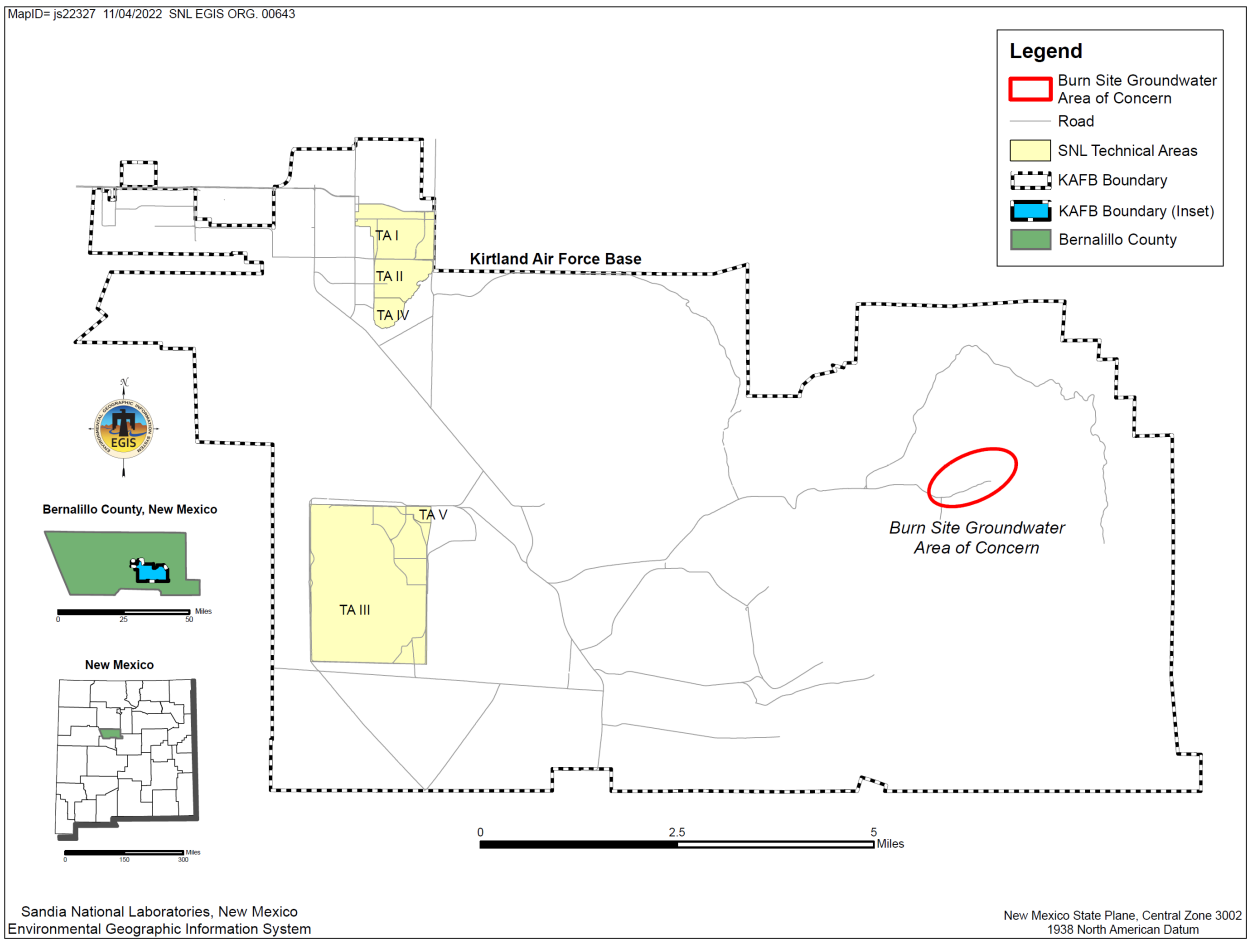

Figure E.1: Facility Location Map (SNL/NM, 2023).

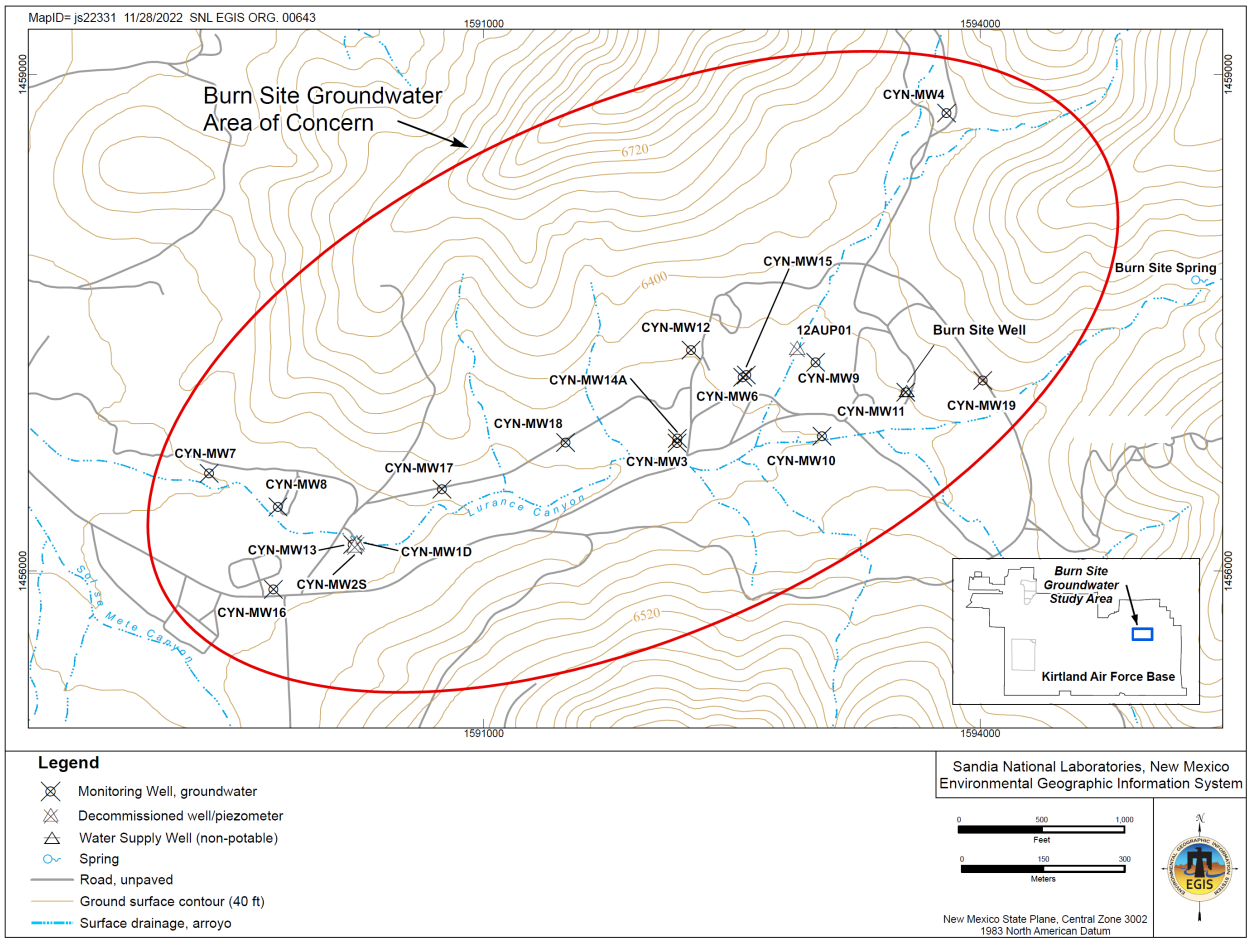

Figure E.2: Burn Site Groundwater Monitoring Well Locations, Current and Former (SNL/NM 2023).

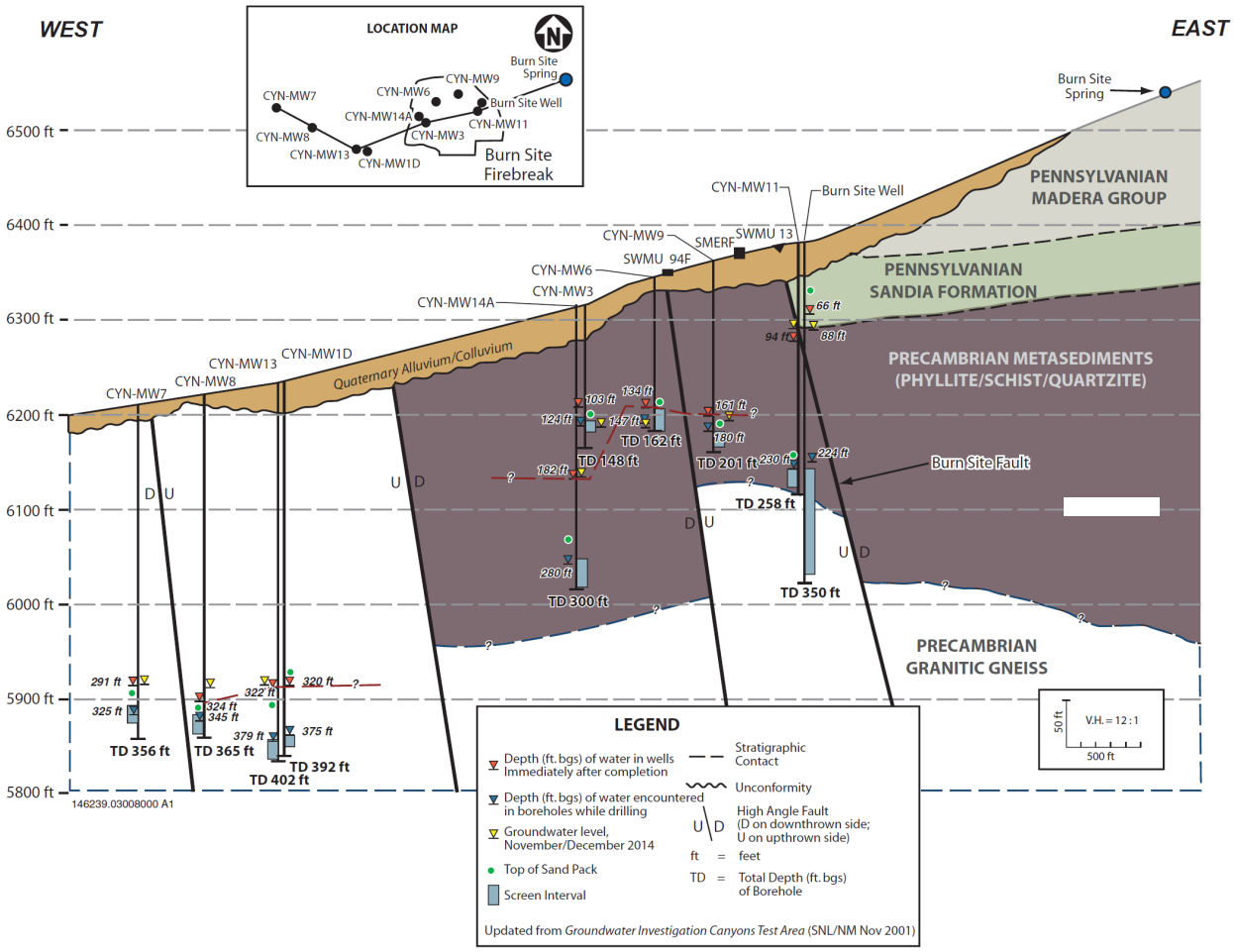

Figure E.3: Fence Diagram through the BSG AOC (SNL/NM, 2023).

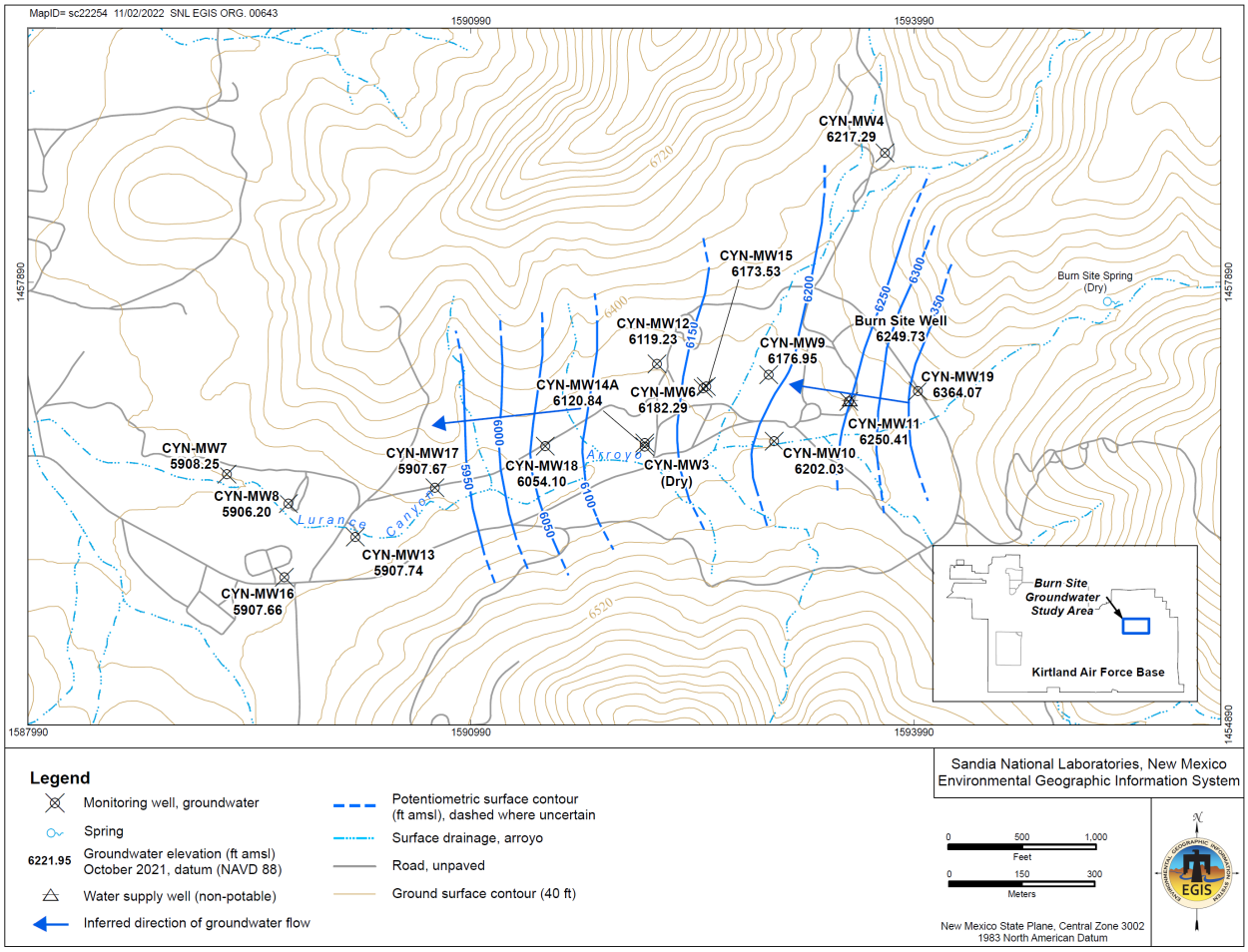

Figure E.4: Monitoring Network and Potentiometric Contours in the BSG AOC (SNL/NM 2023).

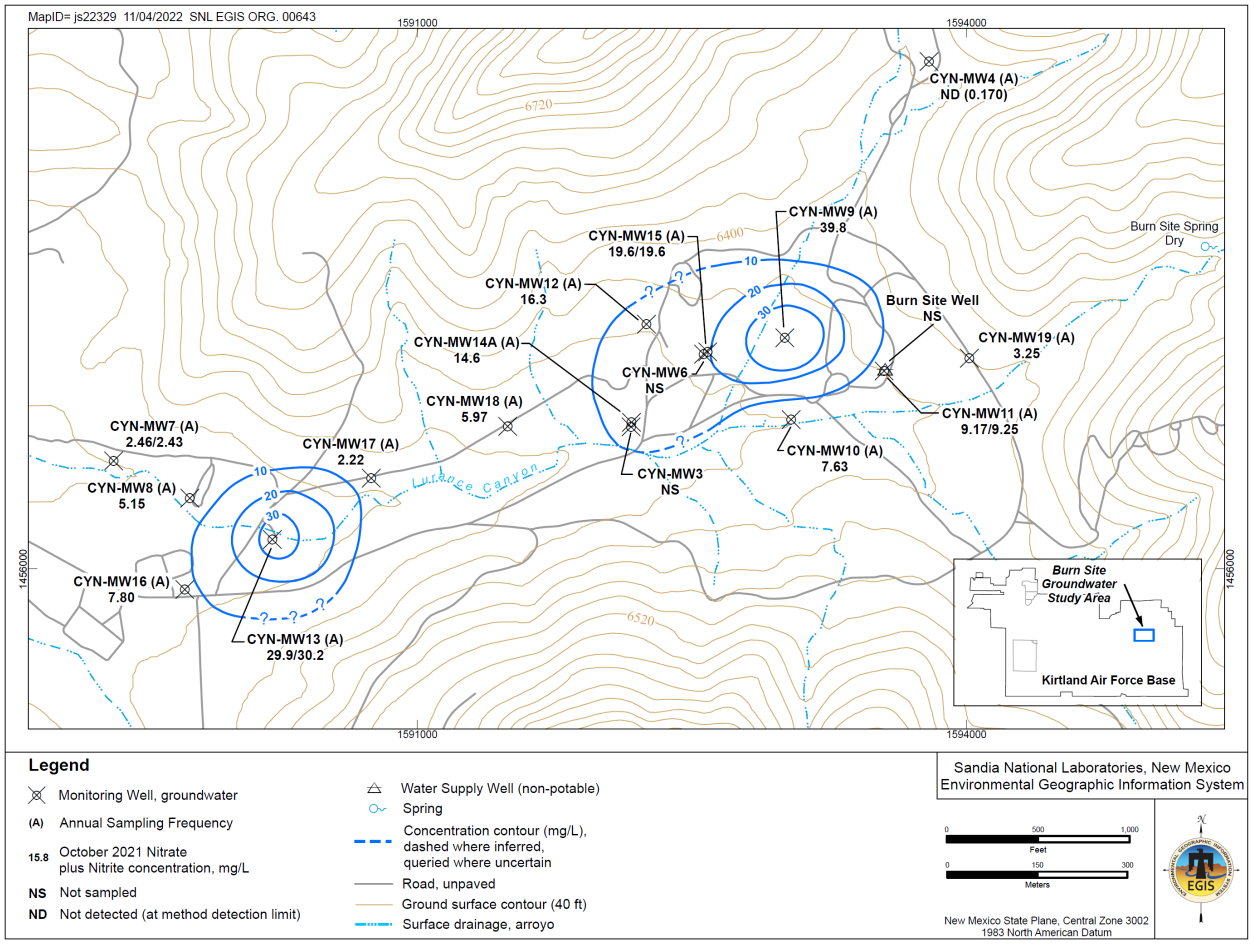

Figure E.5: Monitoring Network for Alternative 1: Long Term Monitoring (SNL/NM 2023).

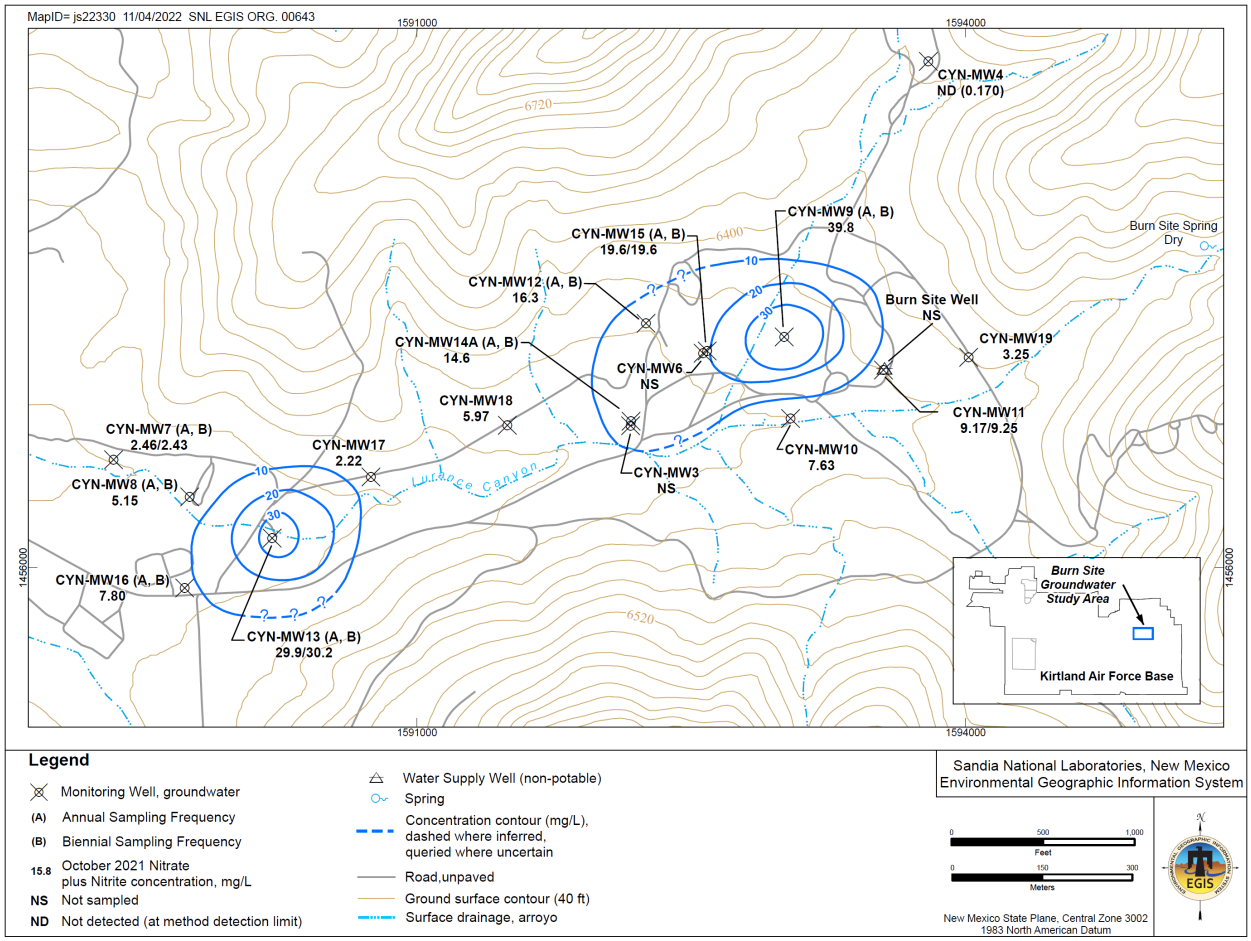

Figure E.6: Monitoring Network for Alternative 2: Monitored Natural Attenuation (SNL/NM 2023).

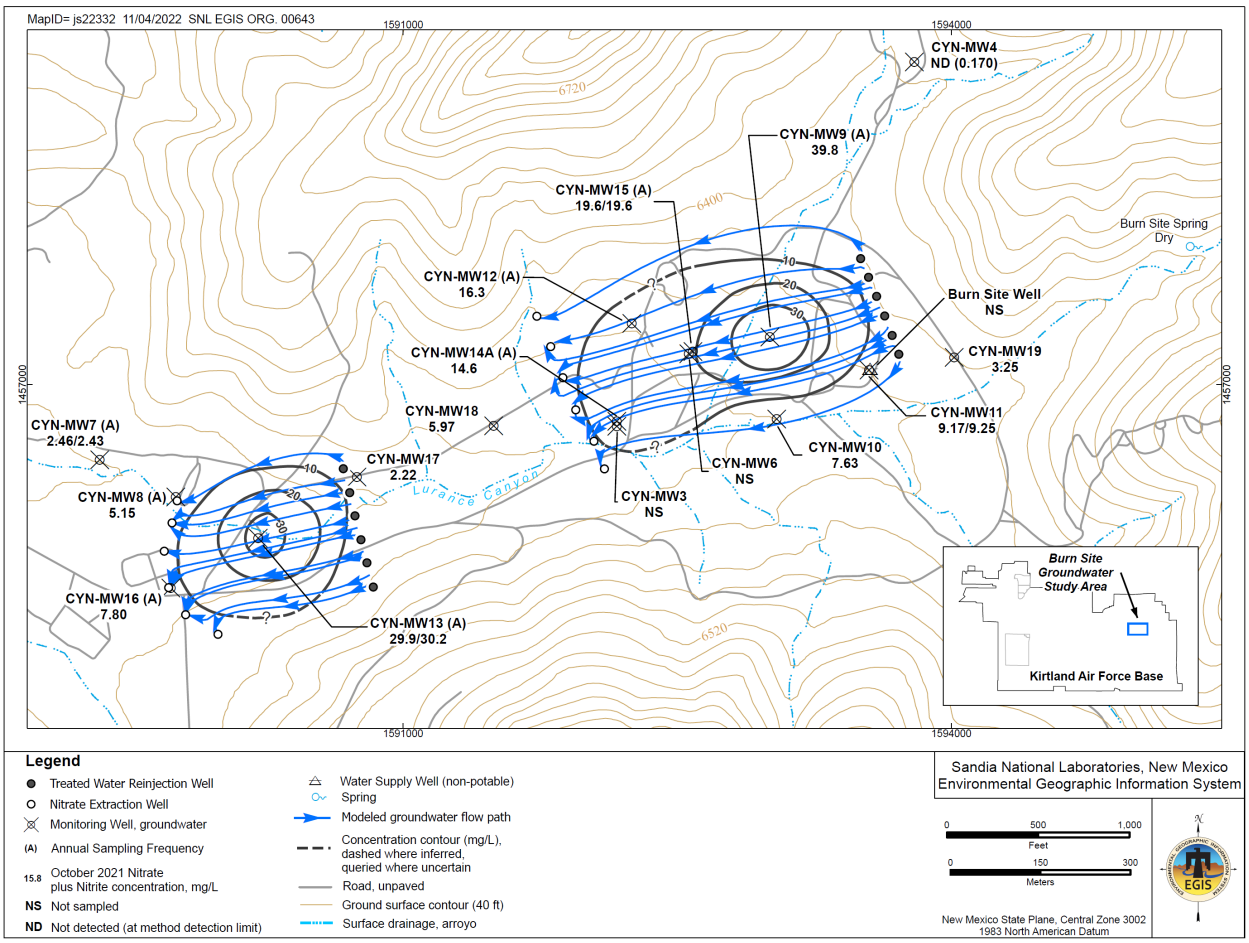

Figure E.7: Conceptual Design for Alternative 3: Groundwater Extraction, Treatment, And Reinjection (SNL/NM 2023).