Department of Energy
National Nuclear Security Administration
Sandia Field Office
P.O. Box 5400
Albuquerque, NM 87185

APR 15 2021

Mr. Andrew Romero
Permit Contact
New Mexico Environment Department
Ground Water Quality Bureau
1190 St. Francis Drive
Santa Fe, New Mexico 87502

Subject: Discharge Permit (DP) - 1845 Quarterly Report, April 2021

Dear Mr. Romero:

The Department of Energy, National Nuclear Security Administration Sandia Field Office submits the enclosed *Discharge Permit DP-1845 Quarterly Report, April 2021,* for Sandia National Laboratories, New Mexico. This submittal is required by Discharge Permit, DP-1845, *Technical Area-V Treatability Study Injection Wells*, Section IV.B, Terms and Conditions #11, and addresses quarterly reporting from October 1 through December 31, 2020. The full-scale operation for the Treatability Study at injection well TAV-INJ1 has completed the injection phase and is currently in the performance monitoring phase. All applicable terms and conditions specified in DP-1845 were met for this reporting period.

If you have any questions, please contact Saj Zappitello of our staff at (505) 845-6885 or Saj.Zappitello@nnsa.doe.gov.

Sincerely,

William V. Wechsler

Digitally signed by William V. Wechsler
Date: 2021.04.15 13:25:44 -06'00'

William V. Wechsler
Assistant Manager for Engineering

Enclosure

cc: See Page 2

cc w/ enclosure:
Laurie King
EPA, Region 6
1201 Elm Street, Suite 500, Dallas, Texas 75270-2102
Chris Catechis
NMED-OB
121 Tijeras Avenue, NE, Suite 1000, Albuquerque, New Mexico 87102
Naomi Davidson
NMED-HWB
121 Tijeras Avenue, NE, Suite 1000, Albuquerque, New Mexico 87102
Zimmerman Library, UNM
1 University of New Mexico, Albuquerque, New Mexico 87101-0001
Cynthia Wimberly, SFO/Legal
Sarah (Saj) Zappitello, SFO/ENG

cc w/o enclosure:
Amy Blumberg, SNL/NM
Christi Leigh, SNL/NM
Paul Shoemaker, SNL/NM
Jun Li, SNL/NM
Melanie Pearson-Hurley, EM-31
Wilhelm Wilborn, EM-EM
Douglas Tonkay, EM-31
Richard Dasher, NA-533
Jessica Arcidiacono, NA-533
Cynthia Wimberly, SFO/Legal
William Wechsler, SFO/ENG
NNSA-2020-001878

ENVIRONMENTAL RESTORATION OPERATIONS
CONSOLIDATED QUARTERLY REPORT, APRIL 2021

CERTIFICATION STATEMENT

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment for knowing violations.

Paul E. Shoemaker Digitally signed by Paul E. Shoemaker Date: 2021.04.01 15:48:57 -06'00'

Signature

April 1, 2021

Date

Paul E. Shoemaker
Defense Waste Management Programs
Sandia National Laboratories/New Mexico
Albuquerque, New Mexico 87185
Operator

and

Signature

4/19/2021

Date

Jeffrey P. Harrell, Manager
U.S. Department of Energy
National Nuclear Security Administration
Sandia Field Office
Owner

Sandia National Laboratories, New Mexico

Environmental Restoration Operations

A U.S. Department of Energy Environmental Cleanup Program

Consolidated Quarterly Report

October – December 2020

April 2021

United States Department of Energy
Sandia Field Office

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CONSOLIDATED QUARTERLY REPORT

April 2021

SANDIA NATIONAL LABORATORIES, NEW MEXICO

ENVIRONMENTAL RESTORATION OPERATIONS

U.S. DEPARTMENT OF ENERGY:	SANDIA FIELD OFFICE
CONTRACTOR:	NATIONAL TECHNOLOGY AND ENGINEERING SOLUTIONS OF SANDIA
PROJECT MANAGER:	Michael D. Barthel

NUMBER OF POTENTIAL RELEASE SITES SUBJECT TO CORRECTIVE ACTION: 6

SUSPECT WASTE: Radionuclides, metals, organic compounds, and explosives

REPORTING PERIOD: October – December 2020

OVERVIEW

This Sandia National Laboratories, New Mexico Environmental Restoration Operations (ER) Consolidated Quarterly Report (ER Quarterly Report) fulfills all quarterly reporting requirements set forth in the Compliance Order on Consent. Table I-1 lists the six sites remaining in the corrective action process. This ER Quarterly Report presents activities and data as follows:

SECTION I: Environmental Restoration Operations Consolidated Quarterly Report, October – December 2020

SECTION II: Perchlorate Screening Quarterly Groundwater Monitoring Report, October – December 2020

SECTION III: Technical Area-V In-Situ Bioremediation Treatability Study Phase I Full-Scale Operation, October – December 2020

ABBREVIATIONS AND ACRONYMS

µg/L	microgram(s) per liter
µS/cm	microsiemen(s) per centimeter
AGMR	Annual Groundwater Monitoring Report
AOC	Area of Concern
BSG	Burn Site Groundwater
CCM	Current Conceptual Model
CME	Corrective Measures Evaluation
COC	constituent of concern
Consent Order	Compliance Order on Consent
CY	Calendar Year
CYN	Canyons (acronym used for well identification only)
Dhc	*Dehalococcoides*
DO	dissolved oxygen
DOE	U.S. Department of Energy
DP	Discharge Permit
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration Operations
ER Quarterly Report	Environmental Restoration Operations Consolidated Quarterly Report
FOP	Field Operating Procedure
GWQB	Ground Water Quality Bureau
HWB	Hazardous Waste Bureau
INJ	injection (acronym used for well identification only)
ISB	in-situ bioremediation
LTS	Long-Term Stewardship
LWDS	liquid waste disposal system (acronym used for well identification only)
MCL	maximum contaminant level
MDL	method detection limit
mg/L	milligrams per liter
MW	monitoring well (acronym used for well identification only)
ND	non-detect
NMED	New Mexico Environment Department
NNSA	National Nuclear Security Administration
NPN	nitrate plus nitrite
NTU	nepholemetric turbidity unit
ORP	oxidation-reduction potential
pH	potential of hydrogen (negative logarithm of the hydrogen ion concentration)
SAP	Sampling and Analysis Plan
SC	specific conductivity

SNL/NM	Sandia National Laboratories, New Mexico
SSO	Sandia Site Office (acronym used only in Section II references)
SWMU	Solid Waste Management Unit
TA2-W	Technical Area-II (Well) (acronym used for well identification only)
TA2-SW	Technical Area-II (Southwest) (acronym used for well identification only)
TAG	Tijeras Arroyo Groundwater
TAV	Technical Area-V (acronym used for well identification only)
TA-V	Technical Area-V
TAVG	Technical Area-V Groundwater
TCE	trichloroethene
TJA	Tijeras Arroyo (acronym used for well identification only)
TOC	total organic carbon
TSWP	Treatability Study Work Plan
VOC	volatile organic compound
WYO	Wyoming (acronym used for well identification numbers in tables only)

SECTION I
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SECTION I
ENVIRONMENTAL RESTORATION OPERATIONS CONSOLIDATED QUARTERLY REPORT, October – December 2020

1.0 Introduction

This Environmental Restoration Operations (ER) Consolidated Quarterly Report (ER Quarterly Report) provides the status of ongoing corrective action activities being implemented at Sandia National Laboratories, New Mexico (SNL/NM) during the October – December 2020 reporting period.

Table I-1 lists the Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) currently identified for corrective action at SNL/NM. This section of the ER Quarterly Report summarizes the work completed during this reporting period at sites undergoing corrective action. Corrective action activities were conducted during this reporting period at the three groundwater AOCs:

- Burn Site Groundwater (BSG) AOC,
- Technical Area-V (TA-V) Groundwater (TAVG) AOC, and
- Tijeras Arroyo Groundwater (TAG) AOC.

Corrective action activities are deferred at the Long Sled Track (SWMU 83), the Gun Facilities (SWMU 84), and the Short Sled Track (SWMU 240) because these three sites are active mission facilities. These three active mission sites are located in Technical Area-III.

There were no SWMUs or AOCs in the corrective action complete regulatory process during this reporting period. Corrective action complete status has been approved for all SWMUs within the surface boundaries of each of the three groundwater AOCs.

2.0 Environmental Restoration Operations Work Completed

The following subsections identify the constituents of concern (COCs), summarize the corrective action milestones, and describe the ER work completed during the October – December 2020 reporting period at the three groundwater AOCs.

2.1 Sites Undergoing Corrective Action

In a letter dated April 14, 2016, the New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) defined the scope and milestones for corrective action at three groundwater AOCs (BSG AOC, TAVG AOC, and TAG AOC) (NMED April 2016). Sections I.2.1.1 through I.2.1.3 discuss the specific milestones from this letter.

2.1.1 Burn Site Groundwater Area of Concern

Nitrate has been identified as a COC in groundwater at the BSG AOC based on detections above the U.S. Environmental Protection Agency (EPA) maximum contaminant level (MCL) in samples collected from monitoring wells. The EPA MCL and State of New Mexico groundwater standard for nitrate (as nitrogen) is 10 milligrams per liter (mg/L). The groundwater sampling and analysis program for the BSG AOC currently includes perchlorate analysis of water from groundwater monitoring well CYN-MW15, which is sampled semiannually.

The U.S. Department of Energy/National Nuclear Security Administration (DOE/NNSA) and SNL/NM personnel met with the NMED HWB on July 20, 2015 to discuss the status of sites currently undergoing corrective action. For the BSG AOC, all parties agreed to a weight-of-evidence characterization program: (1) to conduct additional isotopic analyses/nitrate fingerprinting and age-dating of the groundwater; (2) to conduct a transducer study using existing wells to determine whether the groundwater is unconfined, semi-confined, or confined; and (3) to conduct an aquifer pumping test to help determine the origin of the elevated nitrates in the groundwater.

In January 2019, a Monitoring Well Installation Work Plan for the BSG AOC was submitted to NMED HWB (SNL/NM January 2019a) and subsequently approved by NMED HWB (NMED February 2019). The work plan proposed a minimum of four wells (CYN-MW16 through CYN-MW19) that will help define the extent of nitrate contamination in groundwater and refine the potentiometric surface in the BSG AOC. Long-term sampling from these new well locations, along with other BSG monitoring wells, will provide data to characterize the AOC and assist in evaluating potential remedial actions.

The following activities occurred at the BSG AOC during the October - December 2020 reporting period:

- Groundwater sampling was conducted at all 14 groundwater monitoring wells in October and November 2020. Table I-2 presents the identification and the sampling frequency for these monitoring wells. The complete analytical results for Calendar Year (CY) 2020 groundwater monitoring will be presented in the SNL/NM CY 2020 Annual Groundwater Monitoring Report (AGMR), which is anticipated to be submitted to the NMED HWB in the summer of 2021.
- This was the fifth sampling event conducted at the four recently installed groundwater monitoring wells (CYN-MW16, CYN-MW17, CYN-MW18, and CYN-MW19). The concentration of nitrate plus nitrite during the October sampling event at well CYN-MW16 was 7.20 mg/L, which did not exceed the EPA MCL of 10 mg/L for the third consecutive sampling event. The other three wells have consistently had nitrate plus nitrite concentrations below the nitrate MCL.
- Perchlorate analysis of the November 2020 groundwater sample from the BSG AOC is discussed in Section II of this ER Quarterly Report.

2.1.2 Technical Area-V Groundwater Area of Concern

Trichloroethene (TCE) and nitrate have been identified as COCs in groundwater at the TAVG AOC based on detections above the EPA MCLs in samples collected from monitoring wells. The EPA MCLs and the State of New Mexico groundwater standards for TCE and nitrate (as nitrogen) are 5 micrograms per liter (µg/L) and 10 mg/L, respectively.

Personnel from the DOE/NNSA, DOE Headquarters Office of Environmental Management, SNL/NM, and NMED HWB worked together to address the groundwater contamination at the TAVG AOC. A meeting was held with the NMED HWB on July 20, 2015, and all parties agreed on a phased Treatability Study to evaluate the effectiveness of in-situ bioremediation (ISB) as a potential technology to treat groundwater contamination at the TAVG AOC.

To implement the ISB Treatability Study, SNL/NM personnel planned to install up to three injection wells (TAV-INJ1, TAV-INJ2, and TAV-INJ3) at TA-V near the highest contaminant concentrations in groundwater detected in monitoring wells TAV-MW6, TAV-MW10, and LWDS-MW1, respectively. The substrate solution containing essential food and nutrients for biostimulation was prepared in aboveground tanks. This substrate solution, along with the biodegradation bacteria, was gravity-injected to groundwater via the injection well.

The NMED HWB approved the Revised Treatability Study Work Plan (TSWP) (SNL/NM March 2016) in May 2016 (NMED May 2016). In accordance with the Revised TSWP, the ISB Treatability Study is being conducted in two phases. Phase I included a pilot test, followed by full-scale operation at the first injection well (TAV-INJ1). Phase II of the ISB Treatability Study will include well installation and full-scale operation at the second and third injection wells (TAV-INJ2 and TAV-INJ3). The decision to install the Phase II injection wells will be dependent upon the findings of the Phase I full-scale operation.

The NMED Ground Water Quality Bureau (GWQB) required a groundwater Discharge Permit (DP) for operation of the injection wells. NMED GWQB issued DP-1845 to DOE/NNSA for the SNL/NM ISB Treatability Study injection wells on May 26, 2017 (NMED May 2017a). The DP-1845 term started on May 30, 2017 and will end on May 30, 2022. As required by DP-1845, DOE/NNSA and SNL/NM personnel submit separate quarterly reports to the NMED GWQB.

SNL/NM personnel have completed the Phase I pilot test at injection well TAV-INJ1. The operation and results of the pilot test were presented in Section III of the October 2018 ER Quarterly Report (SNL/NM October 2018). Based on the results of the pilot test, DOE/NNSA and SNL/NM personnel proposed eight modifications for the full-scale operation at well TAV-INJ1 (DOE July 2018). The NMED HWB subsequently approved the modifications on August 13, 2018 (NMED August 2018). Therefore, implementation of the Phase I full-scale operation at well TAV-INJ1 is governed by the Revised TSWP and where applicable, the approved modifications for full-scale operation.

SNL/NM personnel started the Phase I full-scale operation at well TAV-INJ1 in October 2018 and completed the six-month injection period in April 2019. Details on the six-month injection activities were presented in Section III of the October 2019 ER Quarterly Report (SNL/NM October 2019). The injection period is followed by two years of groundwater monitoring for performance of the ISB. The two-year performance monitoring includes three monthly sampling events followed by quarterly sampling events for the remainder of the two-year period, as planned in the Revised TSWP (SNL/NM March 2016). The three monthly sampling events were completed by July 2019. The Phase I ISB Treatability Study performance monitoring is currently on a quarterly schedule until May 2021.

The following activities occurred at TAVG AOC during the October - December 2020 reporting period:

- For performance monitoring of the Phase I ISB Treatability Study, groundwater sampling was conducted at the treatment zone (i.e., at injection well TAV-INJ1 and monitoring well TAV-MW6) in November 2020. Section III presents the groundwater monitoring results for the ISB Treatability Study for this quarter. Analytical results for DP-specific requirements are presented in DP quarterly reports that are submitted separately to the NMED GWQB.
- The TA-V groundwater monitoring network currently comprises 18 active monitoring wells. Of these 18 wells, well TAV-MW6 is designated as an ISB Treatability Study performance monitoring well and follows the sampling frequency and analytes specified for the ISB Treatability Study (see Section III). Well TAV-MW7, because of its proximity to the injection well TAV-INJ1, continues to serve as a monitoring well for the ISB Treatability Study, although no impact from the substrate solution injections has been observed at this deep well. Programmatically TAV-MW7 belongs to the TA-V groundwater monitoring network (SNL/NM January 2019b). Groundwater monitoring results for wells TAV-MW6 and TAV-MW7 are reported in Section III of the ER Quarterly Reports for the duration of the ISB Treatability Study.
- Table I-2 presents the CY 2020 sampling frequency for the monitoring wells at the TAVG AOC for the 17 wells in the TA-V groundwater monitoring network (18 wells minus well TAV-MW6). Groundwater sampling was conducted in November/December 2020. The SNL/NM CY 2020 AGMR will present the analytical results for CY 2020 groundwater monitoring, and is scheduled for submittal to the NMED HWB in the summer of 2021.
- Well AVN-1 is sampled annually (Table I-2). In May 2020, the chromium concentrations in the environmental sample and environmental duplicate sample were 0.112 and 0.115 mg/L, respectively, exceeding the EPA MCL of 0.1 mg/L for the first time at well AVN-1. SNL/NM personnel voluntarily sampled this well for total metals on September 30, 2020. The chromium concentration was 0.122 mg/L, again exceeding the EPA MCL of 0.1 mg/L. Well AVN-1 was installed in May 1995. It is the only well constructed with both stainless-steel casing and stainless-steel screen within the TA-V groundwater monitoring network. The elevated chromium concentration is likely associated with corrosion of the stainless-steel well construction materials. SNL/NM personnel requested NMED's approval to plug, abandon, and replace this well, and NMED subsequently agreed (NMED December 2020). The new well will be designated TAV-MW17 and will be constructed with polyvinyl chloride well screen and casing materials.

- SNL/NM also requested NMED's approval to plug and abandon monitoring wells AVN-2 and LWDS-MW2. Well AVN-2, located in the vicinity of well AVN-1, has been dry since 2008. The proposed new monitoring well TAV-MW17 will serve the role of AVN-1/AVN-2 as the upgradient background well for the TAVG AOC. LWDS-MW2 is constructed with stainless-steel screen, which is also deteriorating. The original purpose of this well was to determine if any deep groundwater contamination was occurring from discharges at the surface impoundments (former SWMU 4). TCE was never detected at this well. In October 2020, the water level at well LWDS-MW2 was approximately 12 feet above top of the screen. Because of its deep completion, it does not serve to delineate groundwater contamination at the TAVG AOC. NMED has concurred with the plan to decommission (plug and abandon) monitoring wells AVN-2 and LWDS-MW2 (NMED December 2020).

2.1.3 Tijeras Arroyo Groundwater Area of Concern

Nitrate has been identified as a COC in groundwater for the TAG AOC based on exceedances of the EPA MCL in samples collected from monitoring wells completed in the Perched Groundwater System and in the merging zone above the Regional Aquifer. TCE has been identified as a COC for the Perched Groundwater System (NMED April 2004). No TCE concentrations in Regional Aquifer samples have exceeded the EPA MCL. The EPA MCLs and State of New Mexico groundwater standards for TCE and nitrate (as nitrogen) are 5 µg/L and 10 mg/L, respectively.

In May 2017, NMED HWB completed its review of the Current Conceptual Model (CCM)/Corrective Measures Evaluation (CME) Report for the TAG AOC (SNL/NM December 2016), which was submitted to the NMED HWB on November 23, 2016 (DOE November 2016). This report was submitted in accordance with NMED's "Summary of Agreements and Proposed Milestones…" letter of April 14, 2016 (NMED April 2016). The subsequent disapproval letter issued by the NMED HWB (NMED May 2017b) requested the inclusion of additional information in a revised report. The Revised TAG CCM/CME Report was submitted to the NMED HWB on February 13, 2018 (SNL/NM February 2018). Personnel from DOE/NNSA, SNL/NM, and NMED HWB met on September 23, 2020 to discuss NMED's ongoing review of the Revised TAG CCM/CME Report (SNL/NM February 2018). In the meeting, NMED HWB personnel stated that their selection of the remedial alternative concerning elevated nitrate concentrations in the Perched Groundwater System is likely to occur in mid-2021.

Table I-2 presents the CY 2020 sampling frequency for the TAG monitoring wells. During October-December 2020, groundwater samples were collected from the 7 monitoring wells that were scheduled for quarterly sampling. Analytical results for the samples are consistent with historical trends. The maximum nitrate plus nitrite concentration detected in Perched Groundwater System wells for the reporting period was 22.2 mg/L, which exceeds the EPA MCL and State of New Mexico groundwater standard of 10 mg/L. The maximum TCE concentration detected in Perched Groundwater System wells for the reporting period was 15.7 µg/L, which exceeds the EPA MCL and State of New Mexico groundwater standard of 5 µg/L. A complete discussion of recent analytical results for the TAG AOC CY 2020 groundwater monitoring will be included in the SNL/NM CY 2020 AGMR, which is scheduled for submittal to the NMED HWB in the summer of 2021.

2.2 Sites in Corrective Action Complete Regulatory Process

There are currently no SWMUs or AOCs at SNL/NM in the corrective action complete regulatory process.

3.0 References

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New Mexico Environment Department (NMED), April 2004. "Compliance Order on Consent Pursuant to the New Mexico Hazardous Waste Act § 74-4-10: Sandia National Laboratories Consent Order," New Mexico Environment Department, Santa Fe, New Mexico. April 29, 2004.

New Mexico Environment Department (NMED), April 2016. Letter to J.P. Harrell (U.S. Department of Energy, NNSA/Sandia Field Office) and M. W. Hazen (Sandia National Laboratories, New Mexico), "Summary of Agreements and Proposed Milestones Pursuant to the Meeting of July 20, 2015, March 30, 2016, Sandia National Laboratories, EPA ID# NM5890110518, HWB-SNL-16-MISC," NMED, Hazardous Waste Bureau, Santa Fe, New Mexico. April 14, 2016.

New Mexico Environment Department (NMED), May 2016. Letter to J. Harrell (U.S. Department of Energy NNSA/Sandia Field Office) and P. Davies (Sandia National Laboratories, New Mexico), "Approval Revised Treatability Study Work Plan for In-Situ Bioremediation at the Technical Area-V Groundwater Area of Concern, Sandia National Laboratories, EPA ID# NM5890110518, HWB-SNL-15-020," NMED, Hazardous Waste Bureau, Santa Fe, New Mexico. May 10, 2016.

New Mexico Environment Department (NMED), May 2017a. Ground Water Discharge Permit, Sandia National Laboratories/New Mexico, Discharge Permit-1845, NMED, Ground Water Quality Bureau, Santa Fe, New Mexico. May 26, 2017.

New Mexico Environment Department (NMED), May 2017b. Letter to J.P. Harrell (U.S. Department of Energy NNSA/Sandia Field Office) and Carol Adkins (Sandia National Laboratories), "Disapproval Tijeras Arroyo Groundwater Current Conceptual Model and Corrective Measures Evaluation Report, December 2016, Sandia National Laboratories [*sic*] New Mexico, EPA ID# NM5890110518, HWB-SNL-16-020," May 18, 2017.

New Mexico Environment Department (NMED), August 2018. Letter to J.P. Harrell (U.S. Department of Energy NNSA/Sandia Field Office) and R.O. Griffith (Sandia National Laboratories), "Approval: Technical Area-V (TA-V) Treatability Study Notification of Full-Scale Operation at Well TAV-INJ1, Sandia National Laboratory, EPA ID# NM5890110518, HWB-SNL-15-020," August 13, 2018.

New Mexico Environment Department (NMED), February 2019. Letter to J.P. Harrell (U.S. Department of Energy NNSA/Sandia Field Office) and P. Shoemaker (Sandia National Laboratories), "Approval: Monitoring Well Installation Work Plan, Burn Site Groundwater Monitoring Wells CYN-MW16 Through CYN-MW23, Sandia National Laboratories, EPA ID# NM5890110518, HWB-SNL-19-003," February 12, 2019.

New Mexico Environment Department (NMED), December 2020. Email correspondence from N. Davidson (NMED) to D. Rast (DOE), NMED Hazardous Waste Bureau, Albuquerque, New Mexico, December 3, 2020.

NMED, see New Mexico Environment Department.

Sandia National Laboratories, New Mexico (SNL/NM), March 2016. *Revised Treatability Study Work Plan for In-Situ Bioremediation at the Technical Area-V Groundwater Area of Concern, Sandia National Laboratories, Albuquerque, New Mexico,* Environmental Restoration Operations, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories, New Mexico (SNL/NM), December 2016. *Tijeras Arroyo Groundwater Current Conceptual Model and Corrective Measures Evaluation Report*, Environmental Restoration Operations, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories, New Mexico (SNL/NM), February 2018. *Revised Tijeras Arroyo Groundwater Current Conceptual Model and Corrective Measures Evaluation Report*, Environmental Restoration Operations, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories, New Mexico (SNL/NM), October 2018. *Environmental Restoration Operations Consolidated Quarterly Report April – June 2018*, Environmental Restoration Operations, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories, New Mexico (SNL/NM), January 2019a. *Monitoring Well Installation Work Plan, Burn Site Groundwater Monitoring Wells CYN-MW16 through CYN-MW23, Sandia National Laboratories, Albuquerque, New Mexico,* Environmental Restoration Operations, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories, New Mexico (SNL/NM), January 2019b. *Environmental Restoration Operations Consolidated Quarterly Report July – September 2018, Sandia National Laboratories, Albuquerque, New Mexico,* Environmental Restoration Operations, Sandia National Laboratories, Albuquerque, New Mexico.

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SNL/NM, see Sandia National Laboratories, New Mexico.

U.S. Department of Energy (DOE), November 2016. Letter to J.E. Kieling (New Mexico Environment Department), "Tijeras Arroyo Groundwater Current Conceptual Model and Corrective Measures Evaluation Report, December 2016," November 23, 2016.

U.S. Department of Energy (DOE), July 2018. Letter to J. E. Kieling (New Mexico Environment Department), "Technical Area-V (TA-V) Treatability Study Notification of Full-Scale Operation at Well TAV-INJ1," July 20, 2018.

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Tables

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Table I-1
Solid Waste Management Units and Areas of Concern
Where Corrective Action is Not Complete

Solid Waste Management Units and Areas of Concern	
Site Number	**Site Description**
83	Long Sled Track
84	Gun Facilities
240	Short Sled Track
NA	Tijeras Arroyo Groundwater Investigation (TAG AOC)
NA	TA-V Groundwater Investigation (TAVG AOC)
NA	Burn Site Groundwater Investigation (BSG AOC)

Notes:

AOC = Area of Concern.
BSG = Burn Site Groundwater.
NA = Not applicable. A site number was not assigned.
TAG = Tijeras Arroyo Groundwater.
TA-V = Technical Area-V.
TAVG = Technical Area-V Groundwater.

Table I-2
Groundwater Sampling and Analysis

Investigation Site	Sampling Frequency in CY 2020	Quarter of Sampling in CY 2020	Location of Analytical Results	Location of Perchlorate Analytical Results	Monitoring Wells in Network
TAVG AOC [a]	Quarterly	1,2,3,4	AGMR	NA	LWDS-MW1, TAV-MW2, TAV-MW4, TAV-MW7, TAV-MW8, TAV-MW10, TAV-MW11, TAV-MW12, TAV-MW14, TAV-MW15, TAV-MW16
	Annually	2	AGMR	NA	AVN-1, LWDS-MW2, TAV-MW3, TAV-MW5, TAV-MW9, TAV-MW13
BSG AOC	Semiannually	2,4	AGMR	Section II of ER Consolidated Quarterly Report	CYN-MW4, CYN-MW7, CYN-MW8, CYN-MW9, CYN-MW10, CYN-MW11, CYN-MW12, CYN-MW13, CYN-MW14A, CYN-MW15
	Quarterly	1,2,3,4	AGMR	NA	CYN-MW16, CYN-MW17, CYN-MW18, CYN-MW19
TAG AOC [b]	Quarterly	1,2,3,4	AGMR	NA	TA2-W-19, TA2-W-26, TA2-W-28, TJA-2, TJA-3, TJA-4, TJA-7
	Semiannually	1,3	AGMR	NA	TA1-W-06, TA2-W-01, TA2-W-27, TJA-6
	Annually	3	AGMR	NA	PGS-2, TA1-W-01, TA1-W-02, TA1-W-03, TA1-W-04, TA1-W-05, TA1-W-08, TA2-NW1-595, WYO-3
	Voluntarily	4	AGMR	NA	TA2-W-24, TA2-W-25, TJA-5

Notes:

[a] TAVG AOC monitoring network comprises 18 active wells: 17 wells are listed here; well TAV-MW6 currently is part of the ISB Treatability Study and follows a separate monitoring plan (see Section I.2.1.2).

[b] Monitoring well WYO-4 was removed from the TAG sampling schedule in response to the August 2017 meeting with NMED HWB personnel.

AGMR = Annual Groundwater Monitoring Report.
AOC = Area of Concern.
AVN = Area-V (North) (acronym used for well identification only).
BSG = Burn Site Groundwater (Area of Concern).
CY = Calendar Year.
CYN = Canyons (Burn Site Groundwater Area of Concern; acronym used for well identification only).
ER = Environmental Restoration.
HWB = Hazardous Waste Bureau.
ISB = In-situ bioremediation.
LWDS = Liquid waste disposal system (acronym used for well identification only).
MW = Monitoring well (acronym used for well identification only).
NA = Not applicable. No wells in the site network are currently being sampled and analyzed for perchlorate or were not sampled during this reporting period.
NMED = New Mexico Environment Department.
PGS = Parade Ground South (acronym used for well identification only).
TA1-W = Technical Area-I (Well) (acronym used for well identification only).
TA2-NW = Technical Area-II (Northwest) (acronym used for well identification only).
TA2-W = Technical Area-II (Well) (acronym used for well identification only).
TAG = Tijeras Arroyo Groundwater (Area of Concern).
TAV = Technical Area-V (acronym used for well identification only).
TAVG = Technical Area-V Groundwater (Area of Concern).
TJA = Tijeras Arroyo (acronym used for well identification only).
WYO = Wyoming (acronym used for well identification only).

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SECTION II
PERCHLORATE SCREENING QUARTERLY GROUNDWATER MONITORING REPORT, October – December 2020

1.0 Introduction

Section IV.B of the Compliance Order on Consent (the Consent Order), between the New Mexico Environment Department (NMED), the U.S. Department of Energy (DOE), and Sandia National Laboratories, New Mexico (SNL/NM), effective on April 29, 2004, stipulates that a select group of groundwater monitoring wells at SNL/NM be sampled for perchlorate (NMED April 2004). This section of the Environmental Restoration Operations (ER) Consolidated Quarterly Report (ER Quarterly Report) summarizes the perchlorate screening groundwater monitoring completed during the October - December 2020 reporting period in response to the requirements of the Consent Order. The outline of this report is based on the required elements of a "Periodic Monitoring Report" described in Section X.D. of the Consent Order (NMED April 2004).

In November 2005, DOE/National Nuclear Security Administration (NNSA) and SNL/NM personnel submitted a letter report on the status of perchlorate screening in groundwater at SNL/NM monitoring wells (SNL/NM November 2005). The letter report summarized previous correspondence and sampling results and outlined proposed future work to comply with NMED Hazardous Waste Bureau (HWB) requirements for perchlorate screening of groundwater. As specified in the letter report, quarterly reports are submitted for wells active in the perchlorate screening monitoring well network.

Based on the NMED HWB response (NMED January 2006), DOE/NNSA and SNL/NM personnel submit each quarterly report within 90 days following the quarter that the data represent. In November 2008, DOE/NNSA and SNL/NM personnel received approval from the NMED HWB to proceed to semiannual reporting (NMED November 2008); however, upon further consideration, the NMED HWB once more required quarterly reporting (NMED April 2009). This did not alter the previously negotiated frequency for monitoring well CYN-MW6, an existing Burn Site Groundwater (BSG) Area of Concern (AOC) monitoring well that has been under the sampling and reporting requirements of the Consent Order since the well was installed, which remains at a semiannual frequency for sampling and reporting. Due to declining water levels, CYN-MW6 has insufficient water to routinely sample and the replacement monitoring well (CYN-MW15) was installed in December 2014; the negotiated semiannual sampling frequency transferred to the replacement well.

In September 2011, DOE/NNSA and SNL/NM personnel requested an extension of the submittal dates by one month for ER Quarterly Reports (SNL/NM September 2011). The NMED HWB approved the request (NMED September 2011), which allows DOE/ NNSA and SNL/NM personnel to submit perchlorate quarterly reports within 120 days following the quarter that the data represent.

This report is the fifty-third perchlorate screening quarterly report submitted since the Fourth Quarter CY 2005 letter report (SNL/NM February 2006).

Groundwater at BSG AOC monitoring well CYN-MW15 was sampled for perchlorate during this reporting period (Table II-1). The corresponding reporting will continue for as long as a well remains active in the perchlorate screening monitoring well network, or unless otherwise negotiated with the NMED.

2.0 Scope of Activities

This report provides October – December 2020 perchlorate screening analytical results for groundwater monitoring well CYN-MW15 (Figure II-1, Table II-1). In accordance with the requirements of Table XI-1 of the Consent Order, a well with four consecutive quarters of non-detects (NDs) for perchlorate at the screening level/method detection limit (MDL) of 4 micrograms per liter (µg/L) is removed from the requirement of continued monitoring for perchlorate. Data for numerous monitoring wells identified in the Consent Order have satisfied this requirement; these wells have been removed from the perchlorate screening program. Perchlorate results for these wells are not discussed in this current report. Table II-2 lists the monitoring wells discussed in previous perchlorate screening reports.

SNL/NM personnel performed groundwater sampling for perchlorate at monitoring well CYN-MW15 in November 2020 (Table II-1). Groundwater sampling activities were conducted in accordance with procedures outlined in the *Burn Site Groundwater Monitoring, Mini-SAP for First Quarter, Fiscal Year 2021* (SNL/NM September 2020).

As described in the Mini-Sampling and Analysis Plans (SAP), groundwater sampling was performed in accordance with current SNL/NM Long-Term Stewardship Project Field Operating Procedures (FOPs). A portable Bennett™ groundwater sampling system was used to collect the groundwater sample. The sampling pump and tubing bundle were decontaminated prior to placement into the monitoring well in accordance with

procedures described in FOP 05-03, "Groundwater Monitoring Equipment Decontamination" (SNL/NM January 2018a). The well was purged a minimum of one saturated screen volume before sampling in accordance with FOP 05-01, "Groundwater Monitoring Well Sampling and Field Analytical Measurements" (SNL/NM January 2018b). Field water quality measurements for turbidity, potential of hydrogen (pH), temperature, specific conductivity (SC), oxidation-reduction potential (ORP), and dissolved oxygen (DO) were obtained from the well prior to collecting the groundwater sample. Groundwater temperature, SC, ORP, DO, and pH were measured with an In-Situ Incorporated Aqua TROLL® 600 Multiparameter water quality meter. Turbidity was measured with a HACH™ Model 2100Q turbidity meter. Purging continued until four stable measurements for turbidity, pH, temperature, and SC were obtained. Groundwater stability is considered acceptable when the following parameters are achieved:

- Turbidity measurements are less than 5 nephelometric turbidity units (NTUs); or for final turbidity values greater than 5 NTUs, the final four measurements are within 10 percent of each other.
- pH is within 0.1 units.
- Temperature is within 1.0 degree Celsius.
- SC is within 5 percent.

Field measurement logs documenting details of well purging and water quality measurements have been submitted to the SNL/NM Customer Funded Record Center.

Groundwater samples were submitted to GEL Laboratories, LLC for chemical analysis of perchlorate using U.S. Environmental Protection Agency (EPA) Method 314.0 (EPA November 1999). Table II-3 provides the sample identification, Analysis Request/Chain-of-Custody form number, and the associated groundwater investigation area. The analytical report from GEL Laboratories, LLC, including certificates of analysis (Appendix A), analytical methods, MDLs, practical quantitation limits, dates of analyses, results of quality control analyses, and data validation findings (Appendix B), have been submitted to the SNL/NM Customer Funded Record Center.

3.0 Regulatory Criteria

For a given monitoring well, four consecutive ND results using the screening level/MDL of 4 µg/L are considered by the NMED HWB as evidence of the absence of perchlorate, such that additional monitoring for perchlorate in that well is not required. If perchlorate

is detected using the screening level/MDL of 4 µg/L in a specific well, then monitoring will continue at that well at a frequency negotiated with the NMED. The Consent Order (NMED April 2004) also requires that detections equal to or greater than 4 µg/L be evaluated by DOE/NNSA and SNL/NM personnel to determine the nature and extent of perchlorate contamination and incorporate the results of this evaluation into a Corrective Measures Evaluation (CME), based on a screening level/MDL of 4 µg/L. The Consent Order, Section VII.C, clarifies that the CME process will be initiated where there is a documented release to the environment, and where corrective measures are necessary to protect human health and the environment.

3.1 Burn Site Groundwater Area of Concern

In March 2007, NMED HWB sent a letter of approval, which required DOE/NNSA and SNL/NM personnel to "determine the nature and extent of the contamination and complete a CME for the perchlorate-impacted groundwater in the vicinity of CYN-MW6" (NMED March 2007). As this was based solely on four quarters of monitoring results, DOE/NNSA and SNL/NM personnel submitted a letter to the NMED HWB in April 2007 (SNL/NM April 2007) recommending further characterization through continued quarterly monitoring of monitoring well CYN-MW6 for an additional four quarters, ending in December 2007, to ensure appropriate characterization of this well. In January 2008, DOE/NNSA and SNL/NM personnel requested a meeting with the NMED HWB to discuss the need for continued monitoring or additional characterization work and, potentially, a CME.

In preparation for discussing the perchlorate-impacted groundwater in the vicinity of monitoring well CYN-MW6, and to show that the requirement "to determine the nature and extent of contamination" (NMED March 2007) had been met, DOE/NNSA and SNL/NM personnel provided supporting information to the NMED HWB (SNL/NM March 2008). Perchlorate in surface soil has been characterized at several Solid Waste Management Units in the study area (SNL/NM June 2006 and March 2008–Appendix C). Based on these data, DOE/NNSA and SNL/NM personnel consider the nature and extent of perchlorate in groundwater at the BSG AOC to be sufficiently characterized. Since 2004, groundwater samples from four other monitoring wells in the vicinity of the BSG AOC have been analyzed for perchlorate, including monitoring wells CYN-MW1D, CYN-MW5, CYN-MW7, and CYN-MW8. All monitoring wells were sampled for four quarters and all results were ND for perchlorate (SNL/NM March 2008–Appendix D).

In accordance with the requirements of Section VI.K.1.b of the Consent Order (NMED April 2004), a human health risk assessment has been performed to evaluate the potential for adverse health effects from the concentrations of perchlorate detected in monitoring well CYN-MW6 groundwater samples. The maximum perchlorate concentration in CYN-MW6 to date of 8.93 µg/L was used in the risk assessment. The calculated hazard quotient of 0.35 is less than the NMED HWB target level of a hazard index (the sum of all hazard quotients) of 1.0 (NMED June 2006, SNL/NM March 2008–Appendix E). For another point of comparison, NMED HWB risk assessment guidance lists a tap water standard of 13.8 µg/L for perchlorate (NMED February 2019a); therefore, the historical maximum concentration detected is 35 percent less than the NMED HWB tap water standard.

Because perchlorate concentrations in samples from monitoring well CYN-MW6 have exceeded the screening level, DOE/NNSA and SNL/NM personnel initiated a negotiation process with the NMED HWB (SNL/NM March 2007) to determine the frequency of continued monitoring. In November 2008, DOE/NNSA and SNL/NM personnel received approval from the NMED HWB to proceed with semiannual monitoring of perchlorate in monitoring well CYN-MW6 and proceed with semiannual reporting of all perchlorate results (NMED November 2008). Upon further consideration, the NMED HWB once more required that DOE/NNSA and SNL/NM personnel resume quarterly monitoring and reporting of perchlorate results except for monitoring well CYN-MW6 (NMED April 2009). Due to declining water levels, CYN-MW6 has insufficient water to routinely sample and was replaced; the last sample collected at CYN-MW6 was on October 15, 2012. The replacement monitoring well (CYN-MW15) was installed in December 2014 and assumed the negotiated semiannual monitoring frequency. Monitoring well CYN-MW14A was also installed in December 2014; this well was considered a new monitoring well that required quarterly sampling due to its deep screen interval.

In April 2009, NMED HWB sent a letter that required DOE/NNSA and SNL/NM personnel to characterize the nature and extent of the perchlorate contamination in soil and groundwater in the BSG AOC (NMED April 2009). A characterization work plan was prepared and submitted to the NMED HWB (SNL/NM November 2009), conditionally approved by the NMED HWB (NMED February 2010), and implemented in July 2010.

In January 2019, a Monitoring Well Installation Work Plan for the BSG AOC was submitted to NMED HWB (SNL/NM January 2019) and subsequently approved by NMED HWB (NMED February 2019b). The work plan proposed a minimum of four monitoring wells (CYN-MW16 through CYN-MW19) that would help define the extent of nitrate contamination in groundwater and refine the potentiometric surface in the BSG AOC. These four new monitoring wells were sampled for the fourth time during the July – September 2020 reporting period (all results were ND) and have met the minimum of four quarters perchlorate sampling requirement.

3.2 Tijeras Arroyo Groundwater and Technical Area-V Groundwater Areas of Concern

The April 2009 letter from the NMED HWB to DOE/NNSA and SNL/NM personnel was not limited to the BSG AOC (NMED April 2009). The NMED HWB had also requested that DOE/NNSA and SNL/NM personnel monitor perchlorate concentrations for a minimum of four quarters at five monitoring wells in the Tijeras Arroyo Groundwater (TAG) AOC and at four monitoring wells in the Technical Area-V Groundwater AOC. All nine monitoring wells from these two AOCs have been sampled for four consecutive monitoring events with no perchlorate detections being reported; therefore, these nine wells have been removed from the perchlorate monitoring well network. A TAG monitoring well (TA2-SW1-320) was damaged and was replaced by well TA2-W-28 in December 2014. The replacement well was installed for monitoring the same depth interval as damaged well TA2-SW1-320. Because well TA2-SW1-320 was not one of the four TAG monitoring wells selected for perchlorate sampling, replacement well TA2-W-28 does not require perchlorate sampling.

4.0 Monitoring Results

Table II-3 summarizes the details of the sample collected from monitoring well CYN-MW15 during the October - December 2020 reporting period. Table II-4 summarizes the current and historical perchlorate results for this monitoring well. Appendix A provides the analytical laboratory certificates of analysis for the October - December 2020 perchlorate data. For the eighth time in thirteen sampling events (since December 2014), perchlorate was ND at the screening level/MDL of 4.0 µg/L in the November 2020 CYN-MW15 environmental groundwater sample (Figure II-2). This ND represents the fourth time in four consecutive sampling events that perchlorate was ND at this well. The

hydrograph for monitoring well CYN-MW15 (Figure II-2) shows that the water table elevation has been decreasing over the past several years.

Table II-5 summarizes the stabilized water quality values measured immediately before the groundwater sample was collected. The field water quality measurements include turbidity, pH, temperature, SC, ORP, and DO.

The analytical data were reviewed and validated in accordance with Administrative Operating Procedure 00-03, "Data Validation Procedure for Chemical and Radiochemical Data," (SNL/NM June 2017). Nothing in the validation of the analytical results indicated that the data should be qualified as unusable. The data are acceptable and reported quality control measures are adequate. Appendix B provides the data validation sample findings summary sheets for the perchlorate data.

No variances or nonconformances in perchlorate sampling field activities, or field conditions from requirements in the groundwater monitoring Mini-SAP (SNL/NM September 2020), were identified during the October - December 2020 sampling activities.

5.0 Summary and Conclusions

Based on analytical data presented in Table II-4 and in previous reports, the following statements can be made:

- The perchlorate concentration for the groundwater sample collected from monitoring well CYN-MW15 was ND for the fourth consecutive sampling event.
- Having met the requirements of the Consent Order (NMED April 2004), DOE/NNSA and SNL/NM personnel will discontinue monitoring for perchlorate at monitoring well CYN-MW15 unless NMED requires further monitoring.
- Since June 2004 (the start of sampling as required by the Consent Order), perchlorate was detected above the screening level/MDL (4 µg/L) in groundwater samples collected from only one well (CYN-MW6) and its replacement well (CYN-MW15) in the perchlorate monitoring well network.
- NMED HWB risk assessment guidance lists a tap water standard of 13.8 µg/L for perchlorate (NMED February 2019a); by comparison, the historical maximum perchlorate concentration detected at CYN-MW15 (4.66 µg/L) is considerably less than the NMED HWB tap water standard.

- DOE/NNSA and SNL/NM personnel will discontinue monitoring and reporting of perchlorate at this time. Based on the requirements of the Consent Order, perchlorate monitoring and reporting will be reinstated when a new well is installed at any of the groundwater investigation study areas.

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Figures

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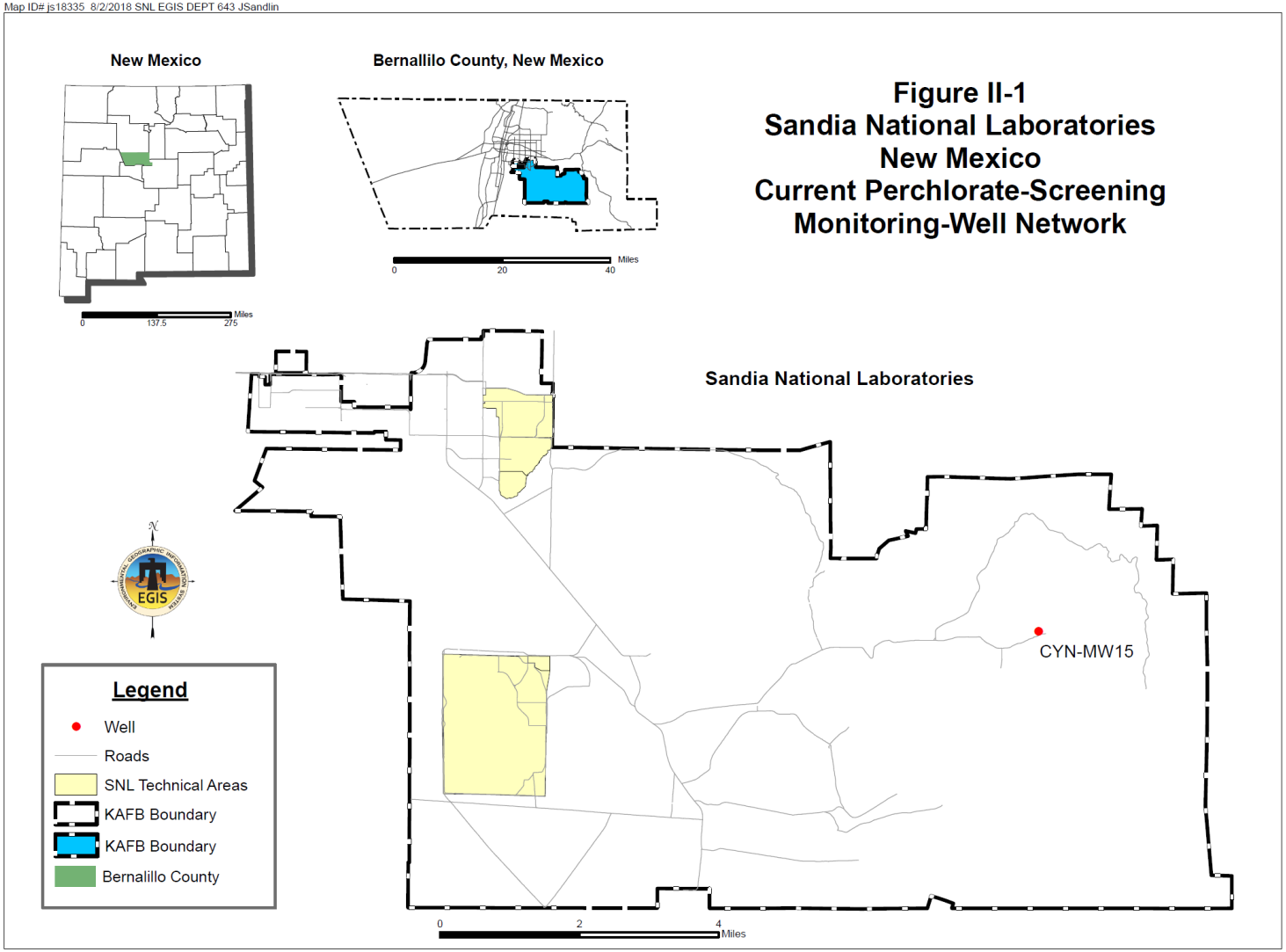
Map ID# js18335_8/2/2018 SNL EGIS DEPT 643 JSandlin



Sandia National Laboratories, New Mexico
Environmenatl Geographic Information System

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

Figure II-1
Sandia National Laboratories, New Mexico
Current Perchlorate Screening Monitoring Well Network, October - December 2020

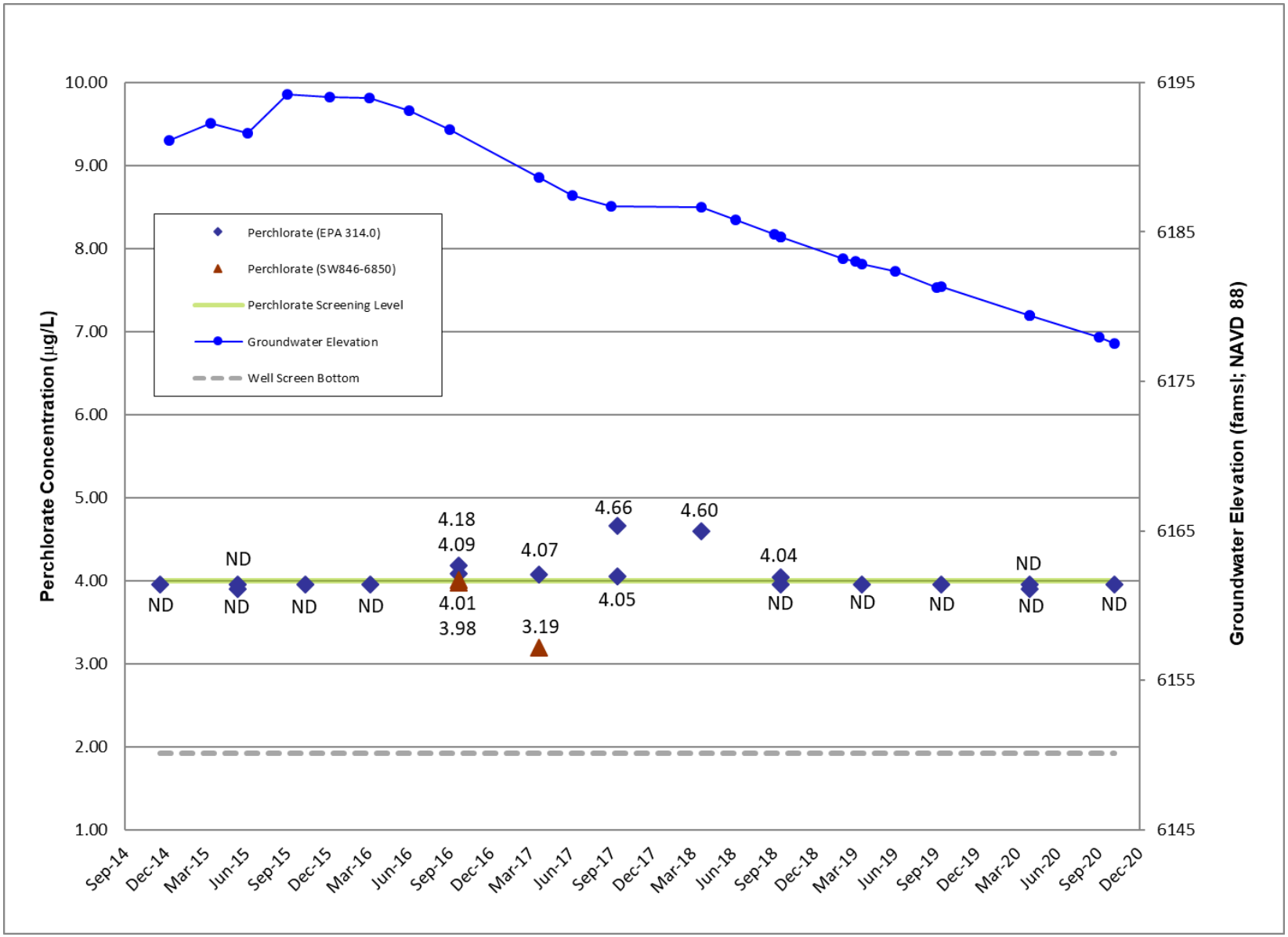


Figure II-2

Groundwater Elevations and Perchlorate Concentrations Over Time in CYN-MW15

Tables

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Table II-1
Current Perchlorate Screening Monitoring Well Network
October - December 2020

Well	Date Sampled	Number of Consecutive Sampling Events[a]	Remaining Number of Sampling Events[b]	Sampling Equipment
CYN-MW15	05-Nov-20	13	0	Bennett™ Pump

Notes:

[a] Includes this sampling event, perchlorate was non-detect for the last four sampling events.
[b] This well has met the requirements of the Consent Order (NMED April 2004) and will be removed from the perchlorate monitoring program unless NMED requires further monitoring.

Consent Order = Compliance Order on Consent.
CYN = Canyons (Burn Site Groundwater Area of Concern).
MW = Monitoring well.
NMED = New Mexico Environment Department.

Table II-2
Monitoring Wells Discussed in Previous Perchlorate Screening Reports

Well	Date of Last Perchlorate Sampling Event
CCBA-MW1	Oct 2014
CCBA-MW2	Oct 2014
CTF-MW1	Jan 2014
CTF-MW2	Sep 2014
CTF-MW3	Sep 2014
CYN-MW1D	Sep 2006
CYN-MW5	Jan 2014
CYN-MW6	Oct 2012
CYN-MW7	Dec 2006
CYN-MW8	Dec 2006
CYN-MW9	May 2011
CYN-MW10	May 2011
CYN-MW11	May 2011
CYN-MW12	May 2011
CYN-MW14A	Sep 2015
CYN-MW16	Jul 2020
CYN-MW17	Jul 2020
CYN-MW18	Jul 2020
CYN-MW19	Jul 2020
LWDS-MW1	Feb 2010
MRN-2	Sep 2006
MRN-3D	Sep 2006

Well	Date of Last Perchlorate Sampling Event
MWL-BW1	Apr 2005
MWL-BW2	Jan 2009
MWL-MW1	Apr 2005
MWL-MW7	Apr 2009
MWL-MW8	Apr 2009
MWL-MW9	Apr 2009
NWTA3-MW2	Jun 2006
OBS-MW1	Oct 2014
OBS-MW2	Oct 2014
OBS-MW3	Oct 2014
SWTA3-MW4	Dec 2006
TA1-W-03	Nov 2010
TA1-W-06	May 2010
TA1-W-08	May 2010
TA2-W-01	May 2010
TA2-W-27	May 2010
TAV-MW11	Nov 2011
TAV-MW12	Nov 2011
TAV-MW13	Nov 2011
TAV-MW14	Nov 2011
TAV-MW15	Oct 2017
TAV-MW16	Nov 2017

Notes:

BW = Background well.
CCBA = Coyote Canyon Blast Area.
CTF = Coyote Test Field.
CYN = Canyons (Burn Site Groundwater Area of Concern).
LWDS = Liquid waste disposal system.
MRN = Magazine Road North.
MW = Monitoring well.
MWL = Mixed Waste Landfill.
NWTA3 = Northwest Technical Area (-III).
OBS = Old Burn Site.
SWTA3 = Southwest Technical Area (-III).
TA1-W = Technical Area-I (Well).
TA2-W = Technical Area-II (Well).
TAV = Technical Area-V.

Table II-3
Sample Details for October – December 2020 Perchlorate Sampling

Well	Sample Identification	AR/COC Number	Associated Groundwater Investigation
CYN-MW15	113809-004	621509	BSG AOC

Notes:

AOC = Area of Concern.
AR/COC = Analysis Request/Chain-of-Custody.
BSG = Burn Site Groundwater.
CYN = Canyons (Burn Site Groundwater Area of Concern).
MW = Monitoring well.

Table II-4
Summary of Perchlorate Screening Analytical Results for the Current Monitoring Well Network, October - December 2020

Well	Sample Date	AR/COC Number	Sample Number	Result (µg/L)	MDL (µg/L)	PQL (µg/L)	MCL (µg/L)	Laboratory Qualifier[a]	Validation Qualifier[b]	Analytical Method[c]	Comments
Burn Site Groundwater Area of Concern											
CYN-MW15	17-Dec-14	615941	096979-020	ND	4.0	12	NE	U		EPA 314.0	
	11-Jun-15	616178	097842-020	ND	4.0	12	NE	U		EPA 314.0	
			097843-020	ND	4.0	12	NE	U		EPA 314.0	Duplicate sample
	10-Nov-15	616396	098486-020	ND	4.0	12	NE	U		EPA 314.0	
	05-Apr-16	616862	099139-008	ND	4.0	12	NE	U		EPA 314.0	
	21-Oct-16	617385	100705-004	4.09	4.0	12	NE	J		EPA 314.0	
			100705-R04	3.98	0.25	1.0	NE			SW846 6850	
			100706-004	4.18	4.0	12	NE	J		EPA 314.0	Duplicate sample
			100706-R04	4.01	0.25	1.0	NE			SW846 6850	Duplicate sample
	19-Apr-17	617823	102400-013	4.07	4.0	12	NE	J		EPA 314.0	
			102400-R13	3.19	0.10	0.40	NE	Hh	J-	SW846 6850	
	13-Oct-17	618205	103748-004	4.05	4.0	12	NE	J		EPA 314.0	
			103749-004	4.66	4.0	12	NE	J		EPA 314.0	Duplicate sample
	19-Apr-18	618667	105068-008	4.60	4.0	12	NE	J		EPA 314.0	
	16-Oct-18	619203	106473-004	ND	4.0	12	NE	U		EPA 314.0	
			106474-004	4.04	4.0	12	NE	J		EPA 314.0	Duplicate sample
	17-Apr-19	619631	108030-008	ND	4.0	12	NE	U		EPA 314.0	
	11-Oct-19	620306	110529-004	ND	4.0	12	NE	NU		EPA 314.0	
	28-Apr-20	602990	112730-006	ND	4.0	12	NE	U		EPA 314.0	
			112731-006	ND	4.0	12	NE	U		EPA 314.0	Duplicate sample
	05-Nov-20	621509	113809-004	ND	4.0	12	NE	U		EPA 314.0	

Notes:

[a]Laboratory Qualifier
If cell is blank, then all quality control samples meet acceptance criteria with respect to submitted samples.
H = Analytical holding time was exceeded.
h = Prep holding time exceeded.
J = Estimated value, the analyte concentration fell above the effective MDL and below the effective PQL.
N = Results associated with a spike analysis that was outside control limits.
U = Analyte is absent or below the MDL.

[b]Validation Qualifier
If cell is blank, then all quality control samples meet acceptance criteria with respect to submitted samples.
J- = The associated numerical value is an estimated quantity with a suspected negative bias.

[c]Analytical Method
EPA 314.0: EPA, November 1999, “Perchlorate in Drinking Water Using Ion Chromatography,” EPA 815/R-00-014.
SW846 6850: EPA, 1986 (and updates), “Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,” SW-846, 3rd ed., EPA, Washington, D.C.

Table II-4 *(Concluded)*
Summary of Perchlorate Screening Analytical Results for the Current Monitoring Well Network, October - December 2020

Notes (*continued*):

%	=	Percent.
µg/L	=	Micrograms per liter.
AR/COC	=	Analysis Request/Chain-of-Custody.
CFR	=	Code of Federal Regulations.
CYN	=	Canyons (Burn Site Groundwater Area of Concern).
EPA	=	U.S. Environmental Protection Agency.
MCL	=	Maximum contaminant level. Established by the EPA Primary Water Regulations (40 CFR 141.11, Subpart B) and subsequent amendments or Title 20, Chapter 7, Part 1 of the New Mexico Administrative Code, incorporating 40 CFR 141.
MDL	=	Method detection limit. The minimum concentration that can be measured and reported with 99% confidence that the analyte is greater than zero; analyte is matrix-specific.
MW	=	Monitoring well.
ND	=	Non-detect (at MDL).
NE	=	Not established.
PQL	=	Practical quantitation limit. The lowest concentration of analytes in a sample that can be reliably determined within specified limits of precision and accuracy by the indicated method under routine laboratory operating conditions.

Table II-5
Perchlorate Screening Groundwater Monitoring
Field Water Quality Measurements[a], October - December 2020

Well	Sample Date	Temperature (°C)	Specific Conductivity (µmho/cm)	Oxidation-Reduction Potential (mV)	pH	Turbidity (NTU)	Dissolved Oxygen (% Sat)	Dissolved Oxygen (mg/L)
Burn Site Groundwater Area of Concern								
CYN-MW15	05-Nov-20	18.05	1209.9	183.5	7.06	0.58	13.80	1.14

Notes

[a] Field measurements obtained immediately before the groundwater sample was collected.

°C = Degrees Celsius.
% Sat = Percent saturation.
µmho/cm = Micromho(s) per centimeter.
CYN = Canyons (Burn Site Groundwater Area of Concern).
mg/L = Milligrams per liter.
mV = Millivolt(s).
MW = Monitoring well.
NTU = Nephelometric turbidity unit.
pH = Potential of hydrogen (negative logarithm of the hydrogen ion concentration).

Appendix A
Analytical Laboratory Certificates of Analysis for the Perchlorate Data

SMO 2012-ARCOC (4-2012)

CONTRACT LABORATORY
ANALYSIS REQUEST AND CHAIN OF CUSTODY

AOP 95-16

526621

Internal Lab

Batch No. n/a

SMO Use

Project Name:	BSG AOC	Date Samples Shipped:	11/5/20
Project/Task Manager:	Michael Skelly	Carrier/Waybill No	32576
Project/Task Number:	195122.12.11.01	Lab Contact:	Edie Kent/843-769-7385
Service Order:	CF058-21	Lab Destination:	GEL
		Contract No.:	1983530

SMO Authorization:

SMO Contact Phone: Wendy Palencia/505-844-3132

Send Report to SMO: Stephanie Montaño/505-284-2553

Page 1 of 1

AR/COC 621509

- ☐ Waste Characterization
- ☐ RMA
- ☐ Released by COC No.
- ☑ 4° Celsius

Bill to: Sandia National Laboratories (Accounts Payable), P.O. Box 5800, MS-0154 Albuquerque, NM 87185-0154

Tech Area:

Building: Room:

Operational Site:

Sample No.	Fraction	Sample Location Detail	Depth (ft)	Date/Time Collected	Sample Matrix	Container Type	Container Volume	Preservative	Collection Method	Sample Type	Parameter & Method Requested	Lab Sample ID
113809	001	CYN-MW15	182	11/5/20 10:35	GW	G	3x40 ml	NONE	G	SA	TPH-GRO (SW846-8015)	001
113809	002	CYN-MW15	182	11/5/20 10:36	GW	AG	4x1 L	NONE	G	SA	TPH-DRO (SW846-8015)	002
113809	003	CYN-MW15	182	11/5/20 10:37	GW	P	125 ml	H2SO4	G	SA	NPN (EPA 353.2)	003
113809	004	CYN-MW15	182	11/5/20 10:38	GW	P	250 ml	None	G	SA	PERCHLORATE (EPA 314.0)	004
113810	001	BSG AOC-TB 11	NA	11/5/20 10:35	DIW	G	3x40 ml	None	G	TB	TPH-GRO (SW846-8015)	005

Last Chain: ☐ Yes

Validation Req'd: ☑ Yes

Background: ☐ Yes

Confirmatory: ☐ Yes

Sample Tracking (SMO Use)

Date Entered:

Entered by:

QC inits.:

Special Instructions/QC Requirements:

EDD ☑ Yes

Turnaround Time ☐ 7-Day* ☐ 15-Day* ☑ 30-Day

Negotiated TAT ☐

Sample Disposal ☐ Return to Client ☑ Disposal by Lab

Return Samples By:

Comments: No verification analysis required for perchlorated. Received trip blanks from lab with head space.

Conditions on Receipt

Sample Team Members

Name	Signature	Init.	Company/Organization/Phone/Cell
Robert Lynch		RL	SNL/08888/505-844-4013/505-250-7090
Zachary Tenorio		ZT	SNL/08888/505-845-8636/505-259-5765

Relinquished by		Org. 8888	Date 11/5/20	Time 1140	Relinquished by	Org.	Date Time
Received by		Org. 0628	Date 11/5/20	Time 1170	Received by	Org.	Date Time
Relinquished by		Org. 0628	Date 11/5/20	Time 1245	Relinquished by	Org.	Date Time
Received by		Org.	Date 11/6/20	Time 740	Received by	Org.	Date Time

Lab Use

*Prior confirmation with SMO required for 7 and 15 day TAT

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: November 30, 2020

Company :	Sandia National Laboratories
Address :	1515 Eubank SE,ORG 4142 BLDG. 1090/120, MS 1103 Albuquerque, New Mexico 87123
Contact:	Ms. Wendy Palencia
Project:	Groundwater, Level C Package

Client Sample ID:	113809-004	Project:	SNLSGWtr
Sample ID:	526621004	Client ID:	SNLS005
Matrix:	AQUEOUS		
Collect Date:	05-NOV-20 10:38		
Receive Date:	06-NOV-20	Client Desc.:	CYN-MW15
Collector:	Client	Vol. Recv.:	

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Ion Chromatography												
EPA 314.0 Perchlorate by IC "As Received"												
Perchlorate	U	ND	0.00400	0.0120	mg/L		1	LXA2	11/24/20	1038	2061354	1

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 314.0 DOE-AL	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Appendix B
Data Validation Sample Findings Summary Sheets for the Perchlorate Data

PO Box 21987
Albuquerque, NM 87154
1-888-678-5447
www.aqainc.net

Memorandum

Date: December 9, 2020

To: File

From: Mary Donivan

Subject: Inorganic Data Review and Validation – SNL
Site: BSG AOC
ARCOC: 621509 and 621512
SDG: 526621
Laboratory: GEL
Project/Task: 195122.12.11.01
Analysis: General Chemistry

See the attached Data Validation Worksheets for supporting documentation on the data review and validation. This validation was performed according to SNL/NM SMO Procedure AOP 00-03 Rev 6.

Summary

Two samples were prepared and analyzed with accepted procedures using method EPA 353.2 (nitrate/nitrite) and one sample was prepared and analyzed with accepted procedures using method EPA 314.0 (perchlorate). Data were reported for the required analyte. No problems were identified with the data package that resulted in the qualification of data.

Data are acceptable and reported QC measures appear to be adequate. The following sections discuss the data review and validation.

Holding Times and Preservation

The samples were prepared and analyzed within the prescribed holding time and were properly preserved.

Calibration

All initial and continuing calibrations met QC acceptance criteria.

Blanks

No target analyte was detected in any of the blanks.

Laboratory Control Sample (LCS)

The LCS recovery met QC acceptance criteria.

Matrix Spike (MS)

The PS analysis met QC acceptance criteria.

Laboratory Replicate

The replicate analysis met QC acceptance criteria.

Detection Limits/Dilutions

All detection limits were properly reported and were correctly adjusted for dilutions performed due to elevated target analyte concentrations and/or matrix interference.

Nitrate/nitrite:
Samples 526621003 and -008 were diluted 50X.

Other QC

No other specific issues that affect data quality were identified.

Reviewed by: Linda Thal **Level:** I **Date:** 12/11/2020

Sample Findings Summary

AR/COC: 621509, 621512

Analytical Method	Sample ID	Analyte Name (CAS#)	Qualifier, RC
SW846 3535A/8015D			
	113809-002/CYN-MW15	Diesel Range Organics (68334-30-5)	UJ, MS3
	113815-002/CYN-MW9	Diesel Range Organics (68334-30-5)	J-, MS3

All other analyses met QC acceptance criteria; no further data should be qualified.

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APPENDIX

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SECTION III
TECHNICAL AREA-V IN-SITU BIOREMEDIATION TREATABILITY STUDY PHASE I FULL-SCALE OPERATION, October – December 2020

1.0 Background

Sandia National Laboratories, New Mexico (SNL/NM) personnel are conducting a Treatability Study of in-situ bioremediation (ISB) to address the groundwater contamination by nitrate and trichloroethene (TCE) at the Technical Area-V (TA-V) Groundwater (TAVG) Area of Concern (AOC). SNL/NM personnel planned to conduct the ISB Treatability Study in two phases. Phase I included a pilot test followed by full-scale operation at the first injection well (TAV-INJ1); Phase II will include well installation and full-scale operation at two additional injection wells (TAV-INJ2 and TAV-INJ3), contingent on the success of Phase I full-scale operation. The locations of the three injection wells TAV-INJ1, TAV-INJ2, and TAV-INJ3 are near monitoring wells TAV-MW6, TAV-MW10, and LWDS-MW1, respectively, where the highest contaminant concentrations in the TAVG AOC have historically been detected.

Table III-1 presents a timeline for the Phase I ISB Treatability Study at TAVG AOC. Phase I pilot test began in November 2017 with injections at well TAV-INJ1 completed in November 2017, followed by pilot test performance monitoring through June 2018. SNL/NM personnel began Phase I full-scale operation at the same injection well in October 2018 and completed the six-month injection period in April 2019. Currently, SNL/NM personnel are conducting the two-year performance monitoring in the ISB treatment zone, which is anticipated to conclude in May 2021. The implementation of the Phase I full-scale operation at well TAV-INJ1 is governed by the Revised Treatability Study Work Plan (TSWP) (SNL/NM March 2016) and where applicable, the approved modifications for the full-scale operation at well TAV-INJ1 based on the pilot test results (U.S. Department of Energy [DOE] July 2018; New Mexico Environment Department [NMED] August 2018). Appendix A provides the NMED Hazardous Waste Bureau (HWB) approval letter and DOE's submittal of the proposed modifications.

This Section III of the Environmental Restoration Operations Consolidated Quarterly Report presents the monitoring results for the October – December 2020 reporting period for the ISB Treatability Study Phase I full-scale operation.

In accordance with the Revised TSWP (SNL/NM March 2016), a technical memorandum for the Phase I ISB Treatability Study will be produced after the performance monitoring period has concluded in May 2021 (Table III-1) and will include both the pilot test and the full-scale operation.

No field activities, other than groundwater monitoring to evaluate the performance of the ISB, occurred during this reporting period. The SNL/NM Long-Term Stewardship (LTS) personnel conduct groundwater monitoring for the entire TAVG AOC, including the ISB treatment zone. Groundwater monitoring includes groundwater elevation measurements, field water quality measurements, and groundwater sampling.

2.0 Groundwater Elevations at Technical Area-V

Figure III-1 shows the October 2020 groundwater elevation contour map (potentiometric surface) for the Regional Aquifer at TA-V. The groundwater elevation contours have not changed significantly since the October 2017 pre-Treatability Study baseline (SNL/NM January 2018). Groundwater flows generally to the west and southwest at TA-V. Overall the groundwater elevation at TA-V has been declining at a rate of 0.5 to 0.8 feet per year (SNL/NM June 2020). Approximately 530,000 gallons of substrate solution were injected over a six-month period (November 2018 – April 2019) during the Phase I full-scale operation, but did not create a noticeable effect on the potentiometric surface contours at TA-V.

3.0 Groundwater Monitoring for Phase I Treatability Study

The Phase I ISB Treatability Study treatment zone encompasses injection well TAV-INJ1 and two nearby monitoring wells (TAV-MW6 and TAV-MW7).

To collect field water quality data, In-Situ Incorporated Aqua TROLL® 600 multi-parameter sondes were installed in injection well TAV-INJ1 and monitoring well TAV-MW6. The parameters measured by the sonde included water column height (pressure) above the sonde, dissolved oxygen (DO), oxidation reduction potential (ORP), potential of hydrogen (pH), specific conductivity (SC), temperature, and turbidity. Pressure readings were converted to groundwater elevation in feet above mean sea level. Sonde readings were collected every 15 minutes.

Injection well TAV-INJ1 and monitoring well TAV-MW6 are sampled to evaluate the performance of the ISB Treatability Study. Wells TAV-INJ1 and TAV-MW6 are screened across the water table; and the midpoint of the TAV-MW7 well screen is approximately 90 feet below the water table. Monitoring well TAV-MW7 was originally designated as a monitoring well to evaluate the performance of the ISB (SNL/NM March 2016). However, neither water level nor water quality in well TAV-MW7 were affected by the injections at well TAV-INJ1 due to the depth of the screen at well TAV-MW7. Therefore, well TAV-MW7 was reverted to the TAVG AOC monitoring network (Appendix A, Modification #7). In addition, using an Aqua TROLL® 600 multi-parameter sonde to collect field water quality data every 15 minutes in well TAV-MW7 was unnecessary and was therefore discontinued in December 2019, following SNL/NM's request (SNL/NM October 2019) and NMED's approval (NMED November 2019). Well TAV-MW7 continues to be sampled and reported with wells TAV-INJ1 and TAV-MW6 in Section III of this quarterly report for consistency and completeness.

The two-year performance monitoring includes three monthly sampling events followed by quarterly sampling events for the remainder of the two-year period, as described in the Revised TSWP (SNL/NM March 2016). The three monthly sampling events were completed by July 2019. The Phase I ISB Treatability Study performance monitoring is currently on a quarterly schedule until May 2021 (Table III-1).

Groundwater monitoring is also conducted at eight wells outside the ISB treatment zone on a quarterly schedule to monitor any lateral impact of the injected solution, as described in the Revised TSWP (SNL/NM March 2016).

Table III-2 lists the sampling dates for the October – December 2020 reporting period for all above-mentioned wells pertinent to the Phase I ISB Treatability Study. Before each well was sampled, field water quality data were collected using an aboveground Aqua TROLL® 600 multi-parameter sonde. Tables III-3 through III-6 present the analytical results. Table III-7 summarizes the stabilized field water quality parameters measured immediately before sample collection at each well.

3.1 Groundwater Monitoring inside the Treatment Zone

Groundwater monitoring inside the Phase I ISB treatment zone includes monitoring of the injection well TAV-INJ1 and monitoring wells TAV-MW6 and TAV-MW7.

3.1.1 Injection Well TAV-INJ1

Groundwater elevation at well TAV-INJ1 returned to the pre-injection static level after the injections were completed in April 2019 and remained unchanged through this reporting period.

With the influx of substrate solution, the water near well TAV-INJ1 has changed from aerobic conditions to anaerobic and reducing conditions since the completion of pilot test injections in November 2017 (Table III-1). Since then, DO, ORP, and pH have remained at optimal levels at well TAV-INJ1 for the biodegradation of nitrate and TCE to occur. During this reporting period, pH was steady around 6.9; DO was at 0.0 milligrams per liter (mg/L); and ORP stabilized around negative (-) 390 millivolts.

SC was approximately 850 microsiemens per centimeter (µS/cm) before the start of full-scale injections (SNL/NM January 2020, Table III-2). SC increased after the end of injections in April 2019, peaked at around 3,500 µS/cm in July 2019, and gradually decreased and stabilized around 2,200 µS/cm during this reporting period.

The baseline groundwater temperature in well TAV-INJ1 was approximately 21.1 degrees Celsius. The injected substrate solution, which was primarily potable water, was colder than groundwater because most of the injections occurred during the winter of 2018 – 2019. After injections were completed in April 2019, the water temperature in well TAV-INJ1 rose slowly and was 20.7 degrees Celsius by the end of December 2020.

Turbidity varied daily between single digit and several tens of nephelometric turbidity units during this reporting period, likely due to the suspension of sediments and biological growth in the injection well. In general, turbidity has been much lower than the levels measured during injections, which were in the tens of thousands of nephelometric turbidity units.

During groundwater sampling at well TAV-INJ1, SNL/NM personnel discovered significant sediment accumulation in the well. This is probably due to the repeated disturbance of the geological formation by the 110 injections over the six-month period. As a result, the sampling pump was placed at approximately mid-depth of the water column, higher than where the pump was previously set during the pre-full-scale operation sampling (approximately two feet above the bottom of the screen) when the well was relatively free of sediment. However, the pump was repeatedly clogged by the sediment during purging even after the pump was placed higher in the well. Beginning in January 2020, SNL/NM

personnel used bailers to remove groundwater on the day before sampling to prevent pump failure, allowed the well to recover overnight, and collected samples the next day using the sampling pump. The overnight-recovery follows the standard practice of the SNL/NM LTS Program for sampling low-yield wells.

The analytical parameters for groundwater samples collected from well TAV-INJ1 include the following, in accordance with Modification #8 (Appendix A):

- Alkalinity (total, bicarbonate, and carbonate)
- Ammonia (as nitrogen)
- Anions (bromide and sulfate)
- *Dehalococcoides* (Dhc) and, if Dhc is present, vinyl chloride reductase
- Dissolved metals (arsenic, iron, and manganese)
- Methane/ethane/ethene
- Nitrate plus nitrite (NPN)
- Total organic carbon (TOC)
- Volatile organic compounds (VOCs)

Table III-3 provides the analytical results for the October – December 2020 sampling event at well TAV-INJ1.

Since the Phase I full-scale operation performance monitoring started in June 2019, a total of eight sampling events have occurred at well TAV-INJ1: the first and last week in June 2019, July 2019, October 2019, January 2020, April 2020, July 2020, and November 2020.

The two constituents of concern at TAVG AOC are NPN and TCE. Since June 2019, NPN has not been detected at well TAV-INJ1. Since June 2019, TCE was detected at estimated values (J-qualified) of 0.4, 0.4, and 0.35 micrograms per liter (µg/L) in January (SNL/NM July 2020), April (SNL/NM October 2020), and July 2020 (SNL/NM January 2021). TCE was not detected in the sampling events before January 2020 and was also not detected in November 2020. Ethene, an intermediate TCE degradation indicator, had only two detects since June 2019 and was not detected in November 2020. Concentration profiles were not generated for NPN, TCE, and ethene at well TAV-INJ1.

Figures III-2 through III-12 show the groundwater monitoring results for alkalinity, ammonia, bromide, sulfate, Dhc, arsenic, iron, manganese, methane, ethane, and TOC since June 2019 at well TAV-INJ1. Baseline concentrations from the November 13, 2017 sampling event (SNL/NM October 2018), which occurred prior to the ISB Treatability Study

(i.e., before the pilot test), are shown in these figures, where applicable. Figures III-2 through III-12 show that:

- Alkalinity (as calcium carbonate, $CaCO_3$) remained relatively unchanged (Figure III-2).
- Ammonia (Figure III-3) and TOC (Figure III-12) serve as the nitrogen and carbon source for microbial activities, respectively. Both were being consumed over time, with TOC being consumed more rapidly than ammonia. The concentration of TOC appears to be stabilizing around 10 mg/L since April 2020.
- Bromide, the inert tracer, maintained its concentration at around 18 mg/L in the groundwater around the injection well (Figure III-4).
- Sulfate was consumed (Figure III-5).
- The population of Dhc has decreased to non-detect since January 2020 (Figure III-6). Dhc did not establish a significant population in the groundwater around the injection well.
- Concentrations of dissolved arsenic have exceeded the U.S. Environmental Protection Agency maximum contaminant level of 0.01 mg/L since June 2019 (Figure III-7 and shown in **bold** in Table III-3 for this reporting period) but are gradually decreasing. Concentrations of dissolved iron were variable (Figure III-8); while concentrations of dissolved manganese have gradually increased since June 2019 (Figure III-9). Concentrations of the three dissolved metals all exceeded their baseline concentrations. Elevated dissolved metal concentrations are to be expected during bioremediation. During ISB, the substrate solution produces strongly anaerobic redox conditions in the aquifer that solubilize and mobilize naturally occurring metals and metalloids. The solubilization of these metals is a transient phenomenon and is limited to the ISB treatment zone. Solubilized metals and metalloids will precipitate into solid form once they leave the anaerobic ISB treatment zone and enter the aerobic aquifer.
- The level of methane remained high (19,000 µg/L) in November 2020 and appears to be increasing (Figure III-10). This trend will be verified in future sampling events.
- Ethane is the product of complete dechlorination of TCE. Small amounts of ethane, between 0.1 and 0.2 µg/L, had been produced previously and at the highest concentration of 0.31 µg/L in November 2020 (Figure III-11). Production of ethane will be further verified in future sampling events.

3.1.2 Monitoring Well TAV-MW6

Well TAV-MW6 is located approximately 50 feet east-southeast of well TAV-INJ1 and is screened across the water table as is well TAV-INJ1. The groundwater elevation in well TAV-MW6 remained at static levels during this reporting period. There were no significant changes in ORP, pH, SC, temperature, and turbidity in this well during this reporting period. However, the concentration of DO has decreased from the baseline of approximately

7.0 mg/L to approximately 4.0 mg/L in October 2019. Since then, the DO concentration increased gradually and stabilized at approximately 4.8 mg/L during this reporting period. The analytical parameters for groundwater samples collected from well TAV-MW6 are the same as those for well TAV-INJ1 in accordance with Modification #8 (Appendix A). Table III-4 provides the analytical results for October – December 2020 sampling event at well TAV-MW6.

In accordance with the Revised TSWP (SNL/NM March 2016), well TAV-MW6 was sampled in September 2018 before full-scale operation, and then monthly during the six-month injection period (November 2018 – April 2019). After the injections, it is sampled at the same frequency as the injection well for the two-year performance monitoring (i.e., three monthly sampling events followed by quarterly sampling events for the remainder of the two-year period).

Figure III-13 shows the concentration profiles of the two constituents of concern at the TAVG AOC (NPN and TCE) and Figure III-14 shows the concentration profiles of bromide and methane since September 2018 at well TAV-MW6. The concentrations for the other analytes (alkalinity, ammonia, sulfate, Dhc, arsenic, iron, manganese, ethane, ethene, and TOC) were consistent with the concentrations before the full-scale operation started in September 2018 (SNL/NM April 2019); therefore, concentration profiles were not generated for these analytes.

Figures III-13 and III-14 show that:

- There was no significant change in the concentrations of TCE from the level in September 2018 before full-scale operation; but overall, there was a slight decreasing trend for the concentrations of NPN (Figure III-13).
- Bromide (the inert tracer) was added to the substrate solution injected at well TAV-INJ1. Bromide concentrations are expected to increase in well TAV-MW6 as the substrate solution moves away from well TAV-INJ1. The bromide concentration at well TAV-MW6 before full-scale operation was 0.815 mg/L in September 2018 (SNL/NM April 2019). The bromide concentration at well TAV-MW6 reached its highest concentration of 4.12 mg/L in June 2019 and decreased to approximately 1.0 mg/L since April 2020 (Figure III-14).
- Methane was not detected at well TAV-MW6 before full-scale operation. Methane concentration increased to the highest of 360 µg/L in October 2019, decreased to between 54 and 60 µg/L from January to July 2020, and was 190 µg/L in November 2020 (Figure III-14).

3.1.3 Monitoring Well TAV-MW7

Well TAV-MW7 is located approximately 27 feet east-southeast of well TAV-INJ1 and is screened approximately 90 feet below the water table.

The analytical parameters for groundwater samples collected from well TAV-MW7 include the following in accordance with Modification #7 (Appendix A):

- Bromide
- Dissolved metals (arsenic, iron, and manganese)
- Ethene
- NPN
- VOCs

Table III-5 provides the analytical results for the October – December 2020 sampling event at well TAV-MW7. Analytical results from this reporting period are consistent with the historical values at this well (SNL/NM June 2020).

3.2 Groundwater Monitoring outside the Treatment Zone

In accordance with Section 5.5 of the Revised TSWP (SNL/NM March 2016), eight wells are sampled quarterly for dissolved metals (arsenic, iron, and manganese) to evaluate the potential impact of the substrate solution on groundwater conditions outside the Phase I ISB Treatability Study treatment zone. The eight wells are: LWDS-MW1, TAV-MW2, TAV-MW4, TAV-MW8, TAV-MW10, TAV-MW11, TAV-MW12, and TAV-MW14 (see Figure III-1 for their locations). The analytical parameters for groundwater samples from these wells include:

- Dissolved metals (arsenic, iron, and manganese)
- NPN
- VOCs

These parameters are the same as those for the other monitoring wells in the TAVG AOC monitoring network (SNL/NM June 2020). Table III-6 provides the analytical results for the October – December 2020 sampling event at these wells. Environmental duplicate samples were collected from wells LWDS-MW1, TAV-MW11, and TAV-MW14 per the monitoring requirement of the SNL/NM LTS Program for the TAVG AOC monitoring network.

Analytical results from this reporting period are consistent with the historical values at these eight wells (SNL/NM June 2020).

3.3 Summary of Groundwater Monitoring Results for Phase I Treatability Study

The water quality and analytical results from injection well TAV-INJ1 show the following:

- The water temperature in the well has been slowly rising, indicating the injected solution is mixing with the native groundwater (the injected solution was colder than the local groundwater). On the other hand, the bromide concentration has remained relatively constant, indicating limited groundwater transport.
- The water quality data measured in the injection well indicate that optimal conditions for biodegradation of nitrate and TCE have been maintained, as reflected by the DO, ORP, and pH levels.
- NPN was not detected. Nitrate would have been biodegraded by native bacteria as being the most favorable electron acceptor after DO was depleted (see Section 3.0 of the Revised TSWP [SNL/NM March 2016]).
- TCE was not detected in November 2020.
- The dechlorination bacteria, Dhc, did not establish a significant population in the groundwater around the injection well. However, small but consistent amounts of ethane production suggest complete dechlorination is occurring at the injection well.
- The methane level remained high, indicating active methanogenic microbial activity.

Well TAV-MW6 serves as the monitoring well for evaluating the effectiveness of ISB inside the treatment zone. The water quality and analytical results from this well show the following:

- The DO concentration at well TAV-MW6 reached the lowest level of approximately 4 mg/L in October 2019 and stabilized at 4.8 mg/L during this reporting period. The overall NPN concentrations showed a slight decreasing trend with nitrate being the next favorable electron acceptor for microorganisms as DO was depleted.
- Bromide, the inert tracer, has migrated to well TAV-MW6. Its peak concentration (4.12 mg/L) was observed in June 2019 and was approximately 24 percent of the bromide concentration at the injection well. Bromide concentration decreased and stabilized at approximately 1.0 mg/L since April 2020.
- The methane concentration at well TAV-MW6 reached the highest point of 360 µg/L in October 2019 and was 190 µg/L in November 2020. Methane was not produced at well TAV-MW6 as indicated by the water quality parameters at this well. Rather, methane migrated to well TAV-MW6 from the injection well.
- The Dhc have not reached well TAV-MW6.

- Dechlorination is not occurring at well TAV-MW6 and TCE concentrations remain unchanged.

The water quality and analytical results from well TAV-MW7 indicate that there is no impact on the deeper groundwater monitored by this well from the substrate solution injected at well TAV-INJ1.

For the eight wells located outside the ISB treatment zone, there is no impact on the groundwater chemistry at these wells from the substrate solution injected at well TAV-INJ1.

4.0 Deviation

No deviations were encountered with regards to the Revised TWSP (SNL/NM March 2016) and where applicable, the approved modifications for the full-scale operation at well TAV-INJ1 (DOE July 2018; NMED August 2018).

5.0 References

DOE, see U.S. Department of Energy.

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Figures

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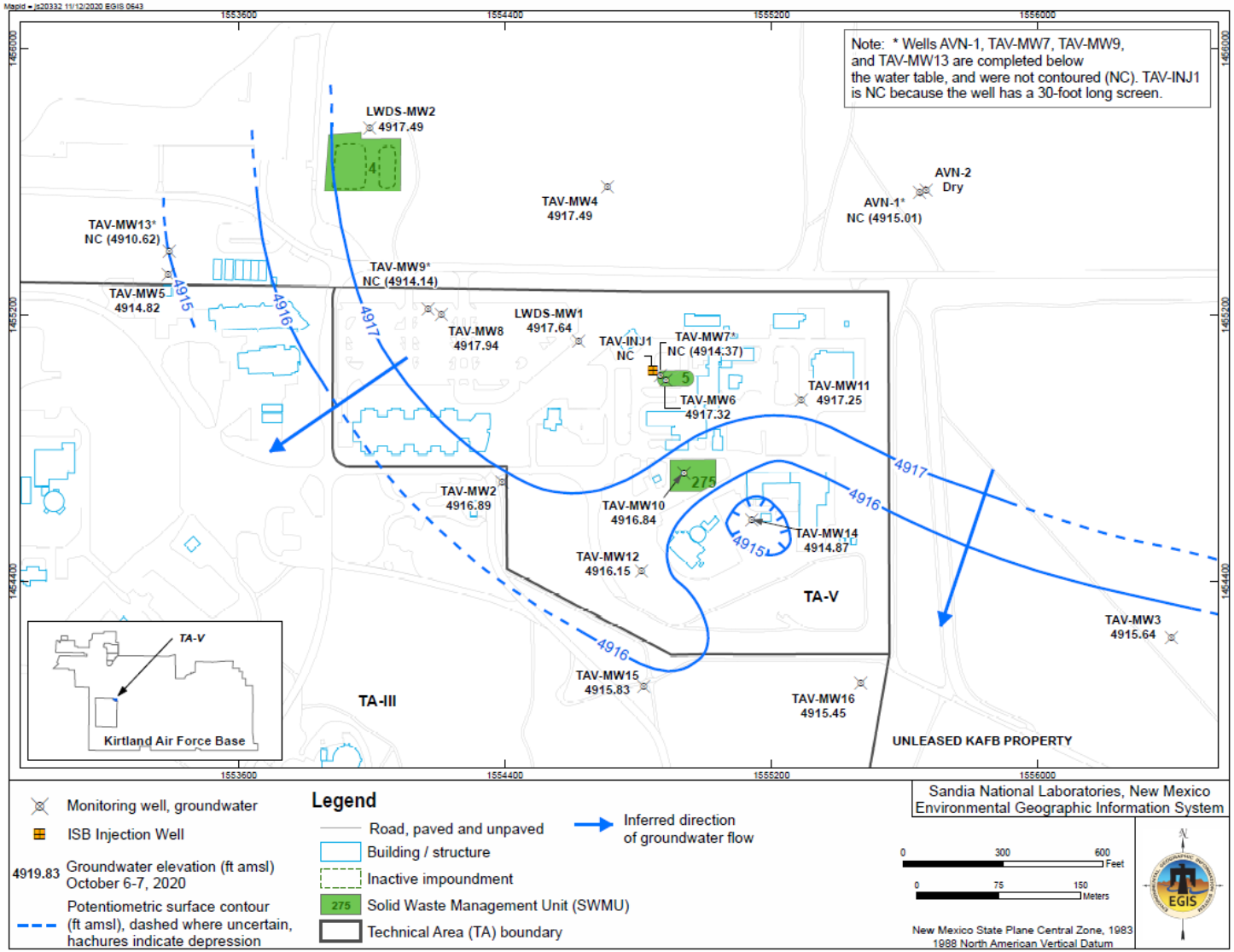

Figure III-1

Well Locations and Potentiometric Surface Contours for October 2020

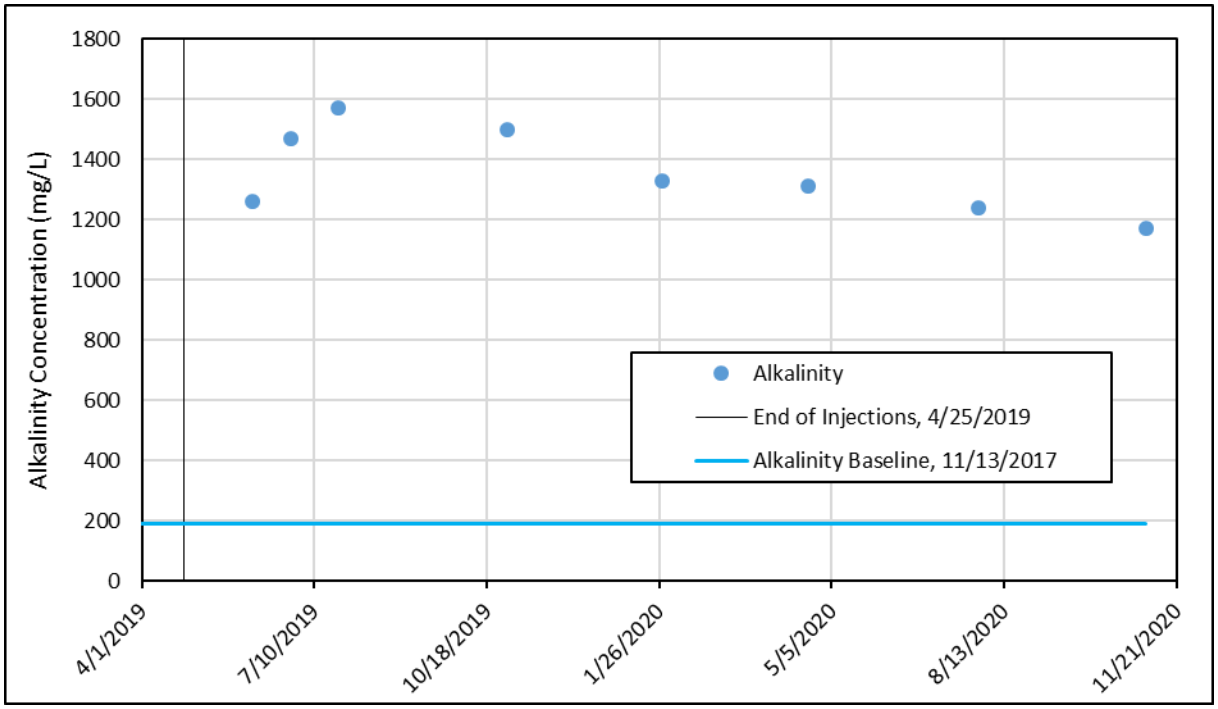

Figure III-2
Concentration of Alkalinity at Injection Well TAV-INJ1, June 2019 – November 2020

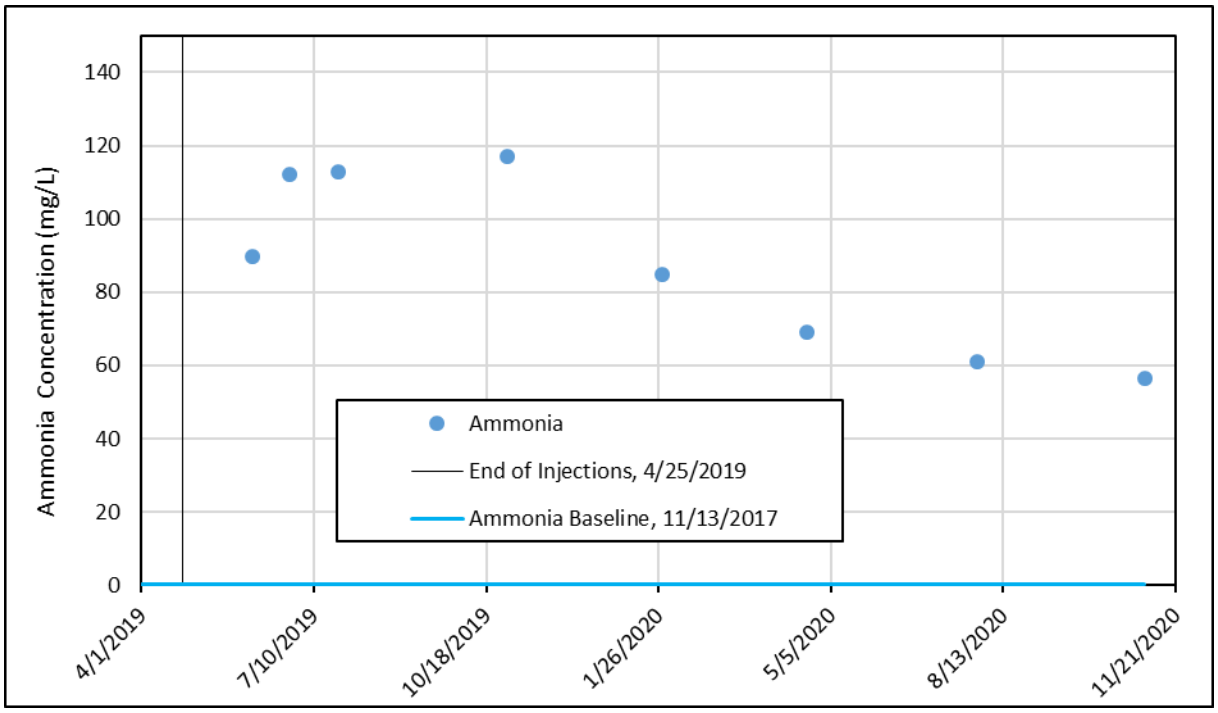

Figure III-3
Concentration of Ammonia at Injection Well TAV-INJ1, June 2019 – November 2020

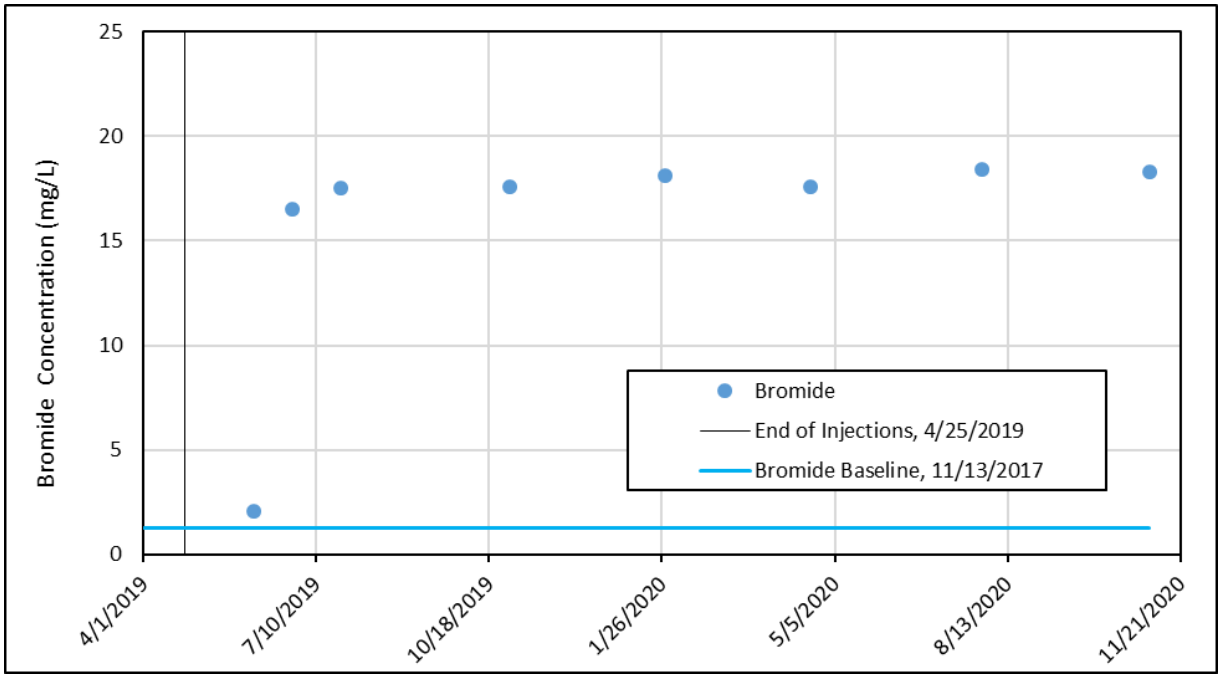

Figure III-4
Concentration of Bromide at Injection Well TAV-INJ1, June 2019 – November 2020

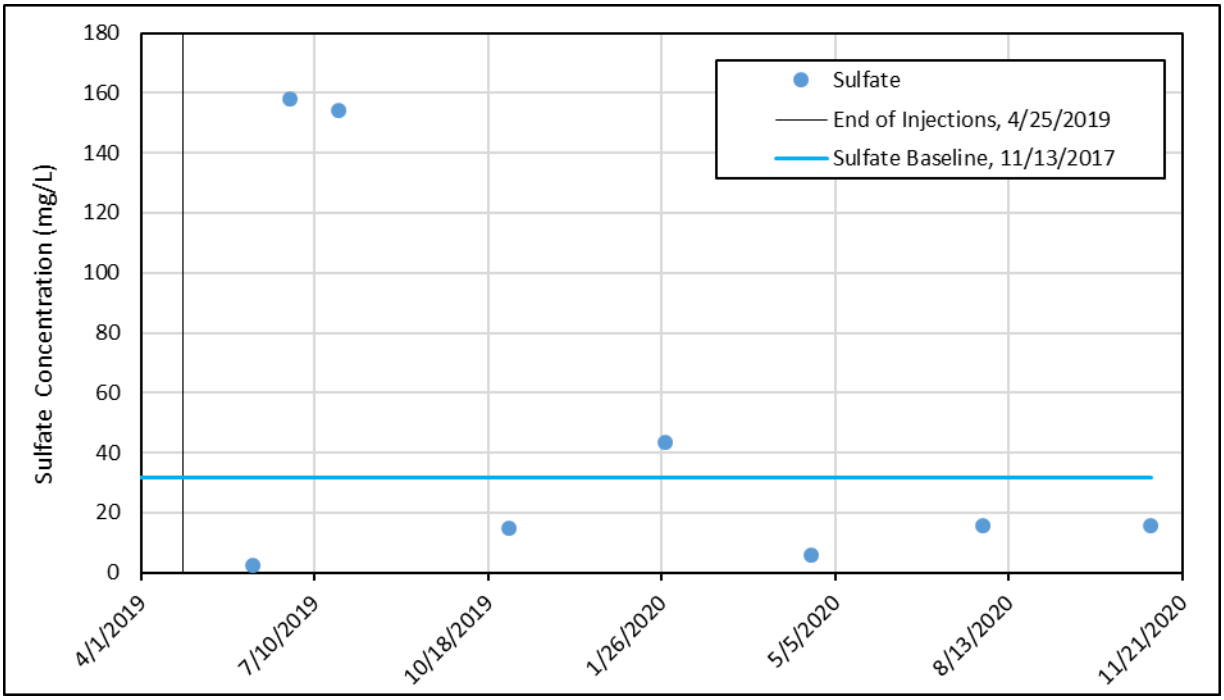

Figure III-5
Concentration of Sulfate at Injection Well TAV-INJ1, June 2019 – November 2020

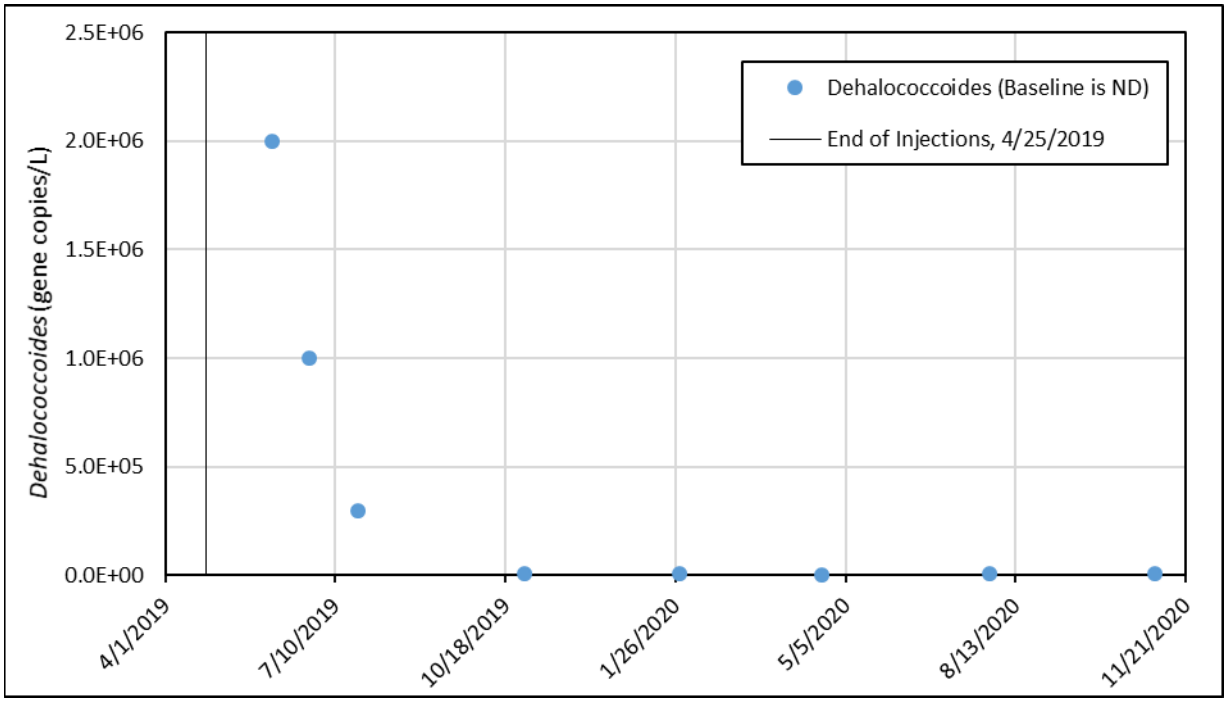

Figure III-6

Enumeration of *Dehalococcoides* at Injection Well TAV-INJ1, June 2019 – November 2020

Note: ND = Not detected.

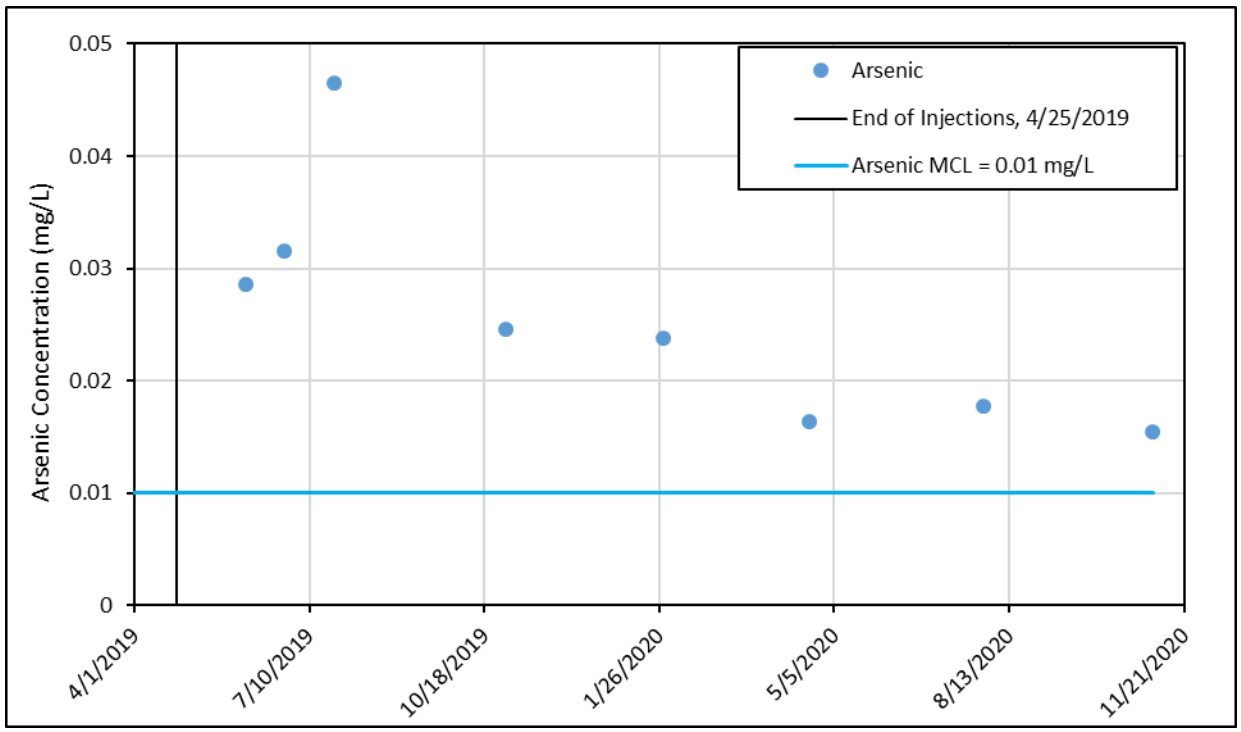

Figure III-7

Concentration of Arsenic at Injection Well TAV-INJ1, June 2019 – November 2020

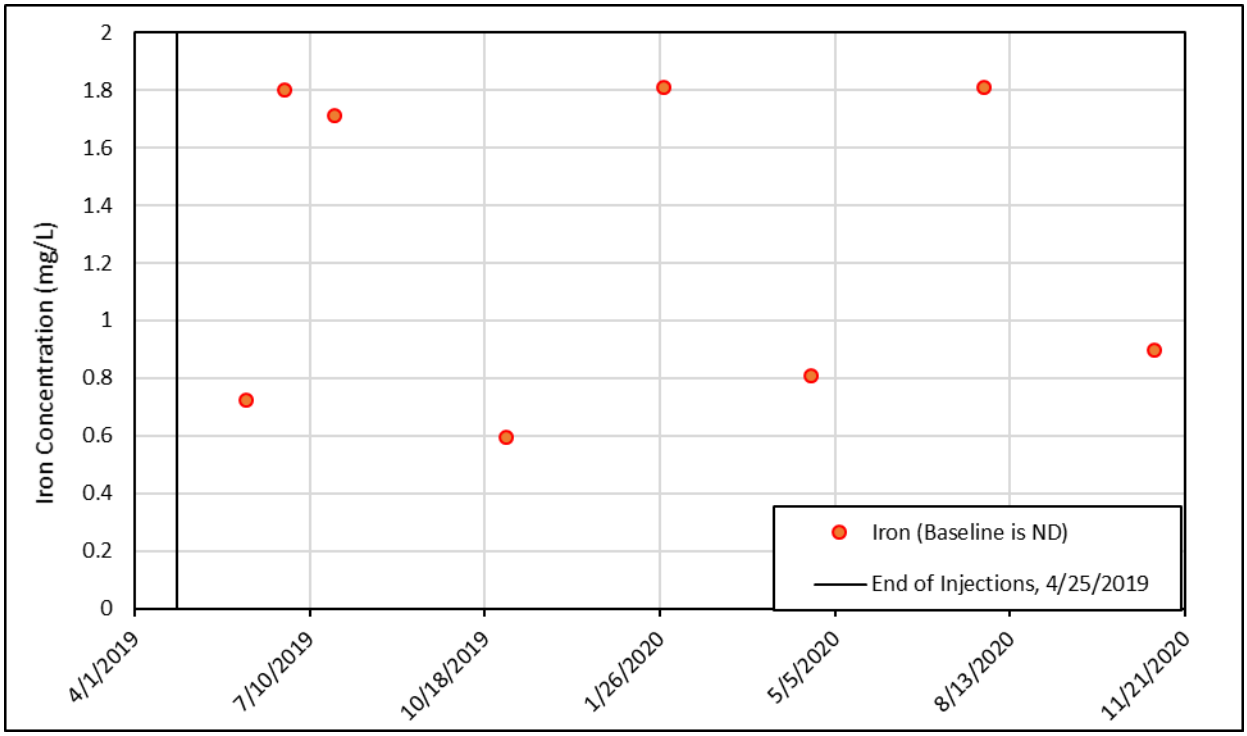

Figure III-8

Concentration of Iron at Injection Well TAV-INJ1, June 2019 – November 2020

Note: ND = Not detected.

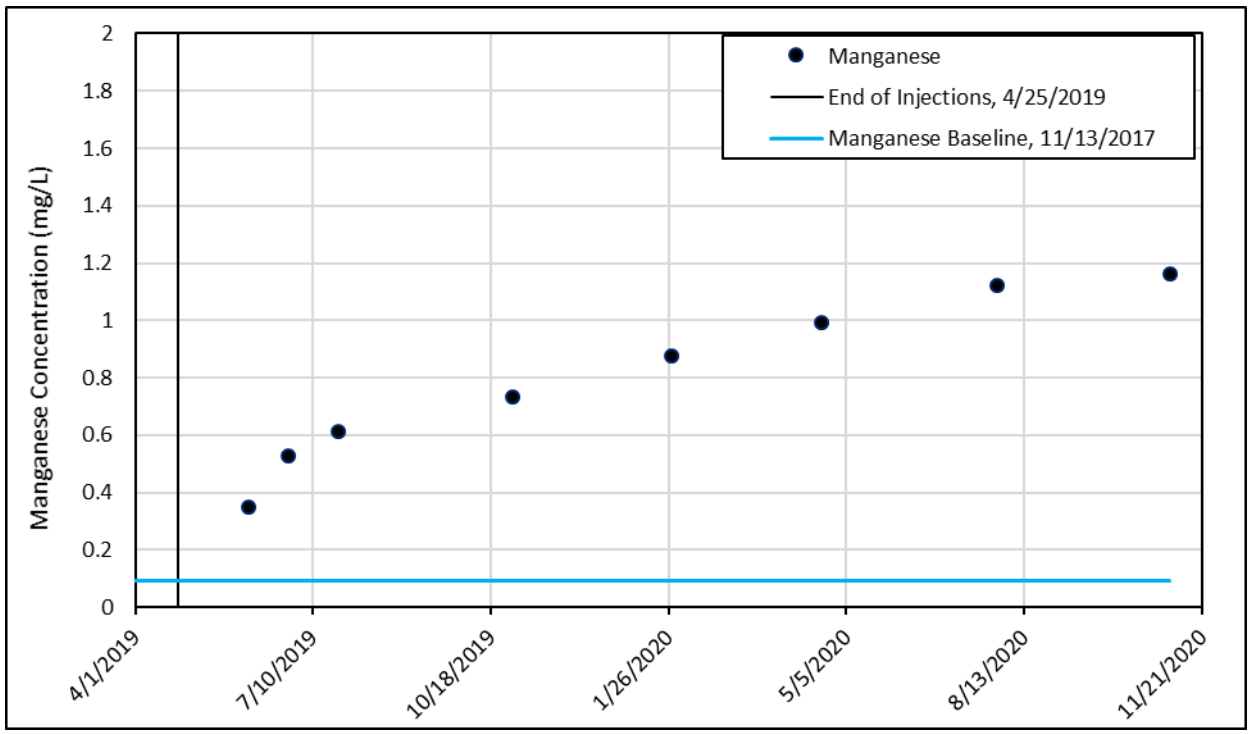

Figure III-9

Concentration of Manganese at Injection Well TAV-INJ1, June 2019 – November 2020

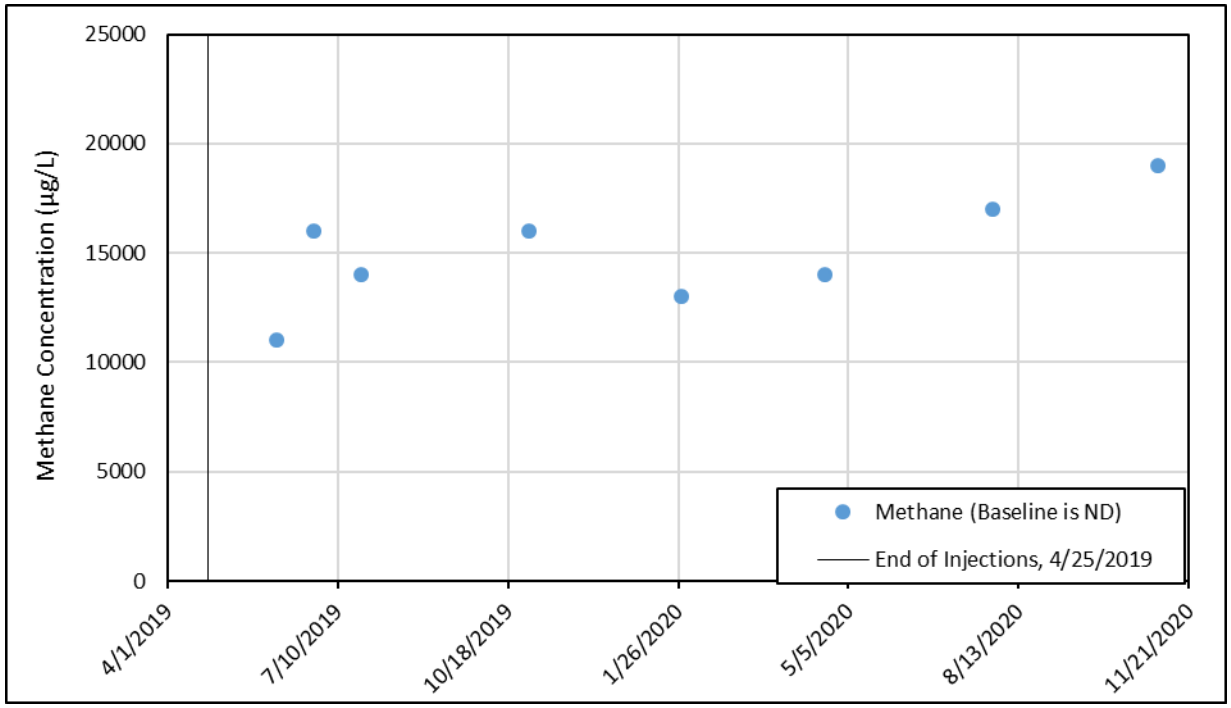

Figure III-10

Concentration of Methane at Injection Well TAV-INJ1, June 2019 – November 2020

Note: ND = Not detected.

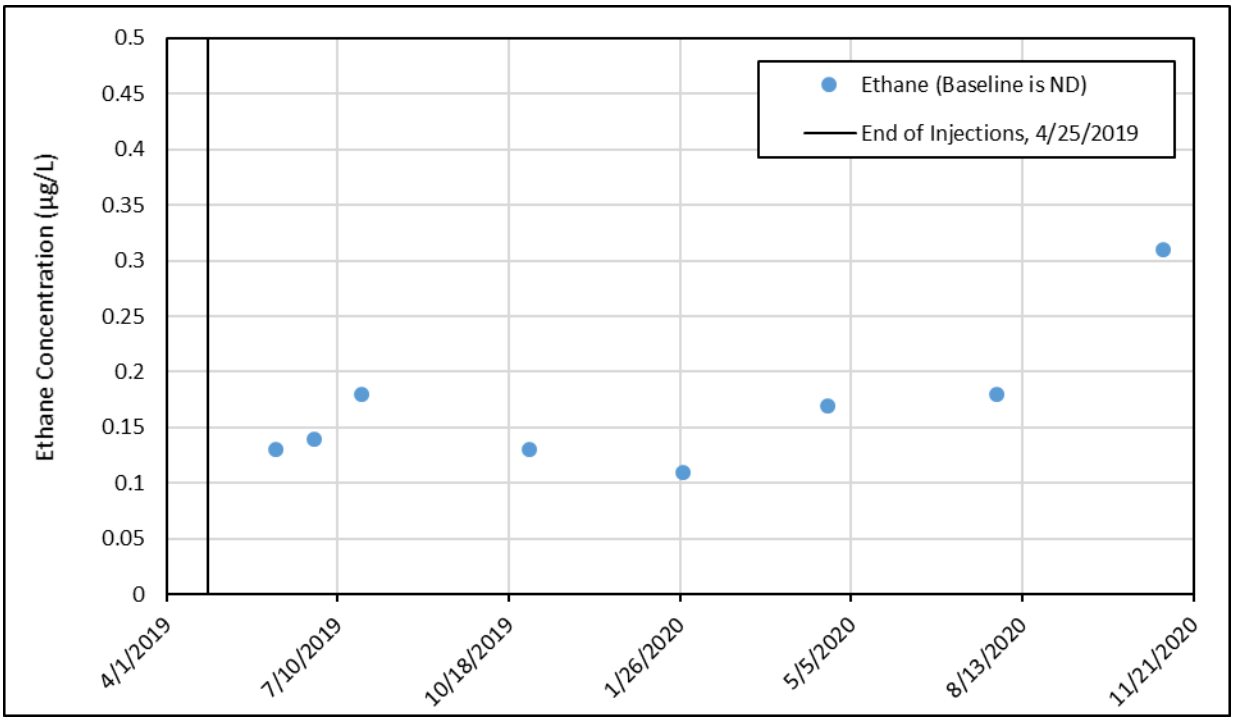

Figure III-11

Concentration of Ethane at Injection Well TAV-INJ1, June 2019 – November 2020

Note: ND = Not detected.

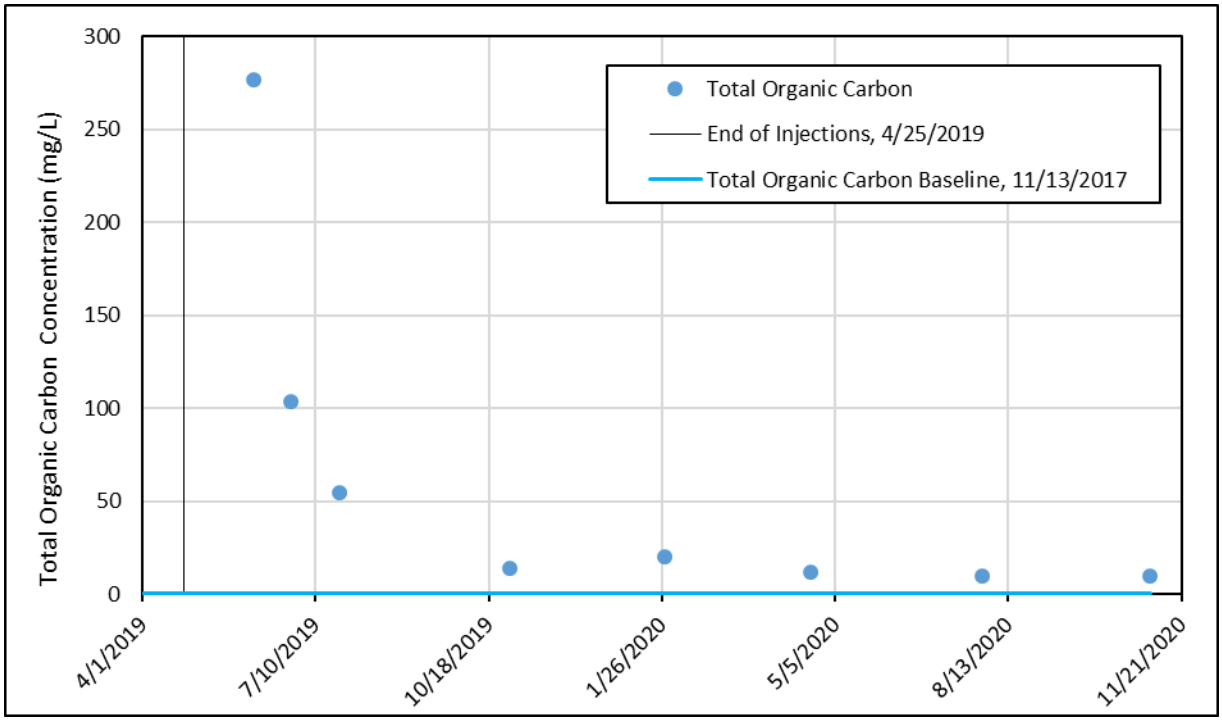

Figure III-12
Concentration of Total Organic Carbon at Injection Well TAV-INJ1, June 2019 – November 2020

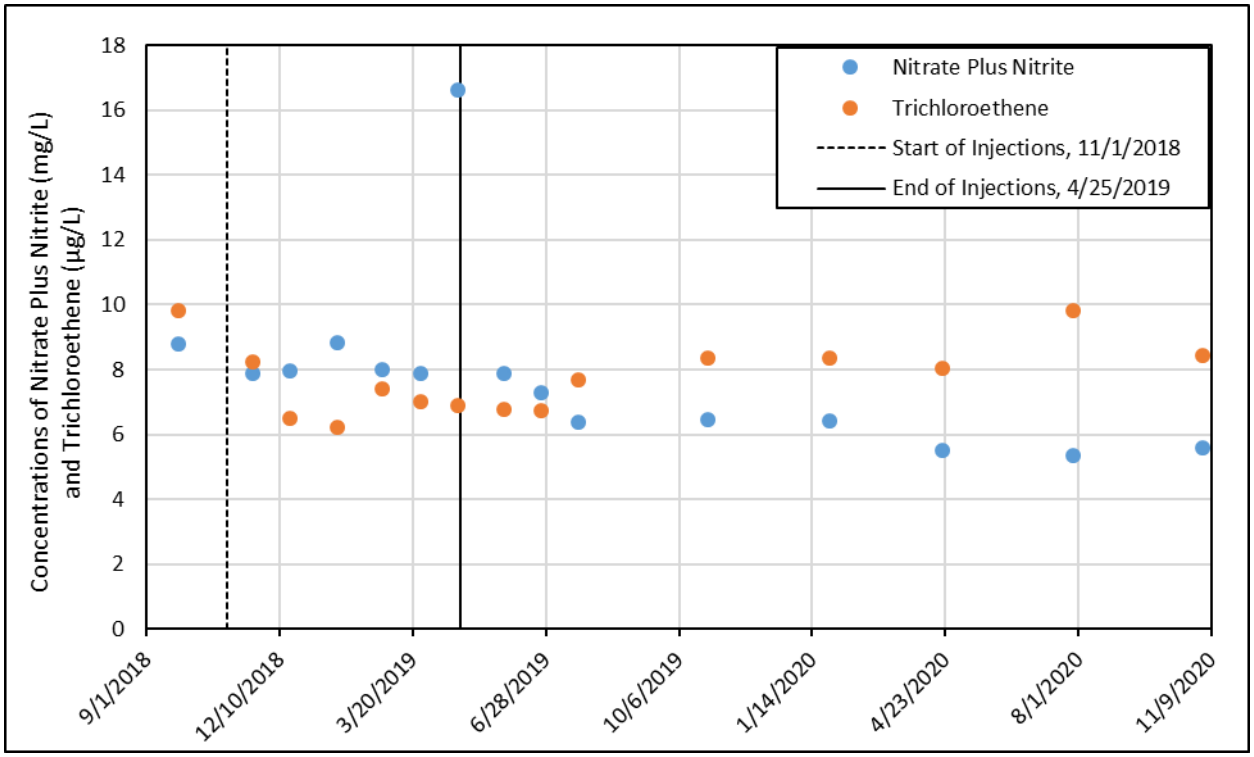

Figure III-13
Concentrations of Nitrate Plus Nitrite and Trichloroethene at Monitoring Well TAV-MW6, September 2018 – November 2020

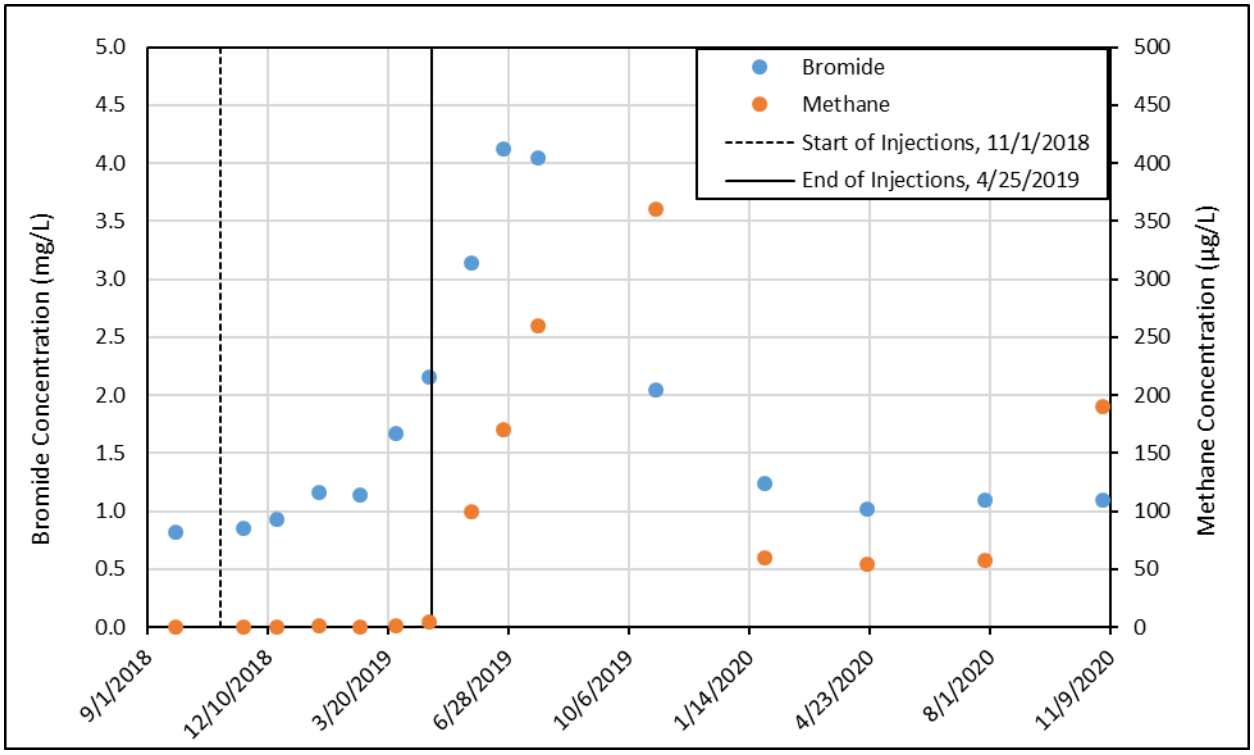

Figure III-14
Concentrations of Bromide and Methane at Monitoring Well TAV-MW6, September 2018 – November 2020

Tables

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Table III-1
Timeline of Phase I In-Situ Bioremediation Treatability Study at TAVG AOC

Time	Event
July 2015	Personnel from DOE/NNSA, DOE Office of Environmental Management, SNL/NM, and NMED HWB agreed on a phased Treatability Study of ISB to evaluate if ISB is a viable technology to treat groundwater contamination at the TAVG AOC.
May 2016	NMED HWB approved the Revised Treatability Study Work Plan.
August 2016	NMOSE issued Permit to Drill to install injection well TAV-INJ1.
May 2017	NMED GWQB issued Discharge Permit (DP)-1845 to DOE/NNSA for the TA-V Treatability Study injection wells.
September – November 2017	SNL/NM personnel installed injection well TAV-INJ1.
November 2017	Conducted Phase I pilot test injections at well TAV-INJ1. Began performance monitoring for Phase I pilot test injections.
June 2018	Completed performance monitoring of Phase I pilot test.
October 2018	SNL/NM personnel started Phase I full-scale operation of the ISB Treatability Study.
November 1, 2018 – April 25, 2019	Conducted the six-month injection period of the Phase I full-scale operation at well TAV-INJ1.
May 2019	Started the two-year performance monitoring of Phase I full-scale operation.
September 2020	Personnel from DOE/NNSA, SNL/NM, and NMED HWB met to discuss the path forward for the ISB Treatability Study.
May 2021	Anticipate completing the performance monitoring of the Phase I full-scale operation.

Notes:
AOC = Area of Concern.
DOE = U.S. Department of Energy.
GWQB = Ground Water Quality Bureau.
HWB = Hazardous Waste Bureau.
INJ = Injection (acronym used for well identification only).
NMED = New Mexico Environment Department.
NMOSE = New Mexico Office of the State Engineer.
NNSA = National Nuclear Security Administration.
SNL/NM = Sandia National Laboratories, New Mexico.
TA-V = Technical Area-V.
TAV = Technical Area-V (acronym used for well identification only).
TAVG = Technical Area-V Groundwater.

Table III-2
Groundwater Sampling Conducted for Treatability Study, October – December 2020

Well Sampled	Sampling Date
Wells inside the Treatment Zone	
TAV-INJ1	3-Nov-20
TAV-MW6	2-Nov-20
TAV-MW7	17-Nov-20
Wells outside the Treatment Zone	
LWDS-MW1	7-Dec-20
TAV-MW2	20-Nov-20
TAV-MW4	23-Nov-20
TAV-MW8	30-Nov-20
TAV-MW10	8-Dec-20
TAV-MW11	24-Nov-20
TAV-MW12	2-Dec-20
TAV-MW14	3-Dec-20

Notes:

INJ = Injection well.
LWDS = Liquid waste disposal system.
MW = Monitoring well.
TAV = Technical Area-V.

Table III-3
Analytical Results for Groundwater Samples Collected at Injection Well TAV-INJ1, October – December 2020

Sample Date	Analyses	Analyte	Result[a]	MDL[b]	PQL[c]	MCL[d]	Units	Lab Qual[e]	Val Qual[f]	Sample No.	Analytical Method[g]	Lab[h]
3-Nov-20	Alkalinity	Alkalinity as $CaCO_3$	1,170	1.45	4.00	NE	mg/L			113939-005	SM 2320B	GEL
3-Nov-20	Alkalinity	Alkalinity, bicarb as $CaCO_3$	1,170	1.45	4.00	NE	mg/L			113939-005	SM 2320B	GEL
3-Nov-20	Alkalinity	Alkalinity, carb as $CaCO_3$	ND	1.45	4.00	NE	mg/L	U		113939-005	SM 2320B	GEL
3-Nov-20	Ammonia	Ammonia	56.5	0.850	2.50	NE	mg/L	B	J	113939-001	EPA 350.1	GEL
3-Nov-20	Anions	Bromide	18.3	0.670	2.00	NE	mg/L			113939-003	SW846 9056A	GEL
3-Nov-20	Anions	Sulfate	15.5	0.133	0.400	NE	mg/L			113939-003	SW846 9056A	GEL
3-Nov-20	Microbial	Dehalococcoides	ND	10,000	10,000	NE	Enumeration/L	U		113932-001	Gene-Trac Dhc	SRM
3-Nov-20	Dissolved Metals	Arsenic	**0.0155**	0.002	0.005	0.01	mg/L			113939-006	SW846 3005A/6020B	GEL
3-Nov-20	Dissolved Metals	Iron	0.897	0.033	0.100	NE	mg/L			113939-006	SW846 3005A/6020B	GEL
3-Nov-20	Dissolved Metals	Manganese	1.16	0.005	0.025	NE	mg/L		J	113939-006	SW846 3005A/6020B	GEL
3-Nov-20	MEE	Methane	19,000	2.50	5.00	NE	µg/L		J	113934-001	AM20GAX	PACE-GC
3-Nov-20	MEE	Ethane	0.31	0.075	1.00	NE	µg/L	J	J	113934-001	AM20GAX	PACE-GC
3-Nov-20	MEE	Ethene	ND	0.120	1.00	NE	µg/L	U	1.00UJ	113934-001	AM20GAX	PACE-GC
3-Nov-20	NPN	Nitrate plus nitrite as N	ND	0.017	0.050	10	mg/L	U	0.050UJ	113939-004	EPA 353.2	GEL
3-Nov-20	TOC	Total Organic Carbon Average	9.87	0.330	1.00	NE	mg/L			113939-002	SW846 9060A	GEL
3-Nov-20	VOC	Dichloroethene, cis-1,2-	ND	0.300	1.00	70	µg/L	U		113938-001	SW846 8260B	GEL
3-Nov-20	VOC	Trichloroethene	ND	0.300	1.00	5	µg/L	U		113938-001	SW846 8260B	GEL

Note: Header nomenclature is explained following Table III-7 in the “Footnotes for Technical Area-V Analytical Results Tables” summary.

Table III-4
Analytical Results for Groundwater Samples Collected at Monitoring Well TAV-MW6, October – December 2020

Sample Date	Analyses	Analyte	Result[a]	MDL[b]	PQL[c]	MCL[d]	Units	Lab Qual[e]	Val Qual[f]	Sample No.	Analytical Method[g]	Lab[h]
2-Nov-20	Alkalinity	Alkalinity as $CaCO_3$	200	1.45	4.00	NE	mg/L			113940-006	SM 2320B	GEL
2-Nov-20	Alkalinity	Alkalinity, bicarb as $CaCO_3$	200	1.45	4.00	NE	mg/L			113940-006	SM 2320B	GEL
2-Nov-20	Alkalinity	Alkalinity, carb as $CaCO_3$	ND	1.45	4.00	NE	mg/L	U		113940-006	SM 2320B	GEL
2-Nov-20	Ammonia	Ammonia	0.085	0.017	0.050	NE	mg/L	B	J+	113940-002	EPA 350.1	GEL
2-Nov-20	Anions	Bromide	1.10	0.067	0.200	NE	mg/L			113940-004	SW846 9056A	GEL
2-Nov-20	Anions	Sulfate	43.1	2.66	8.00	NE	mg/L			113940-004	SW846 9056A	GEL
2-Nov-20	Microbial	Dehalococcoides	ND	3,000	3,000	NE	Enumeration/L	U		113931-001	Gene-Trac Dhc	SRM
2-Nov-20	Dissolved Metals	Arsenic	0.00207	0.002	0.005	0.01	mg/L	J		113940-007	SW846 3005A/6020B	GEL
2-Nov-20	Dissolved Metals	Iron	0.067	0.033	0.100	NE	mg/L	J		113940-007	SW846 3005A/6020B	GEL
2-Nov-20	Dissolved Metals	Manganese	0.0034	0.001	0.005	NE	mg/L	J		113940-007	SW846 3005A/6020B	GEL
2-Nov-20	MEE	Methane	190	2.50	5.00	NE	µg/L		J	113933-001	AM20GAX	PACE-GC
2-Nov-20	MEE	Ethane	ND	0.075	1.00	NE	µg/L	U	1.00UJ	113933-001	AM20GAX	PACE-GC
2-Nov-20	MEE	Ethene	0.25	0.120	1.00	NE	µg/L	J	J	113933-001	AM20GAX	PACE-GC
2-Nov-20	NPN	Nitrate plus nitrite as N	5.61	0.170	0.500	10	mg/L			113940-005	EPA 353.2	GEL
2-Nov-20	TOC	Total Organic Carbon Average	0.469	0.330	1.00	NE	mg/L	J		113940-003	SW846 9060A	GEL
2-Nov-20	VOC	Dichloroethene, cis-1,2-	1.31	0.300	1.00	70	µg/L			113940-001	SW846 8260B	GEL
2-Nov-20	VOC	Trichloroethene	**8.43**	0.300	1.00	5	µg/L			113940-001	SW846 8260B	GEL

Note: Header nomenclature is explained following Table III-7 in the “Footnotes for Technical Area-V Analytical Results Tables” summary.

Table III-5
Analytical Results for Groundwater Samples Collected at Monitoring Well TAV-MW7, October – December 2020

Sample Date	Analyses	Analyte	Result[a]	MDL[b]	PQL[c]	MCL[d]	Units	Lab Qual[e]	Val Qual[f]	Sample No.	Analytical Method[g]	Lab[h]
17-Nov-20	Anions	Bromide	0.255	0.067	0.200	NE	mg/L			114052-001	SW846 9056A	GEL
17-Nov-20	Dissolved Metals	Arsenic	0.00276	0.002	0.005	0.01	mg/L	J		114010-003	SW846 3005A/6020B	GEL
17-Nov-20	Dissolved Metals	Iron	ND	0.033	0.100	NE	mg/L	U		114010-003	SW846 3005A/6020B	GEL
17-Nov-20	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		114010-003	SW846 3005A/6020B	GEL
17-Nov-20	MEE	Ethene	1.20	0.120	1.00	NE	µg/L		J	114055-001	AM20GAX	PACE-GC
17-Nov-20	NPN	Nitrate plus nitrite as N	4.37	0.170	0.500	10	mg/L			114010-002	EPA 353.2	GEL
17-Nov-20	VOC	Dichloroethene, cis-1,2-	ND	0.300	1.00	70	µg/L	U		114010-001	SW846 8260B	GEL
17-Nov-20	VOC	Trichloroethene	ND	0.300	1.00	5	µg/L	U		114010-001	SW846 8260B	GEL

Note: Header nomenclature is explained following Table III-7 in the “Footnotes for Technical Area-V Analytical Results Tables” summary.

Table III-6
Analytical Results for Groundwater Samples Collected at Monitoring Wells
LWDS-MW1, TAV-MW2, TAV-MW4, TAV-MW8, TAV-MW10, TAV-MW11, TAV-MW12, and TAV MW14, October – December 2020

Sample Date	Analyses	Analyte	Result[a]	MDL[b]	PQL[c]	MCL[d]	Units	Lab Qual[e]	Val Qual[f]	Sample No.	Analytical Method[g]	Lab[h]
LWDS-MW1												
7-Dec-20	Dissolved Metals	Arsenic	0.00371	0.002	0.005	0.01	mg/L	J		114058-003	SW846 3005A/6020B	GEL
7-Dec-20	Dissolved Metals	Iron	0.0379	0.033	0.100	NE	mg/L	J		114058-003	SW846 3005A/6020B	GEL
7-Dec-20	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		114058-003	SW846 3005A/6020B	GEL
7-Dec-20	NPN	Nitrate plus nitrite as N	**12.2**	0.170	0.500	10	mg/L			114058-002	EPA 353.2	GEL
7-Dec-20	VOC	Dichloroethene, cis-1,2-	3.19	0.300	1.00	70	µg/L			114058-001	SW846 8260B	GEL
7-Dec-20	VOC	Trichloroethene	**14.1**	0.300	1.00	5	µg/L			114058-001	SW846 8260B	GEL
7-Dec-20 (DUP)	Dissolved Metals	Arsenic	0.00385	0.002	0.005	0.01	mg/L	J		114059-003	SW846 3005A/6020B	GEL
7-Dec-20 (DUP)	Dissolved Metals	Iron	ND	0.033	0.100	NE	mg/L	U		114059-003	SW846 3005A/6020B	GEL
7-Dec-20 (DUP)	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		114059-003	SW846 3005A/6020B	GEL
7-Dec-20 (DUP)	NPN	Nitrate plus nitrite as N	**12.1**	0.170	0.500	10	mg/L			114059-002	EPA 353.2	GEL
7-Dec-20 (DUP)	VOC	Dichloroethene, cis-1,2-	3.22	0.300	1.00	70	µg/L			114059-001	SW846 8260B	GEL
7-Dec-20 (DUP)	VOC	Trichloroethene	**13.3**	0.300	1.00	5	µg/L			114059-001	SW846 8260B	GEL
TAV-MW2												
20-Nov-20	Dissolved Metals	Arsenic	0.00261	0.002	0.005	0.01	mg/L	J		114016-003	SW846 3005A/6020B	GEL
20-Nov-20	Dissolved Metals	Iron	ND	0.033	0.100	NE	mg/L	U		114016-003	SW846 3005A/6020B	GEL
20-Nov-20	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		114016-003	SW846 3005A/6020B	GEL
20-Nov-20	NPN	Nitrate plus nitrite as N	5.11	0.170	0.500	10	mg/L			114016-002	EPA 353.2	GEL
20-Nov-20	VOC	Dichloroethene, cis-1,2-	ND	0.300	1.00	70	µg/L	U		114016-001	SW846 8260B	GEL
20-Nov-20	VOC	Trichloroethene	3.44	0.300	1.00	5	µg/L			114016-001	SW846 8260B	GEL
TAV-MW4												
23-Nov-20	Dissolved Metals	Arsenic	0.00274	0.002	0.005	0.01	mg/L	J		114020-003	SW846 3005A/6020B	GEL
23-Nov-20	Dissolved Metals	Iron	ND	0.033	0.100	NE	mg/L	U		114020-003	SW846 3005A/6020B	GEL
23-Nov-20	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		114020-003	SW846 3005A/6020B	GEL
23-Nov-20	NPN	Nitrate plus nitrite as N	4.52	0.170	0.500	10	mg/L			114020-002	EPA 353.2	GEL
23-Nov-20	VOC	Dichloroethene, cis-1,2-	0.49	0.300	1.00	70	µg/L	J		114020-001	SW846 8260B	GEL
23-Nov-20	VOC	Trichloroethene	**5.08**	0.300	1.00	5	µg/L			114020-001	SW846 8260B	GEL
TAV-MW8												
30-Nov-20	Dissolved Metals	Arsenic	0.00274	0.002	0.005	0.01	mg/L	J		114034-003	SW846 3005A/6020B	GEL
30-Nov-20	Dissolved Metals	Iron	ND	0.033	0.100	NE	mg/L	U		114034-003	SW846 3005A/6020B	GEL
30-Nov-20	Dissolved Metals	Manganese	0.00302	0.001	0.005	NE	mg/L	J		114034-003	SW846 3005A/6020B	GEL
30-Nov-20	NPN	Nitrate plus nitrite as N	7.50	0.170	0.500	10	mg/L			114034-002	EPA 353.2	GEL
30-Nov-20	VOC	Dichloroethene, cis-1,2-	0.50	0.300	1.00	70	µg/L	J		114034-001	SW846 8260B	GEL
30-Nov-20	VOC	Trichloroethene	**5.37**	0.300	1.00	5	µg/L			114034-001	SW846 8260B	GEL
TAV-MW10												
8-Dec-20	Dissolved Metals	Arsenic	0.00288	0.002	0.005	0.01	mg/L	J		114050-003	SW846 3005A/6020B	GEL
8-Dec-20	Dissolved Metals	Iron	ND	0.033	0.100	NE	mg/L	U		114050-003	SW846 3005A/6020B	GEL
8-Dec-20	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		114050-003	SW846 3005A/6020B	GEL
8-Dec-20	NPN	Nitrate plus nitrite as N	**12.0**	0.425	1.25	10	mg/L			114050-002	EPA 353.2	GEL
8-Dec-20	VOC	Dichloroethene, cis-1,2-	2.52	0.300	1.00	70	µg/L			114050-001	SW846 8260B	GEL
8-Dec-20	VOC	Trichloroethene	**13.1**	0.300	1.00	5	µg/L			114050-001	SW846 8260B	GEL

Note: Header nomenclature is explained following Table III-7 in the “Footnotes for Technical Area-V Analytical Results Tables” summary.

Table III-6
Analytical Results for Groundwater Samples Collected at Monitoring Wells
LWDS-MW1, TAV-MW2, TAV-MW4, TAV-MW8, TAV-MW10, TAV-MW11, TAV-MW12, and TAV MW14, October – December 2020 (concluded)

Sample Date	Analyses	Analyte	Result[a]	MDL[b]	PQL[c]	MCL[d]	Units	Lab Qual[e]	Val Qual[f]	Sample No.	Analytical Method[g]	Lab[h]
TAV-MW11												
24-Nov-20	Dissolved Metals	Arsenic	0.0028	0.002	0.005	0.01	mg/L	J		114026-003	SW846 3005A/6020B	GEL
24-Nov-20	Dissolved Metals	Iron	ND	0.033	0.100	NE	mg/L	U		114026-003	SW846 3005A/6020B	GEL
24-Nov-20	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		114026-003	SW846 3005A/6020B	GEL
24-Nov-20	NPN	Nitrate plus nitrite as N	6.95	0.170	0.500	10	mg/L			114026-002	EPA 353.2	GEL
24-Nov-20	VOC	Dichloroethene, cis-1,2-	ND	0.300	1.00	70	µg/L	U		114026-001	SW846 8260B	GEL
24-Nov-20	VOC	Trichloroethene	4.34	0.300	1.00	5	µg/L			114026-001	SW846 8260B	GEL
24-Nov-20 (DUP)	Dissolved Metals	Arsenic	0.00272	0.002	0.005	0.01	mg/L	J		114027-003	SW846 3005A/6020B	GEL
24-Nov-20 (DUP)	Dissolved Metals	Iron	ND	0.033	0.100	NE	mg/L	U		114027-003	SW846 3005A/6020B	GEL
24-Nov-20 (DUP)	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		114027-003	SW846 3005A/6020B	GEL
24-Nov-20 (DUP)	NPN	Nitrate plus nitrite as N	6.93	0.170	0.500	10	mg/L			114027-002	EPA 353.2	GEL
24-Nov-20 (DUP)	VOC	Dichloroethene, cis-1,2-	ND	0.300	1.00	70	µg/L	U		114027-001	SW846 8260B	GEL
24-Nov-20 (DUP)	VOC	Trichloroethene	3.77	0.300	1.00	5	µg/L			114027-001	SW846 8260B	GEL
TAV-MW12												
2-Dec-20	Dissolved Metals	Arsenic	0.00238	0.002	0.005	0.01	mg/L	J		114039-003	SW846 3005A/6020B	GEL
2-Dec-20	Dissolved Metals	Iron	ND	0.033	0.100	NE	mg/L	U		114039-003	SW846 3005A/6020B	GEL
2-Dec-20	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		114039-003	SW846 3005A/6020B	GEL
2-Dec-20	NPN	Nitrate plus nitrite as N	4.39	0.170	0.500	10	mg/L			114039-002	EPA 353.2	GEL
2-Dec-20	VOC	Dichloroethene, cis-1,2-	ND	0.300	1.00	70	µg/L	U		114039-001	SW846 8260B	GEL
2-Dec-20	VOC	Trichloroethene	2.09	0.300	1.00	5	µg/L			114039-001	SW846 8260B	GEL
TAV-MW14												
3-Dec-20	Dissolved Metals	Arsenic	0.00266	0.002	0.005	0.01	mg/L	J	0.005U	114045-003	SW846 3005A/6020B	GEL
3-Dec-20	Dissolved Metals	Iron	ND	0.033	0.100	NE	mg/L	U		114045-003	SW846 3005A/6020B	GEL
3-Dec-20	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		114045-003	SW846 3005A/6020B	GEL
3-Dec-20	NPN	Nitrate plus nitrite as N	7.88	0.425	1.25	10	mg/L			114045-002	EPA 353.2	GEL
3-Dec-20	VOC	Dichloroethene, cis-1,2-	0.46	0.300	1.00	70	µg/L	J		114045-001	SW846 8260B	GEL
3-Dec-20	VOC	Trichloroethene	**5.35**	0.300	1.00	5	µg/L			114045-001	SW846 8260B	GEL
3-Dec-20 (DUP)	Dissolved Metals	Arsenic	0.00241	0.002	0.005	0.01	mg/L	J	0.005U	114046-003	SW846 3005A/6020B	GEL
3-Dec-20 (DUP)	Dissolved Metals	Iron	ND	0.033	0.100	NE	mg/L	U		114046-003	SW846 3005A/6020B	GEL
3-Dec-20 (DUP)	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		114046-003	SW846 3005A/6020B	GEL
3-Dec-20 (DUP)	NPN	Nitrate plus nitrite as N	7.80	0.425	1.25	10	mg/L			114046-002	EPA 353.2	GEL
3-Dec-20 (DUP)	VOC	Dichloroethene, cis-1,2-	0.48	0.300	1.00	70	µg/L	J		114046-001	SW846 8260B	GEL
3-Dec-20 (DUP)	VOC	Trichloroethene	**5.22**	0.300	1.00	5	µg/L			114046-001	SW846 8260B	GEL

Note: Header nomenclature is explained following Table III-7 in the “Footnotes for Technical Area-V Analytical Results Tables” summary.

Table III-7
Field Water Quality Measurements[i], October – December 2020

Well ID	Sample Date	Temperature (°C)	Specific Conductivity (µmho/cm)	Oxidation Reduction Potential (mV)	pH	Turbidity (NTU)	Dissolved Oxygen (% Sat)	Dissolved Oxygen (mg/L)
TAV-INJ1	3-Nov-20	19.64	2009.4	-134.8	6.92	15.6	8.52	0.60
TAV-MW6	2-Nov-20	21.15	737.3	65.5	7.43	4.02	34.50	2.60
TAV-MW7	17-Nov-20	20.94	609.69	157.8	7.41	1.21	2.94	0.23
LWDS-MW1	7-Dec-20	18.75	704.96	182.1	7.59	0.92	103.72	8.32
TAV-MW2	20-Nov-20	19.72	684.91	193.9	7.39	0.82	71.81	5.85
TAV-MW4	23-Nov-20	18.41	484.14	194.8	7.58	0.84	78.85	6.49
TAV-MW8	30-Nov-20	19.01	569.65	189.9	7.51	12.9	71.78	5.90
TAV-MW10	8-Dec-20	18.45	611.27	213.2	7.37	0.53	82.12	6.80
TAV-MW11	24-Nov-20	18.65	556.96	242.9	7.58	0.48	76.18	6.31
TAV-MW12	2-Dec-20	14.93	592.64	172.1	7.42	0.83	67.48	5.97
TAV-MW14	3-Dec-20	18.45	620.36	178.1	7.53	2.84	77.36	6.40

Note: Header nomenclature is explained following Table III-7 in the “Footnotes for Technical Area-V Analytical Results Tables” summary.

Footnotes for Technical Area-V Analytical Results Tables

%	= Percent.
CaCO3	= Calcium carbonate.
Dhc	= Dehalococcoides.
DUP	= Environmental duplicate sample.
Enumeration/L	= gene copies per liter.
EPA	= U.S. Environmental Protection Agency.
ID	= Identifier.
INJ	= Injection well (acronym used for well identification only).
LWDS	= Liquid waste disposal system (acronym used for well identification only).
µg/L	= Micrograms per liter.
mg/L	= Milligrams per liter.
MEE	= Methane, ethane, ethene.
MW	= Monitoring well (acronym used for well identification only).
No.	= Number.
NPN	= Nitrate plus nitrite, as nitrogen.
TAV	= Technical Area-V (acronym used for well identification only).
TOC	= Total organic carbon.
VOC	= Volatile organic compound.

[a]Result

Detected VOCs are presented in the tables.

Bold	= Concentration exceeds the EPA MCL.
ND	= Not detected (at method detection limit).

[b]MDL

MDL	= Method detection limit. The minimum concentration or activity that can be measured and reported with 99% confidence that the analyte is greater than zero, analyte is matrix specific.

[c]PQL

PQL	= Practical quantitation limit. The lowest concentration of analytes in a sample that can be reliably determined within specified limits of precision and accuracy by that indicated method under routine laboratory operating conditions.

[d]MCL

MCL	= Maximum contaminant level. 2018 Edition of the Drinking Water Standards and Health Advisories Tables, EPA 822-F-18-001, Office of Water, U.S. Environmental Protection Agency, Washington, D.C., March 2018.
NE	= Not established.

[e]Lab Qualifier

If cell is blank, then all quality control samples met acceptance criteria with respect to submitted samples.

B	= The analyte was found in the blank above the effective MDL.
J	= Estimated value, the analyte concentration fell above the method detection limit and below the practical quantitation limit.
U	= Analyte is absent or below the method detection limit.

Footnotes for Technical Area-V Analytical Results Tables *(Continued)*

[f]Validation Qualifier

If cell is blank, then all quality control samples met acceptance criteria with respect to submitted samples.

J	= The associated value is an estimated quantity.
J+	= The associated numerical value is an estimated quantity with a suspected positive bias.
U	= The analyte was analyzed for but was not detected. The associated numerical value is the sample quantitation limit.
UJ	= The analyte was analyzed for but was not detected. The associated value is an estimate and may be inaccurate or imprecise.

[g]Analytical Method

AM20GAX	= Proprietary method of Pace Analytical Services, LLC.
Gene-Trac Dhc	= Proprietary method of SiREM.

Clesceri, Rice, Baird, and Eaton, 2012, *Standard Methods for the Examination of Water and Wastewater*, 22nd ed., Method 2320B, published jointly by American Public Health Association, American Water Works Association, and Water Environment Federation. Washington, D.C.

EPA, 1986, (and updates), "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," SW-846, 3rd ed., U.S. Environmental Protection Agency, Cincinnati, Ohio.

EPA, 1984, "Methods for Chemical Analysis of Water and Wastes." EPA 600-4-79-020, U.S. Environmental Protection Agency, Cincinnati, Ohio.

EPA, 1993, "Method 350.1, Determination of Ammonia Nitrogen by Semi-Automated Colorimetry." Revision 2.0.

EPA, 1993, "Method 353.2, Determination of Nitrate-Nitrite Nitrogen by Automated Colorimetry." Revision 2.0.

[h]Lab

GEL	= GEL Laboratories LLC, 2040 Savage Road, Charleston, South Carolina 29407.
PACE-GC	= Pace Analytical Gulf Coast, 7979 Innovation Park Drive, Baton Rouge, Louisiana 70820.
SRM	= SiREM, 130 Stone Road. W, Guelph, Ontario, N1G 3Z2, Canada.

[i]Field Water Quality Measurements

Field measurements collected prior to sampling.

°C	= Degrees Celsius.
% Sat	= Percent saturation.
µmho/cm	= Micromhos per centimeter.
mg/L	= Milligrams per liter.
mV	= Millivolts.
pH	= Potential of hydrogen (negative logarithm of the hydrogen ion concentration).
NTU	= Nephelometric turbidity units.

Appendix A

NMED's Approval Letter and DOE's Submittal with the Enclosure Describing Full-Scale Operation Modifications

State of New Mexico
ENVIRONMENT DEPARTMENT

Hazardous Waste Bureau

2905 Rodeo Park Drive East, Building 1
Santa Fe, New Mexico 87505-6313
Phone (505) 476-6000 Fax (505) 476-6030
www.env.nm.gov

SUSANA MARTINEZ
Governor
JOHN A. SANCHEZ
Lieutenant Governor

BUTCH TONGATE
Cabinet Secretary
J. C. BORREGO
Deputy Secretary

CERTIFIED MAIL – RETURN RECEIPT REQUESTED

August 13, 2018

Jeffrey P. Harrell
Manager
U.S. Department of Energy
NNSA/Sandia Field Office
P.O. Box 5400, MS 0184
Albuquerque, NM 87185-5400

Richard O. Griffith
Senior Manager
Sandia National Laboratories
P.O. Box 5800, MS 0726
Albuquerque, NM 87185-5400

RE: APPROVAL
TECHNICAL AREA-V (TA-V) TREATABILITY STUDY NOTIFICATION OF FULL-SCALE OPERATION AT WELL TAV-INJ1
SANDIA NATIONAL LABORATORY
EPA ID#NM5890110518
HWB-SNL-15-020

Dear Mr. Harrell and Mr. Griffith:

The New Mexico Environment Department (NMED) received the letter titled *Technical Area-V (TA-V) Treatability Study Notification of Full-Scale Operation at Well TAV-INJ1,* dated July 20, 2018, submitted by the U.S. Department of Energy on behalf of itself and NTESS (collectively, the Permittees), on July 26, 2018. NMED has reviewed the letter and hereby issues this Approval of the proposed modifications to the Work Plan and concurs with the decision to proceed with full-scale operation at well TAV-INJ1 of the Treatability Study/Interim Measure at TA-V.

If you have any questions regarding this matter, please contact Naomi Davidson of my staff at (505) 222-9504.

Sincerely,

John E. Kieling
Chief
Hazardous Waste Bureau

cc: D. Cobrain, NMED HWB
B. Wear, NMED HWB
N. Davidson, NMED HWB
L. King, EPA Region 6 (6PD-N)
J. Todd, DOE/NNSA/SFO, MS-0184
D. Rast, DOE/NNSA/SFO, MS-0184
J. Cochran, SNL/NM, MS-0719
E. Boatman, SNL/NM, MS-0718

File: SNL 2018 and Reading, SNL-15-020

Department of Energy
National Nuclear Security Administration
Sandia Field Office
P.O. Box 5400
Albuquerque, NM 87185

JUL 20 2018

Mr. John E. Kieling
Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Bldg. 1
Santa Fe, New Mexico 87505

Subject: Technical Area-V (TA-V) Treatability Study Notification of Full-Scale Operation at Well TAV-INJ1

Dear Mr. Kieling:

The Department of Energy/National Nuclear Security Administration/Sandia Field Office (DOE/NNSA/SFO) and its management and operating contractor, National Technology and Engineering Solutions of Sandia, LLC (NTESS) intend to proceed with full-scale operation at well TAV-INJ1 as part of the Treatability Study of in-situ bioremediation at TA-V Groundwater Area of Concern, Sandia National Laboratories/New Mexico (SNL/NM). Full-scale operation will not commence until at least 60 days after this notification is received at New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB), in accordance with the 2016 Revised Treatability Study Work Plan.

Associated modifications to the full-scale operation based on the experience and monitoring results of the pilot test at well TAV-INJ1 were discussed among personnel from DOE/NNSA/SFO, SNL/NM, and NMED HWB in a meeting held on June 20, 2018. The modifications and the rationale for the modifications to conduct full-scale operation at well TAV-INJ1 are provided in the enclosure.

If you have questions contact David Rast of our staff at (505) 845-5349.

Sincerely,

Jeffrey P. Harrell
Manager

Enclosure

cc: See Page 2

cc w/enclosure:
Naomi Davidson
NMED-HWB
121 Tijeras Avenue, NE,
Albuquerque, New Mexico 87102-3400

Dave Cobrain
NMED-HWB
2905 Rodeo Park Drive East, Bldg. 1
Santa Fe, New Mexico 87505

Laurie King
EPA, Region 6
1445 Ross Ave., Ste. 1200
Dallas, Texas 75202

Susan Lucas-Kamat
NMED-OB, MS-1396

Zimmerman Library, UNM
MSC05 3020
1 University of New Mexico
Albuquerque, New Mexico 87101-0001

cc w/o enclosure:
Amy Blumberg, SNL/NM
Paul Shoemaker, SNL/NM
Christi Leigh, SNL/NM
John Cochran, SNL/NM
Jun Li, SNL/NM
Anna Gallegos, SNL/NM
Howard Huie, DOE/EM-31
Douglas Tonkay, DOE/EM-31
Thomas Longo, NNSA/NA-533
Jessica Arcidiacono, NNSA/NA-533
Cynthia Wimberly, SFO/OOM
James Todd, SFO/ENG
Susan Lacy, SFO/ENG
Steven Black, SFO/ENG
David Rast, SFO/ENG
NNSA-2018-001960

Technical Area-V (TA-V) Treatability Study
Notification of Full-Scale Operation at Well TAV-INJ1

CERTIFICATION STATEMENT

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment for knowing violations.

Paul E. Shoemaker
Signature

July 10, 2018
Date

Paul E. Shoemaker
Defense Waste Management Programs
Sandia National Laboratories/New Mexico
Albuquerque, New Mexico 87185
Operator

and

Signature

7/23/2018
Date

Jeffrey P. Harrell, Manager
U.S. Department of Energy
National Nuclear Security Administration
Sandia Field Office
Owner

ENCLOSURE

The Department of Energy/National Nuclear Security Administration, Sandia Field Office and Sandia National Laboratories, New Mexico (SNL/NM) personnel (i.e., the project team) plan to implement the following modifications for the full-scale operation of the in-situ bioremediation (ISB) Treatability Study at the Technical Area-V (TA-V) Groundwater Area of Concern. The modifications were based on the experience and monitoring results of the pilot test conducted at well TAV-INJ1. The original proposal in the Revised Treatability Study Work Plan (TSWP) (SNL/NM March 2016; NMED May 2016) is repeated verbatim, followed by the rationale for modification and a summary statement of the modification to be implemented in full-scale operation at well TAV-INJ1.

#1: Method for Deoxygenation in Aboveground Tanks

In Section 4.2.2, Page 4-9, the Revised TSWP states, "*One tank will be inoculated with a small amount of soil core/cuttings from the injection well screened interval and have KB-1® Primer added. The purposes of adding soil core/cuttings to the substrate solution are to (1) inoculate the solution with native microorganisms, (2) create a diverse microbial community that will more likely work synergistically with the bioaugmentation culture, and (3) reduce the lag time for initiating biostimulation associated with utilization of the substrate in the subsurface.*"

Rationale for Modification: Two injections of the substrate solution were conducted during the pilot test. The soil core/cuttings were not added to the substrate solution during the first injection, but were added during the second injection. The pilot test results showed that KB-1® Primer itself could produce favorable conditions – low dissolved oxygen (DO) and negative oxidation-reduction potential (ORP) – for safely injecting KB-1® Dechlorinator. KB-1® Dechlorinator are the dechlorinating bacteria that require anaerobic environment to survive.

Based on the experience gained during the pilot test, it is not necessary to rely on growing the microbial community in the aboveground tanks to produce low DO and negative ORP inside the tanks. In fact, the KB-1® Primer alone can sufficiently produce these conditions. Not relying on microbial growth in the aboveground tanks eliminates the biofouling concern for the water stored in the tanks.

During full-scale injection, we will bioaugment the aquifer with KB-1® Dechlorinator throughout the six-month injection; therefore, the three purposes stated above become unnecessary because of the long-term bioaugmentation in the aquifer.

Full-Scale Operation Modification #1: Use substrate components (i.e., chemicals) only to deoxygenate potable water in aboveground tanks.

#2: Number of Aboveground Deoxygenation Tanks for Full-Scale Operation

In Section 4.2.2, Pages 4-9 and 4-10, the Revised TSWP states "*A similar process will be applied to the full-scale injections. Two pairs of tanks will be used for full-scale injection (see section 4.3.2). Both pairs of tanks will be filled halfway with potable water, inoculated, and have KB-1® Primer added. After turning anaerobic, the tanks will be filled with potable water and*

mixed with proportional amounts of the substrate solution components. As with the push/pull test, deoxygenation of the entire tank volume is expected within one to two days. Once anaerobic conditions are restored, half of the tank contents (from each pair) will be injected. This pair of tanks will then be refilled with potable water and mixed with proportional amounts of the substrate solution components. Provided that approximately half a tank of the deoxygenated solution remains in each tank, this accelerated deoxygenation schedule is expected to continue without further use of KB-1® Primer during the remainder of the injection period. By alternating two pair of tanks, injection would not be interrupted while waiting for the substrate solution to turn anaerobic."

Rationale for Modification: Using substrate components (i.e., chemicals) to achieve low DO and negative ORP of the substrate solution for safely injecting KB-1® Dechlorinator, the injection operation can be simplified by alternating two deoxygenation tanks. Based on the experience from the pilot test, the chemicals can lower the DO and ORP to desired levels within a couple of hours. It takes about five and a half hours to inject approximately 5,000 gallons of substrate solution. Therefore, theoretically we can prepare a tank of substrate solution and empty it within a single day. In practice, we will prepare one tank and empty its content the next day. We will alternate using the two existing tanks used in the pilot test. With this modification, we do not need to install two more tanks as proposed in the Revised TSWP.

Full-Scale Operation Modification #2: Use two existing 5,000-gallon aboveground tanks for full-scale injection.

#3: Substitute for KB-1® Primer

In Section 4.2.2, Page 4-8, the Revised TSWP states "*KB-1® Primer is a proprietary mixture of amino acids, potassium bicarbonate, and sodium sulfite that is used to accelerate deoxygenation of water inorganically (sodium sulfite) while still providing an electron donor (amino acids) and buffer (potassium bicarbonate). It can therefore be used as a substitute for ethyl lactate, diammonium phosphate, and yeast extract, although it is significantly more costly and therefore, not suitable for the large volumes planned under full scale injection.*"

Rationale for Modification: With the goal of using chemical method for deoxygenation, the project team conducted bench-scale, 5-gallon bucket tests to evaluate the functionality of the key components of KB-1® Primer. The results of the bucket tests showed that by using the two key ingredients, potassium bicarbonate and sodium sulfite, combined with ethyl lactate and diammonium phosphate, we could achieve the same desired conditions as using the KB-1® Primer alone. The functionality of ethyl lactate as the electron donor and diammonium phosphate as the nutrient can effectively substitute for the amino acids in the KB-1® Primer.

Attachment A includes the Safety Data Sheets (SDS) for potassium bicarbonate and sodium sulfite.

Full-Scale Operation Modification #3: Eliminate KB-1® Primer. Use potassium bicarbonate and sodium sulfite. A Revised Table 4-1 is provided below for the substrate solution components in full-scale operation.

Minor adjustments to the quantities of the substrate components could be necessary during full-scale operation depending on the in-situ water quality measurements of the aboveground tanks content and the groundwater in well TAV-INJ1.

Revised Table 4-1
Substrate Solution Components

Substrate Solution Component	Function	Mixing Ratio (by weight)	Weight per 1,000 gal Water
Primary Components			
Ethyl lactate	Electron donor (substrate)	80.4%	5.64 lbs
Diammonium phosphate	Nutrient and pH buffer	9.0%	0.63 lbs
Accelerite® [a]	Nutrient	6.4%	0.45 lbs
Potassium Bicarbonate	Buffer and acid reducer	1.7%	0.11 lbs
Sodium Sulfite	Deoxygenation and reduction agent	2.5%	0.17 lbs
Primary Components per 1,000 gal Potable Water		**100%**	**7 lbs**
Additional Component Mixed with Substrate Solution			
Sodium bromide	Inert tracer (as bromide)	Not applicable; adjusted per field condition	0.2 lbs

[a] Accelerite® Bioremediation Nutrient is a product of JRW Bioremediation, LLC.
% = Percent.
gal = Gallon(s).
lbs = Pounds.

#4: Substitute for Yeast Extract

In Section 4.2.1, Page 4-7, the Revised TSWP states "*Diammonium phosphate and yeast extract will be added as nutrients to support microbial growth.*"

Rationale for Modification: Accelerite® Bioremediation Nutrient is a product of JRW Bioremediation, LLC (JRW). The composition of Accelerite® is a proprietary nutrient blend of yeast metabolites including B-vitamins and other soluble nutrients. Accelerite® was tested in the bench-scale bucket tests and proved to function the same as the yeast extract obtained from Sigma-Aldrich. There are two advantages of using Accelerite®. First, it is significantly more concentrated, requiring less material to achieve the desired effect. The overall cost for Accelerite® is less than the yeast extract because less material is required. Secondly, Accelerite® is received in liquid form and is much easier to handle in the field than the powder-form yeast extract. Therefore, Accelerite® Bioremediation Nutrient from JRW is chosen to substitute for yeast extract in the full-scale operation.

Attachment A includes the SDS for Accelerite® is Bioremediation Nutrient.

Full-Scale Operation Modification #4: Use Accelerite® Bioremediation Nutrient in place of yeast extract. The Revised Table 4-1 provides the quantity needed for Accelerite® in full-scale operation.

#5: Sampling for Laboratory Analysis of Tank Content

In Section 5.4.2, Pages 5-17 and 5-18 of the Revised TSWP do not state that samples of the injected substrate solution during full-scale injections will be collected for laboratory analysis. However, sampling is implied as we did during the pilot test injections, in accordance with Section 5.4.1, Page 5-15, which states, "*A sample of the injected substrate solution will be collected as it is being injected and analyzed for parameters listed in Table 5-4 and measured for field parameters specified in section 5.3.*"

Rationale for Modification: Samples of the substrate solution in aboveground tanks were collected for laboratory analysis during the pilot test injections. The objective of sampling the tank content was to confirm the ingredients of the substrate solution. However, significant matrix interferences were reported by the analytical laboratory, which resulted in high dilutions for most samples. While preparing the substrate solution, the daily dose, masses or volumes of the substrate components as well as the KB-1® Dechlorinator could be accurately measured before mixing. The volume of the potable water could be accurately measured by the flow meter connected to the fire hydrant. These records provided sufficient information on what was being injected. The laboratory analysis of the tank content did not add any value because the process knowledge of the injectate was sufficient. Therefore, laboratory analysis of the substrate solution is not necessary. In addition, an in-situ water quality sonde is used to monitor the turbidity, specific conductance, pH, ORP, DO, temperature, and pressure in each tank.

Full-Scale Operation Modification #5: No sampling of the aboveground tank content.

#6: Groundwater Sampling at Well TAV-INJ1 during Injection

In Section 5.2.2, Page 5-18, the Revised TSWP states, "*During injection, DO, ORP, and pH will be monitored in well TAV-INJ1 using downhole electronic probes and a data logger. Water levels will also be frequently monitored immediately prior and throughout each workday during injections. Additionally, wells TAV-INJ1, TAV-MW6, and TAV-MW7 will be monitored monthly during injection for the analyses (Table 5-4) and the field parameters listed in section 5.3.*"

Rationale for Modification: During the performance monitoring of the pilot test, it was apparent that we were dominantly sampling the substrate solution that was injected at well TAV-INJ1 instead of the native groundwater. Strong matrix interferences were reported by the analytical laboratory due to the various substrate ingredients. Because we know exactly how we prepare the substrate solution in aboveground tanks, it is not necessary to collect groundwater samples from the injection well during the six-month injection period.

However, we will collect groundwater samples from well TAV-MW6 during injection as planned in the Revised TSWP. In addition, in-situ water quality sondes will be installed in wells TAV-INJ1 and TAV-MW6 during injection. Turbidity, specific conductance, pH, ORP, DO, temperature, and pressure (correlates to water level) will be logged continuously at a frequency set by the project team.

Full-Scale Operation Modification #6: No groundwater sampling at injection well TAV-INJ1 during the six-month injection. Groundwater sampling at well TAV-INJ1 will start one month after the completion of full-scale injections, as proposed for the post-injection monitoring in the Revised TSWP.

#7: ISB Performance Monitoring at Well TAV-MW7

In Section 5.2.2, Page 5-17 (top of page), the Revised TSWP states "*Did results from deeper well TAV-MW7 support the conclusion that further injections will not adversely affect deeper groundwater?"*

Increases in nitrate or bromide concentrations and detections of TCE or associated daughter products in well TAV-MW7 would indicate further injection could drive contamination deeper."

Rationale for Modification: During the pilot test injections, an in-situ water quality sonde was installed in each of the three wells (TAV-INJ1, TAV-MW6, and TAV-MW7). The sonde has sensors for turbidity, specific conductance, pH, ORP, DO, temperature, and pressure. The pressure reading correlates to the height of the water column above the sonde. These seven parameters were logged continuously at a pre-specified interval (e.g., every minute). When injections occurred in well TAV-INJ1 (Figure 1a), we observed instantaneous response in well TAV-MW6 (Figure 1b). However, no response was observed in well TAV-MW7 (Figure 1c). These results indicate that wells TAV-INJ1 and TAV-MW6, both screened across the groundwater table, are **not** hydrogeologically connected with well TAV-MW7, which is screened 90 feet deeper.

The results from the four-month performance monitoring after the pilot test injections also show no indication of any injected ingredient in well TAV-MW7, even though well TAV-MW7 is laterally closer to well TAV-INJ1 than well TAV-MW6. The monitoring results of well TAV-MW7 have been similar to its baseline sampling results in the October – December 2017 Discharge Permit DP-1845 Quarterly Report submitted to the NMED GWQB. A copy of this report was also provided to the NMED HWB.

Well TAV-MW7 would not be useful for monitoring the ISB treatment zone surrounding wells TAV-INJ1 and TAV-MW6. Therefore, we propose to revert it back to the TA-V groundwater monitoring network, which is administered by the SNL Long-Term Stewardship (LTS) group. Under the LTS monitoring plan, well TAV-MW7 is sampled semiannually for nitrate plus nitrite (NPN), volatile organic compounds, and dissolved metals (arsenic, iron, and manganese).

Full-Scale Operation Modification #7: Revert well TAV-MW7 back to the LTS sampling plan with the following additions:

- Increase the sampling frequency from semiannually to quarterly.
- Include bromide in the current analysis suite.
- Include ethene in the current analysis suite, per requirement of the Discharge Permit DP-1845.
- Install an in-situ water quality sonde in well TAV-MW7 in full-scale operation.

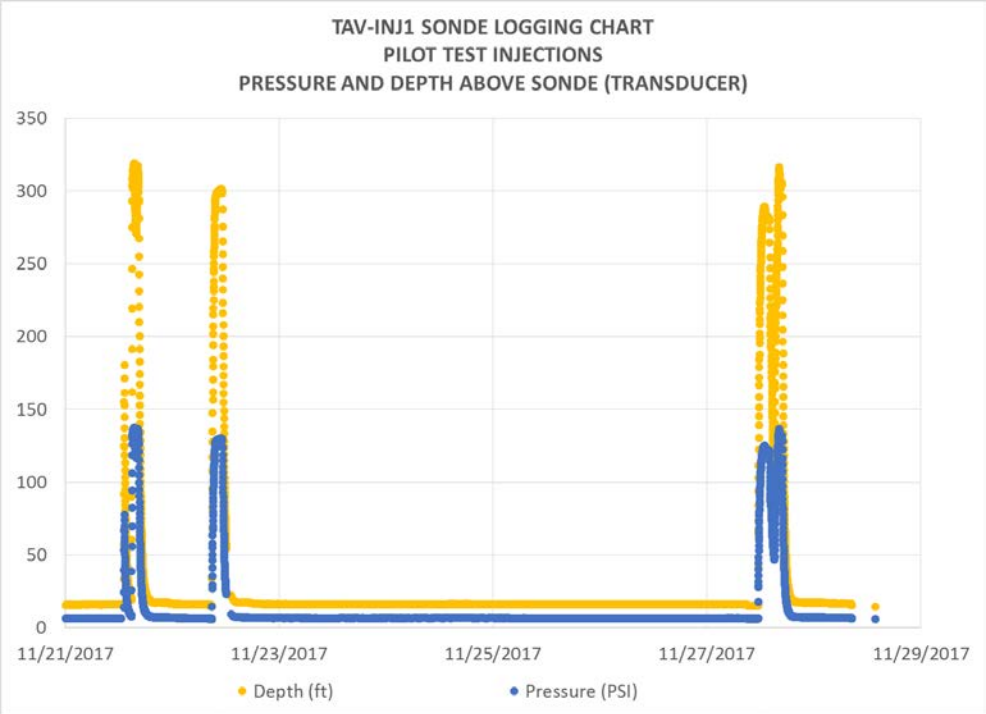

Figure 1a
Pressure and Water Column Height in well TAV-INJ1 during Injections

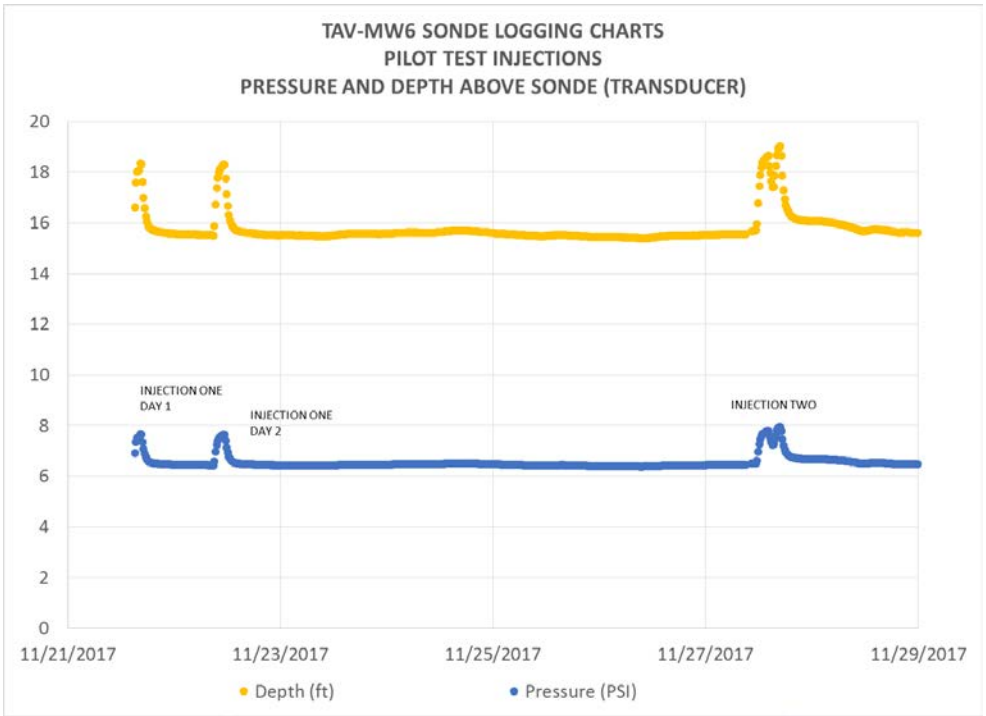

Figure 1b
Pressure and Water Column Height in well TAV-MW6 in
Response to Injections at well TAV-INJ1

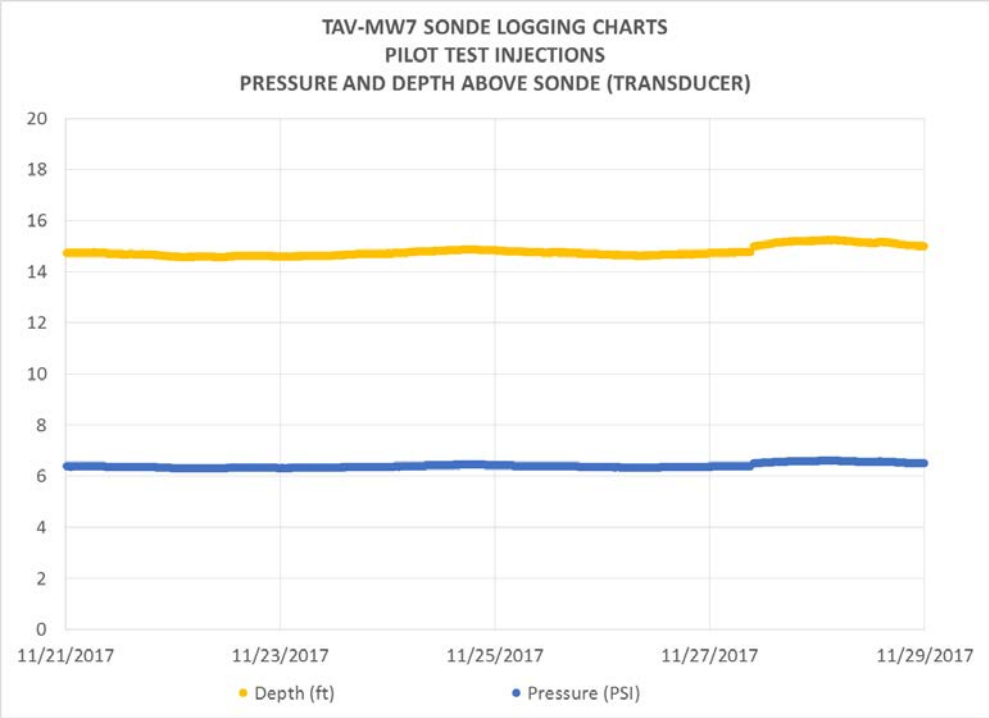

Figure 1c
Pressure and Water Column Height in well TAV-MW7 in
Response to Injections at well TAV-INJ1

In the unlikely event that the sonde readings or the analytical results from well TAV-MW7 show any variation from the baseline, it will be reinstated into the ISB performance monitoring campaign as soon as possible.

#8: Analytical Parameters for Groundwater Samples

In Section 5.3, Page 5-11, Table 5-4, the Revised TSWP provides the analytical parameters for groundwater samples to be collected during the Treatability Study.

Rationale for Modification: Table 5-4 is a comprehensive list that includes all potentially useful parameters identified in the **planning** stage. Based on the results from the pilot test performance monitoring, nine analytes will be eliminated for full-scale operation as explained below.

- Chloride and fluoride – These analytes are not indicative of the performance of the ISB; therefore, are not useful to monitor.

- Nitrite – Baseline samples were collected from injection well TAV-INJ1 and the two nearby monitoring wells TAV-MW6 and TAV-MW7 before the pilot test. Nitrite was either detected near the Practical Quantification Limit or was not detected in the baseline samples (see Table B-2 of the October – December 2017 DP-1845 Quarterly Report). During pilot test performance monitoring, nitrite was not

detected in any of the groundwater samples from wells TAV-INJ1, TAV-MW6, and TAV-MW7 (see Tables B-1 and B-4 of the October – December 2017 DP-1845 Quarterly Report).

Nitrite is highly reactive and is an intermediate compound formed during nitrification and denitrification. It can be oxidized to nitrate or reduced to ammonium in an aquifer. Results of the baseline sampling and the performance monitoring after pilot test injections (which generated reducing conditions in the aquifer) indicate that nitrite apparently does not exist at detectable concentrations during ISB at TA-V. Based on this understanding, nitrite will be eliminated from the analyte list in full-scale operation. Analyses for ammonia and NPN will remain.

- Calcium, magnesium, potassium, and sodium – These analytes are not indicative of the performance of the ISB; therefore, are not useful to monitor.

- Orthophosphate as P – Diammonium phosphate (DAP) is an ingredient of the substrate solution. It acts as a pH buffer and provides phosphorous to support microbial cell generation. Figure 2 presents the orthophosphate concentrations in well TAV-INJ1 during the pilot test performance monitoring. It shows that phosphorous was rapidly utilized by microbes. Figure 2 also presents the concentrations of Total Organic Carbon (TOC), which is the main source for microbial growth. Figure 2 shows the more gradual consumption of TOC compared to the exponential utilization of orthophosphate. It is expected that phosphorous will be completely consumed prior to the depletion of TOC. Therefore, TOC is a more robust and reliable indicator for microbial respiration and growth in the treatment zone. Based on this understanding, orthophosphate will be eliminated from the analyte list in full-scale operation. Analysis for TOC will remain.

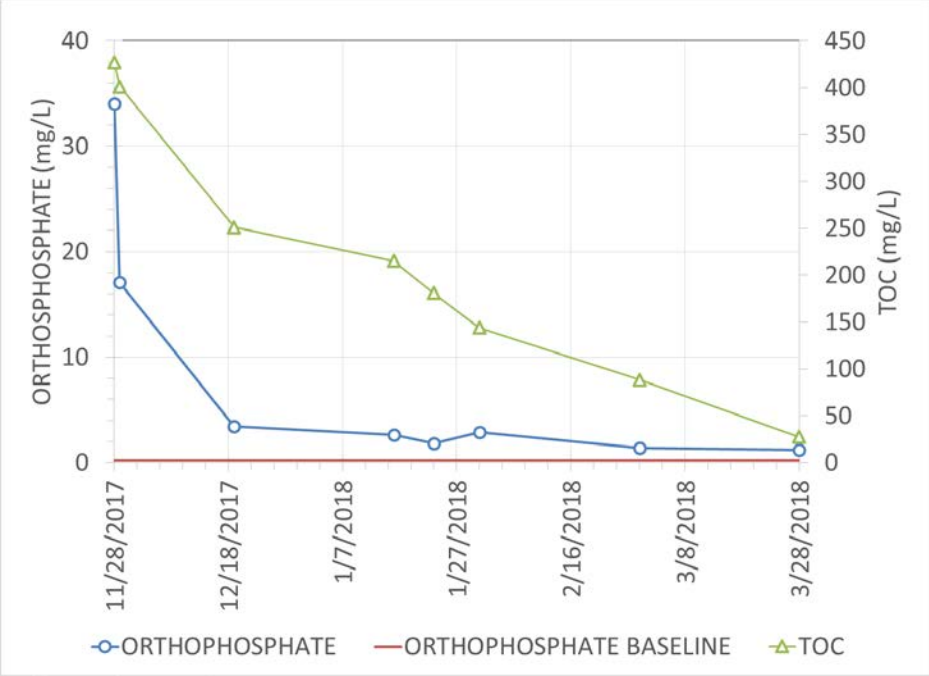

Figure 2
Orthophosphate and TOC Concentrations at TAV-INJ1 following Pilot Test Injections

- Sulfide – Similar to nitrite, sulfides generated during ISB are intermediate compounds and are not expected to persist in a dissolved state. Reactive sulfide was not detected in any of the groundwater samples from wells TAV-INJ1, TAV-MW6, and TAV-MW7 during the pilot test performance monitoring. Therefore, sampling for sulfides in the groundwater from the treatment zone is not warranted for the full-scale operation.

  However, due to the potential for hydrogen sulfide gas to accumulate in the well casing of the injection well, a handheld hydrogen sulfide gas meter will be used to monitor the hydrogen sulfide gas levels during the full-scale injections. The data may be useful to evaluate ISB performance and to address any worker safety concerns for conducting groundwater sampling.

Full-Scale Operation Modification #8: Eliminate unnecessary analytical parameters when wells TAV-INJ1 and TAV-MW6 are sampled. The Revised Table 5-4 is provided below for the analytical parameters for full-scale operation.

Revised Table 5-4
Analytical Parameters for Groundwater Samples

Analytical Group/Analyte in Table 5-4 of the Revised TSWP	Analyte in Table 5-4 of the Revised TSWP	Revised Analyte List for Full-Scale Operation
Alkalinity (total, bicarbonate, and carbonate)	Alkalinity	Yes
Ammonia (as Nitrogen)	Ammonia	Yes
Anions	Bromide	Yes
Anions	Chloride	No
Anions	Fluoride	No
Anions	Nitrite	No
Anions	Sulfate	Yes
Dehalococcoides (Dhc) and, if Dhc is present, vinyl chloride reductase (vcrA).	Dhc and vcrA	Yes
Dissolved Metals	Arsenic	Yes
Dissolved Metals	Calcium	No
Dissolved Metals	Iron	Yes
Dissolved Metals	Magnesium	No
Dissolved Metals	Manganese	Yes
Dissolved Metals	Potassium	No
Dissolved Metals	Sodium	No
Methane/Ethane/Ethene (MEE)	MEE	Yes
Nitrate plus Nitrite (NPN)	NPN	Yes
Orthophosphate (as P)	Orthophosphate (as P)	No
Total Organic Carbon (TOC)	TOC	Yes
Sulfide	Sulfide	No
Volatile Organic Compounds (VOCs)	VOCs	Yes

References

New Mexico Environment Department (NMED), May 2016. Letter to J. Harrell (U.S. Department of Energy NNSA/Sandia Field Office) and P. Davies (Sandia National Laboratories, New Mexico), “Approval Revised Treatability Study Work Plan for In-Situ Bioremediation at the Technical Area-V Groundwater Area of Concern, Sandia National Laboratories, EPA ID# NM5890110518, HWB-SNL-15-020,” NMED, Hazardous Waste Bureau, Santa Fe, New Mexico, May 10, 2016.

Sandia National Laboratories, New Mexico (SNL/NM), March 2016. *Revised Treatability Study Work Plan for In-Situ Bioremediation at the Technical Area-V Groundwater Area of Concern, Sandia National Laboratories, Albuquerque, New Mexico*.