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Sandia National Laboratories, New Mexico

Environmental Restoration Operations

A U.S. Department of Energy Environmental Cleanup Program

Consolidated Quarterly Report

July – September 2019

January 2020

United States Department of Energy
Sandia Field Office

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CONSOLIDATED QUARTERLY REPORT

January 2020

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:	Christi D. Leigh

NUMBER OF POTENTIAL RELEASE SITES SUBJECT TO CORRECTIVE ACTION: 6

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

REPORTING PERIOD: July – September 2019

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, July – September 2019

SECTION II: Because there is no perchlorate sampling collection to report this quarter, this edition of the ER Quarterly Report does not include any analysis of data in Section II "*Perchlorate Screening Quarterly Groundwater Monitoring Report*."

SECTION III: Technical Area-V In-Situ Bioremediation Treatability Study Phase I Full Scale Operation, July – September 2019

ABBREVIATIONS AND ACRONYMS

µg/L	microgram(s) per liter
AGMR	Annual Groundwater Monitoring Report
AOC	Area of Concern
BSG	Burn Site Groundwater
CCM	Current Conceptual Model
COC	constituent of concern
CY	Calendar Year
CYN	Canyons (acronym used for well identification numbers in tables only at Burn Site Groundwater Area of Concern)
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
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
mg/L	milligrams per liter
MW	monitoring well (acronym used for well identification only)
NMED	New Mexico Environment Department
NNSA	National Nuclear Security Administration
NPN	nitrate plus nitrite
ORP	oxidation reduction potential
pH	potential of hydrogen (negative logarithm of the hydrogen ion concentration)
SC	specific conductivity
SNL/NM	Sandia National Laboratories, New Mexico
SWMU	Solid Waste Management Unit
TA1-W	Technical Area-I (Well) (acronym used for well identification only)
TA2-W	Technical Area-II (Well) (acronym used for well identification only)
TAG	Tijeras Arroyo Groundwater
TAV	Technical Area-V (acronym used for well identification numbers in tables only)
TA-V	Technical Area-V

TAVG	Technical Area-V Groundwater
TCE	trichloroethene
TJA	Tijeras Arroyo (acronym used for well identification numbers in tables only)
TOC	total organic carbon
TSWP	Treatability Study Work Plan
VOC	volatile organic compound

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SECTION I
ENVIRONMENTAL RESTORATION OPERATIONS CONSOLIDATED QUARTERLY REPORT, July – September 2019

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 July - September 2019 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 quarterly 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 quarterly reporting period.

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 July - September 2019 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 drinking water 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 analyses of water from one groundwater monitoring well (CYN-MW15).

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 throguh 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 BSG AOC during the July - September 2019 reporting period:

- No groundwater sampling was conducted during this reporting period. Table I-2 presents the identification and the CY 2019 sampling frequency for BSG AOC monitoring wells.

- Began mobilization activities associated with the installation of groundwater monitoring wells CYN-MW16, CYN-MW17, CYN-MW18, and CYN-MW19.

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 drinking water 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 as a potential technology to treat the groundwater contamination at the TAVG AOC.

To implement the Treatability Study, SNL/NM personnel plan 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 will be prepared in aboveground tanks. This substrate solution, along with the biodegradation bacteria, will be gravity-injected to groundwater via injection wells.

The NMED HWB approved the Revised Treatability Study Work Plan (TSWP) (SNL/NM March 2016) on May 10, 2016 (NMED May 2016). In accordance with the Revised TSWP, the Treatability Study will be conducted in two phases. Phase I includes a pilot test followed by full-scale operation at the first injection well (TAV-INJ1). Phase II of the Treatability Study includes 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 is dependent upon the findings of the Phase I full-scale operation.

The NMED Ground Water Quality Bureau (GWQB) requires a groundwater Discharge Permit (DP) for operation of the injection wells. NMED GWQB issued DP-1845 to DOE/NNSA for the SNL/NM TA-V Treatability Study injection wells on May 26, 2017 (NMED May 2017a). The DP-1845 term starts on May 30, 2017 and ends 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, the implementation of the 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 ground-water monitoring for the performance of the in situ bioremediation. 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 occurred in May, June, and July 2019. The Phase I Treatability Study performance monitoring is currently on a quarterly schedule until May 2021.

The following activities occurred at TAVG AOC during the July – September 2019 reporting period:

- For the performance monitoring of the Treatability Study, groundwater sampling was conducted at the treatment zone (i.e., in the proximity of injection well TAV-INJ1) as well as outside the treatment zone during this reporting period. Section III presents the groundwater monitoring results for the 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 a Treatability Study performance monitoring well and follows the sampling frequency and analytes specified for the 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 Treatability Study, although programmatically it belongs to the TA-V groundwater monitoring network (SNL/NM January 2019b). Groundwater monitoring results at wells TAV-MW6 and TAV-MW7 will continue to be reported in Section III of the ER Quarterly Reports for the duration of the Treatability Study.

  Table I-2 presents the CY 2019 sampling frequency for the monitoring wells at TAVG AOC for the 17 wells in the TA-V groundwater monitoring network (18 wells, minus well TAV-MW6). Groundwater sampling was conducted in July and August 2019. The SNL/NM Calendar Year (CY) 2019 Annual Groundwater Monitoring Report will present the analytical results for CY 2019 groundwater monitoring, which is scheduled for submittal to the NMED HWB in the summer of 2020.

- Two first-time exceedances of EPA MCLs occurred in the April – June 2019 reporting period at the TA-V groundwater monitoring network (SNL/NM October 2019):
  - Concentration of nitrate plus nitrite (as nitrogen) at well LWDS-MW2 exceeded the EPA MCL of 10 mg/L.
  - Concentration of TCE at well TAV-MW4 exceeded the EPA MCL of 5 µg/L.

  These two wells were sampled again during this reporting period. The sampling results and evaluation of the exceedances at these two wells are presented in Appendix A.

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. No TCE concentrations in Regional Aquifer samples have exceeded the EPA MCL. The EPA MCLs and State of New Mexico drinking water 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 and Corrective Measures Evaluation Report for the TAG AOC (SNL/NM December 2016), which was submitted to the NMED HWB on November 23, 2016 (DOE November 2016). This November 23, 2016 report was submitted in accordance with NMED's "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 Current Conceptual Model and Corrective Measures Evaluation Report was then submitted to the NMED HWB on February 13, 2018 (SNL/NM February 2018). During a June 20, 2018 meeting, NMED HWB personnel stated that they will complete their review of the revised report in CY 2019.

During August-September 2019, groundwater samples were collected from the 21 monitoring wells (TA1-W-01, TA1-W-02, TA1-W-04, TA1-W-05, TA1-W-06, TA1-W-08, TA2-NW1-595, TA2-W-01, TA2-W-19, TA2-W-24, TA2-W-25, TA2-W-26, TA2-W-27, TA2-W-28, TJA-2, TJA-3, TJA-4, TJA-5, TJA-6, TJA-7, and WYO-3) scheduled for quarterly, semiannual, and annual sampling. Due to ongoing issues, two wells were not sampled. Well PGS-2 has significant grout intrusion and well TA1-W-03 has an insufficient water column for sampling purposes. Table I-2 presents the CY 2019 sampling frequency for the TAG monitoring wells. The analytical results for the TAG AOC CY 2019 groundwater monitoring will be included in the SNL/NM CY 2019 Annual Groundwater Monitoring Report, which is scheduled for submittal to the NMED HWB in the summer of 2020.

2.2 Sites in Corrective Action Complete Regulatory Process

There are currently no SWMUs or AOCs in the corrective action complete regulatory process.

3.0 References

DOE, see U.S. Department of Energy.

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.

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.

Sandia National Laboratories, New Mexico (SNL/NM), October 2019. *Environmental Restoration Operations Consolidated Quarterly Report April – June 2019, Sandia National Laboratories, Albuquerque, New Mexico,* Environmental Restoration Operations, Sandia National Laboratories, Albuquerque, New Mexico.
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.

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 2019	Quarter of Sampling in CY 2019	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	NA	CYN-MW4, CYN-MW7, CYN-MW8, CYN-MW9, CYN-MW10, CYN-MW11, CYN-MW12, CYN-MW13, CYN-MW14A, CYN-MW15
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

Notes:

[a]TAVG AOC monitoring network comprises 18 active wells: 17 wells are listed here; well TAV-MW6 currently is part of the Treatability Study and follows a separate monitoring plan (see Section 2.1.2).
[b] Monitoring well WYO-4 was deleted from the 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).
HWB = Hazardous Waste Bureau.
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 quarterly 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).

APPENDIX A
Evaluation of First-Time Exceedances of EPA MCLs at the TA-V Groundwater Area of Concern

This appendix provides the details of two first-time exceedances of the U.S. Environmental Protection Agency (EPA) Maximum Contaminant Levels (MCLs) at the Technical Area-V (TAV) Groundwater (TAVG) Area of Concern (AOC). One exceedance occurred at monitoring well LWDS-MW2 and the other exceedance occurred at monitoring well TAV-MW4.

In May 2019, concentrations of nitrate plus nitrite (NPN as nitrogen) at well LWDS-MW2 were measured at 12.3 milligrams per liter (mg/L) and 10.1 mg/L in the environmental sample and its duplicate, respectively, exceeding the EPA MCL of 10 mg/L. Also in May 2019, the concentration of trichloroethene (TCE) at well TAV-MW4 was 5.44 micrograms per liter (µg/L), exceeding the EPA MCL of 5 µg/L. These results were reported in the October 2019 Environmental Restoration (ER) Operations Consolidated Report (ER Quarterly Report) (Sandia National Laboratory, New Mexico [SNL/NM] October 2019).

Groundwater sampling at well LWDS-MW2 is on an annual schedule (Table I-2) and the next sampling event is in the second quarter of Calendar Year 2020. However, SNL/NM personnel sampled this well voluntarily for its full analytical suite (dissolved metals, NPN, and volatile organic compounds) in August 2019. Groundwater sampling at well TAV-MW4 is on a quarterly schedule, and it was sampled in August 2019. Table A-1 provides the analytical results for both the May and August 2019 sampling events at these two wells.

Figure A-1 presents the NPN concentrations over time at well LWDS-MW2. Figure A-1 shows that the NPN concentration in May 2019 is abnormally high, but the NPN concentration in August 2019 is consistent with the historical values. The results for the remaining analytical parameters for both May and August 2019 samples are consistent with historical values (SNL/NM June 2019). The May 2019 NPN result at well LWDS-MW2 is currently considered anomalous. This well will continue to be monitored on an annual schedule and its analytical results will be presented in future Annual Groundwater Monitoring Reports (AGMRs).

Figure A-2 presents the TCE concentrations over time at well TAV-MW4. Figure A-2 shows that while the TCE concentration in August 2019 decreased from the TCE concentration in May 2019, it was still above the EPA MCL of 5 µg/L. TCE concentrations over time at well TAV-MW4 are discussed further in the following paragraph. The results for the remaining analytical parameters for both May and August 2019 samples are consistent with historical values (SNL/NM June 2019).

Because TAV-MW4 is one of eight monitoring wells outside the Treatability Study treatment area that are sampled quarterly (see Section III, 3.3), the analytical results will be presented in future ER Quarterly Reports as well as future AGMRs.

Figure A-2 shows that the TCE concentration has been rising slowly since about 2007 at well TAV-MW4. This increasing trend is consistent with the results of the BIOCHLOR fate and transport modeling presented in the 2015 Current Conceptual Model (CCM) report for the TAVG AOC (SNL/NM September 2015). According to the CCM, the natural attenuation mechanisms for TCE include dispersion, diffusion, and sorption. TCE concentration profiles at TAVG AOC were simulated by the BIOCHLOR model and represented in Figure A-3. The then-current (2014) concentrations were used to calibrate the simulation (the red curve in Figure A-3). The BIOCHLOR model "suggests that slight and transient increases in downgradient concentrations are to be expected as the plumes continue to dissipate" (CCM report, page 6-29, SNL/NM September 2015). For example, at the approximate location of well TAV-MW4, TCE concentration is expected to increase from the red curve (2014) to the purple curve (2024), then to the light blue curve (2034), before it decreases to the green curve (2064). The time scale of the rising trend measured at well TAV-MW4 (i.e., an increase to above 5 µg/L in five years [2014 – 2019]) is faster than the BIOCHLOR model prediction. Future monitoring data can be used to refine the BIOCHLOR model to be consistent with the May 2019 TCE concentration at well TAV-MW4.

References

Sandia National Laboratories, New Mexico (SNL/NM), September 2015. *Current Conceptual Model for Technical Area-V Groundwater Area of Concern at Sandia National Laboratories, Albuquerque, New Mexico*.

Sandia National Laboratories, New Mexico (SNL/NM), October 2019. *Environmental Restoration Operations Consolidated Quarterly Report April – June 2019,* Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories, New Mexico (SNL/NM), June 2019. *Annual Groundwater Monitoring Report, Calendar Year 2018,* Long-Term Stewardship Consolidated Groundwater Monitoring Program, Long-Term Stewardship and Environmental Restoration Operations, Sandia National Laboratories, Albuquerque, New Mexico.

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

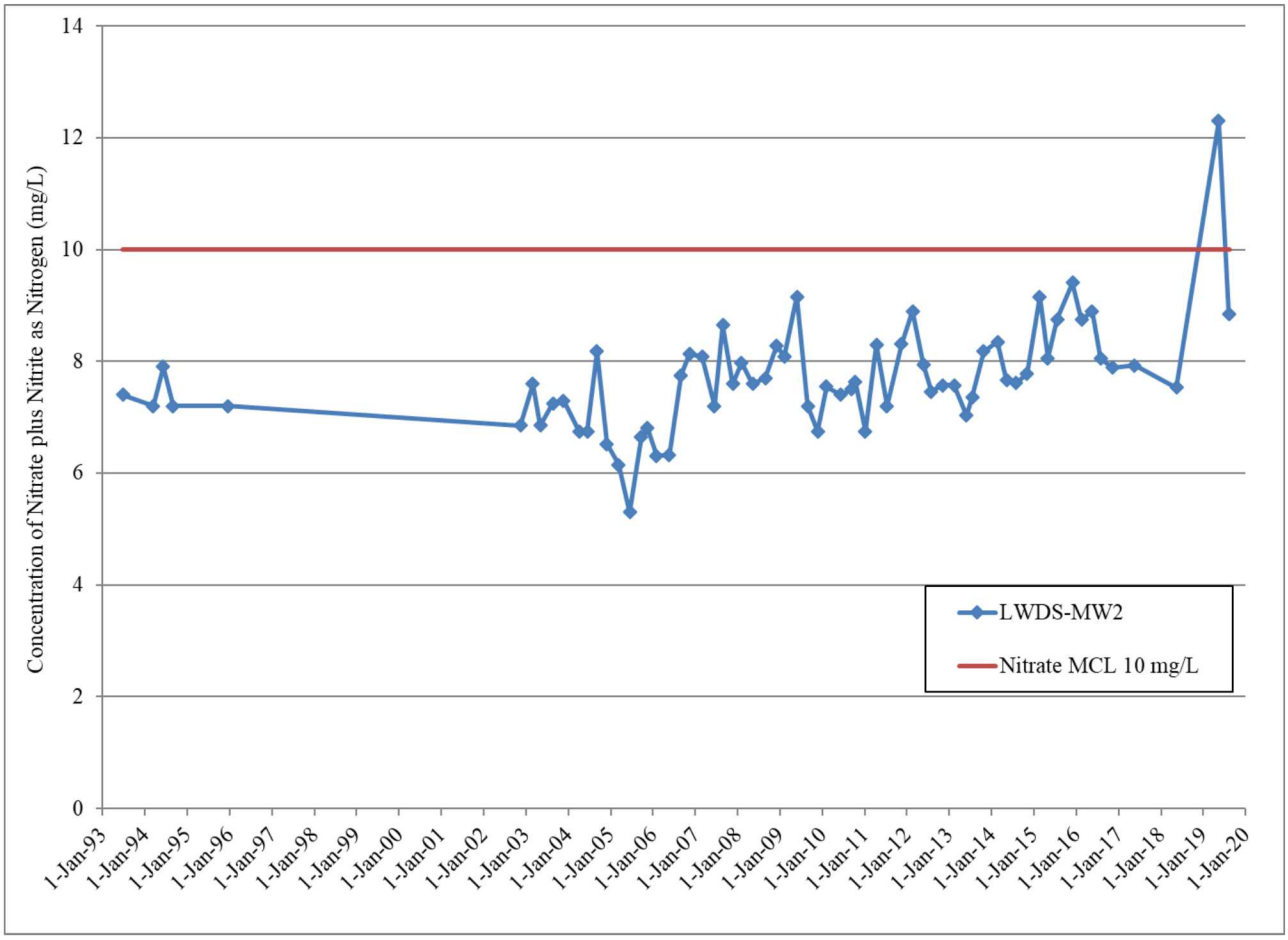

Figure A-1
Nitrate plus Nitrite Concentrations in Groundwater over Time at Well LWDS-MW2

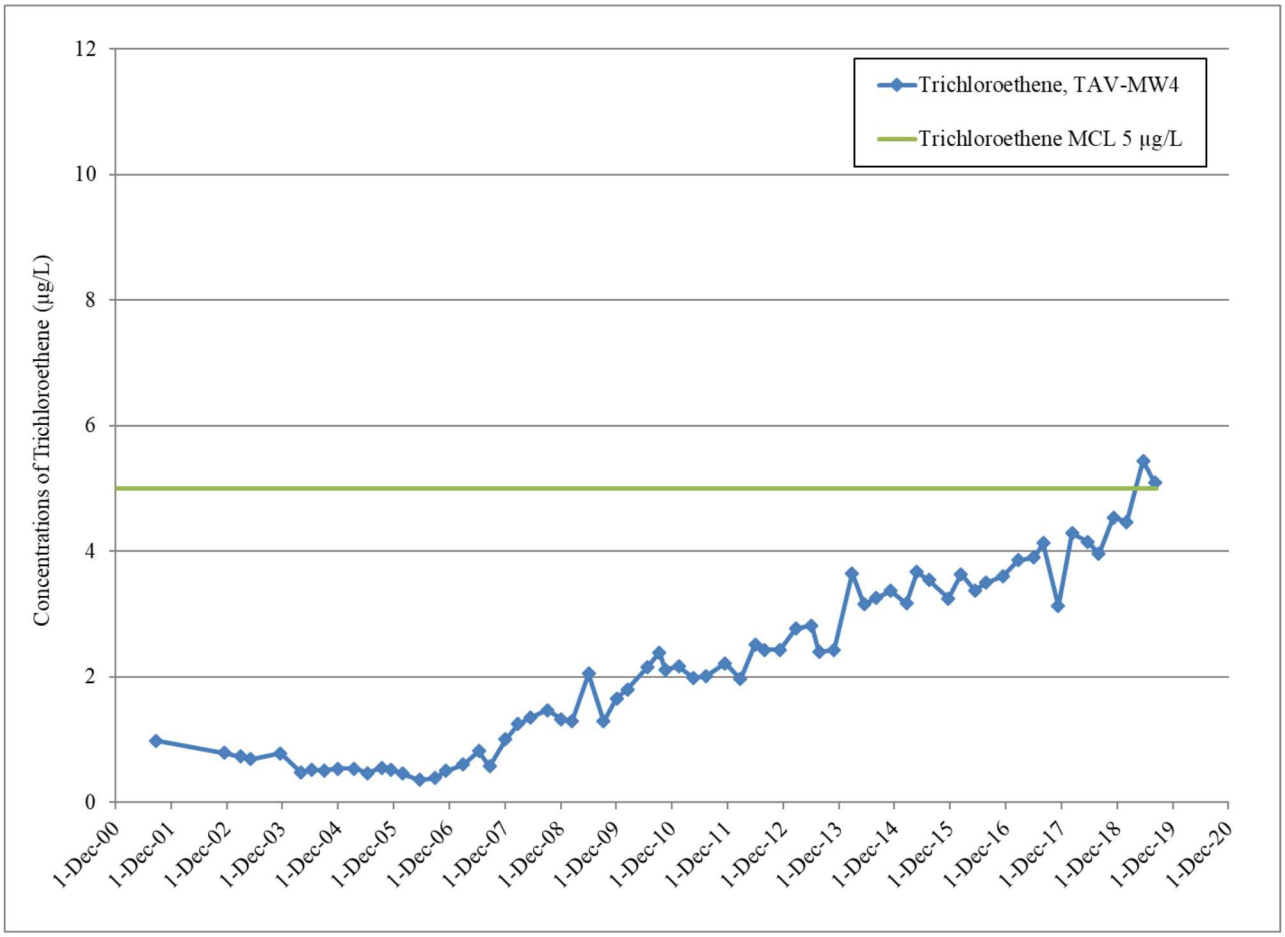

Figure A-2
Trichloroethene Concentrations in Groundwater over Time at Well TAV-MW4

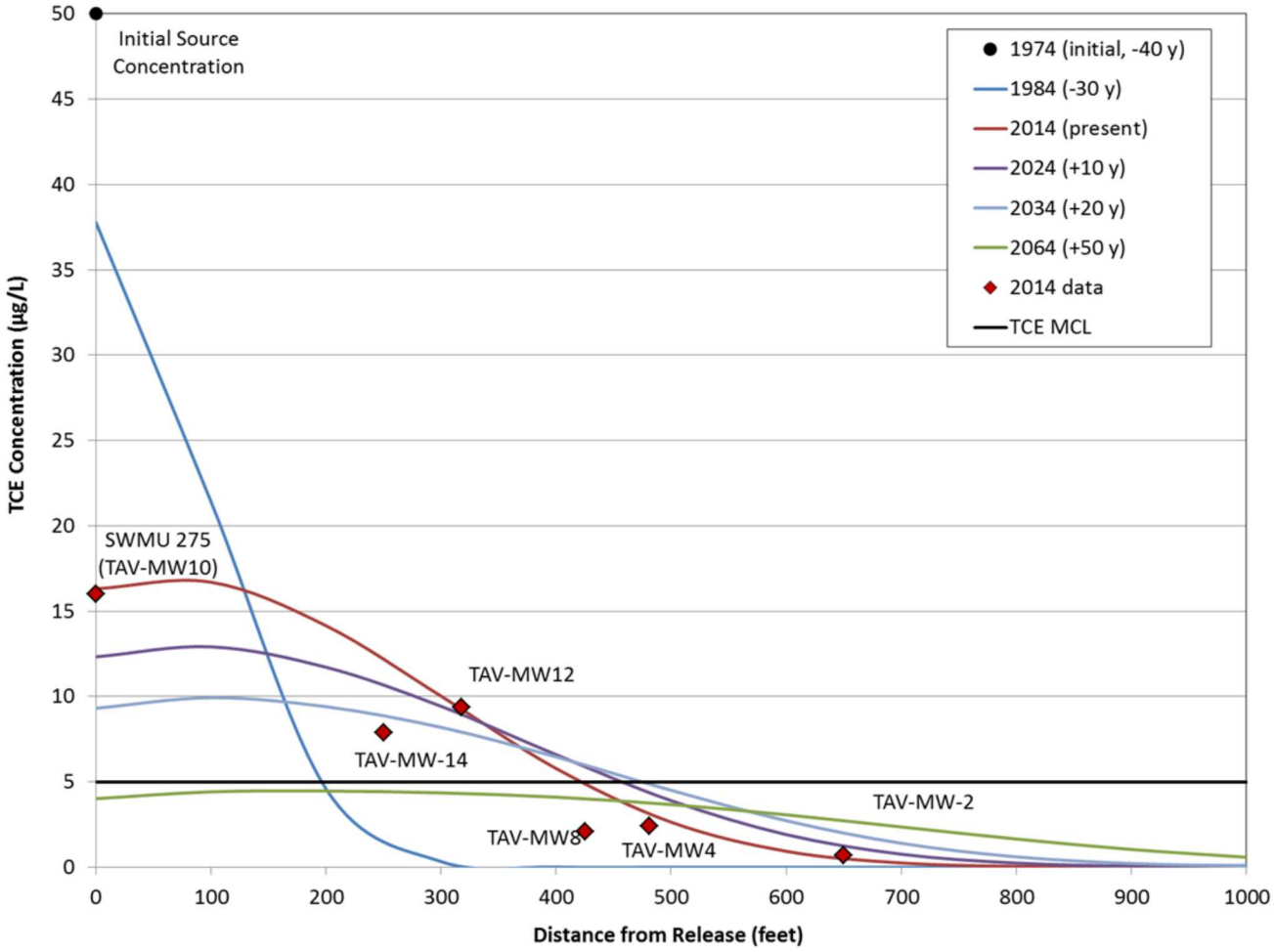

Figure A-3
Modeled Trichloroethene Concentration Profiles by BIOCHLOR
(aka Figure 6-8 in the Current Conceptual Model report [SNL/NM September 2015])

Table A-1
Analytical Results for Groundwater Samples Collected at Monitoring Wells LWDS-MW2 and TAV-MW4, May and August 2019

Sample Date	Analyses	Analyte	Result[a]	MDL[b]	PQL[c]	MCL[d]	Units	Lab Qualifier[e]	Validation Qualifier[f]	Sample No.	Analytical Method[g]	Lab[h]
LWDS-MW2												
14-May-19	Dissolved Metals	Arsenic	0.00284	0.002	0.005	0.01	mg/L	J		108420-003	SW846 3005A/6020B	GEL
14-May-19	Dissolved Metals	Iron	ND	0.033	0.10	NE	mg/L	U		108420-003	SW846 3005A/6020B	GEL
14-May-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		108420-003	SW846 3005A/6020B	GEL
14-May-19	NPN	Nitrate plus nitrite as N	**12.3**	0.425	1.25	10	mg/L			108420-002	EPA 353.2	GEL
14-May-19 (DUP)	Dissolved Metals	Arsenic	0.00278	0.002	0.005	0.01	mg/L	J		108421-003	SW846 3005A/6020B	GEL
14-May-19 (DUP)	Dissolved Metals	Iron	ND	0.033	0.10	NE	mg/L	U		108421-003	SW846 3005A/6020B	GEL
14-May-19 (DUP)	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		108421-003	SW846 3005A/6020B	GEL
14-May-19 (DUP)	NPN	Nitrate plus nitrite as N	**10.1**	0.425	1.25	10	mg/L			108421-002	EPA 353.2	GEL
TAV-MW4												
22-May-19	Dissolved Metals	Arsenic	0.00369	0.002	0.005	0.01	mg/L	J		108437-003	SW846 3005A/6020B	GEL
22-May-19	Dissolved Metals	Iron	ND	0.033	0.10	NE	mg/L	U		108437-003	SW846 3005A/6020B	GEL
22-May-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		108437-003	SW846 3005A/6020B	GEL
22-May-19	NPN	Nitrate plus nitrite as N	6.25	0.17	0.50	10	mg/L			108437-002	EPA 353.2	GEL
22-May-19	VOC	Dichloroethene, cis-1,2-	0.54	0.30	1	70	µg/L	J		108437-001	SW846 8260B	GEL
22-May-19	VOC	Trichloroethene	**5.44**	0.30	1	5	µg/L			108437-001	SW846 8260B	GEL
LWDS-MW2												
9-Aug-19	Dissolved Metals	Arsenic	0.00293	0.002	0.005	0.01	mg/L	J		108915-003	SW846 3005A/6020B	GEL
9-Aug-19	Dissolved Metals	Iron	ND	0.033	0.10	NE	mg/L	U		108915-003	SW846 3005A/6020B	GEL
9-Aug-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		108915-003	SW846 3005A/6020B	GEL
9-Aug-19	NPN	Nitrate plus nitrite as N	8.85	0.425	1.25	10	mg/L			108915-002	EPA 353.2	GEL
TAV-MW4												
6-Aug-19	Dissolved Metals	Arsenic	0.00317	0.002	0.005	0.01	mg/L	J		108793-003	SW846 3005A/6020B	GEL
6-Aug-19	Dissolved Metals	Iron	ND	0.033	0.10	NE	mg/L	U		108794-003	SW846 3005A/6020B	GEL
6-Aug-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		108793-003	SW846 3005A/6020B	GEL
6-Aug-19	NPN	Nitrate plus nitrite as N	4.86	0.17	0.50	10	mg/L			108793-002	EPA 353.2	GEL
6-Aug-19	VOC	Chloroform	0.88	0.30	1	NE	µg/L	J	1.0U	108793-001	SW846 8260B	GEL
6-Aug-19	VOC	Dichloroethene, cis-1,2-	0.31	0.30	1	70	µg/L	J		108793-001	SW846 8260B	GEL
6-Aug-19	VOC	Trichloroethene	**5.09**	0.30	1	5	µg/L			108793-001	SW846 8260B	GEL
6-Aug-19 (DUP)	Dissolved Metals	Arsenic	0.00304	0.002	0.005	0.01	mg/L	J		108794-003	SW846 3005A/6020B	GEL
6-Aug-19 (DUP)	Dissolved Metals	Iron	ND	0.033	0.10	NE	mg/L	U		108794-003	SW846 3005A/6020B	GEL
6-Aug-19 (DUP)	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		108793-003	SW846 3005A/6020B	GEL
6-Aug-19 (DUP)	NPN	Nitrate plus nitrite as N	4.86	0.17	0.50	10	mg/L			108794-002	EPA 353.2	GEL
6-Aug-19 (DUP)	VOC	Chloroform	0.87	0.30	1	NE	µg/L	J	1.0U	108794-001	SW846 8260B	GEL
6-Aug-19 (DUP)	VOC	Trichloroethene	**5.05**	0.30	1	5	µg/L			108794-001	SW846 8260B	GEL

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

Footnotes for Technical Area-V Analytical Results Tables

%	= Percent.
DUP	= Environmental duplicate sample.
EPA	= U.S. Environmental Protection Agency.
LWDS	= Liquid waste disposal system (acronym used for well identification only).
µg/L	= Micrograms per liter.
mg/L	= Milligrams per liter.
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).
VOC	= Volatile organic compound.

[a]Result

Detected VOCs are presented in the tables.

Bold = Value exceed the established 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, DC, 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.

J = Estimated value, the analyte concentration fell above the effective MDL and below the effective PQL.

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.
U = Analyte is absent or below the method detection limit.

[g]Analytical Method

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.

[h]Lab

GEL = GEL Laboratories LLC, 2040 Savage Rd, Charleston, SC 29407.

SECTION II
PERCHLORATE SCREENING QUARTERLY GROUNDWATER MONITORING REPORT, July – September 2019

The groundwater sampling and analysis program for the Burn Site Groundwater Area of Concern currently includes perchlorate analyses of water from one groundwater monitoring well (CYN-MW15). Due to the semiannual nature of the sampling, no groundwater samples were collected for perchlorate analysis during the July - September 2019 reporting period. Therefore, this edition of the Environmental Restoration Consolidated Quarterly Report does not include any analysis of data in Section II "Perchlorate Screening Quarterly Groundwater Monitoring Report."

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SECTION III
TECHNICAL AREA-V IN SITU BIOREMEDIATION TREATABILITY STUDY PHASE I FULL-SCALE OPERATION, July – September 2019

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 Technical Area-V (TA-V) Groundwater (TAVG) Area of Concern (AOC). SNL/NM personnel plan to conduct the Treatability Study in two phases. Phase I includes a pilot test followed by full-scale operation at the first injection well (TAV-INJ1); Phase II includes full-scale operations at two additional injection wells (TAV-INJ2 and TAV-INJ3) contingent on the success of Phase I. The locations of the three injection wells, TAV-INJ1, TAV-INJ2, and TAV-INJ3, are selected close to monitoring wells TAV-MW6, TAV-MW10, and LWDS-MW1, respectively, where the highest contaminant concentrations in TA-V groundwater have been detected.

Table III-1 presents a timeline for the Phase I ISB Treatability Study at TAVG AOC. SNL/NM personnel are currently conducting the Phase I full-scale operation at well TAV-INJ1. 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 TAV-INJ1 (U.S. Department of Energy [DOE] July 2018; New Mexico Environment Department [NMED] August 2018). Appendix A includes a copy of the NMED Hazardous Waste Bureau approval letter and DOE's submittal of the proposed modifications.

This Section III of the Environmental Restoration Operations (ER) Consolidated Quarterly Report (ER Quarterly Report) presents the monitoring results for the July – September 2019 reporting period for the Phase I full-scale operation. No field activities other than groundwater monitoring occurred during this reporting period. In accordance with the Revised TSWP (SNL/NM March 2016), a technical memorandum for the Phase I Treatability Study will be produced after the performance monitoring period has concluded in May 2021 (Table III-1), which will include a discussion of both the pilot test and the full-scale operation.

2.0 Groundwater Elevation at Technical Area-V

The SNL/NM Long-Term Stewardship (LTS) personnel conduct groundwater monitoring for the entire TAVG AOC including the Treatability Study treatment zone. Groundwater monitoring includes groundwater elevation measurements and groundwater sampling.

Figure III-1 shows the June/July 2019 groundwater elevation contour map (potentiometric surface figure) for the Regional Aquifer at TA-V. The general shape of the groundwater elevation contours has 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 0.51 to 0.88 feet per year (SNL/NM June 2019). The approximately 530,000 gallons of treatment solution injected over a six-month period (November 2018 – April 2019) did not create a noticeable impact on the contours of the potentiometric surface at TA-V.

3.0 Groundwater Monitoring for Phase I Full-Scale Operation

SNL/NM personnel have completed the six-month injection period in April 2019 for the Phase I full-scale operation at well TAV-INJ1, and are conducting the two-year performance monitoring in the ISB treatment zone (Table III-1). The treatment zone encompasses the injection well TAV-INJ1 and two nearby monitoring wells (TAV-MW6 and TAV-MW7). Performance monitoring involves groundwater monitoring at all three wells. Even though well TAV-MW7 does not serve for evaluating the effectiveness of ISB, this well is included in the monitoring to define the vertical impact of the injected solution.

Groundwater monitoring is also conducted at eight wells outside the treatment zone on a quarterly schedule, as described in the Revised TSWP (SNL/NM March 2016).

3.1 Groundwater Field Parameters in the Treatment Zone

During this reporting period, the In-Situ Incorporated Aqua TROLL® 600 Multiparameter sondes were installed in all three wells (TAV-INJ1, TAV-MW6, and TAV-MW7). The parameters measured by the sonde include pressure, dissolved oxygen (DO), oxidation reduction potential (ORP), potential of hydrogen (pH), specific conductivity (SC), temperature, and turbidity, in accordance with the Revised TSWP (SNL/NM March 2016). Pressure readings can be converted to groundwater elevation above mean sea level.

Table III-2 presents the comparison of the groundwater field parameters collected by the Aqua TROLL® 600 Multiparameter sonde installed in each of the three wells TAV-INJ1, TAV-MW6, and TAV-MW7 before and after the full-scale injections. The full-scale injections began in November 2018 and completed in April 2019.

3.1.1 Groundwater Quality at Injection Well TAV-INJ1

Groundwater elevations in well TAV-INJ1 returned to the pre-injection static level after the injections were completed, and remained at static level during this reporting period.

With the influx of substrate solution, the water has turned anaerobic with reduced conditions near the injection well since the completion of pilot test injections in November 2017 (Table III-1). Since then, DO, ORP, and pH have remained at optimal levels for the biodegradation of nitrate and TCE to occur. During this reporting period, pH was near 7.0; DO was near 0.0.0 milligrams per liter (mg/L); and ORP was approximately negative (-) 420 millivolts.

SC has stabilized around 3,000 microsiemens per centimeter during this reporting period. The higher SC than the baseline is likely due to byproducts from microbial activity and substrate mineralization inside well TAV-INJ1.

The baseline groundwater temperature in well TAV-INJ1 was approximately 21.1 degrees Celsius. The injected substrate solution, which was mainly potable water, was colder than groundwater. Another reason for the colder substrate solution was that most of the injections occurred in the winter season. After injection was completed in April 2019, the water temperature in well TAV-INJ1 has been rising slowly, and was approximately 19.5 degrees Celsius in September 2019.

Turbidity varied between tens and thousands of nephelometric turbidity units during this reporting period. The variations are likely due to the suspension of sediments and biological growth in the well.

3.1.2 Groundwater Quality at Monitoring Wells TAV-MW6 and TAV-MW7

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 the five months after injections were completed in April 2019, except for DO. The level of DO has decreased

from the baseline of approximately 7.0 mg/L to approximately 4.0 mg/L in September 2019 (Table III-2).

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 groundwater elevation in well TAV-MW7 remained at static levels during this reporting period. There were no significant changes in any of the groundwater quality parameters for well TAV-MW7 (Table III-2).

3.2 Groundwater Sampling in the Treatment Zone

The two-year performance monitoring for the Phase I Treatability Study 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 occurred in May, June, and July 2019. The results for the May and June sampling events were presented in the October 2019 ER Quarterly Report (SNL/NM October 2019). All three wells (TAV-INJ1, TAV-MW6, and TAV-MW7) were sampled in July 2019 during this reporting period.

The Phase I Treatability Study performance monitoring is currently on a quarterly schedule until May 2021 (Table III-1).

Table III-3 lists the sampling dates for the July – September 2019 reporting period for all the wells pertinent to the Treatability Study. Tables III-4 through III-7 presents all the analytical results. Table III-8 summarizes the stabilized water quality parameters measured immediately before sample collection at each well.

3.2.1 Groundwater Sampling at Injection Well TAV-INJ1

During the full-scale operation, the project personnel discovered significant sediment accumulation in well TAV-INJ1. 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 higher than the pre-full-scale operation sampling when the well was relatively free of sediment. The purge volume (before sample collection) at well TAV-INJ1 was 59 gallons that was determined in baseline sampling before Treatability Study. However, after six months of injections, during purging the pump daylighted after pumping approximately 11.5 gallons of groundwater (with the pump set at approximately mid-depth of the water column). The standard practice of the SNL/NM LTS program for low-yield wells is to let the well recover overnight and collect samples the next day.

However, the microbial sample was required to be collected immediately after purging on the first day. For the July sampling event at well TAV-INJ1, the microbial sample was collected on July 23 and the remainder of the samples were collected on July 24, 2019 (Table III-3).

The analytical parameters for groundwater samples 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-4 provides the analytical results for the July – September 2019 sampling event at well TAV-INJ1. In comparison to the sampling results from June 2019 (SNL/NM October 2019), the July 2019 recent results show that:

- For the two constituents of concern in the groundwater at TA-V, NPN was detected below the practical quantitation limit, and TCE was not detected.
- Alkalinity, ammonia, bromide, and sulfate concentrations did not change significantly from June 2019.
- Results of bromide and sulfate in the June 4, 2019 sample appeared anomalous because both concentrations were significantly lower than those in the June 26, 2019 sample. The July 24, 2019 sample results confirmed that the bromide and sulfate results in the June 4, 2019 sample were anomalies.
- The population of Dhc decreased from 10E6 gene copies per liter in June 2019 to 10E5 gene copies per liter in July 2019.
- Concentrations of dissolved arsenic and manganese increased from those in the June 26, 2019 sample; while the concentration of dissolved iron decreased from that in the June 26, 2019 sample. Arsenic exceeded the U.S. Environmental Protection Agency maximum contaminant level of 0.01 mg/L in the July 24, 2019 sample. This was anticipated. During the ISB, the substrate solution produces strongly 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 treatment zone. Solubilized metals and metalloids will precipitate into solid form once they leave the anaerobic treatment zone and enter the aerobic aquifer.

- The level of methane remained high and was similar to that in the June 26, 2019 sample. Ethene was not detected in June 2019 but was detected at 0.47 micrograms per liter (µg/L) in July 2019.
- TOC concentration decreased to about half of the concentration of the June 26, 2019 sample.

3.2.2 Groundwater Sampling at Monitoring Well TAV-MW6

The analytical parameters for groundwater samples from well TAV-MW6 are the same as those for well TAV-INJ1 in accordance with Modification #8 (Appendix A).

Table III-5 provides the analytical results for July – September 2019 sampling event at well TAV-MW6. In comparison to the pre-full-scale operation baseline levels in September 2018 (SNL/NM April 2019), the July 2019 results show that:

- Concentrations of NPN and TCE were consistent with baseline levels.
- Bromide is the inert tracer that was added to the substrate solution. The bromide concentration is expected to increase in well TAV-MW6 as the substrate solution moves away from well TAV-INJ1. The baseline concentration of bromide was 0.815 mg/L. The bromide concentration increased to 4.12 mg/L in the June 24, 2019 sample (SNL/NM October 2019), and was 4.05 mg/L in the July 22, 2019 sample.
- Methane was not detected in the baseline at well TAV-MW6. The concentrations of methane increased from 170 µg/L in the June 24, 2019 sample (SNL/NM October 2019) to 260 µg/L in the July 22, 2019 sample. Ethene has not been detected at this well.
- The results for the other analytes were consistent with the baseline levels.

3.2.3 Groundwater Sampling at Monitoring Well TAV-MW7

The analytical parameters for groundwater samples 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-6 provides the analytical results for the July – September 2019 sampling event at well TAV-MW7, which is screened 90 feet below the water table. All the analytical results

are consistent with baseline levels, including NPN, TCE, and bromide (SNL/NM April 2019).

3.3 Groundwater Sampling 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 (iron, manganese, and arsenic) to evaluate potential impact of substrate solution on groundwater outside the Phase I 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. The analytical parameters for groundwater samples from these wells include the following:

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

These parameters are the same as those for the other monitoring wells in the TA-V groundwater monitoring network (SNL/NM June 2019). Table III-7 provides the analytical results for the July – September 2019 sampling at the eight wells. Duplicate samples were collected from wells LWDS-MW1 and TAV-MW4, per the monitoring scheme of the SNL/NM LTS program for the TA-V groundwater monitoring network. All the analytical results are consistent with the historical values at these eight wells (SNL/NM June 2019).

3.4 Summary of Groundwater Monitoring Results for the Treatability Study

The groundwater elevations remained at static levels during this reporting period in the ISB treatment zone (i.e., the injection well TAV-INJ1 and two monitoring wells TAV-MW6 and TAV-MW7).

The water temperature in well TAV-INJ1 has been slowly rising, indicating the injected solution is mixing with the native groundwater (the injected solution was colder than groundwater).

The groundwater quality in well TAV-INJ1 remained optimal for biodegradation as reflected by the DO, ORP, and pH levels. Meanwhile, microbial activity contributed to the increased SC and turbidity in the well.

The July 2019 groundwater analytical results from well TAV-INJ1 show that:

- NPN was detected below the practical quantitation limit and TCE 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]). It is also possible that the native groundwater was displaced by the injections and has not flowed back or completely mixed with the injected solution.
- The population of the Dhc declined from approximately 10E6 gene copies per liter in June 2019 to approximately 10E5 gene copies per liter in July 2019. Additional monitoring is necessary to help determine if dechlorination is occurring.
- The methane level remained high and TOC continued to be consumed, indicating active microbial activity along with carbon consumption.
- Ethene was detected at 0.47 µg/L. Ethene is the parameter indicating complete TCE dechlorination. Additional monitoring is necessary to confirm if dechlorination is occurring.

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

- The DO levels have decreased in well TAV-MW6, suggesting that the groundwater is becoming anaerobic at this well.
- Bromide, the inert tracer, has migrated to well TAV-MW6; however, its concentration appeared to be stabilizing as of July 2019.
- The Dhc have not reached well TAV-MW6.

The groundwater quality and analytical results from well TAV-MW7 indicate that the substrate solution injected at well TAV-INJ1 has not impacted the deeper groundwater monitored by this well.

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

4.0 Deviations

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.

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.

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.

Sandia National Laboratories, New Mexico (SNL/NM), January 2018. *Discharge Permit-1845 Quarterly Status Report, July – September 2017,* Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories, New Mexico (SNL/NM), April 2019. *Environmental Restoration Operations Consolidated Quarterly Report October – December 2018*, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories, New Mexico (SNL/NM), June 2019. *Annual Groundwater Monitoring Report, Calendar Year 2018*, Long-Term Stewardship Consolidated Groundwater Monitoring Program, Long-Term Stewardship and Environmental Restoration Operations, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories, New Mexico (SNL/NM), October 2019. *Environmental Restoration Operations Consolidated Quarterly Report April – June 2019*, Sandia National Laboratories, Albuquerque, New Mexico.

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

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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Figures

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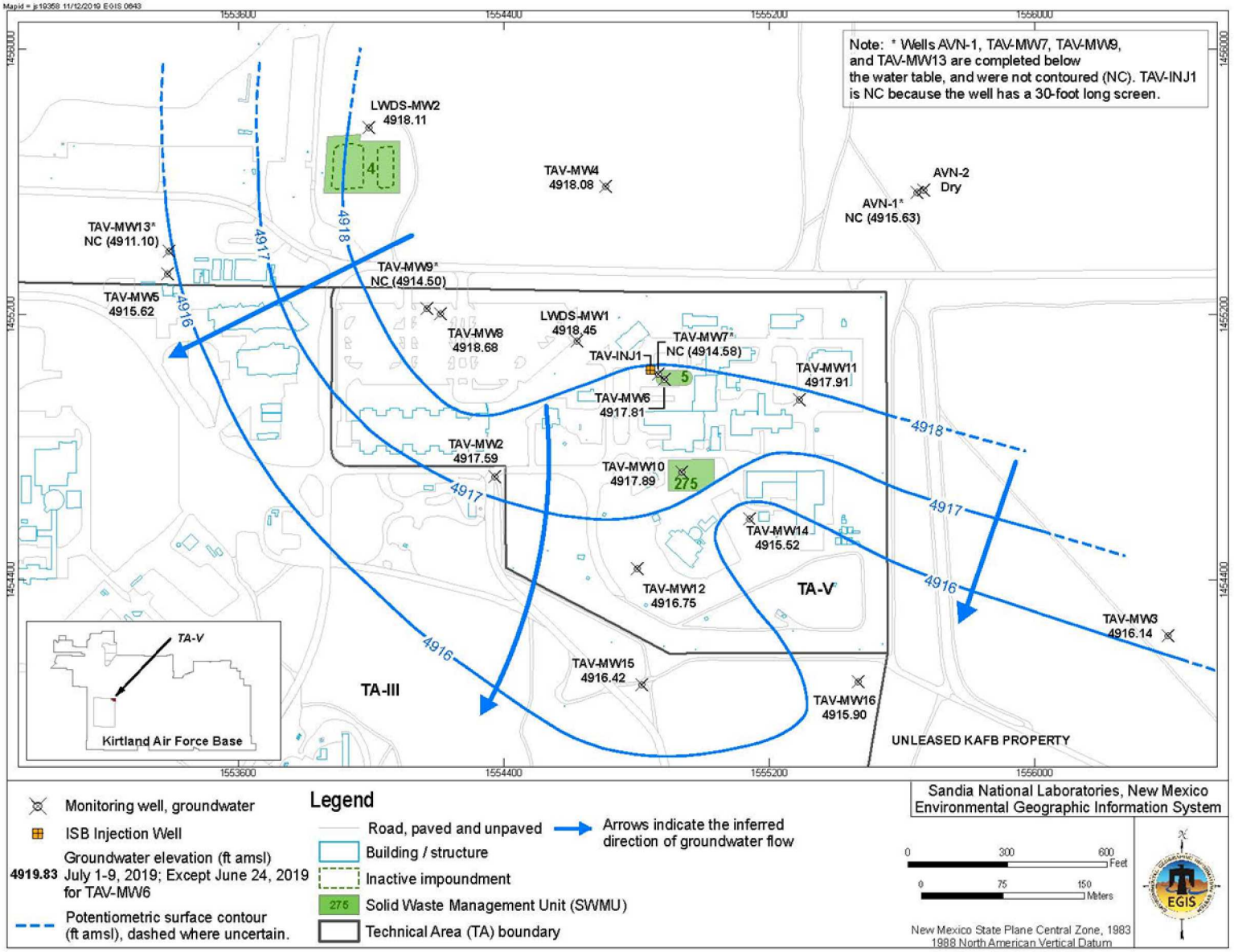

Figure III-1
Well Locations and Potentiometric Surface Contours for June/July 2019

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 In situ Bioremediation (ISB) to evaluate if ISB is a viable technology to treat groundwater contamination at TAVG AOC.
May 2016	NMED HWB approved the Revised Treatability Study Work Plan.
August 2016	NMOSE approved the Permit to Drill application for injection well TAV-INJ1.
May 2017	NMED GWQB issued Discharge Permit (DP)-1845 to DOE/NNSA for the TA-V Treatability Study injection wells.
November 2017	SNL/NM personnel completed installation of injection well TAV-INJ1.
November 2017	Completed Phase I pilot test injections at well TAV-INJ1.
June 2018	Completed performance monitoring of Phase I pilot test.
October 2018	SNL/NM personnel started Phase I full-scale operation of the Treatability Study.
November 1, 2018 – April 25, 2019	Completed 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.
Fall 2020	Anticipate making a decision whether or not to proceed to Phase II of the 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 Defense.
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 = Nation Nuclear Security Administration.
SNL/NM = Sandia National Laboratories, New Mexico.
TA-V = Technical Area–V.
TAV = (acronym used for well identification only).
TAVG = Technical Area-V Groundwater.

Table III-2
Comparison of Groundwater Field Parameters before and after Full-Scale Injections at Wells TAV-INJ1, TAV-MW6, and TAV-MW7

Well ID	TAV-INJ1		TAV-MW6		TAV-MW7	
Groundwater Field Parameter	**Before Full-Scale Injections (October 2018)**	**After Full-Scale Injections (September 2019)**	**Before Full-Scale Injections (October 2018)**	**After Full-Scale Injections (September 2019)**	**During Full-Scale Injections [a] (December 2018)**	**After Full-Scale Injections (September 2019)**
Elevation (ft amsl)	4917.97	4917.50	4918.27	4917.80	4914.96 [b]	4914.70
Dissolved Oxygen (mg/L)	0.01	0.0	7.0	4.0	0.20	0.17
Oxidation Reduction Potential (mV)	-185	-420	200	280	130	140
Potential of Hydrogen (pH)	7.5	7.0	7.5	7.3	7.3	7.0
Specific Conductivity (µS/cm)	850	3,000	670	820	720	780
Temperature (°C)	21.1	19.5	21.1	21.0	21.9	21.8
Turbidity (NTU)	115	10 – 7,000 [c]	5	11	0.7	1

Notes:

Field parameters were recorded by In-Situ Incorporated Aqua TROLL® 600 Multiparameter sondes at 15-minute intervals. All values are approximate. Full-scale injections occurred from November 2018 to April 2019.

[a] No operable sonde was available to be installed in well TAV-MW7 until December 19, 2018.

[b] Water elevation measured on September 24, 2018.

[c] Turbidity varied from day to day likely due to the suspension of sediments and biological growth in the injection well.

°C = Degrees Celsius.
ft amsl = feet above mean sea level.
ID = Identification.
INJ = Injection (acronym used for well identification only).
µS/cm = Microsiemen(s) per centimeter.
mg/L = Milligrams per liter.
mV = Millivolts.
MW = Monitoring well (acronym used for well identification only).
NTU = Nephelometric turbidity units.
TAV = (acronym used for well identification only).

Table III-3
Groundwater Sampling Conducted for Treatability Study, July – September 2019

Monitoring Well	Sampling Date
Wells in the Treatment Zone	
TAV-INJ1	23-24 Jul 2019
TAV-MW6	22 Jul 2019
TAV-MW7	29 Jul 2019
Wells Outside the Treatment Zone	
LWDS-MW1	19 Aug 2019
TAV-MW2	2 Aug 2019
TAV-MW4	6 Aug 2019
TAV-MW8	7 Aug 2019
TAV-MW10	14 Aug 2019
TAV-MW11	5 Aug 2019
TAV-MW12	13 Aug 2019
TAV-MW14	8 Aug 2019

Notes:

[a] Microbial sample was collected on July 23, and the remainder of the samples were collected on July 24, 2019 after the water level had recovered at well TAV-INJ1.

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

Table III-4
Analytical Results for Groundwater Samples Collected at Injection Well TAV INJ1, July – September 2019

Sample Date	Analyses	Analyte	Result[a]	MDL[b]	PQL[c]	MCL[d]	Units	Lab Qual[e]	Val Qual[f]	Sample No.	Analtyical Method[g]	Lab[h]
24-Jul-19	Alkalinity	Alkalinity as $CaCO_3$	1,570	1.45	4	NE	mg/L			108763-006	SM 2320B	GEL
24-Jul-19	Alkalinity	Alkalinity, bicarb as $CaCO_3$	1,570	1.45	4	NE	mg/L			108763-006	SM 2320B	GEL
24-Jul-19	Alkalinity	Alkalinity, carb as $CaCO_3$	ND	1.45	4	NE	mg/L	U		108763-006	SM 2320B	GEL
24-Jul-19	Ammonia	Ammonia	113	1.70	5	NE	mg/L		J	108763-002	EPA 350.1	GEL
24-Jul-19	Anions	Bromide	17.5	1.68	5	NE	mg/L			108763-004	SW846 9056A	GEL
24-Jul-19	Anions	Sulfate	154	3.33	10	NE	mg/L			108763-004	SW846 9056A	GEL
23-Jul-19	Microbial	Dehalococcoides	300,000	2600	2600	NE	Enumeration/L			108769-001	Gene-Trac Dhc	SiREM
24-Jul-19	Dissolved Metals	Arsenic	**0.0465**	0.002	0.005	0.01	mg/L			108763-007	SW846 3005A/6020B	GEL
24-Jul-19	Dissolved Metals	Iron	1.71	0.033	0.10	NE	mg/L			108763-007	SW846 3005A/6020B	GEL
24-Jul-19	Dissolved Metals	Manganese	0.613	0.001	0.005	NE	mg/L			108763-007	SW846 3005A/6020B	GEL
24-Jul-19	MEE	Methane	14,000	0.046	0.50	NE	µg/L		J	108767-001	AM20GAX	PACE
24-Jul-19	MEE	Ethane	0.18	0.005	0.10	NE	µg/L		J	108767-001	AM20GAX	PACE
24-Jul-19	MEE	Ethene	0.47	0.004	0.10	NE	µg/L		J	108767-001	AM20GAX	PACE
24-Jul-19	NPN	Nitrate plus nitrite as N	0.0309	0.017	0.05	10	mg/L	J	J	108763-005	EPA 353.2	GEL
24-Jul-19	TOC	Total Organic Carbon Average	54.7	1.65	5	NE	mg/L			108763-003	SW846 9060A	GEL
24-Jul-19	VOC	Dichloroethene, cis-1,2-	ND	0.30	1	70	µg/L	UH	R	108763-001	SW846 8260B	GEL
24-Jul-19	VOC	Trichloroethene	ND	0.30	1	5	µg/L	UH	R	108763-001	SW846 8260B	GEL

Note: Header nomenclature is explained following Table III-8 in the “Footnotes for Technical Area-V Analytical Results Tables” summary.

Table III-5
Analytical Results for Groundwater Samples Collected at Monitoring Well TAV MW6, July – September 2019

Sample Date	Analyses	Analyte	Result[a]	MDL[b]	PQL[c]	MCL[d]	Units	Lab Qual[e]	Val Qual[f]	Sample No.	Analtyical Method[g]	Lab[h]
22-Jul-19	Alkalinity	Alkalinity as $CaCO_3$	208	1.45	4	NE	mg/L			108757-006	SM 2320B	GEL
22-Jul-19	Alkalinity	Alkalinity, bicarb as $CaCO_3$	208	1.45	4	NE	mg/L			108757-006	SM 2320B	GEL
22-Jul-19	Alkalinity	Alkalinity, carb as $CaCO_3$	ND	1.45	4	NE	mg/L	U		108757-006	SM 2320B	GEL
22-Jul-19	Ammonia	Ammonia	0.0954	0.017	0.05	NE	mg/L		J+	108757-002	EPA 350.1	GEL
22-Jul-19	Anions	Bromide	4.05	0.335	1	NE	mg/L	N	J-	108757-004	SW846 9056A	GEL
22-Jul-19	Anions	Sulfate	38.5	0.665	2	NE	mg/L			108757-004	SW846 9056A	GEL
22-Jul-19	Microbial	Dehalococcoides	ND	3000	3000	NE	Enumeration/L	U		108768-001	Gene-Trac Dhc	SiREM
22-Jul-19	Dissolved Metals	Arsenic	0.00276	0.002	0.005	0.01	mg/L	J		108757-007	SW846 3005A/6020B	GEL
22-Jul-19	Dissolved Metals	Iron	ND	0.033	0.10	NE	mg/L	U		108757-007	SW846 3005A/6020B	GEL
22-Jul-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		108757-007	SW846 3005A/6020B	GEL
22-Jul-19	MEE	Methane	260	0.046	0.50	NE	µg/L		J	108765-001	AM20GAX	PACE
22-Jul-19	MEE	Ethane	ND	0.005	0.10	NE	µg/L	U	0.10UJ	108765-001	AM20GAX	PACE
22-Jul-19	MEE	Ethene	ND	0.004	0.10	NE	µg/L	U	0.10UJ	108765-001	AM20GAX	PACE
22-Jul-19	NPN	Nitrate plus nitrite as N	6.38	0.17	0.50	10	mg/L			108757-005	EPA 353.2	GEL
22-Jul-19	TOC	Total Organic Carbon Average	0.654	0.33	1	NE	mg/L	J	1.0U	108757-003	SW846 9060A	GEL
22-Jul-19	VOC	Dichloroethene, cis-1,2-	0.56	0.30	1	70	µg/L	J	J-	108757-001	SW846 8260B	GEL
22-Jul-19	VOC	Trichloroethene	**7.69**	0.30	1	5	µg/L			108757-001	SW846 8260B	GEL

Note: Header nomenclature is explained following Table III-8 in the “Footnotes for Technical Area-V Analytical Results Tables” summary.

Table III-6
Analytical Results for Groundwater Samples Collected at Monitoring Well TAV-MW7, July – September 2019

Sample Date	Analyses	Analyte	Result[a]	MDL[b]	PQL[c]	MCL[d]	Units	Lab Qual[e]	Val Qual[f]	Sample No.	Analtyical Method[g]	Lab[h]
29-Jul-19	Anions	Bromide	0.274	0.067	0.20	NE	mg/L			108773-001	SW846 9056A	GEL
29-Jul-19	Dissolved Metals	Arsenic	0.00284	0.002	0.005	0.01	mg/L	J		108771-003	SW846 3005A/6020B	GEL
29-Jul-19	Dissolved Metals	Iron	ND	0.033	0.10	NE	mg/L	U		108771-003	SW846 3005A/6020B	GEL
29-Jul-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		108771-003	SW846 3005A/6020B	GEL
29-Jul-19	MEE	Ethene	ND	0.004	0.10	NE	µg/L	U	0.10UJ	108777-001	AM20GAX	PACE
29-Jul-19	NPN	Nitrate plus nitrite as N	4.32	0.085	0.25	10	mg/L			108771-002	EPA 353.2	GEL
29-Jul-19	VOC	Dichloroethene, cis-1,2-	ND	0.30	1	70	µg/L	U		108771-001	SW846 8260B	GEL
29-Jul-19	VOC	Trichloroethene	ND	0.30	1	5	µg/L	U		108771-001	SW846 8260B	GEL

Note: Header nomenclature is explained following Table III-8 in the “Footnotes for Technical Area-V Analytical Results Tables” summary.

Table III-7
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, July – September 2019

Sample Date	Analyses	Analyte	Result[a]	MDL[b]	PQL[c]	MCL[d]	Units	Lab Qualifier[e]	Validation Qualifier[f]	Sample No.	Analytical Method[g]	Lab[h]
LWDS-MW1												
19-Aug-19	Dissolved Metals	Arsenic	0.00393	0.002	0.005	0.01	mg/L	J		108811-003	SW846 3005A/6020B	GEL
19-Aug-19	Dissolved Metals	Iron	ND	0.033	0.10	NE	mg/L	U		108811-003	SW846 3005A/6020B	GEL
19-Aug-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		108811-003	SW846 3005A/6020B	GEL
19-Aug-19	NPN	Nitrate plus nitrite as N	**12.2**	0.17	0.50	10	mg/L			108811-002	EPA 353.2	GEL
19-Aug-19	VOC	Dichloroethene, cis-1,2-	3.52	0.30	1	70	µg/L			108811-001	SW846 8260B	GEL
19-Aug-19	VOC	Trichloroethene	**11.4**	0.30	1	5	µg/L			108811-001	SW846 8260B	GEL
19-Aug-19 (DUP)	Dissolved Metals	Arsenic	0.00423	0.002	0.005	0.01	mg/L	J		108812-003	SW846 3005A/6020B	GEL
19-Aug-19 (DUP)	Dissolved Metals	Iron	ND	0.033	0.10	NE	mg/L	U		108812-003	SW846 3005A/6020B	GEL
19-Aug-19 (DUP)	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		108812-003	SW846 3005A/6020B	GEL
19-Aug-19 (DUP)	NPN	Nitrate plus nitrite as N	**11.8**	0.17	0.50	10	mg/L			108812-002	EPA 353.2	GEL
19-Aug-19 (DUP)	VOC	Dichloroethene, cis-1,2-	3.75	0.30	1	70	µg/L			108812-001	SW846 8260B	GEL
19-Aug-19 (DUP)	VOC	Trichloroethene	**13.6**	0.30	1	5	µg/L			108812-001	SW846 8260B	GEL
TAV-MW2												
2-Aug-19	Dissolved Metals	Arsenic	0.00329	0.002	0.005	0.01	mg/L	J		108785-003	SW846 3005A/6020B	GEL
2-Aug-19	Dissolved Metals	Iron	ND	0.033	0.10	NE	mg/L	U		108785-003	SW846 3005A/6020B	GEL
2-Aug-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		108785-003	SW846 3005A/6020B	GEL
2-Aug-19	NPN	Nitrate plus nitrite as N	4.83	0.17	0.50	10	mg/L			108785-002	EPA 353.2	GEL
2-Aug-19	VOC	Dichloroethene, cis-1,2-	ND	0.30	1	70	µg/L	U		108785-001	SW846 8260B	GEL
2-Aug-19	VOC	Trichloroethene	3.38	0.30	1	5	µg/L			108785-001	SW846 8260B	GEL
TAV-MW4												
6-Aug-19	Dissolved Metals	Arsenic	0.00317	0.002	0.005	0.01	mg/L	J		108793-003	SW846 3005A/6020B	GEL
6-Aug-19	Dissolved Metals	Iron	ND	0.033	0.10	NE	mg/L	U		108793-003	SW846 3005A/6020B	GEL
6-Aug-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		108793-003	SW846 3005A/6020B	GEL
6-Aug-19	NPN	Nitrate plus nitrite as N	4.86	0.17	0.50	10	mg/L			108793-002	EPA 353.2	GEL
6-Aug-19	VOC	Dichloroethene, cis-1,2-	0.31	0.30	1	70	µg/L	J		108793-001	SW846 8260B	GEL
6-Aug-19	VOC	Trichloroethene	**5.09**	0.30	1	5	µg/L			108793-001	SW846 8260B	GEL
6-Aug-19 (DUP)	Dissolved Metals	Arsenic	0.00304	0.002	0.005	0.01	mg/L	J		108794-003	SW846 3005A/6020B	GEL
6-Aug-19 (DUP)	Dissolved Metals	Iron	ND	0.033	0.10	NE	mg/L	U		108794-003	SW846 3005A/6020B	GEL
6-Aug-19 (DUP)	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		108794-003	SW846 3005A/6020B	GEL
6-Aug-19 (DUP)	NPN	Nitrate plus nitrite as N	4.86	0.17	0.50	10	mg/L			108794-002	EPA 353.2	GEL
6-Aug-19 (DUP)	VOC	Dichloroethene, cis-1,2-	ND	0.30	1	70	µg/L	U		108794-001	SW846 8260B	GEL
6-Aug-19 (DUP)	VOC	Trichloroethene	**5.05**	0.30	1	5	µg/L			108794-001	SW846 8260B	GEL

Note: Header nomenclature is explained following Table III-8 in the “Footnotes for Technical Area-V Analytical Results Tables” summary.

Table III-7
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, July – September 2019 (concluded)

Sample Date	Analyses	Analyte	Result[a]	MDL[b]	PQL[c]	MCL[d]	Units	Lab Qualifier[e]	Validation Qualifier[f]	Sample No.	Analytical Method[g]	Lab[h]
TAV-MW8												
7-Aug-19	Dissolved Metals	Arsenic	0.00276	0.002	0.005	0.01	mg/L	J		108817-003	SW846 3005A/6020B	GEL
7-Aug-19	Dissolved Metals	Iron	ND	0.033	0.10	NE	mg/L	U		108817-003	SW846 3005A/6020B	GEL
7-Aug-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		108817-003	SW846 3005A/6020B	GEL
7-Aug-19	NPN	Nitrate plus nitrite as N	6.05	0.425	1.25	10	mg/L			108817-002	EPA 353.2	GEL
7-Aug-19	VOC	Dichloroethene, cis-1,2-	ND	0.30	1	70	µg/L	U		108817-001	SW846 8260B	GEL
7-Aug-19	VOC	Trichloroethene	4.68	0.30	1	5	µg/L			108817-001	SW846 8260B	GEL
TAV-MW10												
14-Aug-19	Dissolved Metals	Arsenic	0.00319	0.002	0.005	0.01	mg/L	J		108802-003	SW846 3005A/6020B	GEL
14-Aug-19	Dissolved Metals	Iron	ND	0.033	0.10	NE	mg/L	U		108802-003	SW846 3005A/6020B	GEL
14-Aug-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		108802-003	SW846 3005A/6020B	GEL
14-Aug-19	NPN	Nitrate plus nitrite as N	**11.6**	0.425	1.25	10	mg/L			108802-002	EPA 353.2	GEL
14-Aug-19	VOC	Dichloroethene, cis-1,2-	1.99	0.30	1	70	µg/L			108802-001	SW846 8260B	GEL
14-Aug-19	VOC	Trichloroethene	**10.6**	0.30	1	5	µg/L			108802-001	SW846 8260B	GEL
TAV-MW11												
5-Aug-19	Dissolved Metals	Arsenic	0.00287	0.002	0.005	0.01	mg/L	J		108787-003	SW846 3005A/6020B	GEL
5-Aug-19	Dissolved Metals	Iron	ND	0.033	0.10	NE	mg/L	U		108787-003	SW846 3005A/6020B	GEL
5-Aug-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		108787-003	SW846 3005A/6020B	GEL
5-Aug-19	NPN	Nitrate plus nitrite as N	6.86	0.17	0.50	10	mg/L			108787-002	EPA 353.2	GEL
5-Aug-19	VOC	Dichloroethene, cis-1,2-	0.39	0.30	1	70	µg/L	J		108787-001	SW846 8260B	GEL
5-Aug-19	VOC	Trichloroethene	4.43	0.30	1	5	µg/L			108787-001	SW846 8260B	GEL
TAV-MW12												
13-Aug-19	Dissolved Metals	Arsenic	0.00335	0.002	0.005	0.01	mg/L	J		108800-003	SW846 3005A/6020B	GEL
13-Aug-19	Dissolved Metals	Iron	ND	0.033	0.10	NE	mg/L	U		108800-003	SW846 3005A/6020B	GEL
13-Aug-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		108800-003	SW846 3005A/6020B	GEL
13-Aug-19	NPN	Nitrate plus nitrite as N	4.85	0.17	0.50	10	mg/L			108800-002	EPA 353.2	GEL
13-Aug-19	VOC	Dichloroethene, cis-1,2-	ND	0.30	1	70	µg/L	U		108800-001	SW846 8260B	GEL
13-Aug-19	VOC	Trichloroethene	2.09	0.30	1	5	µg/L			108800-001	SW846 8260B	GEL
TAV-MW14												
8-Aug-19	Dissolved Metals	Arsenic	0.00279	0.002	0.005	0.01	mg/L	J		108798-003	SW846 3005A/6020B	GEL
8-Aug-19	Dissolved Metals	Iron	ND	0.033	0.10	NE	mg/L	U		108798-003	SW846 3005A/6020B	GEL
8-Aug-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		108798-003	SW846 3005A/6020B	GEL
8-Aug-19	NPN	Nitrate plus nitrite as N	7.05	0.425	1.25	10	mg/L			108798-002	EPA 353.2	GEL
8-Aug-19	VOC	Dichloroethene, cis-1,2-	ND	0.30	1	70	µg/L	U		108798-001	SW846 8260B	GEL
8-Aug-19	VOC	Trichloroethene	4.53	0.30	1	5	µg/L			108798-001	SW846 8260B	GEL

Note: Header nomenclature is explained following Table III-8 in the “Footnotes for Technical Area-V Analytical Results Tables” summary.

Table III-8
Field Water Quality Measurements[i] before Collection of Groundwater Samples at Each Well, July – September 2019

Well ID	Sample Date	Temperature (°C)	Specific Conductivity (µmhos/cm)	Oxidation Reduction Potential (mV)	pH	Turbidity (NTU)	Dissolved Oxygen (% Sat)	Dissolved Oxygen (mg/L)
TAV-INJ1	23-Jul-19	20.59	2872.22	-302.29	6.91	29.7	6.21	0.78
TAV-INJ1	24-Jul-19	21.01	3031.96	-251.68	6.97	34.5	7.11	0.81
TAV-MW6	22-Jul-19	23.09	754.94	101.83	7.40	3.52	55.66	4.02
TAV-MW7	29-Jul-19	21.66	606.55	-15.90	7.37	0.62	3.03	0.39
LWDS-MW1	19-Aug-19	25.70	792.41	197.70	7.30	0.46	82.71	8.41
TAV-MW2	2-Aug-19	22.55	711.63	26.40	7.35	2.02	92.88	7.06
TAV-MW4	6-Aug-19	21.88	514.17	245.50	7.68	0.87	90.33	7.53
TAV-MW8	7-Aug-19	22.25	633.63	255.60	7.52	3.60	94.30	7.32
TAV-MW10	14-Aug-19	22.36	628.00	211.20	7.55	0.38	96.32	8.10
TAV-MW11	5-Aug-19	22.61	622.21	242.10	7.59	0.64	93.34	7.55
TAV-MW12	13-Aug-19	22.82	665.94	206.10	7.41	0.92	79.08	6.53
TAV-MW14	8-Aug-19	22.15	676.81	219.10	7.49	4.51	111.69	9.58

Note: Header nomenclature is explained following Table III-8 in the “Footnotes for Technical Area-V Analytical Results Tables” summary.

Footnotes for Technical Area-V Analytical Results Tables

% = Percent.
$CaCO_3$ = Calcium carbonate.
Dhc = *Dehalococcoides*.
DUP = Duplicate environmental 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 = Value exceed the established MCL.
ND = Not detected (at non 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, DC, 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.
H = Analytical holding time was 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 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+ = Estimated value with a suspected positive bias.
J- = Estimated value with a suspected negative bias.
R = The data are unusable, and resampling or reanalysis are necessary for verification.
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 = Pace Analytical Services LLC, Energy Services Lab, 220 William Pitt Way, Pittsburgh, Pennsylvania 15238.
SiREM = 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.
μmhos/cm = Micromhos per centimeter.
mg/L = Milligrams per liter.
mV = Millivolts.
NTU = Nephelometric turbidity units.
pH = Potential of hydrogen (negative logarithm of the hydrogen ion concentration).

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
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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

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cc w/o enclosure:
Amy Blumberg, SNL/NM
Paul Shoemaker, SNL/NM
Christi Leigh, SNL/NM
John Cochran, SNL/NM
Jun Li, SNL/NM
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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.

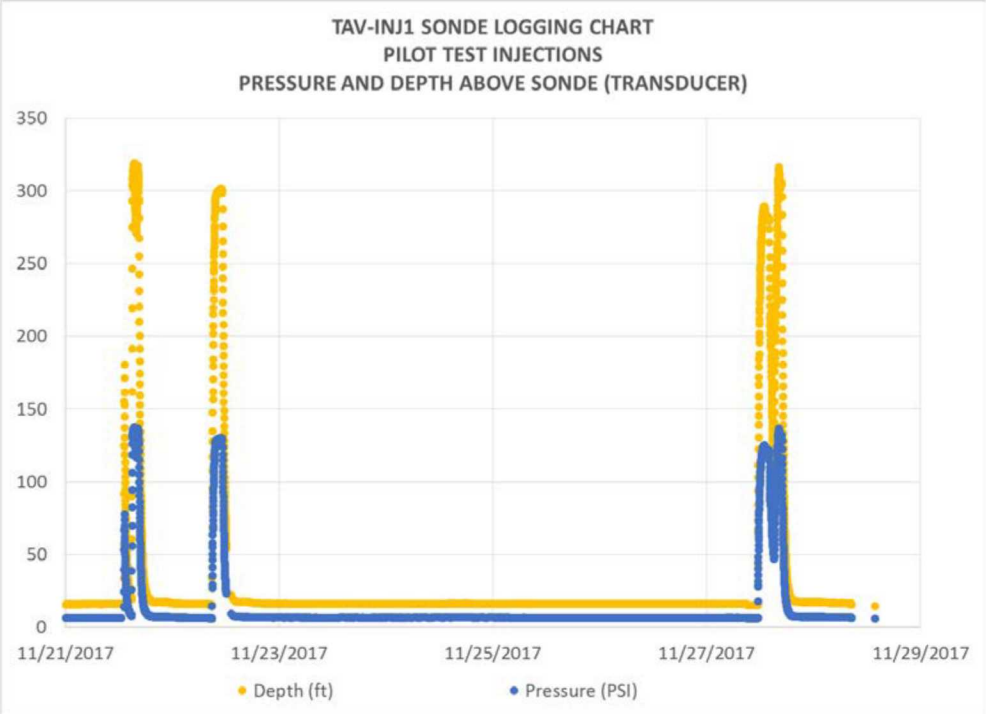

Figure 1a
Pressure and Water Column Height in well TAV-INJ1 during Injections

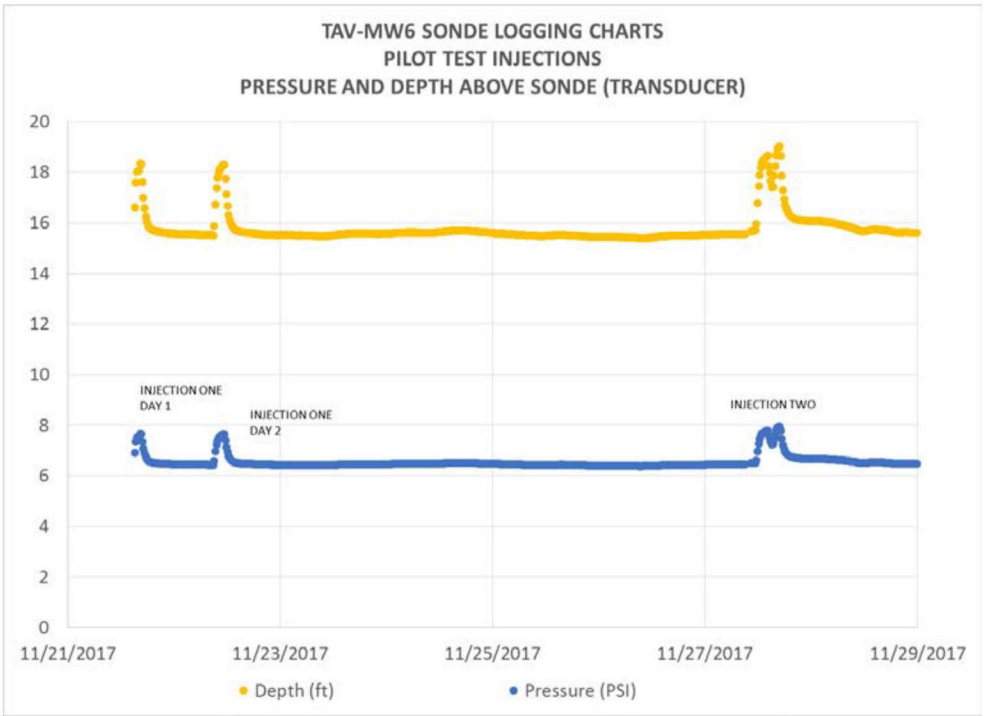

Figure 1b
Pressure and Water Column Height in well TAV-MW6 in
Response to Injections at well TAV-INJ1

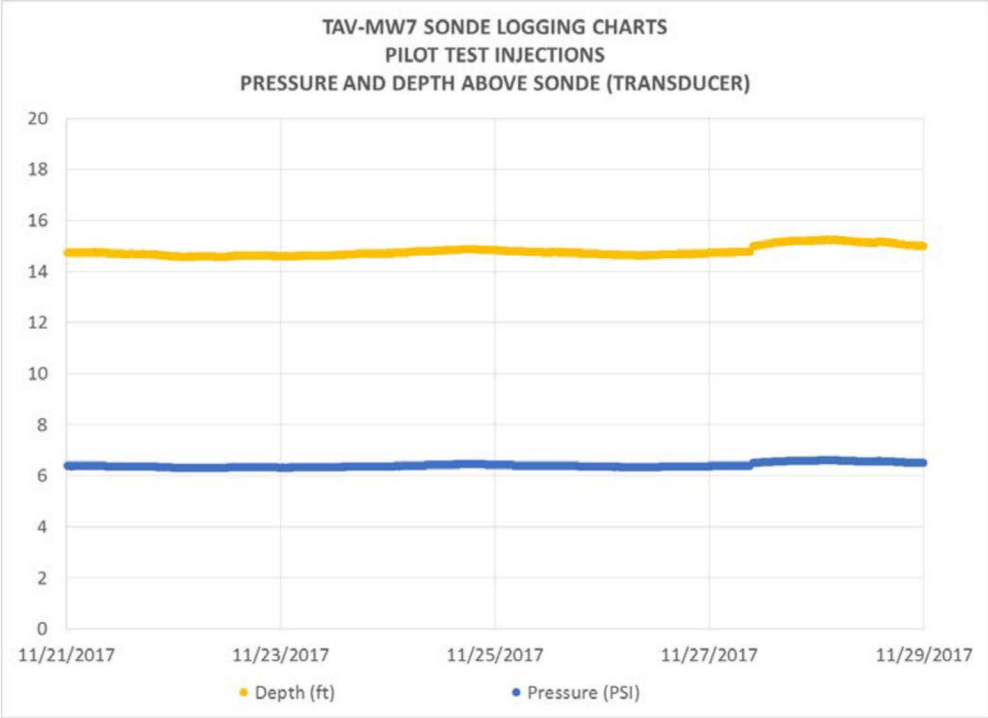

Figure 1c
Pressure and Water Column Height in well TAV-MW7 in
Response to Injections at well TAV-INJ1

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.

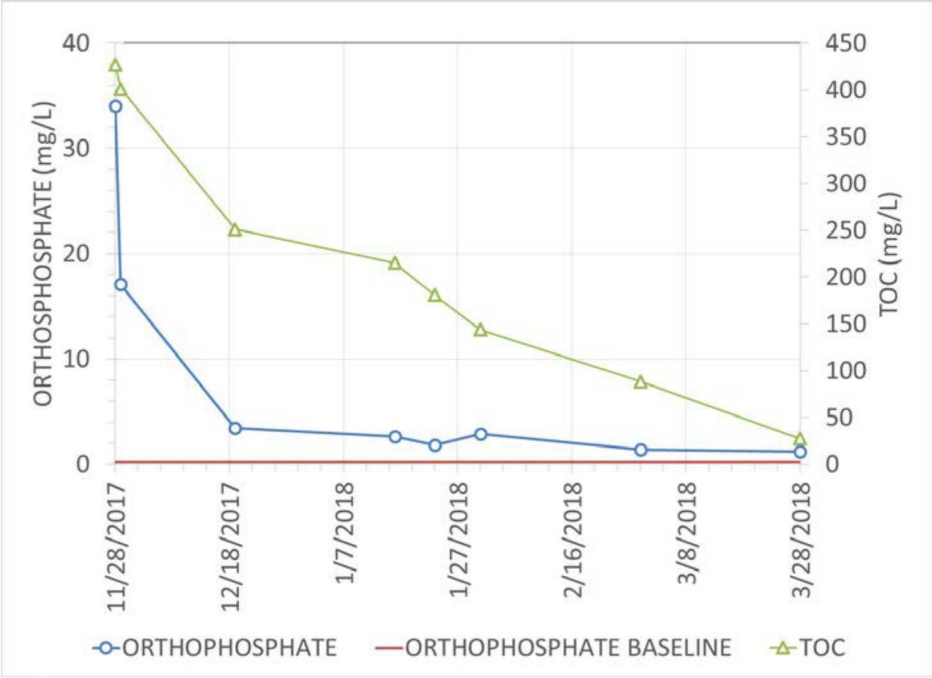

Figure 2
Orthophosphate and TOC Concentrations at TAV-INJ1 following Pilot Test Injections

- 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*.

Sandia National Laboratories