7-2019

Environmental Restoration Operations Consolidated Quarterly Report - July 2019

Sandia National Laboratories/NM

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

JUL 18 2019

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: Department of Energy, National Nuclear Security Administration, Sandia National Laboratories, New Mexico, *Environmental Restoration Operations Consolidated Quarterly Report, July 2019*

Dear Mr. Kieling:

Enclosed is the Subject report, Environmental Protection Agency identification number NM5890110518; which addresses all quarterly reporting (January through March 2019) set forth in the Compliance Order on Consent for Sandia National Laboratories, New Mexico.

If you have questions contact me at (505) 845-6036 or David Rast of our staff at (505) 845-5349.

Sincerely,

Jeffrey P. Harrell
Manager

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cc: See Page 2

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NNSA-2019-002675

ENVIRONMENTAL RESTORATION OPERATIONS
CONSOLIDATED QUARTERLY REPORT, JULY 2019

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.

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Date 7/10/2019

Paul E. Shoemaker
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Sandia National Laboratories

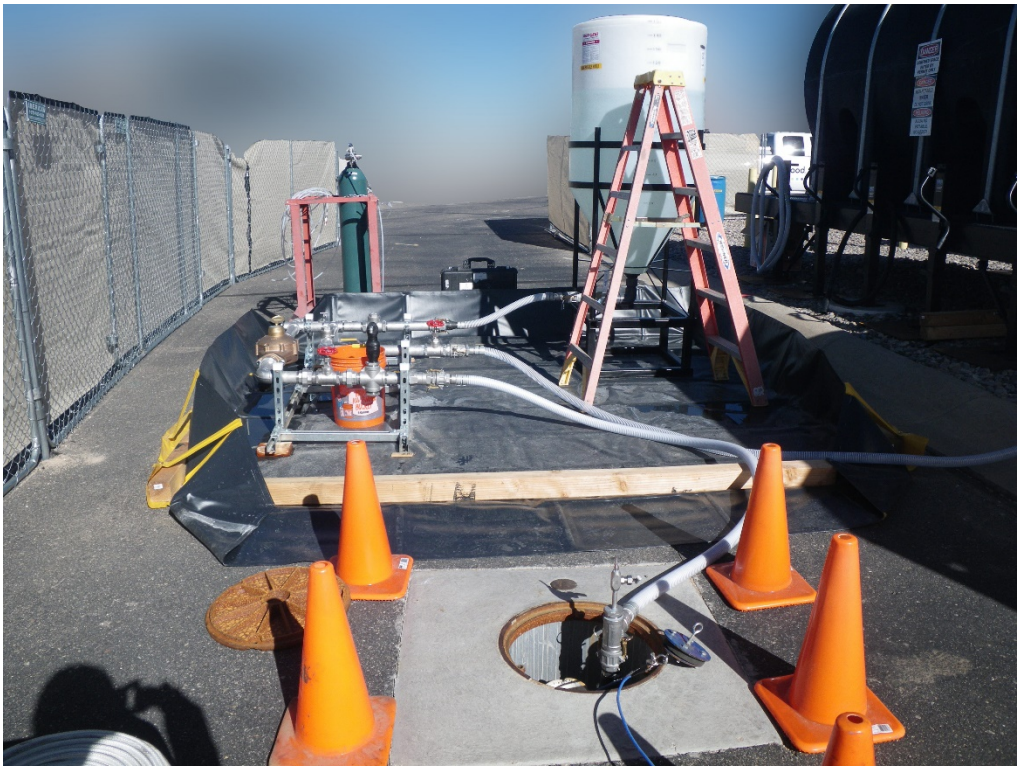
Sandia National Laboratories, New Mexico

Environmental Restoration Operations

A U.S. Department of Energy Environmental Cleanup Program

Consolidated Quarterly Report

January – March 2019



July 2019

U.S. DEPARTMENT OF ENERGY

United States Department of Energy
Sandia Field Office

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CONSOLIDATED QUARTERLY REPORT

July 2019

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: January – March 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, January – March 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 Full-Scale Operation, January – March 2019

ABBREVIATIONS AND ACRONYMS

AOC	Area of Concern
BSG	Burn Site Groundwater
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
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
GEL	GEL Laboratories LLC
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
SNL/NM	Sandia National Laboratories, New Mexico
SWMU	Solid Waste Management Unit
TA1-W	Technical Area-I (Well)
TA2-W	Technical Area-II (Well)
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)
TS/IM	Treatability Study/Interim Measure
TSWP	Treatability Study Work Plan
VOC	volatile organic compound

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SECTION I
ENVIRONMENTAL RESTORATION OPERATIONS CONSOLIDATED QUARTERLY REPORT, January – March 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 January, February, and March 2019 quarterly reporting period.

Table I-1 lists the Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) 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 TA-III.

During the first quarter of Calendar Year (CY) 2019, there were no SWMUs or AOCs in the corrective action complete regulatory process.

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 first quarter of CY 2019 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 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.

The groundwater sampling and analysis program for the BSG AOC 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 this reporting period. Therefore, this edition of the ER Quarterly Report does not include Section II "Perchlorate Screening Quarterly Groundwater Monitoring Report."

The following activities occurred at BSG AOC during January, February, and March 2019:

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

- SNL/NM personnel submitted a monitoring well installation work plan (SNL/NM January 2019a) based on the requirements of the letter received from NMED HWB titled "Disapproval: Recommendations for Additional Characterization Activities at the Burn Site Groundwater AOC, June 2018" (NMED June 2018). NMED HWB approved the well installation work plan on February 12, 2019 (NMED February 2019).

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 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/Interim Measure (TS/IM) of in-situ bioremediation to evaluate the effectiveness of in-situ bioremediation as a potential technology to treat the groundwater contamination at the TAVG AOC.

To implement the TS/IM, 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 TS/IM will be conducted in two phases. Phase I includes a pilot test followed by full-scale operation at the first injection well (TAV-INJ1). SNL/NM personnel have completed the 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 TAV-INJ1 (DOE July 2018). The NMED HWB subsequently approved the modifications on August 13, 2018 (NMED August 2018). Therefore, the forthcoming implementation of the TS/IM is governed by the Revised TSWP and where applicable, the approved modifications for full-scale operation.

Phase II of the TS/IM includes well installation and full-scale operation at the second and third injection wells (TAV-INJ2 and TAV-INJ3). A decision to install the Phase II 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.

The following activities occurred at TAVG AOC during January, February, and March 2019:

- Full-scale operation of Phase I of the TS/IM began in October 2018. By March 31, 2019, 88 injections totaling 423,162 gallons of treatment solution were discharged to groundwater via injection well TAV-INJ1. This was approximately 80 percent of the planned injection volume of 530,000 gallons. The average volume of treatment solution per injection was approximately 4,809 gallons. Along with the treatment solution, a total of 90 liters of the biodegradation bacteria were injected to groundwater by the end of this reporting period. The injection phase of the full-scale operation is expected to conclude in April 2019. No significant problems were encountered during these full-scale injections. Section III of this ER Quarterly Report provides more details on the full-scale operation for this reporting period.

- Groundwater monitoring for the TS/IM was conducted at wells TAV-MW6 and TAV-MW7 during this reporting period. Section III presents the groundwater monitoring results for the TS/IM. 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). Because of its proximity to the injection well TAV-INJ1, well TAV-MW7 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 TS/IM.

- Table I-2 presents the 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 January and February 2019. The SNL/NM 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.

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 micrograms per liter 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 / 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 January, February, and March 2019 groundwater samples were collected from all eleven monitoring wells (TA1-W-06, TA2-W-01, TA2-W-19, TA2-W-26, TA2-W-27, TA2-W-28, TJA-2, TJA-3, TJA-4, TJA-6 and TJA-7) scheduled for quarterly or semiannual sampling. 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.

Routine maintenance was conducted at two TAG wells during this quarterly reporting period. Video logging of wells TA1-W-03 and TJA-2 showed that both casings are in good condition. A passive venting cap (a BaroBall™) was installed at TJA-2.

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), June 2018. Letter to J.P. Harrell (U.S. Department of Energy NNSA/Sandia Field Office) and R.O. Griffith (Sandia National Laboratories), "Disapproval: Recommendations for Additional Characterization Activities at the Burn Site Groundwater Area of Concern (AOC), June 2018 Sandia National Laboratory EPA ID# NM5890110518 HWB-SNL-17-015," June 29, 2018.

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 Paul Shomaker (Sandia National Laboratories), "Approval: Monitoring Well Installation Work Plan Burn Site Groundwater Monitoring Wells CYN-MW16 Through CYN-MW23, January 2019 Sandia National Laboratory 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.

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

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).

SECTION II
PERCHLORATE SCREENING QUARTERLY GROUNDWATER MONITORING REPORT, January – March 2019

The groundwater sampling and analysis program for the BSG AOC 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 this reporting period. Therefore, this edition of the ER 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 FULL-SCALE OPERATION, January – March 2019

1.0 Background

Sandia National Laboratories, New Mexico (SNL/NM) personnel are conducting a Treatability Study of in-situ bioremediation (ISB) at Technical Area-V (TA-V). 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 the second and third injection wells (TAV-INJ2 and TAV-INJ3). The three injection wells, TAV-INJ1, TAV-INJ2, and TAV-INJ3, are located near the highest contaminant concentrations in groundwater detected in monitoring wells TAV-MW6, TAV-MW10, and LWDS-MW1, respectively.

SNL/NM personnel have installed the first injection well TAV-INJ1 and completed the Phase I ISB pilot test at 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). The Phase I ISB full-scale operation at well TAV-INJ1 began in October 2018 with the first injection occurring on November 1, 2018. This section summarizes the activities and monitoring results of the Treatability Study full-scale operation during the January, February, and March 2019 quarterly reporting period.

The implementation of the Treatability Study 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's approval letter and DOE's submittal of the proposed modifications.

2.0 Full-Scale Operation Activities at Well TAV-INJ1

For the ISB Treatability Study, the treatment solution is designed to enhance the degradation of nitrate and trichloroethene (TCE) in the Regional Aquifer. The mixing ratio for the treatment solution (as referred to as amendments) consists of approximately 99.85 percent potable water and 0.15 percent amendments. The mixing ratio of the KB-1 dechlorinating

bacteria, a product purchased from SiREM, is approximately 1.1 liter per 5,000 gallons treatment solution. The goal of the full-scale injections is to deliver a total of 530,000 gallons of treatment solution with 120 liters of KB-1 dechlorinating bacteria over a six-month period.

Table III-1 presents the components of the treatment solution that was proposed before the start of full-scale operation in Appendix A, and adjustments to the quantities of these components that were necessary to provide optimal conditions in the groundwater for the dechlorinating bacteria during operation. Minor adjustments may continue in the future, depending on the response of groundwater chemistry to the amendments.

The treatment solution was mixed in two aboveground 5,000-gallon polyethylene tanks prior to each injection. After the water quality was evaluated using electronic sondes and meters, the treatment solution in the tanks was gravity-injected to the groundwater via injection well TAV-INJ1. The first injection occurred on November 1, 2018. By the end of this reporting period, 88 injections totaling 423,162 gallons of treatment solution was discharged to groundwater. This was approximately 80 percent of the planned injection volume of 530,000 gallons. The average volume of treatment solution per injection was approximately 4,809 gallons. Along with the treatment solution, a total of 90 liters of the KB-1 dechlorinating bacteria were injected to groundwater by the end of this reporting period. The injection phase of the full-scale operation is anticipated to conclude in April 2019.

3.0 Groundwater Monitoring for Full-Scale Operation at Well TAV-INJ1

3.1 Groundwater Levels at Technical Area-V

Figure III-1 shows the January 2019 groundwater elevation contour map (potentiometric surface figure) for the Regional Aquifer at TA-V. The groundwater elevation contours are similar to the baseline October 2017 contours (SNL June 2018). Groundwater flows generally to the west and southwest in the vicinity of the ISB treatment zone.

Increases in water levels were observed in injection well TAV-INJ1 and nearby monitoring well TAV-MW6 during the injections; these wells are screened across the groundwater table and are located approximately 50 feet apart. The water levels in well TAV-MW6 were observed to instantaneously rise and fall with the injections of treatment solution into TAV-INJ1. The average peak head imposed by injections at TAV-INJ1 and recorded at

TAV-MW6 was approximately 1.25 feet above static. Following injections the head in TAV-MW6 was observed to return to static within hours without a sustained increase.

The water level at TAV-MW7 was not observed to respond to injections with immediate pressure pulses as was observed at TAV-MW6. However, between January and March 2019, the water pressure at TAV-MW7 rose approximately 0.85 feet. Additionally, during periods where injections were stopped (e.g., weekends) the water level in TAV-MW7 dropped between 0.2 and 0.4 feet. Well TAV-MW7 is screened approximately 90 feet below the groundwater table and located approximately 30 feet away from well TAV-INJ1. The pressure response recorded at TAV-MW7 supports the concept that the screen section of this well is isolated from the water-table hydrostratigraphic unit. The cumulative pressure increase in well TAV-MW7 resulted from the mounded effluent in and around TAV-INJ1 that was exerting pressure on the surrounding geological formation.

The full-scale injections have not created a long-term impact on the shape of the potentiometric surface at TA-V.

3.2 Groundwater Monitoring at the Treatability Study Treatment Zone

Groundwater monitoring for the ISB Treatability Study full-scale operation at well TAV-INJ1 involves groundwater sampling at the injection well and two nearby monitoring wells TAV-MW6 and TAV-MW7. Injection well TAV-INJ1 is not sampled during the six-month injection phase in accordance with Modification #6 in Appendix A. Monitoring well TAV-MW6 is sampled monthly during the injection phase in accordance with the Revised TSWP (SNL/NM March 2016). Monitoring well TAV-MW7 is sampled quarterly in accordance with Modification #7 in Appendix A.

The analytical parameters for groundwater samples from wells TAV-INJ1 (sampling will start after completing the injection phase) and TAV-MW6 include the following in accordance with Modification #8 in 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
- Volatile organic compounds (VOCs)

During this reporting period, monitoring well TAV-MW6 was sampled monthly. Table III-2 provides the analytical results for the first quarter Calendar Year 2019 sampling at well TAV-MW6. Nitrate and TCE are the constituents of concern in the groundwater at TA-V. NPN concentrations were 8.85, 8.02, and 7.87 milligrams per liter (mg/L) in samples collected in January, February, and March 2019, respectively. All are below the Environmental Protection Agency (EPA) maximum contaminant level (MCL) of 10 mg/L for nitrate. TCE concentrations were 6.24, 7.42, and 7.02 micrograms per liter in samples collected in January, February, and March 2019, respectively. All results for these monthly samples exceeded the EPA MCL of 5 micrograms per liter for TCE. These results are consistent with the baseline sampling results before the full-scale operation (SNL/NM April 2019).

As indicated in Table III-1, bromide is the inert tracer that was added to the treatment solution. Bromide concentration is expected to increase in well TAV-MW6 as injection at TAV-INJ1 continues. Bromide concentrations increased slightly from the baseline result of 0.815 mg/L in September 2018 (SNL/NM April 2019) to 1.67 mg/L in March 2019. The results for the rest of the analytes in samples collected from well TAV-MW6 are consistent with the baseline sampling results.

Even though well TAV-MW7 is located near the injection well TAV-INJ1, no change to the groundwater chemistry in well TAV-MW7 is anticipated as a result of the treatment solution because the well is screened 90 feet below the groundwater table. Currently, well TAV-MW7 programmatically belongs to the TA-V groundwater monitoring network and is administered by the Long-Term Stewardship (LTS) program at SNL/NM. In addition to the analytical parameters that are required under the LTS program (i.e., dissolved metals, NPN, and VOCs), bromide, and ethene are included per requirement of the NMED (see Modification #7 in Appendix A). Therefore, the analytical parameters for groundwater samples from well TAV-MW7 include the following:

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

During this reporting period, monitoring well TAV-MW7 was sampled on January 28, 2019. Table III-3 provides the analytical results for the first quarter Calendar Year 2019 sampling at well TAV-MW7. Duplicate samples were collected and analyzed for dissolved metals, NPN, and VOCs, per the monitoring scheme of the LTS program for the TA-V groundwater monitoring network. NPN concentrations were 3.98 and 4.1 mg/L in the January 28, 2019

sample and its duplicate. Both are below the EPA MCL of 10 mg/L for nitrate. TCE was not detected in the January 28, 2019 sample and it's duplicate. The results for the rest of the analytes in samples collected from well TAV-MW7 are consistent with the baseline sampling results (SNL/NM April 2019).

The increase of the bromide concentration in well TAV-MW6 indicates that the treatment solution injected at TAV-INJ1 is reaching this well, but not in quantities to have an impact on the groundwater chemistry in the well. Groundwater results from well TAV-MW7 indicate that the treatment solution injected at TAV-INJ1 has not impacted the groundwater at this well. -

3.3 Groundwater Monitoring Outside the Treatability Study 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 monitor the impact of treatment solution on groundwater located outside of the Treatability Study treatment zone. For the Phase I Treatability Study, the eight wells that are located outside the treatment zone of TAV-INJ1 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 wells in the TA-V groundwater monitoring network (SNL/NM June 2018). Table III-4 provides the analytical results for the January – March 2019 sampling at the eight wells. Duplicate samples were collected from wells TAV-MW8 and TAV-MW11, per the monitoring scheme of the LTS program for the TA-V groundwater monitoring network.

Table III-5 summarizes the stabilized water quality parameters measured before sample collection at each well sampled in January – March 2019.

All results are consistent with the historical values at these eight wells (SNL/NM June 2018) and there is no change in the groundwater chemistry at these wells from the treatment solution injected at 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 TAV-INJ1 (DOE July 2018; NMED August 2018). -

5.0 References

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.

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.

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), June 2018. *Annual Groundwater Monitoring Report, Calendar Year 2017*, 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 2018. *Environmental Restoration Operations Consolidated Quarterly Report April – June 2018*, 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.

Figures

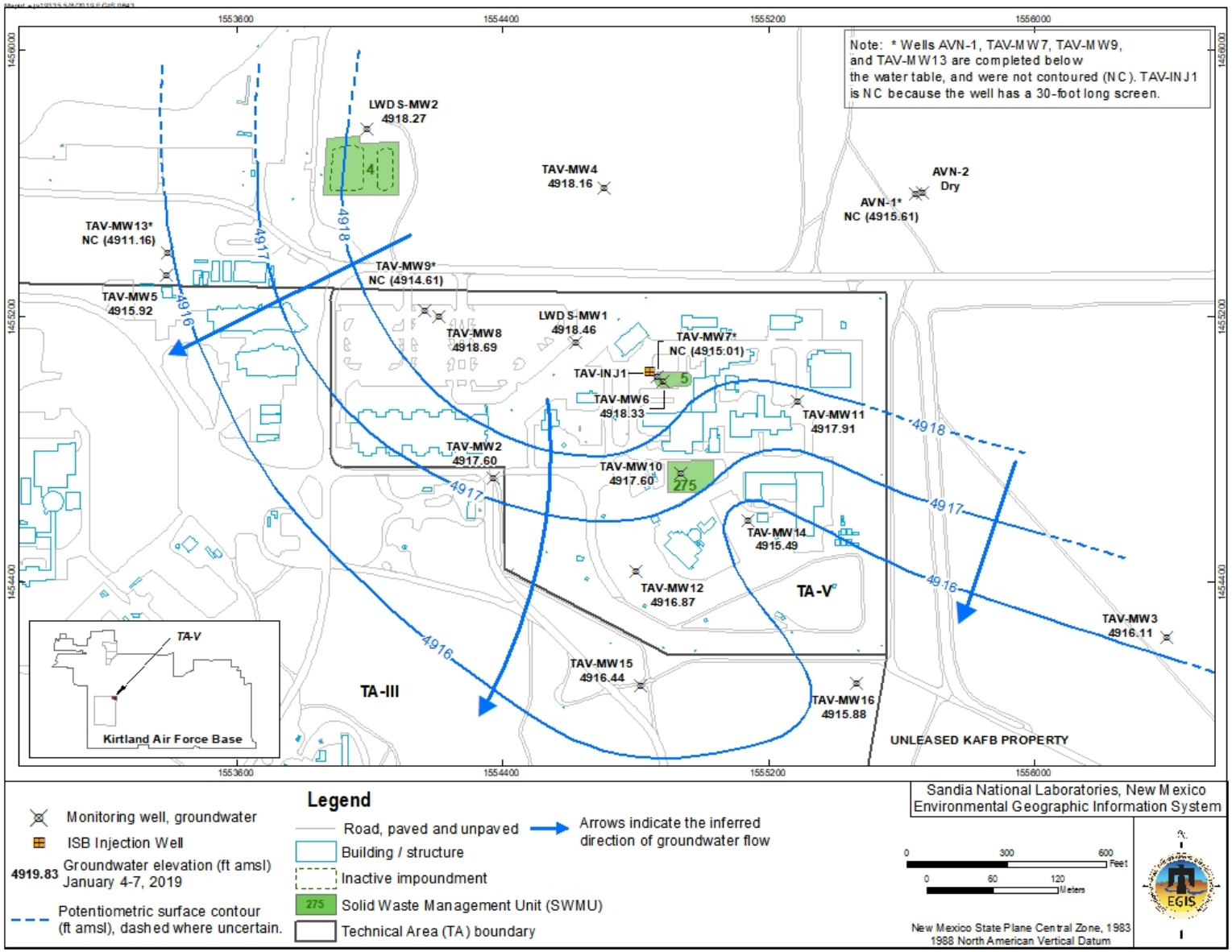

Figure III-1
Well Locations and Potentiometric Surface Contours for January 2019

Tables

Table III-1
Substrate Solution Components for Full-Scale Operation at Well TAV-INJ1

Substrate Solution Component	Function	Mixing Ratio (by weight) [b]	Weight per 1,000 gal of Water [b]	Actual Usage during Full-Scale Operation Weight per 1,000 gal Water
Primary Components				
Ethyl lactate	Electron donor (substrate)	80.4%	5.64 lbs	6.08 lbs
Diammonium phosphate	Nutrient and pH buffer	9.0%	0.63 lbs	0.63 lbs
Accelerite® [a]	Nutrient	6.4%	0.45 lbs	0.39 lbs
Potassium Bicarbonate	pH buffer and acid reducer	1.7%	0.11 lbs	0.75 – 1.5 lbs
Sodium Sulfite	Deoxygenation and reduction agent	2.5%	0.17 lbs	0.5 lbs
Primary Components per 1,000 gal of Potable Water		**100%**	**7 lbs**	**8.35 – 9.1 lbs**
Additional Component Mixed with Substrate Solution				
Sodium bromide	Inert tracer (as bromide)	Not applicable; adjusted per field condition	0.2 lbs	0.2 lbs

Note:

[a] Accelerite® Bioremediation Nutrient is a product of JRW Bioremediation, LLC.

[b] Proposed amount as presented in Appendix A, Modification #3 before the start of full-scale operation.

% = Percent.
gal = Gallon(s).
INJ = Injection (acronym used for well identification only).
lbs = Pounds.
pH = Potential of hydrogen (negative logarithm of the hydrogen ion concentration).
TAV = Technical Area-V (acronym used for well identification only)

Table III-2
Analytical Results of Groundwater Sampling at Well TAV-MW6, January – March 2019

Sample Date	Analyses	Analyte	Result[a]	MDL[b]	PQL[c]	MCL[d]	Units	Lab Qual[e]	Val Qual[f]	Sample No.	Analytical Method[g]	Lab[h]
22-Jan-19	Alkalinity	Alkalinity as $CaCO_3$	187	1.45	4	NE	mg/L			107087-006	SM 2320B	GEL
22-Jan-19	Alkalinity	Alkalinity, bicarb as CaCO3	187	1.45	4	NE	mg/L			107087-006	SM 2320B	GEL
22-Jan-19	Alkalinity	Alkalinity, carb as CaCO3	ND	1.45	4	NE	mg/L	U		107087-006	SM 2320B	GEL
22-Jan-19	Ammonia	Ammonia	0.0211	0.017	0.05	NE	mg/L	J	J-	107087-002	EPA 350.1	GEL
22-Jan-19	Anions	Bromide	1.16	0.067	0.2	NE	mg/L			107087-004	SW846 9056A	GEL
22-Jan-19	Anions	Sulfate	46.4	1.33	4	NE	mg/L			107087-004	SW846 9056A	GEL
22-Jan-19	Microbial	Dehalococcoides	ND	3000		NE	Enumeration/L	U		107090-001	Gene-Trac Dhc	SRM
22-Jan-19	Dissolved Metals	Arsenic	0.00239	0.002	0.005	0.01	mg/L	J		107087-007	SW846 3005A/6020B	GEL
22-Jan-19	Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		107087-007	SW846 3005A/6020B	GEL
22-Jan-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	NU		107087-007	SW846 3005A/6020B	GEL
22-Jan-19	MEE	Methane	0.93	0.014	0.5	NE	µg/L		J	107089-001	AM20GAX	PACE
22-Jan-19	MEE	Ethane	ND	0.007	0.1	NE	µg/L	U	UJ	107089-001	AM20GAX	PACE
22-Jan-19	MEE	Ethene	ND	0.005	0.1	NE	µg/L	U	UJ	107089-001	AM20GAX	PACE
22-Jan-19	NPN	Nitrate plus Nitrite as N	8.85	0.85	2.5	10	mg/L			107087-005	EPA 353.2	GEL
22-Jan-19	TOC	Total Organic Carbon, average	0.48	0.33	1	NE	mg/L	J		107087-003	SW846 9060A	GEL
22-Jan-19	VOC	Dichloroethene, cis-1,2-	0.87	0.3	1	70	µg/L	J		107087-001	SW846 8260B	GEL
22-Jan-19	VOC	Trichloroethene	**6.24**	0.3	1	5	µg/L			107087-001	SW846 8260B	GEL

Note: Header nomenclature is explained following Table III-5 in the “Footnotes for Technical Area-V Analytical Results Tables” summary.

Table III-2 (continued)
Analytical Results of Groundwater Sampling at Well TAV-MW6, January – March 2019

Sample Date	Analyses	Analyte	Result[a]	MDL[b]	PQL[c]	MCL[d]	Units	Lab Qual[e]	Val Qual[f]	Sample No.	Analytical Method[g]	Lab[h]
25-Feb-19	Alkalinity	Alkalinity as CaCO3	191	1.45	4	NE	mg/L			107749-006	SM 2320B	GEL
25-Feb-19	Alkalinity	Alkalinity, bicarb as CaCO3	191	1.45	4	NE	mg/L			107749-006	SM 2320B	GEL
25-Feb-19	Alkalinity	Alkalinity, carb as CaCO3	ND	1.45	4	NE	mg/L	U		107749-006	SM 2320B	GEL
25-Feb-19	Ammonia	Ammonia	0.047	0.017	0.05	NE	mg/L	J		107749-002	EPA 350.1	GEL
25-Feb-19	Anions	Bromide	1.14	0.067	0.2	NE	mg/L			107749-004	SW846 9056A	GEL
25-Feb-19	Anions	Sulfate	43.3	0.665	2	NE	mg/L			107749-004	SW846 9056A	GEL
25-Feb-19	Microbial	Dehalococcoides	ND	3000		NE	Enumeration/L	U		107747-001	Gene-Trac Dhc	SRM
25-Feb-19	Dissolved Metals	Arsenic	ND	0.002	0.005	0.01	mg/L	U		107749-007	SW846 3005A/6020B	GEL
25-Feb-19	Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		107749-007	SW846 3005A/6020B	GEL
25-Feb-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		107749-007	SW846 3005A/6020B	GEL
25-Feb-19	MEE	Methane	ND	0.014	0.5	NE	µg/L	U	UJ	107748-001	AM20GAX	PACE
25-Feb-19	MEE	Ethane	ND	0.007	0.1	NE	µg/L	U	UJ	107748-001	AM20GAX	PACE
25-Feb-19	MEE	Ethene	ND	0.005	0.1	NE	µg/L	U	UJ	107748-001	AM20GAX	PACE
25-Feb-19	NPN	Nitrate plus Nitrite as N	8.02	0.17	0.5	10	mg/L			107749-005	EPA 353.2	GEL
25-Feb-19	TOC	Total Organic Carbon, average	0.499	0.33	1	NE	mg/L	J	J	107749-003	SW846 9060A	GEL
25-Feb-19	VOC	Dichloroethene, cis-1,2-	1.37	0.3	1	70	µg/L			107749-001	SW846 8260B	GEL
25-Feb-19	VOC	Trichloroethene	**7.42**	0.3	1	5	µg/L			107749-001	SW846 8260B	GEL

Note: Header nomenclature is explained following Table III-5 in the “Footnotes for Technical Area-V Analytical Results Tables” summary.

Table III-2 (continued)
Analytical Results of Groundwater Sampling at Well TAV-MW6, January – March 2019

Sample Date	Analyses	Analyte	Result[a]	MDL[b]	PQL[c]	MCL[d]	Units	Lab Qual[e]	Val Qual[f]	Sample No.	Analytical Method[g]	Lab[h]
26-Mar-19	Alkalinity	Alkalinity as CaCO3	194	1.45	4	NE	mg/L			107990-006	SM 2320B	GEL
26-Mar-19	Alkalinity	Alkalinity, bicarb as CaCO3	194	1.45	4	NE	mg/L			107990-006	SM 2320B	GEL
26-Mar-19	Alkalinity	Alkalinity, carb as CaCO3	ND	1.45	4	NE	mg/L	U		107990-006	SM 2320B	GEL
26-Mar-19	Ammonia	Ammonia	0.0466	0.017	0.05	NE	mg/L	J	J-	107990-002	EPA 350.1	GEL
26-Mar-19	Anions	Bromide	1.67	0.067	0.2	NE	mg/L			107990-004	SW846 9056A	GEL
26-Mar-19	Anions	Sulfate	45.8	0.665	2	NE	mg/L			107990-004	SW846 9056A	GEL
26-Mar-19	Microbial	Dehalococcoides	ND	3000		NE	Enumeration/L	U		107993-001	Gene-Trac Dhc	SRM
26-Mar-19	Dissolved Metals	Arsenic	0.00218	0.002	0.005	0.01	mg/L	J		107990-007	SW846 3005A/6020B	GEL
26-Mar-19	Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		107990-007	SW846 3005A/6020B	GEL
26-Mar-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		107990-007	SW846 3005A/6020B	GEL
26-Mar-19	MEE	Methane	1.2	0.094	0.5	NE	µg/L		J	107994-001	AM20GAX	PACE
26-Mar-19	MEE	Ethane	ND	0.011	0.1	NE	µg/L	U	UJ	107994-001	AM20GAX	PACE
26-Mar-19	MEE	Ethene	ND	0.008	0.1	NE	µg/L	U	UJ	107994-001	AM20GAX	PACE
26-Mar-19	NPN	Nitrate plus Nitrite as N	7.87	0.17	0.5	10	mg/L			107990-005	EPA 353.2	GEL
26-Mar-19	TOC	Total Organic Carbon, average	0.678	0.33	1	NE	mg/L	J		107990-003	SW846 9060A	GEL
26-Mar-19	VOC	Dichloroethene, cis-1,2-	0.92	0.3	1	70	µg/L	J		107990-001	SW846 8260B	GEL
26-Mar-19	VOC	Trichloroethene	**7.02**	0.3	1	5	µg/L	B		107990-001	SW846 8260B	GEL

Note: Header nomenclature is explained following Table III-5 in the “Footnotes for Technical Area-V Analytical Results Tables” summary.

Table III-3
Analytical Results of Groundwater Sampling at Well TAV-MW7, January – March 2019

Sample Date	Analyses	Analyte	Result[a]	MDL[b]	PQL[c]	MCL[d]	Units	Lab Qual[e]	Val Qual[f]	Sample No.	Analytical Method[g]	Lab[h]
28-Jan-19	Anions	Bromide	0.351	0.067	0.2	NE	mg/L			107110-001	SW846 9056A	GEL
28-Jan-19	Dissolved Metals	Arsenic	0.00209	0.002	0.005	0.01	mg/L	J		106941-003	SW846 3005A/6020B	GEL
28-Jan-19	Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		106941-003	SW846 3005A/6020B	GEL
28-Jan-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		106941-003	SW846 3005A/6020B	GEL
28-Jan-19	MEE	Ethene	ND	0.005	0.1	NE	µg/L	U	UJ	107111-001	AM20GAX	PACE
28-Jan-19	NPN	Nitrate plus Nitrite as N	3.98	0.17	0.5	10	mg/L			106941-002	EPA 353.2	GEL
28-Jan-19	VOC	Dichloroethene, cis-1,2-	ND	0.3	1	70	µg/L	U		106941-001	SW846 8260B	GEL
28-Jan-19	VOC	Trichloroethene	ND	0.3	1	5	µg/L	U		106941-001	SW846 8260B	GEL
28-Jan-19 (Dup)	Dissolved Metals	Arsenic	0.00206	0.002	0.005	0.01	mg/L	J		106942-003	SW846 3005A/6020B	GEL
28-Jan-19 (Dup)	Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		106942-003	SW846 3005A/6020B	GEL
28-Jan-19 (Dup)	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		106942-003	SW846 3005A/6020B	GEL
28-Jan-19 (Dup)	NPN	Nitrate plus Nitrite as N	4.1	0.17	0.5	10	mg/L			106942-002	EPA 353.2	GEL
28-Jan-19 (Dup)	VOC	Dichloroethene, cis-1,2-	ND	0.3	1	70	µg/L	U		106942-001	SW846 8260B	GEL
28-Jan-19 (Dup)	VOC	Trichloroethene	ND	0.3	1	5	µg/L	U		106942-001	SW846 8260B	GEL

Note: Header nomenclature is explained following Table III-5 in the “Footnotes for Technical Area-V Analytical Results Tables” summary.

Table III-4
Analytical Results of Groundwater Sampling at Wells
LWDS-MW1, TAV-MW2, TAV-MW4, TAV-MW8, TAV-MW10, TAV-MW11, TAV-MW12, and TAV MW14, January – March 2019

Sample Date	Analyses	Analyte	Result[a]	MDL[b]	PQL[c]	MCL[d]	Units	Lab Qual[e]	Val Qual[f]	Sample No.	Analytical Method[g]	Lab[h]
LWDS-MW1												
11-Feb-19	Dissolved Metals	Arsenic	0.00425	0.002	0.005	0.01	mg/L	J		107156-003	SW846 3005A/6020B	GEL
11-Feb-19	Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		107156-003	SW846 3005A/6020B	GEL
11-Feb-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		107156-003	SW846 3005A/6020B	GEL
11-Feb-19	NPN	Nitrate plus Nitrite as N	**12.1**	0.17	0.5	10	mg/L			107156-002	EPA 353.2	GEL
11-Feb-19	VOC	Dichloroethene, cis-1,2-	3.42	0.3	1	70	µg/L			107156-001	SW846 8260B	GEL
11-Feb-19	VOC	Trichloroethene	**15.2**	0.3	1	5	µg/L			107156-001	SW846 8260B	GEL
TAV-MW2												
29-Jan-19	Dissolved Metals	Arsenic	ND	0.002	0.005	0.01	mg/L	U		106939-003	SW846 3005A/6020B	GEL
29-Jan-19	Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		106939-003	SW846 3005A/6020B	GEL
29-Jan-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		106939-003	SW846 3005A/6020B	GEL
29-Jan-19	NPN	Nitrate plus Nitrite as N	4.63	0.17	0.5	10	mg/L			106939-002	EPA 353.2	GEL
29-Jan-19	VOC	Dichloroethene, cis-1,2-	ND	0.3	1	70	µg/L	U		106939-001	SW846 8260B	GEL
29-Jan-19	VOC	Trichloroethene	2.81	0.3	1	5	µg/L			106939-001	SW846 8260B	GEL
TAV-MW4												
31-Jan-19	Dissolved Metals	Arsenic	0.00205	0.002	0.005	0.01	mg/L	J		106961-003	SW846 3005A/6020B	GEL
31-Jan-19	Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		106961-003	SW846 3005A/6020B	GEL
31-Jan-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		106961-003	SW846 3005A/6020B	GEL
31-Jan-19	NPN	Nitrate plus Nitrite as N	4.18	0.17	0.5	10	mg/L			106961-002	EPA 353.2	GEL
31-Jan-19	VOC	Dichloroethene, cis-1,2-	0.42	0.3	1	70	µg/L	J		106961-001	SW846 8260B	GEL
31-Jan-19	VOC	Trichloroethene	4.47	0.3	1	5	µg/L			106961-001	SW846 8260B	GEL
TAV-MW8												
1-Feb-19	Dissolved Metals	Arsenic	ND	0.002	0.005	0.01	mg/L	U		106968-003	SW846 3005A/6020B	GEL
1-Feb-19	Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		106968-003	SW846 3005A/6020B	GEL
1-Feb-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		106968-003	SW846 3005A/6020B	GEL
1-Feb-19	NPN	Nitrate plus Nitrite as N	6.06	0.17	0.5	10	mg/L			106968-002	EPA 353.2	GEL
1-Feb-19	VOC	Dichloroethene, cis-1,2-	0.52	0.3	1	70	µg/L	J		106968-001	SW846 8260B	GEL
1-Feb-19	VOC	Trichloroethene	**6.3**	0.3	1	5	µg/L			106968-001	SW846 8260B	GEL

Note: Header nomenclature is explained following Table III-5 in the “Footnotes for Technical Area-V Analytical Results Tables” summary.

Table III-4 (continued)
Analytical Results of Groundwater Sampling at Wells
LWDS-MW1, TAV-MW2, TAV-MW4, TAV-MW8, TAV-MW10, TAV-MW11, TAV-MW12, and TAV MW14, January – March 2019

Sample Date	Analyses	Analyte	Result[a]	MDL[b]	PQL[c]	MCL[d]	Units	Lab Qual[e]	Val Qual[f]	Sample No.	Analytical Method[g]	Lab[h]
TAV-MW8												
1-Feb-19 (Dup)	Dissolved Metals	Arsenic	0.002	0.002	0.005	0.01	mg/L	J		106969-003	SW846 3005A/6020B	GEL
1-Feb-19 (Dup)	Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		106969-003	SW846 3005A/6020B	GEL
1-Feb-19 (Dup)	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		106969-003	SW846 3005A/6020B	GEL
1-Feb-19 (Dup)	NPN	Nitrate plus Nitrite as N	6.01	0.17	0.5	10	mg/L			106969-002	EPA 353.2	GEL
1-Feb-19 (Dup)	VOC	Dichloroethene, cis-1,2-	0.62	0.3	1	70	µg/L	J		106969-001	SW846 8260B	GEL
1-Feb-19 (Dup)	VOC	Trichloroethene	**6.06**	0.3	1	5	µg/L			106969-001	SW846 8260B	GEL
TAV-MW10												
7-Feb-19	Dissolved Metals	Arsenic	0.00304	0.002	0.005	0.01	mg/L	J		107154-003	SW846 3005A/6020B	GEL
7-Feb-19	Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		107154-003	SW846 3005A/6020B	GEL
7-Feb-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		107154-003	SW846 3005A/6020B	GEL
7-Feb-19	NPN	Nitrate plus Nitrite as N	**11.3**	0.17	0.5	10	mg/L			107154-002	EPA 353.2	GEL
7-Feb-19	VOC	Dichloroethene, cis-1,2-	2.4	0.3	1	70	µg/L			107154-001	SW846 8260B	GEL
7-Feb-19	VOC	Trichloroethene	**14.6**	0.3	1	5	µg/L			107154-001	SW846 8260B	GEL
TAV-MW11												
30-Jan-19	Dissolved Metals	Arsenic	0.00201	0.002	0.005	0.01	mg/L	J		106955-003	SW846 3005A/6020B	GEL
30-Jan-19	Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		106955-003	SW846 3005A/6020B	GEL
30-Jan-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		106955-003	SW846 3005A/6020B	GEL
30-Jan-19	NPN	Nitrate plus Nitrite as N	6.26	0.17	0.5	10	mg/L			106955-002	EPA 353.2	GEL
30-Jan-19	VOC	Dichloroethene, cis-1,2-	0.57	0.3	1	70	µg/L	J		106955-001	SW846 8260B	GEL
30-Jan-19	VOC	Trichloroethene	3.36	0.3	1	5	µg/L			106955-001	SW846 8260B	GEL
30-Jan-19 (Dup)	Dissolved Metals	Arsenic	ND	0.002	0.005	0.01	mg/L	U		106956-003	SW846 3005A/6020B	GEL
30-Jan-19 (Dup)	Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		106956-003	SW846 3005A/6020B	GEL
30-Jan-19 (Dup)	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		106956-003	SW846 3005A/6020B	GEL
30-Jan-19 (Dup)	NPN	Nitrate plus Nitrite as N	6.22	0.17	0.5	10	mg/L			106956-002	EPA 353.2	GEL
30-Jan-19 (Dup)	VOC	Dichloroethene, cis-1,2-	0.66	0.3	1	70	µg/L	J		106956-001	SW846 8260B	GEL
30-Jan-19 (Dup)	VOC	Trichloroethene	3.79	0.3	1	5	µg/L			106956-001	SW846 8260B	GEL

Note: Header nomenclature is explained following Table III-5 in the “Footnotes for Technical Area-V Analytical Results Tables” summary.

Table III-4 (continued)
Analytical Results of Groundwater Sampling at Wells
LWDS-MW1, TAV-MW2, TAV-MW4, TAV-MW8, TAV-MW10, TAV-MW11, TAV-MW12, and TAV MW14, January – March 2019

Sample Date	Analyses	Analyte	Result[a]	MDL[b]	PQL[c]	MCL[d]	Units	Lab Qual[e]	Val Qual[f]	Sample No.	Analytical Method[g]	Lab[h]
TAV-MW12												
5-Feb-19	Dissolved Metals	Arsenic	0.0025	0.002	0.005	0.01	mg/L	J		107150-003	SW846 3005A/6020B	GEL
5-Feb-19	Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		107150-003	SW846 3005A/6020B	GEL
5-Feb-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		107150-003	SW846 3005A/6020B	GEL
5-Feb-19	NPN	Nitrate plus Nitrite as N	6.3	0.085	0.25	10	mg/L			107150-002	EPA 353.2	GEL
5-Feb-19	VOC	Dichloroethene, cis-1,2-	ND	0.3	1	70	µg/L	U		107150-001	SW846 8260B	GEL
5-Feb-19	VOC	Trichloroethene	4.69	0.3	1	5	µg/L			107150-001	SW846 8260B	GEL
TAV-MW14												
6-Feb-19	Dissolved Metals	Arsenic	0.00248	0.002	0.005	0.01	mg/L	J		107152-003	SW846 3005A/6020B	GEL
6-Feb-19	Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		107152-003	SW846 3005A/6020B	GEL
6-Feb-19	Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		107152-003	SW846 3005A/6020B	GEL
6-Feb-19	NPN	Nitrate plus Nitrite as N	7.81	0.17	0.5	10	mg/L			107152-002	EPA 353.2	GEL
6-Feb-19	VOC	Dichloroethene, cis-1,2-	0.56	0.3	1	70	µg/L	J		107152-001	SW846 8260B	GEL
6-Feb-19	VOC	Trichloroethene	**6.6**	0.3	1	5	µg/L			107152-001	SW846 8260B	GEL

Note: Header nomenclature is explained following Table III-5 in the “Footnotes for Technical Area-V Analytical Results Tables” summary.

Table III-5
Field Water Quality Measurements[i] before Groundwater Sampling at Each Well, January – March 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-MW6	22-Jan-19	18.42	726.89	130.98	7.44	0.65	77.43	5.80
TAV-MW6	25-Feb-19	19.30	690.31	142.53	7.47	0.90	80.67	5.87
TAV-MW6	26-Mar-19	21.37	718.20	110.00	7.44	3.95	77.32	5.57
LWDS-MW1	11-Feb-19	16.26	625.84	206.50	7.29	0.92	91.10	7.61
TAV-MW2	29-Jan-19	16.66	668.30	284.40	7.33	2.68	76.10	6.02
TAV-MW4	31-Jan-19	19.12	517.62	252.90	7.55	0.48	90.20	6.77
TAV-MW7	28-Jan-19	18.79	614.90	171.50	7.40	0.93	3.49	0.40
TAV-MW8	01-Feb-19	19.20	615.30	265.30	7.46	1.27	89.40	6.62
TAV-MW10	07-Feb-19	17.19	602.20	224.10	7.45	0.33	85.40	7.18
TAV-MW11	30-Jan-19	19.52	607.80	272.90	7.56	2.13	88.90	6.80
TAV-MW12	05-Feb-19	17.52	578.50	210.10	7.44	1.78	84.10	6.50
TAV-MW14	06-Feb-19	18.25	649.50	230.10	7.42	2.92	84.40	6.85

Note: Header nomenclature is explained following Table III-5 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*.
EPA	= U.S. Environmental Protection Agency.
ID	= Identifier.
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 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, November 2018.

NE = Not established.

[e]Lab Qualifier

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

*	= Recovery of relative percent difference (RPD) not within acceptance limits and/or spike amount not compatible with the sample or the duplicate RPD's are not applicable where the concentration falls below the effective PQL.
B	= The analyte was found in the blank above the effective MDL.
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 negative bias.
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 Rd, Charleston, SC 29407.
PACE = Pace Analytical Services LLC, Energy Services Lab, 220 William Pitt Way, Pittsburgh, PA 15238.
SiREM = SiREM, 130 Stone Rd. 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
www.env.nm.gov

SUSANA MARTINEZ
Governor
JOHN A. SANCHEZ
Lieutenant Governor

BUTCH TONGATE
Cabinet Secretary
J. C. BORREGO
Deputy Secretary

CERTIFIED MAIL – RETURN RECEIPT REQUESTED

August 13, 2018

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

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

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

Dear Mr. Harrell and Mr. Griffith:

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

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

Sincerely,

John E. Kieling
Chief
Hazardous Waste Bureau

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

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

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

JUL 20 2018

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

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

Dear Mr. Kieling:

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

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

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

Sincerely,

Jeffrey P. Harrell
Manager

Enclosure

cc: See Page 2

cc w/enclosure:
Naomi Davidson
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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
Anna Gallegos, SNL/NM
Howard Huie, DOE/EM-31
Douglas Tonkay, DOE/EM-31
Thomas Longo, NNSA/NA-533
Jessica Arcidiacono, NNSA/NA-533
Cynthia Wimberly, SFO/OOM
James Todd, SFO/ENG
Susan Lacy, SFO/ENG
Steven Black, SFO/ENG
David Rast, SFO/ENG
NNSA-2018-001960

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

CERTIFICATION STATEMENT

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

Paul E. Shoemaker
Signature

July 10, 2018
Date

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

and

Signature

7/23/2018
Date

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

ENCLOSURE

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

#1: Method for Deoxygenation in Aboveground Tanks

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

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

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

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

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

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

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

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

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

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

#3: Substitute for KB-1® Primer

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

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

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

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

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

Revised Table 4-1
Substrate Solution Components

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

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

#4: Substitute for Yeast Extract

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

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

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

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

#5: Sampling for Laboratory Analysis of Tank Content

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

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

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

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

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

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

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

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

#7: ISB Performance Monitoring at Well TAV-MW7

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

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

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

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

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

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

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

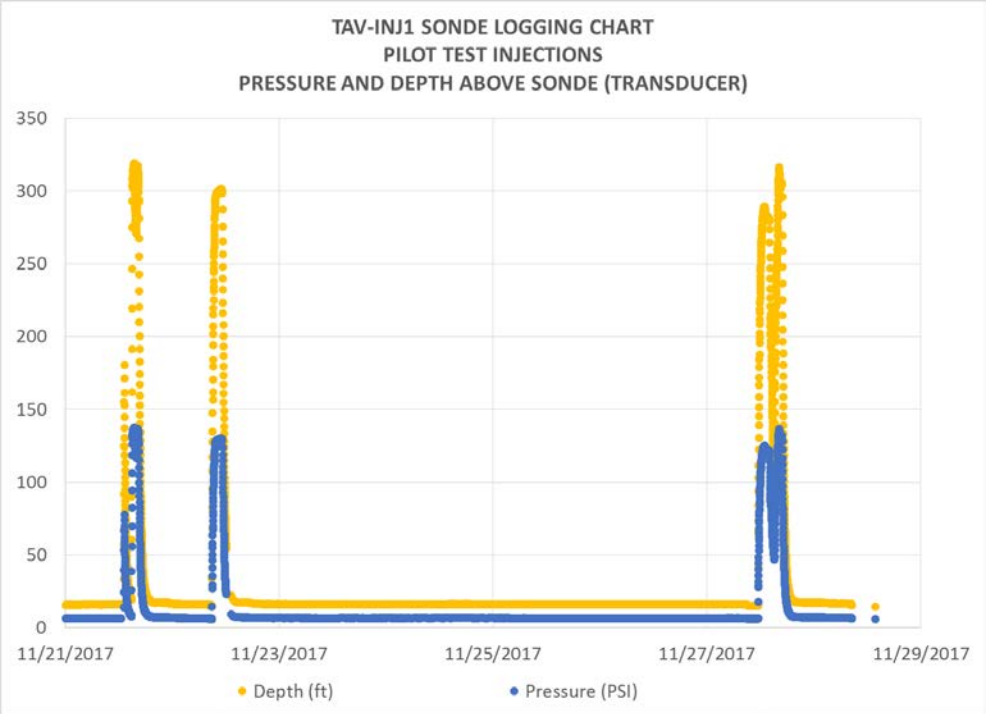

Figure 1a
Pressure and Water Column Height in well TAV-INJ1 during Injections

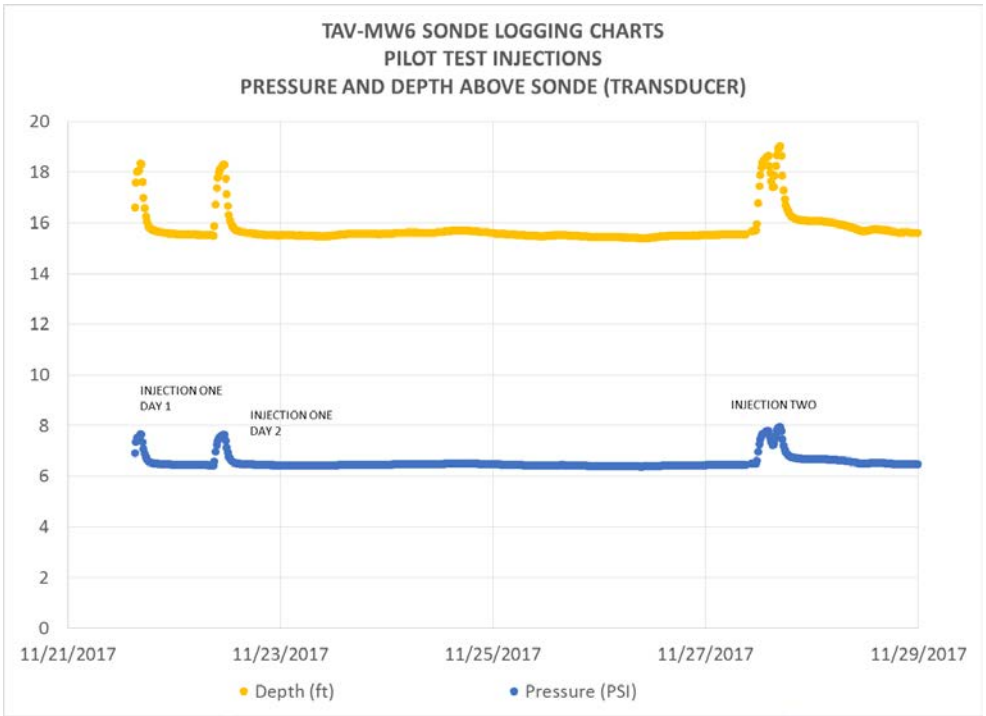

Figure 1b
Pressure and Water Column Height in well TAV-MW6 in
Response to Injections at well TAV-INJ1

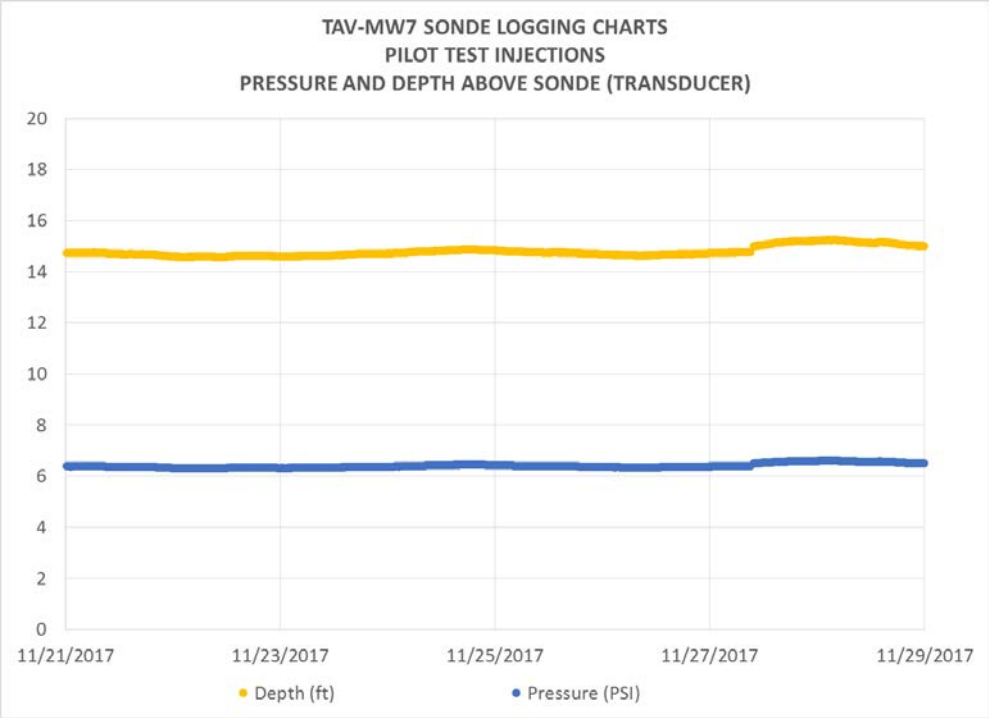

Figure 1c
Pressure and Water Column Height in well TAV-MW7 in
Response to Injections at well TAV-INJ1

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

#8: Analytical Parameters for Groundwater Samples

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

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

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

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

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

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

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

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

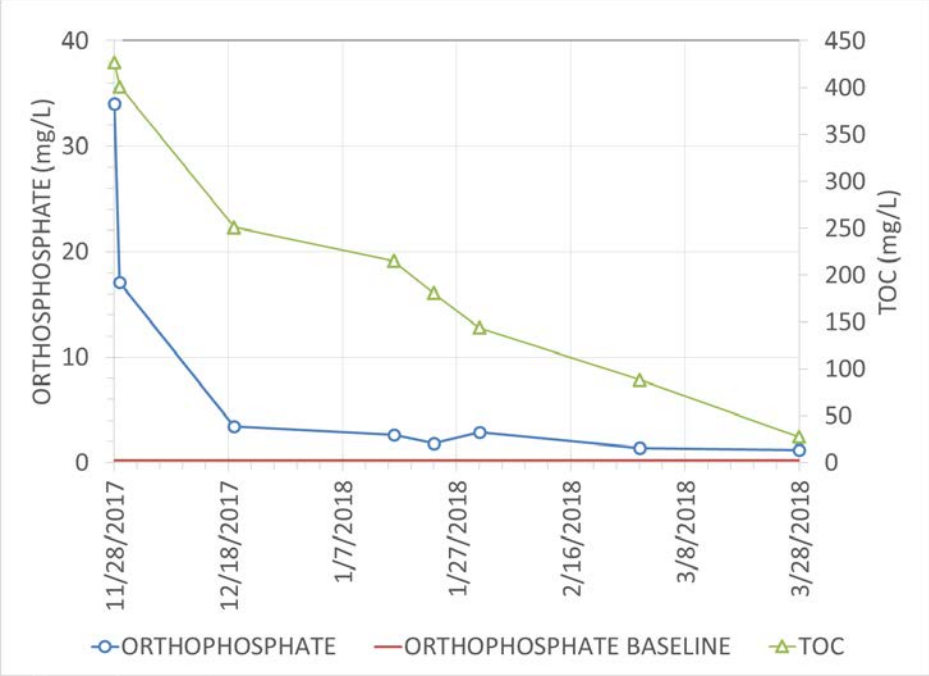

Figure 2
Orthophosphate and TOC Concentrations at TAV-INJ1 following Pilot Test Injections

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

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

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

Revised Table 5-4
Analytical Parameters for Groundwater Samples

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

References

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

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

ATTACHMENT A
Safety Data Sheets

Potassium Bicarbonate ($KHCO_3$)
Sodium Sulfite ($NaSO_3$)
Accelerite® Bioremediation Nutrient

SAFETY DATA SHEET

Version 4.5
Revision Date 09/21/2017
Print Date 06/22/2018

1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product identifiers

Product name : Potassium bicarbonate

Product Number : 237205
Brand : Sigma-Aldrich

CAS-No. : 298-14-6

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses : Laboratory chemicals, Synthesis of substances

1.3 Details of the supplier of the safety data sheet

Company : Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO 63103
USA

Telephone : +1 800-325-5832
Fax : +1 800-325-5052

1.4 Emergency telephone number

Emergency Phone # : +1-703-527-3887 (CHEMTREC)

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

Not a hazardous substance or mixture.

2.2 GHS Label elements, including precautionary statements

Not a hazardous substance or mixture.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

Synonyms : Potassium hydrogen carbonate

Formula : $CHKO_3$
Molecular weight : 100.12 g/mol
CAS-No. : 298-14-6
EC-No. : 206-059-0

No components need to be disclosed according to the applicable regulations.

4. FIRST AID MEASURES

4.1 Description of first aid measures

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration.

In case of skin contact
Wash off with soap and plenty of water.

In case of eye contact
Flush eyes with water as a precaution.

If swallowed
Never give anything by mouth to an unconscious person. Rinse mouth with water.

4.2 Most important symptoms and effects, both acute and delayed
The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed
No data available

5. FIREFIGHTING MEASURES

5.1 Extinguishing media

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture
No data available

5.3 Advice for firefighters
Wear self-contained breathing apparatus for firefighting if necessary.

5.4 Further information
No data available

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Avoid dust formation. Avoid breathing vapours, mist or gas.
For personal protection see section 8.

6.2 Environmental precautions
No special environmental precautions required.

6.3 Methods and materials for containment and cleaning up
Sweep up and shovel. Keep in suitable, closed containers for disposal.

6.4 Reference to other sections
For disposal see section 13.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Further processing of solid materials may result in the formation of combustible dusts. The potential for combustible dust formation should be taken into consideration before additional processing occurs.
Provide appropriate exhaust ventilation at places where dust is formed.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities
Keep container tightly closed in a dry and well-ventilated place.

7.3 Specific end use(s)
Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters

Components with workplace control parameters
Contains no substances with occupational exposure limit values.

8.2 Exposure controls

Appropriate engineering controls
General industrial hygiene practice.

Personal protective equipment

Eye/face protection
Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:Dermatril® (KCL 740 / Aldrich Z677272, Size M)

Splash contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:Dermatril® (KCL 740 / Aldrich Z677272, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Body Protection
Choose body protection in relation to its type, to the concentration and amount of dangerous substances, and to the specific work-place., The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection
Respiratory protection is not required. Where protection from nuisance levels of dusts are desired, use type N95 (US) or type P1 (EN 143) dust masks. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure
No special environmental precautions required.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: granular Colour: white
b)	Odour	odourless
c)	Odour Threshold	No data available
d)	pH	8.2 at 10.01 g/l
e)	Melting point/freezing point	Decomposes before melting.

f)	Initial boiling point and boiling range	No data available
g)	Flash point	Not applicable
h)	Evaporation rate	No data available
i)	Flammability (solid, gas)	No data available
j)	Upper/lower flammability or explosive limits	No data available
k)	Vapour pressure	No data available
l)	Vapour density	No data available
m)	Relative density	2.17 g/cm3 at 20 °C (68 °F)
n)	Water solubility	362 g/l at 25 °C (77 °F)
o)	Partition coefficient: n-octanol/water	No data available
p)	Auto-ignition temperature	No data available
q)	Decomposition temperature	100 °C (212 °F) - Decomposes before melting.
r)	Viscosity	No data available
s)	Explosive properties	No data available
t)	Oxidizing properties	No data available

9.2 Other safety information
No data available

10. STABILITY AND REACTIVITY

10.1 Reactivity
No data available

10.2 Chemical stability
Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions
No data available

10.4 Conditions to avoid
No data available

10.5 Incompatible materials
Strong oxidizing agents, Strong acids

10.6 Hazardous decomposition products
Hazardous decomposition products formed under fire conditions. - Carbon oxides, Potassium oxides
Other decomposition products - No data available
In the event of fire: see section 5

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity
LD50 Oral - Rat - > 2,000 mg/kg
(OECD Test Guideline 401)

LD50 Dermal - Rabbit - > 2,000 mg/kg
(OECD Test Guideline 402)

No data available

Skin corrosion/irritation
Skin - Rabbit
Result: No skin irritation
(Patch Test 24 Hrs.)
Remarks: No data available

Serious eye damage/eye irritation
Eyes - Rabbit
Result: Mild eye irritation

Respiratory or skin sensitisation
Buehler Test - Guinea pig
Result: Did not cause sensitisation on laboratory animals.
(OECD Test Guideline 406)

Germ cell mutagenicity
No data available

Carcinogenicity

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

ACGIH: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.

NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity
No data available

No data available

Specific target organ toxicity - single exposure
No data available

Specific target organ toxicity - repeated exposure
No data available

Aspiration hazard
No data available

Additional Information
RTECS: Not available

To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

12. ECOLOGICAL INFORMATION

12.1 Toxicity

Toxicity to fish	LC50 - Oncorhynchus mykiss (rainbow trout) - 1,300 mg/l - 96 h
Toxicity to daphnia and other aquatic invertebrates	EC50 - Daphnia (water flea) - 630 mg/l

12.2 Persistence and degradability
The methods for determining the biological degradability are not applicable to inorganic substances.

12.3 Bioaccumulative potential
Does not bioaccumulate.

12.4 Mobility in soil
No data available

12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects

No data available

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Product
Offer surplus and non-recyclable solutions to a licensed disposal company.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
Not dangerous goods

IMDG
Not dangerous goods

IATA
Not dangerous goods

15. REGULATORY INFORMATION

SARA 302 Components
No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards
No SARA Hazards

Massachusetts Right To Know Components
No components are subject to the Massachusetts Right to Know Act.

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
Potassium hydrogencarbonate	298-14-6	

New Jersey Right To Know Components

	CAS-No.	Revision Date
Potassium hydrogencarbonate	298-14-6	

California Prop. 65 Components
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

HMIS Rating

Health hazard:	0
Chronic Health Hazard:	
Flammability:	0
Physical Hazard	0

NFPA Rating

Health hazard:	0
Fire Hazard:	0
Reactivity Hazard:	0

Further information

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

Preparation Information

Sigma-Aldrich Corporation
Product Safety – Americas Region
1-800-521-8956

Version: 4.5 Revision Date: 09/21/2017 Print Date: 06/22/2018

SAFETY DATA SHEET

Version 5.5
Revision Date 02/09/2015
Print Date 06/23/2018

1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product identifiers

Product name : Sodium sulfite

Product Number : S0505
Brand : Sigma-Aldrich

CAS-No. : 7757-83-7

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses : Laboratory chemicals, Manufacture of substances

1.3 Details of the supplier of the safety data sheet

Company : Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO 63103
USA

Telephone : +1 800-325-5832
Fax : +1 800-325-5052

1.4 Emergency telephone number

Emergency Phone # : +1-703-527-3887 (CHEMTREC)

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

Not a hazardous substance or mixture.

2.2 GHS Label elements, including precautionary statements

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS

Contact with acids liberates toxic gas.

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

Formula : Na_2O_3S
Molecular weight : 126.04 g/mol
CAS-No. : 7757-83-7
EC-No. : 231-821-4

Hazardous components

Component	Classification	Concentration
Sodium sulphite		
		<= 100 %

4. FIRST AID MEASURES

4.1 Description of first aid measures

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Flush eyes with water as a precaution.

If swallowed
Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed
The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed
No data available

5. FIREFIGHTING MEASURES

5.1 Extinguishing media

Suitable extinguishing media
Dry powder

5.2 Special hazards arising from the substance or mixture
Sulphur oxides, Sodium oxides

5.3 Advice for firefighters
Wear self-contained breathing apparatus for firefighting if necessary.

5.4 Further information
No data available

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Wear respiratory protection. Avoid dust formation. Avoid breathing vapours, mist or gas. Avoid breathing dust.
For personal protection see section 8.

6.2 Environmental precautions
Do not let product enter drains.

6.3 Methods and materials for containment and cleaning up
Pick up and arrange disposal without creating dust. Sweep up and shovel. Do not flush with water. Keep in suitable, closed containers for disposal.

6.4 Reference to other sections
For disposal see section 13.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Further processing of solid materials may result in the formation of combustible dusts. The potential for combustible dust formation should be taken into consideration before additional processing occurs.
Provide appropriate exhaust ventilation at places where dust is formed.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities
Keep container tightly closed in a dry and well-ventilated place.
Never allow product to get in contact with water during storage. Do not store near acids.

Air and moisture sensitive.
Storage class (TRGS 510): Non Combustible Solids

7.3 Specific end use(s)
Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters

Components with workplace control parameters
Contains no substances with occupational exposure limit values.

8.2 Exposure controls

Appropriate engineering controls
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

Eye/face protection
Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:Dermatril® (KCL 740 / Aldrich Z677272, Size M)

Splash contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:Dermatril® (KCL 740 / Aldrich Z677272, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Body Protection
Choose body protection in relation to its type, to the concentration and amount of dangerous substances, and to the specific work-place., The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face particle respirator type N100 (US) or type P3 (EN 143) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure
Do not let product enter drains.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: solid
b)	Odour	No data available
c)	Odour Threshold	No data available
d)	pH	9.0 - 10.5 at 126 g/l at 25 °C (77 °F)

e)	Melting point/freezing point	Decomposes before melting.
f)	Initial boiling point and boiling range	Not applicable
g)	Flash point	No data available
h)	Evaporation rate	No data available
i)	Flammability (solid, gas)	The product is not flammable.
j)	Upper/lower flammability or explosive limits	No data available
k)	Vapour pressure	No data available
l)	Vapour density	No data available
m)	Relative density	2.630 g/cm3
n)	Water solubility	126 g/l at 20 °C (68 °F) - completely soluble
o)	Partition coefficient: n-octanol/water	No data available
p)	Auto-ignition temperature	does not ignite
q)	Decomposition temperature	No data available
r)	Viscosity	No data available
s)	Explosive properties	Not explosive
t)	Oxidizing properties	The substance or mixture is not classified as oxidizing.

9.2 Other safety information
No data available

10. STABILITY AND REACTIVITY

10.1 Reactivity
No data available

10.2 Chemical stability
Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions
No data available

10.4 Conditions to avoid
Exposure to air may affect product quality. Exposure to moisture may affect product quality.

10.5 Incompatible materials
Acids, Strong oxidizing agents

10.6 Hazardous decomposition products
Other decomposition products - No data available
In the event of fire: see section 5

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity
LD50 Oral - Rat - 3,560 mg/kg

LC50 Inhalation - Rat - 4 h - > 5,500 mg/m3

LD50 Dermal - Rat - > 2,000 mg/kg
(OECD Test Guideline 402)

No data available

Skin corrosion/irritation
Skin - Rabbit
Result: No skin irritation
(OECD Test Guideline 404)

Serious eye damage/eye irritation
Eyes - Rabbit
Result: Mild eye irritation
(OECD Test Guideline 405)

Respiratory or skin sensitisation
Prolonged or repeated exposure may cause allergic reactions in certain sensitive individuals.

in vivo assay - Mouse
Result: Did not cause sensitisation on laboratory animals.

Germ cell mutagenicity
No data available

Carcinogenicity

This product is or contains a component that is not classifiable as to its carcinogenicity based on its IARC, ACGIH, NTP, or EPA classification.

IARC:	3 - Group 3: Not classifiable as to its carcinogenicity to humans (Sodium sulphite)
ACGIH:	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.
NTP:	No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
OSHA:	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity
No data available

No data available

Specific target organ toxicity - single exposure
No data available

Specific target organ toxicity - repeated exposure
No data available

Aspiration hazard
No data available

Additional Information
RTECS: WE2150000

May cause irritation of the:, Gastrointestinal tract, violent colic, Diarrhoea, Disturbance of:, circulatory system, Central nervous system depression, death, Persons with allergies and/or asthma may exhibit hypersensitivity to sulfites., To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

Liver - Irregularities - Based on Human Evidence
Liver - Irregularities - Based on Human Evidence

12. ECOLOGICAL INFORMATION

12.1 Toxicity

Toxicity to fish LC50 - Gambusia affinis (Mosquito fish) - 660 mg/l - 96 h

12.2 Persistence and degradability
The methods for determining biodegradability are not applicable to inorganic substances.

12.3 Bioaccumulative potential
No data available

12.4 Mobility in soil
No data available

12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects

No data available

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Product
Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
Not dangerous goods

IMDG
Not dangerous goods

IATA
Not dangerous goods

15. REGULATORY INFORMATION

SARA 302 Components
No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

Massachusetts Right To Know Components
No components are subject to the Massachusetts Right to Know Act.

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
Sodium sulphite	7757-83-7	

New Jersey Right To Know Components

	CAS-No.	Revision Date
Sodium sulphite	7757-83-7	

California Prop. 65 Components
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

HMIS Rating

Health hazard:	1
Chronic Health Hazard:	*
Flammability:	0
Physical Hazard	0

NFPA Rating

Health hazard:	1
Fire Hazard:	0
Reactivity Hazard:	0

Further information

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

Preparation Information

Sigma-Aldrich Corporation
Product Safety – Americas Region
1-800-521-8956

Version: 5.5 Revision Date: 02/09/2015 Print Date: 06/23/2018

MATERIAL SAFETY DATA SHEET

ACCELERITE®
BIOREMEDIATION NUTRIENT

SECTION I PRODUCT IDENTIFICATION

PRODUCT NAME:	Accelerite® Bioremediation Nutrient Liquid
PRODUCT USE:	Bioremediation
SUPPLIER:	JRW Bioremediation, LLC 14321 W. 96th Terrace Lenexa, KS 66215 913-438-5544
EMERGENCY TELEPHONE:	800-779-5545 x 116 (Mon-Fri 9am-5pm CST) 913-961-6644 (afterhours)
DATE REVISED:	06-23-2011

SECTION II COMPOSITION/INFORMATION ON INGREDIENTS

Name
Yeast Product

SECTION III PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling point:	212ºF
Vapor pressure (Mg Hg):	Not determined
Vapor density (air = 1):	Not determined
Solubility in water:	Dispersable
Appearance and odor:	Brown viscous liquid, yeast aroma
Specific gravity (H_2O = 1):	Not determined
Melting point:	Not determined
Evaporation rate:	Not determined
pH:	Not determined
Viscosity:	Not determined
Molecular Weight:	Not determined
Physical State:	Liquid

SECTION IV FIRE AND EXPLOSION HAZARD DATA

Closed cup Flash point:	Not determined
Open cup Flash point:	Not determined
Auto Ignition:	Not determined
Fire Point:	Not determined
Flammable limits:	Not determined
LEL:	Not determined
UEL:	Not determined
Extinguishing media:	none
Special Fire Fighting procedures:	none
Unusual Fire Fighting hazards:	none

SECTION V	**REACTIVITY DATA**
Stability:	Unstable [ ] Stable [X]
Conditions to avoid:	Not Applicable
Incompatibility (materials to avoid):	Not Applicable
Hazardous decomposition or byproducts:	None
Hazardous polymerization:	May Occur [ ] Will Not Occur [X]

SECTION VI **HEALTH HAZARD DATA** Based on concentration as sold

Route/s of Entry:

Inhalation: Respiring yeast generates carbon dioxide. Over exposure to carbon dioxide gas may cause asphyxiation. Move to fresh air.

Skin contact: In case of contact with skin, immediately wash with soap and water.

Eye contact: In case of contact with eyes, immediately flush eyes with water for at least 15 minutes, lifting eyelids to facilitate irrigation. Get medical attention if necessary.

Ingestion: If swallowed, get medical attention.

Health hazards (acute and chronic):	Respiring yeast generates carbon dioxide. Over exposure to carbon dioxide gas may cause asphyxiation.
Carcinogenicity:	No
Signs and symptoms of exposure:	Overexposure to carbon dioxide include: stupor, dizziness, unconsciousness, death.
Medical conditions aggravated by exposure:	None known for this product. Over exposure to carbon dioxide may aggravate certain medical conditions.

SECTION VII	**PRECAUTIONS FOR SAFE HANDLING AND USE**
Steps to be taken in case material is released or spilled:	Contain spill and place material in drum for disposal. Dispose of according to all local, state, and federal regulations at an approved waste treatment facility.
Precautions to be taken in handling and storage:	Prevent spills and leakage. Keep container tightly closed. Keep in properly labeled containers. Store in a cool, dry area.
Other precautions:	No special environmental precautions required.

SECTION VIII	**CONTROL MEASURES**
Respiratory protection (specify type):	No personal respiratory protective equipment normally required in well ventilated areas.
Ventilation:	Use adequate mechanical ventilation, especially in confined spaces. Local exhaust is recommended.
Protective gloves:	Not required but good practice.
Eye protection:	Safety glasses a good practice.
Other protective clothing or equipment:	Unnecessary if other control measures are used.
Hygiene practices:	Good manufacturing practices.

SECTION IX	DOT INFORMATION
DOT hazard class:	Not Applicable
Labeling:	Not Applicable
Proper Shipping Name:	Accelerite® Bioremediation Nutrient
NMFC#:	75480
Class	85

Sandia National Laboratories