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

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Hazardous Waste Bureau

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 Environmental Restoration Operations Consolidated Quarterly Report*, Dated April 2019

Dear Mr. Kieling:

Enclosed is the Subject report, identification number NM5890110518. This report addresses all quarterly reporting (October through December 2018) 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

Enclosure

cc: See Page 2

ENVIRONMENTAL RESTORATION OPERATIONS CONSOLIDATED QUARTERLY REPORT, APRIL 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.

Signature _____ Date 4/11/2019

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

and

Signature _____ Date 4/22/19

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

Sandia National Laboratories, New Mexico

Environmental Restoration Operations

A U.S. Department of Energy Environmental Cleanup Program

Consolidated Quarterly Report

October – December 2018

April 2019

United States Department of Energy
Sandia Field Office

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CONSOLIDATED QUARTERLY REPORT

April 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:	John R. Cochran

NUMBER OF POTENTIAL RELEASE SITES SUBJECT TO CORRECTIVE ACTION: 6

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

REPORTING PERIOD: October – December 2018

OVERVIEW

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

SECTION I: Environmental Restoration Operations Consolidated Quarterly Report, October – December 2018

SECTION II: Perchlorate Screening Quarterly Groundwater Monitoring Report, October – December 2018

SECTION III: Technical Area-V In-Situ Bioremediation Treatability Study Full-Scale Operation Results, October – December 2018

ABBREVIATIONS AND ACRONYMS

AGMR	Annual Groundwater Monitoring Report
AOC	Area of Concern
AVN	Area V (North) (acronym used for well identification numbers in tables only)
BSG	Burn Site Groundwater
CME	Corrective Measures Evaluation
COA	certificates of analysis
COC	constituent of concern
Consent Order	Compliance Order on Consent
CY	Calendar Year
CYN	Canyons (acronym used for well identification numbers in tables only at Burn Site Groundwater Area of Concern)
Dhc	dehalococcoides
DO	dissolved oxygen
DOE	U.S. Department of Energy
DP	Discharge Permit
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration Operations
ER Quarterly Report	Environmental Restoration Operations Consolidated Quarterly Report
FOP	Field Operating Procedure
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
LWDS	liquid waste disposal system (acronym used for well identification only)
MCL	maximum contaminant level
MDL	method detection limit
mg/L	milligrams per liter
µg/L	microgram(s) per liter
MW	monitoring well (acronym used for well identification only)
ND	nondetect
NMED	New Mexico Environment Department
NNSA	National Nuclear Security Administration
NPN	nitrate plus nitrite
ORP	oxidation-reduction potential
PGS	Parade Ground South (acronym used for well identification only)
pH	potential of hydrogen (negative logarithm of the hydrogen ion concentration)

SAP	sampling and analysis plan
SC	specific conductivity
SNL/NM	Sandia National Laboratories, New Mexico
SWMU	Solid Waste Management Unit
TA	Technical Area
TA1-W	Technical Area-I (Well)
TA2-NW	Technical Area-II (Northwest)
TA2-SW	Technical Area II (Southwest)
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
WYO	Wyoming (acronym used for well identification numbers in tables only)

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SECTION I
ENVIRONMENTAL RESTORATION OPERATIONS CONSOLIDATED QUARTERLY REPORT, October – December 2018

1.0 Introduction

This Environmental Restoration Operations (ER) Consolidated Quarterly Report (ER Quarterly Report) provides the status of ongoing corrective action activities being implemented at Sandia National Laboratories, New Mexico (SNL/NM) during the October, November, and December 2018 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. Section I.2.1 summarizes the work completed during this quarter at sites undergoing corrective action *field* activities. Field activities are conducted at the three groundwater AOCs (Burn Site Groundwater [BSG AOC], Technical Area-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 fourth quarter of Calendar Year (CY) 2018, there were no SWMUs or AOCs in the corrective action complete regulatory process.

2.0 Environmental Restoration Operations Work Completed

The following subsections describe the ER work completed during the fourth quarter of CY 2018.

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 constituent of concern (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.

The following activities occurred at BSG AOC during October, November, and December 2018:

- Groundwater sampling was conducted in October 2018. Table I-3 presents the identification and the sampling frequency for these monitoring wells. The analytical results for CY 2018 groundwater monitoring will be presented in the SNL/NM CY 2018 Annual Groundwater Monitoring Report (AGMR), which is anticipated to be submitted to the NMED in the summer of 2019.

- Perchlorate analysis of groundwater samples from the BSG AOC is discussed in Section II of this ER Quarterly Report.

- Continued preparing a monitoring well installation work plan per the requirements set forth in 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 requires installation of a minimum of four new groundwater monitoring wells to further characterize the AOC.

2.1.2 Technical Area-V Groundwater Area of Concern

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

Personnel from the DOE/NNSA, DOE Headquarters Office of Environmental Management, SNL/NM, and NMED HWB worked together to address the groundwater contamination at the TAVG AOC. A meeting was held with the NMED HWB on July 20, 2015, and all parties agreed on a phased Treatability Study/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 LWDS-MW1, TAV-MW6, and TAV-MW10. The proposed injection wells will be used to deliver substrate solution and biodegradation bacteria to groundwater. The substrate solution containing essential food and nutrients for biostimulation will be prepared in aboveground tanks. This substrate solution, along with the biodegradation bacteria, will be gravity-injected to groundwater via injection wells.

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

In addition to the Revised TSWP being approved by the NMED HWB, the NMED Ground Water Quality Bureau (GWQB) required a groundwater Discharge Permit (DP) for the 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 October, November, and December 2018:

- The analytical results from the September 2018 baseline sampling of wells TAV-INJ1, TAV-MW6, and TAV-MW7 are presented in Section III of this ER Quarterly Report .

- Full-scale operation of Phase I of the TS/IM began in October 2018. By December 31, 2018, 29 injections totaling 137,573 gallons of treatment solution were discharged to injection well TAV-INJ1. This was equivalent to approximately 26 percent of the planned injection volume of 530,000 gallons. The average volume of treatment solution per injection was approximately 4,744 gallons. Full-scale operation was scheduled to resume in January 2019 with injections expected to conclude in mid-2019. No significant problems were encountered during these full-scale injections.

- Groundwater monitoring for the TS/IM was conducted at wells TAV-MW6 and TAV-MW7 during this reporting period. Section III presents the details of the full-scale operation activities and groundwater monitoring results of the TS/IM for the fourth quarter quarter of CY 2018. 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, and of these 18 wells, well TAV-MW6 has been designated as a Treatability Study performance monitoring well since the TS/IM started with the pilot test in November 2017. Well TAV-MW7 was also designated as a Treatability Study mornitoring well during the pilot test but it was reverted back to the TA-V groundwater monitoring network starting the fourth quarter of CY 2018 (SNL/NM January 2019). Even though well TAV-MW7 continues to serve as a monitoring well for the TS/IM, programmatically it belongs to the TA-V groundwater monitoring network. Groundwater monitoring results at wells TAV-MW6 and TAV-MW7 will continue to be reported in Section III of the ER quarterly reports.

- 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 November 2018. The SNL/NM CY

2018 AGMR will present the analytical results for CY 2018 groundwater monitoring, which is scheduled for submittal to the NMED HWB in the summer of 2019.

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 Regional Aquifer. TCE has been identified as a COC for the Perched Groundwater System. However, the area where TCE exceedances occurred has naturally dewatered and the last reported TCE concentration was 3.82 µg/L, occurring in November 2015, which is less than the EPA MCL of 5 µg/L (SNL/NM June 2016). No TCE concentrations in Regional Aquifer samples have exceeded the EPA MCL. The EPA MCLs and State of New Mexico drinking water standards for TCE and nitrate (as nitrogen) are 5 µg/L and 10 mg/L, respectively.

In May 2017, NMED HWB completed its review of the Current Conceptual Model and Corrective Measures Evaluation Report for the TAG AOC (SNL/NM December 2016), which was submitted to the NMED HWB on November 23, 2016 (DOE November 2016). This November 23, 2016 report was submitted in accordance with NMED's "Agreements and Proposed Milestones" letter of April 14, 2016 (NMED April 2016). The subsequent disapproval letter issued by the NMED HWB (NMED May 2017b) requested the inclusion of additional information in a revised report. The Revised TAG Current Conceptual Model / 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 the October, November, and December 2018 time period groundwater samples were collected from all seven monitoring wells (TA2-W-19, TA2-W-26, TA2-W-28, TJA-2, TJA-3, TJA-4, and TJA-7) scheduled for quarterly sampling. Table I-2 presents the CY 2018 sampling frequency for the TAG monitoring wells. The analytical results for the TAG AOC CY 2018 groundwater monitoring will be included in the SNL/NM CY 2018 AGMR, which is scheduled for submittal to the NMED HWB in the summer of 2019.

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), October 2017. Letter to J.P. Harrell (U.S. Department of Energy NNSA/Sandia Field Office) and Richard O. Griffith (Sandia National Laboratories), "Approval Request for Extension for Submittal of a Revised Tijeras Arroyo Groundwater Current Conceptual Model and Corrective Measure Evaluation Report, Sandia National Laboratories/New Mexico, EPA ID# NM5890110518, HWB-SNL-16-020," October 13, 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.

NMED, see New Mexico Environment Department

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

Sandia National Laboratories, New Mexico (SNL/NM), June 2016. *Annual Groundwater Monitoring Report, Calendar Year 2015, June 2016, Sandia National Laboratories,* 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), January 2019. *Environmental Restoration Operations Consolidated Quarterly Report July – September 2018, 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), September 2017. Letter to J.E. Kieling (New Mexico Environment Department), "Request for Extension for Submittal of the Revised Tijeras Arroyo Groundwater Current Conceptual Model and Corrective Measures Evaluation Report in Response to the NMED Disapproval Letter dated May 18, 2017", September 25, 2017.

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 2018	Quarter of Sampling in CY 2018	Location of Analytical Results	Location of Perchlorate Analytical Results	Monitoring Wells in Network
TAVG AOC [a]	Quarterly	1,2,3,4	AGMR	NA	LWDS-MW1, TAV-MW2, TAV-MW4, TAV-MW7 TAV-MW8, TAV-MW10, TAV-MW11, TAV-MW12, TAV-MW14, TAV-MW15, TAV-MW16
	Annually	2	AGMR	NA	AVN-1, LWDS-MW2, TAV-MW3, TAV-MW5, TAV-MW9, TAV-MW13
BSG AOC	Semiannually	2,4	AGMR	Section II of ER Consolidated Quarterly Report	CYN-MW4, CYN-MW7, CYN-MW8, CYN-MW9, CYN-MW10, CYN-MW11, CYN-MW12, CYN-MW13, CYN-MW14A, CYN-MW15
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).
ER = Environmental Restoration Operations.
HWB = Hazardous Waste Bureau.
LWDS = Liquid waste disposal system (acronym used for well identification only).
MW = Monitoring well.
NA = Not applicable. No wells in the site network are currently being sampled and analyzed for perchlorate.
NMED = New Mexico Environment Department.
PGS = Parade Ground South (acronym used for well identification only).
TA1-W = Technical Area-I (Well) (acronym used for well identification only).
TA2-NW = Technical Area-II (Northwest) (acronym used for well identification only).
TA2-W = Technical Area-II (Well) (acronym used for well identification only).
TAG = Tijeras Arroyo Groundwater (Area of Concern).
TAV = Technical Area-V (acronym used for well identification only).
TAVG = Technical Area-V Groundwater (Area of Concern).
TJA = Tijeras Arroyo (acronym used for well identification only).
WYO = Wyoming (acronym used for well identification only).

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SECTION II
PERCHLORATE SCREENING QUARTERLY GROUNDWATER MONITORING REPORT, October – December 2018

1.0 Introduction

Section IV.B of the Compliance Order on Consent (the Consent Order), between the New Mexico Environment Department (NMED), the U.S. Department of Energy (DOE), and Sandia National Laboratories, New Mexico (SNL/NM), effective on April 29, 2004, stipulates that a select group of groundwater monitoring wells at SNL/NM be sampled for perchlorate (NMED April 2004). This section of the Environmental Restoration Operations (ER) Consolidated Quarterly Report (ER Quarterly Report) summarizes the perchlorate screening groundwater monitoring completed during the fourth quarter of calendar year (CY) 2018 (October, November, and December 2018) in response to the requirements of the Consent Order. The outline of this report is based on the required elements of a "Periodic Monitoring Report" described in Section X.D. of the Consent Order (NMED April 2004).

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

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

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

This report is the forty-seventh perchlorate screening quarterly report submitted since the November 2005 letter report; the previous reports were submitted for fourth quarter of CY 2005 through the second quarter of CY 2018 (SNL/NM February 2006 and October 2018a).

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

2.0 Scope of Activities

This report provides fourth quarter of CY 2018 (October, November, and December 2018) perchlorate screening groundwater monitoring analytical results for the well CYN-MW15, the only well currently active in the perchlorate screening program (Figure II-1, Table II-1). In accordance with the requirements of Table XI-1 of the Consent Order, a well with four consecutive quarters of nondetects (NDs) for perchlorate at the screening level/method detection limit (MDL) of 4 micrograms per liter (µg/L) is removed from the requirement of continued monitoring for perchlorate. Data for numerous wells identified in the Consent Order have satisfied this requirement; therefore, these wells have been removed from the perchlorate screening program. Previous reports provided perchlorate results for these wells and are not discussed in this current report. Table II-2 lists the wells discussed in previous perchlorate screening reports.

SNL/NM personnel performed groundwater sampling for perchlorate at monitoring well CYN-MW15 in October 2018 (Table II-1). Groundwater sampling activities were conducted in accordance with procedures outlined in the *Burn Site Groundwater Monitoring, Mini-SAP for First Quarter, Fiscal Year 2019* (SNL/NM October 2018a).

As described in the Mini-Sampling and Analysis Plan (SAP), groundwater sampling was performed in accordance with current SNL/NM Environmental Management, Long-Term Stewardship Project Field Operating Procedures (FOPs). A portable Bennett™ groundwater sampling system was used to collect the groundwater samples. The sampling pump and

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

- Turbidity measurements are less than 5 nephelometric turbidity units, or within 10 percent for turbidity values greater than 5 nephelometric turbidity units .
- pH is within 0.1 units.
- Temperature is within 1.0 degree Celsius.
- SC is within 5 percent.

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

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

3.0 Regulatory Criteria

For a given monitoring well, four consecutive ND results using the screening level/MDL of 4 µg/L are considered by the NMED HWB as evidence of the absence of perchlorate, such

that additional monitoring for perchlorate in that well is not required. If perchlorate is detected using the screening level/MDL of 4 µg/L in a specific well, then monitoring will continue at that well at a frequency negotiated with the NMED. The Consent Order (NMED April 2004) also requires that detections equal to or greater than 4 µg/L be evaluated by DOE/NNSA and SNL/NM personnel to determine the nature and extent of perchlorate contamination and incorporate the results of this evaluation into a Corrective Measures Evaluation (CME), based on a screening level/MDL of 4 µg/L. The Consent Order, Section VII.C clarifies that the CME process will be initiated where there is a documented release to the environment, and where corrective measures are necessary to protect human health and the environment.

3.1 Burn Site Groundwater Area of Concern

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

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

In accordance with the requirements of Section VI.K.1.b of the Consent Order (NMED April 2004), a human health risk assessment has been performed to evaluate the potential for adverse health effects from the concentrations of perchlorate detected

in monitoring well CYN-MW6 groundwater samples. The maximum perchlorate concentration to date of 8.93 µg/L was used in the risk assessment. The calculated hazard quotient of 0.35 is less than the NMED HWB target level of a hazard index (the sum of all hazard quotients) of 1.0 (NMED June 2006, SNL/NM March 2008–Appendix E). For another point of comparison, NMED HWB risk assessment guidance lists a tap water standard of 13.8 µg/L for perchlorate (NMED February 2019); therefore, the historical maximum concentration detected is 35 percent less than the NMED HWB tap water standard.

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

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

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

The April 2009 letter from the NMED HWB to DOE/NNSA and SNL/NM personnel was not limited to the BSG AOC (NMED April 2009). The NMED HWB had also requested that DOE/NNSA and SNL/NM personnel monitor perchlorate concentrations for a minimum of four quarters at five monitoring wells in the Tijeras Arroyo Groundwater (TAG) AOC and at four monitoring wells in the Technical Area-V Groundwater AOC (NMED April 2009). All nine wells from these two AOCs have been sampled for four consecutive monitoring events with no perchlorate detections being reported; therefore, these nine wells have been removed

from the perchlorate monitoring network. A TAG monitoring well (TA2-SW1-320) was damaged and was replaced by well, TA2-W-28 in December 2014. The replacement well was installed for monitoring the same depth interval as damaged well TA2-SW1-320. Because well TA2-SW1-320 was not one of the four TAG wells selected for perchlorate sampling, replacement well TA2-W-28 does not require perchlorate sampling.

4.0 Monitoring Results

Table II-3 summarizes the details of samples collected from monitoring well CYN-MW15 in the fourth quarter of CY 2018. Table II-4 summarizes the current and historical perchlorate results for this well. Appendix A provides the analytical laboratory COAs for the fourth quarter of CY 2018 perchlorate data. For the fifth time in nine sampling events (since December 2014), perchlorate was detected above the screening level/MDL of 4.0 µg/L in the CYN-MW15 environmental duplicate groundwater sample at a concentration of 4.04 µg/L; the CYN-MW15 environmental groundwater sample was ND (<4.0 µg/L).

Figure II-2 shows that the October 2018 perchlorate concentrations reported for monitoring well CYN-MW15 were ND (environmental sample) and just above the perchlorate screening level/MDL of 4.0 µg/L (environmental duplicate sample). The hydrograph for monitoring well CYN-MW15 (Figure II-2) shows that the water table elevation has been slightly decreasing over the past year.

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

The analytical data were reviewed and validated in accordance with Administrative Operating Procedure 00-03, "Data Validation Procedure for Chemical and Radiochemical Data," (SNL/NM June 2017). No problems were identified with the analytical data that resulted in qualification of the data as unusable. The data are acceptable, and reported quality control measures are adequate. Appendix B provides the data validation sample findings summary sheets for the perchlorate data.

No variances or nonconformances in perchlorate sampling field activities, or field conditions from requirements in the groundwater monitoring Mini-SAP (SNL/NM October 2018), were identified during the fourth quarter of CY 2018 sampling activities.

5.0 Summary and Conclusions

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

- The perchlorate concentrations for the two groundwater samples from monitoring well CYN-MW15 for the fourth quarter of CY 2018 sampling event were ND and 4.04 µg/L. This is the fifth sampling event that perchlorate was detected at this well (Figure II-2) since December 2014. However, this result was not unexpected as CYN-MW15 was installed to replace CYN-MW6, a well with historical perchlorate detections that ranged up to 8.93 µg/L.

- Since June 2004 (the start of sampling as required by the Consent Order), perchlorate was detected above the screening level/MDL (4 µg/L) in groundwater samples from only one well (CYN-MW6) and its replacement well (CYN-MW15) in the perchlorate monitoring network.

- DOE/NNSA and SNL/NM personnel will continue semiannual monitoring of perchlorate at monitoring well CYN-MW15.

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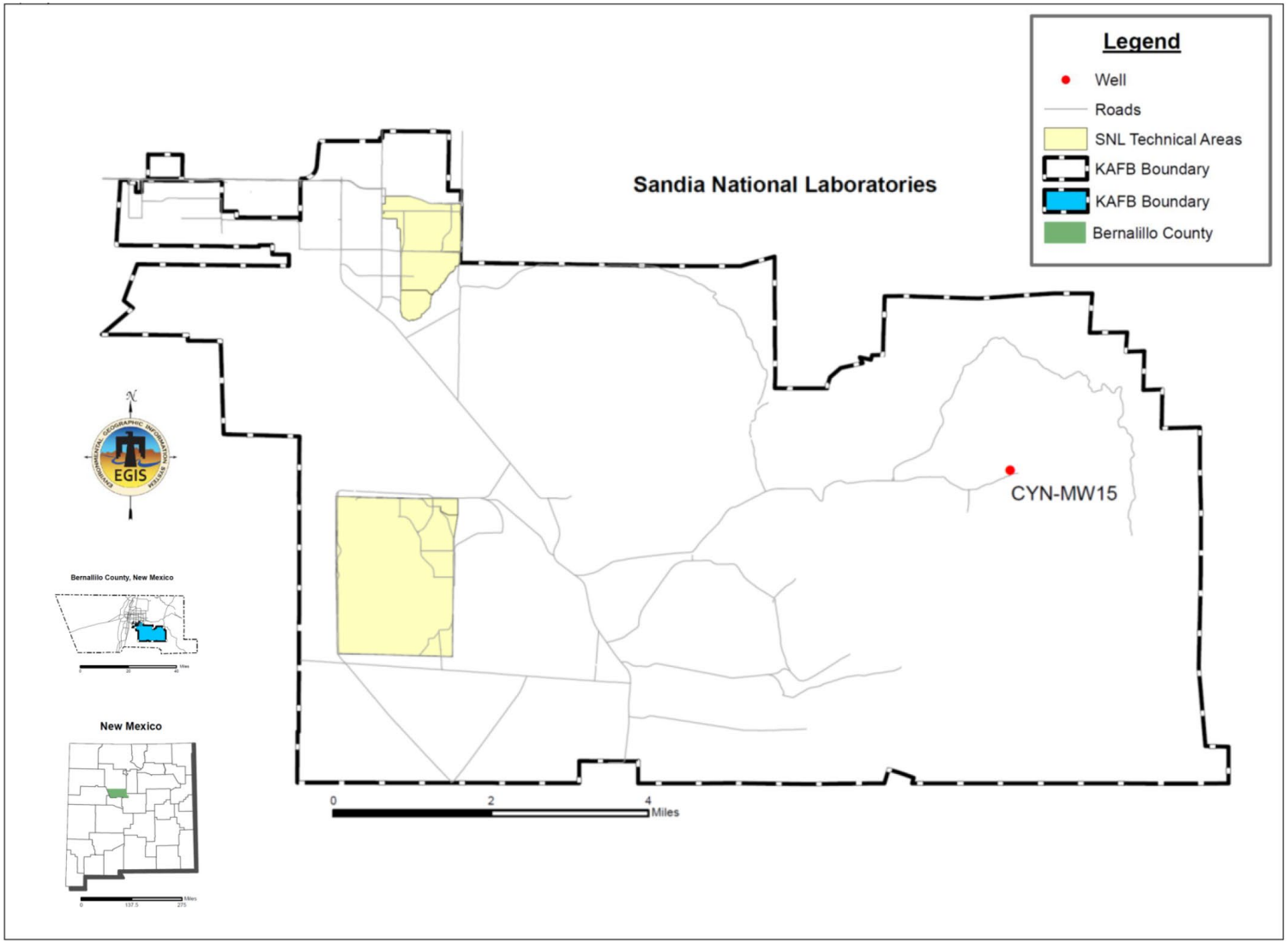
Figures



Sandia National Laboratories, New Mexico
Environmenatl Geographic Information System

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

Figure II-1
Sandia National Laboratories, New Mexico
Current Perchlorate Screening Monitoring Well Network, October – December 2018

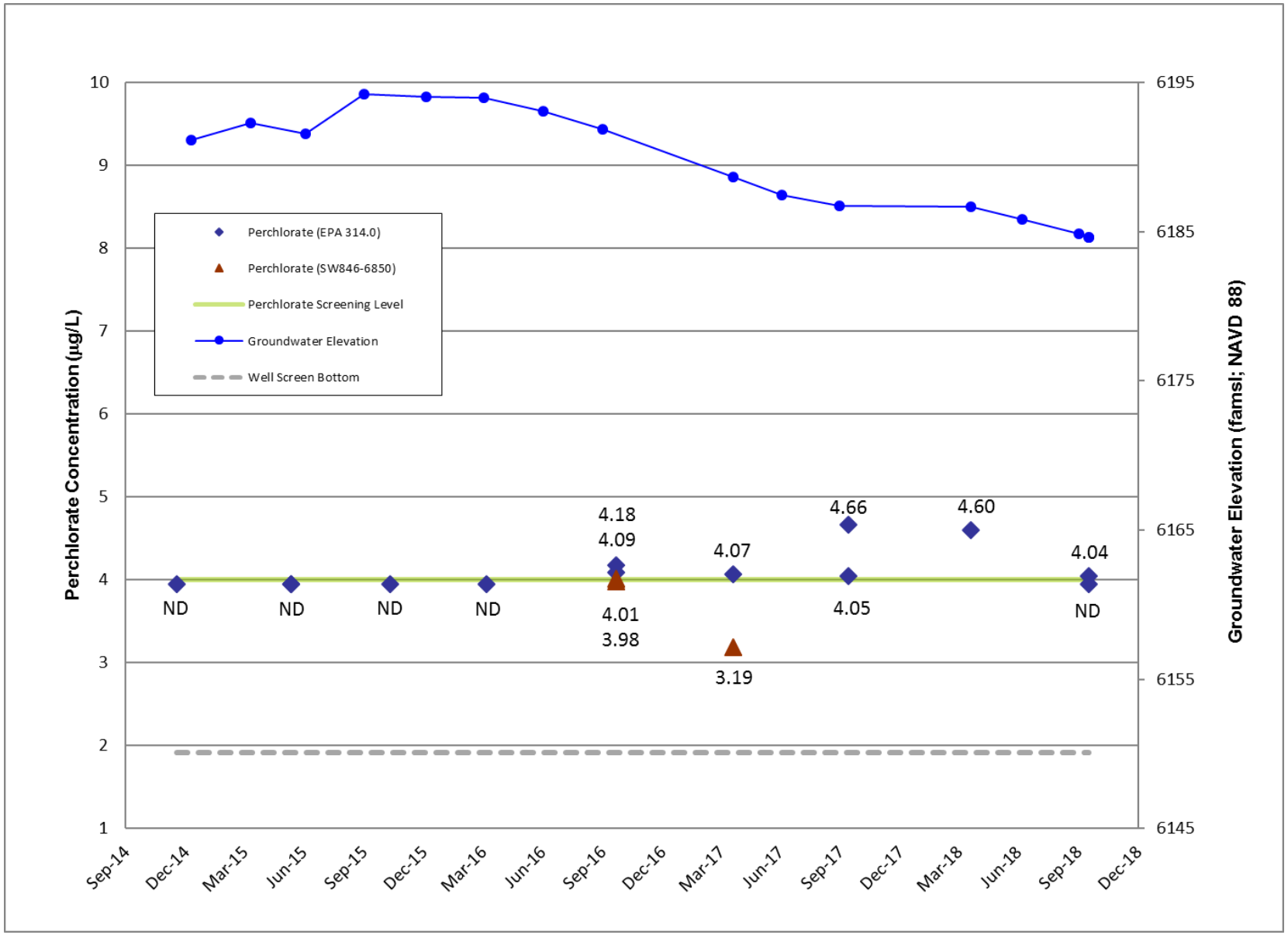


Figure II-2

Groundwater Elevations and Perchlorate Concentrations Over Time in CYN-MW15

Tables

Table II-1
Current Perchlorate Screening Monitoring Well Network
Fourth Quarter, CY 2018

Well	Date Sampled	Number of Consecutive Sampling Events[a]	Remaining Number of Sampling Events	Sampling Equipment
CYN-MW15	16-Oct-18	9	TBD[b]	Bennett™ Pump

Notes

[a]Includes this sampling event.
[b]This well was installed as a replacement well for CYN-MW6. Because perchlorate concentrations in CYN-MW6 have exceeded the screening level/MDL, DOE/NNSA, SNL/NM, and the NMED HWB have agreed to further characterization through continued monitoring in the BSG AOC (NMED February 2010).

AOC = Area of Concern.
BSG = Burn Site Groudnwater.
CY = Calendar Year.
CYN = Canyons (Burn Site Groundwater Area of Concern).
DOE = U.S. Department of Energy.
HWB = Hazardous Waste Bureau.
MDL = Method detection limit.
MW = Monitoring well.
NMED = New Mexico Environment Department.
NNSA = National Nuclear Security Administration.
SNL/NM = Sandia National Laboratories, New Mexico.
TBD = To be determined.

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

Well	
CCBA-MW1	MWL-MW1
CCBA-MW2	MWL-MW7
CTF-MW1	MWL-MW8
CTF-MW2	MWL-MW9
CTF-MW3	NWTA3-MW2
CYN-MW1D	OBS-MW1
CYN-MW5	OBS-MW2
CYN-MW6	OBS-MW3
CYN-MW7	SWTA3-MW4
CYN-MW8	TA1-W-03
CYN-MW9	TA1-W-06
CYN-MW10	TA1-W-08
CYN-MW11	TA2-W-01
CYN-MW12	TA2-W-27
CYN-MW14A	TAV-MW11
LWDS-MW1	TAV-MW12
MRN-2	TAV-MW13
MRN-3D	TAV-MW14
MWL-BW1	TAV-MW15
MWL-BW2	TAV-MW16

Notes

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

Table II-3
Sample Details for Fourth Quarter, CY 2018 Perchlorate Sampling

Well	Sample Identification	AR/COC Number	Associated Groundwater Investigation
CYN-MW15	106473-004	619203	BSG AOC
CYN-MW15 (Duplicate)	106474-004	619203	BSG AOC

Notes

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

Table II-4
Summary of Perchlorate Screening Analytical Results for the Current Monitoring Well Network as of Fourth Quarter, CY 2018

Well	Sample Date	AR/COC Number	Sample Number	Result (µg/L)	MDL (µg/L)	PQL (µg/L)	MCL (µg/L)	Laboratory Qualifier[a]	Validation Qualifier[b]	Analytical Method[c]	Comments
Burn Site Groundwater Area of Concern											
CYN-MW15	17-Dec-14	615941	096979-020	ND	4.0	12	NE	U		EPA 314.0	
	11-Jun-15	616178	097842-020	ND	4.0	12	NE	U		EPA 314.0	
			097843-020	ND	4.0	12	NE	U		EPA 314.0	Duplicate sample
	10-Nov-15	616396	098486-020	ND	4.0	12	NE	U		EPA 314.0	
	05-Apr-16	616862	099139-008	ND	4.0	12	NE	U		EPA 314.0	
	21-Oct-16	617385	100705-004	4.09	4.0	12	NE	J		EPA 314.0	
			100705-R04	3.98	0.25	1	NE			SW846 6850	
			100706-004	4.18	4.0	12	NE	J		EPA 314.0	Duplicate sample
			100706-R04	4.01	0.25	1	NE			SW846 6850	Duplicate sample
	19-Apr-17	617823	102400-013	4.07	4.0	12	NE	J		EPA 314.0	
			102400-R13	3.19	0.1	0.4	NE	Hh	J-	SW846 6850	
	13-Oct-17	618205	103748-004	4.05	4.0	12	NE	J		EPA 314.0	
			103749-004	4.66	4.0	12	NE	J		EPA 314.0	Duplicate sample
	19-Apr-18	618667	105068-008	4.60	4.0	12	NE	J		EPA 314.0	
	16-Oct-18	619203	106473-004	ND	4.0	12	NE	U		EPA 314.0	
			106474-004	4.04	4.0	12	NE	J		EPA 314.0	Duplicate sample

Notes

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

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

Table II-4 (concluded)
Summary of Perchlorate Screening Analytical Results for the Current Monitoring Well Network as of Fourth Quarter, CY 2018

Notes (continued)

[c]Analytical Method

EPA 314.0: EPA, November 1999, "Perchlorate in Drinking Water Using Ion Chromatography," EPA 815/R-00-014 .

SW846 6850: EPA, 1986 (and updates), "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," SW-846, 3rd ed., EPA, Washington, D.C.

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

Table II-5
Perchlorate Screening Groundwater Monitoring
Field Water Quality Measurements[a], Fourth Quarter, CY 2018

Well	Sample Date	Temperature (°C)	Specific Conductivity (µmhos/cm)	Oxidation-Reduction Potential (mV)	pH	Turbidity (NTU)	Dissolved Oxygen (% Sat)	Dissolved Oxygen (mg/L)
Burn Site Groundwater Area of Concern								
CYN-MW15	16-Oct-18	13.76	1238.1	184.8	7.07	0.46	14.53	1.23

Notes

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

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

Appendix A
Analytical Laboratory Certificates of Analysis for the Perchlorate Data

SMO 2012-ARCOC (4-2012)

AOP 95-16

CONTRACT LABORATORY
ANALYSIS REQUEST AND CHAIN OF CUSTODY

Internal Lab

Batch No. N/A

AR/COC 619203

Project Name:	BSG AOC	Date Samples Shipped:	10/18/18	SMO Authorization:	☐ Waste Characterization
Project/Task Manager:	Michael Skelly	Carrier/Waybill No.	289222	SMO Contact Phone:	☐ RMA
Project/Task Number:	195122.12.11.01	Lab Contact:	Edie Kent/843-769-7385	Wendy Palencia/505-844-3132	☐ Released by COC No.
Service Order:	CF058-19	Lab Destination:	GEL	Send Report to SMO:	☑ 4° Celsius
		Contract No.:	1303873	Stephanie Montaño/505-284-2553	Bill to: Sandia National Laboratories (Accounts Payable), P.O. Box 5800, MS-0154 Albuquerque, NM 87185-0154
Tech Area:					
Building:	Room:	Operational Site:			460743

SMO Use

Sample No.	Fraction	Sample Location Detail	Depth (ft)	Date/Time Collected		Sample Matrix	Container Type	Container Volume	Preservative	Collection Method	Sample Type	Parameter & Method Requested	Lab Sample ID
106472	001	FB-3	NA	10/16/18	09:50	DIW	AG	3x40 ml	NONE	G	FB	TPH-GRO (SW846-8015)	022
106473	002	CYN-MW15	182	10/16/18	09:52	GW	AG	4x1 L	NONE	G	SA	TPH-DRO (SW846-8015)	023
106473	001	CYN-MW15	182	10/16/18	09:50	GW	AG	3x40 ml	NONE	G	SA	TPH-GRO (SW846-8015)	024
106473	003	CYN-MW15	182	10/16/18	09:56	GW	P	125 ml	H2SO4	G	SA	NPN (EPA 353.2)	025
106473	004	CYN-MW15	182	10/16/18	09:58	GW	P	250 ml	None	G	SA	PERCHLORATE (EPA 314.0)	026
106474	002	CYN-MW15	182	10/16/18	09:52	GW	AG	4x1 L	NONE	G	DU	TPH-DRO (SW846-8015)	027
106474	001	CYN-MW15	182	10/16/18	09:50	GW	AG	3x40 ml	NONE	G	DU	TPH-GRO (SW846-8015)	028
106474	003	CYN-MW15	182	10/16/18	09:56	GW	P	125 ml	H2SO4	G	DU	NPN (EPA 353.2)	029
106474	004	CYN-MW15	182	10/16/18	09:58	GW	P	250 ml	None	G	DU	PERCHLORATE (EPA 314.0)	030
106475	001	TB-11	NA	10/16/18	09:50	DIW	AG	3x40 ml	NONE	G	TB	TPH-GRO (SW846-8015)	031

Last Chain:	☐ Yes	Sample Tracking	SMO Use
Validation Req'd:	☑ Yes	Date Entered:	
Background:	☐ Yes	Entered by:	
Confirmatory:	☐ Yes	QC inits.:	

Special Instructions/QC Requirements:

EDD ☑ Yes

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

Negotiated TAT ☐

Sample Disposal ☐ Return to Client ☑ Disposal by Lab

Return Samples By:

Comments: Received trip blanks from lab for TPH-GRO with bubbles

Conditions on Receipt

Lab Use

Sample Team Members	Name	Signature	Init.	Company/Organization/Phone/Cell
	William Gibson		WJG	SNL/08888/505-239-7367/505-239-7367
	Christopher Hulliger			AIS/08888//505-382-0353/505-284-3309

Relinquished by		Org. 8888	Date 10/16/18	Time 1149	Relinquished by	Org.	Date	Time
Received by	SMO	Org. 00642	Date 10/16/18	Time 1149	Received by	Org.	Date	Time
Relinquished by	SMO	Org. 00642	Date 10/16/18	Time 1245	Relinquished by	Org.	Date	Time
Received by		Org.	Date 10/17/18	Time 785	Received by	Org.	Date	Time

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

GEL LABORATORIES LLC

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

Certificate of Analysis

Report Date: November 8, 2018

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

Client Sample ID:	106473-004	Project:	SNLSGWater
Sample ID:	461743026	Client ID:	SNLS004
Matrix:	AQUEOUS		
Collect Date:	16-OCT-18 09:58		
Receive Date:	17-OCT-18	Client Desc.:	CYN-MW15
Collector:	Client	Vol. Recv.:	

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Ion Chromatography												
EPA 314.0 Perchlorate by IC "As Received"												
Perchlorate	U	ND	0.004	0.012	mg/L		1	MAR1	10/24/18	1934	1813048	1

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 314.0 DOE-AL	

Notes:

Column headers are defined as follows:

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

GEL LABORATORIES LLC

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

Certificate of Analysis

Report Date: November 8, 2018

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

Client Sample ID:	106474-004	Project:	SNLSGWater
Sample ID:	461743030	Client ID:	SNLS004
Matrix:	AQUEOUS		
Collect Date:	16-OCT-18 09:58		
Receive Date:	17-OCT-18	Client Desc.:	CYN-MW15
Collector:	Client	Vol. Recv.:	

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Ion Chromatography												
EPA 314.0 Perchlorate by IC "As Received"												
Perchlorate	J	0.00404	0.004	0.012	mg/L		1	MAR1	10/24/18	2036	1813048	1

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 314.0 DOE-AL	

Notes:

Column headers are defined as follows:

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

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

ANALYTICAL QUALITY ASSOCIATES, INC.

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

Memorandum

Date: November 26, 2018

To: File

From: Linda Thal

Subject: Inorganic Data Review and Validation – SNL
Site: BSG AOC
ARCOC: 619199, 619200, 619201, 619202, 619203, 619204, 619205 and 619206
SDG: 461743
Laboratory: GEL
Project/Task: 195122.12.11.01
Analysis: General Chemistry

See the attached Data Validation Worksheets for supporting documentation on the data review and validation. This validation was performed according to SNL/NM SMO Procedure AOP 00-03 Rev 5.

Summary

Eleven samples were prepared and analyzed with accepted procedures using method EPA 353.2 (nitrate/nitrite) and three samples were prepared and analyzed with accepted procedures using method EPA 314.0 (perchlorate). Data were reported for all required analytes. Problems were identified with the data package that resulted in the qualification of data.

Nitrate/Nitrite:

1. Samples 461743019 and -038 were analyzed undiluted; however, the MS and replicate analyses were performed on a sample diluted 25X and considered a dissimilar matrix. The associated result for sample -038, an EB, was a detect and will be **qualified J, RP1**. The associated result for sample -019, also an EB, was non-detect and will be **qualified UJ,RP1**.

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

Holding Times and Preservation

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

Calibration

All initial and continuing calibration met QC acceptance criteria.

Blanks

No target analytes were detected in the blanks with the following exception. Nitrate/nitrite was detected at ≤ the PQL in EB-3, sample -038 associated with samples -042 and -045. The associated sample results were detects >5X the EB value and will not be qualified.

Laboratory Control Sample (LCS)

All LCS acceptance criteria were met.

Matrix Spike and Matrix Spike Duplicate (MS/MSD)

All MS/PS recoveries met QC acceptance criteria.

Laboratory Replicate

The replicate analyses met all QC acceptance criteria except as noted above in the Summary section.

Detection Limits/Dilutions

All detection limits were properly reported and were correctly adjusted for dilutions. The following dilutions were performed due to high amounts of target analyte present in the sample.

Nitrate/Nitrite
Samples -003, -006, -011 and -015 were diluted 25X and samples -025, -029, -034, -042 and -045 were diluted 50X.

Other QC

EB-1 submitted with ARCOC 619198 and analyzed in another SDG was associated with the samples on ARCOC 619199 submitted in this SDG. EB-2 and EB-3 were submitted with ARCOCs 619202 and 619205 and were associated with the samples submitted with ARCOCs 619203 and 619206 respectively. Field duplicate pairs were submitted with ARCOCs 619199, 619203 and 619206. There are no "required" review criteria for field duplicate analyses comparability; no data will be qualified as a result.

No other specific issues that affect data quality were identified.

Reviewed by: Mary Donivan **Level:** I **Date:** 11/28/18

Sample Findings Summary

AR/COC: 619199, 619200, 619201, 619202, 619203, 619204, 619205, 619206

Analytical Method	Sample ID	Analyte Name (CAS#)	Qualifier, RC
EPA 353.2			
	106470-003/EB-2	Nitrogen, Nitrate/Nitrite (NO3ASN)	UJ, RP1
	106478-003/EB-3	Nitrogen, Nitrate/Nitrite (NO3ASN)	J, RP1
SW846 3535A/8015D			
	106470-002/EB-2	Diesel Range Organics (68334-30-5)	UJ, H1
	106480-002/CYN-MW13	Diesel Range Organics (68334-30-5)	UJ, MS5
	106534-002/CYN-MW13	Diesel Range Organics (68334-30-5)	UJ, MS5
SW846 8015A/B VOC			
	106472-001/FB-3	Gasoline Range Organics (8006-61-9)	R, H1
	106473-001/CYN-MW15	Gasoline Range Organics (8006-61-9)	R, H1
	106474-001/CYN-MW15	Gasoline Range Organics (8006-61-9)	R, H1
	106475-001/TB-11	Gasoline Range Organics (8006-61-9)	R, H1
	106476-001/CYN-MW9	Gasoline Range Organics (8006-61-9)	R, H1
	106477-001/TB-12	Gasoline Range Organics (8006-61-9)	R, H1
	106478-001/EB-3	Gasoline Range Organics (8006-61-9)	R, H1
	106479-001/TB-13	Gasoline Range Organics (8006-61-9)	R, H1
	106480-001/CYN-MW13	Gasoline Range Organics (8006-61-9)	R, H1
	106482-001/TB-14	Gasoline Range Organics (8006-61-9)	R, H1
	106534-001/CYN-MW13	Gasoline Range Organics (8006-61-9)	R, H1

Analytical Method	Sample ID	Analyte Name (CAS#)	Qualifier, RC

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

SECTION III
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APPENDICES

SECTION III
TECHNICAL AREA-V IN-SITU BIOREMEDIATION TREATABILITY STUDY FULL-SCALE OPERATION RESULTS

1.0 Background

As previously reported in Section III of the Environmental Restoration (ER) Quarterly Report, October 2018 (Sandia National Laboratory, New Mexico [SNL/NM], October 2018), the pilot test for the Technical Area-V (TA-V) in-situ bioremediation (ISB) Treatability Study was conducted during November 2017 at injection well TAV-INJ1 with performance monitoring conducted at two nearby wells, TAV-MW6 and TAV-MW7, and concluded in June 2018. Full-scale operation of the ISB Treatability Study began in October 2018.

This ISB Treatability Study full-scale operation quarterly report summarizes the ongoing full-scale activities and associated analytical results. A comprehensive report for the ISB Treatability Study, including both the pilot test and the full-scale operation, will be produced at the end of the ISB Treatability Study, in accordance with the Revised Treatability Study Work Plan (TSWP) (SNL/NM March 2016).

1.1 Modifications of Full-Scale Operation for the Treatability Study

Based on the results of the pilot test, and discussions with the New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB), the DOE/National Nuclear Security Administration (1) proposed eight modifications for full-scale operations, and (2) proposed to proceed with the full-scale operation of the Treatability Study at injection well TAV-INJ1 on July 20, 2018 (DOE July 2018). The NMED HWB approved the proposed modifications and concurred with the decision to proceed with the full-scale operations on August 13, 2018 (NMED August 2018). NMED's approval letter and DOE's submittal with the proposed modifications are provided in Appendix A. The following summarizes the eight modifications. Detailed rationale for the modifications are provided in Appendix A.

Modification #1: For full-scale operation, use substrate components (i.e., chemicals) to deoxygenate potable water in aboveground tanks.

Modification #2: Use the two existing 5,000-gallon aboveground tanks from pilot test for full-scale injection.

Modification #3: Use potassium bicarbonate and sodium sulfite to deoxygenate and reduce the oxidation-reduction potential of the treatment solution to produce favorable conditions for the dechlorinating bacteria in the ISB process.

Modification #4: Use Accelerite® Bioremediation Nutrient to substitute for yeast extract in treatment solution for full-scale operation.

Modification #5: It is not necessary to sample the content of the aboveground tanks because known amounts of ingredients are dissolved in potable water, and there is sufficient information on what is being injected.

Modification #6: Sampling the water in injection well TAV-INJ1 is not necessary during the injection period because the injection is almost a continuous process and the water in the well casing is predominately the injected solution.

Modification #7: Well TAV-MW7 is reverted back to the TA-V groundwater monitoring network (see Section I, 2.1.2) and is administered by the SNL Long-Term Stewardship group along with the other 16 TA-V groundwater monitoring wells. The sampling frequency for TAV-MW7 is quarterly. The analytical parameters for groundwater samples from well TAV-MW7 include the following:

- Bromide
- Dissolved metals (arsenic, iron, and manganese)
- Ethene
- Nitrate plus nitrite (NPN)
- Volatile organic compounds

Modification #8: Eliminate unnecessary analytical parameters for Treatability Study wells. The revised analytical parameters for groundwater samples of the Treatability Study include:

- 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
- NPN
- Total organic carbon
- Volatile organic compounds

2.0 Baseline Sampling for Full-Scale Operation

Baseline sampling was conducted in September 2018 prior to the full-scale operation. Groundwater samples were collected from wells TAV-INJ, TAV-MW6, and TAV-MW7 prior to commencing discharge in well TAV-INJ1 on November 1, 2018. Analytical parameters for baseline sampling are listed above (see *Modification #8*).

Table III-1 provides the analytical results for the September 2018 baseline groundwater sampling events. Table III-2 summarizes the stabilized water quality parameters measured at each well before groundwater samples were collected. Trichloroethene (TCE) and NPN concentrations for the September 2018 samples are discussed below. The remaining analytes in Table III-1 will be discussed in future quarterly reports after sufficient data are acquired for trend analysis to be conducted.

The baseline sample for injection well TAV-INJ1 was collected on September 26, 2018 (Table III-1). This baseline sample had a TCE concentration of 5.6 micrograms per liter (µg/L). NPN was not reported above the detection limit of 0.017 milligrams per liter (mg/L).

The baseline sample for monitoring well TAV-MW6 was collected on September 25, 2018 (Table III-1). This baseline sample had TCE and NPN concentrations of 9.81 µg/L and 8.78 mg/L, respectively. These values are consistent with previous sampling events. An environmental duplicate sample was also collected on September 25, 2018 for well TAV-MW6; the TCE and NPN concentrations, 9.77 µg/L and 8.6 mg/L, respectively, showed good agreement with the environmental sample.

The baseline sample for monitoring well TAV-MW7 was collected on September 24, 2018 (Table III-1). TCE was not reported above the detection limit of 0.3 µg/L. The NPN concentration was 4.29 mg/L. This well is screened approximately 90 feet below the water table.

3.0 Full-Scale Operation Activities

Full-scale operation of the ISB Treatability Study began in October 2018. The treatment solution is designed to enhance the degradation of TCE and nitrate in the Regional Aquifer. The mixing ratio for the treatment solution consists of approximately 99.9 percent potable

water and 0.1 percent amendments. Table III-3 presents the components of the treatment solution that is proposed in Appendix A. Adjustments to the quantities of these components were necessary to provide optimal conditions in the groundwater for the dechlorinating bacteria. Minor adjustments may continue in the future, depending on the groundwater conditions.

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. By December 31, 2018, 29 injections totaling 137,573 gallons of treatment solution were discharged to injection well TAV-INJ1. This was equivalent to approximately 26 percent on the planned injection volume of 530,000 gallons. The average volume of treatment solution per injection was approximately 4,744 gallons.

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. By the end of 2018, a total of 32.9 liters of KB-1 dechlorinating bacteria were injected to the groundwater via well TAV-INJ1.

4.0 Groundwater Monitoring for Full-Scale Operation

Figure III-1 shows the well locations along with the potentiometric surface contours for October 2018. The potentiometric surface indicates that the groundwater flow at TA-V is generally to the west, with localized flow to the south and southwest.

In accordance with NMED HWB August 13, 2018 approval letter for full-scale operation (NMED August 2018) and the Revised TWSP (SNL/NM March 2016), monitoring well TAV-MW6 is to be sampled monthly after the injection starts, well TAV-MW7 is to be sampled quarterly, and no sampling is to be performed at well TAV-INJ1 during injection.

Table III-4 provides the analytical results for the October-December 2018 sampling efforts. Table III-5 summarizes the stabilized water quality parameters measured at each well before groundwater samples were collected. TCE and NPN concentrations in the samples collected during this reporting period (October-December 2018) samples are discussed below. The remaining analytes shown in Table III-4 will be discussed in future quarterly reports after sufficient data are acquired for trend analysis to be conducted.

During the reporting period, monitoring well TAV-MW6 was sampled twice (Table III-4) after injection started on November 1, 2018. The November 20, 2018 sample contained TCE and NPN concentrations of 8.23 µg/L and 7.89 mg/L, respectively. The December 18, 2018 sample for monitoring well TAV-MW6 had TCE and NPN concentrations of 6.49 µg/L and 7.97 mg/L, respectively. These values are consistent with the baseline sampling event.

During the reporting period, monitoring well TAV-MW7 was sampled once (Table III-4). The November 5, 2018 sample for monitoring well TAV-MW7 did not exceed the TCE detection limit (0.3 µg/L). The NPN concentration was 4.07 mg/L. This well is screened approximately 90 feet below the water table. These values are consistent with the baseline sampling event.

Groundwater results from wells TAV-MW6 and TAV-MW7 indicate that the treatment solution injected at TAV-INJ1 has not reached these two wells. Well TAV-MW6 is located within the Treatability Study treatment zone, and change to the groundwater in this well is anticipated. However, no change to the groundwater in well TAV-MW7 is anticipated because the well is screened 90 feet below the groundwater table (NMED August 2018).

In accordance with Section 5.5 of the Revised TSWP, eight wells will be monitored for dissolved iron, manganese, and arsenic on a quarterly basis in order to monitor the impact of treatment solution on groundwater located outside of the Treatability Study treatment zone (SNL/NM March 2016). For the Phase I Treatability Study, the eight wells that are located outside the treatment zone are LWDS-MW1, TAV-MW2, TAV-MW4, TAV-MW8, TAV-MW10, TAV-MW11, TAV-MW12, and TAV-MW14. Table III-6 provides the November sampling results for these eight wells and Table III-7 summarizes the stabilized water quality parameters measured at each well before groundwater samples were collected. All results are consistent with the historical values at these eight wells (SNL/NM June 2018) and there is no change in the groundwater at these wells from the substrate solution injected at TAV-INJ1.

5.0 Deviations

No deviations were encountered with regards to the NMED HWB August 13, 2018 approval letter for full-scale operation (NMED August 2018) or the Revised TWSP (SNL/NM March 2016).

6.0 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.

Figures

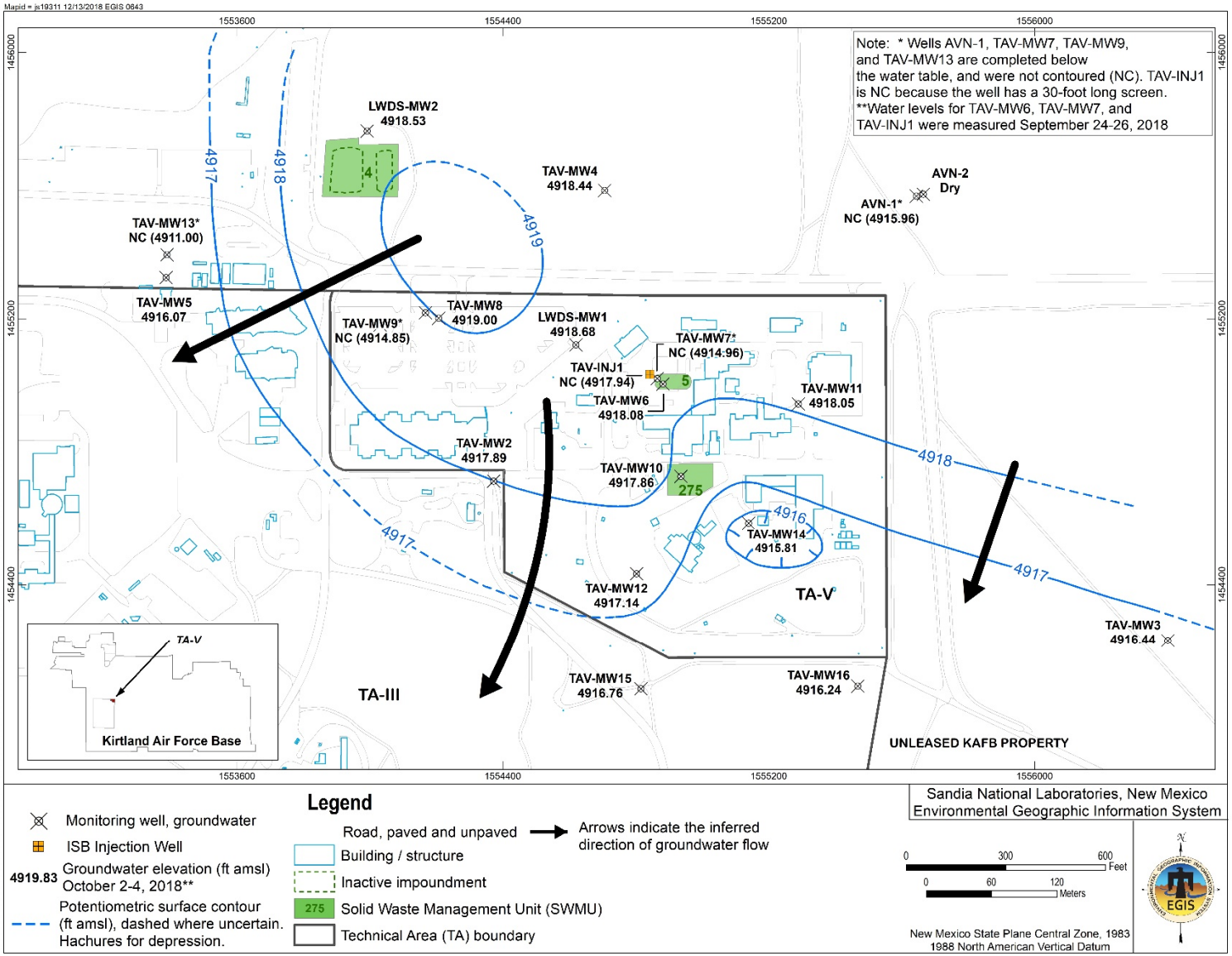

Figure III-1

Well Locations and Potentiometric Surface Contours for October 2018

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Tables

Table III-1
Analytical Results for September 2018 Baseline Groundwater Sampling at Wells TAV-INJ1, TAV-MW6, and TAV-MW7

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-INJ1, sampled on 26-Sep-2018											
Alkalinity	Alkalinity as $CaCO_3$	228	1.45	4	NE	mg/L			106331-006	SM 2320B	GEL
Alkalinity	Alkalinity, bicarb as $CaCO_3$	228	1.45	4	NE	mg/L			106331-006	SM 2320B	GEL
Alkalinity	Alkalinity, carb as $CaCO_3$	ND	1.45	4	NE	mg/L	U		106331-006	SM 2320B	GEL
Ammonia	Ammonia	3.07	0.00625	0.25	NE	mg/L		B	106331-002	EPA 350.1	GEL
Anions	Bromide	7.79	0.335	1	NE	mg/L			106331-004	SW846 9056	GEL
Anions	Sulfate	50.1	0.665	2	NE	mg/L			106331-004	SW846 9056	GEL
Microbial	*Dehalococcoides*	30000	3000	3000	NE	Enumeration/L			106345-001	Gene-Trac Dhc	SiREM
Dissolved Metals	Arsenic	**0.0446**	0.002	0.005	0.010	mg/L			106331-007	SW846 3005/6020	GEL
Dissolved Metals	Arsenic	**0.0468**	0.002	0.005	0.010	mg/L			106331-008*	SW846 3005/6020	GEL
Dissolved Metals	Iron	1.77	0.033	0.1	NE	mg/L			106331-007	SW846 3005/6020	GEL
Dissolved Metals	Iron	1.89	0.033	0.1	NE	mg/L			106331-008*	SW846 3005/6020	GEL
Dissolved Metals	Manganese	6.86	0.001	0.005	NE	mg/L		J	106331-007	SW846 3005/6020	GEL
Dissolved Metals	Manganese	6.71	0.001	0.005	NE	mg/L		J	106331-008*	SW846 3005/6020	GEL
MEE	Methane	260	0.014	0.5	NE	µg/L			106340-001	AM20GAX	PACE
MEE	Ethane	ND	0.0070	0.1	NE	µg/L	U		106340-001	AM20GAX	PACE
MEE	Ethene	0.16	0.0050	0.1	NE	µg/L			106340-001	AM20GAX	PACE
NPN	Nitrate plus nitrite, as nitrogen	ND	0.17	0.5	10	mg/L	U		106331-005	EPA 353.2	GEL
TOC	Total Organic Carbon, average	1.76	0.33	1	NE	mg/L			106331-003	SW846 9060A	GEL
VOC	Trichloroethene	**5.6**	0.3	1	5	µg/L			106331-001	SW846 8260B	GEL
VOC	Dichloroethene, cis-1,2-	1.81	0.3	1	70	µg/L			106331-001	SW846 8260B	GEL

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

Table III-1 (continued)

Analytical Results of September 2018 Baseline Sampling at Wells TAV-INJ1, TAV-MW6, and TAV-MW7

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-MW6, sampled on 25-Sep-2018											
Alkalinity	Alkalinity as $CaCO_3$	194	1.45	4	NE	mg/L			106327-006	SM 2320B	GEL
Alkalinity	Alkalinity, bicarb as $CaCO_3$	194	1.45	4	NE	mg/L			106327-006	SM 2320B	GEL
Alkalinity	Alkalinity, carb as $CaCO_3$	ND	1.45	4	NE	mg/L	U		106327-006	SM 2320B	GEL
Ammonia	Ammonia	ND	0.017	0.05	NE	mg/L	JB	0.5U	106327-002	EPA 350.1	GEL
Anions	Bromide	0.815	0.067	0.2	NE	mg/L			106327-004	SW846 9056	GEL
Anions	Sulfate	42.4	1.33	4	NE	mg/L			106328-004	SW846 9056	GEL
Microbial	*Dehalococcoides*	ND	3000	3000	NE	Enumeration/L	U		106343-001	Gene-Trac Dhc	SiREM
Dissolved Metals	Arsenic	0.00204	0.002	0.005	0.010	mg/L	J		106327-007	SW846 3005/6020	GEL
Dissolved Metals	Arsenic	ND	0.002	0.005	0.010	mg/L	U		106327-008*	SW846 3005/6020	GEL
Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		106327-007	SW846 3005/6020	GEL
Dissolved Metals	Iron	0.047	0.033	0.1	NE	mg/L	J		106328-008*	SW846 3005/6020	GEL
Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		106327-007	SW846 3005/6020	GEL
Dissolved Metals	Manganese	0.00106	0.001	0.005	NE	mg/L	J		106327-008*	SW846 3005/6020	GEL
MEE	Methane	ND	0.014	0.5	NE	µg/L	U		106336-001	AM20GAX	PACE
MEE	Ethane	ND	0.0070	0.1	NE	µg/L	U		106336-001	AM20GAX	PACE
MEE	Ethene	ND	0.0050	0.1	NE	µg/L	U		106336-001	AM20GAX	PACE
NPN	Nitrate plus Nitrite, as nitrogen	8.78	0.17	0.5	10	mg/L			106327-005	EPA 353.2	GEL
TOC	Total Organic Carbon, average	ND	0.33	1	NE	mg/L	J	1.0U	106327-003	SW846 9060A	GEL
VOC	Trichloroethene	**9.81**	0.3	1	5	µg/L			106327-001	SW846 8260B	GEL
VOC	Dichloroethene, cis-1,2-	1.41	0.3	1	70	µg/L			106327-001	SW846 8260B	GEL

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

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-MW6 (Duplicate), collected on 25-Sep-2018											
Alkalinity	Alkalinity as $CaCO_3$	191	1.45	4	NE	mg/L			106328-006	SM 2320B	GEL
Alkalinity	Alkalinity, bicarb as $CaCO_3$	191	1.45	4	NE	mg/L			106328-006	SM 2320B	GEL
Alkalinity	Alkalinity, carb as $CaCO_3$	ND	1.45	4	NE	mg/L	U		106328-006	SM 2320B	GEL
Ammonia	Ammonia	ND	0.017	0.05	NE	mg/L	JB	0.5U	106328-002	EPA 350.1	GEL
Anions	Bromide	0.813	0.067	0.2	NE	mg/L			106328-004	SW846 9056	GEL
Anions	Sulfate	43.4	1.33	4	NE	mg/L			106328-004	SW846 9056	GEL
Dissolved Metals	Arsenic	ND	0.002	0.005	0.010	mg/L	U		106328-007	SW846 3005/6020	GEL
Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		106328-007	SW846 3005/6020	GEL
Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		106328-007	SW846 3005/6020	GEL
NPN	Nitrate plus Nitrite, as nitrogen	8.6	0.17	0.5	10	mg/L			106328-005	EPA 353.2	GEL
TOC	Total Organic Carbon, average	ND	0.33	1	NE	mg/L	J	1.0U	106328-003	SW846 9060A	GEL
VOC	Trichloroethene	**9.77**	0.3	1	5	µg/L			106328-001	SW846 8260B	GEL
VOC	Dichloroethene, cis-1,2-	1.4	0.3	1	70	µg/L			106328-001	SW846 8260B	GEL

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

Table III-1 (continued)
Analytical Results of September 2018 Baseline Sampling at Wells TAV-INJ1, TAV-MW6, and TAV-MW7

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-MW7, sampled on 24-Sep-2018											
Alkalinity	Alkalinity as $CaCO_3$	232	1.45	4	NE	mg/L			106322-004	SM 2320B	GEL
Alkalinity	Alkalinity, bicarb as $CaCO_3$	232	1.45	4	NE	mg/L			106322-004	SM 2320B	GEL
Alkalinity	Alkalinity, carb as $CaCO_3$	ND	1.45	4	NE	mg/L	U		106322-004	SM 2320B	GEL
Anions	Bromide	0.259	0.067	0.2	NE	mg/L			106322-006	SW846 9056	GEL
Anions	Sulfate	64.4	0.665	2	NE	mg/L			106322-002	SW846 9056	GEL
Dissolved Metals	Arsenic	0.00211	0.002	0.005	0.010	mg/L	J		106322-005	SW846 3005/6020	GEL
Dissolved Metals	Arsenic	0.00221	0.002	0.005	0.010	mg/L	J		106322-006*	SW846 3005/6020	GEL
Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		106322-005	SW846 3005/6020	GEL
Dissolved Metals	Iron	0.0713	0.033	0.1	NE	mg/L	J		106322-006*	SW846 3005/6020	GEL
Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		106322-005	SW846 3005/6020	GEL
Dissolved Metals	Manganese	0.00649	0.001	0.005	NE	mg/L			106322-006*	SW846 3005/6020	GEL
MEE	Methane	1.2	0.014	0.5	NE	µg/L		J	106334-001	AM20GAX	PACE
MEE	Ethane	ND	0.007	0.1	NE	µg/L	U	0.1UJ	106334-001	AM20GAX	PACE
MEE	Ethene	ND	0.005	0.1	NE	µg/L	U	0.1UJ	106334-001	AM20GAX	PACE
NPN	Nitrate plus Nitrite, as nitrogen	4.29	0.085	0.25	10	mg/L			106322-003	EPA 353.2	GEL
VOC	Trichloroethene	ND	0.3	1	5	µg/L	U		106322-001	SW846 8260B	GEL
VOC	Dichloroethene, cis-1,2-	ND	0.3	1	70	µg/L	U		106322-001	SW846 8260B	GEL

*split sample.

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

Table III-2
Field Water Quality Measurements[i] before September 2018 Baseline Groundwater Sampling

Well ID	Sample Date	Temperature (°C)	Specific Conductivity (µmhos/cm)	Oxidation-Reduction Potential (mV)	pH	Turbidity (NTU)	Dissolved Oxygen (% Sat)	Dissolved Oxygen (mg/L)
TAV-INJ1	26-Sep-2018	20.81	868.1	-167.1	7.20	1.71	7.58	0.62
TAV-MW6	25-Sep-2018	22.35	734.1	178.0	7.03	1.45	90.3	6.62
TAV-MW7	24-Sep-2018	21.30	656.4	62.6	7.95	1.77	2.86	0.21

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

Table III-3
Substrate Solution Components for Full-Scale Operation

Substrate Solution Component	Function	Mixing Ratio (by weight)	Weight per 1,000 gal of Water	Actual Usage during Full-Scale Operation Mixing Ratio / Weight per 1,000 gal Water
Primary Components				
Ethyl lactate	Electron donor (substrate)	80.4%	5.64 lbs	73.3% / 6.23 lbs
Diammonium phosphate	Nutrient and pH buffer	9.0%	0.63 lbs	7.5% / 0.63 lbs
Accelerite® [a]	Nutrient	6.4%	0.45 lbs	4.6% / 0.39 lbs
Potassium Bicarbonate	Buffer and acid reducer	1.7%	0.11 lbs	8.8% / 0.75 lbs
Sodium Sulfite	Deoxygenation and reduction agent	2.5%	0.17 lbs	5.9% / 0.5 lbs
Primary Components per 1,000 gal of Potable Water		**100%**	**7 lbs**	**100% / 8.5 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.
% = Percent.
gal = Gallon(s).
lbs = Pounds.
pH = Potential of hydrogen (negative logarithm of the hydrogen ion concentration).

Table III-4

Analytical Results of November-December 2018 Groundwater Sampling at Wells TAV-MW6 and TAV-MW7

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-MW6, sampled on 20-Nov-2018											
Alkalinity	Alkalinity as $CaCO_3$	192	1.45	4	NE	mg/L			106716-006	SM 2320B	GEL
Alkalinity	Alkalinity, bicarb as $CaCO_3$	192	1.45	4	NE	mg/L			106716-006	SM 2320B	GEL
Alkalinity	Alkalinity, carb as $CaCO_3$	ND	1.45	4	NE	mg/L	U		106716-006	SM 2320B	GEL
Ammonia	Ammonia	ND	0.017	0.05	NE	mg/L	U		106716-002	EPA 350.1	GEL
Anions	Bromide	0.85	0.067	2	NE	mg/L			106716-004	SW846 9056	GEL
Anions	Sulfate	45	0.665	4	NE	mg/L			106716-004	SW846 9056	GEL
Microbial	*Dehalococcoides*	ND	3000	3000	NE	Enumeration/L	U		106720-001	Gene-Trac Dhc	SiREM
Dissolved Metals	Arsenic	0.00256	0.002	0.005	0.010	mg/L	J		106716-007	SW846 3005/6020	GEL
Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		106716-007	SW846 3005/6020	GEL
Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		106716-007	SW846 3005/6020	GEL
MEE	Methane	ND	0.099	0.5	NE	µg/L	U	0.5UJ	106719-001	AM20GAX	PACE
MEE	Ethane	ND	0.009	0.1	NE	µg/L	U	0.1UJ	106719-001	AM20GAX	PACE
MEE	Ethene	ND	0.005	0.1	NE	µg/L	U	0.1UJ	106719-001	AM20GAX	PACE
NPN	Nitrate plus Nitrite, as nitrogen-	7.89	0.17	0.5	10	mg/L			106716-005	EPA 353.2	GEL
TOC	Total Organic Carbon, average	0.459	0.33	1	NE	mg/L	J		106716-003	SW846 9060A	GEL
VOC	Trichloroethene	**8.23**	0.3	1	5	µg/L			106716-001	SW846 8260B	GEL
VOC	Dichloroethene, cis-1,2-	1.12	0.3	1	70	µg/L			106716-001	SW846 8260B	GEL

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

Table III-4 (continued)
Analytical Results of November-December 2018 Groundwater Sampling at Wells TAV-MW6 and TAV-MW7

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-MW6, sampled on 18-Dec-2018											
Alkalinity	Alkalinity as $CaCO_3$	198	1.45	4	NE	mg/L			106893-006	SM 2320B	GEL
Alkalinity	Alkalinity, bicarb as $CaCO_3$	198	1.45	4	NE	mg/L			106893-006	SM 2320B	GEL
Alkalinity	Alkalinity, carb as $CaCO_3$	ND	1.45	4	NE	mg/L	U		106893-006	SM 2320B	GEL
Ammonia	Ammonia	ND	0.017	0.05	NE	mg/L	JB	0.5U	106893-002	EPA 350.1	GEL
Anions	Bromide	0.925	0.067	0.2	NE	mg/L			106893-004	SW846 9056	GEL
Anions	Sulfate	46.7	1.33	4	NE	mg/L			106893-004	SW846 9056	GEL
Microbial	*Dehalococcoides*	ND	3000	3000	NE	Enumeration/L	U		106897-00	Gene-Trac Dhc	SiREM
Dissolved Metals	Arsenic	0.00265	0.002	0.005	0.010	mg/L	J		106893-007	SW846 3005/6020	GEL
Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		106893-007	SW846 3005/6020	GEL
Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		106893-007	SW846 3005/6020	GEL
MEE	Methane	ND	0.099	0.5	NE	µg/L	U	0.5UJ	106896-001	AM20GAX	PACE
MEE	Ethane	ND	0.009	0.1	NE	µg/L	U	0.1UJ	106896-001	AM20GAX	PACE
MEE	Ethene	ND	0.005	0.1	NE	µg/L	U	0.1UJ	106896-001	AM20GAX	PACE
NPN	Nitrate plus Nitrite, as nitrogen	7.97	0.17	0.5	10	mg/L			106893-005	EPA 353.2	GEL
TOC	Total Organic Carbon, average	ND	0.33	1	NE	mg/L	J	1.0U	106893-003	SW846 9060A	GEL
VOC	Trichloroethene	**6.49**	0.3	1	5	µg/L			106893-001	SW846 8260B	GEL
VOC	Dichloroethene, cis-1,2-	0.84	0.3	1	70	µg/L	J		106893-001	SW846 8260B	GEL

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

Table III-4 (continued)
Analytical Results of November-December 2018 Groundwater Sampling at Wells TAV-MW6 and TAV-MW7

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-MW7, sampled on 5-Nov-2018											
Anions	Bromide	0.249	0.067	0.2	NE	mg/L			106653-001	SW846 9056	GEL
Dissolved Metals	Arsenic	0.00319	0.002	0.005	0.010	mg/L	J		106659-003	SW846 3005/6020	GEL
Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		106659-003	SW846 3005/6020	GEL
Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		106659-003	SW846 3005/6020	GEL
MEE	Ethene	0.14	0.005	0.1	NE	µg/L		J	106657-001	AM20GAX	PACE
NPN	Nitrate plus Nitrite, as nitrogen	4.07	0.17	0.5	10	mg/L			106559-002	EPA 353.2	GEL
VOC	Trichloroethene	ND	0.3	1	5	µg/L	U		106659-001	SW846 8260B	GEL
VOC	Dichloroethene, cis-1,2-	ND	0.3	1	70	µg/L	U		106659-001	SW846 8260B	GEL

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

Table III-5

Field Water Quality Measurements[i] before November-December 2018 Groundwater Sampling at Wells TAV-MW-6 and TAV-MW-7

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	20-Nov-2018	19.44	591.0	29.9*	11.01*	1.49	90.6	7.71
TAV-MW6	18-Dec-2018	19.75	729.3	150.6	7.47	0.90	81.8	5.95
TAV-MW7	5-Nov-2018	20.26	631.3	149.7	7.39	3.25	3.01	0.22

*Suspect value due to Microsoft Surface laptop interference with the instrumentation sonde. The oxidation-reduction potential was 101.8 mV and pH was 7.47, consistent with historical values, after switching to a Dell laptop.

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

Table III-6
Analytical Results of November 2018 Groundwater Sampling
at Wells LWDS-MW1, TAV-MW2, TAV-MW4, TAV-MW8, TAV-MW10, TAV-MW11, TAV-MW12, and TAV-MW14

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 sampled on 19 Nov 2018											
Dissolved Metals	Arsenic	0.00412	0.002	0.005	0.010	mg/L	J		106682-003	SW846 3005/6020	GEL
Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		106682-003	SW846 3005/6020	GEL
Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		106682-003	SW846 3005/6020	GEL
NPN	Nitrate plus Nitrite, as nitrogen	11.9	0.17	0.5	10	mg/L			106682-002	EPA 353.2	GEL
VOC	Acetone	3.61	1.50	10	NE	µg/L	J		106682-001	SW846 8260B	GEL
VOC	Trichloroethene	**16.8**	0.3	1	5	µg/L			106682-001	SW846 8260B	GEL
VOC	Dichloroethene, cis-1,2-	3.47	0.3	1	70	µg/L			106682-001	SW846 8260B	GEL
TAV-MW2 sampled on 6 Nov 2018											
Dissolved Metals	Arsenic	0.00301	0.002	0.005	0.010	mg/L	J		106665-003	SW846 3005/6020	GEL
Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		106665-003	SW846 3005/6020	GEL
Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		106665-003	SW846 3005/6020	GEL
NPN	Nitrate plus Nitrite, as nitrogen	4.78	0.085	0.250	10	mg/L			106665-002	EPA 353.2	GEL
VOC	Trichloroethene	3.18	0.3	1	5	µg/L			106665-001	SW846 8260B	GEL
VOC	Dichloroethene, cis-1,2-	ND	0.3	1	70	µg/L			106665-001	SW846 8260B	GEL
TAV-MW2 (duplicate) sampled on 6 Nov 2018											
Dissolved Metals	Arsenic	0.00327	0.002	0.005	0.010	mg/L	J		106666-003	SW846 3005/6020	GEL
Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		106666-003	SW846 3005/6020	GEL
Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		106666-003	SW846 3005/6020	GEL
NPN	Nitrate plus Nitrite, as nitrogen	4.71	0.085	0.250	10	mg/L			106666-002	EPA 353.2	GEL
VOC	Trichloroethene	3.27	0.3	1	5	µg/L			106666-001	SW846 8260B	GEL
VOC	Dichloroethene, cis-1,2-	ND	0.3	1	70	µg/L	U		106666-001	SW846 8260B	GEL
TAV-MW4 sampled on 8 Nov 2018											
Dissolved Metals	Arsenic	0.00316	0.002	0.005	0.010	mg/L	J		106670-003	SW846 3005/6020	GEL
Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		106670-003	SW846 3005/6020	GEL
Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		106670-003	SW846 3005/6020	GEL
NPN	Nitrate plus Nitrite, as nitrogen	4.67	0.0850	0.250	10	mg/L			106670-002	EPA 353.2	GEL
VOC	Acetone	1.60	1.50	10	NE	µg/L	J, N	J-	106670-001	SW846 8260B	GEL
VOC	Chloroform	0.870	0.3	1	NE	µg/L	J		106670-001	SW846 8260B	GEL
VOC	Trichloroethene	4.54	0.3	1	5	µg/L			106670-001	SW846 8260B	GEL
VOC	Dichloroethene, cis-1,2-	0.350	0.3	1	70	µg/L	J		106670-001	SW846 8260B	GEL
TAV-MW8 sampled on 9 Nov 2018											
Dissolved Metals	Arsenic	0.00289	0.002	0.005	0.010	mg/L	J		106672-003	SW846 3005/6020	GEL
Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		106672-003	SW846 3005/6020	GEL
Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		106672-003	SW846 3005/6020	GEL
NPN	Nitrate plus Nitrite, as nitrogen	6.36	0.170	0.5	10	mg/L			106672-002	EPA 353.2	GEL
VOC	Trichloroethene	4.80	0.3	1	5	µg/L			106672-001	SW846 8260B	GEL
VOC	Dichloroethene, cis-1,2-	0.480	0.3	1	70	µg/L	J		106672-001	SW846 8260B	GEL

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

Table III-6 (continued)
Analytical Results of November 2018 Groundwater Sampling
at Wells LWDS-MW1, TAV-MW2, TAV-MW4, TAV-MW8, TAV-MW10, TAV-MW11, TAV-MW12, and TAV-MW14

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-MW10 sampled on 26 Nov 2018											
Dissolved Metals	Arsenic	0.00297	0.002	0.005	0.010	mg/L	J		106685-003	SW846 3005/6020	GEL
Dissolved Metals	Iron	0.0442	0.033	0.1	NE	mg/L	J		106685-003	SW846 3005/6020	GEL
Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		106685-003	SW846 3005/6020	GEL
NPN	Nitrate plus Nitrite, as nitrogen	**11.4**	0.170	0.5	10	mg/L			106685-002	EPA 353.2	GEL
VOC	Acetone	ND	1.50	10	NE	µg/L	J	10UJ	106685-001	SW846 8260B	GEL
VOC	Trichloroethene	**9.72**	0.3	1	5	µg/L			106685-001	SW846 8260B	GEL
VOC	Dichloroethene, cis-1,2-	1.59	0.3	1	70	µg/L			106685-001	SW846 8260B	GEL
TAV-MW11 sampled on 7 Nov 2018											
Dissolved Metals	Arsenic	0.00287	0.002	0.005	0.010	mg/L	J		106668-003	SW846 3005/6020	GEL
Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		106668-003	SW846 3005/6020	GEL
Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		106668-003	SW846 3005/6020	GEL
NPN	Nitrate plus Nitrite, as nitrogen	6.67	0.170	0.500	10	mg/L			106668-002	EPA 353.2	GEL
VOC	Trichloroethene	3.33	0.3	1	5	µg/L			106668-001	SW846 8260B	GEL
VOC	Dichloroethene, cis-1,2-	0.340	0.3	1	70	µg/L	J		106688-001	SW846 8260B	GEL
TAV-MW12 sampled on 13 Nov 2018											
Dissolved Metals	Arsenic	0.0025	0.002	0.005	0.010	mg/L	J		106674-003	SW846 3005/6020	GEL
Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		106674-003	SW846 3005/6020	GEL
Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		106674-003	SW846 3005/6020	GEL
NPN	Nitrate plus Nitrite, as nitrogen	6.58	0.170	0.500	10	mg/L			106674-002	EPA 353.2	GEL
VOC	Acetone	2.97	1.50	10	NE	µg/L	J		106674-001	SW846 8260B	GEL
VOC	Trichloroethene	3.87	0.3	1	5	µg/L			106674-001	SW846 8260B	GEL
VOC	Dichloroethene, cis-1,2-	ND	0.3	1	70	µg/L	U		106674-001	SW846 8260B	GEL
TAV-MW14 sampled on 14 Nov 2018											
Dissolved Metals	Arsenic	0.0027	0.002	0.005	0.010	mg/L	J		106678-003	SW846 3005/6020	GEL
Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		106678-003	SW846 3005/6020	GEL
Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		106678-003	SW846 3005/6020	GEL
NPN	Nitrate plus Nitrite, as nitrogen	7.91	0.170	0.500	10	mg/L			106678-002	EPA 353.2	GEL
VOC	Trichloroethene	4.59	0.3	1	5	µg/L			106678-001	SW846 8260B	GEL
VOC	Dichloroethene, cis-1,2-	0.420	0.3	1	70	µg/L	J		106678-001	SW846 8260B	GEL
TAV-MW14 (duplicate) sampled on 14 Nov 2018											
Dissolved Metals	Arsenic	0.00279	0.002	0.005	0.010	mg/L	J		106679-003	SW846 3005/6020	GEL
Dissolved Metals	Iron	ND	0.033	0.1	NE	mg/L	U		106679-003	SW846 3005/6020	GEL
Dissolved Metals	Manganese	ND	0.001	0.005	NE	mg/L	U		106679-003	SW846 3005/6020	GEL
NPN	Nitrate plus Nitrite, as nitrogen	7.76	0.170	0.5	10	mg/L			106679-002	EPA 353.2	GEL
VOC	Acetone	3.24	1.50	10	NE	µg/L	J		106679-001	SW846 8260B	GEL
VOC	Trichloroethene	4.57	0.3	1	5	µg/L			106679-001	SW846 8260B	GEL
VOC	Dichloroethene, cis-1,2-	0.410	0.3	1	70	µg/L	J		106679-001	SW846 8260B	GEL

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

Table III-7
Field Water Quality Measurements[i] before November 2018 Groundwater Sampling
at Wells LWDS-MW1, TAV-MW2, TAV-MW4, TAV-MW8, TAV-MW10, TAV-MW11, TAV-MW12, and TAV-MW14

Well ID	Sample Date	Temperature (°C)	Specific Conductivity (µmhos/cm)	Oxidation Reduction Potential (mV)	pH	Turbidity (NTU)	Dissolved Oxygen (% Sat)	Dissolved Oxygen (mg/L)
LWDS-MW1	19-Nov-18	15.79	666.7	142.5	7.20	1.07	97.1	8.72
TAV-MW2	06-Nov-18	19.06	718.6	175.1	7.32	2.29	77.9	6.20
TAV-MW4	08-Nov-18	20.11	553.0	155.6	7.53	0.30	88.9	7.02
TAV-MW8	09-Nov-18	18.68	634.5	122.7	7.47	1.74	83.9	6.86
TAV-MW10	26-Nov-18	19.06	651.2	84.1	7.59	0.47	88.9	7.48
TAV-MW11	07-Nov-18	20.78	630.0	105.8	7.51	0.54	89.3	6.97
TAV-MW12	13-Nov-18	14.77	575.3	210.1	7.61	1.02	82.4	7.34
TAV-MW14	14-Nov-18	19.71	698.7	88.4	7.52	2.17	88.1	7.15

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

Footnotes for Technical Area-V Analytical Results Tables

% = Percent.
$CaCO_3$ = Calcium carbonate.Dhc = *Dehalococcoides*.
EPA = U.S. Environmental Protection Agency.
ID = Identifier.
INJ = Injection (acronym used for well identification only).
LWDS = Liquid waste disposal system (acronym used for well identification only).
µg/L = Micrograms per liter.
mg/L = Milligrams per liter.
MEE = Methane, ethane, ethene.
MW = Monitoring well (acronym used for well identification only).
No. = Number.
NPN = Nitrate plus nitrite, as nitrogen.
TAV = Technical Area-V (acronym used for well identification only).
TOC = Total organic carbon.
VOC = Volatile organic compound.

[a]Result
Detected VOCs are presented in the tables.
Bold = Value exceed the established MCL.
ND = Not detected (at 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.

B = The analyte was found in the blank above the effective MDL.
J = The associated value is an estimated quantity.
J- = Estimated value with a suspected negative bias.
U = The analyte was analyzed for but was not detected. The associated numerical value is the sample quantitation limit.
UJ = The analyte was analyzed for but was not detected. The associated value is an estimate and may be inaccurate or imprecise.

[g]Analytical Method

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

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

EPA, 1986, (and updates), "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," SW-846, 3rd ed.

EPA, 1984, "Methods for Chemical Analysis of Water and Wastes." EPA 600-4-79-020.

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.
Gal = Gallon.
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

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:
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Paul Shoemaker, SNL/NM
Christi Leigh, SNL/NM
John Cochran, SNL/NM
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Howard Huie, DOE/EM-31
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Thomas Longo, NNSA/NA-533
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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.

Signature

Date July 10, 2018

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

and

Signature

Date 7/23/2018

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.

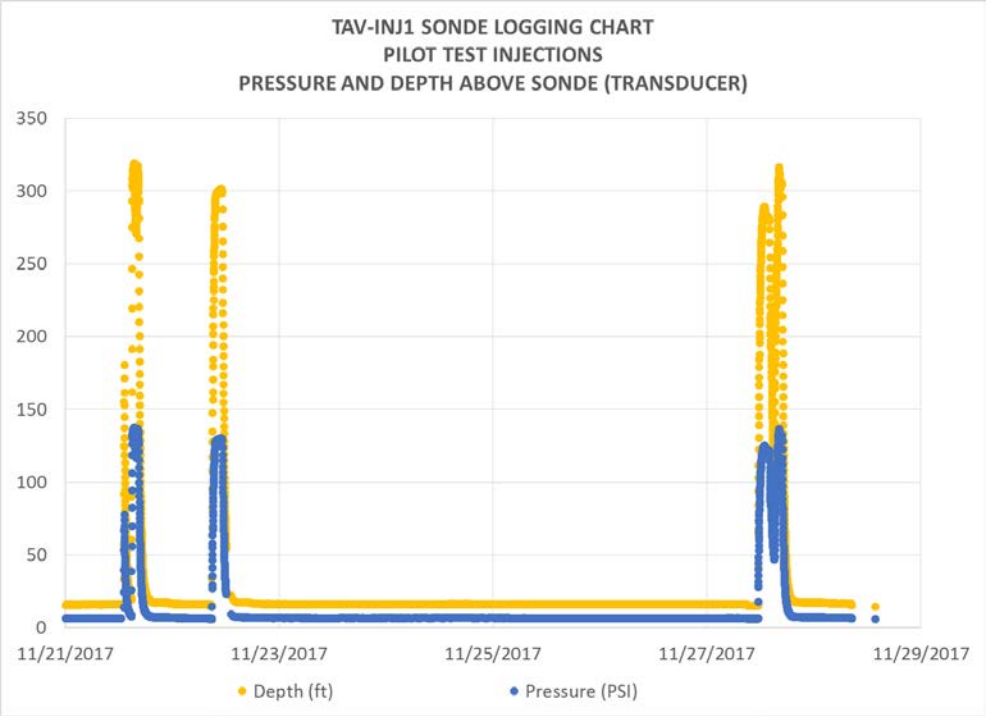

Figure 1a
Pressure and Water Column Height in well TAV-INJ1 during Injections

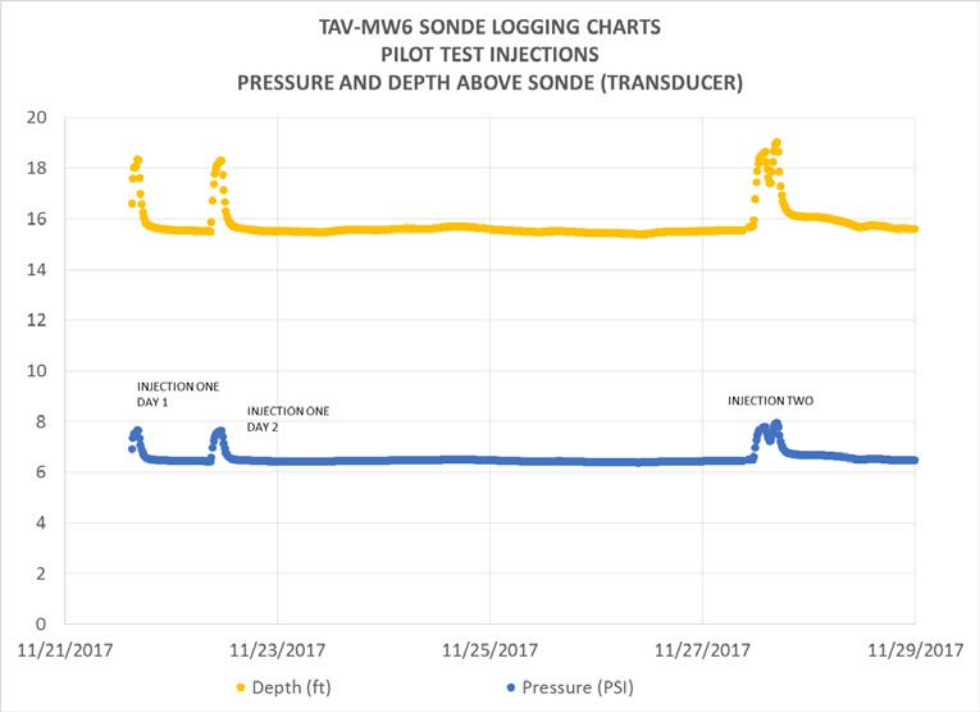

Figure 1b
Pressure and Water Column Height in well TAV-MW6 in
Response to Injections at well TAV-INJ1

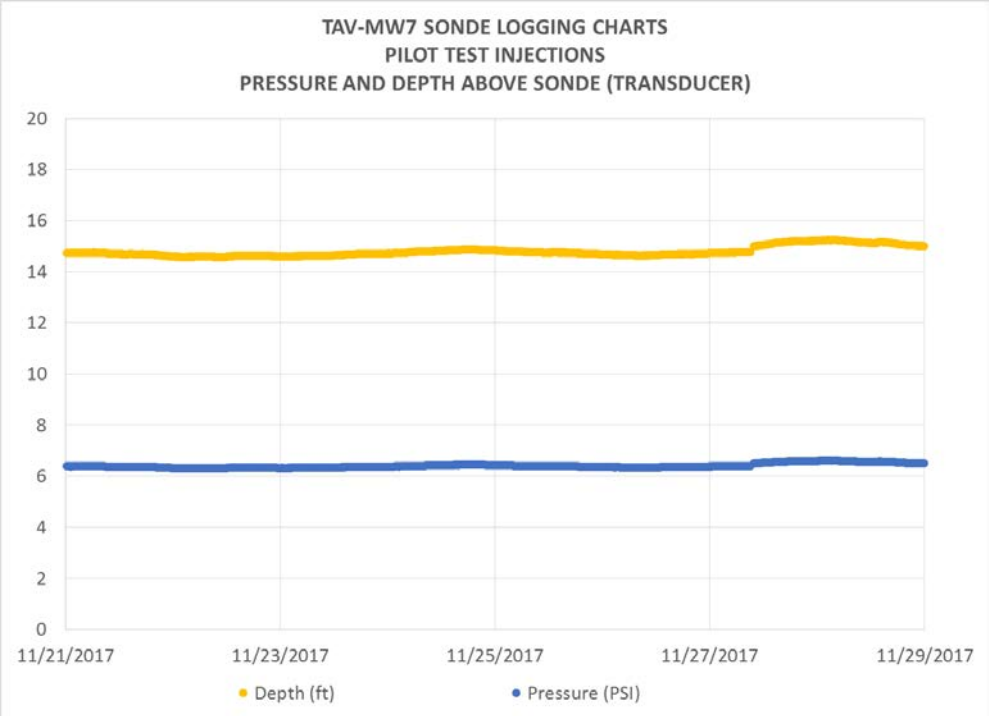

Figure 1c
Pressure and Water Column Height in well TAV-MW7 in
Response to Injections at well TAV-INJ1

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.

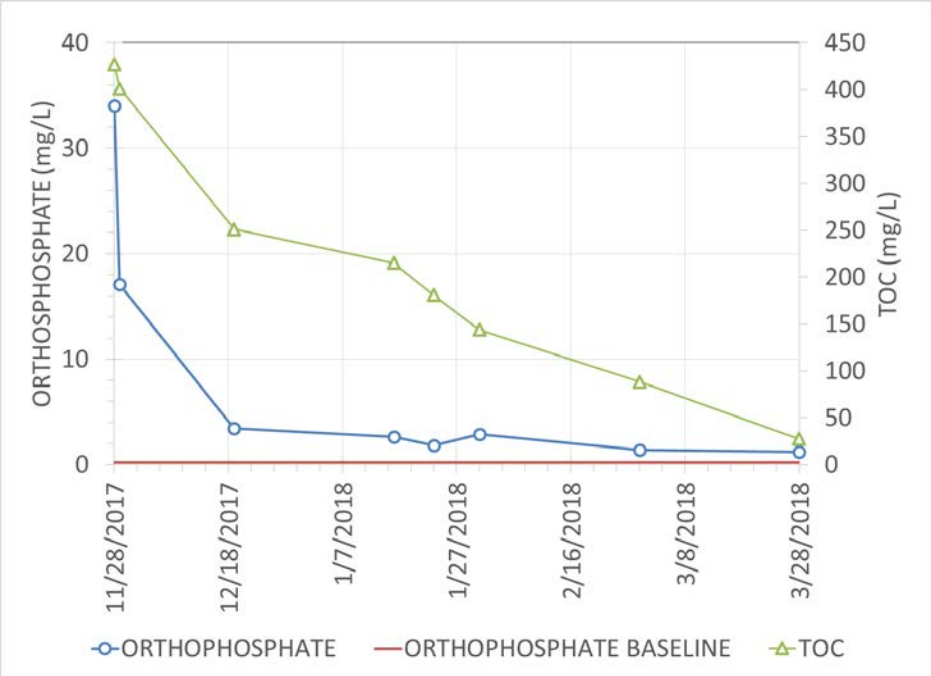

Figure 2
Orthophosphate and TOC Concentrations at TAV-INJ1 following Pilot Test Injections

- 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