LMS/RBL/S31893

2020 Long-Term Hydrologic Monitoring Program Report for Rio Blanco, Colorado, Site

April 2021

U.S. DEPARTMENT OF ENERGY | Legacy Management

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Abbreviations

CDPHE	Colorado Department of Public Health and Environment
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ft	feet
GEMS	Geospatial Environmental Mapping System
LM	Office of Legacy Management
LTHMP	Long-Term Hydrologic Monitoring Program
pCi/L	picocuries per liter
SAP	Sampling and Analysis Plan

1.0 Introduction

This report presents the monitoring data collected by the U.S. Department of Energy (DOE) Office of Legacy Management (LM) at the Rio Blanco, Colorado, Site (Figure 1). The Rio Blanco site was the location of an underground nuclear test in 1973, during which three nuclear devices were detonated nearly simultaneously in a single borehole at depths of 5840, 6230, and 6690 feet (ft) (DOE 2015). The test resulted in residual radionuclide contamination in the area of the detonations. This 2020 sampling event included the collection of samples from the groundwater wells onsite to monitor for any potential contamination that may be attributed to the Rio Blanco nuclear test activities. The report summarizes the laboratory results obtained from this sampling event along with the historical results since monitoring began in the 1970s. This annual report and previous reports are available on the LM public website at https://www.lm.doe.gov/rio_blanco/Sites.aspx. Data collected during this and previous monitoring events are available on the Geospatial Environmental Mapping System (GEMS) website at https://gems.lm.doe.gov/#site=RBL.

2.0 Site Location and Background

The Rio Blanco site is in the Piceance Basin of western Colorado and is 50 miles north of Grand Junction, Colorado (Figure 1). The U.S. Atomic Energy Commission (a predecessor agency to DOE) conducted the underground nuclear test in partnership with the nuclear engineering firm CER Geonuclear Corporation and Continental Oil Company (Conoco). The test was called Project Rio Blanco and was designed to evaluate the use of a nuclear detonation to enhance natural gas production in low-permeability, gas-bearing sandstones of the Williams Fork and Fort Union Formations. It was the third and final natural-gas-reservoir stimulation test in the Plowshare Program, which was designed to develop peaceful uses for nuclear energy.

The three nuclear devices used at the Rio Blanco site were detonated nearly simultaneously in the RB-E-01 emplacement hole at depths of 5840, 6230, and 6690 ft on May 17, 1973. Each device had a reported yield of 33 kilotons (DOE 2015), which produced extremely high temperatures that vaporized a volume of rock, temporarily creating a cavity at each depth (Toman 1975). The fractured rock above each cavity collapsed shortly after the detonation, forming a rubble-filled cavity and a collapse chimney that extends above each detonation point. Each former cavity and collapse chimney, and the surrounding fractured rock, are together referred to as the detonation zone. It was expected that the collapse chimneys created by the detonation would be connected, allowing for improved gas production within the detonation zone (Toman 1975). Reentry wells were drilled into two of the collapse chimneys and tested to determine the success of the nuclear test at improving natural gas production. The first reentry well (RB-AR-1) was a sidetrack hole off the RB-E-01 emplacement hole that was drilled into the upper chimney. The second reentry well (RB-AR-2) was drilled into the lower chimney and tested to determine the success of the detonations at creating a continuous chimney and improving gas productivity. It was determined that the simultaneous detonations failed to create a single elongated interconnected chimney based on tracers included with each device. Additionally, production testing on the reentry wells did not indicate significant increases in productivity from the formation. Results of the testing are summarized in the *Modeling of Flow and Transport Induced by Gas Production Wells near the Project Rio Blanco Site, Piceance Basin, Colorado* (DOE 2013).

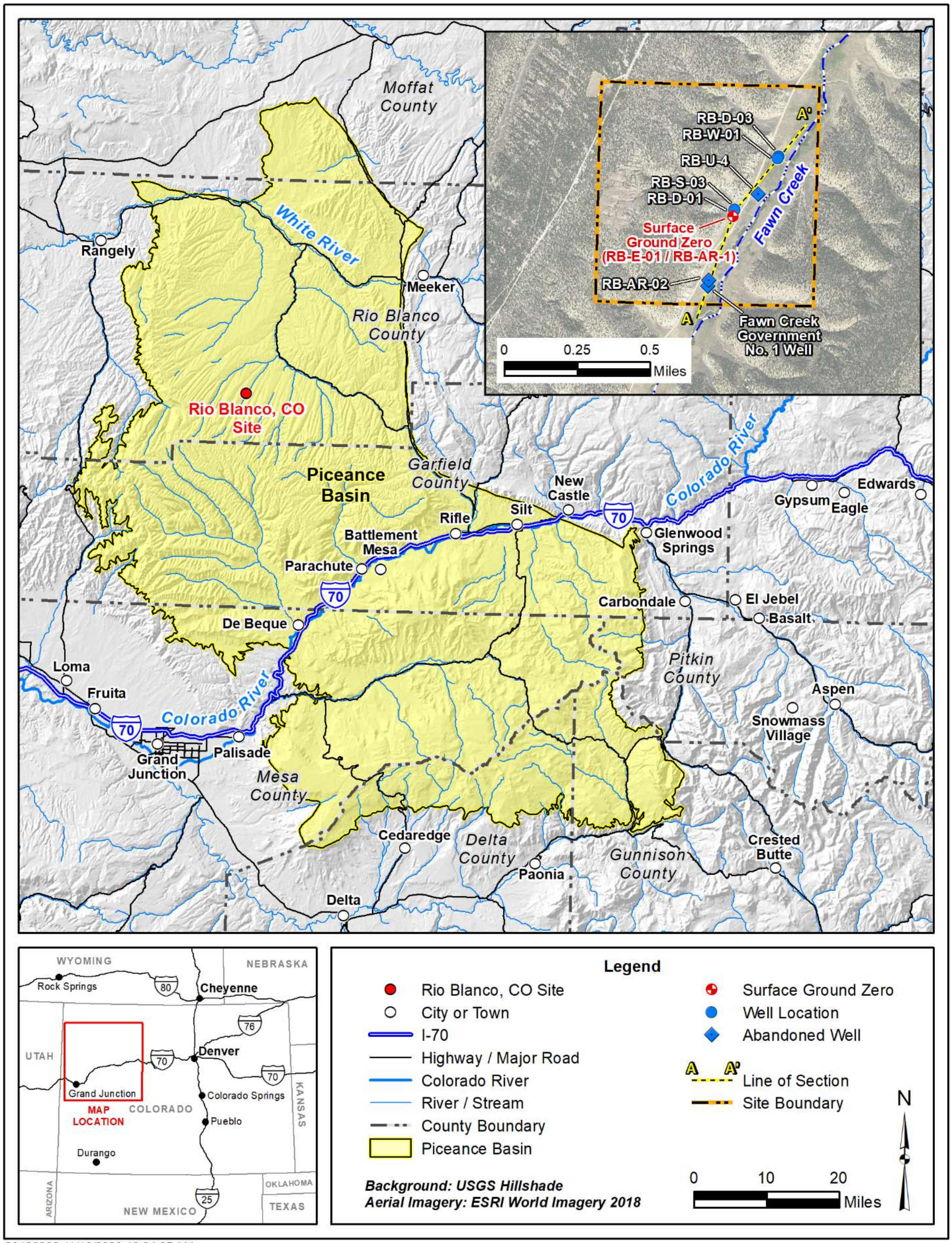

Figure 1. Site Location Map, Rio Blanco, Colorado, Site

Site decommissioning and cleanup activities were initiated in May 1976. These activities included the removal of facility structures and surface liquid waste generated during the test, disposal of liquid waste into the Fawn Creek Government No. 1 well, and restoration of the site surface. Liquid waste injected into the Fawn Creek Government No. 1 well was pumped through perforations in the well between depths of 5600 to 6100 ft. After disposal of the liquid waste was completed, the Fawn Creek Government No. 1 well was recompleted as a gas production well having perforated depths at a shallower interval from 5084 to 5126 ft (ERDA 1978). The RB-E-01 emplacement well, reentry wells RB-AR-1 and RB-AR-2, and wells not planned for long-term monitoring were plugged and abandoned, and the cleanup was completed in November 1976 (ERDA 1978). The Fawn Creek Government No. 1 well was plugged and abandoned in 1986. Figure 2 is a cross section of the Piceance Basin and Rio Blanco site that shows the former gas production wells that were plugged and abandoned, the groundwater wells that were maintained for long-term monitoring near the site, and a schematic of the detonation zone that is not to scale.

A corrective action investigation and risk assessment were completed for the surface of the site in 2002. The investigation determined that no gamma-emitting radionuclides above background levels were present in the site soil or groundwater. Lead and total petroleum hydrocarbons in the form of diesel-range organics above screening levels established during the investigation were found in some of the soil samples collected below a depth of 12 ft; however, the risk assessment concluded that they were not present in sufficient quantities to pose a risk to human health. Groundwater samples collected in 2002 showed no contaminants of concern above the screening levels. The report recommended that no corrective actions be required and that no surface use restrictions be placed on the site (NNSA 2002). The Colorado Department of Public Health and Environment (CDPHE) reviewed and approved the report in 2003 (Stoner 2003).

2.1 Source of Contamination

Surface and subsurface contamination resulted from the underground Rio Blanco nuclear test. The surface cleanup was approved with no further action by CDPHE in 2003. Subsurface contamination remains in the detonation zone near the RB-E-01 emplacement hole, which includes the former cavities, collapse chimneys, and fractured rock surrounding the former cavities (Figure 2). The detonation zone is contaminated by residual radioactive isotopes, with the high-melting-point radionuclides trapped in the solidified melt rock (often referred to as melt glass due to its glassy texture) at the bottom of the former cavities. The radionuclides incorporated in the melt rock can only be released to groundwater very slowly through dissolution of the melt rock (e.g., Tompson et al. 1999; Pawloski et al. 2001). Though dissolution of radionuclides from melt rock can represent a long-term source of subsurface contamination, dissolved-phase transport of radionuclides away from the detonation zone is considered insignificant, because the rock surrounding the former cavities and collapse chimneys is unsaturated with respect to groundwater. The presence of gas in the surrounding formations also severely limits liquid movement, making any solidified radionuclides that may have dissolved in the former cavities essentially immobile.

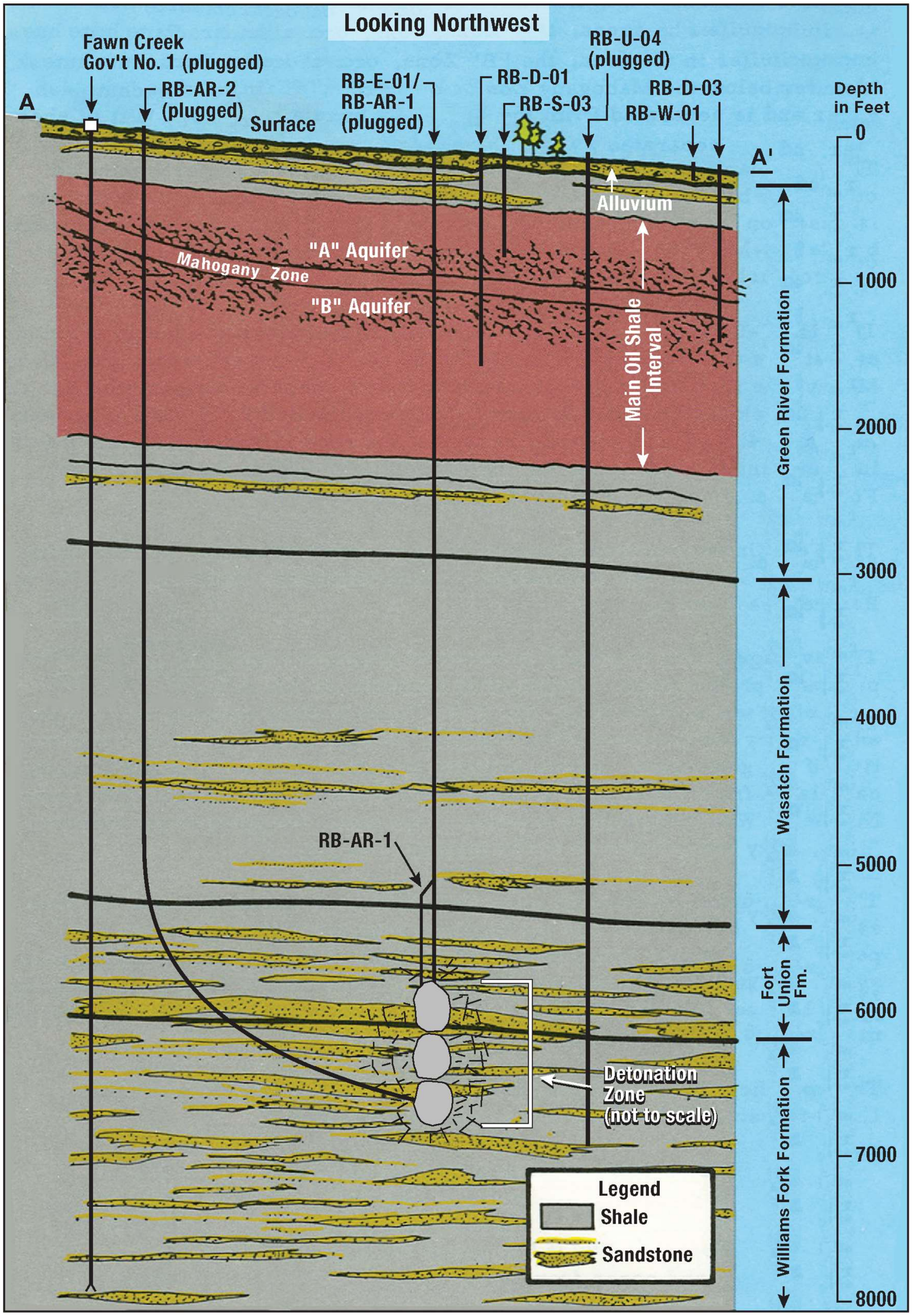

Figure 2. Cross Section of the Piceance Basin and Rio Blanco, Colorado, Site

The primary contaminants of concern are expected to be those radionuclides that can exist in the gas phase, because the gas phase is much more mobile than liquids in the gas-producing reservoirs of the Fort Union and Williams Fork Formations. Of the radionuclides that can exist in the gas phase, tritium and krypton-85 are expected to constitute most of the gaseous radioactivity (Toman 1974). An evaluation of the data obtained from the production testing in 1973 and 1974 indicates that significant quantities of tritium and krypton-85 remain in the detonation zone (DOE 2013). Tritium is the most abundant and considered the greater risk due to its ability to be incorporated into the body, whereas krypton-85 is a noble gas and is not as easily retained in the body (ANL 2007). Since tritium has the greatest health risk and is the most abundant radionuclide remaining in the detonation zone that can be present in the gas and aqueous phases, it is the primary radionuclide of concern at the Rio Blanco site.

2.2 Geologic Setting

The detonations took place in the Fort Union Formation and upper part of the Williams Fork Formation (Figure 2). The Williams Fork Formation is the primary gas-producing zone within the Piceance Basin, which is a northwest-southeast-oriented structure about 100 miles long and 40−50 miles wide, where more than 20,000 ft of sedimentary rocks were deposited. The Colorado River divides the Piceance Basin into a northern and southern province (Figure 1). The Rio Blanco site is in the northern province—the portion of the Piceance Basin between the Colorado and White Rivers—which still retains basinlike features, with rocks dipping inward from the margins toward the deepest part of the basin at the northern end (MacLachlan 1987).

The Fort Union and Williams Fork Formations are encountered at depths of 5330 and 6160 ft at the site, respectively (ERDA 1975). The Williams Fork Formation is composed of low-permeability, discontinuous, interbedded fluviodeltaic sandstones and shales. These sandstones vary in clay content; the cleaner sandstones (less clay) in the lower two-thirds of the formation have recently been the main targets for hydrofracturing and natural gas production. Sandstones in the upper one-third of the Williams Fork are not production targets due to their higher water content, which lowers the relative permeability of the gas phase and causes water production to be excessive compared to the amount of gas that can be produced. This was seen in the gas well production testing data obtained at the Rio Blanco site (DOE 2013). It is also supported by the limited number of natural gas wells in production at the depth of the detonation near the Rio Blanco site. A more detailed description of natural gas production near the Rio Blanco site is provided in the *Modeling of Flow and Transport Induced by Gas Production Wells near the Project Rio Blanco Site, Piceance Basin, Colorado* (DOE 2013).

2.2.1 Site Hydrology

Fawn Creek is the dominant surface water feature on the site (Figure 1). It is a spring-fed perennial stream that receives much of its water from snowmelt and precipitation (USGS 1972). It flows across the site from the south to the northeast and is approximately 300 ft from the RB-E-01 emplacement well (also referred to as surface ground zero), which was later recompleted as the RB-AR-1 reentry well before it was plugged and abandoned in 1976. Fawn Creek discharges into Black Sulphur Creek and then Piceance Creek before it reaches the White River.

Groundwater is encountered at the site in the surficial deposits (shallow alluvium <150 ft thick) and the underlying Green River Formation (approximately 2800 ft thick). The alluvial aquifer is present in the stream valleys and generally consists of sand, gravel, and clay eroded from the Uinta siltstone. The alluvial aquifer is reported as having the highest transmissivity of all rocks in the basin and yields as much as 1500 gallons per minute (USGS 1972). The Green River Formation has two water-bearing zones, an upper aquifer (Zone A or Aquifer A) and a lower zone (Zone B or Aquifer B). These aquifers are separated by the Mahogany Zone (Figure 2), which acts as an aquitard, separating the upper zone from the lower aquifer zone (USGS 1972). Groundwater flow in the shallow alluvium and the dual A/B aquifer system is generally to the east-northeast, which is consistent with the topography in the area. Groundwater in the deeper formations (Wasatch and Fort Union) is too brackish to be considered a useable water source.

The natural gas wells near the site produce some liquids along with natural gas. The liquids (produced water and hydrocarbon condensate) are brought to the surface with the natural gas and mechanically separated at the wellhead. Produced water is a mixture of water vapor in the natural gas that condenses at the surface, formation water, and remnant water from hydrofracturing well development. The produced water is high in total dissolved solids and is not a useable water source.

2.3 Previous Monitoring Program

Groundwater and surface water surrounding the site has been monitored since 1973. This sampling was included in the Long-Term Hydrologic Monitoring Program (LTHMP) in 1976 to assure the public that no radiological contamination associated with the Rio Blanco underground nuclear test has impacted the sample locations near the site. The U.S. Environmental Protection Agency (EPA) performed the LTHMP sampling from the program's inception through 2007. In 2008, LM assumed responsibility for the sampling and conducted a review of all previous LTHMP data to evaluate the effectiveness of the monitoring program. Laboratory results show that Rio Blanco nuclear-test-related contamination has not impacted groundwater or surface water at the sampled locations. The evaluation considered the depth of the detonation and the potential transport pathways for contaminant migration from the detonation zone. It was concluded from this evaluation and numerical modeling studies that the most likely contaminant transport pathway from the detonation zone to the surface would be through a gas production well drilled near enough to the site to allow hydrofractures from the well to interact with nuclear fractures of the detonation (DOE 2013). Based on these findings, a new monitoring program was implemented to emphasize the sampling of natural gas production wells near the site. This sampling program was later refined to the producing natural gas wells within 1 mile of the site. Although gas production wells are the most likely transport path for detonation-related contaminants, LM has continued the sampling of select locations that have been part of the LTHMP.

3.0 Monitoring Program

The monitoring program for the Rio Blanco site includes the collection of samples from groundwater wells and surface water locations on and near the site, and producing natural gas wells within one mile of the site to assess for any potential impacts that may be attributed to the underground nuclear test. Natural gas wells, surface water locations, and offsite wells were not sampled during this monitoring period. Natural gas wells were not sampled because there are no producing natural gas wells currently within one mile of the site. The surface water locations and offsite wells were not sampled because there are no reasonable pathways for detonation-related contaminants to impact these locations and sample results continue to support the determination that these locations have not been impacted by the Rio Blanco detonation (DOE 2020). A summary of the 2020 sampling is provided with the laboratory results in the following sections.

3.1 Groundwater Sampling

Samples were collected from the four groundwater wells onsite (RB-D-01, RB-D-03, RB-S-03, and RB-W-01) during this year's monitoring event (Figure 3). These wells and other offsite wells and surface water locations have been sampled annually as part of the LTHMP since 1976. The LTHMP has historically included 15 locations that are a combination of groundwater wells and surface water locations. Six of these locations (four wells and two surface) are on the Rio Blanco site. The remaining nine locations (two wells and seven surface) are offsite, with these locations ranging from 1 to 7 miles from the former RB-E-01 emplacement well that signifies surface ground zero at the site (Figure 3). The samples are collected according to the *Sampling and Analysis Plan for U.S. Department of Energy Office of Legacy Management Sites* (LMS/PRO/S04351), also called the Sampling and Analysis Plan (SAP). The SAP provides the procedures used to guide the quality assurance and quality control of the annual sampling and monitoring program. These procedures incorporate standards and guidance from EPA, DOE, and ASTM International.

Samples were analyzed for tritium because it is the most mobile contaminant remaining in significant quantities in the detonation zone. All samples were analyzed for tritium using the conventional method, and one sample (well RB-S-03) was analyzed using the electrolytic enrichment method, which allows the laboratory to provide a minimum detectable concentration that is approximately 2 orders of magnitude lower than that of the conventional method. The samples were submitted to ARS Aleut Analytical, which analyzed the samples using accepted procedures based on the specified methods in accordance with the *Department of Defense (DoD) Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories* (DOD and DOE 2017) to ensure that data are of known, documented quality. The laboratory radiochemical minimum detectable concentration reported with these data is an estimate of the predicted detection capability of a given analytical procedure, not an absolute concentration that can or cannot be detected. These laboratory results were validated in accordance with Section 5.0, "Validation of Laboratory Data," in the *Environmental Data Validation Procedure* (LMS/PRO/S15870). Appendix A is a copy of the data validation memo.

3.2 Groundwater Sampling Results

The 2020 laboratory results continue to demonstrate that no detonation-related contaminants have impacted any of the sampled locations (Table 1). Tritium was not detected above the laboratory minimum detectable concentration using the conventional or enrichment analytical methods. Table 1 shows the 2020 laboratory results.

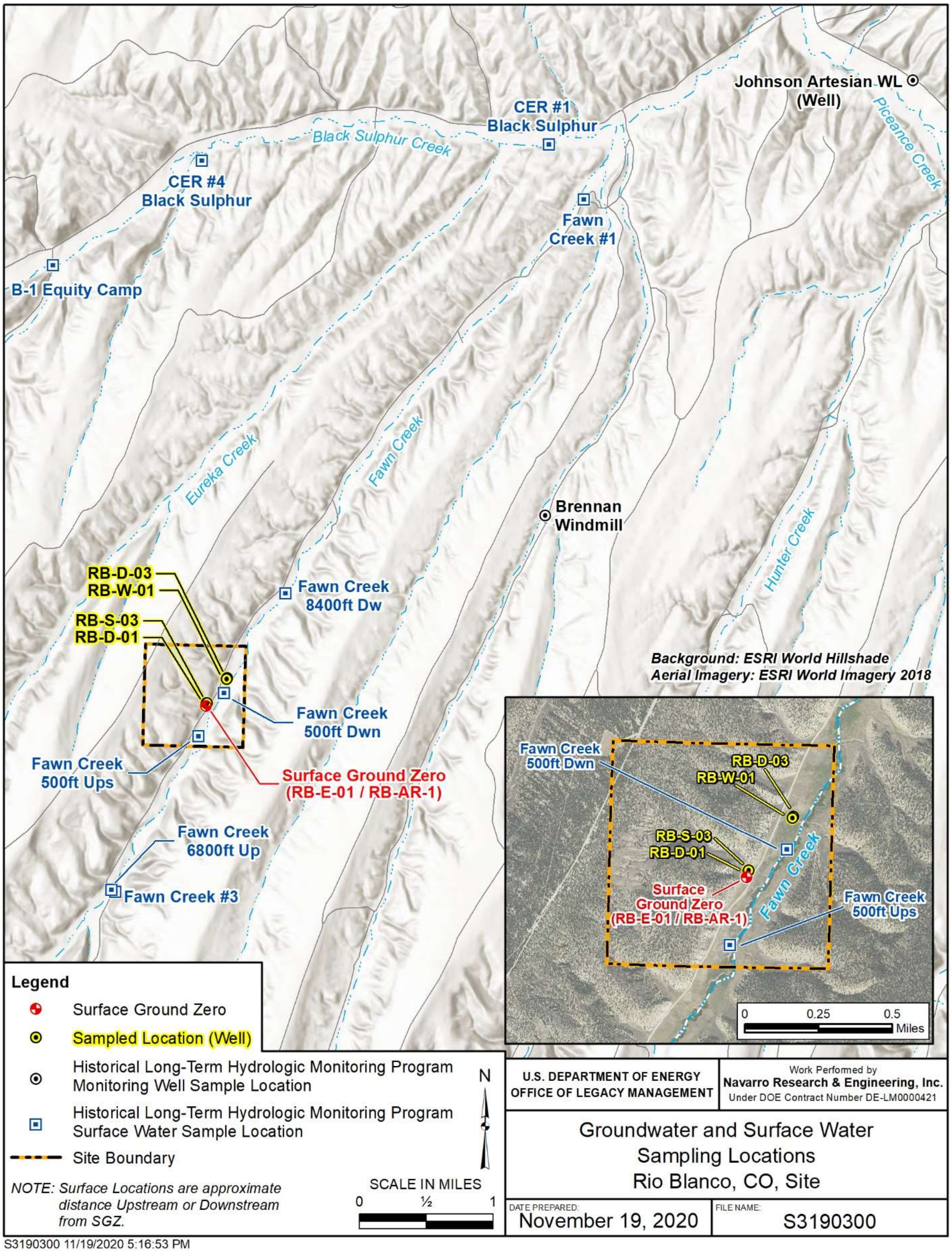

Figure 3. 2020 Groundwater and Surface Water Sampling Locations, Rio Blanco, Colorado, Site

Table 1. 2020 Sample Results, Rio Blanco, Colorado, Site

Sample Location	Sample Type	Sample Date	Tritium by Conventional Method (pCi/L)	Tritium by Enrichment Method (pCi/L)
RB-D-01 (well)	Groundwater	5/27/2020	<352	NA
RB-D-03 (private well)		5/27/2020	<352	NA
			<354[a]	NA
RB-S-03 (well)		5/27/2020	<353	<4.8
RB-W-01 (well)		5/27/2020	<353	NA

Notes:
[a] Field duplicate sample.

Abbreviation:
NA = not analyzed

Historical LTHMP sample results have detected tritium using the enriched method at levels consistent with tritium concentrations in precipitation. The elevated tritium levels in the atmosphere resulted from aboveground nuclear tests conducted by the United States and Soviet Union during the 1950s and early 1960s (Brown 1995). The aboveground testing ended in 1963 with the test ban treaty, and tritium levels in the atmosphere (and precipitation) have been decreasing since that time. The tritium results obtained using the enrichment method are shown along with the plot of tritium in precipitation (Figure 4 and Figure 5) at Ottawa, Canada, which has the longest record of tritium in precipitation in the Northern Hemisphere (Brown 1995). The natural decay rate for tritium (12.3 years) is also included in the figures for comparison. The tritium levels in well samples are noticeably lower than those in precipitation (Figure 4), indicating a significant contribution from pre-atmospheric testing groundwater. The similarity of tritium levels in surface water samples to tritium levels in precipitation (Figure 5) indicates that the surface water locations are primarily supplied by recent precipitation. These results are much lower than the EPA drinking water standard for tritium of 20,000 picocuries per liter (pCi/L) (Title 40 *Code of Federal Regulations* Section 141.16 [40 CFR 141.16]).

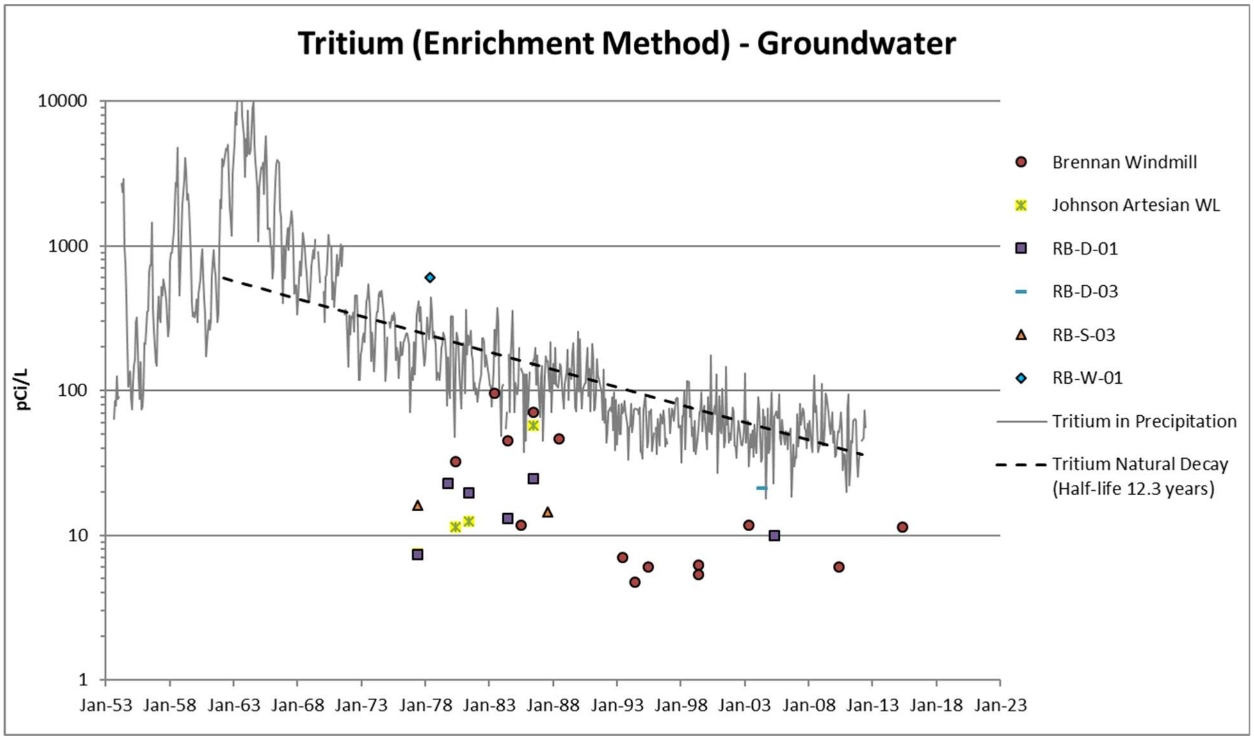

Figure 4. Comparison of Tritium in Wells near the Rio Blanco Site with Tritium in Precipitation at Ottawa, Canada (site with longest historical tritium record [Brown 1995])

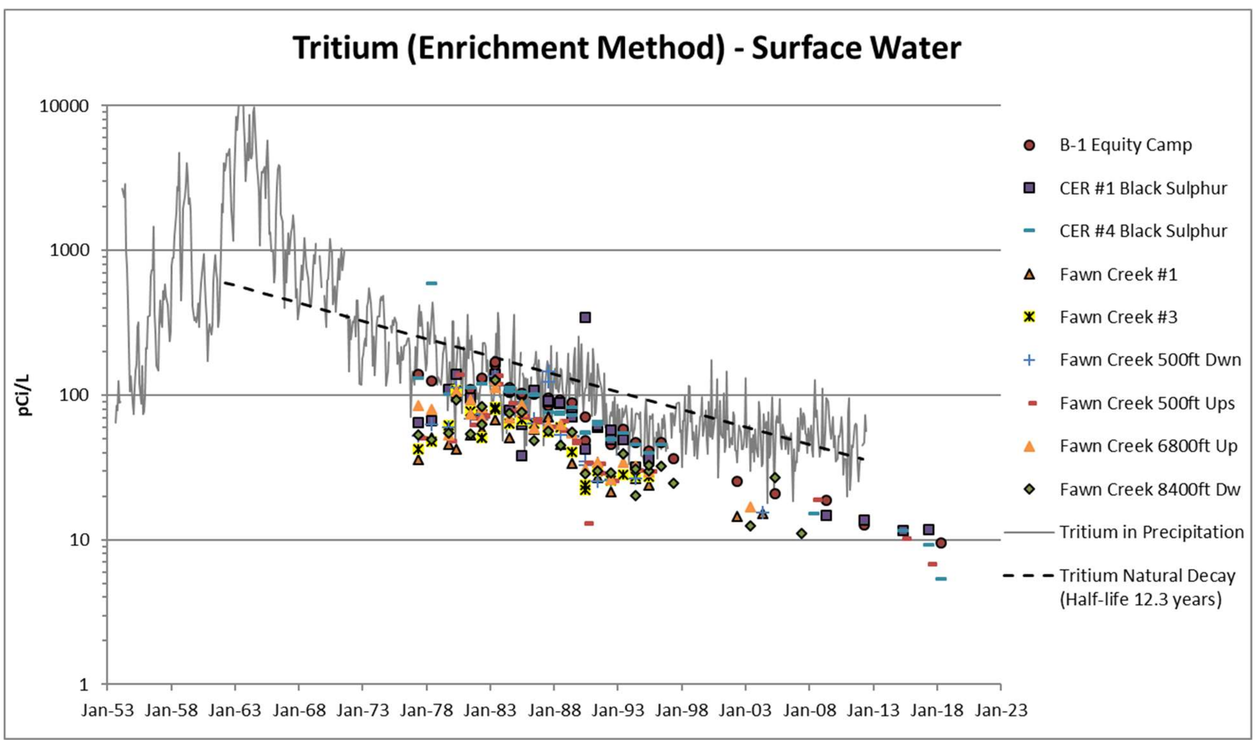

Figure 5. Comparison of Tritium in Surface Water near the Rio Blanco Site with Tritium in Precipitation at Ottawa, Canada (site with longest historical tritium record [Brown 1995])

4.0 Conclusions

The laboratory results obtained from this monitoring event indicate that no Rio Blanco site detonation-related radionuclides have impacted the wells onsite. This is consistent with historical monitoring results from LTHMP sampling events dating back to 1976. Tritium has only been detected at levels at or below tritium concentrations in precipitation at the time the samples were taken. Sampling will continue at the site on an annual basis in 2021 and will be focused on the onsite wells (RB-D-01, RB-D-03, RB-S-03, and RB-W-01) because the historical results do not support the sampling of the offsite locations or onsite surface water locations. This report is available on the LM website at https://www.lm.doe.gov/Rio_Blanco/Sites.aspx. Data collected during this and previous monitoring events are available on the GEMS website at https://gems.lm.doe.gov/#site=RBL.

5.0 References

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Appendix A

Data Validation Memo

May 2020 Groundwater Data
from the Rio Blanco, Colorado, Site

memo

To:	Rick Findlay, Navarro
From:	Samantha Tigar, Navarro
CC:	Steve Donivan, Navarro Janice McDonald, Navarro Samantha Tigar, Navarro Rex Hodges, Navarro
Date:	September 16, 2020
Re:	Validation of May 2020 Groundwater Data from the Rio Blanco, Colorado, Site

Validation of data generated from the May 2020 groundwater sampling event at the Rio Blanco, Colorado, Site has been completed. This Level 3 validation was conducted according to the *Environmental Data Validation Procedure* (LMS/PRO/S15870).

The samples were submitted for analysis identified by Task Code RBL01-01.2005003. Planned monitoring locations are shown in the Sampling and Analysis Work Order (Enclosure 1). Samples were collected at all four planned locations. See the Trip Report (Enclosure 2) for additional details.

All environmental data from this sampling event are considered validated and available for use. Site data are available for viewing with dynamic mapping via the GEMS (Geospatial Environmental Mapping System) website at http://gems.lm.doe.gov/#. The Field Data Assessment (Enclosure 3) includes discussion of the field data and field quality control samples. The Laboratory Performance Assessment (Enclosure 4) documents the review of the laboratory data. An assessment of anomalous data is included in Enclosure 5. Summaries of Enclosures 3, 4, and 5 are presented below.

Sampling and Analysis Work Order (Enclosure 1)

Trip Report (Enclosure 2)

Field Data Assessment (Enclosure 3)

Verification of Field Activities

A Field Activities Verification Checklist was completed with no issues identified.

Assessment of Field Quality Control Samples

Assessment of field quality control samples was conducted. A duplicate sample was collected from location RB-D-03. All duplicate results met the criteria demonstrating acceptable precision.

Laboratory Performance Assessment (Enclosure 4)

Laboratory analytical quality control criteria were met except as qualified in the Laboratory Performance Assessment. Analytical data and the associated qualifiers can be viewed in reports from the environmental database.

Assessment of Anomalous Data (Enclosure 5)

No values were identified as statistical outliers. Assessment of anomalous data is documented in Enclosure 5.

Enclosures (5)

Enclosure 1
Sampling and Analysis Work Order

Navarro Research and Engineering, Inc.

April 30, 2020

Task Assignment 104
Control Number 20-1207

U.S. Department of Energy
Office of Legacy Management
ATTN: Jalena Dayvault
Site Manager
2597 Legacy Way
Grand Junction, CO 81503

SUBJECT: Contract No. DE-LM0000421, Navarro Research and Engineering, Inc. (Navarro)
Task Assignment 104, LTS&M – Nevada Offsites and Monticello Site
May 2020 Environmental Sampling at Rio Blanco, Colorado, Site

REFERENCE: Task Assignment 104, 1-104-1-04-618, Rio Blanco, Colorado, Site

Dear Ms. Dayvault:

The purpose of this letter is to inform you of the upcoming sampling event at the Rio Blanco, Colorado, site. Enclosed are the map and tables specifying sample locations and analytes for monitoring at the site. Water quality data will be collected as part of the routine environmental sampling currently scheduled to begin the week of May 25, 2020.

The following list shows the locations scheduled for sampling during this event.

MONITORING WELLS

On-Site

RB-D-01 RB-D-03 RB-S-03 RB-W-01

All samples will be collected as directed in the *Sampling and Analysis Plan for U.S. Department of Energy Office of Legacy Management Sites*. Notification for access to locations on private property will be conducted prior to the beginning of fieldwork.

Please contact me at (970) 248-6419 if you have any questions.

Sincerely,

Richard C. Findlay

RICHARD FINDLAY (Affiliate)
2020.04.30 14:49:02 -06'00'

Richard C. Findlay
LMS Site Lead

2597 Legacy Way - Grand Junction, CO 81503-1789 -Telephone (970) 248-6000 - Fax (970) 248-6040

RCF/lcg/rv

Enclosures

cc: (electronic)
Jeannie Gueretta, DOE
Paul Kerl, DOE

Ken Kreie, DOE
Karen Brown, Navarro
Stephen Browning, Navarro
Steve Donivan, Navarro
John Elmer, Navarro
Richard Findlay, Navarro
Lauren Goodknight, Navarro
Deana Guzman, Navarro
Sam Marutzky, Navarro
Diana Osborne, Navarro
LM Admin Support
Document Determination
EDD Delivery
Records
File Code: LM 0610.10
RBL 0400-02

Constituent Sampling Breakdown

Site	Rio Blanco				
Analyte	Groundwater	Surface Water	Required Detection Limit (mg/L)	Analytical Method	Line Item Code
Approx. No. Samples/yr	4				
Field Measurements					
Total Alkalinity	X				
Dissolved Oxygen	X				
Redox Potential	X				
pH	X				
Specific Conductance	X				
Static Water Level	X				
Turbidity	X				
Temperature	X				
Laboratory Measurements					
Aluminum					
Ammonia as N (NH3-N)					
Calcium					
Chloride					
Chromium					
Iron					
Lead					
Magnesium					
Manganese					
Molybdenum					
Nitrate + Nitrite as N (NO3+NO2)-N					
Potassium					
Selenium					
Sodium					
Strontium					
Sulfate					
Total Organic Carbon					
Tritium	X		400 pCi/L	Liquid Scintillation	LSC-A-001
Tritium, enriched	25% of the samples		10 pCi/L	Liquid Scintillation	LMR-15
Uranium					
Vanadium					
Zinc					
Total No. of Analytes	2	0			

Note: All analyte samples are considered unfiltered unless stated otherwise. All private well samples are to be unfiltered. The total number of analytes does not include field parameters.

Sampling Frequencies for Locations at Rio Blanco, Colorado

Location ID	Quarterly	Semiannually	Annually	Biennially	Not Sampled	Notes
Monitoring Wells						
On-Site						
RB-D-01			X			
RB-D-03			X			
RB-S-03			X			
RB-W-01			X			
Off-Site						
Johnson Artesian WL					X	
Brennan Windmill					X	
Surface Locations						
On-Site						
Fawn Creek 500ft Dwn					X	
Fawn Creek 500ft Ups					X	
Off-Site						
B-1 Equity Camp					X	
CER #1 Black Sulphur					X	
CER #4 Black Sulphur					X	
Fawn Creek #1					X	
Fawn Creek #3					X	
Fawn Creek 6800ft Up					X	
Fawn Creek 8400ft Dw					X	

Sampling conducted in May

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LEGEND

- WELL TO BE SAMPLED
- SITE BOUNDARY

N

0 1 2 Miles

U.S. DEPARTMENT OF ENERGY
OFFICE OF LEGACY MANAGEMENT

Work Performed by
Navarro Research & Engineering, Inc.
Under DOE Contract Number DE-LM0000421

Planned Sample Locations
Rio Blanco, CO, Site
May 2020

DATE PREPARED: April 28, 2020

FILE NAME: S2955800-11x17

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Enclosure 2
Trip Report

memo

NAVARRO

To:	Rick Findlay, Navarro
From:	Samantha Tigar, Navarro
Date:	June 4, 2020
CC:	Steve Donivan, Navarro Rex Hodges, Navarro Janice McDonald, Navarro EDD Delivery
Re:	Sampling Trip Report

Site: Rio Blanco, Colorado, Site

Dates of Event: May 27, 2020

Team Members: Dan Sellers and Samantha Tigar, Navarro

Number of Locations Sampled: Samples were collected from all four locations identified on the sampling notification letter.

Locations Not Sampled/Reason: All locations were sampled.

Location Specific Information: Nothing to note.

Quality Control Sample Cross Reference: A summary of the quality control sample collected is shown in Table 1.

Table 1. Quality Control Sample Summary

False ID	Sample ID	Location ID	Parent Sample ID	Sample Type	Associated Matrix
2489	RBL01-01.2005003-005	RB-D-03	RBL01-01.2005003-004	Duplicate	Groundwater

Task Code Assigned: All samples were assigned to RBL01-01.2005003. Field data sheets can be found in \\crow\SMS\RBL01-01.2005003\RECORDS\FieldData.

Sample Shipment: Samples were shipped overnight via FedEx from Grand Junction, CO, to ARS International in Port Allen, LA, on May 28, 2020.

Water Level Measurements: Water Levels were measured in all sampled wells.

Well Inspection Summary: No issues identified.

Sampling Method: Samples were collected according to the *Sampling and Analysis Plan (SAP) for the U. S. Department of Energy Office of Legacy Management Sites* (LMS/PRO/S04351, continually updated).

Field Variance: None.

Equipment: Nothing to note.

Stakeholder/Regulatory/DOE: None.

Institutional Controls:

Fences, Gates, and Locks: All gates were left as they were found.
Signs: N/A
Trespassing/Site Disturbances: Nothing to note.

Safety Issues: None.

Access Issues: None.

General Information: Nothing to note.

Immediate Actions Taken: An unsuccessful attempt was made to secure the lid for monitoring well RB-W-01 by drilling holes into the casing.

Future Actions Required or Suggested: The lid for monitoring well RB-W-01 needs to be secured to the casing. A locking mechanism will need to be welded in place.

Enclosure 3
Field Data Assessment

Water Sampling Field Activities Verification Checklist

Project	Rio Blanco, CO, Site	**Date(s) of Water Sampling**	May 27, 2020
Date(s) of Verification	September 14, 2020	**Name of Verifier**	Samantha Tigar

	Response (Yes, No, NA)	**Comments**
1. Is the SAP the primary document directing field procedures?	Yes	
List any Program Directives or other documents, SOPs, instructions.		Work Order letter dated April 30, 2020.
2. Were the sampling locations specified in the planning documents sampled?	Yes	
3. Were field equipment calibrations conducted as specified in the above-named documents?	Yes	Calibrations were performed May 22, 2020.
4. Was an operational check of the field equipment conducted daily?	Yes	
Did the operational checks meet criteria?	Yes	
5. Were the number and types (alkalinity, temperature, specific conductance, pH, turbidity, DO, ORP) of field measurements taken as specified?	No	Field measurements were collected as listed in the sampling field book. During data validation it was discovered that collection of alkalinity, dissolved oxygen, and ORP were requested for this event and the original sampling documentation was outdated.
6. Were wells categorized correctly?	Yes	
7. Were the following conditions met when purging a Category I well:		
Was one pump/tubing volume purged prior to sampling?	Yes	
Did the water level stabilize prior to sampling?	Yes	
Did pH, specific conductance, and turbidity measurements meet criteria prior to sampling?	Yes	
Was the flow rate less than 500 mL/min?	Yes	

Water Sampling Field Activities Verification Checklist (continued)

	Response (Yes, No, NA)	Comments
8. Were the following conditions met when purging a Category II well:		
Was the flow rate less than 500 mL/min?	Yes	
Was one pump/tubing volume removed prior to sampling?	Yes	
9. Were duplicates taken at a frequency of one per 20 samples?	Yes	A duplicate was collected from location RB-D-03.
10. Were equipment blanks taken at a frequency of one per 20 samples that were collected with non-dedicated equipment?	N/A	
11. Were trip blanks prepared and included with each shipment of VOC samples?	N/A	
12. Were the true identities of the QC samples documented?	Yes	
13. Were samples collected in the containers specified?	Yes	
14. Were samples filtered and preserved as specified?	Yes	
15. Were the number and types of samples collected as specified?	Yes	
16. Were chain of custody records completed and was sample custody maintained?	Yes	
17. Was all pertinent information documented on the field data sheets?	Yes	
18. Was the presence or absence of ice in the cooler documented at every sample location?	NA	Sample chilling was not required.
19. Were water levels measured at the locations specified in the planning documents?	Yes	

Data Qualifier Summary

Analytical results and field measurements were qualified as listed in the following table. Refer to the sections below for an explanation of the data qualifiers applied.

Table 1. Data Qualifiers for Sampling Protocol

Locations	Analytes	Flag	Reason
All monitoring well locations	All analytical results and field measurements	F	Category I or II low-flow sampling
RB-W-01	All analytical results and field measurements	Q	Category II purging criteria

Sampling Protocol

Sample results for monitoring wells were qualified with an F flag, indicating the wells were purged and sampled using the low-flow method. Some wells were purged and sampled using Category II criteria. For these wells, the water level drawdown during the purge did not meet the Category I criterion because these wells produced water at a rate less than the minimum low-flow purging rate. Therefore, these wells were classified as Category II. The sample results for these wells were qualified with a Q flag (qualitative), indicating the samples were not collected under the optimal conditions of the Category I stability criteria.

Field Duplicate Analysis

Field duplicate samples are collected and analyzed as an indication of overall precision of the measurement process. The precision observed includes both field and laboratory precision and has more variability than laboratory duplicates, which measure only laboratory performance. For radiochemical measurements, the relative error ratio (the ratio of the absolute difference between the sample and duplicate results and the sum of the 1-sigma uncertainties) is used to evaluate duplicate results and should be less than 3. A duplicate sample was collected from location RB-D-03. All duplicate results met the criteria demonstrating acceptable precision.

Validation Report: Field Duplicates

14-Sep-2020

Project: Rio Blanco Site Monitoring **Task Code:** RBL01-01.2005003 Lab Code: ARS

	Duplicate: RBL01-01.2005003-005				Sample: RBL01-01.2005003-004 RB-D-03						
Analyte	**Result**	**Qualifiers**	**Uncert.**	**Dilution**	**Result**	**Qualifiers**	**Uncert.**	**Dilution**	**RPD**	**RER**	**Units**
Tritium	-18.567	U	206.942	1	113.947	U	208.783	1		0.9	pCi/L

QC Checks: RPD: Relative Percent Difference RER: Relative Error Ratio

Enclosure 4
Laboratory Performance Assessment

General Information

Task Code:	RBL01-01.2005003
Sample Event:	May 27, 2020
Site(s):	Rio Blanco, Colorado, Site
Laboratory:	ARS Aleut Analytical, Port Allen, Louisiana
Work Order No.:	ARS1-20-01344
Analysis:	Radiochemistry
Validator:	Samantha Tigar
Review Date:	September 14, 2020

This validation was performed according to the *Environmental Data Validation Procedure* (LMS/PRO/S15870). The procedure was applied at Level 3, Data Validation.

This validation includes the evaluation of data quality indicators (DQIs) associated with the data. DQIs are the quantitative and qualitative descriptors that are used to interpret the degree of acceptability or utility of data. Indicators of data quality include the analysis of laboratory control samples to assess accuracy; duplicates and replicates to assess precision; and interference check samples to assess bias (see attached Data Validation Worksheets). The comparability, completeness, and sensitivity of the data are also evaluated in the sections to follow.

All analyses were successfully completed. The samples were prepared and analyzed using accepted procedures based on methods specified by line item code, which are listed in Table 2.

Table 1. Analytes and Methods

Analyte	Line Item Code	Prep Method	Analytical Method
Tritium, Enrichment Method	LMR-17	DOE HASL 300	DOE HASL 300
Tritium	LSC-A-001	EPA 906.0m	EPA 906.0m

Data Qualifier Summary

None of the analytical results required qualification.

Sample Shipping/Receiving

ARS Aleut Analytical in Port Allen, Louisiana, received five water samples on May 29, 2020, accompanied by a Chain of Custody form. The Chain of Custody form was checked to confirm that all the samples were listed with sample collection dates and times, and that signatures and dates were present indicating sample relinquishment and receipt. The Chain of Custody form was complete with no errors or omissions. A copy of the air waybill label was included with the receiving documentation.

Preservation and Holding Times

The sample shipment was received intact at ambient temperature, which complies with requirements. The sample aliquots were received in the correct container types and had been preserved correctly for the requested analyses. All analyses were completed within the applicable holding times.

Detection and Quantitation Limits

Radiochemical results are evaluated using the minimum detectable concentration (MDC), decision level concentration (DLC), and determination limit (DL). The DLC is the minimum concentration of an analyte that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is estimated as 3 times the 1-sigma total propagated uncertainty. Results that are greater than the MDC but less than the DLC are qualified with a U flag as not detected. The DL for radiochemical results is the lowest concentration that can be reliably measured and is defined as 3 times the MDC. Results that were not previously U qualified and are less than the DL are qualified with a J flag as estimated values.

The reported MDCs for radiochemical analytes demonstrate compliance with contractual requirements.

Laboratory Instrument Calibration

Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument is capable of producing acceptable qualitative and quantitative data for all analytes. Initial calibration demonstrates that the instrument is capable of acceptable performance in the beginning of the analytical run. Compliance requirements for continuing calibration checks are established to ensure that the instrument continues to be capable of producing acceptable qualitative and quantitative data. All laboratory instrument calibrations were performed correctly in accordance with the cited methods. All calibration and laboratory spike standards were prepared from independent sources.

Method and Calibration Blanks

Method blanks are analyzed to assess any contamination that may have occurred during sample preparation. Calibration blanks are analyzed to assess instrument contamination prior to and during sample analysis. The radiochemistry method blank results were less than the DLC.

Matrix Spike Analysis

Matrix spike and matrix spike duplicate samples were analyzed for tritium as a measure of method performance in the sample matrix. All spike results were within the acceptance range.

Laboratory Replicate Analysis

Laboratory replicate analyses are used to determine laboratory precision for each sample matrix. The relative error ratio for radiochemical replicate results (calculated using the one-sigma total propagated uncertainty) was less than three, indicating acceptable precision.

Laboratory Control Sample

Laboratory control samples were analyzed at the correct frequency to provide information on the accuracy of the analytical method and the overall laboratory performance, including sample preparation. All control sample results were acceptable.

Completeness

Results were reported in the correct units for all analytes requested using contract-required laboratory qualifiers.

Electronic Data Deliverable (EDD) File

The EDD file arrived on August 28, 2020. The contents of the file were compared to the requested analyses to ensure all and only the requested data were delivered. The contents of the EDD were manually examined to verify that the sample results accurately reflected the data contained in the sample data package.

Report Prepared By: ____

Samantha Tigar
Data Validator

General Data Validation Report

Task Code: RBL01-01.2005003 **Lab Code:** ARS **Validator:** Samantha Tigar **Validation Date:** 09-14-2020

Project: Rio Blanco Site Monitoring **# Samples:** 5

Analysis Type: [ ] General Chemistry [ ] Metals [ ] Organics [X] Radiochemistry

Chain of Custody

Present: OK Signed: OK Dated: OK

Sample

Integrity: OK Preservation OK Temperature: OK

Check	**Summary**
Holding Times:	All analyses were completed within the applicable holding times.
Detection Limits:	All detection limits were below the contract required limits.
Field Duplicates:	There was 1 duplicate evaluated.

Radiochemistry Data Validation Worksheet

14-Sep-2020

Project: Rio Blanco Site Monitoring **Task Code:** RBL01-01.2005003 **Lab Code:** ARS

Sample ID	Analyte	Analysis Date	QC Type	Result Type	Result	Flag	TPU	Spike Recovery	Spike Dup Recovery	Lower Limit	Upper Limit	RPD	RPD Limit	RER	Comments
ARS1-B20-00970-01	Enriched Tritium	07-17-2020	LCS	TRG	40.462		12.674	94		75	125				
ARS1-B20-00970-02	Enriched Tritium	07-17-2020	LCSD	TRG	44.263		13.686	102		75	125	8	25		RER=0.4
ARS1-B20-00970-03	Enriched Tritium	07-17-2020	MB	TRG	-0.420	U	2.748								
ARS1-B20-01385-01	Tritium	08-24-2020	LCS	TRG	2916.047		395.095	104		75	125				
ARS1-B20-01385-02	Tritium	08-24-2020	LCSD	TRG	3058.346		406.892	110		75	125	4	25		RER=0.5
ARS1-B20-01385-03	Tritium	08-24-2020	MB	TRG	79.695	U	207.000								
ARS1-B20-01385-13	Tritium	08-25-2020	MS	TRG	8827.056		963.718	102		60	140				

QC Types: LCS: Laboratory Control Sample LCSD: Laboratory Control Sample Duplicate MB: Method Blank MS: Matrix Spike MSD: Matrix Spike Duplicate R: Replicate

Result Types: IS: Internal Standard SC: Spike Analyte TRG: Target analyte

QC Checks: RPD: Relative Percent Difference RER: Relative Error Ratio TPU: Total Propagated Uncertainty

Enclosure 5
Assessment of Anomalous Data

Potential Outliers Report

Potential outliers are results that lie outside the historical range, possibly due to transcription errors, data calculation errors, or measurement system problems. However, outliers can also represent true values outside the historical range. Potential outliers are identified by generating the Data Validation Outliers Report from data in the environmental database. The new data are compared to historical values and data that fall outside the historical data range are listed on the report along with the historical minimum and maximum values. The potential outliers are further reviewed and may be subject to statistical evaluation using the ProUCL application developed by the EPA (https://www.epa.gov/land-research/proucl-software). The review also includes an evaluation of any notable trends in the data that may indicate the outliers represent true extreme values.

There was one value outside the historical range, but it was not identified as a statistical outlier. Further review of the data did not indicate any laboratory errors. Potential anomalies in the field parameters were also examined for patterns of repeated high or low bias, which suggest a systematic error due to instrument malfunction. No such patterns were found and the data from this event are acceptable as qualified. See the Data Validation Outliers Report, below.

Data Validation Outliers Report - No Field Parameters **Report Date: 09/14/2020**

Comparison to Historical Data Since: 1/1/2009 12:00:00 AM Fraction: Any

Task: RBL01-01.2005003

Analyte	Location	Analysis Location	Units	Fraction	Result	Lab Qualifier(s)	Type	HistMIN	HistMAX	HistSetSize	Outlier?
Tritium	RB-S-03	LB	pCi/L	N	92.771	U	> HistMAX	-98.4	78	10	No

FRACTION: D = Dissolved N = NA T = Total

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