LMS/RBL/S28004

2019 Long-Term Hydrologic Monitoring Program Report for Rio Blanco, Colorado, Site

August 2020

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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
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 during which three nuclear devices were detonated nearly simultaneously in a single borehole in 1973. The test resulted in residual radionuclide contamination at the detonation depths of 5840, 6230, and 6690 feet (ft) (DOE 2015). Monitoring includes the collection of samples from groundwater wells and surface water locations near the site to assess for any potential impacts that may be attributed to the Rio Blanco nuclear test. This report summarizes the laboratory analytical results obtained from the sampling event conducted in 2019. 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. The parts of each former cavity, now the lower part of the 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). Two reentry wells were drilled into separate collapse chimneys created by the detonation 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 was tested to determine the success of the detonations at creating a continuous chimney. It was determined that the nuclear test failed to create a single elongate chimney, and water content in the formation was too high for nuclear stimulation to be successful. 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).

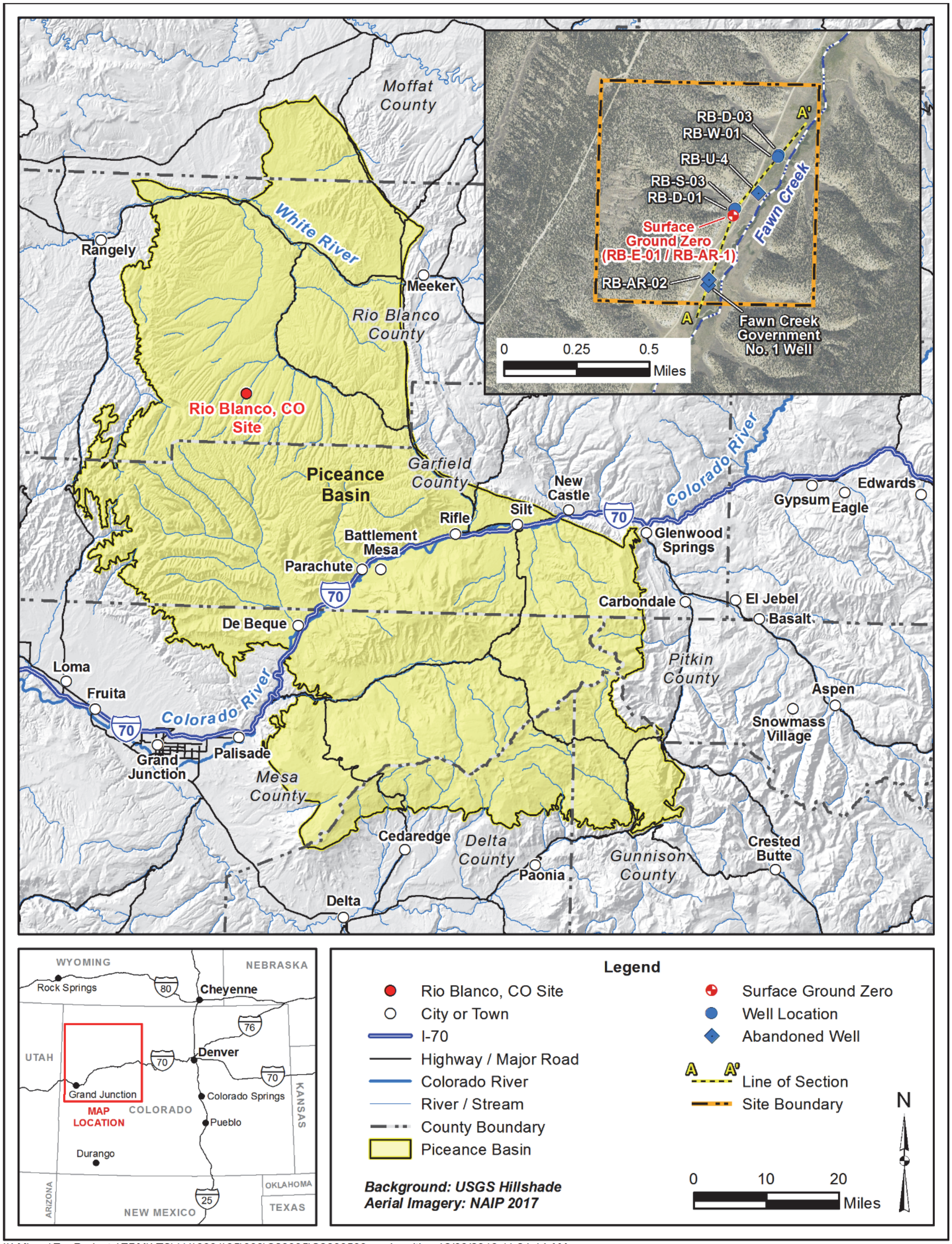

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Figure 1. Site Location Map, Rio Blanco, Colorado, Site

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 restored to a gas production well having a production zone depth 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 soil or groundwater at the site. Lead and total petroleum hydrocarbons in the form of diesel-range organics were found in some of the soil samples collected below a depth of 12 ft that were above screening levels established during the investigation; 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.

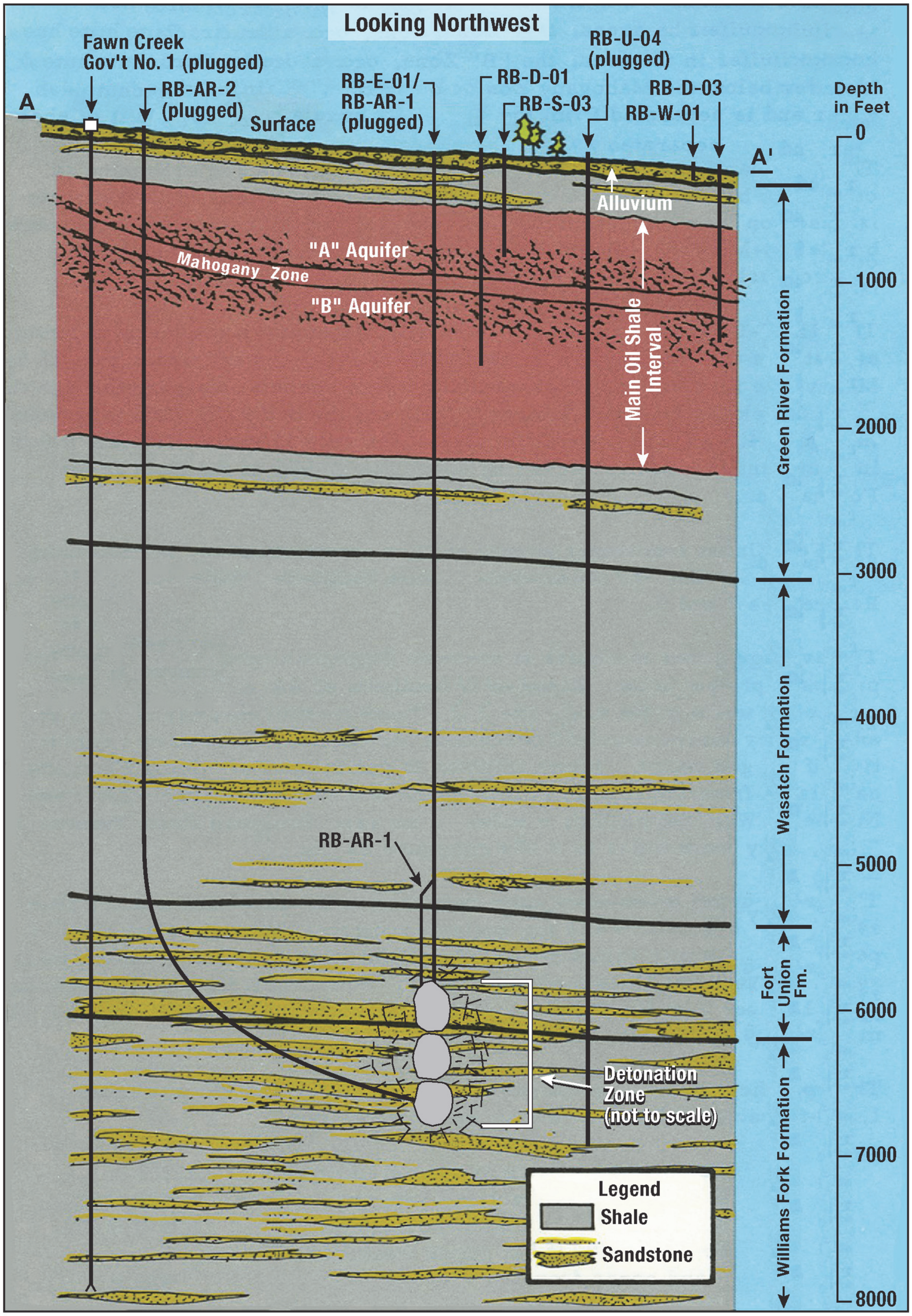

Figure 2. Cross Section of the Piceance Basin and Rio Blanco, Colorado, Site

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 is 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 basin-like 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 Rio Blanco site has been monitored to ensure public safety under the Long-Term Hydrologic Monitoring Program (LTHMP) since 1972. The U.S. Environmental Protection Agency (EPA) performed the LTHMP sampling from the program's inception in 1972 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 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. On the basis of the findings of that evaluation, a new monitoring program was implemented to emphasize the sampling of natural gas production wells near the site. Although gas production wells are the most likely transport path for detonation-related contaminants, LM has continued the sampling of shallow groundwater and surface water at several locations near the site.

3.0 Monitoring Program

The monitoring program for the Rio Blanco site includes the collection of samples from groundwater wells, surface water locations, and producing natural gas wells within 1 mile of the site to assess for any potential impacts that may be attributed to the Rio Blanco underground nuclear test. Natural gas wells were not sampled during this monitoring period. A summary of the surface water and groundwater sampling is provided with the laboratory results in the following sections.

3.1 Groundwater and Surface Water Sampling

LM has continued the yearly sampling of groundwater wells and surface water locations near the site that began in 1972 as part of the LTHMP. The sampling has continued to assure the public that no radiological contamination associated with the Rio Blanco underground nuclear test has impacted the sample locations near the site. Samples are usually collected from 15 locations during the annual monitoring events and are a combination of groundwater wells and surface water locations. Six of the locations (four well and two surface) are on the Rio Blanco site. The remaining nine locations (two well 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). A sample could not be collected from the Brennan Windmill well location during this sampling event, because the windmill pump was not operational, and no water was available in the stock tank for sampling. Samples from these locations were 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 (using conventional and electrolytic enrichment methods), because it is the most mobile contaminant remaining in significant quantities in the detonation zone. Samples from 10 locations were analyzed using the conventional method. Samples from four well locations were 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 the conventional method. Samples were also analyzed for gamma-emitting radionuclides (using high-resolution gamma spectrometry) that may be associated with the nuclear detonation. The samples were analyzed using accepted procedures that were based on the specified methods. 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. All water samples were submitted to GEL Laboratories, which provides analytical services 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. These laboratory analytical results were validated in accordance with Section 5.0, "Validation of Laboratory Data," in the *Environmental Data Validation Procedure* (LMS/PRO/S15870).

3.2 Groundwater and Surface Water Sample Laboratory Results

The 2019 laboratory results continue to demonstrate that no detonation-related contaminants have impacted any of the sampled locations (Table 1). Tritium is the primary radionuclide of concern at the site, and it was not detected above the laboratory minimum detectable concentration using the conventional or enrichment analytical methods. Samples analyzed for gamma-emitting radionuclides using the high-resolution gamma spectrometry method also did not detect any detonation-related radionuclides above the laboratory minimum detectable concentrations. Table 1 shows the 2019 laboratory results.

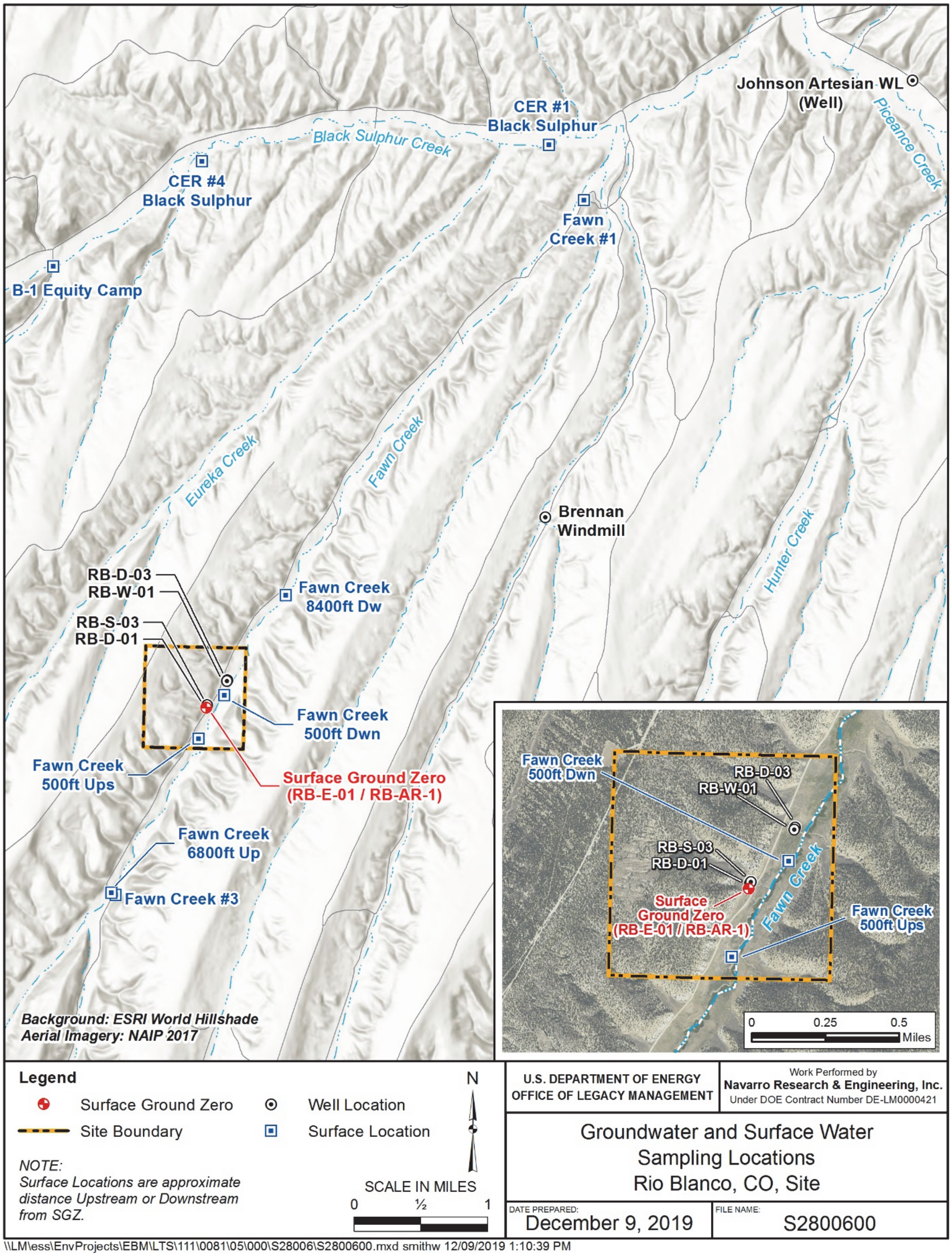

Figure 3. Groundwater and Surface Water Sampling Locations, Rio Blanco, Colorado, Site

Table 1. Groundwater and Surface Water Sample Results, Rio Blanco Site

Sample Location	Sample Type	Sample Date	Tritium by Conventional Method (pCi/L)	Tritium by Enrichment Method (pCi/L)	Gamma-Emitting Radionuclides[a] (pCi/L)
Johnson Artesian WL (private well)	Groundwater	5/28/2019	NA	<4.6	ND
RB-D-01 (well)		5/28/2019	NA	<4.5	ND
RB-D-03 (private well)		5/28/2019	NA	<4.8	ND
RB-S-03 (well)		5/28/2019	NA	<4.9	ND
RB-W-01 (well)		5/28/2019	<289	NA	ND
Brennan Windmill (private well)		5/28/2019	NA	NA	NA
B-1 Equity Camp	Surface water	5/28/2019	<270	NA	ND
CER #1 Black Sulphur		5/28/2019	<289	NA	ND
CER #4 Black Sulphur		5/28/2019	<288	NA	ND
Fawn Creek #1		5/28/2019	<288	NA	ND
Fawn Creek #3		5/28/2019	<281	NA	ND
Fawn Creek 500ft Dwn (500 ft downstream of SGZ)		5/28/2019	<286	NA	ND
Fawn Creek 500ft Ups (500 ft upstream of SGZ)		5/28/2019	<289	NA	ND
Fawn Creek 6800ft Up (6800 ft upstream of SGZ)		5/28/2019	<284	NA	ND
Fawn Creek 8400ft Dw (8400 ft downstream of SGZ)		5/28/2019	<280	NA	ND
			<272	NA	ND

Notes:
[a] See data validation memo (Appendix A, Enclosure 3) for the laboratory method used and radionuclides included in this analysis.
[b] Field duplicate sample.

Abbreviations:
NA = not analyzed
ND = not detected
pCi/L = picocuries per liter
SGZ = surface ground zero

The detection of tritium using the enrichment method is consistent with historical LTHMP results and with the tritium concentration in precipitation that resulted from aboveground nuclear tests during the 1950s and early 1960s (Brown 1995). Aboveground tests conducted by the United States and the Soviet Union ended with the test ban treaty in 1963. The tritium results obtained using the enrichment method are shown with the plot of tritium in precipitation (Figure 4 and Figure 5) at Ottawa, Canada, which is 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 similarity of the tritium levels obtained from the enrichment laboratory method to tritium levels in precipitation indicates that the wells and surface locations are supplied by recent infiltration of water from rain or snowmelt. These results are much lower than the EPA drinking water standard for tritium of 20,000 picocuries per liter (Title 40 *Code of Federal Regulations* Section 141.16 [40 CFR 141.16]). No other detonation-related radionuclides were detected by high-resolution gamma spectrometry analysis. Specific radionuclides that are included in gamma spectrometry analysis are listed in the data validation memo provided as Appendix A.

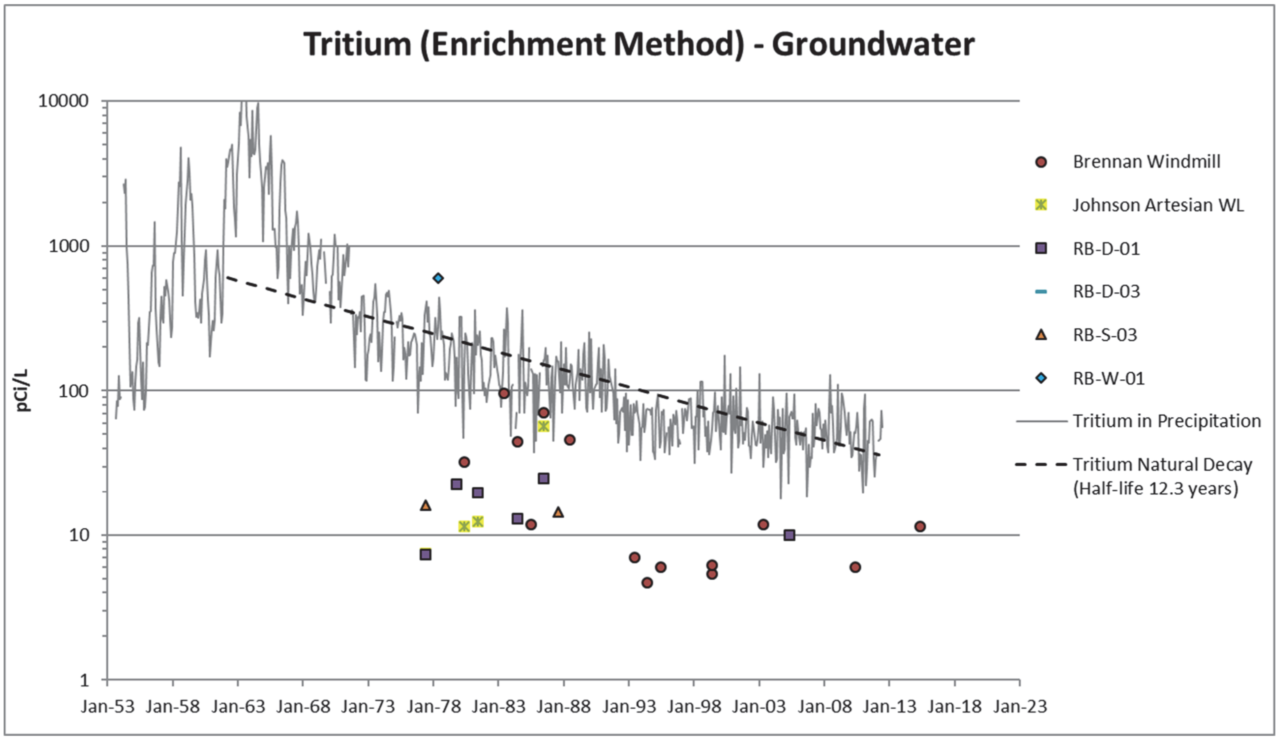

Figure 4. Comparison of Tritium in Wells Near the Rio Blanco Site with Tritium in Precipitation at Ottawa, Canada (site with longest historical tritium record [Brown 1995])

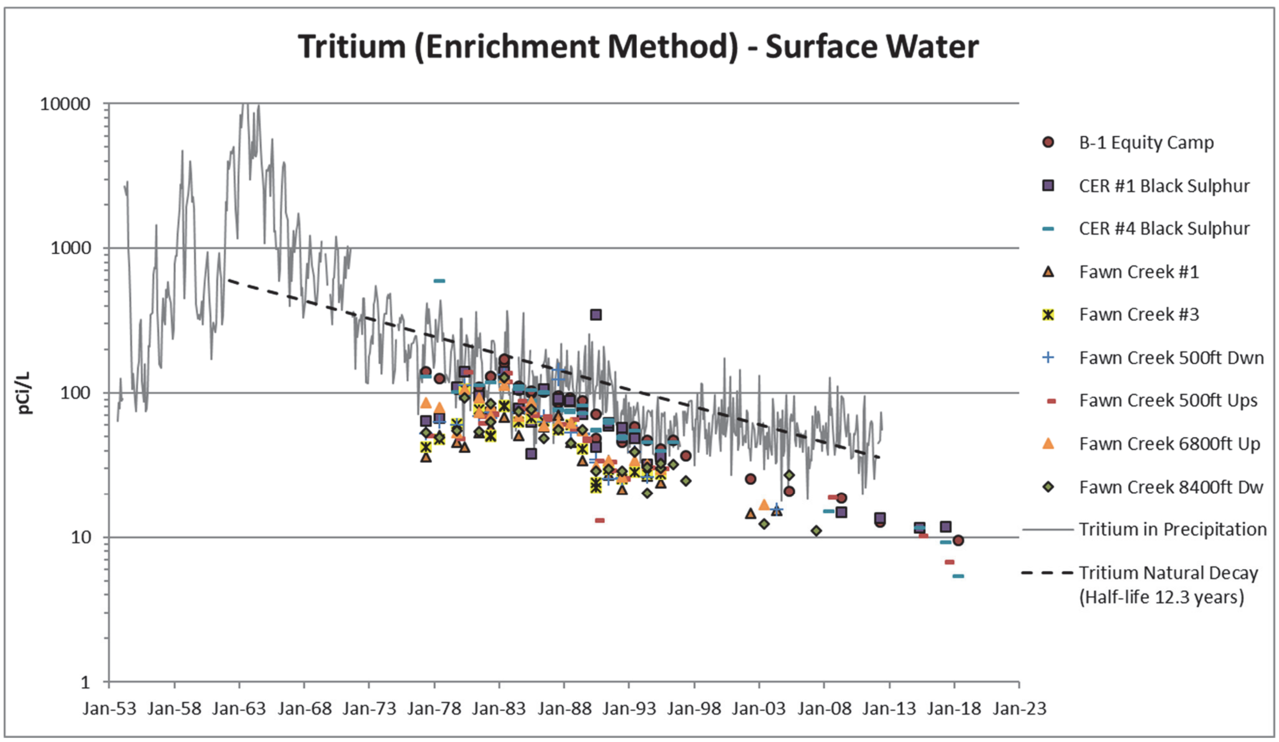

Figure 5. Comparison of Tritium in Surface Water Near the Rio Blanco Site with Tritium in Precipitation at Ottawa, Canada (site with longest historical tritium record [Brown 1995])

4.0 Conclusions

The laboratory results obtained from this monitoring event indicate that no Rio Blanco site detonation-related radionuclides have impacted the groundwater and surface water locations near the site. This is supported by years of monitoring results obtained from the LTHMP sampling events dating back to 1972. Historically, tritium concentrations have only been detected using the enrichment method; those results are consistent with tritium concentrations in precipitation that resulted from aboveground nuclear tests and is not attributed to the Rio Blanco underground nuclear test. Based on these results, the sampling planned for 2020 will focus on the onsite wells (RB-D-01, RB-D-03, RB-S-03, and RB-W-01) and will not include the offsite locations or onsite surface water locations. This report is 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 GEMS website at https://gems.lm.doe.gov/#site=RBL.

5.0 References

ANL (Argonne National Laboratory), 2007. *Radiological and Chemical Fact Sheets to Support Health Risk Analyses for Contaminated Areas*, collaboration with U.S. Department of Energy, Richland Operations Office and Chicago Operations Office, March.

Brown, R.M., 1995. Monthly Tritium in Precipitation at Ottawa, Canada 1953–1995, Atomic Energy of Canada Limited, in *Environmental Isotopes in Hydrology* (I. Clark and P. Fritz 1997), CRC Press, Boca Raton, Florida, http://www.science.uottawa.ca/~eih/ch7/7tritium.htm, last accessed December 2016.

DOD (U.S. Department of Defense) and DOE (U.S. Department of Energy), 2017. *Department of Defense (DoD) Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories,* DoD Quality Systems Manual Version 5.1 and DOE Quality Systems for Analytical Services Version 3.1, January.

DOE (U.S. Department of Energy), 2013. *Modeling of Flow and Transport Induced by Gas Production Wells near the Project Rio Blanco Site, Piceance Basin, Colorado*, LMS/RBL/S09152, Office of Legacy Management, June.

DOE (U.S. Department of Energy), 2015. *United States Nuclear Tests, July 1945 through September 1992,* DOE/NV—209-Rev 16, National Nuclear Security Administration, Nevada Field Office, September.

Environmental Data Validation Procedure, LMS/PRO/S15870, continually updated, prepared by Navarro Research and Engineering, Inc., for the U.S. Department of Energy Office of Legacy Management.

ERDA (U.S. Energy Research and Development Administration), 1975. *Project Rio Blanco Formation Evaluation Well (RB-U-4) Drilling, Completion and Initial Testing Report,* NVO-168, Nevada Operations Office, December.

ERDA (U.S. Energy Research and Development Administration), 1978. *Project Rio Blanco Site Restoration Final Report*, NVO-183, Nevada Operations Office, January.

MacLachlan, M.S., 1987. "General Geology of the Piceance Basin," in *Oil Shale, Water Resources, and Valuable Minerals of the Piceance Basin, Colorado: The Challenges and Choices of Development*, O.J. Taylor, compiler, U.S. Geological Survey Professional Paper 1310.

NNSA (National Nuclear Security Administration), 2002. *Corrective Action Investigation Report for the Rio Blanco Site, Colorado*, DOE/NV–860, Nevada Operations Office, Las Vegas, Nevada, October.

Pawloski, G.A., A.F.B. Tompson, and S.F. Carle (editors), 2001. *Evaluation of the Hydrologic Source Term from Underground Nuclear Tests on Pahute Mesa at the Nevada Test Site: The CHESIRE Test*, Lawrence Livermore National Laboratory, UCRL-ID-147023.

Sampling and Analysis Plan for U.S. Department of Energy Office of Legacy Management Sites, LMS/PRO/S04351, continually updated, prepared by Navarro Research and Engineering, Inc., for the U.S. Department of Energy Office of Legacy Management.

Stoner, 2003. Donna Stoner, Environmental Protection Specialist, Colorado Department of Public Health and Environment, letter (regarding approval of surface closure at the Rio Blanco Site) to Runore C. Wycoff, Director, Environmental Restoration Division, U.S. Department of Energy Nevada Operations Office, February 11.

Toman, J., 1974. *Project Rio Blanco: Project Scientist's Summary Report of Production Test Data and Preliminary Analysis of Top Chimney/Cavity*, UCRL-76280, Lawrence Livermore Laboratory, Livermore, California, November.

Toman, J., 1975. *Project Rio Blanco: Project Scientist's Summary Report of Production Test Data and Preliminary Analysis of Top Chimney/Cavity*, UCRL-76280 REV1, Lawrence Livermore Laboratory, Livermore, California, March.

Tompson, A.F.B., C.J. Bruton, and G.A. Pawloski (editors), 1999. *Evaluation of the Hydrologic Source Term from Underground Nuclear Tests in Frenchman Flat at the Nevada Test Site: The CAMBRIC Test*, Lawrence Livermore National Laboratory, UCRL-ID-132300.

USGS (U.S. Geological Survey), 1972. *Hydraulic Testing and Sampling of Holes RB-E-01 and RB-D-01, Project Rio Blanco, Rio Blanco County, Colorado*, USGS-474-150, Lakewood, Colorado, November.

Appendix A

Data Validation Memo

May 2019 Groundwater and Surface Water Data from the Rio Blanco, Colorado, Site

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memo

To:	Rick Findlay, Navarro
From:	Stephen Donivan, Navarro
CC:	Janice McDonald, Navarro
Date:	September 24, 2019
Re:	Validation of May 2019 Groundwater and Surface Water Data from the Rio Blanco, Colorado, Site

Validation of data generated from the May 2019 groundwater and surface water 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 RBL01-01.1905002. Planned monitoring locations are shown in the Sampling and Analysis Work Order (Enclosure 1). Samples were collected at 14 of the 15 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. There were no significant issues with the field activities.

Assessment of Field Quality Control Samples

Assessment of field quality control samples was conducted. A duplicate sample was collected from location Fawn Creek 8400ft Dw. The duplicate results met all applicable criteria, demonstrating acceptable overall precision of the measurement process.

Laboratory Performance Assessment (Enclosure 4)

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

Assessment of Anomalous Data (Enclosure 5)

Assessment of anomalous data is documented in Enclosure 5. There were no outliers identified.

Enclosures (5)

Enclosure 1
Sampling and Analysis Work Order

NAVARRO

Navarro Research and Engineering, Inc.

May 1, 2019

Task Assignment 104
Control Number 19-1038

U.S. Department of Energy
Office of Legacy Management
ATTN: Jalena Dayvault
LM 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 Off Sites and Monticello Site
May 2019 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 27, 2019.

The following lists show the locations scheduled for sampling during this event.

<u>**MONITORING WELLS**</u>

Off-Site

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

On-Site

Johnson Artesian WL Brennan Windmill

<u>**SURFACE LOCATIONS**</u>

On-Site

Fawn Creek 500ft Dwn Fawn Creek 500ft Ups

Off-Site

B-1 Equity Camp	CER #1 Black Sulphur	CER #4 Black Sulphur	Fawn Creek #1
Fawn Creek #3	Fawn Creek 6800ft Up	Fawn Creek 8400ft Dw	

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

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)
2019.05.01 11:26:06 -06'00'

Richard C. Findlay
LMS Site Lead

RCF/lcg/ks

Enclosures

cc: (electronic)
Bari Brooks, DOE
Darryl Groves, DOE
Jeanie Gueretta, DOE
Paul Kerl, DOE
Art Kleinrath, DOE
Ken Kreie, DOE
Stephen Browning, Navarro
Steve Donivan, Navarro
Richard Findlay, Navarro
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File: LM 0610.10
PBL 0410.02

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

Constituent Sampling Breakdown

Site	Rio Blanco				
Analyte	Groundwater	Surface Water	Required Detection Limit (mg/L)	Analytical Method	Line Item Code
Approx. No. Samples/yr	6	9			
Field Measurements					
Total Alkalinity					
Dissolved Oxygen					
Redox Potential					
pH	X	X			
Specific Conductance	X	X			
Turbidity	X				
Temperature	X	X			
Laboratory Measurements					
Aluminum					
Ammonia as N (NH3-N)					
Calcium					
Chloride					
Chromium					
Gamma Spec	X	X	10 pCi/L	Gamma Spectrometry	GAM-A-001
Gross Alpha					
Gross Beta					
Iron					
Lead					
Magnesium					
Manganese					
Molybdenum					
Nickel					
Nickel-63					
Nitrate + Nitrite as N (NO3+NO2)-N					
Potassium					
Radium-226					
Radium-228					
Selenium					
Silica					
Sodium					
Strontium					
Sulfate					
Sulfide					
Total Organic Carbon					
Tritium	X	X	400 pCi/L	Liquid Scintillation	LSC-A-001
Tritium, enriched	25% of the samples	25% of the samples	10 pCi/L	Liquid Scintillation	LMR-15
Uranium					
Vanadium					
Zinc					
Total No. of Analytes	3	3			

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
- SURFACE LOCATION 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 2019

DATE PREPARED: March 25, 2019

FILENAME: S2482000-11x17

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Enclosure 2
Trip Report

memo

To: Rick Findlay, Navarro
From: Samantha Tigar, Navarro
Date: June 3, 2019
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 28, 2019

Team Members: Jennifer Graham and Samantha Tigar, Navarro

Number of Locations Sampled: Samples were collected from 14 of the 15 locations identified on the sampling notification letter.

Locations Not Sampled/Reason: The Brennan Windmill was not pumping; therefore the location was not sampled.

Location Specific Information: Table 1 provides location specific information.

Table 1. Location Specific Information

Location IDs	Comments
Fawn Creek 6800ft Up	Turbidity was greater than 10 NTUs at this location. The sample for gamma spectrometry was filtered; the tritium sample was not filtered.

Quality Control Sample Cross Reference: A summary of the quality control sample collected is shown in Table 2.

Table 2. Quality Control Sample Summary

False ID	Sample ID	Location ID	Parent Sample ID	Sample Type	Associated Matrix
2489	RBL01-01.1905002-016	Fawn Creek 8400ft Dw	RBL01-01.1905002-010	Duplicate	Surface Water

Task Code Assigned: All samples were assigned to RBL01-01.1905002. Field data sheets can be found in \\crow\SMS\RBL01-01.1905002\RECORDS\FieldData.

Sample Shipment: Samples were shipped overnight via FedEx from Grand Junction, CO, to ARS International in Port Allen, LA, on May 30, 2019.

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: R. Findlay and J. Trnka (Navarro) were present for some sampling activities.

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: None.

Future Actions Required or Suggested: None.

Enclosure 3
Field Data Assessment

Water Sampling Field Activities Verification Checklist

Project	Rio Blanco, Colorado, Site	**Date(s) of Water Sampling**	May 28, 2019
Date(s) of Verification	September 12, 2019	**Name of Verifier**	Stephen Donivan

	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 May 1, 2019
2. Were the sampling locations specified in the planning documents sampled?	No	The Brennan Windmill was not sampled because the pump was not operating.
3. Were field equipment calibrations conducted as specified in the above-named documents?	Yes	Calibrations were performed May 27, 2019
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?	Yes	
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	One duplicate was collected from location Fawn Creek 8400ft Dw
10. Were equipment blanks taken at a frequency of one per 20 samples that were collected with non-dedicated equipment?	No	An equipment blank was not required.
11. Were trip blanks prepared and included with each shipment of VOC samples?	NA	VOC samples were not collected.
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 – Sampling Protocol and Field Measurements

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 and Field Measurements

Location	Analyte(s)	Flag	Reason
RB-D-01, RB-D-03, RB-S-03	All analytical results and field measurements	F	Category I low-flow sampling
RB-W-01	All analytical results and field measurements	FQ	Category II low-flow sampling

Sampling Protocol

Sample results for monitoring wells RB-D-01, RB-D-03, RB-S-03, and RB-W-01 were qualified with an F flag, indicating the wells were purged and sampled using the low-flow method.

Well RB-W-01 was classified as Category II because it produced water at a rate less than the minimum low-flow purging rate. The sample results for this well were qualified with a Q flag (qualitative), indicating the samples were not collected under the optimal conditions of the Category I stability criteria.

Field Measurements

No issues associated with the field measurements were noted.

Equipment Blanks

Equipment blanks are prepared and analyzed to document contamination attributable to the sample collection process. Dedicated equipment was used for all sampling and an equipment blank was not required.

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. A duplicate sample was collected from location Fawn Creek 8400ft Dw. 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. All duplicate results met this criteria demonstrating acceptable precision.

Validation Report: Field Duplicates

11-Sep-2019

Project: Rio Blanco Site Monitoring **Task Code:** RBL01-01.1905002 Lab Code: ARS

	Duplicate: RBL01-01.1905002-016				Sample: RBL01-01.1905002-010 Fawn Creek 8400ft Dw						
Analyte	**Result**	**Qualifiers**	**Uncert.**	**Dilution**	**Result**	**Qualifiers**	**Uncert.**	**Dilution**	**RPD**	**RER**	**Units**
Actinium-228	-0.495	U	12.251	1	4.562	U	10.809	1		0.6	pCi/L
Americium-241	-1.539	U	2.826	1	-0.509	U	5.336	1		0.3	pCi/L
Antimony-125	-3.183	U	17.231	1	-1.901	U	386.150	1		0.0	pCi/L
Cerium-144	-0.369	U	7.903	1	4.235	U	8.003	1		0.8	pCi/L
Cesium-134	-0.205	U	6.617	1	-0.525	U	6.386	1		0.1	pCi/L
Cesium-137	0.155	U	1.609	1	0.009	U	1.728	1		0.1	pCi/L
Cobalt-60	-0.036	U	1.452	1	0.036	U	1.389	1		0.1	pCi/L
Europium-152	-2.380	U	10.237	1	1.075	U	4.347	1		0.6	pCi/L
Europium-154	-0.566	U	1.984	1	-1.304	U	2.080	1		0.5	pCi/L
Europium-155	-0.222	U	2.633	1	-1.066	U	2.766	1		0.4	pCi/L
Lead-212	2.072	U	2.463	1	2.598	U	2.754	1		0.3	pCi/L
Potassium-40	-7.099	U	27.054	1	-25.305	U	51.213	1		0.6	pCi/L
Promethium-144	1.017	U	1.663	1	0.100	U	1.487	1		0.8	pCi/L
Promethium-146	0.099	U	1.534	1	-0.660	U	1.965	1		0.6	pCi/L
Ruthenium-106	1.355	U	13.031	1	1.661	U	14.864	1		0.0	pCi/L
Thorium-234	132.490		27.724	1	158.730		27.075	1		1.3	pCi/L
Tritium	-27.946	U	162.969	1	103.103	U	161.803	1		1.1	pCi/L
Uranium-235	7.854	U	1.739	1	10.048		2.124	1		1.6	pCi/L

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

Validation Report: Field Duplicates

11-Sep-2019

Project: Rio Blanco Site Monitoring **Task Code:** RBL01-01.1905002 Lab Code: ARS

	Duplicate: RBL01-01.1905002-016				Sample: RBL01-01.1905002-010 Fawn Creek 8400ft Dw						
Analyte	**Result**	**Qualifiers**	**Uncert.**	**Dilution**	**Result**	**Qualifiers**	**Uncert.**	**Dilution**	**RPD**	**RER**	**Units**
Uranium-238	132.490		27.724	1	158.730		27.075	1		1.3	pCi/L
Yttrium-88	0.822	U	1.664	1	1.185	U	1.578	1		0.3	pCi/L

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

Enclosure 4
Laboratory Performance Assessment

General Information

Task Code:	RBL01-01.1905002
Sample Event:	May 28, 2019
Site(s):	Rio Blanco, Colorado, Site
Laboratory:	ARS Aleut Analytical, Port Allen, Louisiana
Work Order No.:	ARS1-19-01362
Analysis:	Radiochemistry
Validator:	Stephen Donivan
Review Date:	September 11, 2019

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 2. Analytes and Methods

Analyte	Line Item Code	Prep Method	Analytical Method
Gamma Spectrometry	GAM-A-001	EPA 901.1	EPA 901.1
Tritium, Enrichment Method	LMR-17	DOE HASL 300	DOE HASL 300
Tritium	LSC-A-001	EPA 906.0m	EPA 906.0m

Data Qualifier Summary

Analytical results were qualified as listed in Table 3. Refer to the sections below for an explanation of the data qualifiers applied.

Table 3. Data Qualifier Summary

Sample Number	Location	Analyte	Flag	Reason
RBL01-01.1905002-001	RB-S-03	Thorium-234	U	Nuclide identification criteria were not met
RBL01-01.1905002-001	RB-S-03	Uranium-238	U	Nuclide identification criteria were not met
RBL01-01.1905002-002	RB-W-01	Thorium-234	U	Nuclide identification criteria were not met
RBL01-01.1905002-002	RB-W-01	Uranium-238	U	Nuclide identification criteria were not met
RBL01-01.1905002-002	RB-W-01	Uranium-235	U	Nuclide identification criteria were not met
RBL01-01.1905002-004	Fawn Creek 500ft Dwn	Uranium-235	U	Nuclide identification criteria were not met
RBL01-01.1905002-005	Fawn Creek 500ft Ups	Thorium-234	U	Nuclide identification criteria were not met
RBL01-01.1905002-005	Fawn Creek 500ft Ups	Uranium-235	U	Nuclide identification criteria were not met

Table 3. Data Qualifier Summary (continued)

Sample Number	Location	Analyte	Flag	Reason
RBL01-01.1905002-005	Fawn Creek 500ft Ups	Uranium-238	U	Nuclide identification criteria were not met
RBL01-01.1905002-006	Fawn Creek #3	Thorium-234	U	Nuclide identification criteria were not met
RBL01-01.1905002-006	Fawn Creek #3	Uranium-235	U	Nuclide identification criteria were not met
RBL01-01.1905002-006	Fawn Creek #3	Uranium-238	U	Nuclide identification criteria were not met
RBL01-01.1905002-007	CER #1 Black Sulphur	Lead-212	U	Nuclide identification criteria were not met
RBL01-01.1905002-007	CER #1 Black Sulphur	Potassium-40	U	Less than the Decision Level
RBL01-01.1905002-007	CER #1 Black Sulphur	Thorium-234	U	Nuclide identification criteria were not met
RBL01-01.1905002-007	CER #1 Black Sulphur	Uranium-235	U	Nuclide identification criteria were not met
RBL01-01.1905002-007	CER #1 Black Sulphur	Uranium-238	U	Nuclide identification criteria were not met
RBL01-01.1905002-008	CER #4 Black Sulphur	Thorium-234	U	Nuclide identification criteria were not met
RBL01-01.1905002-008	CER #4 Black Sulphur	Uranium-235	U	Nuclide identification criteria were not met
RBL01-01.1905002-008	CER #4 Black Sulphur	Uranium-238	U	Nuclide identification criteria were not met
RBL01-01.1905002-009	Fawn Creek #1	Thorium-234	U	Nuclide identification criteria were not met
RBL01-01.1905002-009	Fawn Creek #1	Uranium-235	U	Nuclide identification criteria were not met
RBL01-01.1905002-009	Fawn Creek #1	Uranium-238	U	Nuclide identification criteria were not met
RBL01-01.1905002-010	Fawn Creek 8400ft Dw	Thorium-234	U	Nuclide identification criteria were not met
RBL01-01.1905002-010	Fawn Creek 8400ft Dw	Uranium-235	U	Nuclide identification criteria were not met
RBL01-01.1905002-010	Fawn Creek 8400ft Dw	Uranium-238	U	Nuclide identification criteria were not met
RBL01-01.1905002-011	Fawn Creek 6800ft Up	Uranium-235	U	Nuclide identification criteria were not met
RBL01-01.1905002-012	RB-D-01	Thorium-234	U	Nuclide identification criteria were not met
RBL01-01.1905002-012	RB-D-01	Uranium-238	U	Nuclide identification criteria were not met
RBL01-01.1905002-013	RB-D-03	Uranium-235	U	Nuclide identification criteria were not met
RBL01-01.1905002-014	Johnson Artesian WL	Thorium-234	U	Nuclide identification criteria were not met
RBL01-01.1905002-014	Johnson Artesian WL	Uranium-238	U	Nuclide identification criteria were not met
RBL01-01.1905002-014	Johnson Artesian WL	Uranium-235	U	Nuclide identification criteria were not met
RBL01-01.1905002-015	B-1 Equity Camp	Lead-212	U	Less than the Decision Level
RBL01-01.1905002-015	B-1 Equity Camp	Thorium-234	U	Nuclide identification criteria were not met
RBL01-01.1905002-015	B-1 Equity Camp	Uranium-238	U	Nuclide identification criteria were not met
RBL01-01.1905002-015	B-1 Equity Camp	Uranium-235	U	Nuclide identification criteria were not met
RBL01-01.1905002-016	Fawn Creek 8400ft Dw	Thorium-234	U	Nuclide identification criteria were not met
RBL01-01.1905002-016	Fawn Creek 8400ft Dw	Uranium-238	U	Nuclide identification criteria were not met

Sample Shipping/Receiving

ARS Aleut Analytical in Port Allen, Louisiana, received 15 water samples on May 31, 2019, accompanied by a Chain of Custody form. The Chain of Custody form was checked to confirm that all of 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. Copies of the air waybill labels were 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.

Gamma Spectrometry

Activity concentrations above the MDC were reported in some instances where minimum nuclide identification criteria were not met. Such tentative identifications result when the software attempts to calculate net activity concentrations for analytes where any of the following criteria are not satisfied: one or more characteristic peaks for a nuclide must be identified above the critical level, peak shape meets acceptance criteria, or the minimum library peak abundance must be attained. Sample results for gamma-emitting radionuclides that do not meet the identification criteria are qualified with a U flag as not detected.

Method Blanks

Method blanks are analyzed to assess any contamination that may have occurred during sample preparation. All method blank results associated with the samples were below the DLC for all analytes.

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 29, 2019. 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.

General Data Validation Report

Task Code: RBL01-01.1905002 **Lab Code:** ARS **Validator:** Stephen Donivan **Validation Date:** 09-11-2019

Project: Rio Blanco Site Monitoring **# Samples:** 15

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:	There were no detection limits above the contract required limits.
Field Duplicates:	There was 1 duplicate evaluated.

Radiochemistry Data Validation Worksheet

11-Sep-2019

Project: Rio Blanco Site Monitoring **Task Code:** RBL01-01.1905002 **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-B19-01073-01	Enriched Tritium	07-31-2019	LCS	TRG	41.237		12.924	101		75	125				
ARS1-B19-01073-02	Enriched Tritium	07-31-2019	LCSD	TRG	41.775		12.991	102		75	125	1	25		
ARS1-B19-01073-03	Enriched Tritium	07-31-2019	MB	TRG	1.266	U	2.879								
ARS1-B19-01324-01	Americium-241	07-16-2019	LCS	TRG	43436.000		3301.100	99		75	125				
ARS1-B19-01324-01	Cesium-137	07-16-2019	LCS	TRG	53632.000		2477.800	103		75	125				
ARS1-B19-01324-01	Cobalt-60	07-16-2019	LCS	TRG	69349.000		2869.600	101		75	125				
ARS1-B19-01324-02	Americium-241	07-16-2019	LCSD	TRG	41331.000		2966.100	94		75	125	4	25		
ARS1-B19-01324-02	Cesium-137	07-16-2019	LCSD	TRG	53028.000		2347.300	102		75	125	1	25		
ARS1-B19-01324-02	Cobalt-60	07-16-2019	LCSD	TRG	68452.000		2961.600	100		75	125	1	25		
ARS1-B19-01324-03	Actinium-228	08-02-2019	MB	TRG	16.286	U	9.358								
ARS1-B19-01324-03	Americium-241	08-02-2019	MB	TRG	-1.688	U	11.377								
ARS1-B19-01324-03	Antimony-125	08-02-2019	MB	TRG	-0.489	U	13.051								
ARS1-B19-01324-03	Cesium-134	08-02-2019	MB	TRG	-1.050	U	937.620								
ARS1-B19-01324-03	Cesium-137	08-02-2019	MB	TRG	1.858	U	1.583								
ARS1-B19-01324-03	Cobalt-60	08-02-2019	MB	TRG	-1.580	U	6.403								
ARS1-B19-01324-03	Europium-152	08-02-2019	MB	TRG	-0.125	U	3.336								
ARS1-B19-01324-03	Europium-154	08-02-2019	MB	TRG	-0.056	U	1.373								
ARS1-B19-01324-03	Lead-212	08-02-2019	MB	TRG	-2.525	U	3.745								
ARS1-B19-01324-03	Potassium-40	08-02-2019	MB	TRG	-14.629	U	31.425								
ARS1-B19-01324-03	Ruthenium-106	08-02-2019	MB	TRG	0.862	U	16.994								

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

Radiochemistry Data Validation Worksheet

11-Sep-2019

Project: Rio Blanco Site Monitoring **Task Code:** RBL01-01.1905002 **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-B19-01324-03	Thorium-234	08-02-2019	MB	TRG	20.087	U	9.625								
ARS1-B19-01324-03	Uranium-235	08-02-2019	MB	TRG	2.090	U	1.998								
ARS1-B19-01324-03	Uranium-238	08-02-2019	MB	TRG	20.087	U	9.625								
ARS1-B19-01324-03	Yttrium-88	08-02-2019	MB	TRG	1.352	U	1.533								
ARS1-B19-01632-01	Tritium	08-24-2019	LCS	TRG	2951.897		379.113	106		75	125				
ARS1-B19-01632-02	Tritium	08-24-2019	LCSD	TRG	2813.839		366.276	101		75	125	4	25		
ARS1-B19-01632-03	Tritium	08-24-2019	MB	TRG	55.400	U	166.072								
ARS1-B19-01632-15	Tritium	08-25-2019	MS	TRG	4340.274		509.954	94		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 were no potential outliers identified, and the data for this event are acceptable as qualified.

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