LMS/RBL/S14378

2016 Long-Term Hydrologic Monitoring Program Report for Rio Blanco, Colorado, Site

July 2018

Approved for public release; further dissemination unlimited

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
SGZ	surface ground zero

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 that detonated three nuclear devices nearly simultaneously in a single borehole in 1973. The test resulted in residual radionuclide contamination at the depth of the detonations, which were approximately 5840 feet (ft), 6230, and 6,690 ft below ground surface (Toman 1975). 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 2016. 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 located 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 approximately 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 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 rubble 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).

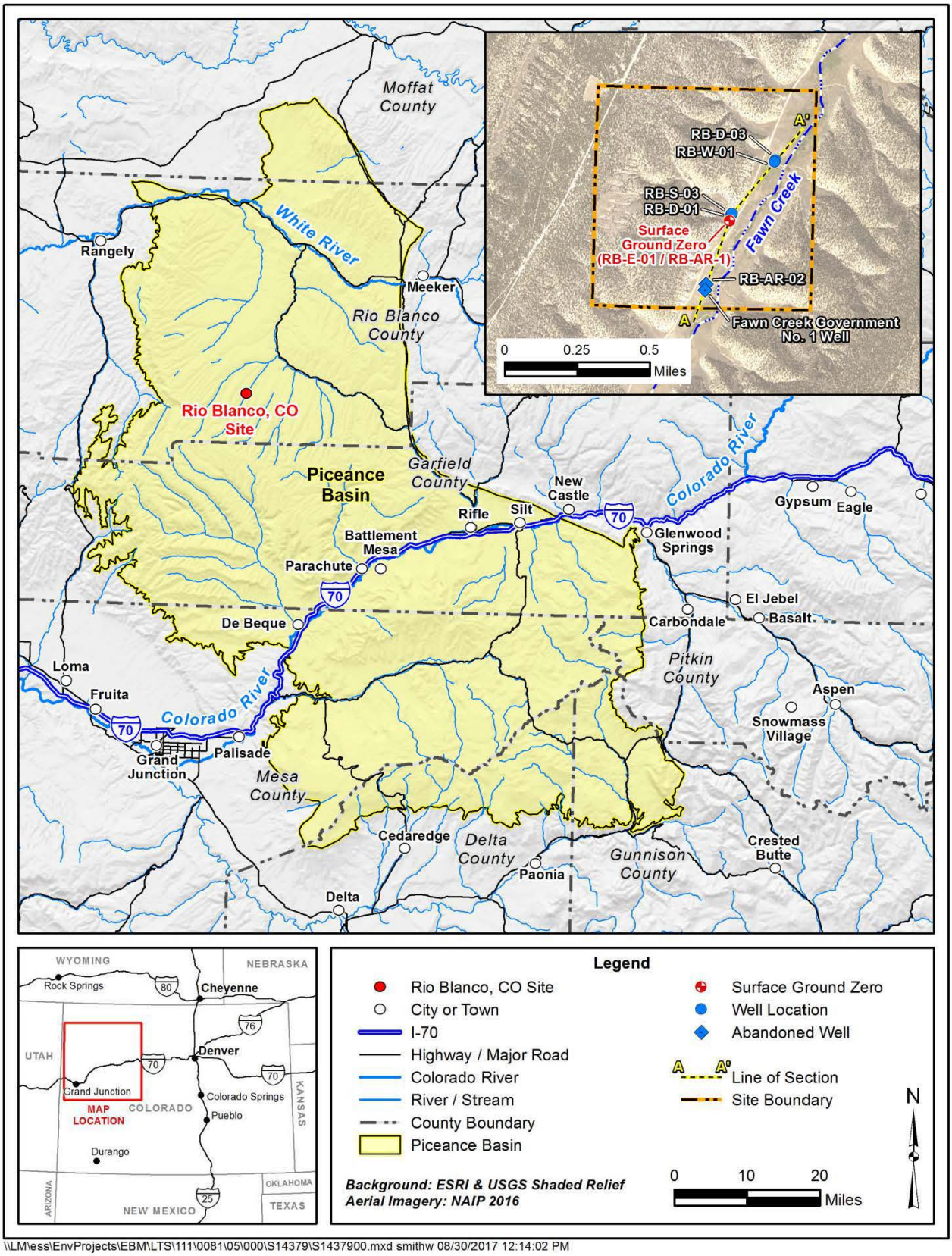

Figure 1. Site Location Map, Rio Blanco, Colorado, Site

Site decommissioning and cleanup activities were initiated in May 1976. This 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.

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 (CDPHE 2003).

2.1 Source of Contamination

Surface and subsurface contamination resulted from the underground Rio Blanco nuclear test. CDPHE approved closure of the surface with no further actions 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 water. 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.

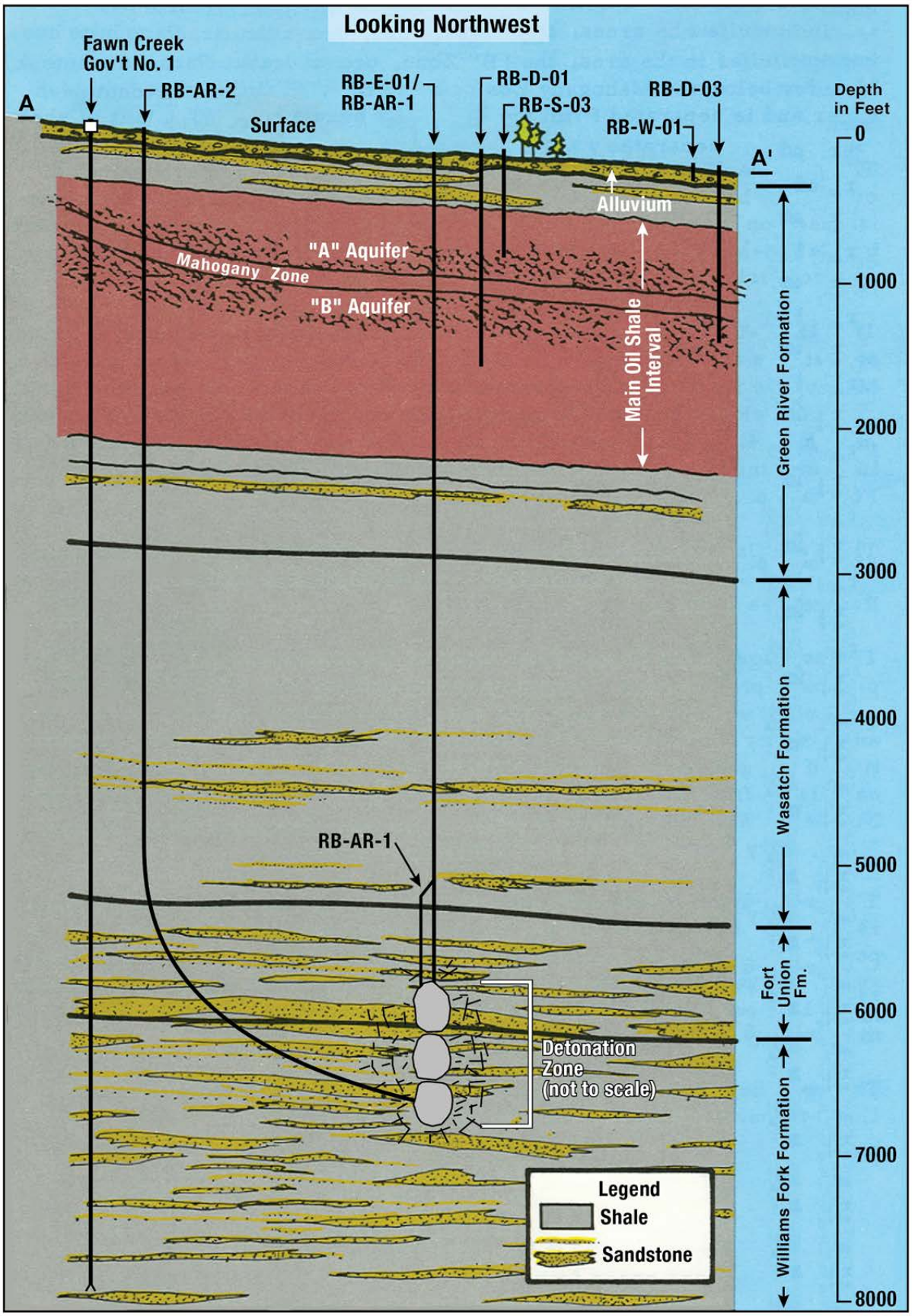

Figure 2. Piceance Basin Cross Section

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 indicate 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 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 located 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 ft and 6160 ft at the site (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 the 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, which was later recompleted as the RB-AR-1 reentry well (also referred to as surface ground zero [SGZ]). Fawn Creek discharges into Black Sulfur 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 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 gpm (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. Analytical results show that Rio Blanco nuclear-test-related contamination has not impacted groundwater or surface water at the sample 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 is 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 near the site to assess for any potential impacts that may be attributed to the Rio Blanco nuclear test. Laboratory analytical results from the sampling of natural gas wells are summarized in a separate report. A summary of the groundwater and surface water sampling is provided with the laboratory analytical 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 was initiated in 1972 as part of the LTHMP. The sampling has continued to assure the public that no radiological contamination associated with the Rio Blanco nuclear test has impacted the sample locations near the site. Samples were collected from 15 locations (Figure 3) during this monitoring event 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 Rio Blanco, site (Figure 3). Samples collected 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) (Sampling and Analysis Plan). The Sampling and Analysis Plan can be accessed on the LM public website at https://energy.gov/lm/downloads/sampling-and-analysis-plan-us-department-energy-office-legacy-management-sites.

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 11 locations were analyzed using the conventional method, and four sample 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 data were validated according to the "Standard Practice for Validation of Environmental Data" section in the *Environmental Procedures Catalog* (LMS/POL/S04325).

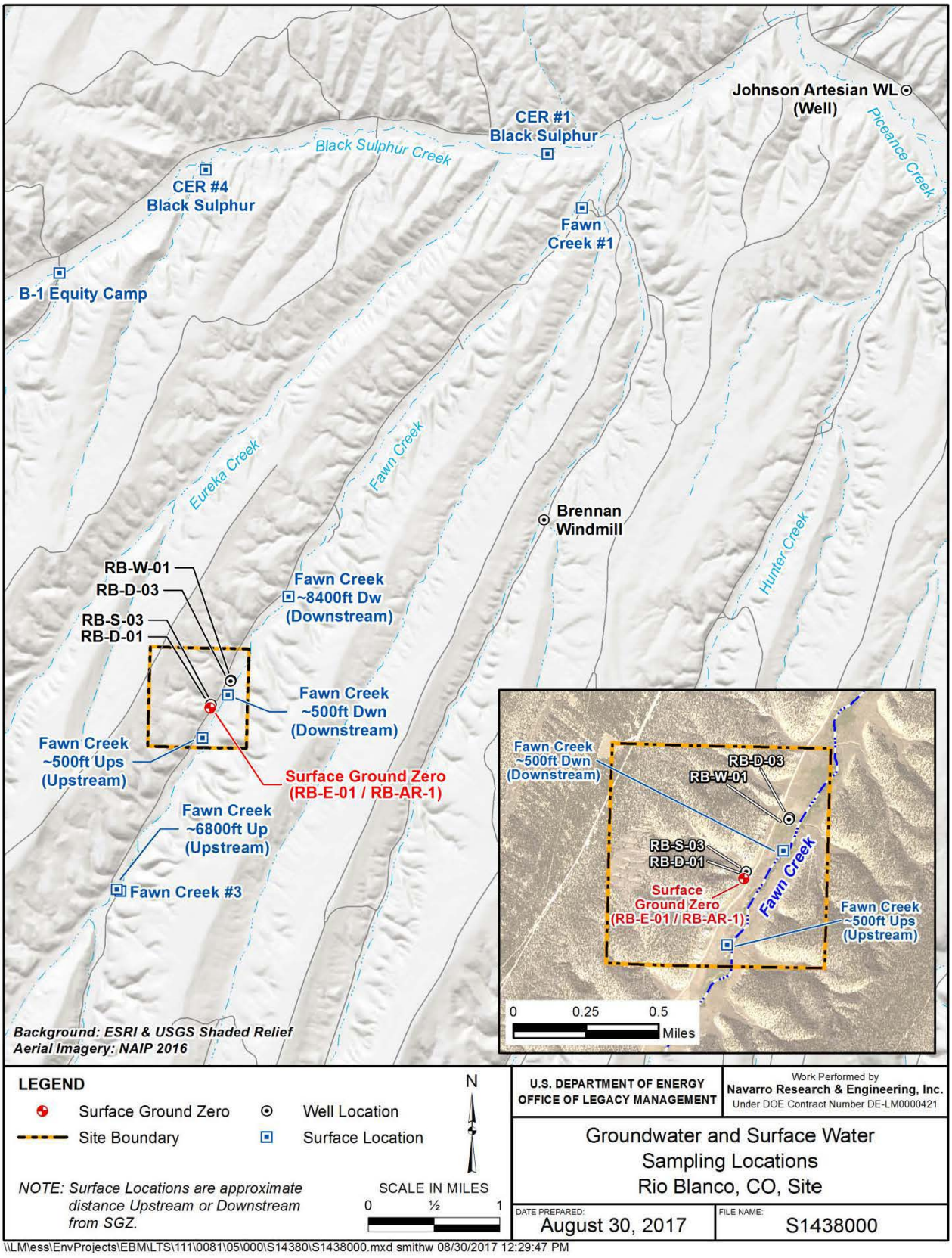

Figure 3. Groundwater and Surface Water Sample Locations, Rio Blanco, Colorado, Site

3.2 Groundwater and Surface Water Sample Analytical Results

Table 1 shows the laboratory analytical results for samples collected at the Rio Blanco site on May 23, 2016. The results continue to demonstrate that no Rio Blanco site detonation-related contaminants have impacted any of the sampled locations. Tritium was not detected above the laboratory minimum detectable concentration using the conventional analytical method. Two of the four samples analyzed using the enrichment method detected tritium above the laboratory minimum detectable concentration (Table 1). 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 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 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 (pCi/L) (Title 40 *Code of Federal Regulations* Part 141.16). No other radionuclides were detected by high-resolution gamma spectrometry analysis. Specific radionuclides that are included in gamma spectrometry analysis are listed in the data validation package provided as Appendix A.

Table 1. Groundwater and Surface Water Sample Analytical Results for Rio Blanco Site Samples Collected May 23, 2016

Sample Location	Sample Type	Tritium by Conventional Method (pCi/L)	Tritium by Enrichment Method (pCi/L)	Gamma-Emitting Radionuclides[a] (pCi/L)
RB-D-01 (well)	Groundwater	NA	<2.59	ND
RB-S-03 (well)		<386	NA	ND
RB-D-03 (private well)		NA	<2.82	ND
RB-W-01 (private well)		<382	NA	ND
Johnson artesian well (private well)		NA	4.18	ND
Brennan windmill (private well)		<385	NA	ND
Fawn Creek 500 ft downstream of SGZ	Surface water	<398	NA	ND
Fawn Creek 500 ft upstream of SGZ		<399	NA	ND
		<335[b]	NA	ND[b]
B-1 Equity Camp		NA	15.5	ND
CER #1 Black Sulphur		<339	NA	ND[c]
CER #4 Black Sulphur		<337	NA	ND
Fawn Creek #1		<394	NA	ND
Fawn Creek #3		<399	NA	ND[c]
Fawn Creek 6800 ft upstream of SGZ		<400	NA	ND
Fawn Creek 8400 ft downstream of SGZ		<335	NA	ND

Notes:
[a] See data validation package for list of radionuclides included in this analysis.
[b] Field duplicate sample.
[c] The sample was filtered because the turbidity requirements were not met per the Sampling and Analysis Plan.

Abbreviations:
ft = feet
NA = not analyzed
ND = not detected
SGZ = surface ground zero

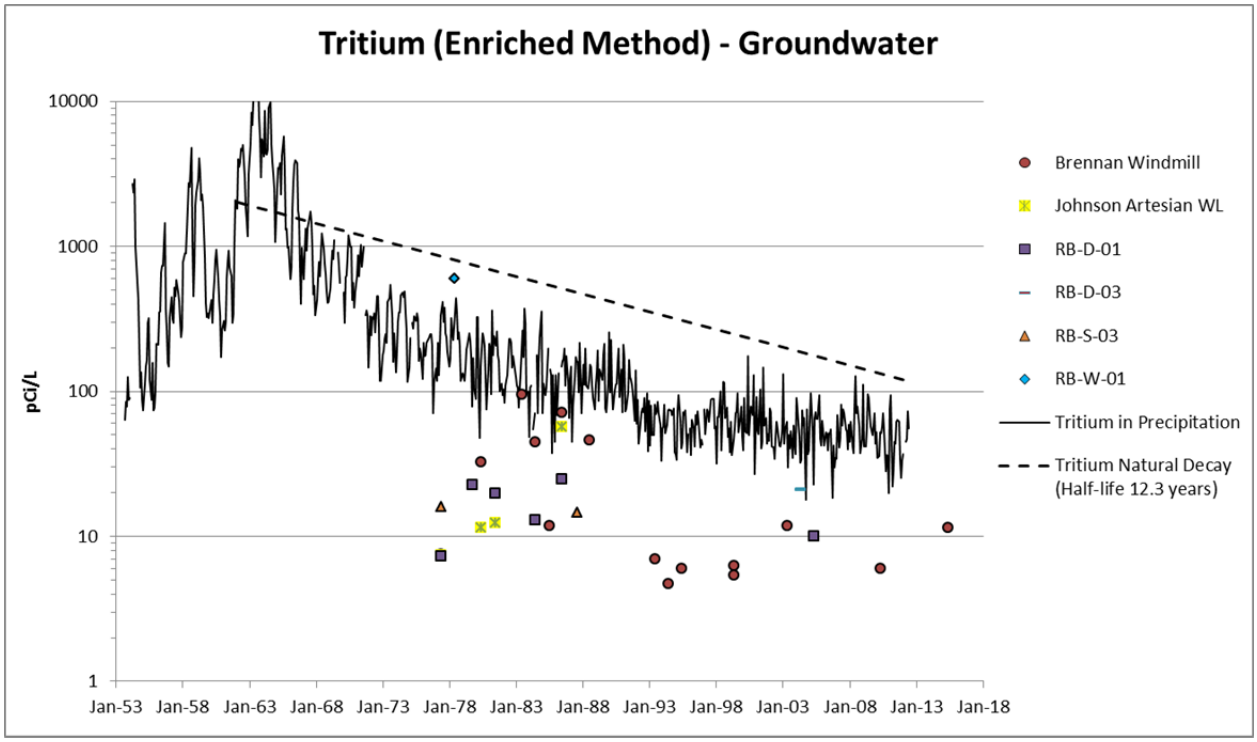

Figure 4. Comparison of Enriched Tritium in Sampled Wells in the Vicinity of the Rio Blanco Site with Tritium in Precipitation at Ottawa, Canada (site with longest historical tritium record [Brown 1995])

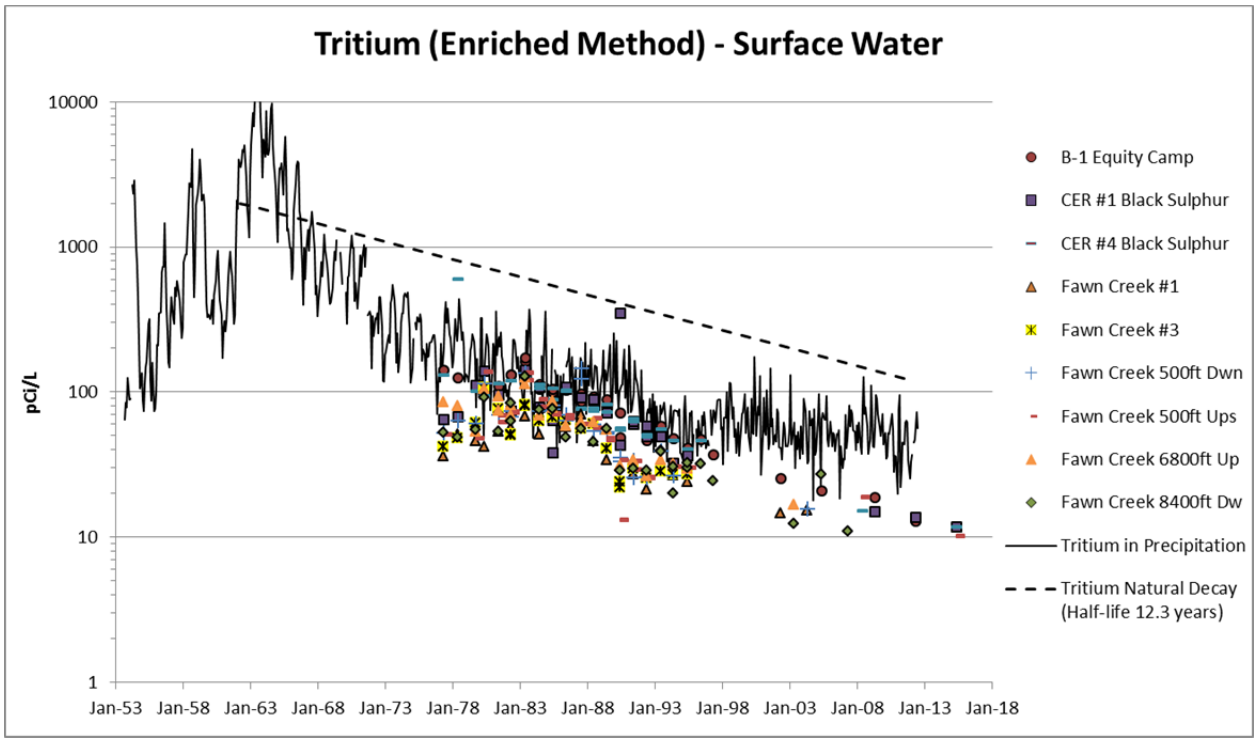

Figure 5. Comparison of Enriched Tritium in Shallow Aquifer Surface Water in the Vicinity of the Rio Blanco Site with Tritium in Precipitation at Ottawa, Canada (site with longest historical tritium record [Brown 1995])

4.0 Conclusions

The laboratory analytical results obtained from this monitoring event continue to demonstrate that no Rio Blanco site detonation-related contaminants have impacted the groundwater and surface water near the site. 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

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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.

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Appendix A

Data Validation Package
May 2016 Groundwater and Surface Water Sampling at the Rio Blanco, Colorado, Site

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Data Validation Package

May 2016
Groundwater and Surface Water Sampling at the Rio Blanco, Colorado, Site

February 2017

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Sampling Event Summary

Site: Rio Blanco, Colorado, Site

Sampling Period: May 23, 2016

Annual sampling was conducted at the Rio Blanco, Colorado, site for the Long-Term Hydrologic Monitoring Program on May 23, 2016, to monitor groundwater and surface water for potential radionuclide contamination. Planned monitoring locations are shown in Attachment 1, Sampling and Analysis Work Order.

Sampling and analyses were conducted as specified in the *Sampling and Analysis Plan for U.S. Department of Energy Office of Legacy Management Sites* (LMS/PRO/S04351, continually updated, http://energy.gov/lm/downloads/sampling-and-analysis-plan-us-department-energy-office-legacy-management-sites). A duplicate sample was collected from location Fawn Creek 500ft Ups. Samples were analyzed for gamma-emitting radionuclides by high-resolution gamma spectrometry and for tritium using the conventional and enrichment methods. Water levels were measured at all sampled wells. See Attachment 2, Trip Report for additional details.

The electrolytic enrichment method for tritium analysis yielded positive results for the samples analyzed ranging from 4.2 to 15.5 picocuries per liter (pCi/L). These results are consistent with background levels for tritium and are well below the EPA drinking water standard for tritium of 20,000 pCi/L. All high-resolution gamma spectrometry results were below detectable concentrations. An assessment of anomalous data is included in Attachment 4. The results from this sampling event indicate that groundwater and surface water supplies in the area have not been impacted by detonation-related contaminants.

Richard C. Findlay — 8-29-2017

Rick Findlay, Site Lead — Date
Navarro Research and Engineering, Inc.

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Data Assessment Summary

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Water Sampling Field Activities Verification Checklist

Project	Rio Blanco, Colorado, Site	**Date(s) of Water Sampling**	May 23, 2016
Date(s) of Verification	January 25, 2017	**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 April 14, 2016.
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 on May 19, 2016.
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	A duplicate sample was collected at location Fawn Creek 500ft Ups.
10. Were equipment blanks taken at a frequency of one per 20 samples that were collected with non-dedicated equipment?	Yes	One equipment blank was collected.
11. Were trip blanks prepared and included with each shipment of VOC samples?	NA	
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 cooling was not required.
19. Were water levels measured at the locations specified in the planning documents?	Yes	

Laboratory Performance Assessment

General Information

Task ID:	RBL01.1-16050001
Sample Event:	May 23, 2016
Site(s):	Rulison, Colorado, Site
Laboratory:	GEL Laboratories, Charleston, South Carolina
Work Order No.:	398221
Analysis:	Radiochemistry
Validator:	Stephen Donivan
Review Date:	January 24, 2017

This validation was performed according to "Standard Practice for Validation of Environmental Data" found in Appendix A of the *Sampling and Analysis Plan for U.S. Department of Energy Office of Legacy Management Sites* (LMS/PRO/S04351, continually updated, http://energy.gov/lm/downloads/sampling-and-analysis-plan-us-department-energy-office-legacy-management-sites). 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 Figures 1 and 2, Data Validation Worksheets). The DQIs comparability, completeness, and sensitivity 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 1.

Table 1. 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 2 based on this validation. Refer to the validation worksheets and the sections below for an explanation of the data qualifiers applied.

Table 2. Data Validation Qualifiers

Sample Number	Location	Analyte	Flag	Reason
398221016	Johnson Artesian WL	Tritium	J	Less than the determination limit

Sample Shipping/Receiving

GEL Laboratories in Charleston, South Carolina, received 19 water samples on May 26, 2016, accompanied by a Chain of Custody form. The Chain of Custody was checked to confirm that all the samples were listed with a sample collection date and time, and that signatures and dates were present indicating sample relinquishment and receipt. The Chain of Custody had no errors or omissions.

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 MDC is a measure of radiochemical method performance and was calculated and reported as specified in *Quality Systems for Analytical Services*. 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 one-sigma total propagated uncertainty. Results that are greater than the MDC, but less than the DLC are qualified with a "U" flag (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 not previously "U" qualified that 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.

Radiochemical Analysis

Tritium
Instrument quench calibration curves were generated on July 1, 2016. The daily instrument checks performed on August 8 and 16, 2016 met the acceptance criteria.

Gamma Spectrometry
The gamma spectrometry efficiency calibrations were performed within a year prior to sample analysis. All daily calibration and background check results met the acceptance criteria.

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 25, 2016. The EDD was examined to verify that the file was complete and in compliance with requirements. The contents of the file were compared to the requested analyses to ensure all and only the requested data are delivered. The contents of the EDD were manually examined to verify that the sample results accurately reflect the data contained in the sample data package.

General Data Validation Report

Task Code: RBL01.1-16050001 **Lab Code:** GEN **Validator:** Stephen Donivan **Validation Date:** 01-25-2017

Project: Rio Blanco Site Monitoring **# Samples:** 16

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 238 detection limits above the contract required limits.
Field Blanks:	There was 1 field blank associated with this task.
Field Duplicates:	There was 1 duplicate evaluated.

Figure 1. General Validation Worksheet

Radiochemistry Data Validation Worksheet

24-Jan-2017

Project: Rio Blanco Site Monitoring **Task Code:** RBL01.1-16050001 **Lab Code:** GEN

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
	Actinium-228	08-19-2016	LCS	TRG	-466	U	959								
	Actinium-228	08-19-2016	MB	TRG	3.82	U	17.2								
	Actinium-228	08-19-2016	R	TRG	7.45	U	17.0					0			
	Americium-241	08-19-2016	LCS	SC	1.14E+05		14400	104		75	125				
	Americium-241	08-19-2016	MB	TRG	1.26	U	10.7								
	Americium-241	08-19-2016	R	TRG	11.5	U	22.7					0			
	Antimony-125	08-19-2016	LCS	TRG	-28.4	U	565								
	Antimony-125	08-19-2016	MB	TRG	0.408	U	7.72								
	Antimony-125	08-19-2016	R	TRG	-4.6	U	9.58					0			
	Cerium-144	08-19-2016	LCS	TRG	-839	U	1120								
	Cerium-144	08-19-2016	MB	TRG	-4.2	U	17.7								
	Cerium-144	08-19-2016	R	TRG	20.8	U	25.5					0			
	Cesium-134	08-19-2016	LCS	TRG	-5.53	U	259								
	Cesium-134	08-19-2016	MB	TRG	-0.966	U	3.34								
	Cesium-134	08-19-2016	R	TRG	-1.46	U	3.69					0			
	Cesium-137	08-19-2016	LCS	SC	46400		4800	108		75	125				
	Cesium-137	08-19-2016	MB	TRG	-2.04	U	2.98								
	Cesium-137	08-19-2016	R	TRG	-0.835	U	3.47					32.3			
	Cobalt-60	08-19-2016	LCS	SC	42500		4730	99.4		75	125				
	Cobalt-60	08-19-2016	MB	TRG	-1.26	U	3.27								
	Cobalt-60	08-19-2016	R	TRG	3.77	U	3.52					0			

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

Figure 2. Radiochemistry Validation Worksheet

Radiochemistry Data Validation Worksheet

24-Jan-2017

Project: Rio Blanco Site Monitoring **Task Code:** RBL01.1-16050001 **Lab Code:** GEN

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
	Europium-152	08-19-2016	LCS	TRG	-242	U	519								
	Europium-152	08-19-2016	MB	TRG	-2.24	U	7.80								
	Europium-152	08-19-2016	R	TRG	-5.35	U	11.4					0			
	Europium-154	08-19-2016	LCS	TRG	264	U	357								
	Europium-154	08-19-2016	MB	TRG	0.0973	U	9.02								
	Europium-154	08-19-2016	R	TRG	5.56	U	10.9					0			
	Europium-155	08-19-2016	LCS	TRG	-52.2	U	614								
	Europium-155	08-19-2016	MB	TRG	-4.25	U	8.44								
	Europium-155	08-19-2016	R	TRG	-0.404	U	12.3					0			
	Lead-212	08-19-2016	LCS	TRG	-146	U	292								
	Lead-212	08-19-2016	MB	TRG	4.14	U	8.33								
	Lead-212	08-19-2016	R	TRG	6.76	U	10.0					0			
	Potassium-40	08-19-2016	LCS	TRG	-241	U	881								
	Potassium-40	08-19-2016	MB	TRG	-7.06	U	48.2								
	Potassium-40	08-19-2016	R	TRG	-19.1	U	56.4					0			
	Promethium-144	08-19-2016	LCS	TRG	-97.1	U	179								
	Promethium-144	08-19-2016	MB	TRG	1.83	U	3.23								
	Promethium-144	08-19-2016	R	TRG	-0.872	U	4.22					0			
	Promethium-146	08-19-2016	LCS	TRG	-179	U	292								
	Promethium-146	08-19-2016	MB	TRG	-1.63	U	3.57								
	Promethium-146	08-19-2016	R	TRG	1.44	U	4.57					0			
	Ruthenium-106	08-19-2016	LCS	TRG	597	U	1750								
	Ruthenium-106	08-19-2016	MB	TRG	9.73	U	29.5								

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

Figure 2. Radiochemistry Validation Worksheet (continued)

Radiochemistry Data Validation Worksheet

Project: Rio Blanco Site Monitoring **Task Code:** RBL01.1-16050001 **Lab Code:** GEN

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
	Ruthenium-106	08-19-2016	R	TRG	-35.1	U	37.9					0			
	Thorium-234	08-19-2016	LCS	TRG	-11500	U	14100								
	Thorium-234	08-19-2016	MB	TRG	-65.9	U	128								
	Thorium-234	08-19-2016	R	TRG	25.5	U	230					0			
	Tritium	08-09-2016	LCS	SC	83.2		24.9	102		75	125				
	Tritium	08-09-2016	MB	TRG	1.49	U	1.67								
	Tritium	08-16-2016	MB	TRG	4.02	U	223								
	Tritium	08-16-2016	MS	SC	1800		470	77.1		75	125				
	Tritium	08-16-2016	R	TRG	2.05	U	217					0			
	Tritium	08-17-2016	LCS	SC	2050		512	88.8		75	125				
	Uranium-235	08-19-2016	LCS	TRG	31.0	U	996								
	Uranium-235	08-19-2016	MB	TRG	17.1	U	20.0								
	Uranium-235	08-19-2016	R	TRG	-1.31	U	24.7					0			
	Uranium-238	08-19-2016	LCS	TRG	-11500	U	14100								
	Uranium-238	08-19-2016	MB	TRG	-65.9	U	128								
	Uranium-238	08-19-2016	R	TRG	25.5	U	230					0			
	Yttrium-88	08-19-2016	LCS	TRG	-16.7	U	94.7								
	Yttrium-88	08-19-2016	MB	TRG	1.23	U	3.30								
	Yttrium-88	08-19-2016	R	TRG	12.0	U	9.68					0			

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

Figure 2. Radiochemistry Validation Worksheet (continued)

Sampling Quality Control Assessment

The following information summarizes and assesses quality control for this sampling event.

Sampling Protocol

Wells RB-D-01, RB-D-03, RB-S-03, and RB-W-01 were sampled using dedicated bladder pumps or a peristaltic pump with dedicated tubing. Data from these wells are qualified with an "F" flag in the database indicating the wells were purged and sampled using the low-flow sampling method. The data from well RB-W-01 were further qualified with a "Q" flag because this well was classified as Category II. All other sample locations were domestic wells or surface water locations.

Equipment Blank

Equipment blanks were prepared and analyzed to document contamination attributable to the sample collection process. One equipment blank was submitted with these samples. There were no analytes detected in this blank.

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 500ft Ups. 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 (Figure 3).

Validation Report: Field Duplicates

24-Jan-2017

Project: Rio Blanco Site Monitoring **Task Code:** RBL01.1-16050001 Lab Code: GEN

	Duplicate: RBL01.1-16050001-016				Sample: RBL01.1-16050001-005 Fawn Creek 500ft Ups						
Analyte	**Result**	**Qualifiers**	**Uncert**	**Dilution**	**Result**	**Qualifiers**	**Uncert.**	**Dilution**	**RPD**	**RER**	**Units**
Actinium-228	6.50	U	18.2	1	-2.33	U	16.4	1		0.7	pCi/L
Americium-241	16.9	U	21.5	1	-14.1	U	23.2	1		1.9	pCi/L
Antimony-125	5.01	U	9.40	1	-1.93	U	8.09	1		1.1	pCi/L
Cerium-144	-3.92	U	20.9	1	-11.3	U	19.2	1		0.5	pCi/L
Cesium-134	-1.26	U	3.82	1	-1.76	U	3.30	1		0.2	pCi/L
Cesium-137	0.433	U	3.86	1	-0.989	U	2.81	1		0.6	pCi/L
Cobalt-60	2.04	U	3.64	1	-0.344	U	3.50	1		0.9	pCi/L
Europium-152	-8.57	U	9.76	1	-1.32	U	11.0	1		-1.0	pCi/L
Europium-154	2.39	U	10.2	1	-3.54	U	8.97	1		0.9	pCi/L
Europium-155	-3.56	U	9.92	1	2.31	U	8.95	1		-0.9	pCi/L
Lead-212	6.31	U	10.8	1	0.705	U	8.54	1		0.8	pCi/L
Potassium-40	4.23	U	55.9	1	-49	U	56.3	1		1.3	pCi/L
Promethium-144	-0.204	U	3.85	1	3.17	U	6.00	1		-0.9	pCi/L
Promethium-146	0.293	U	4.46	1	-0.016	U	3.41	1		0.1	pCi/L
Ruthenium-106	40.2	U	40.3	1	-17.3	U	28.9	1		2.3	pCi/L
Thorium-234	224	U	264	1	-40.1	U	238	1		1.5	pCi/L
Tritium	182	U	203	1	-43.6	U	223	1		1.5	pCi/L
Uranium-235	-9.44	U	23.1	1	-15	U	23.4	1		0.3	pCi/L
Uranium-238	224	U	264	1	-40.1	U	238	1		1.5	pCi/L
Yttrium-88	-3.59	U	6.82	1	9.22	U	5.71	1		-2.8	pCi/L

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

Figure 3. Field Duplicates

Certification

All laboratory analytical quality control criteria were met except as qualified in this report. The data qualifiers listed on the environmental database reports are defined on the last page of each report. All data in this package are considered validated and available for use.

Laboratory Coordinator: Stephen Donivan 2-23-2017
Stephen Donivan Date

Data Validation Lead: Stephen Donivan 2-23-2017
Stephen Donivan Date

Attachment 1

Sampling and Analysis Work Order

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April 14, 2016

Task Assignment 104
Control Number 16-0506

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

SUBJECT: Contract No. DE-LM0000421, Navarro Research & Engineering, Inc. (Navarro)
Task Assignment 104 LTS&M-Nevada Off Sites and Monticello Site
May 2015 Environmental Sampling at the Rio Blanco, Colorado, Site

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

Dear Mr. Kleinrath:

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 at this site as part of the routine environmental sampling currently scheduled to begin the week of May 16, 2016.

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

MONITORING WELLS

Off-Site

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

On-Site

Johnson Artesian WL Brennan Windmill

SURFACE LOCATIONS

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	

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) 248-6477 or Rick Findlay at (970) 248-6419 if you have any questions.

Sincerely,

Richard D. Hutton
LMS Site Lead

RDH/lcg/bkb

Enclosures (3)

cc: (electronic)
Christina Pennal, DOE
Bev Cook, Navarro
Steve Donivan, Navarro
Lauren Goodknight, Navarro
Rick Hutton, Navarro
Kenneth Karp, Navarro
Sam Marutzky, Navarro
Diana Osborne, Navarro
EDD Delivery
rc-grand.junction
File: RUL 400.02

Rio Blanco, Colorado, Site, Planned Sample Locations Map

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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

Be sure to pick different locations from last year for enriched tritium.

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					
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 Dissolved Solids					
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 private well samples are to be unfiltered. The total number of analytes does not include field parameters.

Attachment 2

Trip Report

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memo

NAVARRO

To: Distribution
From: Daniel Sellers
Date: June 7, 2016
CC: Art Kleinrath, DOE
Steve Donivan, Navarro
Rick Findlay, Navarro
Rex Hodges, Navarro
EDD Delivery
Re: Sampling Trip Report

Site: Rio Blanco, Colorado, Site

Date of Sampling Event: May 23, 2016

Team Members: Dan Sellers and Samantha Tigar

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

Locations Not Sampled/Reason: All scheduled locations were sampled.

Location Specific Information:

Location IDs	Comments
Fawn Creek #3 and CER #1 Black Sulphur	Turbidity was not met. Samples for gamma spectrometry were filtered. Samples for tritium were not filtered.
RB-D-01, RB-D-03, Johnson Artesian WL, and B-1 Equity Camp	Enriched tritium samples were collected at these locations.

Quality Control Sample Cross Reference: The following is the false identification assigned to the quality control sample.

False ID	Sample ID	True ID	Sample Type	Associated Matrix
2489	RBL01.1-16050001-016	Fawn Creek 500ft Ups	Duplicate	Surface Water
2731	RBL01.1-16050001-017	Associated with using tubing reel with weight to collect samples at RB-D-03 and RB-W-01	Equipment Blank	Water

Task Code Assigned: Samples were assigned to task code RBL01.1-16050001. Field data sheets can be found in \\crow\SMS\RBL01.1-16050001\FieldData.

Sample Shipment: Samples were shipped overnight via FedEx from Grand Junction, Colorado, to GEL Laboratories in Charleston, South Carolina, on May 25, 2016.

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

Well Inspection Summary: No issues were 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). Earthsoft EDGE, version 6.4 software edition, was used to collect field data for this event.

Field Variance: None.

Equipment: All equipment functioned properly.

Stakeholder/Regulatory/DOE: Nothing to note.

Institutional Controls:

Fences, Gates, and Locks: All property owner gates were left as found.
Signs: No issues were observed.
Trespassing/Site Disturbances: None observed.
Disposal Cell/Drainage Structure Integrity: N/A.

Safety Issues: None.

Access Issues: None.

General Information: Nothing to note.

Immediate Actions Taken: None.

Future Actions Required or Suggested: None.

Attachment 3

Data Presentation

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Groundwater Quality Data

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Groundwater Quality Data by Location For Site RBL01, Rio Blanco Site

Location: Brennan Windmill CO-00419-000110

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Actinium-228	pCi/L	05/23/2016	F	T	-8.03	13.5	18.7	U		Y
Americium-241	pCi/L	05/23/2016	F	T	-2.2	16.5	25.6	U		Y
Antimony-125	pCi/L	05/23/2016	F	T	-2.55	6.67	11.2	U		Y
Cerium-144	pCi/L	05/23/2016	F	T	1.86	17.4	29.5	U		Y
Cesium-134	pCi/L	05/23/2016	F	T	0.123	2.54	4.63	U		Y
Cesium-137	pCi/L	05/23/2016	F	T	0.423	2.97	4.73	U		Y
Cobalt-60	pCi/L	05/23/2016	F	T	0.363	2.44	4.60	U		Y
Europium-152	pCi/L	05/23/2016	F	T	-9.77	9.72	11.4	U		Y
Europium-154	pCi/L	05/23/2016	F	T	-5.92	7.88	10.5	U		Y
Europium-155	pCi/L	05/23/2016	F	T	3.04	8.40	14.4	U		Y
Lead-212	pCi/L	05/23/2016	F	T	4.13	7.37	9.16	U		Y
pH	s.u.	05/23/2016	F	N	8.13					Y
Potassium-40	pCi/L	05/23/2016	F	T	-12	48.1	62.3	U		Y
Promethium-144	pCi/L	05/23/2016	F	T	0.114	2.72	4.92	U		Y
Promethium-146	pCi/L	05/23/2016	F	T	2.90	4.41	5.62	U		Y
Ruthenium-106	pCi/L	05/23/2016	F	T	6.20	24.8	45.5	U		Y
Specific Conductance	umhos/cm	05/23/2016	F	N	2077					Y
Temperature	C	05/23/2016	F	N	15.52					Y
Thorium-234	pCi/L	05/23/2016	F	T	36.8	268	208	U		Y
Tritium	pCi/L	05/23/2016	F	N	-175	207	385	U		Y

Groundwater Quality Data by Location For Site RBL01, Rio Blanco Site

Location: Brennan Windmill CO-00419-000110

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Turbidity	NTU	05/23/2016	F	N	5.04					Y
Uranium-235	pCi/L	05/23/2016	F	T	8.23	24.6	22.2	U		Y
Uranium-238	pCi/L	05/23/2016	F	T	36.8	268	208	U		Y
Yttrium-88	pCi/L	05/23/2016	F	T	2.53	4.10	8.10	U		Y

Groundwater Quality Data by Location For Site RBL01, Rio Blanco Site

Location: Johnson Artesian WL CO-00419-000111

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Actinium-228	pCi/L	05/23/2016	F	T	10.6	19.2	32.6	U		Y
Americium-241	pCi/L	05/23/2016	F	T	2.46	29.3	47.1	U		Y
Antimony-125	pCi/L	05/23/2016	F	T	-9.78	12.4	18.9	U		Y
Cerium-144	pCi/L	05/23/2016	F	T	-8.25	30.5	52.9	U		Y
Cesium-134	pCi/L	05/23/2016	F	T	0.221	4.75	8.89	U		Y
Cesium-137	pCi/L	05/23/2016	F	T	0.251	4.16	7.78	U		Y
Cobalt-60	pCi/L	05/23/2016	F	T	3.92	4.97	9.68	U		Y
Europium-152	pCi/L	05/23/2016	F	T	4.07	12.2	21.6	U		Y
Europium-154	pCi/L	05/23/2016	F	T	-11.8	12.3	16.9	U		Y
Europium-155	pCi/L	05/23/2016	F	T	3.36	15.4	27.5	U		Y
Lead-212	pCi/L	05/23/2016	F	T	8.48	13.2	15.7	U		Y
pH	s.u.	05/23/2016	F	N	8.46					Y
Potassium-40	pCi/L	05/23/2016	F	T	-20.3	58.1	101	U		Y
Promethium-144	pCi/L	05/23/2016	F	T	-3.69	4.96	7.98	U		Y
Promethium-146	pCi/L	05/23/2016	F	T	-1.4	5.54	9.44	U		Y
Ruthenium-106	pCi/L	05/23/2016	F	T	-3.51	36.3	67.5	U		Y
Specific Conductance	umhos/cm	05/23/2016	F	N	2157					Y
Temperature	C	05/23/2016	F	N	16.50					Y
Thorium-234	pCi/L	05/23/2016	F	T	316	329	381	U		Y
Tritium	pCi/L	05/23/2016	F	N	4.18	2.07	2.96		J	Y

Groundwater Quality Data by Location For Site RBL01, Rio Blanco Site

Location: Johnson Artesian WL CO-00419-000111

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Turbidity	NTU	05/23/2016	F	N	3.00					Y
Uranium-235	pCi/L	05/23/2016	F	T	42.5	55.6	46.6	U		Y
Uranium-238	pCi/L	05/23/2016	F	T	316	329	381	U		Y
Yttrium-88	pCi/L	05/23/2016	F	T	7.73	9.46	19.5	U		Y

Groundwater Quality Data by Location For Site RBL01, Rio Blanco Site

Location: RB-D-01 Non-verifiable TOC Elevation data, available in 2007 Independent Survey, Inc. survey.

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Actinium-228	pCi/L	05/23/2016	F	T	-24.2	20.6	21.7	U	F	Y
Americium-241	pCi/L	05/23/2016	F	T	-2.45	33.9	51.2	U	F	Y
Antimony-125	pCi/L	05/23/2016	F	T	1.38	10.0	17.7	U	F	Y
Cerium-144	pCi/L	05/23/2016	F	T	26.2	30.2	51.6	U	F	Y
Cesium-134	pCi/L	05/23/2016	F	T	5.41	4.87	8.63	U	F	Y
Cesium-137	pCi/L	05/23/2016	F	T	-0.601	3.30	5.98	U	F	Y
Cobalt-60	pCi/L	05/23/2016	F	T	2.10	3.74	7.54	U	F	Y
Europium-152	pCi/L	05/23/2016	F	T	0.000191	10.4	18.2	U	F	Y
Europium-154	pCi/L	05/23/2016	F	T	5.86	8.29	17.0	U	F	Y
Europium-155	pCi/L	05/23/2016	F	T	-0.305	12.7	22.9	U	F	Y
Lead-212	pCi/L	05/23/2016	F	T	7.93	11.6	14.0	U	F	Y
pH	s.u.	05/23/2016	F	N	7.84				F	Y
Potassium-40	pCi/L	05/23/2016	F	T	9.88	66.2	74.6	U	F	Y
Promethium-144	pCi/L	05/23/2016	F	T	-1.54	4.41	7.66	U	F	Y
Promethium-146	pCi/L	05/23/2016	F	T	1.30	4.62	8.60	U	F	Y
Ruthenium-106	pCi/L	05/23/2016	F	T	-4.57	34.3	62.3	U	F	Y
Specific Conductance	uS/cm	05/23/2016	F	N	1335				F	Y
Temperature	C	05/23/2016	F	N	11.46				F	Y
Thorium-234	pCi/L	05/23/2016	F	T	198	356	466	U	F	Y
Tritium	pCi/L	05/23/2016	F	N	1.34	1.57	2.59	U	F	Y

Groundwater Quality Data by Location For Site RBL01, Rio Blanco Site

Location: RB-D-01 Non-verifiable TOC Elevation data, available in 2007 Independent Survey, Inc. survey.

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Turbidity	NTU	05/23/2016	F	N	1.93				F	Y
Uranium-235	pCi/L	05/23/2016	F	T	5.61	35.8	41.3	U	F	Y
Uranium-238	pCi/L	05/23/2016	F	T	198	356	466	U	F	Y
Yttrium-88	pCi/L	05/23/2016	F	T	1.45	6.56	11.9	U	F	Y

Groundwater Quality Data by Location For Site RBL01, Rio Blanco Site

Location: RB-D-03 CO-00419-000115

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Actinium-228	pCi/L	05/23/2016	F	T	5.97	23.2	38.9	U	F	Y
Americium-241	pCi/L	05/23/2016	F	T	4.69	18.7	29.1	U	F	Y
Antimony-125	pCi/L	05/23/2016	F	T	11.0	13.1	23.2	U	F	Y
Cerium-144	pCi/L	05/23/2016	F	T	-5.09	25.5	44.4	U	F	Y
Cesium-134	pCi/L	05/23/2016	F	T	-0.936	4.28	7.88	U	F	Y
Cesium-137	pCi/L	05/23/2016	F	T	-4.25	4.70	6.75	U	F	Y
Cobalt-60	pCi/L	05/23/2016	F	T	-1.56	3.73	6.79	U	F	Y
Europium-152	pCi/L	05/23/2016	F	T	1.11	10.5	19.4	U	F	Y
Europium-154	pCi/L	05/23/2016	F	T	-1.34	13.2	25.2	U	F	Y
Europium-155	pCi/L	05/23/2016	F	T	5.87	12.5	20.4	U	F	Y
Lead-212	pCi/L	05/23/2016	F	T	9.91	12.7	11.9	U	F	Y
pH	s.u.	05/23/2016	F	N	8.82				F	Y
Potassium-40	pCi/L	05/23/2016	F	T	-48.1	70.4	120	U	F	Y
Promethium-144	pCi/L	05/23/2016	F	T	-0.0225	5.06	8.30	U	F	Y
Promethium-146	pCi/L	05/23/2016	F	T	-2.15	5.06	8.67	U	F	Y
Ruthenium-106	pCi/L	05/23/2016	F	T	-24.5	49.3	81.0	U	F	Y
Specific Conductance	uS/cm	05/23/2016	F	N	830				F	Y
Temperature	C	05/23/2016	F	N	11.01				F	Y
Thorium-234	pCi/L	05/23/2016	F	T	66.3	235	256	U	F	Y
Tritium	pCi/L	05/23/2016	F	N	2.48	1.81	2.82	U	F	Y

Groundwater Quality Data by Location For Site RBL01, Rio Blanco Site

Location: RB-D-03 CO-00419-000115

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Turbidity	NTU	05/23/2016	F	N	1.92				F	Y
Uranium-235	pCi/L	05/23/2016	F	T	-13.4	28.3	36.6	U	F	Y
Uranium-238	pCi/L	05/23/2016	F	T	66.3	235	256	U	F	Y
Yttrium-88	pCi/L	05/23/2016	F	T	-0.792	7.97	15.4	U	F	Y

Groundwater Quality Data by Location For Site RBL01, Rio Blanco Site

Location: RB-S-03 Non-verifiable TOC Elevation data, available in 2007 Independent Survey, Inc. survey.

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Actinium-228	pCi/L	05/23/2016	F	T	4.93	22.9	39.3	U	F	Y
Americium-241	pCi/L	05/23/2016	F	T	-3.3	7.04	10.5	U	F	Y
Antimony-125	pCi/L	05/23/2016	F	T	-9.61	13.0	20.7	U	F	Y
Cerium-144	pCi/L	05/23/2016	F	T	1.58	25.4	44.8	U	F	Y
Cesium-134	pCi/L	05/23/2016	F	T	0.250	5.20	9.82	U	F	Y
Cesium-137	pCi/L	05/23/2016	F	T	0.00	10.7	8.59	U	F	Y
Cobalt-60	pCi/L	05/23/2016	F	T	0.907	4.76	9.26	U	F	Y
Europium-152	pCi/L	05/23/2016	F	T	2.40	11.7	21.4	U	F	Y
Europium-154	pCi/L	05/23/2016	F	T	-3.61	12.2	22.1	U	F	Y
Europium-155	pCi/L	05/23/2016	F	T	-0.864	10.1	17.8	U	F	Y
Lead-212	pCi/L	05/23/2016	F	T	0.164	11.3	13.4	U	F	Y
pH	s.u.	05/23/2016	F	N	8.25				F	Y
Potassium-40	pCi/L	05/23/2016	F	T	50.3	62.3	86.1	U	F	Y
Promethium-144	pCi/L	05/23/2016	F	T	-0.309	5.33	9.45	U	F	Y
Promethium-146	pCi/L	05/23/2016	F	T	-0.0681	5.44	9.85	U	F	Y
Ruthenium-106	pCi/L	05/23/2016	F	T	-3.7	46.5	83.0	U	F	Y
Specific Conductance	uS/cm	05/23/2016	F	N	840				F	Y
Temperature	C	05/23/2016	F	N	11.11				F	Y
Thorium-234	pCi/L	05/23/2016	F	T	13.1	113	176	U	F	Y
Tritium	pCi/L	05/23/2016	F	N	-71	214	386	U	F	Y

Groundwater Quality Data by Location For Site RBL01, Rio Blanco Site

Location: RB-S-03 Non-verifiable TOC Elevation data, available in 2007 Independent Survey, Inc. survey.

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Turbidity	NTU	05/23/2016	F	N	2.79				F	Y
Uranium-235	pCi/L	05/23/2016	F	T	-18.5	29.2	39.0	U	F	Y
Uranium-238	pCi/L	05/23/2016	F	T	13.1	113	176	U	F	Y
Yttrium-88	pCi/L	05/23/2016	F	T	-12.4	11.0	13.9	U	F	Y

Groundwater Quality Data by Location For Site RBL01, Rio Blanco Site

Location: RB-W-01

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Actinium-228	pCi/L	05/23/2016	F	T	-1.83	11.2	15.5	U	FQ	Y
Americium-241	pCi/L	05/23/2016	F	T	-0.548	8.10	14.2	U	FQ	Y
Antimony-125	pCi/L	05/23/2016	F	T	2.81	6.19	9.78	U	FQ	Y
Cerium-144	pCi/L	05/23/2016	F	T	3.95	14.0	24.0	U	FQ	Y
Cesium-134	pCi/L	05/23/2016	F	T	1.39	2.43	4.47	U	FQ	Y
Cesium-137	pCi/L	05/23/2016	F	T	-0.976	2.20	3.61	U	FQ	Y
Cobalt-60	pCi/L	05/23/2016	F	T	0.255	2.27	4.13	U	FQ	Y
Europium-152	pCi/L	05/23/2016	F	T	-0.113	6.51	10.2	U	FQ	Y
Europium-154	pCi/L	05/23/2016	F	T	-2.25	6.17	10.2	U	FQ	Y
Europium-155	pCi/L	05/23/2016	F	T	-3.71	6.56	10.6	U	FQ	Y
Lead-212	pCi/L	05/23/2016	F	T	0.00	6.22	5.93	U	FQ	Y
pH	s.u.	05/23/2016	F	N	7.92				FQ	Y
Potassium-40	pCi/L	05/23/2016	F	T	-8.79	41.1	57.1	U	FQ	Y
Promethium-144	pCi/L	05/23/2016	F	T	-0.124	2.18	3.97	U	FQ	Y
Promethium-146	pCi/L	05/23/2016	F	T	-0.98	2.60	4.39	U	FQ	Y
Ruthenium-106	pCi/L	05/23/2016	F	T	7.78	21.5	38.0	U	FQ	Y
Specific Conductance	uS/cm	05/23/2016	F	N	1469				FQ	Y
Temperature	C	05/23/2016	F	N	11.50				FQ	Y
Thorium-234	pCi/L	05/23/2016	F	T	-117	117	140	U	FQ	Y
Tritium	pCi/L	05/23/2016	F	N	-126	209	382	U	FQ	Y

Groundwater Quality Data by Location For Site RBL01, Rio Blanco Site

Location: RB-W-01

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Turbidity	NTU	05/23/2016	F	N	2.37				FQ	Y
Uranium-235	pCi/L	05/23/2016	F	T	0.00	17.8	19.5	U	FQ	Y
Uranium-238	pCi/L	05/23/2016	F	T	-117	117	140	U	FQ	Y
Yttrium-88	pCi/L	05/23/2016	F	T	-2.61	4.15	6.82	U	FQ	Y

SAMPLE TYPE: D = Duplicate E = Equipment Blank F = Field Sample FB = Field Blank TB = Trip Blank

FRACTION: D = Dissolved N = NA T = Total

MDC / MDL: MDC = Radiochemical minimum detectable concentration MDL = Non-radiochemical minimum detection limit

LAB QUALIFIERS (details can be found in laboratory report):
* = One or more quality control criteria failed (e.g., laboratory control sample, surrogate spike, or calibration verification recovery).
B = Blank contamination. The reported result is associated with a contaminated blank.
D = Result is from the analysis of a diluted sample.
H = Holding time was exceeded.
J = The reported result is an estimated value (e.g., matrix interference was observed or the analyte was detected at a concentration outside the quantitation range).
U = Analytical result is below the MDC or MDL.
Z = Laboratory defined qualifier, see case narrative.

DATA QUALIFIERS:
F = Low flow sampling method used.
L = Less than 3 bore volumes purged prior to sampling.
U = Parameter analyzed for, but not detected.
G = Possible grout contamination, pH > 9
Q = Qualitative result due to sampling technique.
X = Location is undefined.
J = Estimated value
R = Rejected, unusable result

QA QUALIFIER: Yes = Validated, acceptable as qualified.

Surface Water Quality Data

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Surface Water Quality Data by Location For Site RBL01, Rio Blanco Site

Location: B-1 Equity Camp CO-00419-000109

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Actinium-228	pCi/L	05/23/2016	F	T	5.51	20.1	32.6	U		Y
Americium-241	pCi/L	05/23/2016	F	T	-20.6	28.3	44.6	U		Y
Antimony-125	pCi/L	05/23/2016	F	T	4.24	11.3	20.9	U		Y
Cerium-144	pCi/L	05/23/2016	F	T	-13.9	35.0	49.8	U		Y
Cesium-134	pCi/L	05/23/2016	F	T	2.05	4.97	9.11	U		Y
Cesium-137	pCi/L	05/23/2016	F	T	-5.8	5.37	7.48	U		Y
Cobalt-60	pCi/L	05/23/2016	F	T	2.42	4.72	9.06	U		Y
Europium-152	pCi/L	05/23/2016	F	T	1.07	12.6	22.0	U		Y
Europium-154	pCi/L	05/23/2016	F	T	-1.34	13.9	21.8	U		Y
Europium-155	pCi/L	05/23/2016	F	T	5.77	15.0	25.5	U		Y
Lead-212	pCi/L	05/23/2016	F	T	11.1	13.2	12.6	U		Y
pH	s.u.	05/23/2016	F	N	8.21					Y
Potassium-40	pCi/L	05/23/2016	F	T	-51.1	74.9	111	U		Y
Promethium-144	pCi/L	05/23/2016	F	T	-4.15	6.74	9.11	U		Y
Promethium-146	pCi/L	05/23/2016	F	T	-1.54	5.36	9.48	U		Y
Ruthenium-106	pCi/L	05/23/2016	F	T	-1.73	43.5	78.0	U		Y
Specific Conductance	uS/cm	05/23/2016	F	N	765					Y

Surface Water Quality Data by Location For Site RBL01, Rio Blanco Site

Location: B-1 Equity Camp CO-00419-000109

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Temperature	C	05/23/2016	F	N	8.91					Y
Thorium-234	pCi/L	05/23/2016	F	T	-114	282	433	U		Y
Tritium	pCi/L	05/23/2016	F	N	15.5	4.11	2.91			Y
Turbidity	NTU	05/23/2016	F	N	1.66					Y
Uranium-235	pCi/L	05/23/2016	F	T	6.03	40.1	48.2	U		Y
Uranium-238	pCi/L	05/23/2016	F	T	-114	282	433	U		Y
Yttrium-88	pCi/L	05/23/2016	F	T	4.43	7.08	14.8	U		Y

Surface Water Quality Data by Location For Site RBL01, Rio Blanco Site

Location: CER #1 Black Sulphur CO-00419-000107

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Actinium-228	pCi/L	05/23/2016	F	D	2.04	13.5	15.4	U		Y
Americium-241	pCi/L	05/23/2016	F	D	-1.88	7.00	11.9	U		Y
Antimony-125	pCi/L	05/23/2016	F	D	-0.621	7.60	11.2	U		Y
Cerium-144	pCi/L	05/23/2016	F	D	-6.92	16.2	26.2	U		Y
Cesium-134	pCi/L	05/23/2016	F	D	1.81	2.75	4.80	U		Y
Cesium-137	pCi/L	05/23/2016	F	D	-0.192	2.77	4.22	U		Y
Cobalt-60	pCi/L	05/23/2016	F	D	0.770	2.22	4.11	U		Y
Europium-152	pCi/L	05/23/2016	F	D	1.52	6.77	11.3	U		Y
Europium-154	pCi/L	05/23/2016	F	D	3.25	7.12	13.0	U		Y
Europium-155	pCi/L	05/23/2016	F	D	4.33	8.21	11.7	U		Y
Lead-212	pCi/L	05/23/2016	F	D	-4.39	5.85	7.78	U		Y
pH	s.u.	05/23/2016	F	N	8.20					Y
Potassium-40	pCi/L	05/23/2016	F	D	-4.96	40.8	59.6	U		Y
Promethium-144	pCi/L	05/23/2016	F	D	1.81	2.81	4.88	U		Y
Promethium-146	pCi/L	05/23/2016	F	D	-0.641	2.95	4.93	U		Y
Ruthenium-106	pCi/L	05/23/2016	F	D	17.7	25.1	43.7	U		Y
Specific Conductance	umhos/cm	05/23/2016	F	N	1020					Y

Surface Water Quality Data by Location For Site RBL01, Rio Blanco Site

Location: CER #1 Black Sulphur CO-00419-000107

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Temperature	C	05/23/2016	F	N	12.58					Y
Thorium-234	pCi/L	05/23/2016	F	D	-103	110	136	U		Y
Tritium	pCi/L	05/23/2016	F	N	27.1	194	339	U		Y
Turbidity	NTU	05/23/2016	F	N	50.9					Y
Uranium-235	pCi/L	05/23/2016	F	D	-15	18.8	23.0	U		Y
Uranium-238	pCi/L	05/23/2016	F	D	-103	110	136	U		Y
Yttrium-88	pCi/L	05/23/2016	F	D	1.52	4.77	8.93	U		Y

Surface Water Quality Data by Location For Site RBL01, Rio Blanco Site

Location: CER #4 Black Sulphur CO-00419-000108

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Actinium-228	pCi/L	05/23/2016	F	T	-7.43	20.9	31.0	U		Y
Americium-241	pCi/L	05/23/2016	F	T	-11.1	28.5	42.2	U		Y
Antimony-125	pCi/L	05/23/2016	F	T	0.906	11.0	20.3	U		Y
Cerium-144	pCi/L	05/23/2016	F	T	-5.94	32.4	50.8	U		Y
Cesium-134	pCi/L	05/23/2016	F	T	-1.96	4.79	8.48	U		Y
Cesium-137	pCi/L	05/23/2016	F	T	0.778	4.54	8.29	U		Y
Cobalt-60	pCi/L	05/23/2016	F	T	-1.55	4.63	7.62	U		Y
Europium-152	pCi/L	05/23/2016	F	T	5.30	12.2	21.5	U		Y
Europium-154	pCi/L	05/23/2016	F	T	0.727	11.5	21.9	U		Y
Europium-155	pCi/L	05/23/2016	F	T	15.6	15.9	25.7	U		Y
Lead-212	pCi/L	05/23/2016	F	T	1.54	13.6	16.6	U		Y
pH	s.u.	05/23/2016	F	N	7.85					Y
Potassium-40	pCi/L	05/23/2016	F	T	-9.52	55.9	109	U		Y
Promethium-144	pCi/L	05/23/2016	F	T	2.57	5.59	10.1	U		Y
Promethium-146	pCi/L	05/23/2016	F	T	-1.18	5.19	9.27	U		Y
Ruthenium-106	pCi/L	05/23/2016	F	T	24.6	44.2	69.1	U		Y
Specific Conductance	uS/cm	05/23/2016	F	N	1281					Y

Surface Water Quality Data by Location For Site RBL01, Rio Blanco Site

Location: CER #4 Black Sulphur CO-00419-000108

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Temperature	C	05/23/2016	F	N	10.38					Y
Thorium-234	pCi/L	05/23/2016	F	T	113	351	372	U		Y
Tritium	pCi/L	05/23/2016	F	N	142	201	337	U		Y
Turbidity	NTU	05/23/2016	F	N	1.87					Y
Uranium-235	pCi/L	05/23/2016	F	T	-6.8	29.3	45.0	U		Y
Uranium-238	pCi/L	05/23/2016	F	T	113	351	372	U		Y
Yttrium-88	pCi/L	05/23/2016	F	T	2.67	7.28	15.1	U		Y

Surface Water Quality Data by Location For Site RBL01, Rio Blanco Site

Location: Fawn Creek #1 CO-00419-000105

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Actinium-228	pCi/L	05/23/2016	F	T	6.94	16.7	29.4	U		Y
Americium-241	pCi/L	05/23/2016	F	T	2.50	18.7	29.4	U		Y
Antimony-125	pCi/L	05/23/2016	F	T	-1.5	9.86	17.3	U		Y
Cerium-144	pCi/L	05/23/2016	F	T	7.25	27.8	42.1	U		Y
Cesium-134	pCi/L	05/23/2016	F	T	2.97	4.43	8.32	U		Y
Cesium-137	pCi/L	05/23/2016	F	T	1.94	3.60	6.84	U		Y
Cobalt-60	pCi/L	05/23/2016	F	T	-0.167	3.19	6.21	U		Y
Europium-152	pCi/L	05/23/2016	F	T	4.04	9.88	17.9	U		Y
Europium-154	pCi/L	05/23/2016	F	T	-2.83	11.4	17.8	U		Y
Europium-155	pCi/L	05/23/2016	F	T	-10.5	11.9	17.8	U		Y
Lead-212	pCi/L	05/23/2016	F	T	-3.72	8.23	11.6	U		Y
pH	s.u.	05/23/2016	F	N	7.65					Y
Potassium-40	pCi/L	05/23/2016	F	T	-31.1	49.8	83.2	U		Y
Promethium-144	pCi/L	05/23/2016	F	T	1.84	3.94	7.42	U		Y
Promethium-146	pCi/L	05/23/2016	F	T	1.77	4.06	7.42	U		Y
Ruthenium-106	pCi/L	05/23/2016	F	T	-22.9	34.0	56.2	U		Y
Specific Conductance	uS/cm	05/23/2016	F	N	1553					Y

Surface Water Quality Data by Location For Site RBL01, Rio Blanco Site

Location: Fawn Creek #1 CO-00419-000105

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Temperature	C	05/23/2016	F	N	9.38					Y
Thorium-234	pCi/L	05/23/2016	F	T	161	200	221	U		Y
Tritium	pCi/L	05/23/2016	F	N	-106	217	394	U		Y
Turbidity	NTU	05/23/2016	F	N	1.30					Y
Uranium-235	pCi/L	05/23/2016	F	T	8.68	26.1	36.9	U		Y
Uranium-238	pCi/L	05/23/2016	F	T	161	200	221	U		Y
Yttrium-88	pCi/L	05/23/2016	F	T	1.14	6.59	13.2	U		Y

Surface Water Quality Data by Location For Site RBL01, Rio Blanco Site

Location: Fawn Creek #3 CO-00419-000106

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Actinium-228	pCi/L	05/23/2016	F	D	8.24	19.2	20.6	U		Y
Americium-241	pCi/L	05/23/2016	F	D	4.51	19.6	34.6	U		Y
Antimony-125	pCi/L	05/23/2016	F	D	-0.000903	7.62	13.2	U		Y
Cerium-144	pCi/L	05/23/2016	F	D	-1.34	19.6	33.0	U		Y
Cesium-134	pCi/L	05/23/2016	F	D	-0.772	3.67	5.48	U		Y
Cesium-137	pCi/L	05/23/2016	F	D	-0.667	2.87	5.03	U		Y
Cobalt-60	pCi/L	05/23/2016	F	D	2.26	3.28	6.06	U		Y
Europium-152	pCi/L	05/23/2016	F	D	-2.55	10.6	13.9	U		Y
Europium-154	pCi/L	05/23/2016	F	D	1.85	12.9	14.7	U		Y
Europium-155	pCi/L	05/23/2016	F	D	0.773	9.54	16.4	U		Y
Lead-212	pCi/L	05/23/2016	F	D	0.314	7.97	8.12	U		Y
pH	s.u.	05/23/2016	F	N	7.69					Y
Potassium-40	pCi/L	05/23/2016	F	D	27.2	61.0	53.6	U		Y
Promethium-144	pCi/L	05/23/2016	F	D	-0.775	3.40	5.90	U		Y
Promethium-146	pCi/L	05/23/2016	F	D	-2.45	3.54	5.29	U		Y
Ruthenium-106	pCi/L	05/23/2016	F	D	2.98	31.7	49.9	U		Y
Specific Conductance	uS/cm	05/23/2016	F	N	1362					Y

Surface Water Quality Data by Location For Site RBL01, Rio Blanco Site

Location: Fawn Creek #3 CO-00419-000106

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Temperature	C	05/23/2016	F	N	9.59					Y
Thorium-234	pCi/L	05/23/2016	F	D	-125	230	290	U		Y
Tritium	pCi/L	05/23/2016	F	N	104	233	399	U		Y
Turbidity	NTU	05/23/2016	F	N	15.8					Y
Uranium-235	pCi/L	05/23/2016	F	D	3.29	24.8	27.3	U		Y
Uranium-238	pCi/L	05/23/2016	F	D	-125	230	290	U		Y
Yttrium-88	pCi/L	05/23/2016	F	D	0.251	5.45	10.3	U		Y

Surface Water Quality Data by Location For Site RBL01, Rio Blanco Site

Location: Fawn Creek 500ft Dwn CO-00419-000103

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Actinium-228	pCi/L	05/23/2016	F	T	4.06	21.1	32.5	U		Y
Americium-241	pCi/L	05/23/2016	F	T	0.658	18.7	24.9	U		Y
Antimony-125	pCi/L	05/23/2016	F	T	-7.82	10.5	16.7	U		Y
Cerium-144	pCi/L	05/23/2016	F	T	8.91	21.3	37.4	U		Y
Cesium-134	pCi/L	05/23/2016	F	T	-1.08	3.99	7.16	U		Y
Cesium-137	pCi/L	05/23/2016	F	T	-0.485	4.24	6.42	U		Y
Cobalt-60	pCi/L	05/23/2016	F	T	2.42	4.03	7.93	U		Y
Europium-152	pCi/L	05/23/2016	F	T	1.40	9.08	16.6	U		Y
Europium-154	pCi/L	05/23/2016	F	T	-10.2	11.4	17.4	U		Y
Europium-155	pCi/L	05/23/2016	F	T	1.12	9.64	17.2	U		Y
Lead-212	pCi/L	05/23/2016	F	T	7.44	11.6	12.9	U		Y
pH	s.u.	05/23/2016	F	N	8.42					Y
Potassium-40	pCi/L	05/23/2016	F	T	-58.8	65.6	97.9	U		Y
Promethium-144	pCi/L	05/23/2016	F	T	1.36	4.19	7.84	U		Y
Promethium-146	pCi/L	05/23/2016	F	T	0.554	4.10	7.43	U		Y
Ruthenium-106	pCi/L	05/23/2016	F	T	14.7	40.4	72.3	U		Y
Specific Conductance	uS/cm	05/23/2016	F	N	1137					Y

Surface Water Quality Data by Location For Site RBL01, Rio Blanco Site

Location: Fawn Creek 500ft Dwn CO-00419-000103

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Temperature	C	05/23/2016	F	N	14.87					Y
Thorium-234	pCi/L	05/23/2016	F	T	49.4	244	209	U		Y
Tritium	pCi/L	05/23/2016	F	N	-82.4	221	398	U		Y
Turbidity	NTU	05/23/2016	F	N	5.73					Y
Uranium-235	pCi/L	05/23/2016	F	T	-18	25.0	30.8	U		Y
Uranium-238	pCi/L	05/23/2016	F	T	49.4	244	209	U		Y
Yttrium-88	pCi/L	05/23/2016	F	T	-0.563	6.04	11.6	U		Y

Surface Water Quality Data by Location For Site RBL01, Rio Blanco Site

Location: Fawn Creek 500ft Ups CO-00419-000102

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Actinium-228	pCi/L	05/23/2016	F	T	-2.33	16.4	24.5	U		Y
Actinium-228	pCi/L	05/23/2016	D	T	6.50	18.2	26.0	U		Y
Americium-241	pCi/L	05/23/2016	F	T	-14.1	23.2	36.9	U		Y
Americium-241	pCi/L	05/23/2016	D	T	16.9	21.5	33.9	U		Y
Antimony-125	pCi/L	05/23/2016	F	T	-1.93	8.09	14.0	U		Y
Antimony-125	pCi/L	05/23/2016	D	T	5.01	9.40	17.4	U		Y
Cerium-144	pCi/L	05/23/2016	F	T	-11.3	19.2	31.8	U		Y
Cerium-144	pCi/L	05/23/2016	D	T	-3.92	20.9	36.9	U		Y
Cesium-134	pCi/L	05/23/2016	F	T	-1.76	3.30	5.50	U		Y
Cesium-134	pCi/L	05/23/2016	D	T	-1.26	3.82	6.87	U		Y
Cesium-137	pCi/L	05/23/2016	F	T	-0.989	2.81	4.91	U		Y
Cesium-137	pCi/L	05/23/2016	D	T	0.433	3.86	6.95	U		Y
Cobalt-60	pCi/L	05/23/2016	F	T	-0.344	3.50	6.29	U		Y
Cobalt-60	pCi/L	05/23/2016	D	T	2.04	3.64	7.39	U		Y
Europium-152	pCi/L	05/23/2016	F	T	-1.32	11.0	14.3	U		Y
Europium-152	pCi/L	05/23/2016	D	T	-8.57	9.76	15.3	U		Y
Europium-154	pCi/L	05/23/2016	F	T	-3.54	8.97	14.8	U		Y

Surface Water Quality Data by Location For Site RBL01, Rio Blanco Site

Location: Fawn Creek 500ft Ups CO-00419-000102

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Europium-154	pCi/L	05/23/2016	D	T	2.39	10.2	19.6	U		Y
Europium-155	pCi/L	05/23/2016	F	T	2.31	8.95	16.0	U		Y
Europium-155	pCi/L	05/23/2016	D	T	-3.56	9.92	17.4	U		Y
Lead-212	pCi/L	05/23/2016	F	T	0.705	8.54	9.60	U		Y
Lead-212	pCi/L	05/23/2016	D	T	6.31	10.8	11.8	U		Y
pH	s.u.	05/23/2016	F	N	8.49					Y
Potassium-40	pCi/L	05/23/2016	F	T	-49	56.3	66.8	U		Y
Potassium-40	pCi/L	05/23/2016	D	T	4.23	55.9	65.8	U		Y
Promethium-144	pCi/L	05/23/2016	F	T	3.17	6.00	5.85	U		Y
Promethium-144	pCi/L	05/23/2016	D	T	-0.204	3.85	6.82	U		Y
Promethium-146	pCi/L	05/23/2016	F	T	-0.016	3.41	6.02	U		Y
Promethium-146	pCi/L	05/23/2016	D	T	0.293	4.46	7.87	U		Y
Ruthenium-106	pCi/L	05/23/2016	F	T	-17.3	28.9	48.2	U		Y
Ruthenium-106	pCi/L	05/23/2016	D	T	40.2	40.3	71.6	U		Y
Specific Conductance	uS/cm	05/23/2016	F	N	1122					Y
Temperature	C	05/23/2016	F	N	14.07					Y
Thorium-234	pCi/L	05/23/2016	F	T	-40.1	238	314	U		Y

Surface Water Quality Data by Location For Site RBL01, Rio Blanco Site

Location: Fawn Creek 500ft Ups CO-00419-000102

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Thorium-234	pCi/L	05/23/2016	D	T	224	264	257	U		Y
Tritium	pCi/L	05/23/2016	F	N	-43.6	223	399	U		Y
Tritium	pCi/L	05/23/2016	D	N	182	203	335	U		Y
Turbidity	NTU	05/23/2016	F	N	8.73					Y
Uranium-235	pCi/L	05/23/2016	F	T	-15	23.4	28.6	U		Y
Uranium-235	pCi/L	05/23/2016	D	T	-9.44	23.1	33.5	U		Y
Uranium-238	pCi/L	05/23/2016	F	T	-40.1	238	314	U		Y
Uranium-238	pCi/L	05/23/2016	D	T	224	264	257	U		Y
Yttrium-88	pCi/L	05/23/2016	F	T	9.22	5.71	10.9	U		Y
Yttrium-88	pCi/L	05/23/2016	D	T	-3.59	6.82	11.6	U		Y

Surface Water Quality Data by Location For Site RBL01, Rio Blanco Site

Location: Fawn Creek 6800ft Up CO-00419-000101

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Actinium-228	pCi/L	05/23/2016	F	T	-7.77	21.2	34.0	U		Y
Americium-241	pCi/L	05/23/2016	F	T	-2.48	19.2	34.8	U		Y
Antimony-125	pCi/L	05/23/2016	F	T	3.61	10.4	19.3	U		Y
Cerium-144	pCi/L	05/23/2016	F	T	14.3	26.0	45.9	U		Y
Cesium-134	pCi/L	05/23/2016	F	T	-1.62	4.33	7.64	U		Y
Cesium-137	pCi/L	05/23/2016	F	T	0.826	3.52	6.85	U		Y
Cobalt-60	pCi/L	05/23/2016	F	T	-2.72	4.72	7.95	U		Y
Europium-152	pCi/L	05/23/2016	F	T	1.00	11.1	20.3	U		Y
Europium-154	pCi/L	05/23/2016	F	T	4.27	11.7	23.8	U		Y
Europium-155	pCi/L	05/23/2016	F	T	10.7	12.6	21.9	U		Y
Lead-212	pCi/L	05/23/2016	F	T	-4.76	10.0	14.7	U		Y
pH	s.u.	05/23/2016	F	N	8.32					Y
Potassium-40	pCi/L	05/23/2016	F	T	67.1	71.2	78.2	U		Y
Promethium-144	pCi/L	05/23/2016	F	T	2.74	4.82	9.11	U		Y
Promethium-146	pCi/L	05/23/2016	F	T	5.44	5.42	9.47	U		Y
Ruthenium-106	pCi/L	05/23/2016	F	T	-28	46.1	65.4	U		Y
Specific Conductance	uS/cm	05/23/2016	F	N	932					Y

Surface Water Quality Data by Location For Site RBL01, Rio Blanco Site

Location: Fawn Creek 6800ft Up CO-00419-000101

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Temperature	C	05/23/2016	F	N	12.03					Y
Thorium-234	pCi/L	05/23/2016	F	T	-88.2	223	354	U		Y
Tritium	pCi/L	05/23/2016	F	N	225	243	400	U		Y
Turbidity	NTU	05/23/2016	F	N	8.34					Y
Uranium-235	pCi/L	05/23/2016	F	T	-17.5	27.6	38.5	U		Y
Uranium-238	pCi/L	05/23/2016	F	T	-88.2	223	354	U		Y
Yttrium-88	pCi/L	05/23/2016	F	T	7.33	7.50	16.8	U		Y

Surface Water Quality Data by Location For Site RBL01, Rio Blanco Site

Location: Fawn Creek 8400ft Dw CO-00419-000104

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Actinium-228	pCi/L	05/23/2016	F	T	24.4	27.6	27.2	U		Y
Americium-241	pCi/L	05/23/2016	F	T	-22.8	37.5	59.8	U		Y
Antimony-125	pCi/L	05/23/2016	F	T	8.30	11.0	20.2	U		Y
Cerium-144	pCi/L	05/23/2016	F	T	26.3	29.7	50.0	U		Y
Cesium-134	pCi/L	05/23/2016	F	T	-2.33	5.47	9.40	U		Y
Cesium-137	pCi/L	05/23/2016	F	T	-0.361	3.57	6.65	U		Y
Cobalt-60	pCi/L	05/23/2016	F	T	3.88	5.45	10.1	U		Y
Europium-152	pCi/L	05/23/2016	F	T	-4.9	14.2	21.1	U		Y
Europium-154	pCi/L	05/23/2016	F	T	-6.04	14.7	21.3	U		Y
Europium-155	pCi/L	05/23/2016	F	T	-7.65	12.6	21.2	U		Y
Lead-212	pCi/L	05/23/2016	F	T	-7.15	9.83	14.8	U		Y
pH	s.u.	05/23/2016	F	N	8.22					Y
Potassium-40	pCi/L	05/23/2016	F	T	84.4	64.5	93.4	U		Y
Promethium-144	pCi/L	05/23/2016	F	T	1.23	4.47	8.44	U		Y
Promethium-146	pCi/L	05/23/2016	F	T	-0.717	4.97	8.84	U		Y
Ruthenium-106	pCi/L	05/23/2016	F	T	15.3	46.4	82.0	U		Y
Specific Conductance	uS/cm	05/23/2016	F	N	1108					Y

Surface Water Quality Data by Location For Site RBL01, Rio Blanco Site

Location: Fawn Creek 8400ft Dw CO-00419-000104

Report Date: 01/25/2017

Parameter	Units	Sample Date	Sample Type	Fraction	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Temperature	C	05/23/2016	F	N	13.70					Y
Thorium-234	pCi/L	05/23/2016	F	T	-165	335	515	U		Y
Tritium	pCi/L	05/23/2016	F	N	158	201	335	U		Y
Turbidity	NTU	05/23/2016	F	N	2.59					Y
Uranium-235	pCi/L	05/23/2016	F	T	21.5	35.0	45.2	U		Y
Uranium-238	pCi/L	05/23/2016	F	T	-165	335	515	U		Y
Yttrium-88	pCi/L	05/23/2016	F	T	-5.48	9.02	15.0	U		Y

SAMPLE TYPE: D = Duplicate E = Equipment Blank F = Field Sample FB = Field Blank TB = Trip Blank

FRACTION: D = Dissolved N = NA T = Total

MDC / MDL: MDC = Radiochemical minimum detectable concentration MDL = Non-radiochemical minimum detection limit

LAB QUALIFIERS (details can be found in laboratory report):
* = One or more quality control criteria failed (e.g., laboratory control sample, surrogate spike, or calibration verification recovery).
B = Blank contamination. The reported result is associated with a contaminated blank.
D = Result is from the analysis of a diluted sample.
H = Holding time was exceeded.
J = The reported result is an estimated value (e.g., matrix interference was observed or the analyte was detected at a concentration outside the quantitation range).
U = Analytical result is below the MDC or MDL.
Z = Laboratory defined qualifier, see case narrative.

DATA QUALIFIERS:
F = Low flow sampling method used.
L = Less than 3 bore volumes purged prior to sampling.
U = Parameter analyzed for, but not detected.
G = Possible grout contamination, pH > 9
Q = Qualitative result due to sampling technique.
X = Location is undefined.
J = Estimated value
R = Rejected, unusable result

QA QUALIFIER: Yes = Validated, acceptable as qualified.

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Equipment Blank Data

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Water Quality Data For Site RBL01, Rio Blanco Site

Report Date: 01/25/2017

Location: Equipment Blank

Parameter	Units	Sample Date	Sample Type	Matrix	Fraction	Depth Range (ft BLS)	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Actinium-228	pCi/L	05/23/2016	E	WATER	T		0.00	23.5	22.3	U		Y
Americium-241	pCi/L	05/23/2016	E	WATER	T		8.62	11.3	23.4	U		Y
Antimony-125	pCi/L	05/23/2016	E	WATER	T		7.08	9.93	17.8	U		Y
Cerium-144	pCi/L	05/23/2016	E	WATER	T		-5.88	22.7	38.9	U		Y
Cesium-134	pCi/L	05/23/2016	E	WATER	T		1.69	4.86	8.01	U		Y
Cesium-137	pCi/L	05/23/2016	E	WATER	T		0.879	5.98	6.78	U		Y
Cobalt-60	pCi/L	05/23/2016	E	WATER	T		-1.31	3.52	6.31	U		Y
Europium-152	pCi/L	05/23/2016	E	WATER	T		-2.38	9.67	17.0	U		Y
Europium-154	pCi/L	05/23/2016	E	WATER	T		-4.08	8.43	14.9	U		Y
Europium-155	pCi/L	05/23/2016	E	WATER	T		3.12	10.4	18.5	U		Y
Lead-212	pCi/L	05/23/2016	E	WATER	T		-0.784	8.39	12.3	U		Y
Potassium-40	pCi/L	05/23/2016	E	WATER	T		-14.2	53.7	83.7	U		Y
Promethium-144	pCi/L	05/23/2016	E	WATER	T		0.677	4.02	7.48	U		Y
Promethium-146	pCi/L	05/23/2016	E	WATER	T		-1.19	4.18	7.23	U		Y
Ruthenium-106	pCi/L	05/23/2016	E	WATER	T		-31.4	36.8	57.9	U		Y
Thorium-234	pCi/L	05/23/2016	E	WATER	T		47.9	163	199	U		Y
Tritium	pCi/L	05/23/2016	E	WATER	N		191	204	336	U		Y

Water Quality Data For Site RBL01, Rio Blanco Site

Report Date: 01/25/2017

Location: Equipment Blank

Parameter	Units	Sample Date	Sample Type	Matrix	Fraction	Depth Range (ft BLS)	Result	Uncertainty	MDC/MDL	Lab	Data	QA
Uranium-235	pCi/L	05/23/2016	E	WATER	T		-14.3	22.8	33.4	U		Y
Uranium-238	pCi/L	05/23/2016	E	WATER	T		47.9	163	199	U		Y
Yttrium-88	pCi/L	05/23/2016	E	WATER	T		3.99	6.32	13.2	U		Y

SAMPLE TYPE: D = Duplicate E = Equipment Blank F = Field Sample FB = Field Blank TB = Trip Blank

FRACTION: D = Dissolved N = NA T = Total

MDC / MDL: MDC = Radiochemical minimum detectable concentration MDL = Non-radiochemical minimum detection limit

LAB QUALIFIERS (details can be found in laboratory report):
* = One or more quality control criteria failed (e.g., laboratory control sample, surrogate spike, or calibration verification recovery).
B = Blank contamination. The reported result is associated with a contaminated blank.
D = Result is from the analysis of a diluted sample.
H = Holding time was exceeded.
J = The reported result is an estimated value (e.g., matrix interference was observed or the analyte was detected at a concentration outside the quantitation range).
U = Analytical result is below the MDC or MDL.
Z = Laboratory defined qualifier, see case narrative.

DATA QUALIFIERS:
F = Low flow sampling method used.
L = Less than 3 bore volumes purged prior to sampling.
U = Parameter analyzed for, but not detected.
G = Possible grout contamination, pH > 9
Q = Qualitative result due to sampling technique.
X = Location is undefined.
J = Estimated value
R = Rejected, unusable result

QA QUALIFIER: Yes = Validated, acceptable as qualified.

Attachment 4

Assessment of Anomalous Data

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Potential Outliers Report

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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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