

**Monitoring Results
Natural Gas Wells
Near Project Rulison
First Quarter 2012**

**U.S. Department of Energy Office of Legacy Management
Grand Junction, Colorado**

Date Sampled:

23 March 2012

Background:

Project Rulison was the second Plowshare Program test to stimulate natural-gas recovery from deep and low permeability formations. On 10 September 1969, a 40-kiloton-yield nuclear device was detonated 8,426 feet (1.6 miles) below the ground surface in the Williams Fork Formation at what is now the Rulison, Colorado, Site. Following the detonation a series of production tests were conducted with the site being ultimately shut down and the site being remediated.

Purpose:

As part of the U.S. Department of Energy (DOE) Office of Legacy Management (LM) mission to protect human health and the environment, LM will monitor natural gas wells that are near the Rulison site for radionuclides associated with the detonation. While the very low permeability of Williams Fork Formation limits migration, institutional-control restrictions limit subsurface access in the detonation zone. Oversight is permitted for wells within 3 miles of the site, which allows the State of Colorado and DOE to review drilling permits and gas-well development practices to help protect human health and the environment from the Rulison-related contaminants. The DOE *Rulison Monitoring Plan* (LMS/RUL/S06178) provides guidance for sample collection frequency, based on distance from the Rulison detonation point, the types of analyses, and the reporting thresholds.

Summary of Results:

For the eight wells with samples collected in the first quarter, none of the analytical results exceeded the screening levels specified in Table 3a and Table 3b.

Samples Collected:

During the first quarter of 2012, produced-water samples were collected from eight of ten gas wells identified in the first-quarter sample plan; (two of the wells produced no water). In addition, a baseline water sample and a sediment sample for radiochemistry analyses were collected at an injection well located miles away from the Rulison site. The eight wells and the injection well are listed in Table 1. Sample collection information is listed in Table 2 in order of sample collection.

Table 1. Sample Collection Locations

Pad	Collection Location	Well Name
26N	Well head separator	Battlement Mesa (BM) 26-33B, -33C; BM 26-34B, -34C, -34D
26K	Well head separator	BM 26-22B, -22C, -22D
35B	Pump skid & filter skid	Parachute Ranch Federal 35-31C inj

Table 2. Sample Collection Information

Seq.	Name	API # 05-045-	Location Type/ Subtype	Sample Phase		BHL Data		Comments
				Gas	Liquid	T (°F)	P (psi)	
1	BM 26-33B	15743	WL / NGSA	no	yes	95.0	292.1	2 L of produced water
2	BM 26-33C	15742	WL / NGSA	no	yes	82.3	292.2	2 L of produced water
3	BM 26-33D	15739	WL / NGSA	no	no	86.2	280.9	The well produced no water
4	BM 26-34A	15744	WL / NGSA	no	no	79.9	292.1	The well produced no water
5	BM 26-34B	15745	WL / NGSA	no	yes	66.8	292.8	2 L of produced water
6	BM 26-34C	15741	WL / NGSA	no	yes	67.6	282.3	2 L of produced water
7	BM 26-34D	15748	WL / NGSA	no	yes	80.3	271.0	2 L of produced water
8	BM 26-22B	16086	WL / NGSA	no	yes	61.0	299.1	2 L of produced water
9	BM 26-22C	16087	WL / NGSA	no	yes	86.0	305.5	2 L of produced water
10	BM 26-22D	16074	WL / NGSA	no	yes	72.3	301.0	2 L of produced water
Seq.	Name	API # 05-045-	Location Type/ Subtype	Sample Phase		Comments		
				Sediment	Liquid			
11	Pad 35B Pump Skid	15147	TS / TINT	no	yes	Water sample collected after the pump skid filter and before the filter skid.		
12	Pad 35B Filter Skid	15147	TS / TINT	yes	no	Sediment scraped from filter.		

Abbreviations:

API American Petroleum Institute
 BM Battlement Mesa
 L liter
 NA missing or not applicable
 NGSA natural gas well - angle
 P pressure
 psi pounds per square inch
 Seq. sequence
 T temperature
 TINT treatment system internal location
 TS treatment system
 WL well location

Sample Locations:

The bottom-hole locations (BHLs) of the 10 gas wells planned for sample collection are between 0.75 and 1.07 miles from the Project Rulison detonation point. All gas wells sampled are producing gas from the Williams Fork Formation at a depth near the Rulison detonation point.

A produced-water sample is collected at the well head from a tap on the common line connecting two gas-liquid separators and the accumulation tank. The produced water collected from one well separator is isolated from the other well separator by valves. Lines from each of the two separators are purged of produced water and condensate prior to sample collection.

Accumulated produced water from gas wells (including the Battlement Mesa field) is trucked or piped to skim tanks located on the injection well pad. Water from the skim tank is piped to the pump skid. The water sample was collected after the pump-skid filter. Water from the pump skid is piped to the filter skid where it is filtered for sediments before injection. The sediment sample was collected at the filter skid.

Monitoring Protocol:

The *Rulison Monitoring Plan* provides guidance regarding the type and frequency of sample collection as a function of distance and heading from the Rulison detonation point; it also specifies the types of analyses. A copy of the monitoring plan is available at <http://www.lm.doe.gov/Rulison/Documents.aspx>

Table 3a. Gas-Phase Concentrations for Tritium Sample Results

Analyte	Reporting Units	Screening Conc.	Action Conc.	Comment
Tritium	TU	19,293	TBD	5.183×10^{-6} pCi/cc/TU

Abbreviations:

pCi/cc/TU picocuries per cubic centimeter per tritium unit
 TBD to be determined
 TU tritium unit

Table 3b. Liquid-Phase Concentrations for Tritium and Various Analytical Method Results

Analyte	Reporting Units	Screening Concentration	Action Concentration	Comment
Tritium	pCi/L	800	TBD	20,000 pCi/L = EPA drinking water standard
Lab Method				
Gross alpha	pCi/L	3 x background	TBD	
Gross beta	pCi/L	3 x background	TBD	
High-resolution gamma spectroscopy	pCi/L	20	TBD	Based on cesium-137

Notes:

See the *Rulison Monitoring Plan*, Table 2, for response scenarios to use when the screening and/or action concentrations are exceeded.
 The derived air effluent concentration for a 50 millirems per year (mrem/year) dose from tritium exposure is 0.10 pCi (tritium) /cc (methane).

Abbreviations:

pCi/L picocuries per liter
 TBD to be determined

Results:

One water sample was collected from each of eight gas wells. One water sample and one sediment sample were collected at the injection well location.

All analytic results are listed in Appendix A, “Liquid-Phase Sample Results” and Appendix B, “Injection Pad Sample Results.”

Laboratory Qualifiers:

A “detect” is a laboratory result greater than the laboratory’s reporting threshold or minimum detectable concentration (MDC).

A “nondetect” is a laboratory result that is less than the laboratory’s MDC for that sample. The laboratory qualifies a “nondetect” with a “U.”

Data Validation Qualifiers:

A “detect” result that is less than 3 times the sample MDC is assigned the data qualifier “J.”

A laboratory result less than three times the one-sigma total propagated uncertainty is considered a “nondetect” and assigned the data qualifier “U.” Three times the one-sigma propagated uncertainty is called the Decision Level Concentration.

Results Summaries:

Summary results for liquid-phase tritium are in Table 4a. Liquid-phase results for gross alpha/beta are summarized in Table 4b, and potassium-40 results are shown in Table 4c. Sample volumes not adequate for laboratory analysis are counted as not applicable (NA).

Table 4a. Summary of Tritium Samples, Based on Laboratory Assigned Qualifiers

Collection Location	Total Liquid Samples	Tritium Results (Liquid Phase)		
		Detect	Nondetect	NA
Natural gas wells	8	0	8	0

Abbreviation:

NA Missing or not applicable

Table 4b. Summary of Gross Alpha/Beta Liquid-Phase Samples, Based on Laboratory Assigned Qualifiers

Collection Location	Total Liquid Samples	Gross Alpha Results			Gross Beta Results		
		Detect	Nondetect	NA	Detect	Nondetect	NA
Natural gas wells	8	5	3	0	8	0	0

Abbreviation:

NA Missing or not applicable

Table 4c. Summary of Potassium-40 Liquid-Phase Samples, Based on Laboratory Assigned Qualifiers

Collection Location	Total Samples	Potassium-40 Results		
		Detect	Nondetect	NA
Natural gas wells	8	3	5	0

Abbreviation:

NA Missing or not applicable

In Table 4b, the laboratory reported 5 of the gross-alpha results as “detect”; data validation qualified these results as one “U” and four “J”. Four of the eight gross-beta “detect” results were qualified as “J” by data validation.

In Table 4c, three potassium-40 “detect” results reported by the laboratory were qualified as “J” by data validation.

Table 5 summarizes the statistics for detected gross-alpha and gross-beta results. Backgrounds for gross alpha or gross beta have not been established.

Table 5. Statistics for Detected Gross-Alpha and Gross Beta Results

Counting Statistic	Gross Alpha	Gross Beta	Units
Number of detects	5	8	NA
Maximum	81.4	284.0	pCi/L
Third quartile	59.9	217.2	pCi/L
Mean	50.9	173.7	pCi/L
Median	43.8	170.0	pCi/L
First quartile	39.1	131.0	pCi/L
Minimum	30.4	76.3	pCi/L

Abbreviations:

NA missing or not applicable

pCi/L picocuries per liter

The water and sediment samples were collected at the injection well for the purpose of a baseline. Analytic results are provided in Appendix B.

The distance and heading from the Rulison emplacement well to the BHLs of the wells planned for sample collection are listed in Table 6.

Table 6. Bottom-Hole Locations of Wells Sampled and Ground Zero

Pad	Well Name	Total Depth (ft)	Location			Rulison GZ to BHL		Comment	
			Q-Q	S	Lat (NAD 83)	Long (NAD 83)	Distance (miles)		Heading (degrees)
	25-95 (R-E)	8,701	NENW	25	39.405361	-107.948444	0		Ground zero (GZ), vertical well
26N	BM 26-33B	9,966	NWSE	26	39.406892	-107.962558	0.76	W9.5°N	
26N	BM 26-33C	10,072	NWSE	26	39.406006	-107.962544	0.76	W4.9°N	
26N	BM 26-33D	10,068	NWSE	26	39.405124	-107.962544	0.75	W0.3°N	
26N	BM 26-34A	10,087	SWSE	26	39.404311	-107.962565	0.76	S86.1°W	
26N	BM 26-34B	10,046	SWSE	26	39.403498	-107.962561	0.77	S81.9°W	
26N	BM 26-34C	9,986	SWSE	26	39.402515	-107.962576	0.78	S77.0°W	
26N	BM 26-34D	9,986	SWSE	26	39.401665	-107.964508	0.90	S75.0°W	
26K	BM 26-22B	10,094	SENW	26	39.410530	-107.967228	1.07	W21.1°N	
26K	BM 26-22C	10,047	SENW	26	39.409618	-107.967223	1.05	W17.8°N	
26K	BM 26-22D	10,057	SENW	26	39.408687	-107.967163	1.03	W14.6°N	
35B	Parachute Ranch Federal 35-31C inj	5725-5790 5982-6026 (see comment)	NWNE	35	39.398778	-108.073042	NA	NA	Permitted injection well – Cozzette and Corcoran formations respectively.

Abbreviations:

GZ ground zero
 Lat latitude
 Long longitude
 NAD 83 North American Datum of 1983
 Q-Q quarter-quarter section
 S Section

Appendix A
Liquid-Phase Sample Results

RESULTS REPORT
RIN: 12034421
Site: Rulison Site
Location: BM 26-22B
Ticket Number: KEQ 150
Report Date: 5/24/2012

Parameter	Units	Sample Date	ID	Result	TPU ¹	Lab	Qualifiers Data	QA
Actinium-228	pCi/L	03/23/2012	N001	23.6	11.1		U	#
Americium-241	pCi/L	03/23/2012	N001	-0.474	3.5	U		#
Antimony-125	pCi/L	03/23/2012	N001	6.03	6.74	U		#
Cerium-144	pCi/L	03/23/2012	N001	-4.88	11.6	U		#
Cesium-134	pCi/L	03/23/2012	N001	-3.92	3.16	U		#
Cesium-137	pCi/L	03/23/2012	N001	-0.438	3.05	U		#
Chloride	mg/L	03/23/2012	N001	8900				#
Cobalt-60	pCi/L	03/23/2012	N001	-3.05	3.63	U		#
Europium-152	pCi/L	03/23/2012	N001	-12.5	17.4	U		#
Europium-154	pCi/L	03/23/2012	N001	7.19	18.8	U		#
Europium-155	pCi/L	03/23/2012	N001	1.6	5.64	U		#
Gross Alpha	pCi/L	03/23/2012	N001	43.8	25.9		J	#
Gross Beta	pCi/L	03/23/2012	N001	76.3	34.1		J	#
Lead-212	pCi/L	03/23/2012	N001	-1.06	6.55	U		#
Potassium-40	pCi/L	03/23/2012	N001	54.2	71.1	U		#
Promethium-144	pCi/L	03/23/2012	N001	-0.56	3.32	U		#
Promethium-146	pCi/L	03/23/2012	N001	-0.554	3.5	U		#
Ruthenium-106	pCi/L	03/23/2012	N001	2.93	28.7	U		#
Thorium-234	pCi/L	03/23/2012	N001	29.1	46.9	U		#
Tritium	pCi/L	03/23/2012	N001	-275	180	U		#
Uranium-235	pCi/L	03/23/2012	N001	1.01	18.9	U		#
Uranium-238	pCi/L	03/23/2012	N001	29.1	46.9	U		#
Yttrium-88	pCi/L	03/23/2012	N001	1.33	5.6	U		#

RESULTS REPORT
RIN: 12034421
Site: Rulison Site
Location: BM 26-22C
Ticket Number: KEQ 151
Report Date: 5/24/2012

Parameter	Units	Sample		Result	TPU ¹	Qualifiers	
		Date	ID			Lab	Data
Actinium-228	pCi/L	03/23/2012	N001	21.9	12.8	U	#
Americium-241	pCi/L	03/23/2012	N001	6.03	5.19	U	#
Antimony-125	pCi/L	03/23/2012	N001	-5.55	8.95	U	#
Cerium-144	pCi/L	03/23/2012	N001	0.498	14.7	U	#
Cesium-134	pCi/L	03/23/2012	N001	-3.62	4.11	U	#
Cesium-137	pCi/L	03/23/2012	N001	3.27	3.77	U	#
Chloride	mg/L	03/23/2012	N001	12000			#
Cobalt-60	pCi/L	03/23/2012	N001	0.899	4.15	U	#
Europium-152	pCi/L	03/23/2012	N001	7.57	22.7	U	#
Europium-154	pCi/L	03/23/2012	N001	-4.07	22.2	U	#
Europium-155	pCi/L	03/23/2012	N001	-0.95	7.43	U	#
Gross Alpha	pCi/L	03/23/2012	N001	81.4	38.6		J #
Gross Beta	pCi/L	03/23/2012	N001	221	57.8		#
Lead-212	pCi/L	03/23/2012	N001	6.3	7.7	U	#
Potassium-40	pCi/L	03/23/2012	N001	165	94.2		J #
Promethium-144	pCi/L	03/23/2012	N001	4.2	3.95	U	#
Promethium-146	pCi/L	03/23/2012	N001	3.52	4.19	U	#
Ruthenium-106	pCi/L	03/23/2012	N001	-23.5	34.5	U	#
Thorium-234	pCi/L	03/23/2012	N001	5.61	52.3	U	#
Tritium	pCi/L	03/23/2012	N001	-268	182	U	#
Uranium-235	pCi/L	03/23/2012	N001	-32.5	17.6	U	#
Uranium-238	pCi/L	03/23/2012	N001	5.61	52.3	U	#
Yttrium-88	pCi/L	03/23/2012	N001	1.55	4.43	U	#

RESULTS REPORT
RIN: 12034421
Site: Rulison Site
Location: BM 26-22D
Ticket Number: KEQ 152
Report Date: 5/24/2012

Parameter	Units	Sample		Result	TPU ¹	Qualifiers	
		Date	ID			Lab	Data
Actinium-228	pCi/L	03/23/2012	N001	33.7	26.1	U	#
Americium-241	pCi/L	03/23/2012	N001	7.86	19.4	U	#
Antimony-125	pCi/L	03/23/2012	N001	3.65	7.95	U	#
Cerium-144	pCi/L	03/23/2012	N001	-9.18	15	U	#
Cesium-134	pCi/L	03/23/2012	N001	-2.38	3.68	U	#
Cesium-137	pCi/L	03/23/2012	N001	-2.7	3.49	U	#
Chloride	mg/L	03/23/2012	N001	14000			#
Cobalt-60	pCi/L	03/23/2012	N001	-2.02	4.1	U	#
Europium-152	pCi/L	03/23/2012	N001	4.95	17.2	U	#
Europium-154	pCi/L	03/23/2012	N001	-3.29	18.8	U	#
Europium-155	pCi/L	03/23/2012	N001	5.73	9.01	U	#
Gross Alpha	pCi/L	03/23/2012	N001	32.1	33.3	U	#
Gross Beta	pCi/L	03/23/2012	N001	284	64.1		#
Lead-212	pCi/L	03/23/2012	N001	6.34	8.37	U	#
Potassium-40	pCi/L	03/23/2012	N001	196	87.9		J #
Promethium-144	pCi/L	03/23/2012	N001	2.36	3.92	U	#
Promethium-146	pCi/L	03/23/2012	N001	-0.227	4.17	U	#
Ruthenium-106	pCi/L	03/23/2012	N001	2.72	33	U	#
Thorium-234	pCi/L	03/23/2012	N001	31.3	84.8	U	#
Tritium	pCi/L	03/23/2012	N001	-98.1	181	U	#
Uranium-235	pCi/L	03/23/2012	N001	24.6	15.8	U	#
Uranium-238	pCi/L	03/23/2012	N001	31.3	84.8	U	#
Yttrium-88	pCi/L	03/23/2012	N001	-2.88	8.22	U	#

RESULTS REPORT
RIN: 12034421
Site: Rulison Site
Location: BM 26-33B
Ticket Number: KEQ 143
Report Date: 5/24/2012

Parameter	Units	Sample		Result	TPU ¹	Qualifiers		
		Date	ID			Lab	Data	QA
Actinium-228	pCi/L	03/23/2012	N001	35.8	16.3	TI	U	#
Americium-241	pCi/L	03/23/2012	N001	-6.18	37.6	U		#
Antimony-125	pCi/L	03/23/2012	N001	3.29	10.3	U		#
Cerium-144	pCi/L	03/23/2012	N001	-10.7	17.5	U		#
Cesium-134	pCi/L	03/23/2012	N001	-1.67	4.07	U		#
Cesium-137	pCi/L	03/23/2012	N001	-0.12	4.07	U		#
Chloride	mg/L	03/23/2012	N001	9300				#
Cobalt-60	pCi/L	03/23/2012	N001	0.341	4.01	U		#
Europium-152	pCi/L	03/23/2012	N001	9.71	21.6	U		#
Europium-154	pCi/L	03/23/2012	N001	15	22.2	U		#
Europium-155	pCi/L	03/23/2012	N001	5.34	10.7	U		#
Gross Alpha	pCi/L	03/23/2012	N001	30.4	20		U	#
Gross Beta	pCi/L	03/23/2012	N001	136	43.6		J	#
Lead-212	pCi/L	03/23/2012	N001	8.55	9.8	U		#
Potassium-40	pCi/L	03/23/2012	N001	109	107	U		#
Promethium-144	pCi/L	03/23/2012	N001	4.48	4.46	U		#
Promethium-146	pCi/L	03/23/2012	N001	-0.685	4.79	U		#
Ruthenium-106	pCi/L	03/23/2012	N001	4.03	36.9	U		#
Thorium-234	pCi/L	03/23/2012	N001	91.4	56.5		J	#
Tritium	pCi/L	03/23/2012	N001	-105	184	U		#
Uranium-235	pCi/L	03/23/2012	N001	12.9	17.5	U		#
Uranium-238	pCi/L	03/23/2012	N001	91.4	56.5		J	#
Yttrium-88	pCi/L	03/23/2012	N001	1.09	4	U		#

RESULTS REPORT
RIN: 12034421
Site: Rulison Site
Location: BM 26-33C
Ticket Number: KEQ 144
Report Date: 5/24/2012

Parameter	Units	Sample		Result	TPU ¹	Qualifiers	
		Date	ID			Lab	Data
Actinium-228	pCi/L	03/23/2012	N001	16.3	18	U	#
Americium-241	pCi/L	03/23/2012	N001	-39.6	57.9	U	#
Antimony-125	pCi/L	03/23/2012	N001	7.54	5.77	U	#
Cerium-144	pCi/L	03/23/2012	N001	-6.69	13.3	U	#
Cesium-134	pCi/L	03/23/2012	N001	-0.367	2.43	U	#
Cesium-137	pCi/L	03/23/2012	N001	-2.46	2.32	U	#
Chloride	mg/L	03/23/2012	N001	11000			#
Cobalt-60	pCi/L	03/23/2012	N001	-2.42	2.39	U	#
Europium-152	pCi/L	03/23/2012	N001	-6.95	11.9	U	#
Europium-154	pCi/L	03/23/2012	N001	-1.18	12.7	U	#
Europium-155	pCi/L	03/23/2012	N001	2.54	8.88	U	#
Gross Alpha	pCi/L	03/23/2012	N001	39.5	26.8	U	#
Gross Beta	pCi/L	03/23/2012	N001	186	45.6		#
Lead-212	pCi/L	03/23/2012	N001	0.773	9.18	U	#
Potassium-40	pCi/L	03/23/2012	N001	131	75.4		J #
Promethium-144	pCi/L	03/23/2012	N001	0.531	2.33	U	#
Promethium-146	pCi/L	03/23/2012	N001	0.592	2.57	U	#
Ruthenium-106	pCi/L	03/23/2012	N001	15.1	21	U	#
Thorium-234	pCi/L	03/23/2012	N001	31.6	115	U	#
Tritium	pCi/L	03/23/2012	N001	-253	178	U	#
Uranium-235	pCi/L	03/23/2012	N001	8.72	12.9	U	#
Uranium-238	pCi/L	03/23/2012	N001	31.6	115	U	#
Yttrium-88	pCi/L	03/23/2012	N001	2.8	2.51	U	#

RESULTS REPORT
RIN: 12034421
Site: Rulison Site
Location: BM 26-34B
Ticket Number: KEQ 147
Report Date: 5/24/2012

Parameter	Units	Sample		Result	TPU ¹	Qualifiers	
		Date	ID			Lab	Data
Actinium-228	pCi/L	03/23/2012	N001	15.5	28.1	U	#
Americium-241	pCi/L	03/23/2012	N001	-5.86	29.8	U	#
Antimony-125	pCi/L	03/23/2012	N001	5.34	9.52	U	#
Cerium-144	pCi/L	03/23/2012	N001	-5.46	17.9	U	#
Cesium-134	pCi/L	03/23/2012	N001	1.01	4.55	U	#
Cesium-137	pCi/L	03/23/2012	N001	1.02	4.02	U	#
Chloride	mg/L	03/23/2012	N001	11000			#
Cobalt-60	pCi/L	03/23/2012	N001	3.11	5.13	U	#
Europium-152	pCi/L	03/23/2012	N001	16	23.6	U	#
Europium-154	pCi/L	03/23/2012	N001	-0.613	24.8	U	#
Europium-155	pCi/L	03/23/2012	N001	5.08	11.5	U	#
Gross Alpha	pCi/L	03/23/2012	N001	-1.52	21.9	U	#
Gross Beta	pCi/L	03/23/2012	N001	116	36.5		J #
Lead-212	pCi/L	03/23/2012	N001	0.897	9.54	U	#
Potassium-40	pCi/L	03/23/2012	N001	5.42	88.2	U	#
Promethium-144	pCi/L	03/23/2012	N001	5.04	4.59	U	#
Promethium-146	pCi/L	03/23/2012	N001	-3.11	4.75	U	#
Ruthenium-106	pCi/L	03/23/2012	N001	-32.1	40.2	U	#
Thorium-234	pCi/L	03/23/2012	N001	-54.5	113	U	#
Tritium	pCi/L	03/23/2012	N001	-112	182	U	#
Uranium-235	pCi/L	03/23/2012	N001	2.16	28.1	U	#
Uranium-238	pCi/L	03/23/2012	N001	-54.5	113	U	#
Yttrium-88	pCi/L	03/23/2012	N001	3.59	2.87	U	#

RESULTS REPORT
RIN: 12034421
Site: Rulison Site
Location: BM 26-34C
Ticket Number: KEQ 148
Report Date: 5/24/2012

Parameter	Units	Sample		Result	TPU ¹	Qualifiers	
		Date	ID			Lab	Data
Actinium-228	pCi/L	03/23/2012	N001	2.07	28.2	U	#
Americium-241	pCi/L	03/23/2012	N001	5.72	20.2	U	#
Antimony-125	pCi/L	03/23/2012	N001	-3.58	9.88	U	#
Cerium-144	pCi/L	03/23/2012	N001	-8.96	18	U	#
Cesium-134	pCi/L	03/23/2012	N001	0.319	4.38	U	#
Cesium-137	pCi/L	03/23/2012	N001	2.75	4.55	U	#
Chloride	mg/L	03/23/2012	N001	10000			#
Cobalt-60	pCi/L	03/23/2012	N001	-1.71	5.01	U	#
Europium-152	pCi/L	03/23/2012	N001	4.86	25.4	U	#
Europium-154	pCi/L	03/23/2012	N001	5.35	26.5	U	#
Europium-155	pCi/L	03/23/2012	N001	-2.59	10.4	U	#
Gross Alpha	pCi/L	03/23/2012	N001	39.1	20.4		J #
Gross Beta	pCi/L	03/23/2012	N001	216	52		J #
Lead-212	pCi/L	03/23/2012	N001	4.38	8.99	U	#
Potassium-40	pCi/L	03/23/2012	N001	135	99.4	U	#
Promethium-144	pCi/L	03/23/2012	N001	-0.239	4.85	U	#
Promethium-146	pCi/L	03/23/2012	N001	-3.73	5.16	U	#
Ruthenium-106	pCi/L	03/23/2012	N001	-3.28	40.8	U	#
Thorium-234	pCi/L	03/23/2012	N001	-71.1	90.3	U	#
Tritium	pCi/L	03/23/2012	N001	-132	330	U	#
Uranium-235	pCi/L	03/23/2012	N001	23.6	18.1	U	#
Uranium-238	pCi/L	03/23/2012	N001	-71.1	90.3	U	#
Yttrium-88	pCi/L	03/23/2012	N001	4.92	4.99	U	#

RESULTS REPORT
RIN: 12034421
Site: Rulison Site
Location: BM 26-34D
Ticket Number: KEQ 149
Report Date: 5/24/2012

Parameter	Units	Sample		Result	TPU ¹	Qualifiers	
		Date	ID			Lab	Data
Actinium-228	pCi/L	03/23/2012	N001	20.1	23.4	U	#
Americium-241	pCi/L	03/23/2012	N001	-9.36	15.5	U	#
Antimony-125	pCi/L	03/23/2012	N001	-1.36	6.33	U	#
Cerium-144	pCi/L	03/23/2012	N001	-2.28	13.3	U	#
Cesium-134	pCi/L	03/23/2012	N001	-10.7	8.06	U	#
Cesium-137	pCi/L	03/23/2012	N001	-1.22	2.68	U	#
Chloride	mg/L	03/23/2012	N001	12000			#
Cobalt-60	pCi/L	03/23/2012	N001	-1.93	2.95	U	#
Europium-152	pCi/L	03/23/2012	N001	-5.18	14.9	U	#
Europium-154	pCi/L	03/23/2012	N001	9.74	14.8	U	#
Europium-155	pCi/L	03/23/2012	N001	0	6.95	U	#
Gross Alpha	pCi/L	03/23/2012	N001	59.9	31.5		J #
Gross Beta	pCi/L	03/23/2012	N001	154	49.7		J #
Lead-212	pCi/L	03/23/2012	N001	2.97	7.59	U	#
Potassium-40	pCi/L	03/23/2012	N001	89.4	84.7	U	#
Promethium-144	pCi/L	03/23/2012	N001	-1.17	4.63	U	#
Promethium-146	pCi/L	03/23/2012	N001	1.93	3.19	U	#
Ruthenium-106	pCi/L	03/23/2012	N001	9.41	25	U	#
Thorium-234	pCi/L	03/23/2012	N001	29.5	75.6	U	#
Tritium	pCi/L	03/23/2012	N001	-206	180	U	#
Uranium-235	pCi/L	03/23/2012	N001	-2.35	13.4	U	#
Uranium-238	pCi/L	03/23/2012	N001	29.5	75.6	U	#
Yttrium-88	pCi/L	03/23/2012	N001	0.885	3.09	U	#

Appendix B
Injection-Pad Sample Results

RESULTS REPORT**RIN: 12034421****Site: Rulison Site****Location: Pad 35B Filter Skid****Ticket Number: KEQ 437****Report Date: 5/24/2012**

Parameter	Units	Sample		Result	TPU ¹	Qualifiers		
		Date	ID			Lab	Data	QA
Gross Alpha	pCi/L	03/23/2012	N001	5.59	3.5		J	#
Gross Beta	pCi/L	03/23/2012	N001	3.5	3.45	U		#

RESULTS REPORT**RIN: 12034421****Site: Rulison Site****Location: Pad 35B Pump Skid****Ticket Number: KEQ 355****Report Date: 5/24/2012**

Parameter	Units	Sample Date	ID	Result	TPU ¹	Lab	Qualifiers Data	QA
Actinium-228	pCi/L	03/23/2012	N001	4.6	19.2	U		#
Americium-241	pCi/L	03/23/2012	N001	2.48	3.24	U		#
Antimony-125	pCi/L	03/23/2012	N001	-2.77	6.56	U		#
Cerium-144	pCi/L	03/23/2012	N001	4.51	11.4	U		#
Cesium-134	pCi/L	03/23/2012	N001	-3	3.01	U		#
Cesium-137	pCi/L	03/23/2012	N001	-2.63	3.1	U		#
Chloride	mg/L	03/23/2012	N001	12000				#
Cobalt-60	pCi/L	03/23/2012	N001	0.139	3.46	U		#
Europium-152	pCi/L	03/23/2012	N001	-2.77	16.2	U		#
Europium-154	pCi/L	03/23/2012	N001	-10.2	17.4	U		#
Europium-155	pCi/L	03/23/2012	N001	4.11	5.72	U		#
Gross Alpha	pCi/L	03/23/2012	N001	47.5	38.2	U		#
Gross Beta	pCi/L	03/23/2012	N001	115	48.7		J	#
Lead-212	pCi/L	03/23/2012	N001	-3.66	6.72	U		#
Potassium-40	pCi/L	03/23/2012	N001	64.9	70.8	U		#
Promethium-144	pCi/L	03/23/2012	N001	-2.65	3.17	U		#
Promethium-146	pCi/L	03/23/2012	N001	-0.18	3.49	U		#
Ruthenium-106	pCi/L	03/23/2012	N001	19.8	28.5	U		#
Thorium-234	pCi/L	03/23/2012	N001	31.4	46.1	U		#
Tritium	pCi/L	03/23/2012	N001	-15.4	193	U		#
Uranium-235	pCi/L	03/23/2012	N001	15.1	12.3	U		#
Uranium-238	pCi/L	03/23/2012	N001	31.4	46.1	U		#
Yttrium-88	pCi/L	03/23/2012	N001	-2.21	5.54	U		#